IJA # 2633

University of London General Certificate of Education Overseas Exams, Physics and Chemisty, 1951-1972

Physics 1

540

UNIVERSITY OF LONDON

General Certificate of Education Examination

SUMMER 1972 **ORDINARY LEVEL**

Physics 1

Two hours

Answer FIVE questions, choosing NOT MORE THAN TWO questions from each of sections A, B and C. All questions carry equal marks.

All necessary working must be shown.

Candidates are reminded of the necessity for good English and orderly presentation in their answers.

Where necessary, assume the acceleration of free fall (acceleration due to gravity), $g = 10$ *metres per second*^{2}.

PSE 71/306 8/3/3/100/R40,000

Turn over

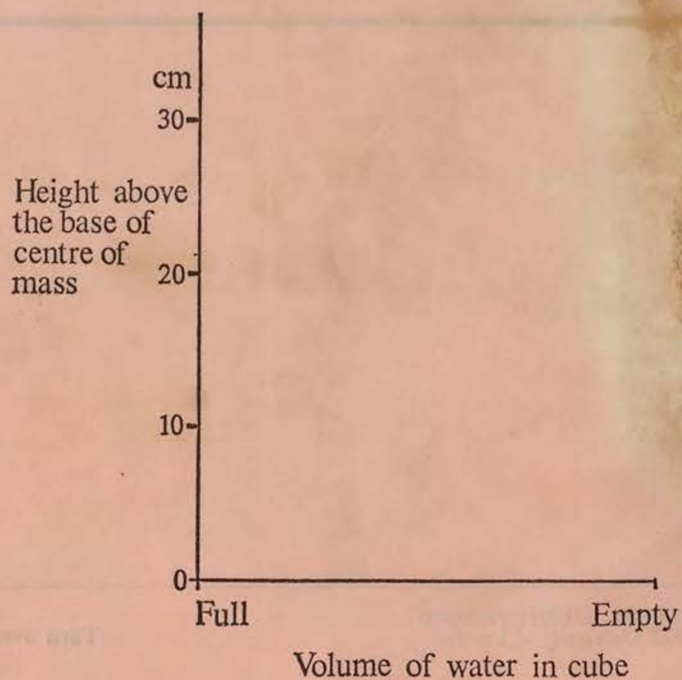
Section A

A1. (*a*) Describe carefully how you would determine experimentally the position of the centre of mass of a sheet of stiff cardboard of irregular shape and explain the theory upon which your method depends. How would you check that you had located the centre of mass successfully?

(*b*) A hollow metal cube of side 30 centimetres has a closely fitting flat metal lid. Both the cube and the lid are made from the same sheet metal of uniform thickness and are of small but not negligible mass. The cube is completed filled with water, the lid replaced, and then stood on a tripod. Two small holes, one in the lid and the other in the base, are now pierced in the cube and water begins to drip steadily from the base of the cube.

(i) Explain why two holes are necessary if the water is to drip freely from the base of the cube.

(ii) Copy the diagram below into your answer book and on it sketch the approximate form of the graph obtained on plotting the height above the base of the centre of mass of the cube and its contents against the volume of water in the cube.

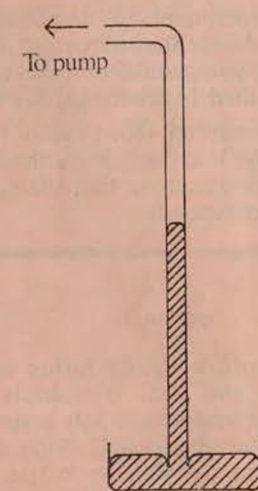


A2. State what is meant by *pressure* and explain how a gas produces a pressure on the walls of a vessel which contains it. Describe how you would use a U-tube, containing a suitable *named* liquid, to determine the excess pressure of the gas supply in a school laboratory.

State the additional information required and show how it would be used in order to express this excess pressure in *newtons per square metre*.

The lower end of a long vertical glass tube dips into a dish of clean dry mercury which is open to the atmosphere whilst the other end of the tube is connected to a vacuum pump. When the pump is operated the mercury rises in the tube. Explain why this is so.

State the factors which will affect the maximum height to which the mercury will rise above the level in the dish when the pump is operated for some time. You may assume that there is sufficient mercury in the dish for the lower end of the tube to remain immersed throughout the experiment.



A3. A wooden block rests on a rigid, uniformly rough plank which can be inclined to the horizontal by raising one of its ends. When the plank is inclined at a certain angle it is found that the block will slide down the plank with a constant velocity after being given a gentle tap.

Name the forces which act on the block as it slides down the plank after it is tapped and explain

(*a*) why the block does not accelerate,

(*b*) why the block will not move unless given a gentle tap.

State the energy changes which occur as the block slides down the plank.

Describe in detail how you would show experimentally that the block was in fact moving down the plank at constant velocity and how you could determine the value of this velocity.

A4. (*a*) Distinguish between a *longitudinal* and a *transverse* wave and name one example of each.

(*b*) Describe an experiment to demonstrate *interference*, showing or stating clearly the sources of the waves involved and the result that you would observe or detect. Explain how the result obtained is accounted for by interference.

(*c*) A tuning fork is marked 480. Explain what this marking means. Calculate the wavelength of the note it will emit when sounding in air assuming the velocity of sound in air to be 340 metres per second.

Section B

B5. (*a*) A glass bottle with a tightly fitting screw cap is filled with water at 0 °C and then completely immersed in a beaker of crushed ice and water. Salt is sprinkled on the ice to lower its temperature below 0 °C. After a few minutes, the bottle cracks. Explain (i) why the bottle has cracked and (ii) why it was necessary to lower the temperature of the ice below 0 °C.

(*b*) Describe an experiment in which a *measured* amount of mechanical energy is transformed into a *measured* quantity of heat. Give a good description, or a well-labelled diagram, of your apparatus and show clearly how the mechanical work done and the heat produced are both measured. Explain clearly what steps are taken to minimise the heat lost during the operation.

B6. Explain each of the following:

(*a*) A boy finds it easy to slide across the surface of a frozen pond when he is wearing ice skates but not so easy when he removes his skates and tries to slide on the soles of his shoes.

(*b*) It is sometimes difficult to unscrew a metal cap from a glass bottle when it is first removed from a refrigerator which is at about 3 °C but becomes quite easy once the bottle has been standing in the warm air for a little while.

(*c*) A black metal buckle feels warmer than the white shiny plastic belt to which it is attached when both are exposed to the hot sun.

(*d*) Glass wool (or fibre glass) is a good material for insulating the roof of a house.

B7. Describe an experiment to obtain a series of corresponding angles of incidence and reflection for rays of light reflected from the surface of a plane mirror. Indicate the relationship between these pairs of angles.

When a plane mirror is made of thick glass silvered on the back surface, it is found that an incident ray and the corresponding reflected ray do not meet at either surface of the glass. Explain with the aid of a diagram why this is so.

A lamp is placed in front of a thick glass mirror held vertically. Draw a diagram showing how more than one image of the lamp may be seen when viewed from one side.

B8. Describe how you would test by experiment that, for a converging lens,

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f},$$

where u and v are the distances of the object and its image respectively from the lens and f has a fixed value.

Having determined the value of the constant f, how would you then check that this value was the distance from the lens to its principal focus?

How does the eye accommodate in order to produce on the retina a sharp image of a near or of a distant object? Explain the use of *either* a converging lens *or* a diverging lens to correct a common named defect of the human eye.

Turn over

Section C

C9. Describe the structure of a simple cell. Name two defects of the simple cell and describe how these have been reduced in the construction of a modern dry cell.

Draw a diagram to show the structure of a dry cell.

State

(*a*) why a dry cell is unable to maintain *large* currents for long periods of time,

(*b*) two advantages that a secondary cell or accumulator possesses over a dry cell,

(*c*) the source of the electrical energy which a dry cell provides,

(*d*) how the electricity passes through the electrolyte of a simple cell.

C10. Describe a simple experiment to demonstrate that a mechanical force acts on a conductor when carrying a current in a magnetic field. Draw a diagram of the arrangement of the apparatus used and show the direction of the force in relation to the directions of the current and field.

Explain why the coil of a galvanometer or ammeter of the moving coil type experiences a turning force for a given current and why the coil comes to rest indicating a fixed deflection as long as there is a steady current.

A moving coil galvanometer gives a full scale deflection for a current of 5 mA (0·005 ampere) passing through it or for a potential difference of 0·1 volt applied across it. It may be adapted to measure *either* currents up to a full scale maximum of 1·00 ampere *or* potential differences up to 10·0 volts. Describe and explain how *one* of these adaptations can be made, and calculate the value of the required resistance for the adaptation you choose.

C11. Describe how you can demonstrate by experiment the conversion of mechanical energy into electrical energy by electromagnetic induction and the variations you would make to test any two of the factors on which the magnitude of the induced e.m.f. depends.

Draw a labelled diagram of a transformer suitable for transforming from 240 volts a.c. to 12 volts a.c. Give details of the materials used in its structure and reasons for their choice.

Explain what is meant by the statement that the efficiency of a transformer is less than 100% and give one reason why this must be so.

C12. (*a*) Describe the basic *differences* between a diode and a cathode ray tube (i) in structure, and (ii) in the *manner* in which each is used.

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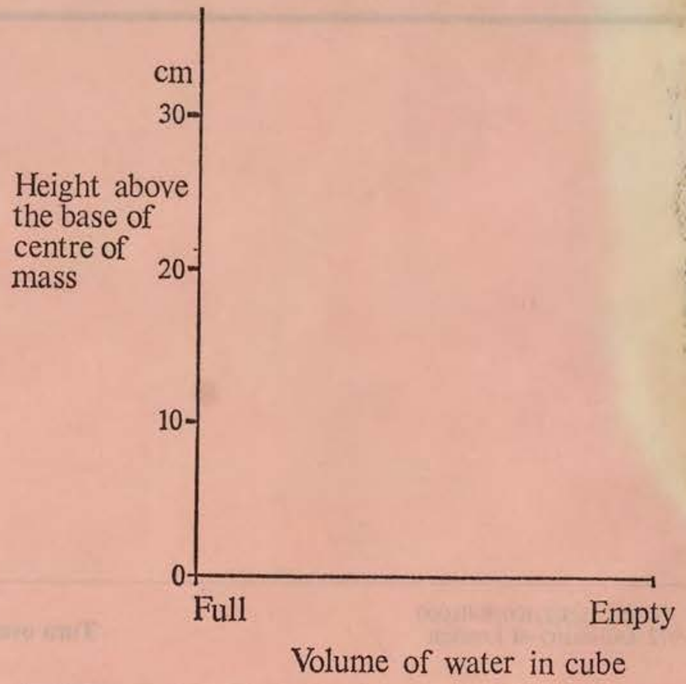

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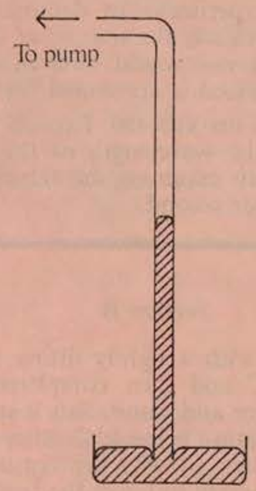

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Physics

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$$\pi = \frac{22}{7}.$$

TSE 70/1657 9/3/3/100/39765

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Section A

1. (*a*) Describe how you would measure, by experiment, the accelerations produced by the same constant force when applied, in turn, to two freely-moving trolleys one of which has exactly twice the mass of the other. You may assume that the acceleration, in each instance, is constant, but you should describe how the necessary measurements are made and how they are used in your determinations.

State and account for the relationship you would expect to obtain between these two accelerations.

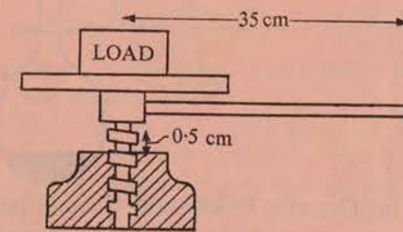
(*b*) A pump is used to spray water from a pool to form a fountain. Determine the minimum power of the pump if it ejects 45 litres per minute and the spray reaches an average vertical height of 4 metres. You may assume that 1 litre of water has a mass of 1 kg and that $g = 1000$ centimetres per second^2 or 10 metres per second^2.

Give *one* reason why the water, after returning to the pool, might have a different temperature from that which left the pump.

---

2. (*a*) Describe how you would determine experimentally the position of the centre of mass [centre of gravity] of a thin sheet of material of irregular shape and uniform thickness.

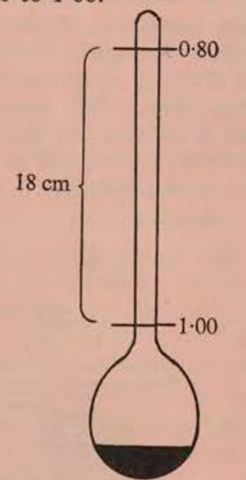
When the bunsen burner, as shown below, stands on its base it can be tilted through a fairly large angle before it topples over, but if stood on its barrel, with its base uppermost, a small displacement will cause it to topple. Explain these observations as fully as you can. Why, with the bunsen burner standing on its barrel, will it topple more easily in some directions than in others?



(*b*) The handle of the screw jack shown above is 35 cm long and the pitch of the screw is 0·5 cm. What force must be applied at the end of the handle when lifting a load of 220 kilogrammes force (2200 N) if the efficiency of the jack is 40% [0·4]?

Turn over

3. The diagram shows one form of common hydrometer used to measure the relative densities [specific gravities] of liquids over the range 0·80 to 1·00.



(*a*) Describe briefly how it could be used

(i) to check that the relative density of paraffin is 0·80 [You should include two precautions that would make the check reliable],

(ii) to test Archimedes' principle as applied to a floating body.

(*b*) If the area of cross-section of the stem is 0·50 cm^2 and the distance between the 0·80 and 1·00 divisions is 18 cm determine

(iii) the volume of the hydrometer below the 1·00 graduation,

(iv) the position of the 0·90 graduation.

[You may assume density of water = 1·00 gramme per $centimetre^3$.]

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4. (*a*) Describe the apparatus required and how it would be set up in order to observe Brownian motion in *either* a liquid *or* a gas. [A diagram may be given but is not essential.]

Describe briefly what is observed and explain what causes the observed motion.

(*b*) Two point sources, placed fairly close to each other, emit waves of the same frequency. Draw a diagram to show the resulting pattern of wave-fronts produced by the sources. On your diagram mark several points where maximum interference occurs and explain why the interference is a maximum at these points.

Section B

5. (*a*) Describe an experiment to obtain a cooling curve for naphthalene or paraffin wax when cooling from the liquid to the solid state. Sketch the curve so obtained. Indicate the melting point of the solid and give reasons for what is observed at this temperature.

A volume change often accompanies a change of state between a solid and a liquid. Describe *one* situation in which this is *either* an advantage *or* a disadvantage.

(*b*) Explain briefly why (i) if you breathe gently on to the back of your hand, you will warm it, (ii) if you blow strongly on your hand you will cool it.

---

6. (*a*) Describe the differences in the manner in which heat is transmitted by *conduction* and *radiation*.

Describe an experiment which shows that a shiny or white surface is a poorer *absorber* of heat radiation than a dull or black surface. Give a brief explanation of one use made of this fact in everyday life.

(*b*) Describe a method of showing that heat radiation is to be found spread over an infra-red region in the spectrum of electromagnetic radiation from the sun.

How does the action of a greenhouse depend on the difference in behaviour between longer and shorter wavelengths of infra-red radiation?

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7. Describe an experiment you would perform in order to obtain a series of corresponding angles of incidence and refraction for rays of light passing from air into a transparent substance such as glass or perspex. Mention any special precautions taken to ensure accuracy and indicate how you would use your readings to evaluate the refractive index of the material relative to air.

State the conditions for total internal reflection to take place at the surface separating two media. Draw a diagram of an arrangement which uses the phenomenon to deviate, through 90°, a ray of light in air.

Show clearly how the conditions for total internal reflection have been satisfied in the example chosen and state why the ray is deviated through exactly 90°.

---

8. (*a*) Explain, or show by a diagram, what is meant by the *principal focus* and the *focal length* of a converging lens.

Determine, graphically or otherwise, how far an object must be placed in front of a converging lens of focal length 10 cm in order to produce an erect [upright] image of linear magnification 4.

(*b*) Describe how you could demonstrate that white light is composed of a number of colours.

Explain:

(i) the appearance of a red scarf with blue stripes in daylight when the scarf is viewed through a red filter or a sheet of red glass,

(ii) why blue and yellow paints [pigments], when mixed, produce a shade of green.

Section C

9. (*a*) Describe and explain how you would use a negatively charged leaf electroscope to show that the charge acquired by a dry glass rod when it is rubbed with silk is positive. You must state what you would observe during the test and draw diagrams to explain how your observations are linked with the movement of charge [or electrons] on the cap and leaf of the electroscope.

(*b*) Describe, with the aid of a diagram, the structure of an electromagnet and state clearly those features of its design and use which affect its attractive force.

Explain, with the aid of a diagram, the action of an electric bell.

---

10. (*a*) Why is a fuse often included in an electrical circuit? Describe, as fully as you can, the principles upon which the action of a fuse depends.

(*b*) Four identical cells, each of e.m.f. 1·5 volts and possessing internal resistance, are connected so as to form a battery of e.m.f. 6·0 volts. The battery is then joined in series with an ammeter of negligible resistance and a coil of fixed resistance 12 ohms. The ammeter then reads 0·3 amperes. Draw a diagram of the circuit and show clearly how the cells must be connected. Determine (i) the internal resistance of the battery and (ii) the value of the resistor which must be connected in parallel with the 12-ohm coil in order to increase the ammeter reading to 0·5 amperes.

What would a high resistance voltmeter read when connected to the terminals of the 6-volt battery in this latter case?

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11. (*a*) Describe the structure and mode of action of a *moving-coil* loudspeaker.

(*b*) A coil is rotated between the poles of a powerful horseshoe magnet so as to produce an *alternating current* in an external resistor.

Draw a diagram in each case to show how:

(i) the coil is positioned in relation to the poles of the magnet,

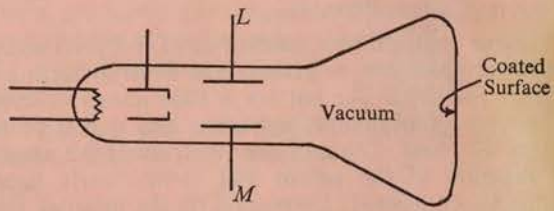
(ii) electrical contact is made between the ends of the coil and the external resistor,

(iii) the current varies with time as the coil rotates.

Describe, or show on a diagram, the position of the coil in relation to the magnetic field when the current is at a maximum and explain why this is so.

Turn over

12. (*a*)



The diagram shows a tube suitable for producing a narrow beam of electrons and accelerating them so that they pass between two horizontal plates, *L* and *M*, before striking the far end of the tube which is coated with a fluorescent material.

(i) How is a copious supply of electrons produced in the tube?

(ii) How and why are the electrons accelerated?

(iii) How can the plates *L* and *M* be used to deflect the electron beam and in what direction will it be deflected?

(iv) Describe briefly some other method of deflecting the beam and then show how the direction of the deflection is related to the method used.

(*b*) Explain the terms *radioactivity* and *half-life* as applied to a material. Describe briefly any one method of demonstrating that a material is radioactive. You must name the apparatus used in your demonstration and state clearly how the observations made lead to the conclusion that the material is radioactive.

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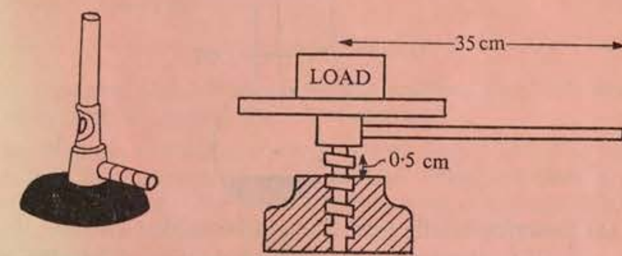

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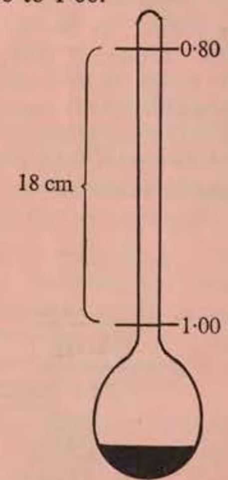

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(ii) to test Archimedes' principle as applied to a floating body.

(*b*) If the area of cross-section of the stem is 0·50 cm^2 and the distance between the 0·80 and 1·00 divisions is 18 cm determine

(iii) the volume of the hydrometer below the 1·00 graduation,

(iv) the position of the 0·90 graduation.

[You may assume density of water = 1·00 gramme per $centimetre^3$.]

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4. (*a*) Describe the apparatus required and how it would be set up in order to observe Brownian motion in *either* a liquid *or* a gas. [A diagram may be given but is not essential.]

Describe briefly what is observed and explain what causes the observed motion.

(*b*) Two point sources, placed fairly close to each other, emit waves of the same frequency. Draw a diagram to show the resulting pattern of wave-fronts produced by the sources. On your diagram mark several points where maximum interference occurs and explain why the interference is a maximum at these points.

Section B

5. (*a*) Describe an experiment to obtain a cooling curve for naphthalene or paraffin wax when cooling from the liquid to the solid state. Sketch the curve so obtained. Indicate the melting point of the solid and give reasons for what is observed at this temperature.

A volume change often accompanies a change of state between a solid and a liquid. Describe *one* situation in which this is *either* an advantage *or* a disadvantage.

(*b*) Explain briefly why (i) if you breathe gently on to the back of your hand, you will warm it, (ii) if you blow strongly on your hand you will cool it.

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6. (*a*) Describe the differences in the manner in which heat is transmitted by *conduction* and *radiation*.

Describe an experiment which shows that a shiny or white surface is a poorer *absorber* of heat radiation than a dull or black surface. Give a brief explanation of one use made of this fact in everyday life.

(*b*) Describe a method of showing that heat radiation is to be found spread over an infra-red region in the spectrum of electromagnetic radiation from the sun.

How does the action of a greenhouse depend on the difference in behaviour between longer and shorter wavelengths of infra-red radiation?

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7. Describe an experiment you would perform in order to obtain a series of corresponding angles of incidence and refraction for rays of light passing from air into a transparent substance such as glass or perspex. Mention any special precautions taken to ensure accuracy and indicate how you would use your readings to evaluate the refractive index of the material relative to air.

State the conditions for total internal reflection to take place at the surface separating two media. Draw a diagram of an arrangement which uses the phenomenon to deviate, through 90°, a ray of light in air.

Show clearly how the conditions for total internal reflection have been satisfied in the example chosen and state why the ray is deviated through exactly 90°.

Turn over

8. (*a*) Explain, or show by a diagram, what is meant by the *principal focus* and the *focal length* of a converging lens.

Determine, graphically or otherwise, how far an object must be placed in front of a converging lens of focal length 10 cm in order to produce an erect [upright] image of linear magnification 4.

(*b*) Describe how you could demonstrate that white light is composed of a number of colours.

Explain:

(i) the appearance of a red scarf with blue stripes in daylight when the scarf is viewed through a red filter or a sheet of red glass,

(ii) why blue and yellow paints [pigments], when mixed, produce a shade of green.

Section C

9. (*a*) Describe and explain how you would use a negatively charged leaf electroscope to show that the charge acquired by a dry glass rod when it is rubbed with silk is positive. You must state what you would observe during the test and draw diagrams to explain how your observations are linked with the movement of charge [or electrons] on the cap and leaf of the electroscope.

(*b*) Describe, with the aid of a diagram, the structure of an electromagnet and state clearly those features of its design and use which affect its attractive force.

Explain, with the aid of a diagram, the action of an electric bell.

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10. (*a*) Why is a fuse often included in an electrical circuit? Describe, as fully as you can, the principles upon which the action of a fuse depends.

(*b*) Four identical cells, each of e.m.f. 1·5 volts and possessing internal resistance, are connected so as to form a battery of e.m.f. 6·0 volts. The battery is then joined in series with an ammeter of negligible resistance and a coil of fixed resistance 12 ohms. The ammeter then reads 0·3 amperes. Draw a diagram of the circuit and show clearly how the cells must be connected. Determine (i) the internal resistance of the battery and (ii) the value of the resistor which must be connected in parallel with the 12-ohm coil in order to increase the ammeter reading to 0·5 amperes.

What would a high resistance voltmeter read when connected to the terminals of the 6-volt battery in this latter case?

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11. (*a*) Describe the structure and mode of action of a *moving-coil* loudspeaker.

(*b*) A coil is rotated between the poles of a powerful horseshoe magnet so as to produce an *alternating current* in an external resistor.

Draw a diagram in each case to show how:

(i) the coil is positioned in relation to the poles of the magnet,

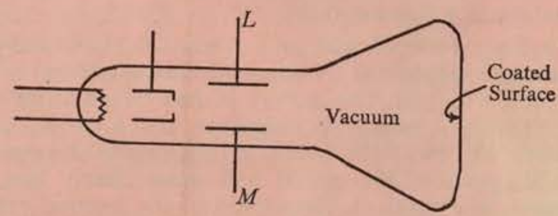
(ii) electrical contact is made between the ends of the coil and the external resistor,

(iii) the current varies with time as the coil rotates.

Describe, or show on a diagram, the position of the coil in relation to the magnetic field when the current is at a maximum and explain why this is so.

Turn over

12. (*a*)



The diagram shows a tube suitable for producing a narrow beam of electrons and accelerating them so that they pass between two horizontal plates, L and M, before striking the far end of the tube which is coated with a fluorescent material.

(i) How is a copious supply of electrons produced in the tube?

(ii) How and why are the electrons accelerated?

(iii) How can the plates L and M be used to deflect the electron beam and in what direction will it be deflected?

(iv) Describe briefly some other method of deflecting the beam and then show how the direction of the deflection is related to the method used.

(*b*) Explain the terms *radioactivity* and *half-life* as applied to a material. Describe briefly any one method of demonstrating that a material is radioactive. You must name the apparatus used in your demonstration and state clearly how the observations made lead to the conclusion that the material is radioactive.

Physics
540/1

UNIVERSITY OF LONDON

General Certificate of Education Examination

SUMMER 1971 **ORDINARY LEVEL**

Physics 1

Two hours

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The quantities quoted in round brackets are for the use of candidates who wish to work in SI units.

Where necessary, assume

$$\pi = \frac{22}{7}.$$

TSE 70/1657 9/3/3/100/39765

Turn over

Section A

1. (*a*) Describe how you would measure, by experiment, the accelerations produced by the same constant force when applied, in turn, to two freely-moving trolleys one of which has exactly twice the mass of the other. You may assume that the acceleration, in each instance, is constant, but you should describe how the necessary measurements are made and how they are used in your determinations.

State and account for the relationship you would expect to obtain between these two accelerations.

(*b*) A pump is used to spray water from a pool to form a fountain. Determine the minimum power of the pump if it ejects 45 litres per minute and the spray reaches an average vertical height of 4 metres. You may assume that 1 litre of water has a mass of 1 kg and that $g = 1000$ centimetres per second^2 or 10 metres per second^2.

Give *one* reason why the water, after returning to the pool, might have a different temperature from that which left the pump.

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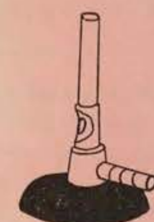
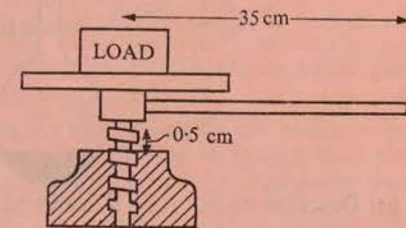
2. (*a*) Describe how you would determine experimentally the position of the centre of mass [centre of gravity] of a thin sheet of material of irregular shape and uniform thickness.

When the bunsen burner, as shown below, stands on its base it can be tilted through a fairly large angle before it topples over, but if stood on its barrel, with its base uppermost, a small displacement will cause it to topple. Explain these observations as fully as you can. Why, with the bunsen burner standing on its barrel, will it topple more easily in some directions than in others?





(*b*) The handle of the screw jack shown above is 35 cm long and the pitch of the screw is 0·5 cm. What force must be applied at the end of the handle when lifting a load of 220 kilogrammes force (2200 N) if the efficiency of the jack is 40% [0·4]?

V.R. = 2 × 22/7 × 35 / 0.5 = 20/1 × 22/7 = 440

M.A. / 440 = 40 / 100

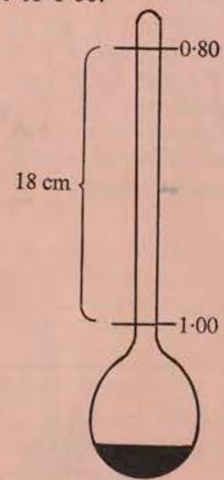
M.A. = 4 × 440 / 10 = 176

176 = 220 / effort

effort = 220 / 176 = 1.

Turn over

3. The diagram shows one form of common hydrometer used to measure the relative densities [specific gravities] of liquids over the range 0·80 to 1·00.



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4. (*a*) Describe the apparatus required and how it would be set up in order to observe Brownian motion in *either* a liquid *or* a gas. [A diagram may be given but is not essential.]

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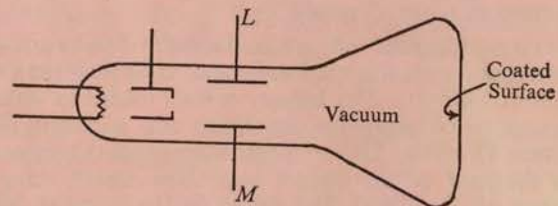

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Physics
540/1

UNIVERSITY OF LONDON

General Certificate of Education Examination

SUMMER 1971 **ORDINARY LEVEL**

Physics 1

Two hours

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TSE 70/1657 9/3/3/100/39765

Turn over

Section A

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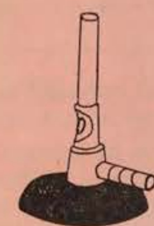

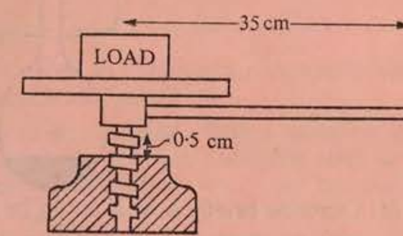

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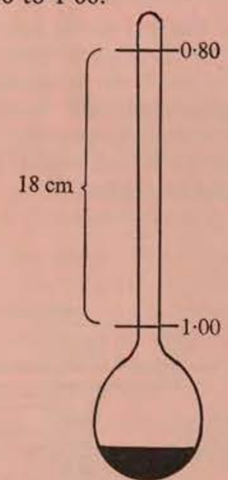

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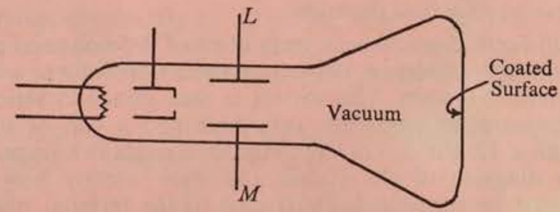

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Physics

540/1

UNIVERSITY OF LONDON

General Certificate of Education Examination

SUMMER 1971 **ORDINARY LEVEL**

Physics 1

Two hours

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TSE 70/1657 9/3/3/100/39765

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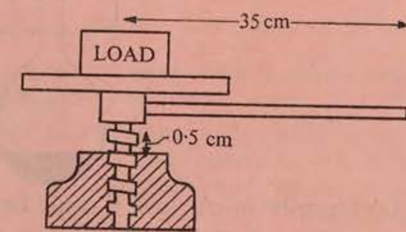

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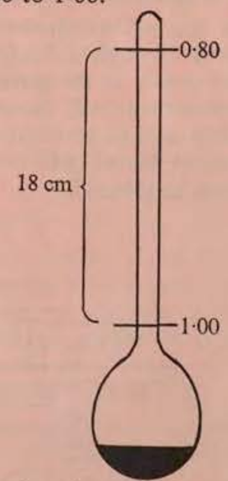

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---

4. (*a*) Describe the apparatus required and how it would be set up in order to observe Brownian motion in *either* a liquid *or* a gas. [A diagram may be given but is not essential.]

Describe briefly what is observed and explain what causes the observed motion.

(*b*) Two point sources, placed fairly close to each other, emit waves of the same frequency. Draw a diagram to show the resulting pattern of wave-fronts produced by the sources. On your diagram mark several points where maximum interference occurs and explain why the interference is a maximum at these points.

Section B

5. (*a*) Describe an experiment to obtain a cooling curve for naphthalene or paraffin wax when cooling from the liquid to the solid state. Sketch the curve so obtained. Indicate the melting point of the solid and give reasons for what is observed at this temperature.

A volume change often accompanies a change of state between a solid and a liquid. Describe *one* situation in which this is *either* an advantage *or* a disadvantage.

(*b*) Explain briefly why (i) if you breathe gently on to the back of your hand, you will warm it, (ii) if you blow strongly on your hand you will cool it.

---

6. (*a*) Describe the differences in the manner in which heat is transmitted by *conduction* and *radiation*.

Describe an experiment which shows that a shiny or white surface is a poorer *absorber* of heat radiation than a dull or black surface. Give a brief explanation of one use made of this fact in everyday life.

(*b*) Describe a method of showing that heat radiation is to be found spread over an infra-red region in the spectrum of electromagnetic radiation from the sun.

How does the action of a greenhouse depend on the difference in behaviour between longer and shorter wavelengths of infra-red radiation?

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7. Describe an experiment you would perform in order to obtain a series of corresponding angles of incidence and refraction for rays of light passing from air into a transparent substance such as glass or perspex. Mention any special precautions taken to ensure accuracy and indicate how you would use your readings to evaluate the refractive index of the material relative to air.

State the conditions for total internal reflection to take place at the surface separating two media. Draw a diagram of an arrangement which uses the phenomenon to deviate, through 90°, a ray of light in air.

Show clearly how the conditions for total internal reflection have been satisfied in the example chosen and state why the ray is deviated through exactly 90°.

Turn over

8. (*a*) Explain, or show by a diagram, what is meant by the *principal focus* and the *focal length* of a converging lens.

Determine, graphically or otherwise, how far an object must be placed in front of a converging lens of focal length 10 cm in order to produce an erect [upright] image of linear magnification 4.

(*b*) Describe how you could demonstrate that white light is composed of a number of colours.

Explain:

(i) the appearance of a red scarf with blue stripes in daylight when the scarf is viewed through a red filter or a sheet of red glass,

(ii) why blue and yellow paints [pigments], when mixed, produce a shade of green.

Section C

9. (*a*) Describe and explain how you would use a negatively charged leaf electroscope to show that the charge acquired by a dry glass rod when it is rubbed with silk is positive. You must state what you would observe during the test and draw diagrams to explain how your observations are linked with the movement of charge [or electrons] on the cap and leaf of the electroscope.

(*b*) Describe, with the aid of a diagram, the structure of an electromagnet and state clearly those features of its design and use which affect its attractive force.

Explain, with the aid of a diagram, the action of an electric bell.

---

10. (*a*) Why is a fuse often included in an electrical circuit? Describe, as fully as you can, the principles upon which the action of a fuse depends.

(*b*) Four identical cells, each of e.m.f. 1·5 volts and possessing internal resistance, are connected so as to form a battery of e.m.f. 6·0 volts. The battery is then joined in series with an ammeter of negligible resistance and a coil of fixed resistance 12 ohms. The ammeter then reads 0·3 amperes. Draw a diagram of the circuit and show clearly how the cells must be connected. Determine (i) the internal resistance of the battery and (ii) the value of the resistor which must be connected in parallel with the 12-ohm coil in order to increase the ammeter reading to 0·5 amperes.

What would a high resistance voltmeter read when connected to the terminals of the 6-volt battery in this latter case?

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11. (*a*) Describe the structure and mode of action of a *moving-coil* loudspeaker.

(*b*) A coil is rotated between the poles of a powerful horseshoe magnet so as to produce an *alternating current* in an external resistor.

Draw a diagram in each case to show how:

(i) the coil is positioned in relation to the poles of the magnet,

(ii) electrical contact is made between the ends of the coil and the external resistor,

(iii) the current varies with time as the coil rotates.

Describe, or show on a diagram, the position of the coil in relation to the magnetic field when the current is at a maximum and explain why this is so.

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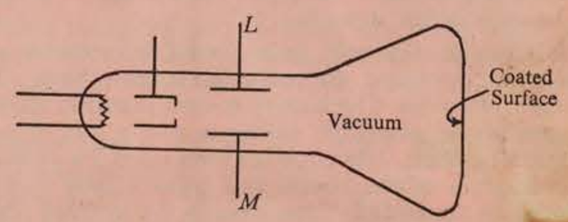
12. (*a*)



The diagram shows a tube suitable for producing a narrow beam of electrons and accelerating them so that they pass between two horizontal plates, *L* and *M*, before striking the far end of the tube which is coated with a fluorescent material.

(i) How is a copious supply of electrons produced in the tube?

(ii) How and why are the electrons accelerated?

(iii) How can the plates *L* and *M* be used to deflect the electron beam and in what direction will it be deflected?

(iv) Describe briefly some other method of deflecting the beam and then show how the direction of the deflection is related to the method used.

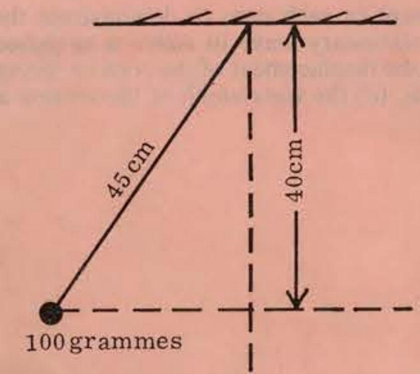
(*b*) Explain the terms *radioactivity* and *half-life* as applied to a material. Describe briefly any one method of demonstrating that a material is radioactive. You must name the apparatus used in your demonstration and state clearly how the observations made lead to the conclusion that the material is radioactive.

Part II

Section A

Answer any TWO questions in this section.

13. Describe in detail a laboratory method for determining the acceleration due to gravity. State *one* reason why the acceleration due to gravity has not the same value at all places on the earth's surface.



A small metal sphere of mass 100 grammes is suspended from a rigid support by a light string of length 45 cm. The sphere is then drawn aside, keeping the string taut, until its centre is 40 cm vertically below the supporting beam, as shown.

Determine (*a*) the increase in potential energy of the sphere in this position, (*b*) the maximum possible velocity of the sphere if it is then released from rest so that it swings in a vertical plane and (*c*) its maximum momentum.

(i) Draw a labelled diagram of a common hydrometer and explain carefully why a narrow stem leads to greater sensitivity than a wide stem.

A solid block of wood of density 0·6 gramme per cm³ weighs 306 grammes in air. Determine (*a*) the volume of the block, (*b*) the volume immersed when it floats freely in a liquid of density 0·9 gramme per cm³ and (*c*) the minimum extra vertical force required to cause the block to submerge completely in the liquid.

(ii) A body of mass 0·5 kg is projected across a uniformly rough horizontal floor with an initial velocity of 4 metres per second. It takes 2 seconds to come to rest.

Determine (*d*) the retardation (negative acceleration), assuming it to be uniform and (*e*) the change in momentum per second.

Turn over

15. (i) A test is carried out on a simple machine of velocity ratio 3 and it is found that an effort of 24 kgf (240 newtons) moves a load W which rises steadily through a vertical distance of 2 metres. If the efficiency of the machine at this load is 75% determine (*a*) the mechanical advantage, (*b*) the value of the load W and (*c*) the energy lost (wasted work) in the performance of this test.

(ii) Describe an experiment to determine how the extension of a light spring depends upon the load which it supports. Show graphically how these two quantities, extension and load, are related as the spring is gradually stretched to a point a little beyond its elastic limit.

What indication will there be, when the load is removed, that the elastic limit has been exceeded?

16. (i) Describe how you would determine the velocity of sound in air by any one method. Show clearly how the result is obtained from the readings taken.

(ii) Describe one experiment in each case to demonstrate the production of (*a*) a progressive wave and (*b*) a stationary wave in *either* a stretched elastic cord *or* a spring. Draw a diagram to show the displacement of the cord or spring in case (*b*) and indicate on it (*c*) the position of a node, (*d*) the wavelength of the motion and (*e*) its amplitude.

Section B

Answer any TWO questions in this section.

17. Explain each of the following:

(*a*) You are likely to feel colder if you stand in a breeze when wearing a wet bathing costume than if you were sheltered from the breeze.

(*b*) The inside of a greenhouse becomes much warmer than the outside during a spell of sunny weather.

(*c*) A fast moving lead pellet may melt after impact with a sheet of steel.

(*d*) A thick glass vessel is much more likely to crack than a thin one when a hot liquid is poured into it.

18. A hot liquid is contained in a closed vacuum flask.

Describe the features in the design of such a flask which enable it to keep its contents hot for a considerable time. Illustrate your answer with a labelled diagram and explain how such features reduce the loss of heat.

A vacuum flask of thermal capacity 30 cal per deg C (126 joules per deg C) contains 20 grammes of ice floating in 200 grammes of water at 0°C. Heat is supplied at a constant rate by a small immersion heater of negligible thermal capacity and it is found that it takes 5 minutes for the ice to melt and a further 32 minutes to raise the temperature of the flask and its contents to 40°C. Determine (*a*) the rate at which the heat is supplied by the heater and (*b*) the latent heat of fusion of ice (specific latent heat of ice).

[Assume that the specific heat of water is 1 cal per gramme per deg C (4·2 joule per gramme per deg C).]

19. Describe how you would attempt, by experiment, to establish a relationship between the angle which an incident ray makes with the normal to a mirror and the angle which the reflected ray makes with the same normal. Use the result to show where the image of a luminous point object or source placed a short distance in front of a plane mirror will appear to be when viewed by an eye suitably positioned.

If a white-hot filament lamp were used as the luminous point source it could emit two other radiations which are invisible to the eye but are capable of being reflected by the mirror.

Name the radiations and mention two *other* properties which both possess in common with visible light. State one method by which *one* of these radiations may be detected, indicating to which radiation you are referring.

Turn over

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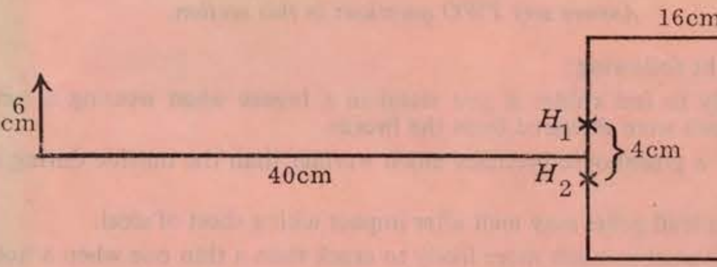

The diagram shows an illuminated arrow of length 6 cm placed 40 cm in front of a pinhole camera 16 cm in length having two small holes, H_1 and H_2, 4 cm apart.

(*a*) Make a scale diagram and draw suitable rays from the luminous arrow to show how two images are formed on the back of the box.

(*b*) Show why one large blurred image is obtained if the cardboard between the small holes were cut away to form one large circular hole of diameter 4 cm.

(*c*) Draw, separately, a ray diagram to show how a suitable converging lens, placed at 40 cm from the luminous arrow, may produce a sharp real image at a distance of 16 cm from the lens and determine the focal length required.

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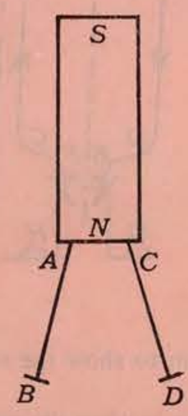
Section C

Answer any TWO questions in this section.

21.



(i) The diagram shows what is observed when two steel pins, *AB* and *CD*, hang from the north pole of a magnet, *NS*. Why is the distance *BD* greater than the distance *AC* and what does this indicate regarding the condition of *AB* and *CD*? Describe briefly how you would show that the condition stated was correct, assuming you may use normal laboratory apparatus.

(ii) Explain, briefly, the following:

(*a*) When an uncharged metal plate held by an insulating handle is brought into contact with the cap of a negatively charged leaf electroscope the divergence of the leaf is decreased.

(*b*) As the same metal plate is then brought near the cap again the leaf begins to diverge.

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22. It is required to pass a current from a battery through a solenoid so that the current can be varied from 1 A to 4 A with the aid of a rheostat.

(*a*) Draw a circuit diagram of the arrangement including a switch, or key, an ammeter to check the current reading and a voltmeter connected so that the p.d. *across the battery* may be measured.

(*b*) If the solenoid has a resistance of 1 ohm and the battery, of negligible internal resistance, has an e.m.f. of 6 V, determine the value of the rheostat resistance to give the required minimum current of 1 A.

(*c*) Explain why the initial setting of the rheostat for the maximum current of 4 A may need to be altered after a short time if the current is to be maintained constant.

(*d*) Show, or explain, which end of the solenoid will behave as a north pole while the current is flowing.

(*e*) If, while the minimum current of 1 A was flowing, the north pole of a strong magnet were plunged into the end of the solenoid which had north polarity, *explain* why the needle of the ammeter would flicker, and whether the current would momentarily increase or decrease.

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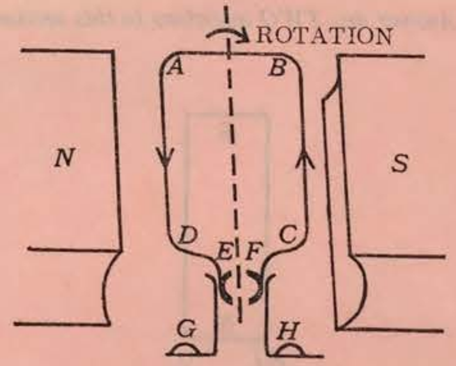

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(*a*) why the coil, *ABCD*, will rotate when the current flows in it and why it will turn in the clockwise direction shown;

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24. (i) Describe an experiment that can be carried out in a school laboratory which shows that *either* cathode rays *or* beta particles carry a negative charge. You need only indicate your source of rays or particles and the apparatus used for detection or measurement, but you should give as full a description as possible of what is done and observed and explain how you link the conclusion with the experimental observations.

(ii) The simplest model of an atom consists of electrons which are in orbit around a nucleus.

Describe the differences between the nucleus of hydrogen, mass number, 1; atomic number (proton number), 1; and

(*a*) the nucleus of helium, mass number, 4; atomic number (proton number), 2;

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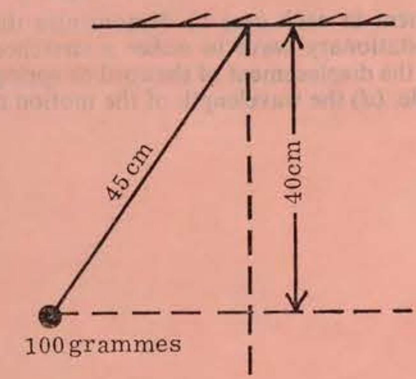

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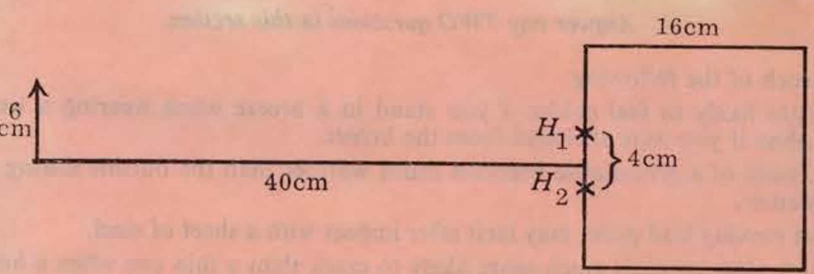

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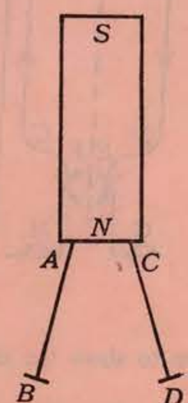

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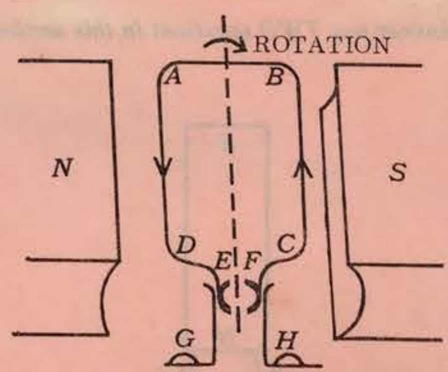

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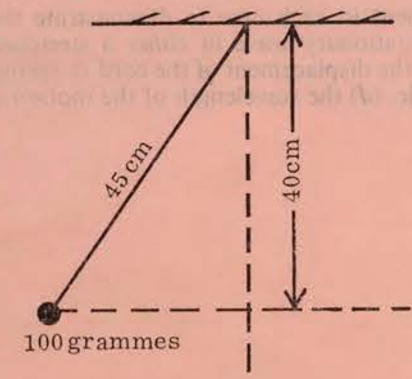

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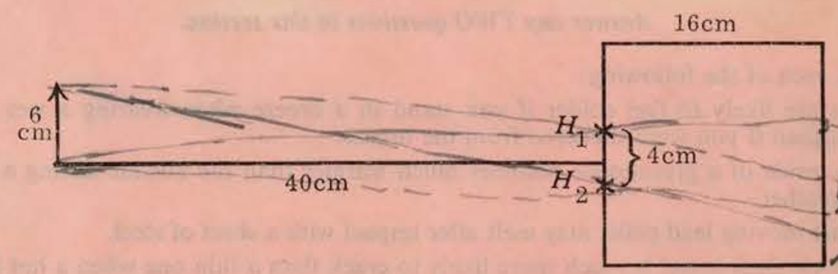

The diagram shows an illuminated arrow of length 6 cm placed 40 cm in front of a pinhole camera 16 cm in length having two small holes, H_1 and H_2, 4 cm apart.

(*a*) Make a scale diagram and draw suitable rays from the luminous arrow to show how two images are formed on the back of the box.

(*b*) Show why one large blurred image is obtained if the cardboard between the small holes were cut away to form one large circular hole of diameter 4 cm.

(*c*) Draw, separately, a ray diagram to show how a suitable converging lens, placed at 40 cm from the luminous arrow, may produce a sharp real image at a distance of 16 cm from the lens and determine the focal length required.

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Section C

Answer any TWO questions in this section.

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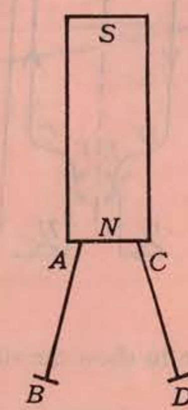

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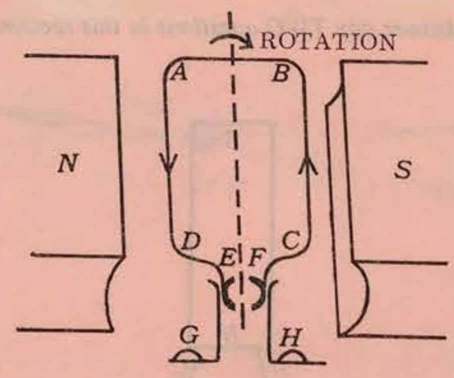
(*b*) If the solenoid has a resistance of 1 ohm and the battery, of negligible internal resistance, has an e.m.f. of 6 V, determine the value of the rheostat resistance to give the required minimum current of 1 A.

(*c*) Explain why the initial setting of the rheostat for the maximum current of 4 A may need to be altered after a short time if the current is to be maintained constant.

(*d*) Show, or explain, which end of the solenoid will behave as a north pole while the current is flowing.

(*e*) If, while the minimum current of 1 A was flowing, the north pole of a strong magnet were plunged into the end of the solenoid which had north polarity, *explain* why the needle of the ammeter would flicker, and whether the current would momentarily increase or decrease.

23. 

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(ii) The simplest model of an atom consists of electrons which are in orbit around a nucleus.

Describe the differences between the nucleus of hydrogen, mass number, 1; atomic number (proton number), 1; and

(*a*) the nucleus of helium, mass number, 4; atomic number (proton number), 2;

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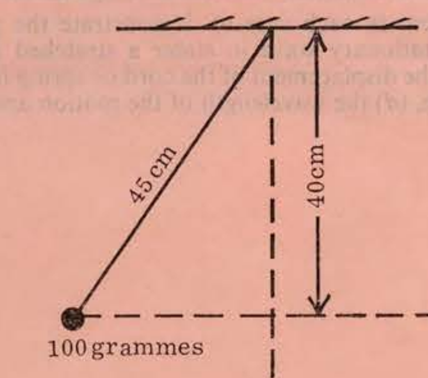
Which of these three substances are isotopes of the same element? Give a reason.

Part II

Section A

Answer any TWO questions in this section.

13. Describe in detail a laboratory method for determining the acceleration due to gravity. State *one* reason why the acceleration due to gravity has not the same value at all places on the earth's surface.



A small metal sphere of mass 100 grammes is suspended from a rigid support by a light string of length 45 cm. The sphere is then drawn aside, keeping the string taut, until its centre is 40 cm vertically below the supporting beam, as shown.

Determine (*a*) the increase in potential energy of the sphere in this position, (*b*) the maximum possible velocity of the sphere if it is then released from rest so that it swings in a vertical plane and (*c*) its maximum momentum.

14. (i) Draw a labelled diagram of a common hydrometer and explain carefully why a narrow stem leads to greater sensitivity than a wide stem.

A solid block of wood of density 0·6 gramme per cm³ weighs 306 grammes in air. Determine (*a*) the volume of the block, (*b*) the volume immersed when it floats freely in a liquid of density 0·9 gramme per cm³ and (*c*) the minimum extra vertical force required to cause the block to submerge completely in the liquid.

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15. (i) A test is carried out on a simple machine of velocity ratio 3 and it is found that an effort of 24 kgf (240 newtons) moves a load *W* which rises steadily through a vertical distance of 2 metres. If the efficiency of the machine at this load is 75% determine (*a*) the mechanical advantage, (*b*) the value of the load *W* and (*c*) the energy lost (wasted work) in the performance of this test.

(ii) Describe an experiment to determine how the extension of a light spring depends upon the load which it supports. Show graphically how these two quantities, extension and load, are related as the spring is gradually stretched to a point a little beyond its elastic limit.

What indication will there be, when the load is removed, that the elastic limit has been exceeded?

16. (i) Describe how you would determine the velocity of sound in air by any one method. Show clearly how the result is obtained from the readings taken.

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Section B

Answer any TWO questions in this section.

17. Explain each of the following:

(*a*) You are likely to feel colder if you stand in a breeze when wearing a wet bathing costume than if you were sheltered from the breeze.

(*b*) The inside of a greenhouse becomes much warmer than the outside during a spell of sunny weather.

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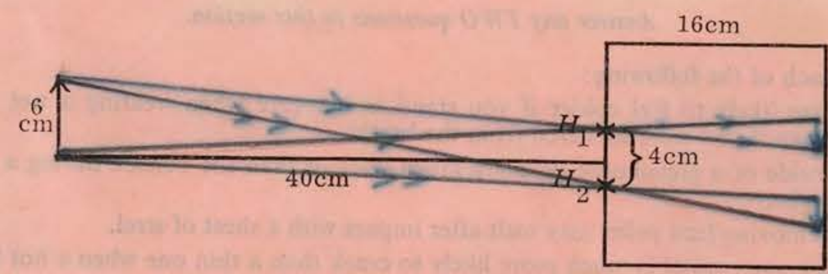

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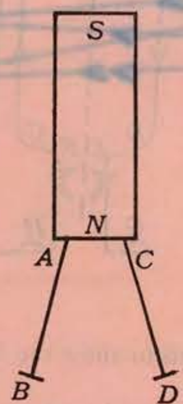

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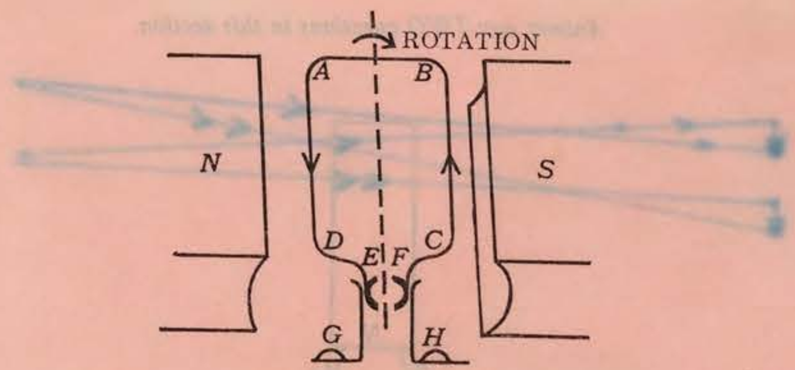

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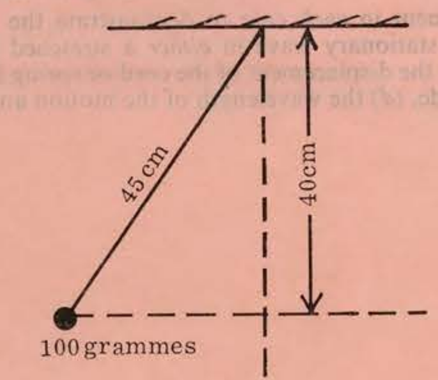

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$80 \times 20 = \frac{1600}{5} = 320$ $= 320 \times 32 = 10240 - 10000$ $= 240$

$20L + 10000$

$\frac{20}{5} = 4$

24 × 32 = 48 + 72 = 768

$L = 12$

$Q = mst = 30 \times 40 = 1200$

$20L + 220 \times 40 + 30 \times 40 = 4 \times 32$

$\frac{1200}{5} = 240$

$20L = 128$

$20 \times 80 = 4x - 8800 - 1200 = 4x - 10000$

$R = \frac{2900}{5} = 560$

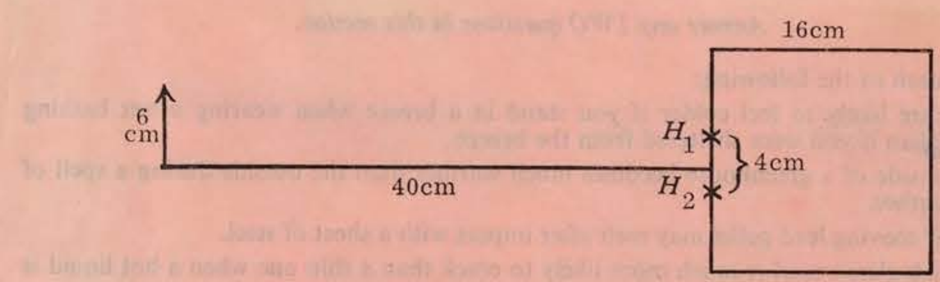
1600

$11600 = 4x$

$20L + 10000 = 240 \times 32$ $= 7680$

$x = \frac{11600}{4} = 2900$

20.



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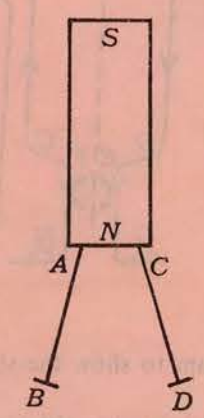

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Turn over

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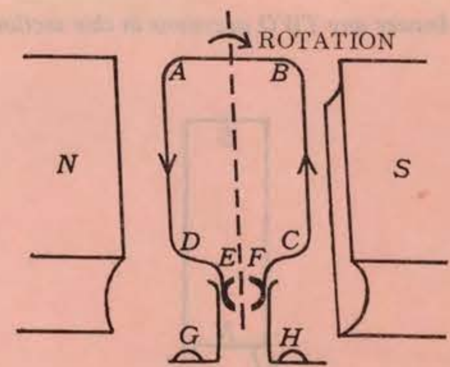

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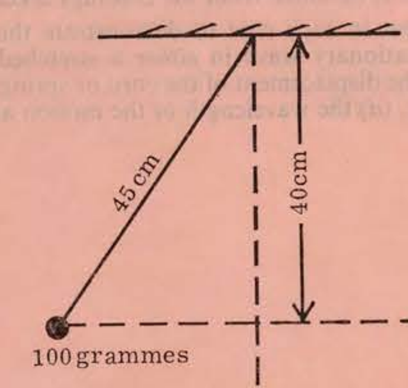

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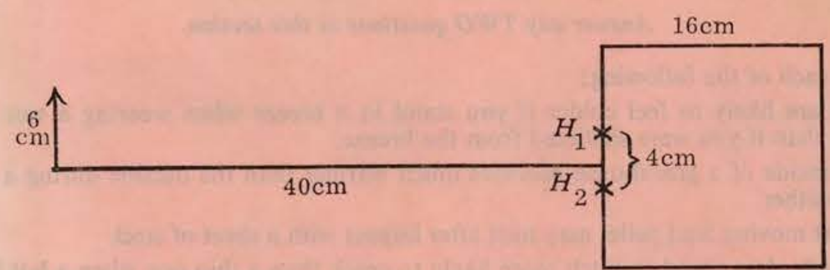
19. Describe how you would attempt, by experiment, to establish a relationship between the angle which an incident ray makes with the normal to a mirror and the angle which the reflected ray makes with the same normal. Use the result to show where the image of a luminous point object or source placed a short distance in front of a plane mirror will appear to be when viewed by an eye suitably positioned.

If a white-hot filament lamp were used as the luminous point source it could emit two other radiations which are invisible to the eye but are capable of being reflected by the mirror.

Name the radiations and mention two *other* properties which both possess in common with visible light. State one method by which *one* of these radiations may be detected, indicating to which radiation you are referring.

Turn over

20.



The diagram shows an illuminated arrow of length 6 cm placed 40 cm in front of a pinhole camera 16 cm in length having two small holes, H_1 and H_2, 4 cm apart.

(*a*) Make a scale diagram and draw suitable rays from the luminous arrow to show how two images are formed on the back of the box.

(*b*) Show why one large blurred image is obtained if the cardboard between the small holes were cut away to form one large circular hole of diameter 4 cm.

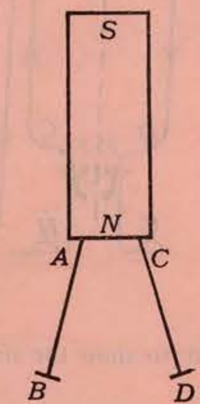
(*c*) Draw, separately, a ray diagram to show how a suitable converging lens, placed at 40 cm from the luminous arrow, may produce a sharp real image at a distance of 16 cm from the lens and determine the focal length required.

(*d*) Describe and explain the defect in vision known as short sight.

Section C

Answer any TWO questions in this section.

21.



(i) The diagram shows what is observed when two steel pins, *AB* and *CD*, hang from the north pole of a magnet, *NS*. Why is the distance *BD* greater than the distance *AC* and what does this indicate regarding the condition of *AB* and *CD*? Describe briefly how you would show that the condition stated was correct, assuming you may use normal laboratory apparatus.

(ii) Explain, briefly, the following:

(*a*) When an uncharged metal plate held by an insulating handle is brought into contact with the cap of a negatively charged leaf electroscope the divergence of the leaf is decreased.

(*b*) As the same metal plate is then brought near the cap again the leaf begins to diverge.

(*c*) When the plate again makes contact with the cap the divergence is of the same value as in the final stage of (*a*), above.

22. It is required to pass a current from a battery through a solenoid so that the current can be varied from 1 A to 4 A with the aid of a rheostat.

(*a*) Draw a circuit diagram of the arrangement including a switch, or key, an ammeter to check the current reading and a voltmeter connected so that the p.d. *across the battery* may be measured.

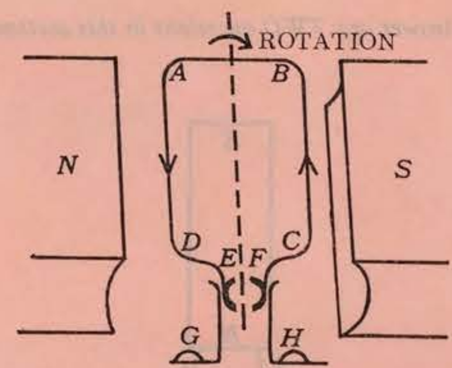
(*b*) If the solenoid has a resistance of 1 ohm and the battery, of negligible internal resistance, has an e.m.f. of 6 V, determine the value of the rheostat resistance to give the required minimum current of 1 A.

(*c*) Explain why the initial setting of the rheostat for the maximum current of 4 A may need to be altered after a short time if the current is to be maintained constant.

(*d*) Show, or explain, which end of the solenoid will behave as a north pole while the current is flowing.

(*e*) If, while the minimum current of 1 A was flowing, the north pole of a strong magnet were plunged into the end of the solenoid which had north polarity, *explain* why the needle of the ammeter would flicker, and whether the current would momentarily increase or decrease.

23.



(i) The above is a simplified diagram to show the structure and action of a simple d.c. motor. Explain, briefly:

(*a*) why the coil, *ABCD*, will rotate when the current flows in it and why it will turn in the clockwise direction shown;

(*b*) why the split ring, *EF*, and the brushes, *GH*, are included in the structure;

(*c*) why such a motor will occasionally not start to rotate when the current is switched on but will give continuous rotation after a slight push.

(ii) An electric motor taking a current of 5 A at a p.d. of 240 V is connected by cable to a generator some distance away. If the p.d. at the terminals of the generator is 250 V determine (*d*) the resistance of the cable, (*e*) the power supplied by the generator, (*f*) the loss of power in the cable.

24. (i) Describe an experiment that can be carried out in a school laboratory which shows that *either* cathode rays *or* beta particles carry a negative charge. You need only indicate your source of rays or particles and the apparatus used for detection or measurement, but you should give as full a description as possible of what is done and observed and explain how you link the conclusion with the experimental observations.

(ii) The simplest model of an atom consists of electrons which are in orbit around a nucleus.

Describe the differences between the nucleus of hydrogen, mass number, 1; atomic number (proton number), 1; and

(*a*) the nucleus of helium, mass number, 4; atomic number (proton number), 2;

(*b*) the nucleus of deuterium, mass number, 2; atomic number (proton number), 1.

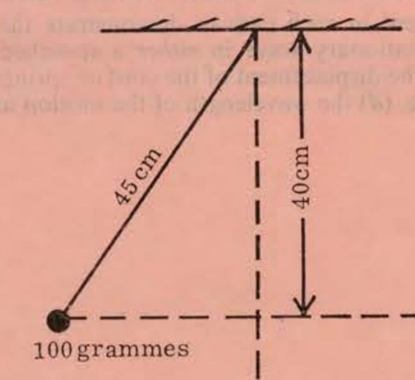
Which of these three substances are isotopes of the same element? Give a reason.

Part II

Section A

Answer any TWO questions in this section.

13. Describe in detail a laboratory method for determining the acceleration due to gravity. State *one* reason why the acceleration due to gravity has not the same value at all places on the earth's surface.



A small metal sphere of mass 100 grammes is suspended from a rigid support by a light string of length 45 cm. The sphere is then drawn aside, keeping the string taut, until its centre is 40 cm vertically below the supporting beam, as shown.

Determine (*a*) the increase in potential energy of the sphere in this position, (*b*) the maximum possible velocity of the sphere if it is then released from rest so that it swings in a vertical plane and (*c*) its maximum momentum.

(i) Draw a labelled diagram of a common hydrometer and explain carefully why a narrow stem leads to greater sensitivity than a wide stem.

A solid block of wood of density 0·6 gramme per cm^3 weighs 306 grammes in air. Determine (*a*) the volume of the block, (*b*) the volume immersed when it floats freely in a liquid of density 0·9 gramme per cm^3 and (*c*) the minimum extra vertical force required to cause the block to submerge completely in the liquid.

(ii) A body of mass 0·5 kg is projected across a uniformly rough horizontal floor with an initial velocity of 4 metres per second. It takes 2 seconds to come to rest.

Determine (*d*) the retardation (negative acceleration), assuming it to be uniform and (*e*) the change in momentum per second.

Turn over

15. (i) A test is carried out on a simple machine of velocity ratio 3 and it is found that an effort of 24 kgf (240 newtons) moves a load *W* which rises steadily through a vertical distance of 2 metres. If the efficiency of the machine at this load is 75% determine (*a*) the mechanical advantage, (*b*) the value of the load *W* and (*c*) the energy lost (wasted work) in the performance of this test.

(ii) Describe an experiment to determine how the extension of a light spring depends upon the load which it supports. Show graphically how these two quantities, extension and load, are related as the spring is gradually stretched to a point a little beyond its elastic limit. What indication will there be, when the load is removed, that the elastic limit has been exceeded?

16. (i) Describe how you would determine the velocity of sound in air by any one method. Show clearly how the result is obtained from the readings taken.

(ii) Describe one experiment in each case to demonstrate the production of (*a*) a progressive wave and (*b*) a stationary wave in *either* a stretched elastic cord *or* a spring. Draw a diagram to show the displacement of the cord or spring in case (*b*) and indicate on it (*c*) the position of a node, (*d*) the wavelength of the motion and (*e*) its amplitude.

Section B

Answer any TWO questions in this section.

17. Explain each of the following:

(*a*) You are likely to feel colder if you stand in a breeze when wearing a wet bathing costume than if you were sheltered from the breeze.

(*b*) The inside of a greenhouse becomes much warmer than the outside during a spell of sunny weather.

(*c*) A fast moving lead pellet may melt after impact with a sheet of steel.

(*d*) A thick glass vessel is much more likely to crack than a thin one when a hot liquid is poured into it.

18. A hot liquid is contained in a closed vacuum flask.

Describe the features in the design of such a flask which enable it to keep its contents hot for a considerable time. Illustrate your answer with a labelled diagram and explain how such features reduce the loss of heat.

A vacuum flask of thermal capacity 30 cal per deg C (126 joules per deg C) contains 20 grammes of ice floating in 200 grammes of water at 0°C. Heat is supplied at a constant rate by a small immersion heater of negligible thermal capacity and it is found that it takes 5 minutes for the ice to melt and a further 32 minutes to raise the temperature of the flask and its contents to 40°C. Determine (*a*) the rate at which the heat is supplied by the heater and (*b*) the latent heat of fusion of ice (specific latent heat of ice).

[Assume that the specific heat of water is 1 cal per gramme per deg C (4·2 joule per gramme per deg C).]

19. Describe how you would attempt, by experiment, to establish a relationship between the angle which an incident ray makes with the normal to a mirror and the angle which the reflected ray makes with the same normal. Use the result to show where the image of a luminous point object or source placed a short distance in front of a plane mirror will appear to be when viewed by an eye suitably positioned.

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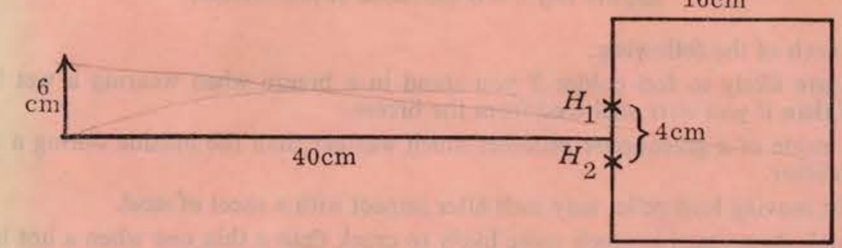

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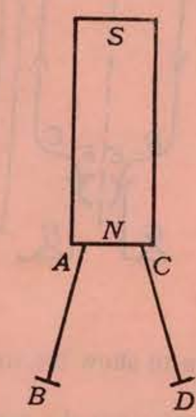

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(*c*) Explain why the initial setting of the rheostat for the maximum current of 4 A may need to be altered after a short time if the current is to be maintained constant.

(*d*) Show, or explain, which end of the solenoid will behave as a north pole while the current is flowing.

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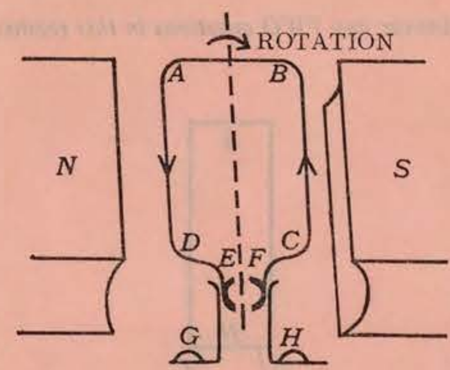

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(*a*) the nucleus of helium, mass number, 4; atomic number (proton number), 2;

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Which of these three substances are isotopes of the same element? Give a reason.

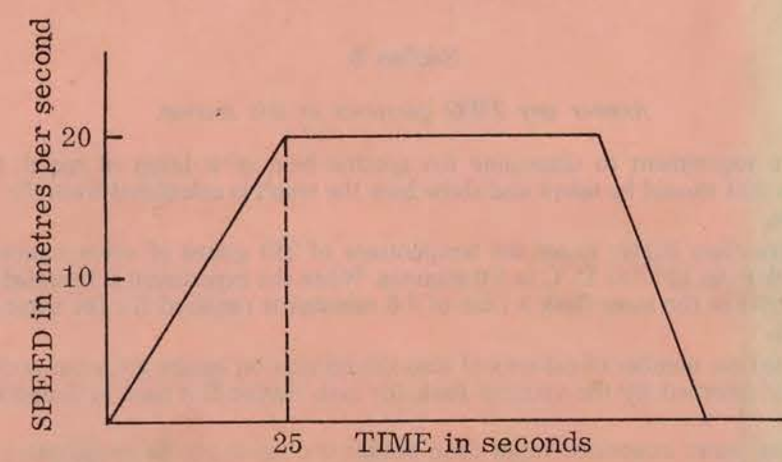
Part II

Answer SIX questions in this Part, TWO from each of Sections A, B and C. Answers to questions in this Part must be written in a separate answer-book.

Section A

Answer any TWO questions in this section.

13.



The graph shows the motion of a car which accelerates uniformly from rest to a speed of 20 metres per second in 25 seconds and is brought to rest from that speed with a uniform retardation of 400 cm per second^2 on a level unimpeded straight road. If the total distance travelled is 1 km, determine:

(*a*) the time during which the car is uniformly retarded,

(*b*) the distance travelled at uniform speed,

(*c*) the total time taken to travel the 1 km.

If the engine exerts a constant force of 60 million dynes (600 newtons) during the initial acceleration determine the constant force required to produce the retardation of the car.

14. (i) How would you demonstrate that, within some elastic limit, a metal, such as copper, is perfectly elastic? Describe briefly what is observed if the elastic limit is exceeded.

(ii) A uniform plank of length 10 ft and mass 60 lb rests on a horizontal platform with a 2 ft length of the plank projecting over the edge of the platform.

(*a*) To what point on the overhanging end of the plank can a man weighing 150 lb move before the plank overbalances?

(*b*) What is the smallest mass which, placed on the other end of the plank, will allow the man to move to the end of the projecting plank without the plank overbalancing?

15. Describe an experiment by which an approximate value for the density of air may be obtained. Show how the measurements made are used to obtain the final result.

By what fraction and in what way would the density be altered if such an experiment, first performed in winter at an air temperature of 12°C, were then repeated in summer at the same pressure but at an air temperature of 27°C?

Explain briefly how the molecules of air exert a pressure on the walls of a closed container and why the pressure increases when the volume of gas in the container is decreased whilst its temperature remains constant.

Turn Over

16. Explain the difference between a transverse and a longitudinal wave. Give an example of each.

Plane waves are incident on a narrow gap. Draw the appearance of the waves or draw the wave-fronts before and after they have passed through the gap, (*a*) when the wavelength of the waves is large, (*b*) when the wavelength is very small. What name is given to this effect?

Describe an experiment which shows that sound waves will not travel through a vacuum but light waves will.

Section B

Answer any TWO questions in this section.

17. Describe an experiment to determine the specific heat of a lump of metal. State the precautions that should be taken and show how the result is calculated from the measurements made.

A small immersion heater raises the temperature of 250 grams of water contained in a vacuum flask from 15°C to 55°C in 5·0 minutes. When the experiment is repeated with 500 grams of water in the same flask a time of 9·0 minutes is required for the same range of temperature.

Determine (*a*) the number of calories of heat the immersion heater gives out each minute, (*b*) the heat absorbed by the vacuum flask for each degree C it rises in temperature.

18. (i) Some hot water contained in an open beaker is observed to be evaporating steadily. Describe what is believed to be the behaviour of the water molecules *below* and *above* the surface of the hot water. Name and describe the processes by which the water gradually cools to room temperature assuming that the beaker rests on a table.

(ii) Describe an experiment to show what effect *either* an increase *or* a decrease in pressure will have on the boiling point of water.

19. Explain, with the aid of a diagram, the action of a concave spherical mirror on a narrow incident beam of light travelling parallel to its axis.

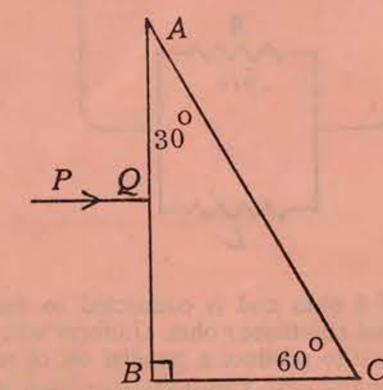
A concave mirror of radius of curvature 40 cm forms a sharply focused image of a small object on a screen placed at a distance of 80 cm from the mirror. Determine, graphically or otherwise, (*a*) the position of the object and (*b*) the linear magnification.

Give a detailed account of a reliable experimental method for determining the focal length of a concave mirror.

20. 'Paraffin oil has a greater refractive index than water.'

What information does the above statement give with regard to (*a*) the relative velocities of light in paraffin oil and in water and (*b*) the path of a ray of light when passing from water into a layer of paraffin oil floating on top of it?

A small but intense source of light is situated at the bottom of a large tank of clear water. Explain and illustrate by means of a diagram why the source does not appear to be as far below the surface as it actually is.



ABC is the triangular section of a glass prism whose angles are as shown. *PQ* shows the path of a ray of light which meets the side *AB* normally.

Determine, graphically or otherwise, the angle that the ray which emerges from the side *AC* makes with the normal at the point of emergence.

Explain why the ray *PQ* would not emerge from the side *AC*, as above, if the angles of the prism at *A* and *C* were both 45°.

(Assume that the refractive index of glass relative to air is 1·5.)

Section C

Answer any TWO questions in this section.

21. (i) Describe how a leaf electroscope may be used to

(*a*) test the insulating properties of a given material, and

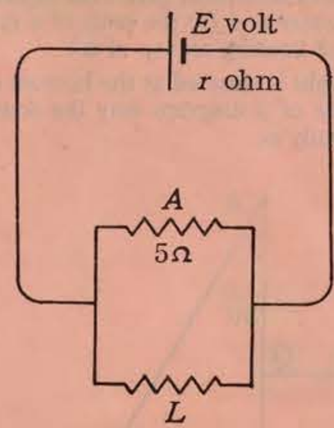
(*b*) identify the sign of the charge on a charged insulated conductor.

Explain in each case how your conclusions are derived from your observations.

(ii) Describe the structure of any one type of *secondary* cell, naming the substances used for its positive plate, its negative plate and its electrolyte.

What advantages has such a cell over the dry (Leclanché) cell?

22.



The coil A has a resistance of 5 ohm and is connected to the terminals of a cell of constant e.m.f. E volt and internal resistance r ohm. Uniform wire of length L cm is joined across the ends of the 5-ohm coil to produce a parallel net of resistance 4 ohm.

Determine (*a*) the resistance of the wire L and (*b*) its length if the resistivity (specific resistance) of its material is 0·000050 ohm-cm and its cross-sectional area is 0·004 cm^2.

The current drawn from the cell when the wire, L, is connected across A, as shown, is 0·3 amp but this is reduced to 0·25 amp when the wire is removed, leaving A alone connected to the cell. Determine (*c*) the e.m.f. of the cell, (*d*) the internal resistance of the cell and (*e*) the electrical energy dissipated in the 5-ohm resistor when the current of 0·25 amp flows through it for a period of 4 minutes.

23. Describe how you would proceed to magnetise an iron nail (*a*) electrically and (*b*) by making use of the earth's magnetic field. Show clearly how the polarity in case (*a*) is related to the direction in which the current flows and in case (*b*) to the way in which the nail is positioned.

Give a labelled diagram to show the construction of the telephone receiver (earpiece) and describe its mode of action.

24. (i) Describe the structure of a diode valve and state the conditions for an electric current to pass between its electrodes.

Show by means of a diagram how the current through a constant resistance will vary with time when it is connected in series with a diode and an alternating voltage supply. Account briefly for the shape of the diagram drawn.

(ii) Name the three fundamental particles of which the atoms of an element are composed. How are these particles distributed in the atom of an element whose *atomic number* is 3 and *mass number* 7?

Physics
Overseas
46

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

JANUARY 1967

Ordinary Level

PHYSICS

for Candidates Overseas

Three hours

Answer SIX questions, choosing TWO from each section. Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

Section A

1. 'The acceleration due to gravity is 32 ft per sec per sec.' Explain what this statement means and describe an experiment to check the value given.

A horizontal force of 2 lb wt is applied for a period of 4 seconds to a body of mass 12 lb causing it to accelerate uniformly from rest along a rough horizontal surface. At the end of this period the velocity of the body is found to be 15 ft per sec. Determine the frictional force between the body and the horizontal surface. The force of 2 lb wt is now removed and the body continues to slide until it finally comes to rest under the action of the frictional force. Determine the retardation (negative acceleration) during this second stage of its motion.

Turn Over

TE&S 64/1398 6/2/100/7250

2. State *Boyle's law* and describe an experiment to verify it for air. Your description must include a diagram of the apparatus used together with a statement of the precautions taken and a clear explanation of the way you would make use of your observations.

A long narrow-bore glass tube of uniform section is sealed at one end, the other end being open to the atmosphere. An unbroken thread of mercury, 5 cm long, encloses a column of air of length 30 cm when the tube is held horizontally. Assuming that the barometric height is 75 cm of mercury, determine the length of this air column when the tube is held vertically with the open end (*a*) downwards and (*b*) upwards.

3. (*a*) Give a diagram of the common lift pump and explain its action.

(*b*) Describe the structure and mode of action of an aneroid barometer. State a disadvantage that this barometer has compared with the simple mercury type.

4. Answer any *two* of the following:

(*a*) State *either* the triangle *or* the parallelogram *law of forces* and use it to solve the following problem. A 5 lb weight is suspended at the end of a light cord and is pulled aside and held in equilibrium by a horizontal force of 3 lb wt. Find the tension in the cord and its inclination to the vertical.

(*b*) Explain the terms *machine*, *mechanical advantage* and *velocity ratio*. Derive the relation between the last two quantities and the efficiency of a machine.

A machine has a velocity ratio of 4 and an efficiency of 65%. Determine the load that may be raised by applying an effort of 12·5 lb wt.

(*c*) State the *law of flotation*.

A thin metal box has a rectangular base that measures 2 ft by 1 ft 6 in and vertical sides. It is open at the top and has a mass of 30 lb. Determine the depth to which it will sink when floating freely in water. Paraffin oil of specific gravity 0·8 is now poured into the box until the level of the oil inside is the same as that of the water outside. What is now the depth immersed? [You may ignore the thickness of the metal. Density of water = 62·5 lb per cu ft.]

Section B

5. Define *calorie* and *specific heat*.

Describe how you would determine the latent heat of vaporisation of water at its normal boiling point. Your account must include a carefully drawn diagram of the apparatus used and a clear explanation of how you deduce the result from the readings taken.

An aluminium tray has a mass of 200 gm and contains ½ litre of water at 20° C. It is put into the freezing compartment of a refrigerator. If the contents of the tray just completely solidify in 90 minutes determine the rate at which the refrigerator absorbs heat. What fraction of the total heat lost was given up by the tray?

[Latent heat of fusion of ice = 80 cal per gm; specific heat of aluminium = 0·21 cal per gm per deg C.]

6. Answer any *two* of the following:

(*a*) Explain the term *mechanical equivalent of heat* and describe an experiment to determine its value.

(*b*) What is meant by the statement, 'The coefficient of linear expansion of iron is 0·000012 per deg C'?

Describe an experiment to check the accuracy of this statement.

(*c*) Give a labelled diagram of a maximum and minimum thermometer and explain its action.

7. Define *refractive index* and *critical angle* and state how they are related. Describe an apparent depth method for determining the refractive index of a transparent liquid such as water.

A transparent solid glass cube has sides of length 10 cm and one of its faces is silvered. The cube is placed on a horizontal plane surface with the silvered face vertical and on the side remote from the observer. A pin is placed upright at a distance of 5 cm in front of the cube so that its image can be seen in the silvered face. An observer looks into the cube so that his eye, the pin and its image all lie in the same straight line. Calculate the distance of the image from the object pin. [Refractive index of glass relative to air = 1·5.]

Turn Over

8. (*a*) Give a labelled diagram of the human eye and explain briefly its action. How is the eye (i) able to focus clearly objects at varying distances from it, and (ii) able to control the amount of light which enters it?

(*b*) A person's near-point is 10 inches in front of his eye and he wishes to use a converging (convex) lens so as to produce, at his near-point, an image of a small object with a magnification of 3. Determine, graphically or otherwise, the focal length of the lens required if it is held close to the eye. State the sign convention used if the problem is solved by calculation.

9. What three factors decide the pitch of the note produced when a stretched wire is plucked or bowed and in what way do they do so? Describe an experiment to test your statement in regard to any one of these factors.

A vibrating tuning fork of frequency 480 cycles per sec is held at the open end of an air column whose length can be varied by means of a piston. If the note which is heard is loudest when the length of the column is first 17·3 cm and then when it is 52·3 cm, calculate the velocity of sound in air.

Section C

10. Explain what is meant by *magnetic field* and *magnetic line of force*.

If a piece of soft iron is placed in a magnetic field, describe what happens to (*a*) the iron, (*b*) the magnetic field. Illustrate with a diagram.

Describe how you would plot a magnetic field using a small compass.

Give a diagram showing the lines of force in the neighbourhood of a bar magnet placed horizontally with its axis in the earth's magnetic meridian and its N-seeking pole pointing *south*. Mark the positions of the neutral points.

11. Describe a gold leaf electroscope and explain how it would be used to show that:

(*a*) the charge on an ebonite rod rubbed with fur is of opposite sign to the charge on a glass rod rubbed with silk;

(*b*) the charge on one insulated metal sphere is greater than that on another;

(*c*) the potential of one insulated charged conductor differs from that of another.

State and explain what happens when an earthed conductor is gradually brought nearer to the cap of a charged electroscope.

12. Define *electrochemical equivalent* and describe how the electrochemical equivalent of copper may be accurately determined, giving a full circuit diagram with anode, cathode and electrolyte clearly marked.

Explain briefly how the knowledge of the electrochemical equivalent of a metal may be used in industrial electroplating.

If a total charge of 12,060 coulombs is required to liberate 1 gm of oxygen, calculate the electrochemical equivalent of an element which has a chemical equivalent of 29·3. [Chemical equivalent of oxygen = 8.]

13. A car spotlight bulb is labelled '12 volt, 24 watt'. What does this mean and what current will be passing through the bulb when it is being used correctly?

Describe how you would test by experiment that the bulb is correctly labelled.

What would be the total resistance in the circuit if this spotlight and two other lamps each of which is rated 12 volt, 0·3 amp (and being so used) were all connected in parallel? Calculate also the total energy consumed each minute by the lamps when a potential difference of 12 volts is applied across them and state what happens to this energy.

Turn Over

14. Answer any *two* of the following:

(*a*) Describe with the help of a circuit diagram how to compare the electromotive forces of two cells by the potentiometer method.

(*b*) Describe, with the aid of a diagram, a *moving coil loudspeaker* and explain its action. Why should a larger diameter loudspeaker produce a greater volume of sound than one of smaller diameter?

(*c*) Describe the structure and give the action of a *hot wire* ammeter. Explain one advantage and one disadvantage of this instrument.

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

JANUARY 1967

Ordinary Level

PHYSICS

for Candidates Overseas

Three hours

Answer SIX questions, choosing TWO from each section. Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

Section A

1. 'The acceleration due to gravity is 32 ft per sec per sec.' Explain what this statement means and describe an experiment to check the value given.

A horizontal force of 2 lb wt is applied for a period of 4 seconds to a body of mass 12 lb causing it to accelerate uniformly from rest along a rough horizontal surface. At the end of this period the velocity of the body is found to be 15 ft per sec. Determine the frictional force between the body and the horizontal surface. The force of 2 lb wt is now removed and the body continues to slide until it finally comes to rest under the action of the frictional force. Determine the retardation (negative acceleration) during this second stage of its motion.

Turn Over

TE&S 64/1398 6/2/100/7250

2. State *Boyle's law* and describe an experiment to verify it for air. Your description must include a diagram of the apparatus used together with a statement of the precautions taken and a clear explanation of the way you would make use of your observations.

A long narrow-bore glass tube of uniform section is sealed at one end, the other end being open to the atmosphere. An unbroken thread of mercury, 5 cm long, encloses a column of air of length 30 cm when the tube is held horizontally. Assuming that the barometric height is 75 cm of mercury, determine the length of this air column when the tube is held vertically with the open end (*a*) downwards and (*b*) upwards.

3. (*a*) Give a diagram of the common lift pump and explain its action.

(*b*) Describe the structure and mode of action of an aneroid barometer. State a disadvantage that this barometer has compared with the simple mercury type.

4. Answer any *two* of the following:

(*a*) State *either* the triangle *or* the parallelogram *law of forces* and use it to solve the following problem. A 5 lb weight is suspended at the end of a light cord and is pulled aside and held in equilibrium by a horizontal force of 3 lb wt. Find the tension in the cord and its inclination to the vertical.

(*b*) Explain the terms *machine*, *mechanical advantage* and *velocity ratio*. Derive the relation between the last two quantities and the efficiency of a machine.

A machine has a velocity ratio of 4 and an efficiency of 65%. Determine the load that may be raised by applying an effort of 12·5 lb wt.

(*c*) State the *law of flotation*.

A thin metal box has a rectangular base that measures 2 ft by 1 ft 6 in and vertical sides. It is open at the top and has a mass of 30 lb. Determine the depth to which it will sink when floating freely in water. Paraffin oil of specific gravity 0·8 is now poured into the box until the level of the oil inside is the same as that of the water outside. What is now the depth immersed? [You may ignore the thickness of the metal. Density of water = 62·5 lb per cu ft.]

Section B

5. Define *calorie* and *specific heat*.

Describe how you would determine the latent heat of vaporisation of water at its normal boiling point. Your account must include a carefully drawn diagram of the apparatus used and a clear explanation of how you deduce the result from the readings taken.

An aluminium tray has a mass of 200 gm and contains $\frac{1}{2}$ litre of water at 20° C. It is put into the freezing compartment of a refrigerator. If the contents of the tray just completely solidify in 90 minutes determine the rate at which the refrigerator absorbs heat. What fraction of the total heat lost was given up by the tray?

[Latent heat of fusion of ice = 80 cal per gm; specific heat of aluminium = 0·21 cal per gm per deg C.]

6. Answer any *two* of the following:

(*a*) Explain the term *mechanical equivalent of heat* and describe an experiment to determine its value.

(*b*) What is meant by the statement, 'The coefficient of linear expansion of iron is 0·000012 per deg C'?

Describe an experiment to check the accuracy of this statement.

(*c*) Give a labelled diagram of a maximum and minimum thermometer and explain its action.

7. Define *refractive index* and *critical angle* and state how they are related. Describe an apparent depth method for determining the refractive index of a transparent liquid such as water.

A transparent solid glass cube has sides of length 10 cm and one of its faces is silvered. The cube is placed on a horizontal plane surface with the silvered face vertical and on the side remote from the observer. A pin is placed upright at a distance of 5 cm in front of the cube so that its image can be seen in the silvered face. An observer looks into the cube so that his eye, the pin and its image all lie in the same straight line. Calculate the distance of the image from the object pin. [Refractive index of glass relative to air = 1·5.]

Turn Over

8. (*a*) Give a labelled diagram of the human eye and explain briefly its action. How is the eye (i) able to focus clearly objects at varying distances from it, and (ii) able to control the amount of light which enters it?

(*b*) A person's near-point is 10 inches in front of his eye and he wishes to use a converging (convex) lens so as to produce, at his near-point, an image of a small object with a magnification of 3. Determine, graphically or otherwise, the focal length of the lens required if it is held close to the eye. State the sign convention used if the problem is solved by calculation.

9. What three factors decide the pitch of the note produced when a stretched wire is plucked or bowed and in what way do they do so? Describe an experiment to test your statement in regard to any one of these factors.

A vibrating tuning fork of frequency 480 cycles per sec is held at the open end of an air column whose length can be varied by means of a piston. If the note which is heard is loudest when the length of the column is first 17·3 cm and then when it is 52·3 cm, calculate the velocity of sound in air.

Section C

10. Explain what is meant by *magnetic field* and *magnetic line of force*.

If a piece of soft iron is placed in a magnetic field, describe what happens to (*a*) the iron, (*b*) the magnetic field. Illustrate with a diagram.

Describe how you would plot a magnetic field using a small compass.

Give a diagram showing the lines of force in the neighbourhood of a bar magnet placed horizontally with its axis in the earth's magnetic meridian and its N-seeking pole pointing *south*. Mark the positions of the neutral points.

11. Describe a gold leaf electroscope and explain how it would be used to show that:

(*a*) the charge on an ebonite rod rubbed with fur is of opposite sign to the charge on a glass rod rubbed with silk;

(*b*) the charge on one insulated metal sphere is greater than that on another;

(*c*) the potential of one insulated charged conductor differs from that of another.

State and explain what happens when an earthed conductor is gradually brought nearer to the cap of a charged electroscope.

12. Define *electrochemical equivalent* and describe how the electrochemical equivalent of copper may be accurately determined, giving a full circuit diagram with anode, cathode and electrolyte clearly marked.

Explain briefly how the knowledge of the electrochemical equivalent of a metal may be used in industrial electroplating.

If a total charge of 12,060 coulombs is required to liberate 1 gm of oxygen, calculate the electrochemical equivalent of an element which has a chemical equivalent of 29·3. [Chemical equivalent of oxygen = 8.]

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Describe how you would test by experiment that the bulb is correctly labelled.

What would be the total resistance in the circuit if this spotlight and two other lamps each of which is rated 12 volt, 0·3 amp (and being so used) were all connected in parallel? Calculate also the total energy consumed each minute by the lamps when a potential difference of 12 volts is applied across them and state what happens to this energy.

Turn Over

14. Answer any *two* of the following:

(*a*) Describe with the help of a circuit diagram how to compare the electromotive forces of two cells by the potentiometer method.

(*b*) Describe, with the aid of a diagram, a *moving coil loudspeaker* and explain its action. Why should a larger diameter loudspeaker produce a greater volume of sound than one of smaller diameter?

(*c*) Describe the structure and give the action of a *hot wire* ammeter. Explain one advantage and one disadvantage of this instrument.

P with C I

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UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

JANUARY 1967

Ordinary Level

PHYSICS WITH CHEMISTRY I

PHYSICS

One and a half hours

Answer FOUR questions.

Diagrams of apparatus should be given wherever they clarify an answer. Graph paper is supplied.
Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

1. Define *potential energy* and *kinetic energy*.

State the law of conservation of energy, using a swinging pendulum to illustrate your statement.

A piece of metal having a mass of 28 lb is dropped from a stationary balloon which is at a height of 3,000 ft. Using the above law, or otherwise, find the velocity of the metal after it has dropped (*a*) 900 ft, and (*b*) 1,600 ft. Find also its kinetic energy at the instant it hits the ground.

[$g = 32$ ft per sec per sec.]

TE&S 64/1430 7/2/2/100/5550

Turn Over

2. (*a*) Define *specific gravity*.

Describe an experiment, using the method of balancing columns, to determine the specific gravity of olive oil. Explain how your answer is obtained from the readings taken.

(*b*) Describe an experiment to measure the pressure of the gas supply in your laboratory. What modification would need to be made in order that the same apparatus could be used to measure the pressure of the water supply in the laboratory?

3. Define *specific heat*, *latent heat*. Describe an experiment to determine the latent heat of fusion of ice, mentioning particularly any precautions you would take to obtain a reasonably accurate result.

Calculate the quantity of heat required to convert 50 gm of ice at $-20°$ C to steam at $100°$ C. [Specific heat of ice = 0·5 cal per gm per degree C; latent heat of fusion of ice = 80 cal per gm; latent heat of steam = 540 cal per gm.]

4. (*a*) Describe simple experiments (one for each) to show that (i) evaporation produces cooling, and (ii) mechanical energy can be converted into heat energy.

(*b*) Describe a simple experiment which demonstrates that light travels in straight lines, and show, by means of a diagram, how a pin-hole camera produces an image. What would be the effect of (i) increasing the length of the camera, and (ii) making the hole larger ?

5. How would you determine, experimentally, the focal length of a concave mirror by the method of conjugate points?

An object 2 in high is placed on, and perpendicular to, the axis of a concave mirror at a distance of 9 inches from its pole. If the focal length of the mirror is 6 in find, either graphically or by calculation, the position and height of the image produced. Enumerate the characteristics of the image.

6. Explain how an echo is produced, and describe an experiment which makes use of the formation of an echo to determine the velocity of sound in air.

A man standing between two parallel vertical cliffs fires a pistol and hears two echoes of the report, the first 0·5 sec after firing and the other after a *further* 1·0 sec. His distance from the nearer of the two cliffs is 275 ft. Calculate (*a*) the velocity of sound in the air, and (*b*) the distance between the two cliffs.

7. Answer *either* (*a*) *or* (*b*) but not both.

(*a*) Describe two simple experiments, one for each, to show that (i) the two ends of a bar magnet have different polarities, and (ii) that the magnetic force is strongest near its ends. Explain how you would use a compass needle to determine (iii) which end of an unmarked bar magnet is the N pole, and (iv) which terminal of an unlabelled battery is positive.

(*b*) Explain how a gold leaf electroscope may be used to show (i) that there are two different kinds of electrostatic charge, and (ii) that when two materials such as ebonite and fur are rubbed together, equal quantities of the two different kinds are produced.

Given a glass rod, a piece of silk fabric and two insulated brass spheres, what experiment would you perform in order to obtain a positive charge on one of the spheres, and a negative charge on the other? How would you demonstrate that your experiment was successful?

8. State *Ohm's law* and describe an experiment to demonstrate it.

A battery of 6 dry cells in series, each having an e.m.f. of 1·5 volts and internal resistance of 0·5 ohms, is connected in series with a 2 ohm coil. Find (*a*) the current through the battery, and (*b*) the potential difference between its terminals.

9. Define *electromotive force* and explain how polarisation occurs in a simple cell.

Describe, with the aid of a diagram, an ordinary dry cell, and explain (*a*) how it produces current, and (*b*) how polarisation is reduced to a minimum. State one disadvantage of this cell.

P with C I
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UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

JANUARY 1967

Ordinary Level

PHYSICS WITH CHEMISTRY I

PHYSICS

One and a half hours

Answer FOUR questions.

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[$g = 32$ ft per sec per sec.]

TE&S 64/1430 7/2/2/100/5550

Turn Over

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Physics
Overseas
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UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

JANUARY 1967

Ordinary Level

PHYSICS

for Candidates Overseas

Three hours

Answer SIX questions, choosing TWO from each section. Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

Section A

1. 'The acceleration due to gravity is 32 ft per sec per sec.' Explain what this statement means and describe an experiment to check the value given.

A horizontal force of 2 lb wt is applied for a period of 4 seconds to a body of mass 12 lb causing it to accelerate uniformly from rest along a rough horizontal surface. At the end of this period the velocity of the body is found to be 15 ft per sec. Determine the frictional force between the body and the horizontal surface. The force of 2 lb wt is now removed and the body continues to slide until it finally comes to rest under the action of the frictional force. Determine the retardation (negative acceleration) during this second stage of its motion.

Turn Over

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2. State *Boyle's law* and describe an experiment to verify it for air. Your description must include a diagram of the apparatus used together with a statement of the precautions taken and a clear explanation of the way you would make use of your observations.

A long narrow-bore glass tube of uniform section is sealed at one end, the other end being open to the atmosphere. An unbroken thread of mercury, 5 cm long, encloses a column of air of length 30 cm when the tube is held horizontally. Assuming that the barometric height is 75 cm of mercury, determine the length of this air column when the tube is held vertically with the open end (*a*) downwards and (*b*) upwards.

3. (*a*) Give a diagram of the common lift pump and explain its action.

(*b*) Describe the structure and mode of action of an aneroid barometer. State a disadvantage that this barometer has compared with the simple mercury type.

4. Answer any *two* of the following:

(*a*) State *either* the triangle *or* the parallelogram *law of forces* and use it to solve the following problem. A 5 lb weight is suspended at the end of a light cord and is pulled aside and held in equilibrium by a horizontal force of 3 lb wt. Find the tension in the cord and its inclination to the vertical.

(*b*) Explain the terms *machine*, *mechanical advantage* and *velocity ratio*. Derive the relation between the last two quantities and the efficiency of a machine.

A machine has a velocity ratio of 4 and an efficiency of 65%. Determine the load that may be raised by applying an effort of 12·5 lb wt.

(*c*) State the *law of flotation*.

A thin metal box has a rectangular base that measures 2 ft by 1 ft 6 in and vertical sides. It is open at the top and has a mass of 30 lb. Determine the depth to which it will sink when floating freely in water. Paraffin oil of specific gravity 0·8 is now poured into the box until the level of the oil inside is the same as that of the water outside. What is now the depth immersed? [You may ignore the thickness of the metal. Density of water = 62·5 lb per cu ft.]

Section B

5. Define *calorie* and *specific heat*.

Describe how you would determine the latent heat of vaporisation of water at its normal boiling point. Your account must include a carefully drawn diagram of the apparatus used and a clear explanation of how you deduce the result from the readings taken.

An aluminium tray has a mass of 200 gm and contains ½ litre of water at 20° C. It is put into the freezing compartment of a refrigerator. If the contents of the tray just completely solidify in 90 minutes determine the rate at which the refrigerator absorbs heat. What fraction of the total heat lost was given up by the tray?

[Latent heat of fusion of ice = 80 cal per gm; specific heat of aluminium = 0·21 cal per gm per deg C.]

6. Answer any *two* of the following:

(*a*) Explain the term *mechanical equivalent of heat* and describe an experiment to determine its value.

(*b*) What is meant by the statement, 'The coefficient of linear expansion of iron is 0·000012 per deg C'?

Describe an experiment to check the accuracy of this statement.

(*c*) Give a labelled diagram of a maximum and minimum thermometer and explain its action.

7. Define *refractive index* and *critical angle* and state how they are related. Describe an apparent depth method for determining the refractive index of a transparent liquid such as water.

A transparent solid glass cube has sides of length 10 cm and one of its faces is silvered. The cube is placed on a horizontal plane surface with the silvered face vertical and on the side remote from the observer. A pin is placed upright at a distance of 5 cm in front of the cube so that its image can be seen in the silvered face. An observer looks into the cube so that his eye, the pin and its image all lie in the same straight line. Calculate the distance of the image from the object pin. [Refractive index of glass relative to air = 1·5.]

Turn Over

8. (*a*) Give a labelled diagram of the human eye and explain briefly its action. How is the eye (i) able to focus clearly objects at varying distances from it, and (ii) able to control the amount of light which enters it?

(*b*) A person's near-point is 10 inches in front of his eye and he wishes to use a converging (convex) lens so as to produce, at his near-point, an image of a small object with a magnification of 3. Determine, graphically or otherwise, the focal length of the lens required if it is held close to the eye. State the sign convention used if the problem is solved by calculation.

9. What three factors decide the pitch of the note produced when a stretched wire is plucked or bowed and in what way do they do so? Describe an experiment to test your statement in regard to any one of these factors.

A vibrating tuning fork of frequency 480 cycles per sec is held at the open end of an air column whose length can be varied by means of a piston. If the note which is heard is loudest when the length of the column is first 17·3 cm and then when it is 52·3 cm, calculate the velocity of sound in air.

Section C

10. Explain what is meant by *magnetic field* and *magnetic line of force*.

If a piece of soft iron is placed in a magnetic field, describe what happens to (*a*) the iron, (*b*) the magnetic field. Illustrate with a diagram.

Describe how you would plot a magnetic field using a small compass.

Give a diagram showing the lines of force in the neighbourhood of a bar magnet placed horizontally with its axis in the earth's magnetic meridian and its N-seeking pole pointing *south*. Mark the positions of the neutral points.

11. Describe a gold leaf electroscope and explain how it would be used to show that:

(*a*) the charge on an ebonite rod rubbed with fur is of opposite sign to the charge on a glass rod rubbed with silk;

(*b*) the charge on one insulated metal sphere is greater than that on another;

(*c*) the potential of one insulated charged conductor differs from that of another.

State and explain what happens when an earthed conductor is gradually brought nearer to the cap of a charged electroscope.

12. Define *electrochemical equivalent* and describe how the electrochemical equivalent of copper may be accurately determined, giving a full circuit diagram with anode, cathode and electrolyte clearly marked.

Explain briefly how the knowledge of the electrochemical equivalent of a metal may be used in industrial electroplating.

If a total charge of 12,060 coulombs is required to liberate 1 gm of oxygen, calculate the electrochemical equivalent of an element which has a chemical equivalent of 29·3. [Chemical equivalent of oxygen = 8.]

13. A car spotlight bulb is labelled '12 volt, 24 watt'. What does this mean and what current will be passing through the bulb when it is being used correctly?

Describe how you would test by experiment that the bulb is correctly labelled.

What would be the total resistance in the circuit if this spotlight and two other lamps each of which is rated 12 volt, 0·3 amp (and being so used) were all connected in parallel? Calculate also the total energy consumed each minute by the lamps when a potential difference of 12 volts is applied across them and state what happens to this energy.

Turn Over

14. Answer any *two* of the following:

(*a*) Describe with the help of a circuit diagram how to compare the electromotive forces of two cells by the potentiometer method.

(*b*) Describe, with the aid of a diagram, a *moving coil loudspeaker* and explain its action. Why should a larger diameter loudspeaker produce a greater volume of sound than one of smaller diameter?

(*c*) Describe the structure and give the action of a *hot wire* ammeter. Explain one advantage and one disadvantage of this instrument.

P w C II

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UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

JANUARY 1967

Ordinary Level

PHYSICS WITH CHEMISTRY II

CHEMISTRY

One and a half hours

Answer FOUR questions.

Diagrams of apparatus should be given wherever they clarify an answer. Any chemical reactions described should also be represented by equations wherever possible.
Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

1. Give definitions of (*a*) an acidic oxide, (*b*) a basic oxide, (*c*) a neutral oxide. Give one example in each case. Indicate briefly how you would obtain (*d*) a basic oxide from lead nitrate, (*e*) an acidic oxide from sodium carbonate, (*f*) a neutral oxide from the acidic oxide obtained in (*e*).

2. What do you understand by the terms *oxidation* and *reduction*?
Describe how you would carry out the following conversions and indicate in each case whether it is an oxidation or reduction; (*a*) chlorine to hydrogen chloride, (*b*) hydrogen sulphide to sulphur, (*c*) ferrous chloride to ferric chloride.

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Turn Over

3. Explain *four* of the following:

(*a*) A white precipitate is formed when carbon dioxide is passed into a saturated solution of sodium carbonate.

(*b*) A black precipitate is formed when hydrogen sulphide is passed into a solution of copper sulphate.

(*c*) A brown gas is formed when air and ammonia are mixed and passed over heated platinum.

(*d*) A blue precipitate, which goes black on heating, is formed when ammonia gas is passed into a solution of copper sulphate.

(*e*) Beads of moisture appear on the outside of a beaker of cold water when heated by a bunsen flame.

4. State the *law of constant composition*. Indicate briefly *two* different methods of preparing cupric oxide and how you would use your samples to verify the law.

5. Draw a diagram of Kipp's apparatus and indicate how you would charge it to produce hydrogen sulphide.

State, giving the equation in each case, the action of hydrogen sulphide on (*a*) chlorine water, (*b*) a solution of sulphur dioxide, (*c*) a solution of lead nitrate.

6. How is hydrogen chloride prepared in the laboratory? What special precautions would you take to prepare a solution of it in water?

State the action of hydrochloric acid on each of the following:

(*a*) sodium carbonate, (*b*) magnesium ribbon, (*c*) manganese dioxide, indicating in each case whether the acid is concentrated or dilute.

7. Draw a diagram of the apparatus you would use to measure accurately the volume of hydrogen liberated from a dilute acid by a metal.

How, and under what conditions, does hydrogen react with (*a*) oxygen, (*b*) copper oxide, (*c*) chlorine?

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

JANUARY 1967

Ordinary Level

PHYSICS WITH CHEMISTRY II

CHEMISTRY

One and a half hours

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TE&S 64/1431 7/2/100/5550

Turn Over

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State, giving the equation in each case, the action of hydrogen sulphide on (*a*) chlorine water, (*b*) a solution of sulphur dioxide, (*c*) a solution of lead nitrate.

6. How is hydrogen chloride prepared in the laboratory? What special precautions would you take to prepare a solution of it in water?

State the action of hydrochloric acid on each of the following: (*a*) sodium carbonate, (*b*) magnesium ribbon, (*c*) manganese dioxide, indicating in each case whether the acid is concentrated or dilute.

7. Draw a diagram of the apparatus you would use to measure accurately the volume of hydrogen liberated from a dilute acid by a metal.

How, and under what conditions, does hydrogen react with (*a*) oxygen, (*b*) copper oxide, (*c*) chlorine?

Physics
Overseas
46

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

JANUARY 1967

Ordinary Level

PHYSICS

for Candidates Overseas

Three hours

Answer SIX questions, choosing TWO from each section. Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

Section A

1. 'The acceleration due to gravity is 32 ft per sec per sec.' Explain what this statement means and describe an experiment to check the value given.

A horizontal force of 2 lb wt is applied for a period of 4 seconds to a body of mass 12 lb causing it to accelerate uniformly from rest along a rough horizontal surface. At the end of this period the velocity of the body is found to be 15 ft per sec. Determine the frictional force between the body and the horizontal surface. The force of 2 lb wt is now removed and the body continues to slide until it finally comes to rest under the action of the frictional force. Determine the retardation (negative acceleration) during this second stage of its motion.

Turn Over

TE&S 64/1398 6/2/100/7250

2. State *Boyle's law* and describe an experiment to verify it for air. Your description must include a diagram of the apparatus used together with a statement of the precautions taken and a clear explanation of the way you would make use of your observations.

A long narrow-bore glass tube of uniform section is sealed at one end, the other end being open to the atmosphere. An unbroken thread of mercury, 5 cm long, encloses a column of air of length 30 cm when the tube is held horizontally. Assuming that the barometric height is 75 cm of mercury, determine the length of this air column when the tube is held vertically with the open end (*a*) downwards and (*b*) upwards.

3. (*a*) Give a diagram of the common lift pump and explain its action.

(*b*) Describe the structure and mode of action of an aneroid barometer. State a disadvantage that this barometer has compared with the simple mercury type.

4. Answer any *two* of the following:

(*a*) State *either* the triangle *or* the parallelogram *law of forces* and use it to solve the following problem. A 5 lb weight is suspended at the end of a light cord and is pulled aside and held in equilibrium by a horizontal force of 3 lb wt. Find the tension in the cord and its inclination to the vertical.

(*b*) Explain the terms *machine*, *mechanical advantage* and *velocity ratio*. Derive the relation between the last two quantities and the efficiency of a machine.

A machine has a velocity ratio of 4 and an efficiency of 65%. Determine the load that may be raised by applying an effort of 12·5 lb wt.

(*c*) State the *law of flotation*.

A thin metal box has a rectangular base that measures 2 ft by 1 ft 6 in and vertical sides. It is open at the top and has a mass of 30 lb. Determine the depth to which it will sink when floating freely in water. Paraffin oil of specific gravity 0·8 is now poured into the box until the level of the oil inside is the same as that of the water outside. What is now the depth immersed? [You may ignore the thickness of the metal. Density of water = 62·5 lb per cu ft.]

Section B

5. Define *calorie* and *specific heat*.

Describe how you would determine the latent heat of vaporisation of water at its normal boiling point. Your account must include a carefully drawn diagram of the apparatus used and a clear explanation of how you deduce the result from the readings taken.

An aluminium tray has a mass of 200 gm and contains $\frac{1}{2}$ litre of water at 20° C. It is put into the freezing compartment of a refrigerator. If the contents of the tray just completely solidify in 90 minutes determine the rate at which the refrigerator absorbs heat. What fraction of the total heat lost was given up by the tray?

[Latent heat of fusion of ice = 80 cal per gm; specific heat of aluminium = 0·21 cal per gm per deg C.]

6. Answer any *two* of the following:

(*a*) Explain the term *mechanical equivalent of heat* and describe an experiment to determine its value.

(*b*) What is meant by the statement, 'The coefficient of linear expansion of iron is 0·000012 per deg C'?

Describe an experiment to check the accuracy of this statement.

(*c*) Give a labelled diagram of a maximum and minimum thermometer and explain its action.

7. Define *refractive index* and *critical angle* and state how they are related. Describe an apparent depth method for determining the refractive index of a transparent liquid such as water.

A transparent solid glass cube has sides of length 10 cm and one of its faces is silvered. The cube is placed on a horizontal plane surface with the silvered face vertical and on the side remote from the observer. A pin is placed upright at a distance of 5 cm in front of the cube so that its image can be seen in the silvered face. An observer looks into the cube so that his eye, the pin and its image all lie in the same straight line. Calculate the distance of the image from the object pin. [Refractive index of glass relative to air = 1·5.]

Turn Over

8. (*a*) Give a labelled diagram of the human eye and explain briefly its action. How is the eye (i) able to focus clearly objects at varying distances from it, and (ii) able to control the amount of light which enters it?

(*b*) A person's near-point is 10 inches in front of his eye and he wishes to use a converging (convex) lens so as to produce, at his near-point, an image of a small object with a magnification of 3. Determine, graphically or otherwise, the focal length of the lens required if it is held close to the eye. State the sign convention used if the problem is solved by calculation.

9. What three factors decide the pitch of the note produced when a stretched wire is plucked or bowed and in what way do they do so? Describe an experiment to test your statement in regard to any one of these factors.

A vibrating tuning fork of frequency 480 cycles per sec is held at the open end of an air column whose length can be varied by means of a piston. If the note which is heard is loudest when the length of the column is first 17·3 cm and then when it is 52·3 cm, calculate the velocity of sound in air.

Section C

10. Explain what is meant by *magnetic field* and *magnetic line of force*.

If a piece of soft iron is placed in a magnetic field, describe what happens to (*a*) the iron, (*b*) the magnetic field. Illustrate with a diagram.

Describe how you would plot a magnetic field using a small compass.

Give a diagram showing the lines of force in the neighbourhood of a bar magnet placed horizontally with its axis in the earth's magnetic meridian and its N-seeking pole pointing *south*. Mark the positions of the neutral points.

11. Describe a gold leaf electroscope and explain how it would be used to show that:

(*a*) the charge on an ebonite rod rubbed with fur is of opposite sign to the charge on a glass rod rubbed with silk;

(*b*) the charge on one insulated metal sphere is greater than that on another;

(*c*) the potential of one insulated charged conductor differs from that of another.

State and explain what happens when an earthed conductor is gradually brought nearer to the cap of a charged electroscope.

12. Define *electrochemical equivalent* and describe how the electrochemical equivalent of copper may be accurately determined, giving a full circuit diagram with anode, cathode and electrolyte clearly marked.

Explain briefly how the knowledge of the electrochemical equivalent of a metal may be used in industrial electroplating.

If a total charge of 12,060 coulombs is required to liberate 1 gm of oxygen, calculate the electrochemical equivalent of an element which has a chemical equivalent of 29·3. [Chemical equivalent of oxygen = 8.]

13. A car spotlight bulb is labelled '12 volt, 24 watt'. What does this mean and what current will be passing through the bulb when it is being used correctly?

Describe how you would test by experiment that the bulb is correctly labelled.

What would be the total resistance in the circuit if this spotlight and two other lamps each of which is rated 12 volt, 0·3 amp (and being so used) were all connected in parallel? Calculate also the total energy consumed each minute by the lamps when a potential difference of 12 volts is applied across them and state what happens to this energy.

Turn Over

14. Answer any *two* of the following:

(*a*) Describe with the help of a circuit diagram how to compare the electromotive forces of two cells by the potentiometer method.

(*b*) Describe, with the aid of a diagram, a *moving coil loudspeaker* and explain its action. Why should a larger diameter loudspeaker produce a greater volume of sound than one of smaller diameter?

(*c*) Describe the structure and give the action of a *hot wire* ammeter. Explain one advantage and one disadvantage of this instrument.

Physics
Overseas
46

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

JANUARY 1966

Ordinary Level

PHYSICS

for Candidates Overseas

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Assume that 1 gallon of water weighs 10 lb; 1 h.p. = 550 ft lb wt per sec.

Section A

1. Draw a diagram to show a force exerting a clockwise moment and explain how you would calculate its moment. Describe an experiment to verify the law of moments.

Loads of 15 lb and 25 lb are carried at the two ends of a uniform bar 4 ft long. What will be the exact position of the point of support to maintain the bar horizontal assuming its weight may be neglected?

If the point of support is found to be 19 inches from the 25 lb load, calculate the weight of the bar.

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Turn Over

2. State *Archimedes' principle* and use it to derive the law which applies to floating bodies. Describe an experiment based on Archimedes' principle to determine the specific gravity of an unknown liquid. Explain how the result is obtained.

A flat piece of cork of mass 20·0 gm is floated on paraffin of density 0·80 gm per cc. Weights are gradually added on top of the cork until the liquid just covers the cork. If the added weights amount to 44·0 gm, calculate the density of the cork.

3. State *Boyle's law* and describe an experiment to test it for air. Indicate how the conditions have been maintained for which Boyle's law applies.

On a day when the atmospheric pressure is 75·0 cm of mercury the mercury column in a vertical barometer tube is only 72·0 cm in length and the space above the mercury 25·0 cm in length. If the tube is of uniform cross-section of area 0·80 sq cm, calculate the volume of air at atmospheric pressure which has been trapped above the mercury.

4. Answer any *two* of the following:

(*a*) Define *uniform acceleration.* A car starts from rest and moves with a uniform acceleration of 2 ft per sec per sec for $\frac{1}{2}$ min. It then travels at a uniform velocity for another 5 min and is finally brought to rest with a uniform retardation in 10 sec. What is the total distance covered by the car?

(*b*) Distinguish between *energy* and *power*.

Calculate the minimum horse-power of an engine used for pumping 12,000 gallons of water per hour from a depth of 50 ft. Explain why the horse-power will need to be greater than this.

(*c*) Give a labelled diagram of a pulley block and tackle with a velocity ratio of 5 and calculate its efficiency if a load of 50 lb wt is just raised by an effort of 16 lb wt. Give reasons for the low efficiency.

Section B

5. Why is mercury commonly used in thermometers in preference to alcohol?

Explain why an alcohol thermometer might be preferred in some circumstances.

Draw a clearly labelled diagram of a clinical thermometer and explain its action.

Calculate (*a*) the centigrade temperature corresponding to 140° F, (*b*) the Fahrenheit temperature corresponding to 140° C.

6. Answer any *two* of the following:

(*a*) Define *latent heat of fusion* of a substance. Describe an experiment to measure the latent heat of fusion of ice and explain how the result is calculated.

(*b*) Distinguish between the transmission of heat by *conduction*, *convection* and *radiation.* Why is paper used to wrap round a carton of ice cream in order to delay its melting, and why are several thin sheets of paper preferable to one thick sheet?

(*c*) Explain the meaning of (i) relative humidity, (ii) dew point.

How would you determine the dew point on a particular day?

7. Explain the meanings of *principal focus* and *focal length* of a concave mirror. Describe one use of a concave mirror and explain how an accurate value of its focal length can be determined by experiment.

What is the focal length of a concave mirror which produces, at a point on the axis distant 18 cm from its pole, a real inverted image exactly twice the size of the object?

How far and in what direction would the object have to be moved for the image to have the same magnification but to be upright instead of inverted?

8. (*a*) Explain what is meant by the *refractive index* of a material relative to air and describe an experiment to determine its value for glass by tracing light rays through a glass block.

(*b*) Explain how a prism disperses a narrow beam of white light into its component colours.

Draw a diagram showing the arrangement of the apparatus to project a pure spectrum of white light on a screen and show the paths of rays that produce the blue and the red in the spectrum.

9. Define *frequency* and *wavelength* as applied to a sound wave in air.

Describe how the velocity of sound in air may be measured.

How, if at all, is the velocity of sound in a gas affected by the following changes: (*a*) an increase in temperature, (*b*) an increase in pressure, and (*c*) a reduction in frequency?

If the velocity of sound in air is 330 metres per sec, calculate the frequency of a note whose wavelength is 60 cm.

Turn Over

Section C

10. Explain the terms *neutral point* and *line of force*.

Describe how you would magnetise a steel bar (*a*) by an electrical method and (*b*) by means of another magnet, so that a marked end becomes a north-seeking pole. Show how you can test whether you have succeeded.

Soft iron is often used in the construction of the cores of electromagnets. Give reasons for this choice of material.

11. Explain what is meant by a *condenser* and define its *capacitance*.

Describe experiments, one in each instance, to show how the capacitance of a parallel plate condenser depends upon (*a*) the distance between the plates, (*b*) the area of the plates, and (*c*) the material between them. Explain why the observations justify your conclusions.

12. Define *resistivity* (specific resistance) and derive a unit in which it may be expressed.

Describe an experiment to determine the resistivity of a material available in the form of a long wire. Give a circuit diagram showing how you would use the apparatus you select and indicate clearly how you obtain the final result from the readings taken.

What resistor must be connected in parallel with a coil of resistance 5 ohms to produce a combined resistance of 3 ohms?

13. Explain how you would show that a bar magnet may be used to produce an electromotive force in a coil of insulated wire. State the factors affecting the magnitude of this emf and give a diagram that shows clearly how its direction is related to the way in which the magnet is used.

A flat coil rotates about an axis in its plane between the poles of a horse-shoe magnet, the axis being perpendicular to the field. Show graphically how the electromotive force in the coil varies with time as the coil is rotated at constant speed. What is the angle between the plane of the coil and the magnetic field when the emf is at a maximum?

Indicate how a direct current could be obtained from the coil.

14. Answer any *two* of the following:

(*a*) Define the *coulomb*.

A copper voltameter has two plates only and a current is passed through it for 30 min. It is found that the increase in the mass of the cathode is 0·50 gm. What current is flowing in the circuit, and what is the resistance between the two plates if they are connected directly to a cell of constant e.m.f. 2·0 volts and internal resistance 0·50 ohm?

[Electrochemical equivalent of copper = 0·00033 gm per coulomb.]

(*b*) Describe the construction and mode of action of a carbon microphone.

(*c*) Define the *watt* and the *volt*.

Two wires of resistance 6 and 9 ohms are connected (i) in series, (ii) in parallel with a 60 volt supply of negligible resistance. Determine the current drawn from the supply and the *total* heat developed per second in each of the two cases.

[Assume 1 calorie = 4·2 joules.]

Physics
46

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

SUMMER 1966

Ordinary Level

PHYSICS

Three hours

Answer SIX questions, choosing TWO from each section. Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

Assume that $g = 32$ ft per sec per sec; 1 calorie = 4·2 joules.

Section A

1. Define *energy* and distinguish between *potential* energy and *kinetic* energy.

Show that the gain in kinetic energy of a body falling freely from rest under gravity is equal to its loss in potential energy.

A platform which is used to raise material is moving vertically upwards with a uniform velocity of 8 ft per sec when a stone accidentally falls over the edge. If the height of the platform at the moment the stone leaves it is 48 ft above ground level, determine (i) the time interval between the stone leaving the platform and attaining its greatest vertical height, (ii) the velocity of impact with the ground.

If the stone has a mass of 2 oz determine the kinetic energy on impact and indicate how this energy may be dissipated.

TE&S 64/1396 6/2/100/38850

Turn Over

2. Describe an experiment to show that a floating body is displacing its own weight of the liquid in which it floats.

Draw a diagram of a common hydrometer suitable for measuring specific gravities over a range of 0·8 to 1·0. State the reasons for the particular features in its design.

A cylindrical tube of uniform section, sealed flat at its lower end and containing lead shot, floats upright in water with 2 cm of its length projecting above the free surface of the liquid. When the water is replaced by a liquid of specific gravity 0·9 the length projecting above the surface is reduced to 1 cm. Determine the total length of the cylinder.

3. Distinguish between *mass* and *weight* and explain why the weight of a body changes on moving it from the equator to one of the poles.

Describe an experiment you would carry out in order to determine the position of the centre of gravity of a flat closed wire frame of irregular shape. Explain how you would mark the position of the centre of gravity.

A uniform rod, AB, of length 8 ft and mass 7 lb rests horizontally across two supports placed 6 ft apart, one support being in contact with the end B of the rod. Calculate the reactions at the supports. At what distance from A must a load of 8 lb wt be suspended in order that the rod shall just leave the support at B?

4. Answer any *two* of the following:

(*a*) State the *parallelogram law of forces* and describe an experiment, which applies the law, to determine the weight of a lump of metal. Your account must include a diagram of the experimental arrangement of your apparatus together with a clear explanation of how you deduce the final result.

(*b*) Define *coefficient of friction* and describe an experiment to determine its value for a wooden block and a horizontal table top.

(*c*) 'One horse-power is equal to 550 ft lb wt per second.'

Explain the terms *power* and *ft lb wt* in the above statement.

A flight of stairs contains 18 separate steps each of vertical height 9 inches and a boy is found to take 5 sec to run from the bottom to the top of the flight. If the weight of the boy is 7 st 12 lb determine the minimum horse-power that he must develop. Why, in fact, will his rate of working be in excess of your calculated value?

$\frac{18 \times 3}{4} = \frac{54}{4} = 13\frac{1}{2} \times$ 54

13.5×110

Section B

5. How does the volume of a fixed mass of an ideal gas vary with its temperature when its pressure is kept constant? Describe an experiment that you would perform in order to test the relationship for air.

A gas is contained at a pressure of 1 atmosphere and temperature 20° C inside a sealed glass globe which fractures when the pressure inside rises above 2 atmospheres. Determine the maximum temperature to which the globe may be raised before it breaks. You may neglect the expansion of the globe.

6. Answer any *two* of the following:

(*a*) Give an account of the transfer of heat by conduction and describe an experiment that shows that copper is a better conductor of heat than iron.

(*b*) What is meant by the *thermal capacity* of a body?

An iron nut of mass 56 gm is heated in a bunsen flame until the temperature becomes steady and is then transferred rapidly to a deep hole in a large block of ice. The top of the hole is covered immediately with a block of the same ice, to act as a lid. When thermal conditions have become steady, the lid is removed and the water formed in the cavity is absorbed by a weighed dry sponge. Ths sponge is found to have increased in weight by 75·6 gm.

Assuming that the latent heat of fusion of ice is 80 cal per gm and that the specific heat of iron is 0·12 cal per gm per deg C calculate the temperature to which the nut was heated by the bunsen flame.

State *two* possible sources of error in this experiment.

(*c*) State *three* good reasons why water is considered unsuitable for use in thermometers.

Give a labelled diagram of a clinical thermometer and describe its action.

Turn Over

7. (*a*) State the laws of reflection of light and describe how you would verify one of them.

What are the characteristics of an image formed by reflection in a plane mirror?

(*b*) A converging (convex) lens has a focal length of 20 cm and forms a virtual image three times the size of an object placed in front of it. Using a scale of 1 inch to represent 10 cm make an accurate scale drawing to determine the position of the object. Check your result by calculation, stating clearly the sign convention that you adopt.

8. What are the factors which decide the intensity of illumination of a surface illuminated by a source of light?

Describe how you would use a simple form of photometer in order to compare the luminous intensities (candle powers) of two lamps.

An 80 candle power lamp is placed 4 ft above a horizontal table. What is the intensity of illumination at a point on the table, immediately below the lamp?

Determine the intensity of illumination at the same point when a plane mirror is placed 8 ft from the table and parallel to it so that the lamp lies between them. Assume that the mirror reflects all the light that is incident upon it.

9. Give examples of how we recognise that sound travels with a finite speed very much less than that of light and that different sounds travel with the same speed.

Describe how the speed of sound in air at ordinary temperatures may be measured.

Explain how sound is produced when a stringed instrument is plucked and the manner in which the sound travels through air to the listener.

Section C

10. Give an account of the theory explaining the magnetisation of a ferromagnetic material such as iron or steel and describe briefly two experiments which may have led up to this theory.

Use the theory to explain

(*a*) what happens when a magnet is used to stroke a piece of steel;

(*b*) why a horseshoe magnet stored without a keeper is liable to become demagnetised and how keepers help magnets to retain their magnetisation.

11. Explain why the leaf of a gold leaf electroscope rises when a positively charged rod is held near the cap and how the electroscope may be given a permanent positive charge using a negatively charged rod. How would you use the positively charged electroscope to test the sign of the charge on some other charged rod?

A flat plate is placed on the cap of an electroscope which is then given a permanent charge. A second plate held in the hand is brought close to the first plate. *Explain* what happens to the gold leaf and how the capacitance of the arrangement has been altered.

12. (*a*) Give a diagram showing the structure of a *dry* cell.

Label the components and describe the part which each one plays in the working of the cell.

(*b*) Define *electromotive force*. Calculate the total energy provided by a battery of e.m.f. 2·50 volts when it causes a steady current of 0·40 amp to flow for 15 min through an electric bulb.

If the battery had an internal resistance of 2·00 ohms, calculate the number of calories of heat dissipated in the electric bulb in that time.

Turn Over

13. Describe the structure and explain the action of an instrument used for measuring or indicating an electric current. Illustrate with a clearly labelled diagram.

An accumulator of e.m.f. 2·0 volts and negligible internal resistance is connected in series with a resistor of resistance 50 ohms and an ammeter of resistance 5 ohms. A voltmeter of resistance 450 ohms is connected in parallel with the 50 ohm resistor.

Calculate the readings of (*a*) the ammeter (*b*) the voltmeter.

14. Answer any *two* of the following:

(*a*) Draw a clearly labelled diagram showing the structure of an electric bell and the continuous electric circuit when it is connected to a battery and a bell push.

Explain the function of each of the main parts of the bell.

(*b*) An induction coil consists of a primary coil of thick insulated wire wound round a bundle of soft iron wires and a secondary coil with hundreds of turns of fine insulated wire wound over the primary. A vibrator interrupts the electric current passing through the primary coil at a rapid rate. *Explain*

(i) why an e.m.f. is produced in the secondary coil;

(ii) the factors that decide the magnitude of this emf;

(iii) the reason for using a bundle of iron wires and not a solid piece of iron.

(*c*) Describe the structure of a *diode* valve and state the circumstances in which a current will flow between its electrodes.

Draw the diagram of the circuit which would be set up to test your statement and give a use of the diode.

$\frac{1}{R} = \frac{1}{50} + \frac{1}{450} = \frac{10}{450} = \frac{1}{45}$, $R_{AV} = 45\Omega$

$I = \frac{2}{45+5} = \frac{2}{50} = \frac{1}{25}$ amps

2000

102
420

v = 40
u = 40/3

16³ : energy

t = 8 sec

v = 256

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

SUMMER 1966

Ordinary Level

PHYSICS

Three hours

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TE&S 64/1396 6/2/100/38850

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Explain how sound is produced when a stringed instrument is plucked and the manner in which the sound travels through air to the listener.

Section C

10. Give an account of the theory explaining the magnetisation of a ferromagnetic material such as iron or steel and describe briefly two experiments which may have led up to this theory.

Use the theory to explain

(*a*) what happens when a magnet is used to stroke a piece of steel;

(*b*) why a horseshoe magnet stored without a keeper is liable to become demagnetised and how keepers help magnets to retain their magnetisation.

11. Explain why the leaf of a gold leaf electroscope rises when a positively charged rod is held near the cap and how the electroscope may be given a permanent positive charge using a negatively charged rod. How would you use the positively charged electroscope to test the sign of the charge on some other charged rod?

A flat plate is placed on the cap of an electroscope which is then given a permanent charge. A second plate held in the hand is brought close to the first plate. *Explain* what happens to the gold leaf and how the capacitance of the arrangement has been altered.

12. (*a*) Give a diagram showing the structure of a *dry* cell.

Label the components and describe the part which each one plays in the working of the cell.

(*b*) Define *electromotive force*. Calculate the total energy provided by a battery of e.m.f. 2·50 volts when it causes a steady current of 0·40 amp to flow for 15 min through an electric bulb.

If the battery had an internal resistance of 2·00 ohms, calculate the number of calories of heat dissipated in the electric bulb in that time.

Turn Over

13. Describe the structure and explain the action of an instrument used for measuring or indicating an electric current. Illustrate with a clearly labelled diagram.

An accumulator of e.m.f. 2·0 volts and negligible internal resistance is connected in series with a resistor of resistance 50 ohms and an ammeter of resistance 5 ohms. A voltmeter of resistance 450 ohms is connected in parallel with the 50 ohm resistor.

Calculate the readings of (*a*) the ammeter (*b*) the voltmeter.

14. Answer any *two* of the following:

(*a*) Draw a clearly labelled diagram showing the structure of an electric bell and the continuous electric circuit when it is connected to a battery and a bell push.

Explain the function of each of the main parts of the bell.

(*b*) An induction coil consists of a primary coil of thick insulated wire wound round a bundle of soft iron wires and a secondary coil with hundreds of turns of fine insulated wire wound over the primary. A vibrator interrupts the electric current passing through the primary coil at a rapid rate. *Explain*

(i) why an e.m.f. is produced in the secondary coil;

(ii) the factors that decide the magnitude of this emf;

(iii) the reason for using a bundle of iron wires and not a solid piece of iron.

(*c*) Describe the structure of a *diode* valve and state the circumstances in which a current will flow between its electrodes.

Draw the diagram of the circuit which would be set up to test your statement and give a use of the diode.

Physics
46

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

SUMMER 1966

Ordinary Level

PHYSICS

Three hours

Answer SIX questions, choosing TWO from each section. Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

Assume that $g = 32$ ft per sec per sec; 1 calorie $= 4{\cdot}2$ joules.

Section A

1. Define *energy* and distinguish between *potential* energy and *kinetic* energy.

Show that the gain in kinetic energy of a body falling freely from rest under gravity is equal to its loss in potential energy.

A platform which is used to raise material is moving vertically upwards with a uniform velocity of 8 ft per sec when a stone accidentally falls over the edge. If the height of the platform at the moment the stone leaves it is 48 ft above ground level, determine (i) the time interval between the stone leaving the platform and attaining its greatest vertical height, (ii) the velocity of impact with the ground.

If the stone has a mass of 2 oz determine the kinetic energy on impact and indicate how this energy may be dissipated.

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Turn Over

2. Describe an experiment to show that a floating body is displacing its own weight of the liquid in which it floats.

Draw a diagram of a common hydrometer suitable for measuring specific gravities over a range of 0·8 to 1·0. State the reasons for the particular features in its design.

A cylindrical tube of uniform section, sealed flat at its lower end and containing lead shot, floats upright in water with 2 cm of its length projecting above the free surface of the liquid. When the water is replaced by a liquid of specific gravity 0·9 the length projecting above the surface is reduced to 1 cm. Determine the total length of the cylinder.

3. Distinguish between *mass* and *weight* and explain why the weight of a body changes on moving it from the equator to one of the poles.

Describe an experiment you would carry out in order to determine the position of the centre of gravity of a flat closed wire frame of irregular shape. Explain how you would mark the position of the centre of gravity.

A uniform rod, AB, of length 8 ft and mass 7 lb rests horizontally across two supports placed 6 ft apart, one support being in contact with the end B of the rod. Calculate the reactions at the supports. At what distance from A must a load of 8 lb wt be suspended in order that the rod shall just leave the support at B?

4. Answer any *two* of the following:

(*a*) State the *parallelogram law of forces* and describe an experiment, which applies the law, to determine the weight of a lump of metal. Your account must include a diagram of the experimental arrangement of your apparatus together with a clear explanation of how you deduce the final result.

(*b*) Define *coefficient of friction* and describe an experiment to determine its value for a wooden block and a horizontal table top.

(*c*) 'One horse-power is equal to 550 ft lb wt per second.'

Explain the terms *power* and *ft lb wt* in the above statement.

A flight of stairs contains 18 separate steps each of vertical height 9 inches and a boy is found to take 5 sec to run from the bottom to the top of the flight. If the weight of the boy is 7 st 12 lb determine the minimum horse-power that he must develop. Why, in fact, will his rate of working be in excess of your calculated value?

Section B

5. How does the volume of a fixed mass of an ideal gas vary with its temperature when its pressure is kept constant? Describe an experiment that you would perform in order to test the relationship for air.

A gas is contained at a pressure of 1 atmosphere and temperature 20° C inside a sealed glass globe which fractures when the pressure inside rises above 2 atmospheres. Determine the maximum temperature to which the globe may be raised before it breaks. You may neglect the expansion of the globe.

6. Answer any *two* of the following:

(*a*) Give an account of the transfer of heat by conduction and describe an experiment that shows that copper is a better conductor of heat than iron.

(*b*) What is meant by the *thermal capacity* of a body?

An iron nut of mass 56 gm is heated in a bunsen flame until the temperature becomes steady and is then transferred rapidly to a deep hole in a large block of ice. The top of the hole is covered immediately with a block of the same ice, to act as a lid. When thermal conditions have become steady, the lid is removed and the water formed in the cavity is absorbed by a weighed dry sponge. Ths sponge is found to have increased in weight by 75·6 gm.

Assuming that the latent heat of fusion of ice is 80 cal per gm and that the specific heat of iron is 0·12 cal per gm per deg C calculate the temperature to which the nut was heated by the bunsen flame.

State *two* possible sources of error in this experiment.

(*c*) State *three* good reasons why water is considered unsuitable for use in thermometers.

Give a labelled diagram of a clinical thermometer and describe its action.

Turn Over

7. (*a*) State the laws of reflection of light and describe how you would verify one of them.

What are the characteristics of an image formed by reflection in a plane mirror?

(*b*) A converging (convex) lens has a focal length of 20 cm and forms a virtual image three times the size of an object placed in front of it. Using a scale of 1 inch to represent 10 cm make an accurate scale drawing to determine the position of the object. Check your result by calculation, stating clearly the sign convention that you adopt.

8. What are the factors which decide the intensity of illumination of a surface illuminated by a source of light?

Describe how you would use a simple form of photometer in order to compare the luminous intensities (candle powers) of two lamps.

An 80 candle power lamp is placed 4 ft above a horizontal table. What is the intensity of illumination at a point on the table, immediately below the lamp?

Determine the intensity of illumination at the same point when a plane mirror is placed 8 ft from the table and parallel to it so that the lamp lies between them. Assume that the mirror reflects all the light that is incident upon it.

9. Give examples of how we recognise that sound travels with a finite speed very much less than that of light and that different sounds travel with the same speed.

Describe how the speed of sound in air at ordinary temperatures may be measured.

Explain how sound is produced when a stringed instrument is plucked and the manner in which the sound travels through air to the listener.

Section C

10. Give an account of the theory explaining the magnetisation of a ferromagnetic material such as iron or steel and describe briefly two experiments which may have led up to this theory.

Use the theory to explain

(*a*) what happens when a magnet is used to stroke a piece of steel;

(*b*) why a horseshoe magnet stored without a keeper is liable to become demagnetised and how keepers help magnets to retain their magnetisation.

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Label the components and describe the part which each one plays in the working of the cell.

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If the battery had an internal resistance of 2·00 ohms, calculate the number of calories of heat dissipated in the electric bulb in that time.

Turn Over

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An accumulator of e.m.f. 2·0 volts and negligible internal resistance is connected in series with a resistor of resistance 50 ohms and an ammeter of resistance 5 ohms. A voltmeter of resistance 450 ohms is connected in parallel with the 50 ohm resistor.

Calculate the readings of (*a*) the ammeter (*b*) the voltmeter.

14. Answer any *two* of the following:

(*a*) Draw a clearly labelled diagram showing the structure of an electric bell and the continuous electric circuit when it is connected to a battery and a bell push.

Explain the function of each of the main parts of the bell.

(*b*) An induction coil consists of a primary coil of thick insulated wire wound round a bundle of soft iron wires and a secondary coil with hundreds of turns of fine insulated wire wound over the primary. A vibrator interrupts the electric current passing through the primary coil at a rapid rate. *Explain*

(i) why an e.m.f. is produced in the secondary coil;

(ii) the factors that decide the magnitude of this emf;

(iii) the reason for using a bundle of iron wires and not a solid piece of iron.

(*c*) Describe the structure of a *diode* valve and state the circumstances in which a current will flow between its electrodes.

Draw the diagram of the circuit which would be set up to test your statement and give a use of the diode.

Physics
Overseas
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UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

JANUARY 1965

Ordinary Level

PHYSICS

for Candidates Overseas

Three hours

Answer SIX questions, choosing TWO from each section. Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

Section A

1. Explain the meaning of the statement that the acceleration due to gravity is 980 cm. per sec. per sec.

Describe an experiment to determine this acceleration.

A stone is thrown vertically upwards and returns to the thrower 3 seconds later. Find (*a*) the greatest height reached by the stone, (*b*) its initial velocity, (*c*) its position and velocity after one second.

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Turn Over

2. State *Archimedes' principle* and describe an experiment to test its truth.

What is the specific gravity of a solid which weighs 54 gm. wt. in air and 34 gm. wt. completely immersed in water? If the solid is suspended by a string so that it is completely immersed in a liquid of specific gravity 0·75, what is the tension in the string?

3. Define *work*, *efficiency of a machine*.

With the aid of a diagram, explain the action of a hydraulic press.

In operating a hydraulic press, a force of 400 lb. wt. applied to the plunger produces a thrust on the ram of 4,800 lb. wt. The diameters of the plunger and ram are 1·5 in. and 6 in. respectively, and the distance travelled by the plunger in one stroke is 5 in. Find (*a*) the work done on the ram in one stroke, (*b*) the efficiency of the press.

4. Answer any *two* of the following:

(*a*) Describe how to set up a simple mercury barometer. Explain how it is used.

Give two reasons for the choice of mercury as the barometric liquid.

(*b*) Define *centre of gravity*.

A tapering rod, one metre long, is supported by spring balances, one at each end, so that its axis is horizontal. If the readings of the spring balances are 90 gm. wt. and 30 gm. wt. respectively, find the weight of the rod and the position of its centre of gravity. Where must a 100 gm. wt. be hung from the rod so that the readings of the balances are equal when the axis of the rod is horizontal?

(*c*) State the conditions of equilibrium for three non-parallel coplanar forces.

The bob of a simple pendulum of mass 20 gm. is drawn aside by a horizontal force until the thread makes an angle of 30° with the vertical. Find the tension in the thread and the horizontal force.

Section B

5. State *Charles' law* and describe an experiment to illustrate it. Show how a value of the absolute zero of temperature may be deduced from the observations.

Hydrogen is pumped into a steel cylinder until its pressure is 1,000 cm. of mercury. If the temperature of the gas is then 47°C. what will its pressure become if the temperature falls to 15°C.?

6. Answer any *two* of the following:

(*a*) Draw a labelled diagram of a maximum and minimum thermometer and explain how it works.

(*b*) Distinguish between the processes of *conduction* and *convection* and give one example of each.

(*c*) Explain the statement that heat is a form of energy. Give a brief description of an experiment to determine the relation between a unit of heat energy and a unit of mechanical energy.

7. (*a*) Explain *total internal reflection* of light and state the circumstances in which it occurs.

Draw diagrams to show how a right-angled isosceles prism may be used to deviate a narrow parallel beam of light through (i) 90°, (ii) 180°. Explain briefly the action of the prism in each instance.

(*b*) With the aid of a ray diagram, show what is meant by the *principal focus* of a convex mirror.

A mirror forms a virtual image of a small object placed on its axis. If the distances of the object and image from the mirror are respectively 10 cm. and 30 cm., find its radius of curvature. State whether the mirror is concave or convex.

8. Describe an experiment to obtain a reliable value for the focal length of a converging lens.

With the aid of ray diagrams, explain the use of (*a*) a converging lens as a magnifying glass, (*b*) a diverging lens to correct defective vision.

Turn Over

9. What is meant by *resonance*? Give one example of resonance in sound and one in another branch of Physics.

Describe an experiment to compare the frequencies of two tuning forks.

Why is there a difference in the quality of the notes of the same fundamental frequency emitted by closed and open organ pipes?

Section C

10. Give *two* entirely different methods of magnetising a steel knitting needle and in each instance indicate the polarity of the magnet obtained.

Describe *three* different tests to show that the needle is magnetised and *two* effective methods by which it can be demagnetised.

11. Describe *one* experiment in each instance (*a*) to determine the distribution of the charge on the surface of a conductor of irregular shape, (*b*) to compare the magnitudes of the charges on two small conductors. State the result expected in (*a*).

Describe an experiment to demonstrate the leakage of charge from the end of a pin fixed to an insulated charged conductor and explain the action of a lightning conductor.

12. State the factors which determine the rate at which heat is produced in a conductor when an electric current flows through it.

Describe an experiment to determine how this rate depends on *one* of these factors. Give a circuit diagram.

Assuming no heat losses, find how long it will take an electric heater, rated at 1600 watts, to raise the temperature of 1 litre of water from 20°C. to 100°C., if the thermal capacity of the containing vessel is 30 cal. per deg. C.

(4·2 joules = 1 calorie.)

13. State the *laws of electrolysis* and describe an experiment to verify *one* of these laws, giving a circuit diagram.

A current of 2·0 amp. passes for 15 minutes through a circuit containing a copper voltameter and a silver voltameter in series. If 0·594 gm. of copper is deposited, find (*a*) the electrochemical equivalent of copper, (*b*) the mass of silver deposited.

(At. wt. of copper 63·6; of silver 108. Valency of copper 2; of silver 1.)

14. Answer any *two* of the following:

(*a*) Draw a diagram of an electric bell, labelling the different parts and naming the materials of which they are made. Describe the action of the bell.

(*b*) A battery of two cells, each of e.m.f. 1·5 volts and internal resistance 2 ohms, is used to pass a current through a resistance of 4 ohms. What is the current when the cells are in (i) series, (ii) parallel? What is the reading of a high resistance voltmeter connected to the terminals of the battery in the circuit when the cells are in parallel and why does it differ from the e.m.f. of the battery?

(*c*) Describe an experiment to demonstrate electromagnetic induction. How would you use your apparatus to demonstrate the factors which determine the magnitude of the induced e.m.f.?

Physics
46

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

SUMMER 1965

Ordinary Level

PHYSICS

Three hours

Answer SIX questions, choosing TWO from each section.

Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

Assume $g = 32$ ft per sec per sec; $\pi = 22/7$;
1 h.p. $= 550$ ft lb wt per sec.

Section A

1. Explain what is meant by *uniform velocity*.

In an emergency stop, a car driver has a 'thinking time' of $\frac{3}{4}$ sec before beginning to apply his brakes and, when travelling at 30 m.p.h., the application of the maximum constant braking force brings the car to rest in 2 sec. Draw an accurate graph showing the variation of velocity with time during these $2\frac{3}{4}$ sec and calculate for such an emergency stop (*a*) the distance the car travels before the brakes are applied, (*b*) the negative acceleration produced by the brakes, (*c*) the distance the car travels after the brakes are applied, (*d*) the total distance covered if the car were travelling initially at 45 m.p.h., assuming that the retarding force caused by the brakes is the same as for the lower speed.

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Turn Over

2. Draw a clearly labelled diagram of *either* a screw jack *or* a Weston differential pulley, showing where the load and the effort are applied. Derive the formula for calculating the velocity ratio. Explain how the value of the velocity ratio can be found by experiment.

A machine having a velocity ratio of 50 can lift a load of 1,000 lb wt by applying an effort of 50 lb wt. Calculate (*a*) the efficiency, (*b*) the wasted energy when the load is raised 3 ft from the ground.

Explain an advantage of having a machine with a low efficiency.

3. State *Archimedes' principle* and define *specific gravity*.

Describe how the specific gravity of a solid substance may be measured accurately by the application of Archimedes' principle. Show how you obtain the expression used to calculate the result.

Calculate the volume of a metal cylinder of mass 105 gm which has an apparent weight of 92·5 gm when fully immersed in water of density 1·00 gm per cc. When a piece of wax of mass 20 gm is attached to the cylinder and both are fully immersed in water, the total apparent weight is found to be 87·5 gm. What is the density of the wax?

4. Answer any *two* of the following:

(*a*) Define *work*, *power*.

A car of mass 15 cwt starting from rest on a level road travels 200 ft in 10 sec with uniform acceleration. Assuming there were no frictional forces, what force would be necessary to accelerate the car? If there are constant frictional forces totalling 175 lb wt, what is (i) the work done by the engine during the period considered, (ii) the horse-power developed?

(*b*) Draw a diagram illustrating the principle of the hydraulic (Bramah) press and explain its action. Calculate the pressure transmitted if a load of 2,000 lb wt is supported on a circular ram of diameter 3 ft 4 in. (Neglect friction.)

(*c*) Describe carefully how you would use a siphon to remove the major part of the water contained in a large fixed tank, open at the top. Draw a diagram and use it to explain the action of the siphon.

Section B

5. (*a*) Describe one experiment in each instance to show the expansion of a solid, a liquid and a gas on heating.

(*b*) A compound strip of brass and iron is straight at room temperature. Give a labelled diagram to show its appearance when it is heated. Describe one use of such a strip.

A compound strip of brass and iron, 10 cm long at 20°C, is held horizontally with the iron uppermost. When heated from below with a bunsen, the temperature of the brass is 820°C and of the iron 770°C. Calculate the difference in lengths of the iron and the brass. (Coefficient of linear expansion of brass is 0·000019 and of iron 0·000012 per deg C.)

6. Answer any *two* of the following:

(*a*) Define *thermal capacity*, *specific heat*. State the relation between them.

In order to obtain the temperature of a freezing mixture, a 500 gm iron weight is left in it for some time. The iron is then rapidly transferred to a well-lagged copper calorimeter of mass 100 gm containing 110 gm of water at 40°C. If the final temperature of the mixture is 12·0°C, calculate the temperature of the freezing mixture. (Specific heat of iron is 0·12 and of copper 0·10 cal per gm per deg C.)

(*b*) State all the possible ways in which heat can leave hot water contained in an open thermos flask and explain how they have been minimized in the construction of the flask. Illustrate your answer with a labelled diagram.

(*c*) Distinguish between evaporation and boiling of a liquid. Describe and explain an experiment to show that evaporation requires heat.

7. (*a*) State what is meant by *refraction of light* and describe an experiment to demonstrate it.

(*b*) Give the conditions for total internal reflection to occur and illustrate with a diagram.

Draw a diagram to show how a glass prism can be used to deviate a parallel beam of light through 90° by means of total internal reflection. Explain the action of the prism.

Calculate the minimum value for the refractive index of glass for which a 90° deviation is possible.

Turn Over

8. A convex lens of focal length 2 in is used to produce on a screen an image of a film with a magnification of 3. What are the distances of the screen and the film from the lens? Draw a ray diagram showing how the image is formed. (If the results are obtained by calculation the sign convention used must be stated.)

Give a labelled diagram showing the structure of a projection lantern. Draw the paths of suitably chosen rays to illustrate the action of the instrument. Give two reasons why the image produced is said to be real and account for any slight colouration which is sometimes seen although white light has been passed through a black and white slide.

9. State the relation between the frequency of the note obtained by plucking a stretched string and the tension in the string.

Describe an experiment to verify your statement.

A note is obtained by plucking a wire 50 cm long stretched by a load of 4 kgm wt. What load must be used to give a note which is an octave above the first when (*a*) the length of the wire remains at 50 cm, (*b*) the length is reduced to 30 cm?

Section C

10. Describe how a compass needle can be used to determine the direction of the current in a straight wire when the wire is (*a*) vertical, (*b*) horizontal and lying in the meridian. In each instance, give a diagram showing how the direction of the current is obtained.

A rectangular coil of wire is suspended by a torsion fibre between the poles of a horseshoe magnet with the plane of the coil parallel to the field. Explain why the coil is deflected when a current passes through it. State the factors which determine the magnitude of the deflection of the coil and indicate how they do so. Give a rule by which its direction of motion can be obtained and illustrate with a diagram.

11. Describe, with the aid of diagrams, how a gold leaf electroscope can be charged positively by induction and explain what happens at each stage of the process.

A tall hollow metal can stands on the cap of a gold leaf electroscope. A charged insulated metal ball is made to touch the outside of the can. Why is the divergence of the leaves different from that which would be observed if the ball had been lowered into the can to touch the bottom?

Describe an experiment to show that the total charge induced by a conductor equals the inducing charge.

12. Explain the terms *anode*, *cathode*.

Describe an experiment to check the accuracy of the 1 amp reading of an ammeter, assuming that a value for the electrochemical equivalent of copper is available.

What is the cost of depositing a layer of silver 0·2 mm thick on an object of total surface area 150 sq cm if a current of 1 amp used for an hour costs 2*d*? (Density of silver is 10·5 gm per cc; electrochemical equivalent of silver is 0·00112 gm per coulomb.)

13. State the factors which determine the resistance of a uniform metal wire and indicate how they do so.

Give a labelled diagram of a metre bridge and describe how it is used to measure a resistance of about 10 ohms. The theory of the method is not required.

Resistors of 6 ohms and 8 ohms are connected in parallel to a battery of e.m.f. 12 volts and of internal resistance 6 ohms. What is the current in each resistor?

14. Answer any *two* of the following:

(*a*) Give a diagram showing the structure of a Daniell cell, naming its components.

State one advantage and one disadvantage of the cell and explain on what factors its internal resistance depends.

(*b*) Describe the structure and give the action of a hot wire ammeter. Why is it suitable for measuring both alternating and direct current?

(*c*) State *Lenz's law*.

The ends of a solenoid are connected together by a wire. Give diagrams showing the direction of the current (if any) induced in the solenoid when the N. pole of a magnet is (i) thrust into the solenoid, (ii) at rest in the solenoid, (iii) rapidly withdrawn.

A copper disc is rotated by an electric motor. Explain why the disc comes to rest more quickly when the current is cut off if the disc rotates between the poles of a horseshoe magnet.

Induced current in the disc (eddy current) bringing about forces which tend to oppose the motion by Lenz's law

Physics
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UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

SUMMER 1965

Ordinary Level

PHYSICS

Three hours

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Turn Over

2. Draw a clearly labelled diagram of *either* a screw jack *or* a Weston differential pulley, showing where the load and the effort are applied. Derive the formula for calculating the velocity ratio. Explain how the value of the velocity ratio can be found by experiment.

   A machine having a velocity ratio of 50 can lift a load of 1,000 lb wt by applying an effort of 50 lb wt. Calculate (*a*) the efficiency, (*b*) the wasted energy when the load is raised 3 ft from the ground.

   Explain an advantage of having a machine with a low efficiency.

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   Describe how the specific gravity of a solid substance may be measured accurately by the application of Archimedes' principle. Show how you obtain the expression used to calculate the result.

   Calculate the volume of a metal cylinder of mass 105 gm which has an apparent weight of 92·5 gm when fully immersed in water of density 1·00 gm per cc. When a piece of wax of mass 20 gm is attached to the cylinder and both are fully immersed in water, the total apparent weight is found to be 87·5 gm. What is the density of the wax?

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   (*c*) Describe carefully how you would use a siphon to remove the major part of the water contained in a large fixed tank, open at the top. Draw a diagram and use it to explain the action of the siphon.

Section B

5. (*a*) Describe one experiment in each instance to show the expansion of a solid, a liquid and a gas on heating.

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   In order to obtain the temperature of a freezing mixture, a 500 gm iron weight is left in it for some time. The iron is then rapidly transferred to a well-lagged copper calorimeter of mass 100 gm containing 110 gm of water at 40°C. If the final temperature of the mixture is 12·0°C, calculate the temperature of the freezing mixture. (Specific heat of iron is 0·12 and of copper 0·10 cal per gm per deg C.)

   (*b*) State all the possible ways in which heat can leave hot water contained in an open thermos flask and explain how they have been minimized in the construction of the flask. Illustrate your answer with a labelled diagram.

   (*c*) Distinguish between evaporation and boiling of a liquid. Describe and explain an experiment to show that evaporation requires heat.

7. (*a*) State what is meant by *refraction of light* and describe an experiment to demonstrate it.

   (*b*) Give the conditions for total internal reflection to occur and illustrate with a diagram.

   Draw a diagram to show how a glass prism can be used to deviate a parallel beam of light through 90° by means of total internal reflection. Explain the action of the prism.

   Calculate the minimum value for the refractive index of glass for which a 90° deviation is possible.

Turn Over

8. A convex lens of focal length 2 in is used to produce on a screen an image of a film with a magnification of 3. What are the distances of the screen and the film from the lens? Draw a ray diagram showing how the image is formed. (If the results are obtained by calculation the sign convention used must be stated.)

Give a labelled diagram showing the structure of a projection lantern. Draw the paths of suitably chosen rays to illustrate the action of the instrument. Give two reasons why the image produced is said to be real and account for any slight colouration which is sometimes seen although white light has been passed through a black and white slide.

9. State the relation between the frequency of the note obtained by plucking a stretched string and the tension in the string.

Describe an experiment to verify your statement.

A note is obtained by plucking a wire 50 cm long stretched by a load of 4 kgm wt. What load must be used to give a note which is an octave above the first when (*a*) the length of the wire remains at 50 cm, (*b*) the length is reduced to 30 cm?

Section C

10. Describe how a compass needle can be used to determine the direction of the current in a straight wire when the wire is (*a*) vertical, (*b*) horizontal and lying in the meridian. In each instance, give a diagram showing how the direction of the current is obtained.

A rectangular coil of wire is suspended by a torsion fibre between the poles of a horseshoe magnet with the plane of the coil parallel to the field. Explain why the coil is deflected when a current passes through it. State the factors which determine the magnitude of the deflection of the coil and indicate how they do so. Give a rule by which its direction of motion can be obtained and illustrate with a diagram.

11. Describe, with the aid of diagrams, how a gold leaf electroscope can be charged positively by induction and explain what happens at each stage of the process.

A tall hollow metal can stands on the cap of a gold leaf electroscope. A charged insulated metal ball is made to touch the outside of the can. Why is the divergence of the leaves different from that which would be observed if the ball had been lowered into the can to touch the bottom?

Describe an experiment to show that the total charge induced by a conductor equals the inducing charge.

12. Explain the terms *anode, cathode.*

Describe an experiment to check the accuracy of the 1 amp reading of an ammeter, assuming that a value for the electrochemical equivalent of copper is available.

What is the cost of depositing a layer of silver 0·2 mm thick on an object of total surface area 150 sq cm if a current of 1 amp used for an hour costs 2*d*? (Density of silver is 10·5 gm per cc; electrochemical equivalent of silver is 0·00112 gm per coulomb.)

13. State the factors which determine the resistance of a uniform metal wire and indicate how they do so.

Give a labelled diagram of a metre bridge and describe how it is used to measure a resistance of about 10 ohms. The theory of the method is not required.

Resistors of 6 ohms and 8 ohms are connected in parallel to a battery of e.m.f. 12 volts and of internal resistance 6 ohms. What is the current in each resistor?

Turn Over

14. Answer any *two* of the following:

(*a*) Give a diagram showing the structure of a Daniell cell, naming its components.

State one advantage and one disadvantage of the cell and explain on what factors its internal resistance depends.

(*b*) Describe the structure and give the action of a hot wire ammeter. Why is it suitable for measuring both alternating and direct current?

(*c*) State *Lenz's law.*

The ends of a solenoid are connected together by a wire. Give diagrams showing the direction of the current (if any) induced in the solenoid when the N. pole of a magnet is (i) thrust into the solenoid, (ii) at rest in the solenoid, (iii) rapidly withdrawn.

A copper disc is rotated by an electric motor. Explain why the disc comes to rest more quickly when the current is cut off if the disc rotates between the poles of a horseshoe magnet.

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

SUMMER 1965

Ordinary Level

PHYSICS

Three hours

Answer SIX questions, choosing TWO from each section.

Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

Assume $g = 32$ ft per sec per sec; $\pi = 22/7$;
1 h.p. = 550 ft lb wt per sec.

Section A

1. Explain what is meant by *uniform velocity*.

In an emergency stop, a car driver has a 'thinking time' of $\frac{3}{4}$ sec before beginning to apply his brakes and, when travelling at 30 m.p.h., the application of the maximum constant braking force brings the car to rest in 2 sec. Draw an accurate graph showing the variation of velocity with time during these $2\frac{3}{4}$ sec and calculate for such an emergency stop (*a*) the distance the car travels before the brakes are applied, (*b*) the negative acceleration produced by the brakes, (*c*) the distance the car travels after the brakes are applied, (*d*) the total distance covered if the car were travelling initially at 45 m.p.h., assuming that the retarding force caused by the brakes is the same as for the lower speed.

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Turn Over

2. Draw a clearly labelled diagram of *either* a screw jack *or* a Weston differential pulley, showing where the load and the effort are applied. Derive the formula for calculating the velocity ratio. Explain how the value of the velocity ratio can be found by experiment.

A machine having a velocity ratio of 50 can lift a load of 1,000 lb wt by applying an effort of 50 lb wt. Calculate (*a*) the efficiency, (*b*) the wasted energy when the load is raised 3 ft from the ground.

Explain an advantage of having a machine with a low efficiency.

3. State *Archimedes' principle* and define *specific gravity*.

Describe how the specific gravity of a solid substance may be measured accurately by the application of Archimedes' principle. Show how you obtain the expression used to calculate the result.

Calculate the volume of a metal cylinder of mass 105 gm which has an apparent weight of 92·5 gm when fully immersed in water of density 1·00 gm per cc. When a piece of wax of mass 20 gm is attached to the cylinder and both are fully immersed in water, the total apparent weight is found to be 87·5 gm. What is the density of the wax?

4. Answer any *two* of the following:

(*a*) Define *work*, *power*.

A car of mass 15 cwt starting from rest on a level road travels 200 ft in 10 sec with uniform acceleration. Assuming there were no frictional forces, what force would be necessary to accelerate the car? If there are constant frictional forces totalling 175 lb wt, what is (i) the work done by the engine during the period considered, (ii) the horse-power developed?

(*b*) Draw a diagram illustrating the principle of the hydraulic (Bramah) press and explain its action. Calculate the pressure transmitted if a load of 2,000 lb wt is supported on a circular ram of diameter 3 ft 4 in. (Neglect friction.)

(*c*) Describe carefully how you would use a siphon to remove the major part of the water contained in a large fixed tank, open at the top. Draw a diagram and use it to explain the action of the siphon.

Section B

5. (*a*) Describe one experiment in each instance to show the expansion of a solid, a liquid and a gas on heating.

(*b*) A compound strip of brass and iron is straight at room temperature. Give a labelled diagram to show its appearance when it is heated. Describe one use of such a strip.

A compound strip of brass and iron, 10 cm long at 20°C, is held horizontally with the iron uppermost. When heated from below with a bunsen, the temperature of the brass is 820°C and of the iron 770°C. Calculate the difference in lengths of the iron and the brass. (Coefficient of linear expansion of brass is 0·000019 and of iron 0·000012 per deg C.)

6. Answer any *two* of the following:

(*a*) Define *thermal capacity*, *specific heat*. State the relation between them.

In order to obtain the temperature of a freezing mixture, a 500 gm iron weight is left in it for some time. The iron is then rapidly transferred to a well-lagged copper calorimeter of mass 100 gm containing 110 gm of water at 40°C. If the final temperature of the mixture is 12·0°C, calculate the temperature of the freezing mixture. (Specific heat of iron is 0·12 and of copper 0·10 cal per gm per deg C.)

(*b*) State all the possible ways in which heat can leave hot water contained in an open thermos flask and explain how they have been minimized in the construction of the flask. Illustrate your answer with a labelled diagram.

(*c*) Distinguish between evaporation and boiling of a liquid. Describe and explain an experiment to show that evaporation requires heat.

7. (*a*) State what is meant by *refraction of light* and describe an experiment to demonstrate it.

(*b*) Give the conditions for total internal reflection to occur and illustrate with a diagram.

Draw a diagram to show how a glass prism can be used to deviate a parallel beam of light through 90° by means of total internal reflection. Explain the action of the prism.

Calculate the minimum value for the refractive index of glass for which a 90° deviation is possible.

Turn Over

8. A convex lens of focal length 2 in is used to produce on a screen an image of a film with a magnification of 3. What are the distances of the screen and the film from the lens? Draw a ray diagram showing how the image is formed. (If the results are obtained by calculation the sign convention used must be stated.)

Give a labelled diagram showing the structure of a projection lantern. Draw the paths of suitably chosen rays to illustrate the action of the instrument. Give two reasons why the image produced is said to be real and account for any slight colouration which is sometimes seen although white light has been passed through a black and white slide.

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Describe an experiment to verify your statement.

A note is obtained by plucking a wire 50 cm long stretched by a load of 4 kgm wt. What load must be used to give a note which is an octave above the first when (*a*) the length of the wire remains at 50 cm, (*b*) the length is reduced to 30 cm?

Section C

10. Describe how a compass needle can be used to determine the direction of the current in a straight wire when the wire is (*a*) vertical, (*b*) horizontal and lying in the meridian. In each instance, give a diagram showing how the direction of the current is obtained.

A rectangular coil of wire is suspended by a torsion fibre between the poles of a horseshoe magnet with the plane of the coil parallel to the field. Explain why the coil is deflected when a current passes through it. State the factors which determine the magnitude of the deflection of the coil and indicate how they do so. Give a rule by which its direction of motion can be obtained and illustrate with a diagram.

11. Describe, with the aid of diagrams, how a gold leaf electroscope can be charged positively by induction and explain what happens at each stage of the process.

A tall hollow metal can stands on the cap of a gold leaf electroscope. A charged insulated metal ball is made to touch the outside of the can. Why is the divergence of the leaves different from that which would be observed if the ball had been lowered into the can to touch the bottom?

Describe an experiment to show that the total charge induced by a conductor equals the inducing charge.

12. Explain the terms *anode*, *cathode*.

Describe an experiment to check the accuracy of the 1 amp reading of an ammeter, assuming that a value for the electrochemical equivalent of copper is available.

What is the cost of depositing a layer of silver 0·2 mm thick on an object of total surface area 150 sq cm if a current of 1 amp used for an hour costs 2*d*? (Density of silver is 10·5 gm per cc; electrochemical equivalent of silver is 0·00112 gm per coulomb.) 1s. 4d

13. State the factors which determine the resistance of a uniform metal wire and indicate how they do so.

Give a labelled diagram of a metre bridge and describe how it is used to measure a resistance of about 10 ohms. The theory of the method is not required.

Resistors of 6 ohms and 8 ohms are connected in parallel to a battery of e.m.f. 12 volts and of internal resistance 6 ohms. What is the current in each resistor?

2500
1250
625

14. Answer any *two* of the following:

(*a*) Give a diagram showing the structure of a Daniell cell, naming its components.

State one advantage and one disadvantage of the cell and explain on what factors its internal resistance depends.

(*b*) Describe the structure and give the action of a hot wire ammeter. Why is it suitable for measuring both alternating and direct current?

(*c*) State *Lenz's law*.

The ends of a solenoid are connected together by a wire. Give diagrams showing the direction of the current (if any) induced in the solenoid when the N. pole of a magnet is (i) thrust into the solenoid, (ii) at rest in the solenoid, (iii) rapidly withdrawn.

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UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

JANUARY 1964

Ordinary Level

PHYSICS

Three hours

Answer SIX questions, choosing TWO from each section. Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

Assume $g = 32$ ft. per sec. per sec., $\pi = 22/7$, 1 H.P. = 550 ft. lb. wt. per sec.

SECTION A

1. Explain the terms *energy* and *power*.

State the principle of the conservation of energy and illustrate its meaning by discussing the energy changes involved when a body, initially at rest, falls from a height on to soft ground which it penetrates before finally coming to rest.

A pump raises 2,100 gallons of water per hour from a well 35 ft. below ground level to a storage tank 75 ft. above the ground. Calculate the minimum horse-power of the pumping engine if its efficiency is 70%.

(1 gallon of water weighs 10 lb.)

2. Define *mechanical advantage and velocity ratio.*

Describe how you would determine, by experiment, the efficiency of a machine used for lifting a heavy load.

A load of 2 tons wt. placed on the top of a screw-jack is lifted by a force of 64 lb. wt. applied at right angles to the operating arm at a distance of 14 inches from the axis of the screw. If the screw has two threads to the inch, find its mechanical advantage, velocity ratio, and efficiency. X

Turn Over

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3. State *Boyle's law* and describe an experiment to test it.

In setting up a mercury barometer, a uniform tube was filled only to a level 2·4 cm. below the open end when the tube was vertical. It was then sealed, inverted, and opened under mercury, in the usual manner, when a 'barometric' height of 66 cm. was recorded. Why was this reading too low and what was the correct atmospheric pressure if the length of the tube above the mercury column in the faulty barometer was 20 cm.?

4. Answer any *two* of the following:

(*a*) Describe, with the help of a labelled diagram, a common hydrometer graduated to record a density range of 0·80 to 1·00 gm. per c.c. Give reasons for the particular features of its design and explain why it floats at different depths in liquids of different densities.

(*b*) Explain what is meant by *centre of gravity*, *stable equilibrium*.

State and explain, with the aid of diagrams, why the base of a bunsen burner is *heavily* weighted and of *large* area.

(*c*) Derive, from first principles, an expression for the distance travelled by a uniformly accelerated body moving from rest, in terms of the acceleration and the time.

A ball dropped from rest on to horizontal ground 64 feet below, rebounds with $\frac{3}{4}$ of the velocity with which it hits the ground. Find the time that elapses between the first and second impacts of the ball with the ground.

SECTION B

5. Define *specific heat* and *latent heat of fusion*.

Describe an experiment to determine the specific heat of a metal, stressing the precautions that should be taken and showing how the result is calculated.

Find the rate at which heat must be extracted in a refrigerator to produce 60 gm. of ice per sec. at $-6°$ C. from water at 20° C. State why, in practice, this rate must be exceeded.

(Specific heat of ice = 0·5 cal. per gm. per deg. C.; latent heat of fusion of ice = 80 cal. per gm.)

6. Answer any *two* of the following:

(*a*) Describe and explain an experiment which does not involve measurements, to show that the coefficient of linear expansion of brass is greater than that of steel.

A brass scale which has been correctly graduated at 0° C., is used to measure a distance on a hot day. Explain why the result is inaccurate and state, giving the reason, whether the distance is greater or less than the observed value.

(*b*) Describe an experiment to compare a dull black surface with a polished surface as a radiator of heat. State the conclusion of the experiment and quote an example of its application in everyday life.

(*c*) The temperature of naphthalene contained in a test tube is recorded every half-minute as it cools from 95° C. to 50° C. Show the nature of the graph obtained on plotting temperature against time and explain its shape, given that the melting point of naphthalene is 78° C.

7. (*a*) Draw a diagram showing the types of lenses used and their arrangement in a compound microscope and trace the path of two rays from a non-axial point on an object to an eye viewing the object through the microscope.

(*b*) By means of a diagram show how a right-angled isosceles glass prism can be used to invert a parallel beam of light without producing deviation.

8. Indicate on a diagram what is meant by *centre of curvature*, *pole*, and *principal focus* of a concave mirror.

Describe a reliable method for finding the focal length of a concave mirror.

An object is placed on the axis and 4 inches from the pole of a concave mirror and an erect image is formed three times the size of the object. Find the radius of curvature of the mirror and give a ray diagram showing how the image is formed.

9. Define *frequency* and *wavelength*. Deduce an expression for the velocity of sound in terms of the frequency and wavelength. What is the evidence that the velocity of a sound in air is independent of its wavelength?

Describe three different methods of producing a musical note, the source of vibration in each instance being different. In what ways will these notes be likely to differ from one another even though they are of the same pitch?

SECTION C

10. What is meant in magnetism by *line of force* and by *neutral point*?

Why can iron filings be used to plot the lines of force in a strong magnetic field but are unsuitable if the field is weak?

A bar magnet stands vertically on a table with its N pole downwards. Describe how you would plot the lines of force round the end of the magnet. Give a diagram of the field and mark the position of the neutral point.

11. Describe an electrophorus and state how it is used to give an insulated conductor a positive charge. Give diagrams to illustrate the distribution and nature of the charge in each stage of the operation.

Why is it possible to obtain a series of approximately equal charges from this instrument without recharging it and what is the source of energy of these charges?

12. State *Ohm's law* and show how it leads to a definition of resistance.

Describe an experiment to determine how the resistance of a uniform wire depends on its length. Give a diagram of the arrangement of the apparatus and state the result expected.

A resistance of 6 ohms is connected between two points *A* and *B* and resistances of 3 ohms and 4 ohms in parallel between *B* and a point *C*. If a potential difference of 9 volts is applied across *A* and *C*, what is (*a*) the current in each resistance, (*b*) the potential difference between *B* and *C*?

13. State the *laws of electrolysis* and define the terms *anode* and *cathode*.

Describe an experiment to determine how the mass of copper deposited in a copper voltameter varies with the quantity of electricity passing through it. Give a circuit diagram and full experimental details.

An electric current passes through two voltameters in series, containing copper sulphate and silver nitrate respectively. What is the mass of silver deposited in a given time if the mass of copper deposited in that time is 1 gm? (At. wt. of copper is 63, at. wt. of silver is 108, valency of copper is 2, valency of silver is 1.)

14. Answer any *two* of the following:

(*a*) Describe the structure of a carbon microphone and explain its action.

(*b*) Give a labelled diagram of a Daniell cell and explain its action. State one advantage and one disadvantage of this cell.

(*c*) Describe the structure and mode of action of a moving coil galvanometer.

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

SUMMER 1964

Ordinary Level

PHYSICS

Three hours

Answer SIX questions, choosing TWO from each section. Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

Assume that $g = 32$ ft. per sec. per sec.

Section A

1. Deduce an expression for the pressure due to a liquid of density d gm. per c.c. at a point h cm. below its surface.

Describe the determination of the density of copper sulphate solution by a method which involves balancing liquid columns. Give the theory of the method.

A U-tube of uniform cross-section is partly filled with water. Oil of density 0·75 gm. per c.c. is poured into one arm until the surface of the water in that arm is depressed a distance of 4 cm. What is the length of the column of oil?

$\frac{8}{0.75} = \frac{32}{3}$

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Turn Over

2. State the conditions under which three non-parallel coplanar forces produce equilibrium. Describe an experiment to illustrate your statement.

A crate is dragged steadily in one direction along a horizontal floor by a rope which makes an angle of 30° with the floor in the vertical plane containing the direction of motion. If the tension in the rope is 100 lb.wt. find (*a*) the effective force on the crate along the floor, (*b*) the force tending to lift the crate.

3. Define *moment of a force about an axis, centre of gravity*. State the *principle of moments* and describe an experiment to test its validity.

A steel rod 7 in. long consists of two cylindrical parts, 3 in. and 4 in. long respectively, having a common axis. If the area of cross-section of the shorter part is twice that of the longer find the position of the centre of gravity of the rod.

4. Answer any *two* of the following:

(*a*) Describe one practical example in which friction is of use and one in which it is a disadvantage.

A railway truck of 20 tons weight, travels a distance of 45 ft. down a slope of 1 in 180 with constant velocity. What is the work done against the frictional force?

(*b*) State *Archimedes' principle*. Find the volume of the largest piece of wax which can be held fully immersed in glycerine by a fine thread attached to the base of the container, if the thread breaks when the pull on it exceeds 85 gm.wt. (Specific gravity of wax is 0·92; of glycerine 1·26.)

(*c*) Define *uniform acceleration*. Find the distance travelled by a body of mass 24 lb. while its velocity is reduced from 28 ft. per sec. to 12 ft. per sec. by a constant force of 15 lb.wt.

Section B

5. State the law which indicates how the pressure of a fixed mass of air varies with its temperature as recorded on a mercury thermometer, when the volume remains constant.

Describe an experiment to verify the law.

80 c.c. of hydrogen are collected at 15° C. and 75 cm. of mercury pressure. What is its volume at S.T.P.?

6. Answer any *two* of the following:

(*a*) Describe experiments to determine the positions of the fixed points on an ungraduated mercury thermometer.

(*b*) Define *specific heat*. A small electric heater immersed in 80 gm. of water in a calorimeter of thermal capacity 8 cal. per deg. C. raises the temperature from 9·5° C. to 20·0° C. in 12 minutes. Using the same apparatus with 60 gm. of oil instead of water, it is found that the temperature of the oil rises from 6·5° C. to 23·0° C. in 9 minutes. Find the specific heat of the oil.

(*c*) Distinguish between a *saturated* vapour and an *unsaturated* vapour.

Explain why (i) a film of moisture forms on the outside of a glass of cold water when it is brought into a warm room, (ii) the boiling point of a liquid rises when the pressure on its surface is increased.

7. (*a*) Define *refractive index*.

Explain, with the help of a ray diagram, why water in a swimming-pool appears to be shallower than it really is. What is the apparent depth of a swimming-pool if its real depth is 8 ft. and it is viewed from a springboard vertically above? (Refractive index of water is 4/3.)

(*b*) Define *principal focus*, *centre of curvature*, *principal axis* of a *convex* mirror.

Determine the position of a small object on the axis of a *concave* mirror of radius of curvature 30 cm. when the mirror forms a virtual image three times the height of the object.

8. Distinguish between *deviation* and *dispersion* of a beam of light. Draw a diagram of an optical arrangement suitable for obtaining, on a screen, the spectrum of the light from a slit illuminated by an electric lamp, and show the paths of two rays from a point on the slit to the screen. State the adjustments necessary to produce a pure spectrum.

Describe and explain the appearance of a red tie with blue spots when observed in (*a*) red light, (*b*) green light.

Turn Over

9. Define *frequency*, *amplitude* as applied to sound waves. What characteristics of a musical note are altered when these quantities are varied?

Describe an experiment to determine the frequency of a tuning fork, being provided with any apparatus you require including a fork of known frequency.

Calculate the wavelength in air of (*a*) a note of 400 vibrations per sec., and (*b*) a note an octave higher, when the velocity of sound in air is 33,000 cm. per sec.

Section C

10. Define *declination* (magnetic variation), *dip*.

Describe how you would obtain the value at a given place of *either* the declination *or* the dip.

Explain why a vertical iron girder is often found to be magnetised. State the polarity of the girder. In what position must an unmagnetised iron girder be placed in order (i) to become as strongly magnetised as possible by the earth's field, (ii) to remain unmagnetised along its length?

11. Describe experiments, one in each instance, to show that (i) equal and opposite charges are produced when ebonite is rubbed on fur, (ii) the inside surface of a charged hollow can has the same potential as the outside surface but has no charge, (iii) silk thread is a better insulator than cotton thread.

12. Define *electromotive force*, *volt*.

Describe a potentiometer circuit and explain how it is used to compare the e.m.fs of a Daniell and a Leclanché cell.

A Daniell cell, an ammeter of negligible resistance and a variable resistance, are connected in series. The ammeter reads 0·22 amp. when the resistance is 2·0 ohms and 0·10 amp. when the resistance is changed to 8·0 ohms. Find the e.m.f. and the internal resistance of the cell.

13. Describe an experiment to show the production of an induced current in a coil of wire. What factors determine the magnitude of the current? With the aid of a diagram, show how the direction of the current in the coil can be predicted.

Describe the structure and explain the action of an appliance which depends on electromagnetic induction for its operation.

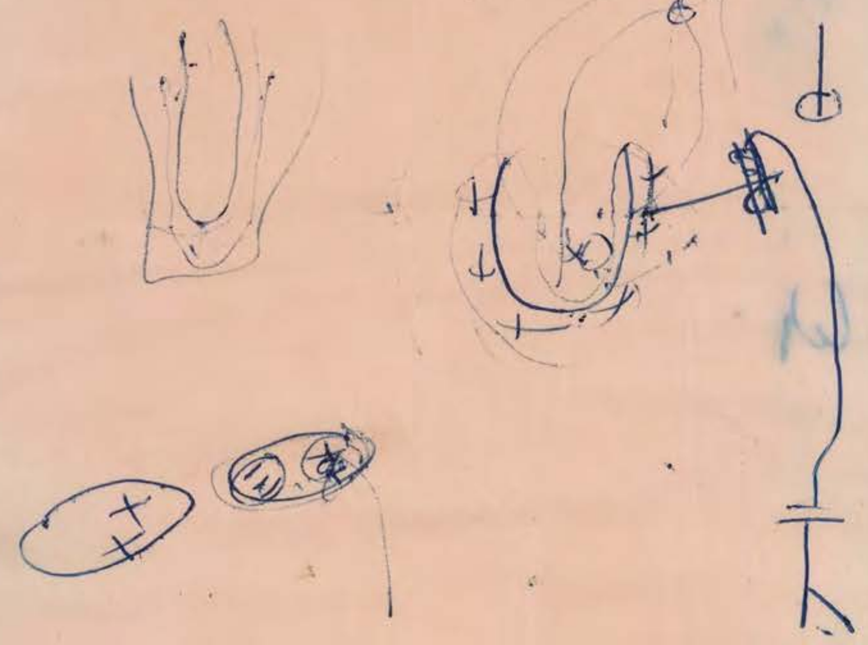
14. Answer any *two* of the following:

(*a*) Describe an experiment to demonstrate that a mechanical force acts on a current carrying conductor when it is suitably placed in a magnetic field. On a diagram indicate the directions of the current, the field, and the motion of the conductor.

(*b*) Describe an experiment to determine the electrochemical equivalent of copper, stating the precautions necessary in order to obtain an accurate result. On a circuit diagram indicate the electrode on which the copper is deposited.

(*c*) Define *watt*, *kilowatt-hour*.

A washing machine for use on 240-volt mains has a 1/3 h.p. motor and a heating element rated at 2 kilowatts. What current does it take when in use and what is the cost of using it for 40 minutes each week for a period of 12 weeks if the cost of electricity is 2d. per unit? (Assume 1 h.p. = 0·75 kilowatt.)



UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

JANUARY 1963

PHYSICS

Three hours

Answer SIX questions, choosing TWO from each section.

Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

SECTION A

1. Define *uniform acceleration.*

Deduce an expression for the distance s travelled in time t by a body which starts from rest and moves with uniform acceleration a

A ball rolls from rest down an inclined plane and the distances s travelled after times t are given in the following table:—

s ft.	0	0·75	3·00	6·75	12·00	18·75
t sec.	0	1·0	2·0	3·0	4·0	5·0

Plot a graph of s against t^2 and use it (a) to show that the ball moves with uniform acceleration, (b) to determine the value of this acceleration.

2. Define *density*. If the specific gravity of a metal is 8·9, what is the density in lb. per cu. ft., given that 1,000 oz. of water occupy 1 cu. ft. ?

Describe an experiment to find the density of air at atmospheric temperature and pressure.

Assuming that there is no change in total volume when salt is dissolved in water, what mass of salt of specific gravity 2·20 must be dissolved in 100 gm. of water to give a salt solution of specific gravity 1·14?

Turn Over

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3. What are the conditions for a body to be in equilibrium under the action of three non-parallel coplanar forces ?

Describe an experiment to find the resultant of forces of 3 lb. wt. and 5 lb. wt. acting at a point in directions inclined at an angle of 60°. Explain why your method gives the required result.

A uniform cylinder of mass 200 gm. rests with its axis horizontal in the right angle formed by two smooth planes inclined at 30° and 60° respectively to the horizontal so that its curved surface is in contact with the planes. What force does the cylinder exert on each plane ?

4. Answer any *two* of the following:

(*a*) Describe a *force* pump and explain its action.

(*b*) Define *moment of a force* about an axis.

A uniform bar is 6 ft. long. A weight of 10 lb. hangs from one end and a weight of 15 lb. from the other. The bar is found to balance horizontally on a knife edge placed 4 in. from the centre. What is the weight of the bar and the force exerted on the knife edge ?

(*c*) Define *energy*. Distinguish between *potential energy* and *kinetic energy*.

A body of mass 1 kgm. falls vertically from rest on to soft ground and penetrates a distance of 10 cm. against an average resistance of 100 kgm. wt. Through what vertical distance does the body fall ?

Section B

5. Define *latent heat* and describe an experiment to determine its value for steam formed at atmospheric pressure.

Dry steam under reduced pressure and at 60° C. (the boiling point of water under that pressure) enters a condenser, the condensed water formed being at 40° C. when it leaves the condenser. If the cooling is achieved by water which enters the circulating tubes of the condenser at 15° C. and leaves them at 35° C., what mass of cooling water is required per gram of steam condensed?

(Latent heat of steam at 60° C. = 560 cal. per gm.)

6. Answer any *two* of the following:

(*a*) Distinguish between *real* and *apparent* expansion of a liquid and describe a simple experiment in illustration. Why is it usual to neglect the expansion of the container when dealing with the expansion of a gas on heating ?

Explain how the height of the mercury column in a barometer is affected by (i) the expansion of the mercury, (ii) the expansion of the glass, when there is a rise in temperature.

(*b*) Explain how heat is transmitted by (i) *conduction*, (ii) *convection*.

Describe an experiment to show that water is a bad conductor of heat.

(*c*) Define *dew point* and describe an experiment to determine it.

What conclusion may be drawn about the state of the atmosphere when the dew point is (i) 15° C., (ii) 4° C., respectively, given that the air temperature in both instances is 15° C. ?

7. What lenses are used and how are they arranged in a compound microscope? Give the purpose of each lens.

Draw a diagram showing the paths of two rays from a non-axial point on an object to an eye looking at it through the microscope.

8. (*a*) Define *refractive index*. Explain the meaning of *total internal reflection*, stating the circumstances in which it occurs.

A narrow parallel beam of light is incident normally on the curved surface of a semi-cylindrical block of glass. The angle of incidence in the glass at the plane surface is varied until total reflection just occurs. If this angle is 41°, what is the refractive index of the glass ?

(*b*) Define *luminous intensity*, *illumination* and state the units in which each is measured.

A small lamp, fitted with a glass shade, is placed 10 ft. from a screen, where it produces the same illumination as a standard lamp of 10 candle power placed 6 ft. from the screen. It is found that the lamp must be moved 2 ft. further away from the screen when its shade is removed, to produce the same illumination as before. Find the fraction of light absorbed by the shade and the candle power of the lamp when unshaded.

9. (*a*) Explain the formation of an *echo* and describe a practical use of echoes.

(*b*) A metal strip presses lightly on the teeth of a cog wheel as it rotates at 400 revolutions per minute. If the wheel has 48 teeth, find the frequency and the wavelength in air of the note emitted, given that the velocity of sound in air at the time of the experiment is 1,120 ft. per sec.

State, giving reasons, how the wavelength will change if (i) the speed of rotation is increased, (ii) the temperature of the air rises.

Section C

10. Explain what is meant by *magnetic field, neutral point.*

Draw a diagram of the magnetic field in a horizontal plane which is obtained when (*a*) a bar magnet is placed horizontally with its axis in the magnetic meridian and its N. pole pointing South, and (*b*) a bar magnet and a bar of soft iron are placed a few centimetres apart in the same straight line. (Ignore the effect of the earth's field in (*b*).)

What magnetic property of soft iron does the field in (*b*) illustrate ? State a practical use of this property.

11. Describe an experiment to show (*a*) that the whole of the charge on a charged hollow conductor resides on its outside surface, (*b*) that the charge is not evenly distributed over the surface of a charged conductor of irregular shape. Indicate, in general terms, how the charge is distributed in (*b*).

A gold leaf electroscope stands inside a box made of metal gauze and is completely enclosed. The box rests on an insulated stand and is charged by connecting it to a Wimshurst machine. State and explain the effect, if any, on the leaves of the electroscope.

12. Define *resistance, electromotive force*. State how *each* of these quantities varies, if at all, for a given type of cell with (*a*) the area of the plates, (*b*) the distance between them.

A cell is connected in turn to a resistance of (i) 7 ohms, (ii) 12 ohms and the readings of a high resistance voltmeter connected to the terminals of the cell are 1·05 and 1·20 volts respectively. What will be the reading of the voltmeter if the cell is connected to a resistance of 2 ohms ?

13. With the help of a diagram, describe a moving coil ammeter and explain its action. State and explain how the deflection of such an ammeter for a given current would be altered, if the strength of the magnet were increased.

A moving coil ammeter of resistance 5 ohms measures a maximum current of 50 milliamp. How can it be adapted to measure a maximum current of 5 amp?

14. Answer any *two* of the following:

(*a*) Describe an experiment to measure a current by means of its chemical effect.

(*b*) Describe an experiment to compare the e.m.fs. of two primary cells, using a potentiometer.

(*c*) Describe an experiment to illustrate electromagnetic induction. On a diagram illustrating the experiment, indicate the direction of the induced current. State the factors on which the magnitude of the e.m.f. depends.

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

January 1963

PHYSICS

Three hours

Answer SIX questions, choosing TWO from each section.

Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

Section A

1. Define *uniform acceleration.*

Deduce an expression for the distance s travelled in time t by a body which starts from rest and moves with uniform acceleration a

A ball rolls from rest down an inclined plane and the distances s travelled after times t are given in the following table:—

s ft.	0	0·75	3·00	6·75	12·00	18·75
t sec.	0	1·0	2·0	3·0	4·0	5·0

Plot a graph of s against t^2 and use it (*a*) to show that the ball moves with uniform acceleration, (*b*) to determine the value of this acceleration.

2. Define *density*. If the specific gravity of a metal is 8·9, what is the density in lb. per cu. ft., given that 1,000 oz. of water occupy 1 cu. ft. ?

Describe an experiment to find the density of air at atmospheric temperature and pressure.

Assuming that there is no change in total volume when salt is dissolved in water, what mass of salt of specific gravity 2·20 must be dissolved in 100 gm. of water to give a salt solution of specific gravity 1·14?

Turn Over

Th.P. 61/32 6/2/50/11500

3. What are the conditions for a body to be in equilibrium under the action of three non-parallel coplanar forces ?

Describe an experiment to find the resultant of forces of 3 lb. wt. and 5 lb. wt. acting at a point in directions inclined at an angle of 60°. Explain why your method gives the required result.

A uniform cylinder of mass 200 gm. rests with its axis horizontal in the right angle formed by two smooth planes inclined at 30° and 60° respectively to the horizontal so that its curved surface is in contact with the planes. What force does the cylinder exert on each plane ?

4. Answer any *two* of the following:

(*a*) Describe a *force* pump and explain its action.

(*b*) Define *moment of a force* about an axis.

A uniform bar is 6 ft. long. A weight of 10 lb. hangs from one end and a weight of 15 lb. from the other. The bar is found to balance horizontally on a knife edge placed 4 in. from the centre. What is the weight of the bar and the force exerted on the knife edge ?

(*c*) Define *energy*. Distinguish between *potential energy* and *kinetic energy*.

A body of mass 1 kgm. falls vertically from rest on to soft ground and penetrates a distance of 10 cm. against an average resistance of 100 kgm. wt. Through what vertical distance does the body fall ?

SECTION B

5. Define *latent heat* and describe an experiment to determine its value for steam formed at atmospheric pressure.

Dry steam under reduced pressure and at 60° C. (the boiling point of water under that pressure) enters a condenser, the condensed water formed being at 40° C. when it leaves the condenser. If the cooling is achieved by water which enters the circulating tubes of the condenser at 15° C. and leaves them at 35° C., what mass of cooling water is required per gram of steam condensed ?

(Latent heat of steam at 60° C. = 560 cal. per gm.)

6. Answer any *two* of the following:

(*a*) Distinguish between *real* and *apparent* expansion of a liquid and describe a simple experiment in illustration. Why is it usual to neglect the expansion of the container when dealing with the expansion of a gas on heating ?

Explain how the height of the mercury column in a barometer is affected by (i) the expansion of the mercury, (ii) the expansion of the glass, when there is a rise in temperature.

(*b*) Explain how heat is transmitted by (i) *conduction*, (ii) *convection*.

Describe an experiment to show that water is a bad conductor of heat.

(*c*) Define *dew point* and describe an experiment to determine it.

What conclusion may be drawn about the state of the atmosphere when the dew point is (i) 15° C., (ii) 4° C., respectively, given that the air temperature in both instances is 15° C. ?

7. What lenses are used and how are they arranged in a compound microscope? Give the purpose of each lens.

Draw a diagram showing the paths of two rays from a non-axial point on an object to an eye looking at it through the microscope.

8. (*a*) Define *refractive index*. Explain the meaning of *total internal reflection*, stating the circumstances in which it occurs.

A narrow parallel beam of light is incident normally on the curved surface of a semi-cylindrical block of glass. The angle of incidence in the glass at the plane surface is varied until total reflection just occurs. If this angle is 41°, what is the refractive index of the glass ?

(*b*) Define *luminous intensity*, *illumination* and state the units in which each is measured.

A small lamp, fitted with a glass shade, is placed 10 ft. from a screen, where it produces the same illumination as a standard lamp of 10 candle power placed 6 ft. from the screen. It is found that the lamp must be moved 2 ft. further away from the screen when its shade is removed, to produce the same illumination as before. Find the fraction of light absorbed by the shade and the candle power of the lamp when unshaded.

9. (*a*) Explain the formation of an *echo* and describe a practical use of echoes.

(*b*) A metal strip presses lightly on the teeth of a cog wheel as it rotates at 400 revolutions per minute. If the wheel has 48 teeth, find the frequency and the wavelength in air of the note emitted, given that the velocity of sound in air at the time of the experiment is 1,120 ft. per sec.

State, giving reasons, how the wavelength will change if (i) the speed of rotation is increased, (ii) the temperature of the air rises.

Turn Over

Section C

10. Explain what is meant by *magnetic field, neutral point.*

Draw a diagram of the magnetic field in a horizontal plane which is obtained when (*a*) a bar magnet is placed horizontally with its axis in the magnetic meridian and its N. pole pointing South, and (*b*) a bar magnet and a bar of soft iron are placed a few centimetres apart in the same straight line. (Ignore the effect of the earth's field in (*b*).)

What magnetic property of soft iron does the field in (*b*) illustrate? State a practical use of this property.

11. Describe an experiment to show (*a*) that the whole of the charge on a charged hollow conductor resides on its outside surface, (*b*) that the charge is not evenly distributed over the surface of a charged conductor of irregular shape. Indicate, in general terms, how the charge is distributed in (*b*).

A gold leaf electroscope stands inside a box made of metal gauze and is completely enclosed. The box rests on an insulated stand and is charged by connecting it to a Wimshurst machine. State and explain the effect, if any, on the leaves of the electroscope.

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A cell is connected in turn to a resistance of (i) 7 ohms, (ii) 12 ohms and the readings of a high resistance voltmeter connected to the terminals of the cell are 1·05 and 1·20 volts respectively. What will be the reading of the voltmeter if the cell is connected to a resistance of 2 ohms?

13. With the help of a diagram, describe a moving coil ammeter and explain its action. State and explain how the deflection of such an ammeter for a given current would be altered, if the strength of the magnet were increased.

A moving coil ammeter of resistance 5 ohms measures a maximum current of 50 milliamp. How can it be adapted to measure a maximum current of 5 amp?

14. Answer any *two* of the following:

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(*b*) Describe an experiment to compare the e.m.fs. of two primary cells, using a potentiometer.

(*c*) Describe an experiment to illustrate electromagnetic induction. On a diagram illustrating the experiment, indicate the direction of the induced current. State the factors on which the magnitude of the e.m.f. depends.

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

SUMMER 1963

Ordinary Level

PHYSICS

Three hours

Answer SIX questions, choosing TWO from each section. Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

Assume $g = 32$ ft. per sec. per sec.

Section A

1. Explain what is meant by a uniform acceleration of 240 ft. per sec. per min. What is the value of this acceleration in ft. per sec. per sec.?

Describe an experiment to determine the acceleration due to gravity.

A car starting from rest with a uniform acceleration travels 11 ft. in the sixth second of its motion. What is the acceleration and how far does the car travel in the first 10 sec.?

2. What is meant by the *parallelogram of forces*? Describe an experiment to illustrate it.

Horizontal forces of 10, 7, and 4 lb. wt. act on a body on a horizontal plane in directions N, S, and E respectively, their lines of action passing through its centre of gravity. Find graphically or by calculation the resultant force in magnitude and direction.

If the mass of the body is 10 lb. and there is a frictional force of 2 lb. wt., with what acceleration does the body start to move?

Turn Over

Th.P. 61/888 7/2/25/29000

3. Describe how you would set up and use a simple barometer to measure the atmospheric pressure.

What are the objections to the use of water as the barometric liquid?

If the reading of a mercury barometer is 75·58 cm. at the base of a mountain and 66·37 cm. at the summit, what is the height of the mountain?

(Density of mercury = 13·6 gm. per c.c.; average density of air = 0·00125 gm. per c.c.)

4. Answer any *two* of the following:

(*a*) Draw a diagram of a block and tackle with a velocity ratio of 4. If this machine is used to lift a lump of metal weighing 200 lb. and the weight of the lower block and the frictional force are together equivalent to a load of 100 lb. wt., what is the effort required and the efficiency of the arrangement?

(*b*) Explain how (i) the moment of a force, (ii) the work done by a force, are each measured.

A trap door of mass 20 lb. in a horizontal floor is made of a uniform piece of wood 4 ft. square, smoothly hinged along one side. What is the least vertical force required to raise the door?

What is the work done when the door is raised through an angle of 45°?

(*c*) What condition must be satisfied for a body to float in a liquid?

A uniform glass tube of cross sectional area 2·25 sq. cm., closed at its lower end, is suitably weighted to float vertically in a liquid. If the length immersed in water is 15·2 cm., what is the length immersed in a liquid of density 1·16 gm. per c.c. and what is the weight of the tube and contents?

SECTION B

5. Define *coefficient of expansion of a gas at constant pressure* and describe an experiment to determine its value.

A capillary tube sealed at the lower end stands vertically and contains a thread of mercury 10 cm. long which seals off a column of air 25 cm. long at 12° C. What is the pressure on this air if the barometric height is 75 cm. of mercury? To what temperature must the tube be heated for the mercury to rise 5 cm.?

6. Answer any *two* of the following:

(*a*) Describe a thermometer for recording the maximum and minimum temperature over a period of 24 hours and explain how it acts.

(*b*) Define *boiling point* of a liquid.

Describe one experiment in each instance to show how the boiling point of water is affected by (i) a change in the pressure, (ii) the addition of salt to the water.

(*c*) Explain what is meant by the ' mechanical equivalent of heat '. Describe an experiment to determine its value.

7. (*a*) State the *laws of reflection* of light.

If a small illuminated object is placed in front of a thick plate glass mirror, silvered on the back, several images are seen. Explain the formation of these images and indicate which one is usually brightest.

(*b*) What is meant by *refractive index*? Illustrate your answer with a diagram.

Draw a diagram to show the path of a narrow parallel beam of red light refracted through a triangular glass prism and use the diagram to explain the term *deviation*.

Draw another diagram to indicate what happens if white light is used instead of red and use this diagram to show that the refractive index of the glass is less for red than for blue light.

8. Explain the terms *principal focus* and *focal length* as applied to a converging lens.

Describe two experiments to determine the focal length of a converging lens.

An illuminated object 1·05 cm. long is placed on and at right angles to the axis of a converging lens and an image 0·35 cm. long is formed on a screen suitably placed at a distance of 80 cm. from the object. Find the position of the lens and its focal length.

Turn Over

9. State the factors which determine the frequency of transverse vibrations of a stretched wire. Describe an experiment to investigate the relation between frequency and *one* of these factors and show how the result is obtained from the observations.

A stretched wire emits a note of 300 vibrations per sec. when plucked. On altering the length of the wire by 20 cm., the tension remaining the same, the note emitted has a frequency of 450 vibrations per sec. What was the original length of the wire?

SECTION C

10. Explain what is meant by *magnetic field* and by *magnetic induction*.

Describe an experiment to plot the magnetic field inside and outside of a solenoid carrying a direct current, in a plane containing its axis. Draw a diagram of the field, marking the directions of the lines of force and the direction of the current.

If you were provided with bars of iron and steel of the same dimensions, and any other necessary apparatus, how would you demonstrate the main differences in the magnetic properties of iron and steel? State these differences and indicate, giving reasons, which of these metals you would use for (*a*) a compass needle, (*b*) the core of an electromagnet.

11. Describe a gold leaf electroscope. Explain how it may be used (*a*) to test the sign of a charge, (*b*) to show that the potential of a conductor is raised as the charge on it is increased.

Give details of the additional apparatus required, and how it is used, to enable the conductor in (*b*) above to receive a larger charge for a given rise in potential.

12. Describe the structure of a voltmeter and explain how it works.

A 12·0 volt battery of negligible internal resistance and resistances of 30 and 70 ohms respectively are connected in series. Calculate the potential difference between the ends of the 70 ohm resistance. Draw a circuit diagram showing how a voltmeter could be used to record this potential difference.

If a resistance of 60 ohms is now connected in parallel with the one of 30 ohms, find the new value of the potential difference between the ends of the 70 ohm resistance.

13. State the essential condition for the production of an induced e.m.f. in a conductor. What determines its magnitude?

Give an account, with a diagram, of the structure and mode of action of a transformer which supplies 12 volts when connected to 240 volt mains. If this transformer takes 0·55 amp. from the mains when used to light five 12 v. 24 w. lamps in parallel, find (*a*) its efficiency, (*b*) the cost of using it for 10 hours, at 6d. per kilowatt-hour.

14. Answer any *two* of the following:

(*a*) Describe the potentiometer method of comparing the e.m.f.s. of a Daniell and a Leclanché cell. Give a circuit diagram and name the essential components of the circuit.

(*b*) Define *electrochemical equivalent*. Explain, giving experimental details, the use of a copper voltameter to check the 1·0 amp. graduation of an ammeter.

(*c*) Give an account of the structure and mode of action of a telephone earpiece.

UNIVERSITY OF LONDON

General Certificate of Education Examination

January, 1962

Ordinary Level

PHYSICS

Thursday, 18 January: 9.30 to 12.30

Answer SIX questions, choosing TWO from each section.

Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

SECTION A

1. Define *density* and *specific gravity*. Why are they numerically the same when density is expressed in c.g.s. units ?

Describe an experiment to find the density of a piece of wax which floats on water and show how the result is deduced.

A specific gravity bottle weighs 23·28 gm. when empty and 62·88 gm. when partly filled with sand. When filled up with water, the bottle and contents weigh 97·88 gm. The weight of the bottle filled with water only is 73·28 gm. What is the specific gravity of the sand ?

2. Explain what is meant by the *components* of a force and show that a single force can have any number of pairs of components.

A body of mass 100 gm. is held at rest on a smooth plane inclined at 30° to the horizontal by a force applied horizontally. Give a diagram showing the forces acting on the body and find the magnitude of the applied force. What is the magnitude and direction of the least force necessary to keep the body at rest on the plane ?

What would be the work done in moving the body 50 cm. up the plane if there were a frictional force of 10 gm. wt. ?

3. Explain the terms *mechanical advantage*, *velocity ratio*, *efficiency* as applied to a machine and deduce the relation connecting them.

A block and tackle has a velocity ratio of 4. Give a diagram of the arrangement and describe how you would find its efficiency.

A man can exert a pull of 200 lb. wt. What is the maximum load he can raise with this pulley system, assuming an efficiency of 60% ?

[Turn Over

4. Answer any **two** of the following:—

(*a*) What is meant by a *force* ?

Describe an experiment to show that a body acted upon by a constant force moves with constant acceleration.

(*b*) With the aid of a diagram, describe the construction of a bicycle pump and explain the action in pumping up a tyre.

(*c*) Describe the essential features of an aneroid barometer and explain its action.

SECTION B

5. State two distinct ways in which mechanical energy may be transformed into heat energy.

Describe and explain an experiment to determine the relation between a unit of heat and a unit of work, stating the units used.

A steam engine develops 195 H.P. and its boiler uses 400 lb. of coal per hour. If the calorific value of the coal is 13,500 B.Th.U. per lb., find the efficiency of the plant.
(1 B.Th.U. = 780 ft. lb. wt. and 1 H.P. = 550 ft. lb. wt. per sec.)

6. Answer any **two** of the following:—

(*a*) Explain what is meant by *saturated vapour pressure*. How, if at all, does its value depend upon (i) the temperature, (ii) the presence of air in the space containing the vapour ?

Describe an experiment to measure the S.V.P. of ether at room temperature.

(*b*) Explain why, in very cold weather, (i) water in a pond freezes from the surface downwards and (ii) the temperature at the bottom of the pond is 4° C. even when freezing has taken place for some considerable time.

(*c*) Define *latent heat of steam* and *thermal capacity*.

Steam at 100° C., which has not been dried, is passed into a calorimeter containing water of combined thermal capacity 300 cal. per deg. C. The mass of the calorimeter and contents is thereby increased by 18 gm. and their temperature is raised from 7° C. to 40° C., stirring having taken place. Find the mass of water originally present in the steam.

(Latent heat of steam = 540 cal. per gm.)

7. Explain the following with the aid of ray diagrams:—

(*a*) The choice of a convex mirror rather than a plane one as the driving mirror of a car.

(*b*) The apparent bending of a stick partly immersed in water and held obliquely to its surface.

(*c*) The use of a right-angled isosceles prism to invert an image of an object.

8. Explain the terms *focal length* and *linear magnification* as applied to a converging lens.

How would you use a converging lens of focal length about 5 cm. to project a highly magnified image of an illuminated slide on the wall of the laboratory ? Give a ray diagram of the arrangement.

If you were also provided with a converging lens of focal length 50 cm., describe how you would arrange the two lenses as a telescope to view a lamp at the other end of the laboratory.

State the differences between the image of the slide formed by the single lens and that of the lamp seen in the telescope as regards (*a*) their nature, (*b*) the type of magnification.

9. Explain the terms *frequency*, *resonance*.

Describe **one** experiment in each instance to demonstrate (*a*) the dependence of pitch on frequency, (*b*) resonance (excluding the resonance tube).

A vertical glass tube is filled with water which is allowed to run away slowly at the lower end. At the same time a tuning fork is maintained in vibration above the upper end which is open. As the tube empties, two positions of resonance of the air column are observed, the distance between the corresponding water surfaces being 27·5 cm. Find the frequency of the fork if, during the experiment, the velocity of sound in the air in the tube is 330 metres per sec.

State, with an explanation, how the above distance will alter if the temperature of the air rises.

SECTION C

10. Give a diagram showing the lines of magnetic force due to a current in a straight conductor, in a plane perpendicular to the conductor.

Describe an experiment to show that a current carrying conductor which is perpendicular to a magnetic field, experiences a mechanical force. Show clearly the directions of the current, the magnetic field and the force.

Describe a simple electric motor and explain why a commutator is necessary to obtain continuous rotation.

11. Assuming that you have an insulated negatively charged conductor, how would you charge a gold leaf electroscope (*a*) positively, (*b*) negatively ?

How would you use the electroscope to test the sign of the charge on a conductor without transferring any charge ?

State and explain the effect of bringing an earthed conductor near the cap of a charged electroscope.

(Give diagrams to illustrate your answers.)

[**Turn Over**

12. Define *resistance* and establish the formula for the combined resistance of two resistances connected in parallel.

A battery consisting of 6 cells, each of e.m.f. 2·0 volts and internal resistance 0·1 ohms, is connected to a 9-ohm coil. Find the current in the coil. If now a 6-ohm coil is connected in parallel with the one of 9 ohms, find the new value of the current in the latter.

What would be the reading of a high resistance voltmeter, connected to the terminals of the battery, in each of the above circuits ?

13. Define *electrochemical equivalent* and explain the terms *anode* and *cathode*.

Describe an experiment to show the relation between the mass of copper deposited in the electrolysis of a solution of copper sulphate and the quantity of electricity which passes. Give a circuit diagram, full experimental details and state the result.

What time is required for a current of 1·2 amp. to deposit 0·18 gm. of copper in a copper voltameter ?
(E.c.e. of copper = 0·00033 gm. per coulomb.)

14. Answer any **two** of the following:—

(*a*) Define (i) *magnetic meridian*, (ii) *declination* (*magnetic variation*), (iii) *dip*.

Assuming that the magnetic field of the earth is that which would be produced by a short magnet placed at the centre with its axis slightly inclined to the earth's axis, indicate, with the help of a diagram, how the angle of dip would vary over the earth's surface.

(*b*) The ends of a coil of wire are joined together to form a closed circuit. How could you produce in the coil without breaking the circuit (i) a momentary direct current, (ii) an alternating current ? What factors determine the magnitude and direction of the current in (i) ?

(*c*) Describe a hot wire ammeter and explain its action. Why is it suitable for measuring either alternating or direct current ?

UNIVERSITY OF LONDON

General Certificate of Education Examination

January, 1962

Ordinary Level

PHYSICS

Thursday, 18 January: 9.30 to 12.30

Answer SIX questions, choosing TWO from each section.

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SECTION A

1. Define *density* and *specific gravity*. Why are they numerically the same when density is expressed in c.g.s. units ?

Describe an experiment to find the density of a piece of wax which floats on water and show how the result is deduced.

A specific gravity bottle weighs 23·28 gm. when empty and 62·88 gm. when partly filled with sand. When filled up with water, the bottle and contents weigh 97·88 gm. The weight of the bottle filled with water only is 73·28 gm. What is the specific gravity of the sand ?

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A body of mass 100 gm. is held at rest on a smooth plane inclined at 30° to the horizontal by a force applied horizontally. Give a diagram showing the forces acting on the body and find the magnitude of the applied force. What is the magnitude and direction of the least force necessary to keep the body at rest on the plane ?

What would be the work done in moving the body 50 cm. up the plane if there were a frictional force of 10 gm. wt. ?

3. Explain the terms *mechanical advantage*, *velocity ratio*, *efficiency* as applied to a machine and deduce the relation connecting them.

A block and tackle has a velocity ratio of 4. Give a diagram of the arrangement and describe how you would find its efficiency.

A man can exert a pull of 200 lb. wt. What is the maximum load he can raise with this pulley system, assuming an efficiency of 60% ?

[Turn Over

Th.P. 60/1104 8/4/11000

4. Answer any **two** of the following:—

(*a*) What is meant by a *force* ?

Describe an experiment to show that a body acted upon by a constant force moves with constant acceleration.

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(*c*) Describe the essential features of an aneroid barometer and explain its action.

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(*a*) Explain what is meant by *saturated vapour pressure*. How, if at all, does its value depend upon (i) the temperature, (ii) the presence of air in the space containing the vapour ?

Describe an experiment to measure the S.V.P. of ether at room temperature.

(*b*) Explain why, in very cold weather, (i) water in a pond freezes from the surface downwards and (ii) the temperature at the bottom of the pond is 4° C. even when freezing has taken place for some considerable time.

(*c*) Define *latent heat of steam* and *thermal capacity*.

Steam at 100° C., which has not been dried, is passed into a calorimeter containing water of combined thermal capacity 300 cal. per deg. C. The mass of the calorimeter and contents is thereby increased by 18 gm. and their temperature is raised from 7° C. to 40° C., stirring having taken place. Find the mass of water originally present in the steam.

(Latent heat of steam = 540 cal. per gm.)

7. Explain the following with the aid of ray diagrams:—

(*a*) The choice of a convex mirror rather than a plane one as the driving mirror of a car.

(*b*) The apparent bending of a stick partly immersed in water and held obliquely to its surface.

(*c*) The use of a right-angled isosceles prism to invert an image of an object.

8. Explain the terms *focal length* and *linear magnification* as applied to a converging lens.

How would you use a converging lens of focal length about 5 cm. to project a highly magnified image of an illuminated slide on the wall of the laboratory ? Give a ray diagram of the arrangement.

If you were also provided with a converging lens of focal length 50 cm., describe how you would arrange the two lenses as a telescope to view a lamp at the other end of the laboratory.

State the differences between the image of the slide formed by the single lens and that of the lamp seen in the telescope as regards (*a*) their nature, (*b*) the type of magnification.

9. Explain the terms *frequency*, *resonance*.

Describe **one** experiment in each instance to demonstrate (*a*) the dependence of pitch on frequency, (*b*) resonance (excluding the resonance tube).

A vertical glass tube is filled with water which is allowed to run away slowly at the lower end. At the same time a tuning fork is maintained in vibration above the upper end which is open. As the tube empties, two positions of resonance of the air column are observed, the distance between the corresponding water surfaces being 27·5 cm. Find the frequency of the fork if, during the experiment, the velocity of sound in the air in the tube is 330 metres per sec.

State, with an explanation, how the above distance will alter if the temperature of the air rises.

SECTION C

10. Give a diagram showing the lines of magnetic force due to a current in a straight conductor, in a plane perpendicular to the conductor.

Describe an experiment to show that a current carrying conductor which is perpendicular to a magnetic field, experiences a mechanical force. Show clearly the directions of the current, the magnetic field and the force.

Describe a simple electric motor and explain why a commutator is necessary to obtain continuous rotation.

11. Assuming that you have an insulated negatively charged conductor, how would you charge a gold leaf electroscope (*a*) positively, (*b*) negatively ?

How would you use the electroscope to test the sign of the charge on a conductor without transferring any charge ?

State and explain the effect of bringing an earthed conductor near the cap of a charged electroscope.

(Give diagrams to illustrate your answers.)

[Turn Over

12. Define *resistance* and establish the formula for the combined resistance of two resistances connected in parallel.

A battery consisting of 6 cells, each of e.m.f. 2·0 volts and internal resistance 0·1 ohms, is connected to a 9-ohm coil. Find the current in the coil. If now a 6-ohm coil is connected in parallel with the one of 9 ohms, find the new value of the current in the latter.

What would be the reading of a high resistance voltmeter, connected to the terminals of the battery, in each of the above circuits ?

13. Define *electrochemical equivalent* and explain the terms *anode* and *cathode*.

Describe an experiment to show the relation between the mass of copper deposited in the electrolysis of a solution of copper sulphate and the quantity of electricity which passes. Give a circuit diagram, full experimental details and state the result.

What time is required for a current of 1·2 amp. to deposit 0·18 gm. of copper in a copper voltameter ?
(E.c.e. of copper = 0·00033 gm. per coulomb.)

14. Answer any **two** of the following:—

(*a*) Define (i) *magnetic meridian*, (ii) *declination* (*magnetic variation*), (iii) *dip*.

Assuming that the magnetic field of the earth is that which would be produced by a short magnet placed at the centre with its axis slightly inclined to the earth's axis, indicate, with the help of a diagram, how the angle of dip would vary over the earth's surface.

(*b*) The ends of a coil of wire are joined together to form a closed circuit. How could you produce in the coil without breaking the circuit (i) a momentary direct current, (ii) an alternating current ? What factors determine the magnitude and direction of the current in (i) ?

(*c*) Describe a hot wire ammeter and explain its action. Why is it suitable for measuring either alternating or direct current ?

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

SUMMER 1962

PHYSICS

Three hours

Answer SIX questions, choosing TWO from each section.

Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

Assume that $g = 32$ ft. per sec. per sec., 4·2 joules = 1 calorie.

SECTION A

1. Distinguish between the *mass* and the *weight* of a body. Explain why the variation in the weight of a body at different places on the earth's surface can be detected by means of a very sensitive spring balance but not by a beam balance.

A metal block, mass 20 lb., comes to rest in 2·5 sec., after sliding 25 ft. in a straight line across a horizontal floor. Assuming that the block is uniformly retarded, find the force in lb. wt. opposing its motion and the work done against this force in the first 2 seconds of its motion.

Trace the changes of energy that occur during the motion of the block.

2. State *Boyle's law* and describe an experiment to verify it. Indicate the graphs that should be obtained if (*a*) p were plotted against $1/v$, (*b*) pv were plotted against p, where p and v refer to the pressures and volumes obtained from the experiment.

A uniform tube, 96 cm. long, sealed at one end, is lowered vertically with its open end downwards into mercury until the length of the enclosed air column is 84 cm. Find the depth of immersion of the tube in the mercury, given that the atmospheric pressure at the time of the experiment is 77 cm. of mercury.

Turn Over

3. Define *mechanical advantage*, *velocity ratio*, *efficiency* of a machine.

Give a labelled diagram of a pulley block and tackle of velocity ratio 5 and explain why it has this velocity ratio.

In an efficiency test carried out on this machine the following results were obtained:

Load in lb. wt.	20	80	140	220	300
Effort in lb. wt.	10	25	40	60	80

Calculate the efficiency in each instance and plot a graph showing how the efficiency varies with the load.

Comment on the variation of the efficiency with the load and give a reason for this variation.

4. Answer any *two* of the following:

(*a*) State *Archimedes' principle*.

A weather forecasting balloon, of volume 10 cubic metres, contains hydrogen of density 0·090 gm. per litre and its fabric weighs 6·5 kilograms. What is the weight of the equipment it carries if it is floating in air of density 1·25 gm. per litre? Assume that the volume of the equipment is negligible compared with that of the balloon.

(*b*) State the theorem of the *triangle of forces*.

A slab of concrete weighing 2·5 cwt. rests on a plane inclined at 30° to the horizontal. Find, graphically or otherwise, the normal reaction of the plane and the frictional force preventing motion.

(*c*) Define *centre of gravity* and describe an experiment to determine its position for a sheet of cardboard of uniform thickness but of irregular shape. Explain why the method used gives the required result.

SECTION B

5. Distinguish between *real* and *apparent* expansion of a liquid.

Define *coefficient of apparent expansion* and describe an experiment to find this coefficient for water between room temperature and 60° C.

What volume of mercury at 0° C. must be placed in a flask of volume 100 c.c. at 0° C. so that it just fills the flask at 100° C.?

(Coefficient of expansion of mercury = 0·00018 per deg. C., Coefficient of linear expansion of glass = 0·000009 per deg. C.)

6. Answer any *two* of the following:

(*a*) Describe a vacuum flask. Illustrate your answer with a labelled diagram and explain the particular features of its construction which make it suitable for keeping a hot liquid hot.

(*b*) Define *latent heat*.

Describe an experiment to find the latent heat of fusion of ice.

(*c*) State and explain what is observed as alcohol is gradually introduced into the space above the mercury in a barometer until a thin layer of alcohol rests on the mercury surface.

State what happens to the alcohol and to the level of the mercury in the tube if (i) the barometer tube is pushed deeper into the mercury reservoir, (ii) the top of the tube is warmed slightly.

7. (*a*) Define *principal focus* of a concave mirror.

An object 2 cm. high is situated on and perpendicular to the axis of a concave mirror of radius of curvature 30 cm. and is 10 cm. from the mirror. Find, graphically or by calculation, the position and size of the image and indicate on a diagram, the paths of three rays from a point on the object to an eye viewing the image.

(*b*) Explain the statement that the refractive index from glass to air is 2/3.

A rectangular glass block measures 6 in. by 2 in. Trace the path of a ray from a point in air which is at a perpendicular distance of 2 in. from the middle of one of the longer sides, for an angle of incidence of 40°. Measure the length of the path of the refracted ray in the glass.

8. Explain, with ray diagrams, the use of a lens (*a*) as a magnifying glass, (*b*) in a camera. State the characteristics of the image formed in each instance.

The distance between the film and the lens in a camera is 2·5 inches when it is focused on an object 5 ft. from the lens. How far must the lens be moved, and in what direction, in order to focus the camera on distant objects ?

9. What is meant by *frequency*, *musical interval* ?

How does the frequency of the note obtained by plucking a stretched wire depend on (*a*) the length of the wire, (*b*) its tension ?

Describe an experiment to verify the statement given in *either* (a) *or* (b).

Why is the intensity of the sound emitted by a plucked wire increased when it is mounted on a board ?

Turn Over

SECTION C

10. Give an account of a theory which explains the difference between a piece of unmagnetised steel and a steel magnet and describe two experiments in support of this theory.

Give *three* tests to determine whether or not a short steel needle is magnetised.

Explain why iron filings can be used to plot the lines of magnetic force round a bar magnet.

11. (*a*) Give a diagram of a *gold leaf electroscope* labelling its essential features. How would you use a gold leaf electroscope to compare the insulating properties of cotton and silk thread?

(*b*) What is meant by the *capacitance* of a condenser? Describe and explain an experiment to show that the capacitance of a condenser depends on the material between its plates.

12. Describe a primary cell in common use and explain how the defects of a simple cell have been overcome.

A Daniell cell, of e.m.f. 1·1 volts and internal resistance 2 ohms, is connected in series with a switch and a resistance of 3 ohms. What is the reading of a high resistance voltmeter connected across the poles of the cell when the switch is (*a*) open, (*b*) closed? Explain the difference in the readings.

13. Explain what is meant by the statement that the electro-chemical equivalent of copper is 0·00033 gm. per coulomb and describe an experiment to verify it.

Copper is electrolytically refined by depositing it on the cathode of a suitable voltameter. If the current is adjusted to be 1/50 amp. for each sq. cm. of the cathode surface, find the time required to deposit a layer of copper 2 mm. thick.

(Density of copper = 8·9 gm. per c.c.)

14. Answer any *two* of the following:

(*a*) Describe the structure of a moving coil loudspeaker and explain its action.

(*b*) It is required to raise the temperature of 20 litres of water from 15° C. to 75° C. in 30 minutes by means of an electric heater. What must be the power of the heater and what current will it take if it is designed for use on 240 volt mains? Explain why, in practice, the power must be greater than that calculated above.

(*c*) Describe the measurement of a resistance by means of a metre bridge.

State one important advantage of this method over the voltmeter-ammeter method.

Mr Obadiah

UNIVERSITY OF LONDON

General Certificate of Education Examination

Summer, 1961

Ordinary Level

PHYSICS

Thursday, 29 June: 9.30 to 12.30

Answer SIX questions, choosing TWO from each section.

Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

SECTION A

1. In what circumstances is *work* done by a force? State and explain a unit in which it is measured.

A train, starting from rest, is uniformly accelerated at 1·1 ft. per sec. per sec. until it attains a constant velocity of 30 m.p.h. Construct a velocity-time graph for the first minute of its motion and find the distance it travels in this time.

If the motion of the train is opposed by a steady resistance of 500 lb. wt., find the horse-power required to maintain the constant velocity of 30 m.p.h. on a horizontal track. What extra power is required to maintain this velocity along a track which rises 1 ft. in every 200 ft. of track, if the train weighs 120 tons?

(1 H.P. = 550 ft. lb. wt. per sec.)

2. State what is meant by the *triangle of forces* and describe, with full explanation, an experiment to illustrate it.

A uniform girder *AB*, of 100 lb. wt., makes an angle of 30° with the ground which is horizontal. The end *A* rests on the ground and the end *B* is attached by a rope to a point *C* vertically above *A* so that the angle *ABC* is 60°. Find, graphically or otherwise, the tension in the rope and the force exerted by the ground on the girder.

3. Define *pressure*. Describe a U-tube manometer suitable for measuring (*a*) the pressure of the domestic gas supply, (*b*) the pressure of the water supplied to a room in a house from a storage tank in the loft. Describe how you would use *one* of these and how you would calculate the pressure.

The water pressure in the mains pipe at the base of a building 36 ft. high is 50 lb. wt. per sq. in. Find the pressure at the top of the building given that 1 cu. ft. of water weighs 62·5 lb.

[Turn Over

4. Answer any **two** of the following:—

(*a*) Define *specific gravity* and state *Archimedes' principle*. The reading of a compression balance when a beaker containing glycerine of sp. gr. 1·25 is placed on the pan is 160 gm. wt., while that of a spring balance carrying a lump of brass of sp. gr. 8·5 is 340 gm. wt. The spring balance is then held so that the brass is completely immersed in the glycerine without touching the beaker or causing any overflow. Find the new reading of each balance.

(*b*) Define *coefficient of friction* and describe an experiment to determine its value between a block of metal and a wood surface.

(*c*) Draw a labelled diagram of a single rope pulley block and tackle having a velocity ratio of 5. If, using the above machine, a load of 50 lb. wt. is raised a distance of 2 ft. by an effort of 16 lb. wt., find (i) its efficiency, (ii) the work wasted in the machine.

SECTION B

5. How does the volume of a constant mass of gas vary with the temperature if the pressure is kept constant ?

Describe an experiment to verify your statement.

A long narrow glass tube of uniform cross section stands vertically with the closed end uppermost. A thread of mercury 12 cm. long seals off a volume of air 25 cm. long at 15° C. Find the pressure exerted by the air. What length of the tube would it occupy if the temperature were raised to 87° C. ?

(Barometric height = 76 cm. of mercury.)

6. Answer any **two** of the following:—

(*a*) Ice at − 10° C. is gradually heated until after melting the temperature of the water formed rises to 80° C. By means of a diagram, show how the volume changes with the temperature.

By reference to the diagram, explain why (i) water is unsuitable as a thermometric liquid, (ii) water pipes may burst during frosty weather.

(*b*) Describe an experiment to find the thermal capacity of a lump of metal, giving full experimental details and pointing out any precautions which should be taken.

(*c*) Describe a clinical thermometer and explain its action. State *one* requirement, in each instance, to enable it to be (i) quick in action, (ii) sensitive.

7. (*a*) Distinguish between a *real* and a *virtual* image.

By means of scale diagrams, find the position and nature of the image formed by (i) a convex lens, (ii) a concave lens, when a small object is placed on the axis of the lens at a distance away of twice its focal length.

(*b*) What is meant by *accommodation* of the eye and how is it brought about ?

Describe the defect in vision known as *short sight* and show how it can be corrected by the use of a suitable spectacle lens.

8. Define *refractive index* and explain what is meant by *critical angle*. Describe an experiment to find the refractive index of glass.

A small object is placed at the bottom of a beaker containing a liquid of refractive index 4/3 to a depth of 10 cm. A pin placed horizontally above the beaker is adjusted until there is no parallax between the image of the pin formed by reflection at the liquid surface and the image of the object. What is the height of the pin above the liquid surface ?

9. A sounding body is maintained in steady vibration and a graph is plotted of the displacement against the time. How could you determine from the graph the amplitude and the frequency of the vibration ? What characteristic of the sound is associated with the shape of the graph ?

Describe how you would determine the frequency of a tuning fork by means of a resonance tube, assuming that the velocity of sound at room temperature is known.

SECTION C

10. How would you magnetise a rod of steel *AB*, by electrical means, so that the end *A* becomes a N pole ? Illustrate your answer with a suitable diagram giving the direction of the current and the polarity of the magnet.

Describe a moving iron ammeter and explain its action, pointing out why iron is preferred to steel. Explain why this instrument can be used to measure both alternating and direct current.

11. Describe and explain an experiment to show that the divergence of the leaves of an electroscope is due to a difference of potential between the cap and the case.

The cap of an electroscope is connected to a large insulated metal plate and the system is charged. A similar plate, connected to earth, is placed opposite to and parallel with the first one. State and *explain* what happens when (*a*) the earthed plate is moved nearer to the charged one without touching it, (*b*) a sheet of glass is placed between the plates.

Name the practical device which is based on the above experiment and state what is achieved by its use.

[**Turn Over**

12. State the factors which determine the *resistance* of a metal wire and indicate how they do so.

Describe the metre-bridge method to determine the resistance of a coil of wire.

A resistance of 10 ohms is placed in the left-hand gap of a metre-bridge and resistances of 15 ohms and 10 ohms joined in parallel in the other gap. What is the position of the balance point from the left hand end of the bridge wire ?

13. Explain what is meant by *electromagnetic induction* and state the law which indicates the magnitude of the induced e.m.f. Describe an experiment in support of your answer and indicate on a diagram how the direction of the induced current is determined by the cause producing it.

Describe **either** a simple A.C. dynamo **or** a transformer, and explain how it works.

14. Answer any **two** of the following:—

(*a*) Give an expression for the rate at which heat is produced in a conductor carrying an electric current, stating the physical quantities involved and the units in which they are measured.

Water in an electric kettle connected to a 240-volt supply took 6 minutes to reach its boiling point. How long would it have taken if the supply had been one of 210 volts ?

(*b*) A Daniell cell of e.m.f. 1·1 volts, maintained a constant current of 0·35 amp. in a circuit for 20 minutes. Find (i) the energy supplied by the cell in this time, (ii) the change in mass of its positive pole, indicating whether this was an increase or decrease.

(E.c.e. of copper = 0·00033 gm. per coulomb.)

(*c*) Describe the diode valve and give details of the cathode circuit. State the essential condition, in each instance, to produce an anode current which is (i) zero, (ii) a maximum, assuming that the cathode is at a constant temperature suitable for the normal working of the valve.

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

JANUARY, 1960

PHYSICS

TUESDAY, January 12.—*Afternoon,* 2 *to* 5

Answer SIX *questions, choosing* TWO *from each section.*

Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalised.

Assume that g = 32 ft. per sec. per sec.

SECTION A

1. Explain what is meant by the term *energy* and define a unit in which it is measured. Distinguish between *potential* and *kinetic energy*.

A car of mass 2,400 lb. travelling along a horizontal straight road is brought to rest in a distance of 75 yd. by a constant force of 600 lb. wt. exerted by its brakes. Find (*a*) the initial velocity of the car, and (*b*) the time taken for the car to come to rest.

Discuss the changes of energy which occur as the car is brought to rest.

2. Describe, with the aid of a labelled diagram, the common hydrometer suitable for measuring the specific gravities of liquids between 1·00 and 1·10. Explain the features of its construction which make it sensitive to small changes in specific gravity.

A common hydrometer weighs 36 gm. and its total volume is 37 c.c. Its stem is 10 cm. long and has a constant area of cross-section of 0·50 sq. cm. Find the length of the stem above the surface when the hydrometer floats in (*a*) water, (*b*) brine of sp. gr. 1·08.

What is the maximum specific gravity reading that can be marked on the stem of this hydrometer?

3. Describe an experiment to show that the atmosphere exerts a considerable pressure.

Explain (*a*) the action of the aneroid barometer, (*b*) its use for measuring heights. [Details of the instrument are *not* required.]

The total surface area of an aneroid barometer is 200 sq. cm. Calculate the increase in thrust in gm. wt. exerted upon it by the atmosphere when the mercury barometer rises by 0·5 cm. [Density of mercury = 13·6 gm. per c.c.]

4. (*a*) Describe *either* a pulley block and tackle *or* a screw jack suitable for raising a heavy load by the application of a small force.

Describe how you would measure the efficiency of the machine for a given load.

(*b*) Define *coefficient of friction.*

A block of metal weighing 200 lb. wt. rests on a horizontal surface, the coefficient of friction between the two surfaces being 0·25. Explain why a horizontal force of 40 lb. wt. applied to the block fails to move it. What additional horizontal force applied to the block will just produce movement if it acts (i) in the same direction as the force of 40 lb. wt., (ii) at right angles to it?

SECTION B

5. State the law which indicates the way in which the volume of a fixed mass of gas varies with its temperature when its pressure is maintained at a constant value.

Describe an experiment to verify the law.

The density of air at S.T.P. is 1·29 gm. per litre. What is its density at 28°C., the pressure remaining unaltered?

6. Answer any *two* of the following:—

(*a*) Define *thermal capacity, latent heat of vaporisation.*

A small immersion heater placed in 92 gm. of water contained in a well lagged vessel of thermal capacity 8 cal. per deg. C. raised the temperature from 17°C. to 80°C. in a given time.

The water was replaced by 80 gm. of alcohol at the same initial temperature and the heater was switched on for the same time as before. The temperature of the alcohol rose to its boiling point 77°C. and 14 gm. of alcohol were boiled away. Given that the specific heat of alcohol is 0·60 cal. per gm. per deg. C. and assuming no heat losses in either experiment, find the latent heat of vaporisation of alcohol.

(*b*) Why does a thermometer, the bulb of which is covered with damp muslin, generally indicate a lower temperature than another thermometer with an uncovered bulb placed near to it?

Explain the factors upon which the difference of temperature depends. In what circumstances are the two thermometer readings identical?

(*c*) Explain what is meant by the statement that "the mechanical equivalent of heat is 4·2 joules per cal."

An engine consumes 2 kilograms of oil per hour. If the calorific value of the oil is 9,000 cal. per gm. and if the engine converts one third of the heat supplied to it into useful work, find the power it develops in kilowatts.

7. Explain what is meant by stating that the refractive index of a given kind of glass is 1·5.

Describe how you could verify this statement by experiment.

Draw an accurate diagram, full scale, showing the path of a ray of light through a parallel sided block of the above glass, if the distance between the refracting faces is 3 inches and the angle of incidence is 50°. Measure the distance through which the ray is displaced laterally.

8. Answer any *two* of the following:—

(*a*) What is (i) a real image, (ii) a virtual one?

Show, by means of ray diagrams, how a magnified image of *each* type may be produced by a concave mirror.

(*b*) Explain, with the aid of a ray diagram, the use of a glass prism, with either one or two converging lenses, to obtain a pure spectrum of white light.

(*c*) Describe an experiment to determine the focal length of a converging lens, and explain how you obtain your result from the readings taken. [State your sign convention if you use one].

9. What is meant by *resonance*? Give two examples of resonance from any branches of Physics.

Describe a laboratory experiment to determine the frequency of a tuning fork. State the precautions you would take to ensure an accurate result.

What would be the effect of a rise in temperature on the frequency of a note given by a wire stretched between two fixed pegs? Explain your answer.

Section C

10. What is (*a*) a *line*, and (*b*) a *field*, of magnetic force?

A long bar magnet is fixed vertically with its N. pole resting on a sheet of drawing paper. Describe how you would obtain an accurate map of the field due to the pole and to the earth. Draw a diagram of the map you would expect to obtain.

If a neutral point is located 25 cm. from the pole of the magnet, calculate the strength of the pole. [$H_0 = 0{\cdot}18$ oersted.]

11. Describe the essential parts of a gold leaf electroscope and explain how it may be charged positively by induction. How would you use the electroscope (*a*) to determine the sign of the charge on an insulated metal sphere, and (*b*) to find which of two charged spheres has the greater charge?

12. Describe an experiment to show (*a*) that a current carrying conductor has a magnetic field and (*b*) that a mechanical force acts on the conductor when placed suitably in another magnetic field.

If the conductor is in the form of a flat coil show how the result in (*b*) is used in the construction of a moving coil galvanometer.

13. What is meant by the electromotive force of a cell? Why is the e.m.f. of a primary cell different from the potential difference between its terminals when it is supplying current? Show how you would use a potentiometer circuit to compare the e.m.f. of a Daniell cell with that of a standard cell. Explain how your experiment does so.

A battery of dry cells gives a current of 0·5 amp. when its terminals are connected to a 4 ohm resistance. When the resistance is halved, the current rises to 0·6 amp. Find the internal resistance of the battery.

14. (*a*) State the laws of electrolysis. A silver and a copper voltameter are connected in series, and a suitable current is passed through them for 20 minutes. If 1·2 gm. of silver are deposited, calculate the mass of copper deposited, and the current through the circuit.

[Chemical equivalent of copper is 31·5, and of silver is 108. Electrochemical equivalent of silver = 0·001118 gm. per coulomb.]

(*b*) What is meant by *electromagnetic induction*? Explain how the principle is used in the construction of a transformer. What is the difference between a step-up and a step-down transformer?

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

Summer, 1960

PHYSICS

THURSDAY, *June* 30.—*Afternoon*, 2 *to* 5

Answer SIX *questions, choosing* TWO *from each section.*
Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalised.

Assume that g = 980 cm. per sec. per sec.

Section A

1. What is meant by stating that the acceleration of a body is 4 ft. per sec. per sec.? In what circumstances is an acceleration uniform?

Describe an experiment to find the acceleration due to gravity, showing clearly the method of obtaining the result.

A body of mass 100 gm. is released from rest 19·6 metres above the ground. Find (*a*) its time of fall, (*b*) its kinetic energy on reaching the ground.

2. Distinguish between *force* and *pressure*.

How would you show experimentally that the pressure due to a liquid at a point below its surface is proportional to the depth?

A U-tube of cross sectional area 1 sq. cm. contains mercury which rises a short distance up each limb. 12·4 c.c. of water are poured in one limb and 7·0 c.c. of a liquid of specific gravity 0·80 in the other. What is the difference in level between the surfaces of the water and the liquid? (The specific gravity of mercury is 13·6.)

C.P. 59/1301 6/2/259C

[P.T.O.

3. A fixed mass of gas is kept at a constant temperature. How does (*a*) the volume, (*b*) the density, vary with the pressure? Describe an experiment to determine how the volume varies with the pressure. Show how you would use the observations you make to obtain the result.

The pressure of oxygen contained in a 25 litre cylinder is 60 atmospheres. What volume of oxygen at atmospheric pressure is obtained from the cylinder when the pressure falls to 48 atmospheres, the temperature remaining constant?

4. Answer any *two* of the following:—

(*a*) State Archimedes' principle as applied to a floating body.

What is the least force required to submerge completely in water a piece of wax weighing 23 gm.? What is the smallest mass of aluminium foil wrapped round the wax which would achieve the same purpose, the aluminium also being completely immersed?

(The specific gravity of the wax is 0·92 and that of aluminium 2·7.)

(*b*) What is meant by (i) the *centre of gravity* of a body and (ii) *stable equilibrium*?

With the aid of diagrams explain how a bus is tested for stability and why, in making this test, the upper deck is fully loaded and the lower one left empty.

(*c*) What is meant by the *resultant* of a number of forces acting at a point?

How would you prove experimentally that the resultant of two forces acting at a point can be calculated by means of the parallelogram rule?

SECTION B

5. What is meant by the statement that the coefficient of linear expansion of brass is 0·000018 per deg. C.? Give a detailed account of an experiment to verify it.

The internal diameter of a brass ring is 15·94 cm. and the diameter of a wheel is 16·00 cm., both measured at the same temperature. Find the smallest rise in temperature through which the brass ring must be heated in order that it may just slip on to the wheel.

6. Answer any *two* of the following:—

(*a*) Give an account of the transference of heat by *conduction* and *convection*.

Describe an experiment to show that copper is a better conductor of heat than iron.

(*b*) Distinguish between *thermal capacity* and *specific heat*.

A block of aluminium, mass 500 gm., at 20°C. was heated in a furnace until it just melted. Find the quantity of heat required.

If, in this process, the furnace consumed 100 litres of gas of calorific value 4,000 cal. per litre, find its efficiency.

(Aluminium melts at 660°C., its specific heat is 0·22 cal. per gm. per deg. C. and its latent heat of fusion is 76 cal. per gm.)

(*c*) Explain why a copper wire, weighted at each end and slung over a block of ice, gradually sinks through the ice leaving it solid as before. Give another example in which the same physical principle is involved.

7. (*a*) Describe the pinhole camera and explain how the image is formed. Explain what happens when the size of the hole is increased.

(*b*) Explain how a single lens is used as a magnifying glass.

A man whose near point is 25 cm. from his eye uses a magnifying glass of focal length 5 cm. Where must the object be placed to obtain the image at his near point?

(If the answer is obtained by calculation, state the sign convention used.)

8. A triangular glass prism is placed between a screen and a narrow slit illuminated by an electric filament lamp. Describe the appearance of the coloured band on the screen when the light meets the prism at a suitable angle and explain its formation.

What additional apparatus would be required to obtain the least possible overlapping of the colours? Give a diagram of the new arrangement showing the paths of two rays from a point on the slit to the screen.

How would the appearance on the screen be altered if a piece of red glass were placed between the lamp and the slit?

9. Give reasons for the following:—

(*a*) A noise differs from a musical note.

(*b*) Musical notes differ in *pitch*, *loudness* and *quality*.

Describe how you would determine the frequency of the note emitted by a tuning fork, showing how the result would be obtained from your observations.

[P.T.O.

SECTION C

10. Define *magnetic field, magnetic line of force.*
Describe how you would plot a magnetic field using a small compass.

Give diagrams of the fields which would be obtained near (*a*) a U-shaped magnet lying flat on a table, (*b*) an air cored solenoid carrying a direct current, in a plane containing its axis.

Explain the action of the keeper which is placed across the poles of the magnet in (*a*) above when it is not in use and state *two* ways in which the solenoid in (*b*) could be made into a stronger electromagnet.

11. Describe the gold leaf electroscope and explain how you would use it to investigate the distribution of charge over the surface of a pear shaped conductor. State the results of the experiment.

Describe an experiment to illustrate the discharging action of points and give a brief account of one application.

12. Describe, with the aid of a diagram, a moving coil galvanometer and explain its action. Explain how such a galvanometer may be adapted for use with large currents.

In order to check the graduation of an ammeter, it was placed in a circuit in series with a copper voltameter. When the ammeter reading was kept constant at 1·0 amp., a mass of 0·66 gm. of copper was deposited on the cathode of the voltameter in 30 minutes. What was the error in the ammeter reading?

(Electrochemical equivalent of copper = 0·00033 gm. per coulomb.)

13. How would you show by experiment that the heat produced in unit time in an electrically heated wire of constant resistance is directly proportional to the square of the potential difference between its ends? Give a circuit diagram.

A 240 v. electric cooker has two identical heating elements which may be connected to the mains in three different ways, viz.: (*a*) *one* element only is used, the other being disconnected, (*b*) both elements are used in *series*, and (*c*) both are used in *parallel*. If the resistance of each element is 18 ohms find the rate of production of heat energy, in cal. per sec., in each arrangement.

Find the cost of using the cooker for $2\frac{1}{2}$ hours connected as in (*c*) if the price of electricity is $1\frac{1}{2}$d. per unit.

(4·2 joules = 1 cal.)

14. Answer any *two* of the following:—

(*a*) Give a labelled diagram of a dry form of the Leclanché cell and explain how, and to what extent, the defects of the simple voltaic cell are overcome in it.

(*b*) Describe and explain the action of a telephone receiver.

(*c*) Describe, with the help of a circuit diagram, the potentiometer method of comparing the electromotive forces of two cells.

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

SUMMER, 1959

PHYSICS

THURSDAY, June 18.—Morning, 9.30 to 12.30

Answer SIX *questions, choosing* TWO *from each section.*

Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalised.

Assume that g=32 ft. per sec. per sec.

SECTION A

1. Define *kinetic energy* and *potential energy*, stating how each is measured and a unit in which each is expressed.
A pile driver is raised to a height of 20 ft. and allowed to fall on to a pile to be driven into the ground. Give an account of the changes of energy which occur from the beginning of the motion until the pile driver is again at rest. If the mass of the driver is 3/4 cwt. calculate the kinetic energy just before it strikes the pile. 1680

2. State Archimedes' principle and describe an experiment to verify it. Explain how your experiment does so.
Two spheres of equal size but of different materials are completely immersed in a vessel of water. One is suspended by a string the tension in which is 900 gm. wt. whilst the other is prevented from floating by a string attached to the base of the vessel. Draw diagrams to show the forces acting on each sphere. If the volume of each sphere is 120 c.c. and the tension in the second string is 24 gm. wt., find the mass and density of each sphere.

1020 24
8.5 0.2

3. State the parallelogram law for forces and explain how the same law may be applied to velocities.

A man can row at 2 m.p.h. in still water and wants to cross a river to a point exactly opposite. If the river is 150 yd. wide and is flowing at $1\frac{1}{2}$ m.p.h., find, by means of a scale drawing or otherwise, the direction in which he must set off. How long will it take him to cross?

4. Answer any *two* of the following:—

(*a*) Describe and explain the action of a siphon.

(*b*) How could you find the specific gravity of steel by using a specific gravity bottle and a sufficient number of small steel ball bearings? Why is this method capable of giving very accurate results?

(*c*) Draw a diagram of a system of pulleys having a velocity ratio of 5. How do you know that the velocity ratio in the arrangement you have drawn is, in fact, 5? In order to lift a mass of 1 ton with such a system, an effort of 5 cwt. is required. Find the efficiency of the arrangement. How do you account for the wastage of energy?

Section B

5. Define *latent heat* and describe an experiment to determine its value for the fusion of ice.

A thick iron calorimeter weighing 650 gm. is closed by a rubber bung having two holes fitted with glass tubes, forming a water trap. Steam at 100°C. is passed into the vessel through one of the tubes, and escapes through the other until no more will condense, all condensed steam being retained. Find the latent heat of steam from the following data:—mass of steam condensed 12·6 gm., initial temperature of the calorimeter 9°C., specific heat of iron = 0·115 cal. per gm. per deg. C. What precautions would you take to ensure a more reliable result? Give your reasons.

6. Answer any *two* of the following:—

(*a*) Draw a diagram of a maximum and minimum thermometer, label it, and explain how the thermometer functions.

(*b*) Define *dew point*. Describe an experiment to determine its value at any particular place. Explain one use for a knowledge of the dew point.

(*c*) What is meant by (i) *boiling*, (ii) *saturation vapour pressure* of a liquid? Describe an experiment to show that the pressure on the surface of a liquid affects the temperature at which it boils.

7. Define the *luminous intensity* (illuminating power) of a lamp and the *illumination* (intensity of illumination) of a surface. Describe and explain the use of either a grease spot or a wax photometer to compare the luminous intensities of two lamps.

A 60 c.p. lamp is placed 6 ft. from a small screen. Calculate the illumination produced at the screen. A plane mirror is now placed 9 ft. from the screen and parallel to it, so that the lamp is between them. Calculate the new illumination of the screen assuming that the mirror reflects all the light falling on it.

8. Answer any *two* of the following:—

(*a*) Explain what is meant by *critical angle*.

Draw diagrams to show how a right angled isosceles prism may be used to deviate a narrow parallel beam of light through (i) 90°, (ii) 180°. Explain briefly.

(*b*) Define, with the aid of a ray diagram, the terms *principal focus* and *focal length* for a diverging lens.

A diverging lens of focal length 10 cm. produces a virtual image half the size of the object. Find the distance of the object from the lens.

Mention any *one* use of a diverging lens.

(*c*) Give a ray diagram of a compound microscope consisting of two lenses by drawing two rays through the instrument from a non-axial point on the object to the eye. Show clearly the formation of both the intermediate and final images.

9. Describe experiments, one in each instance, to show that (*a*) a source of sound is vibrating, (*b*) a material medium is needed to transmit sound, and (*c*) the pitch of a musical note depends upon the frequency of the vibrations producing it.

Describe and explain a method of comparing the frequencies of two tuning forks.

Section C

10. Describe how an electric current may be used (*a*) to magnetise a steel bar, (*b*) to demagnetise it.

Draw a diagram of the magnetic field produced by a current flowing in a long straight wire in a plane at right angles to the wire. State a rule which gives the relation between the direction of the current and that of the field.

A long vertical wire carrying a current passes through a horizontal bench. Give a diagram of the resultant magnetic field on the surface of the bench around the wire due to the current and the earth. Mark the positions of any neutral points formed in this field.

[P.T.O.

11. Define *capacitance* of an electrical condenser. On what factors does its value depend, and how do they affect it?

Describe an experiment to illustrate how the capacitance depends upon *one* of the factors given and explain how the experiment does so.

Describe the construction of one type of condenser in common use.

12. Define the *electromotive force* of a cell. Explain how it differs from the potential difference between the terminals of the cell when the cell is supplying a current.

A battery of e.m.f. 15 volts and internal resistance 3 ohms is connected to two coils of resistances 3 and 6 ohms respectively, (*a*) when the coils are in series, and (*b*) when they are in parallel.

Find in *each* instance (i) the current through the battery, (ii) the p.d. between the terminals of the battery, (iii) the heat produced per minute in the 6 ohm coil.

[4·2 joules = 1 cal.]

13. Describe an experiment to demonstrate the production of an induced current and give a diagram to show how the *direction* of the current is linked with the cause producing it.

Describe two further experiments to illustrate factors upon which the *strength* of the induced current depends.

A flat coil of wire rotates at a constant rate about an axis which is at right angles to a uniform magnetic field. Indicate, with the help of a graph, how the induced e.m.f. varies during one complete revolution of the coil. What are the positions of the coil, relative to the field, when the e.m.f. has a maximum value?

14. (*a*) Define *watt*.

A car headlamp bulb is labelled '12v. 36w'. What does this mean? Show, with the aid of a circuit diagram, how you would use an ammeter and a voltmeter to check the accuracy of the statement.

(*b*) Define *electrochemical equivalent*. Describe, giving a circuit diagram, how you would determine its value for copper.

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

SUMMER, 1959

PHYSICS

THURSDAY, June 18.—*Morning*, 9.30 *to* 12.30

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UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

AUTUMN, 1955

PHYSICS

MONDAY, November 14.—*Morning,* 9.30 *to* 12.30

[*Not more than* SEVEN *questions are to be answered and of these* TWO *are to be answered from each of two of the Sections and* THREE *from the remaining Section.*]

[*The value of g when required should be taken as* 32 *ft. sec.*$^{-2}$ *or* 981 *cm. sec.*$^{-2}$]

SECTION A

1. Define *acceleration* and *force*. How are they related in any particular instance?

A motor car of mass 15 cwt. has its speed reduced from 80 m.p.h. to 20 m.p.h. in 11 sec., by the application of its brakes. Determine (*a*) the retardation (assumed constant), (*b*) the force which produces it. Determine also, from the instant the brakes are applied, (*c*) the time taken to come to rest and (*d*) the distance the car travels before coming to rest.

2. Define *centre of gravity*.

What do you understand by the terms *stable*, *unstable* and *neutral* equilibrium? Illustrate your answer by means of diagrams.

Explain why a double decker bus is more stable when it is full inside and empty on top, than when it is full on top and empty inside.

3. Explain why the specific gravity bottle is capable of giving very accurate results in determinations of specific gravities.

Describe how you would use it to find the specific gravity of steel, using small steel ball bearings.

A steel cube of side 2·4 in. weighs 3·9 lb. Calculate (*a*) its density and (*b*) its specific gravity. (Given 1 cu. ft. of water weighs 62·5 lb.)

C.P. 54/1966 5/2/58C

4. Describe an experiment to show how the pressure at a given level in a liquid depends on the depth of that level below the surface. What result would you expect to get?

Show how this knowledge is applied to the working of a lift pump .

Explain with the aid of a diagram the working of a pump capable of raising water from a well to a storage tank 75 ft. above the ground, the level of the water in the well being 20 ft. below the surface of the ground.

5. Answer any *two* of the following:—

(*a*) What is meant by the law of the lever?
Describe the three different types of levers and give *one* example of each kind, showing with the aid of diagrams how the law is applied and the advantage which is gained.

(*b*) Describe *two* experiments to show that in some respects the surface of a liquid behaves like a stretched membrane.

(*c*) Describe how you would set up an ordinary mercury barometer, and explain how the pressure of the atmosphere is found from it. What experiment could be performed to test whether there was any air in the space above the mercury? What difference would there be if the space contained water vapour instead of air?

SECTION B

6. Define *specific heat, latent heat.*

What do you understand by the term *water equivalent* of a calorimeter?

Calculate the total water equivalent of a copper calorimeter of mass 95·7 gm. containing 162·8 gm. of turpentine (Specific heat of copper is 0·094 and of turpentine is 0·43.)

The temperature of the turpentine was 30°C. and small pieces of dried ice at 0°C. were added until the temperature fell to 8°C. Find the mass of ice added. (Latent heat of fusion of ice = 80 cal. per gm.)

7. Define *coefficient of linear expansion* and describe a method of determining its value for copper.

How could it be shown that a very great force is exerted when the expansion or contraction of a metal is resisted? Describe *one* instance where this fact is made use of and *one* where it has to be allowed for.

8. Answer any *two* of the following:—

(*a*) Define dew point and relative humidity. Describe an experiment to determine the dew point. How can the relative humidity be determined from a knowledge of it?

(*b*) How could it be shown that water is a bad conductor of heat?
Show by means of a diagram the essentials of a domestic hot water system and explain how it works.

(*c*) A mercury thermometer has been filled and sealed. Describe the process of graduating it. What precautions must be taken to ensure accuracy?

9. Define *focal length* as applied to (i) a convex lens and (ii) a convex mirror.

In an experiment to determine the focal length of a convex lens, a small slit was illuminated and placed at convenient distances (u) from the lens on an optical bench. The image of the slit was received on a screen and the distances of the screen (v) from the lens were measured in each instance. The results were as follows:—

u cm.	10	12	16	20	25	40
v cm.	41·7	24·4	16·4	13·5	11·9	10·1

Calculate in each instance $\frac{100}{u}$ and $\frac{100}{v}$ and, on the graph paper provided, draw a graph connecting these values. Use your graph to determine the focal length of the lens, explaining your method.

10. What is meant by (*a*) the *candle power* of a lamp and (*b*) the *intensity of illumination* produced by it? Describe a method of comparing the candle powers of two lamps.

Two lamps, A and B, give equal illumination on a screen when placed at distances of 40 and 60 cm. from it. If the stronger lamp is 100 candle power, what is the weaker one?

A slab of glass interposed between the screen and the 100 C.P. lamp cuts off $\frac{5}{9}$ths of the light. At what distance from the screen must the other lamp be placed to give equal illumination again.

11. Describe a sonometer. How may it be used to compare the frequencies of two notes?

Two cog wheels, A and B, in a piece of machinery, revolve at 15 and 8 revolutions per second respectively. A has 28 teeth, and a card held against it emits a note in unison with 16·8 cm. of the sonometer wire. When the card is transferred to B, the length of the wire has to be changed to 25·2 cm. for unison. Calculate (*a*) the frequency of the card when touching A, (*b*) its frequency when touching B, (*c*) the number of teeth on B.

SECTION C

12. Explain the terms *variation* and *dip* with reference to the earth's magnetic field, and describe an experiment to determine the value of *one* of them at a place.

A bar of soft iron is held (*a*) horizontally in the magnetic meridian, (*b*) horizontally at right angles to the meridian, (*c*) vertically. State the effect, if any, in each position, if the bar is hammered. What explanation of the results can you offer?

13. State the law connecting the force between two small charged bodies and their distance apart.

Two similar conducting pith balls, each of mass 0·02 gm., are suspended from a point by silk fibres each 13 cm. long. Describe how to charge the pith balls positively, being provided with an ebonite rod and a piece of fur. Assuming their charges to be equal, and that they are repelled to a distance apart of 10 cm., draw a diagram of the arrangement, indicating all the forces involved, and calculate (*a*) the force of repulsion, (*b*) the charge on each ball.

14. State Ohm's law and describe an experiment to determine the resistance of a conductor by the direct application of this law.

Explain what is meant by the internal resistance of a primary cell, and state *three* factors which affect its value in different cells.

When a battery is connected to a conductor of resistance 300 ohms the potential difference between the terminals of the battery is 15 volts. On disconnecting the conductor, the potential difference rises to 16 volts. Calculate the internal resistance of the battery.

15. State Faraday's laws of electrolysis and describe an experiment to illustrate *one* of them.

Calculate the volume of mercury liberated in 40 minutes by a current of 2 amp. passing through a solution of a mercury salt. (Electro-chemical equivalent of hydrogen = 0·00001044 gm. coulomb^{-1}, chemical equivalent of mercury = 200·6, density of mercury = 13·6 gm. cm.$^{-3}$.)

16. Answer *two* of the following:—

(*a*) Describe a simple form of moving coil galvanometer. What factors determine the value of the deflection produced by a given current?

(*b*) Draw a diagram to show the structure of a simple direct current dynamo and explain how the current is generated.

(*c*) Describe and explain the action of (*a*) the transmitter, (*b*) the receiver, of a telephone circuit.

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

SUMMER, 1955

PHYSICS

MONDAY, June 13.—*Morning*, 9.30 *to* 12.30

[*Not more than* SEVEN *questions are to be answered and of these* TWO *are to be answered from each of two of the Sections and* THREE *from the remaining Section.*]

[*The value of g when required should be taken as* 980 *cm. sec.*$^{-2}$]

SECTION A

1. Define *dyne* and *erg* and explain the relationship between the dyne and the gram-weight.

A mass of 6 kgm., is pulled by a force of 30 gm.-wt., along a frictionless, horizontal plane. Calculate (*a*) the acceleration, (*b*) the velocity 3 sec. after starting from rest, (*c*) the distance gone and the work done in those 3 sec.

2. State the triangle law for forces and describe an experiment to illustrate it.

A ventilating window, 2 ft. from top to bottom, has a mass of 2 lb. and has a smooth hinge along its lower, horizontal edge. A horizontal cord, attached to its upper edge, holds the window at an angle of 30° with the vertical. Make a scale diagram, indicating a triangle of forces. Hence, or otherwise, determine (*a*) the direction and magnitude of the reaction at the hinge, (*b*) the tension in the cord. (Assume the centre of gravity of the window to be at its middle point.)

C.P. 54/1951 5/2/15250 **[P.T.O.**

3. Define *centre of gravity*.

A uniform, plane sheet of metal ABCD of negligible thickness has AC = 5″, AD = AB = 3″ and CB = CD = 4″. Draw the piece of metal to scale and mark the positions of the centres of gravity of the triangles ABC and ADC. Hence find the centre of gravity of the whole figure, explaining your method. How could you verify your result experimentally?

4. The following results were obtained in a experiment to investigate the stretching of an elastic cord:—

Stretching force in kgm.-wt.	0	$\frac{1}{2}$	1	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3
Length of cord in cm.	340·0	340·6	341·2	341·8	342·4	343·1	344·1

On the squared paper provided, plot a graph to illustrate Hooke's law. State this law and point out its validity for the specimen used in the experiment.

Describe an experiment by which these results may have been obtained.

5. Answer *two* of the following:—

(*a*) Describe the construction and action of an aneroid barometer. Why do its readings vary (i) from day to day, (ii) with height above sea level?

(*b*) Describe the construction and action of a common lift pump. What factors determine the maximum height to which such a pump can raise a liquid?

(*c*) Draw a diagram of a pulley system consisting of four pulleys, pointing out how the diagrammatic representation differs from the practical system. State the velocity ratio of the system you draw and calculate the load which could be raised with an effort of 20 lb.-wt. if the efficiency is 65%.

Section B

6. Explain the statement, "the mechanical equivalent of heat is 4·2 joules cal.$^{-1}$", and describe an experiment to verify this value.

A piece of lead falls 3 metres from rest, coming to rest again on the ground. Calculate the rise in its temperature, the specific heat of lead being 0·032. State the assumptions you make in the calculation.

7. Air is blown through some ether in a copper can. Explain (*a*) the effect on the temperature of the ether, (*b*) the formation of mist on the outside of the can. On another day, repetition of the experiment produced the mist at a lower temperature. Explain the reason for this and describe a practical application of these effects.

8. Explain and give an illustration of the use of the following:—

(*a*) the bending of a compound bar of two different metals attached side by side, when heated;

(*b*) the movement of air when heated;

(*c*) the delay in the passage of a flame through a piece of wire gauze.

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Section C

12. (*a*) Define *magnetic pole strength, magnetic field strength*. Describe a method for determining the positions of the poles of a bar magnet.

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One of the gaps of a metre bridge is closed by a 2-ohm resistance and the other by a 3-ohm coil. Where will the point of balance be? What resistance, placed in parallel with the 3-ohm coil, will be required in order that the balance point may be at the mid point of the bridge wire?

15. (*a*) Draw a diagram of an electric bell. Show clearly the path of the current through it and explain its method of working. What cell would be the most convenient to work it? Give your reasons.

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Describe *either* (i) an induction coil *or* (ii) a transformer.

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UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

SUMMER, 1955

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SECTION A

1. Define *dyne* and *erg* and explain the relationship between the dyne and the gram-weight.

A mass of 6 kgm., is pulled by a force of 30 gm.-wt., along a frictionless, horizontal plane. Calculate (*a*) the acceleration, (*b*) the velocity 3 sec. after starting from rest, (*c*) the distance gone and the work done in those 3 sec.

2. State the triangle law for forces and describe an experiment to illustrate it.

A ventilating window, 2 ft. from top to bottom, has a mass of 2 lb. and has a smooth hinge along its lower, horizontal edge. A horizontal cord, attached to its upper edge, holds the window at an angle of 30° with the vertical. Make a scale diagram, indicating a triangle of forces. Hence, or otherwise, determine (*a*) the direction and magnitude of the reaction at the hinge, (*b*) the tension in the cord. (Assume the centre of gravity of the window to be at its middle point.)

3. Define *centre of gravity*.

A uniform, plane sheet of metal ABCD of negligible thickness has AC = 5″, AD = AB = 3″ and CB = CD = 4″. Draw the piece of metal to scale and mark the positions of the centres of gravity of the triangles ABC and ADC. Hence find the centre of gravity of the whole figure, explaining your method. How could you verify your result experimentally?

4. The following results were obtained in a experiment to investigate the stretching of an elastic cord:—

Stretching force in kgm.-wt.	0	$\frac{1}{2}$	1	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3
Length of cord in cm.	340·0	340·6	341·2	341·8	342·4	343·1	344·1

On the squared paper provided, plot a graph to illustrate Hooke's law. State this law and point out its validity for the specimen used in the experiment.

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(*a*) Describe the construction and action of an aneroid barometer. Why do its readings vary (i) from day to day, (ii) with height above sea level?

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6. Explain the statement, "the mechanical equivalent of heat is 4·2 joules cal.$^{-1}$", and describe an experiment to verify this value.

A piece of lead falls 3 metres from rest, coming to rest again on the ground. Calculate the rise in its temperature, the specific heat of lead being 0·032. State the assumptions you make in the calculation.

7. Air is blown through some ether in a copper can. Explain (*a*) the effect on the temperature of the ether, (*b*) the formation of mist on the outside of the can. On another day, repetition of the experiment produced the mist at a lower temperature. Explain the reason for this and describe a practical application of these effects.

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UNIVERSITY OF LONDON

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Ordinary Level

SUMMER, 1954

PHYSICS

Examiners:
H. L. W. SHARMAN, Esq., B.Sc.
A. VENABLES, Esq., M.Sc.

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A train starts from station *A*, accelerates at the rate of 22/45 ft. per sec. per sec. and reaches its maximum speed in 3 minutes. It maintains this speed for 25 minutes and then retards uniformly to rest at station *B*, after a further 5 minutes.

Find its maximum speed in miles per hour and the distances gone during each of the three stages.

Draw a graph of the motion, plotting the velocity in MILES PER HR., against the time in HOURS and verify that the total distance gone is equal to the distance represented by the area of the trapezium enclosed by the graph and the time axis.

(Use a scale of 2 in. to represent 10 minutes ($\frac{1}{6}$hr.) on your time axis.)

2. State the parallelogram law for forces. Describe an experiment to illustrate it and show how the law may be applied to resolve a force into two perpendicular components.

A nail projects horizontally from a vertical wall and a cord attached to its head is pulled at an angle of 30 degrees to the wall, with a force of 12 lb. wt. By a scale drawing, or otherwise, find (*a*) the force tending to bend the nail, (*b*) the force tending to pull it out of the wall.

3. State Boyle's law and describe an experiment to verify it for air.

A fairly wide, strong walled glass tube, closed at its upper end, cylindrical in shape, 2 ft. long and open at its lower end, was weighted and lowered vertically into the bed of a river until it touched the bottom. When withdrawn, it was found that the water had risen $7\frac{1}{2}$ in. inside the tube. Find the depth of the river.

(Atmospheric pressure at the surface of the river may be taken as that due to 33 ft. of river water.)

4. Define *specific gravity* and hence obtain an expression for the specific gravity of a liquid in terms of its density.

Describe with a sketch, Hare's inverted U-tube apparatus for finding the specific gravity of a liquid. Indicate clearly the measurements taken and show how the result is obtained from them.

In such an experiment to determine the specific gravity of methylated spirit, the length of the column of water was 11·6 cm. and that of the methylated spirit 14·5 cm. Calculate the specific gravity of the liquid. If the length of the water column was then altered to 15 cm., what would be the height of the column of methylated spirit?

5. Answer any *two* of the following:—

(*a*) Describe any two experiments which show that air exerts a considerable pressure.

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(*c*) Two pieces of clean, dry capillary tubing are placed upright, one in a beaker of mercury and the other in a beaker of water. Each tube is pushed well down, raised a little and then clamped. Draw sketches to show the liquid surfaces inside and outside the tubes.

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Section B

6. Give a short account of the methods by which a vessel containing a hot liquid loses its heat.

Draw a diagram of a vacuum flask and explain how the rate of loss of heat by a hot liquid placed in the flask is reduced to a minimum.

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An object, $\frac{3}{4}$ in. in height, is placed on and perpendicular to the principal axis of a converging lens whose focal length is 10 in. Draw ray diagrams to show the formation of the image when the object is (*a*) 18 in., (*b*) 5 in. from the lens. From these diagrams, or otherwise, find the size and position of the image in each instance. In what other ways do the images differ?

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11. Describe an experiment to demonstrate that the prongs of a tuning fork vibrate when it emits sound and explain the increased loudness of the sound when the stem of the vibrating fork is held in contact with a table.

A tuning fork has the number 256 stamped on it. What does this signify? A sonometer wire is adjusted to be in unison with this fork. State exactly two different ways in which the wire could be readjusted so as to be in unison with a fork marked 384.

Section C

12. What is meant by a line of magnetic force? Describe how such lines may be plotted using (*a*) a compass needle, (*b*) iron filings. Point out any advantage each method may have, compared with the other and explain why iron filings indicate the lines of force.

Two bar magnets, long enough for the effect of their S. poles to be ignored, are placed vertically with their N. poles 9 cm. apart on a horizontal plane. A neutral point is formed 3 cm. from one of the poles which has a pole strength of 100 c.g.s. units. Sketch the lines of force (ignoring the effect of the earth's magnetism) and calculate the strength of the other pole.

13. Describe a gold leaf electroscope and a method by which you could give it a permanent positive charge. State and explain what happens when the following are placed, in turn, near the plate of the charged electroscope:—

(*a*) a glass rod rubbed with silk,

(*b*) an ebonite rod rubbed with fur,

(*c*) an uncharged metal rod.

14. Describe an experiment to show how the quantity of heat produced by an electric current flowing in a conductor, depends upon the strength of the current. State the conclusion to which the experiment would lead.

Two wires, P and Q, of 4 and 6 ohms resistance respectively, are connected first in series and then in parallel with a battery of e.m.f. 8 volts and of negligible internal resistance. In each instance, (*a*) draw the circuit, (*b*) calculate the value of the current through each wire, (*c*) compare the quantities of heat produced per sec. in the two wires, stating clearly in which of the two wires (P or Q) the quantity is the greater.

15. State the laws of electrolysis.

A current is passed through two voltameters connected in series. One is designed for copper plating an object, the other for electrolysing water. Draw a diagram of the voltameters indicating the complete circuit. State what happens at each of the four electrodes. If 0·12 gm. of copper is liberated in the one voltameter, calculate the volumes at S.T.P. of the gases liberated in the other. (Chemical equivalent of copper = 31·5; density of hydrogen at S.T.P. = 0·09 gm. per litre.)

16. Answer *two* of the following:—

(*a*) What is meant by *local action* and *polarisation* in connection with a simple cell? How are they minimised in the Leclanché cell? Draw a diagram of this cell in its dry form.

(*b*) Describe how a galvanometer, a coil of wire and a bar magnet may be used to demonstrate the production of induced currents. What further experiments could be made with this apparatus to discover something about the magnitude and direction of such currents? State the results you would expect to obtain.

(*c*) Describe a simple electric motor. Explain the function of the commutator.

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13. Describe a gold leaf electroscope and a method by which you could give it a permanent positive charge. State and explain what happens when the following are placed, in turn, near the plate of the charged electroscope:—

(*a*) a glass rod rubbed with silk,

(*b*) an ebonite rod rubbed with fur,

(*c*) an uncharged metal rod.

14. Describe an experiment to show how the quantity of heat produced by an electric current flowing in a conductor, depends upon the strength of the current. State the conclusion to which the experiment would lead.

Two wires, P and Q, of 4 and 6 ohms resistance respectively, are connected first in series and then in parallel with a battery of e.m.f. 8 volts and of negligible internal resistance. In each instance, (*a*) draw the circuit, (*b*) calculate the value of the current through each wire, (*c*) compare the quantities of heat produced per sec. in the two wires, stating clearly in which of the two wires (P or Q) the quantity is the greater.

15. State the laws of electrolysis.

A current is passed through two voltameters connected in series. One is designed for copper plating an object, the other for electrolysing water. Draw a diagram of the voltameters indicating the complete circuit. State what happens at each of the four electrodes. If 0·12 gm. of copper is liberated in the one voltameter, calculate the volumes at S.T.P. of the gases liberated in the other. (Chemical equivalent of copper = 31·5; density of hydrogen at S.T.P. = 0·09 gm. per litre.)

16. Answer *two* of the following:—

(*a*) What is meant by *local action* and *polarisation* in connection with a simple cell? How are they minimised in the Leclanché cell? Draw a diagram of this cell in its dry form.

(*b*) Describe how a galvanometer, a coil of wire and a bar magnet may be used to demonstrate the production of induced currents. What further experiments could be made with this apparatus to discover something about the magnitude and direction of such currents? State the results you would expect to obtain.

(*c*) Describe a simple electric motor. Explain the function of the commutator.

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Advanced Level

SUMMER, 1954

PHYSICS.– I

Examiners :

F. G. LUTON, Esq., B.Sc., M.A.
R. W. B. STEPHENS, Esq., B.Sc., Ph.D.

TUESDAY, June 15.—*Morning*, 9.30 *to* 12.30

[*Answer* SIX *questions, and not more than six.*]

[g=981 cm. sec.$^{-2}$; $4{\cdot}18\times10^7$ ergs=1 calorie; standard atmospheric pressure $=1{\cdot}013\times10^6$ dynes cm.$^{-2}$.]

1. Explain briefly what is meant by the absolute gas scale of temperature, and describe an experiment by means of which the zero of absolute temperature on the gas scale may be deduced.

The height of the mercury column in the uniform glass tube of a barometer containing some air is 55·64 cm. when the temperature is 0° C. When the temperature is raised to 100° C. the height of the column is 50·88 cm. The distance of the top of the tube from the level in the cistern is 100·0 cm. in each case and the atmospheric pressure is 76·00 cm. of mercury. Assuming that the air behaves as an ideal gas find a value for the melting point of ice on the absolute gas scale. Neglect any effects due to the change of temperature of the mercury or of the glass.

T. & F.—53/1364 6/2/10000

[P. T. O.

2. A unit mass of ice at $-10°$ C. is gently heated until converted into water and finally into steam. Describe the changes of volume that occur, and give approximate figures for their magnitudes.

Describe and explain a method of determining the coefficient of real expansion of a liquid between 0° C. and 100° C.

Calculate the fraction of the volume of a glass vessel which must be filled with mercury in order that the unoccupied space shall be of constant volume at temperatures for which the coefficient of linear expansion of glass $= 8{\cdot}50 \times 10^{-6}$ per deg. C. and the coefficient of expansion of mercury $= 182 \times 10^{-6}$ per deg. C.

3. Explain clearly why the values of the specific heat of a gas at constant pressure and the specific heat at constant volume differ from each other, and derive an expression for the difference.

Describe and explain a method of determining the specific heat of a gas *either* (*a*) at constant volume *or* (*b*) at constant pressure.

If the density of hydrogen at S.T.P. is $8{\cdot}99 \times 10^{-5}$ gm. cm.$^{-3}$ and its specific heat at constant pressure is 3·41 cal. gm.$^{-1}$ deg. C.$^{-1}$, what is the specific heat at constant volume ?

4. Two exactly similar metal rods are heated at one end to the same temperature, while their cooler ends are maintained at the temperature of the room. One rod is bare and the sides of the other are lagged with non-conducting material. Explain why, in the steady state, the temperature distributions along the two rods are different.

Describe a method of determining the thermal conductivity of a good conductor.

A metal disc, 20 cm. in diameter and 0·8 cm. thick, is suspended horizontally in air at 20° C. A cork disc of the same dimensions is laid centrally on the metal, and the upper surface of the cork is maintained at 100° C. Under these conditions the metal reaches a stationary temperature of 50° C. If the thermal conductivity of cork is $1{\cdot}2 \times 10^{-4}$ c.g.s. centigrade units, what is the thermal emissivity of the surface of the metal ? Neglect heat loss from the curved surface of the cork.

5. Define *lumen* and *foot-candle*. What is the connection between them ?

Describe an accurate form of photometer. How would you use it to investigate the variation of luminous intensity of an electric filament lamp with the potential difference across the filament ? Give full experimental details and state the nature of the result you would expect.

6. Describe the construction of a simple astronomical (Kepler) telescope, explaining the function of each part and giving a diagram showing the formation of the image of an object point not on the axis.

Derive an expression for the angular magnification given by such a telescope in normal adjustment, in terms of the focal lengths of the lenses.

An astronomical telescope is made with lenses of focal lengths 100·0 cm. and 10·0 cm. How far apart must the lenses be placed if the image of a star is to be formed 200 cm. from the eye-lens ? With this adjustment what is the angular magnification ?

7. Use the wave theory of light—

(*a*) to derive an expression for the refractive index of a medium in terms of the velocity of light ;

(*b*) to explain the formation of interference fringes in Young's two-slit experiment.

What information regarding the nature of light waves is provided by the phenomenon of polarisation ?

8. Show by a simple diagram what is meant by the chromatic aberration of a convex lens.

Define *dispersive power*, and derive an expression for the difference in focal power of a lens for red light and for blue, in terms of dispersive power.

It is required to construct an achromatic telescope objective of power 1 dioptre. Show how this can be done if two kinds of glass are available, *A* of dispersive power 1/30 and *B* of dispersive power 1/40. Express your result in dioptres.

[P. T. O.

9. What is the nature of the difference between longitudinal and transverse waves propagated along a wire? Explain how a sine curve can be used to represent either type of motion.

What length of wire of linear density 0·088 gm. cm.$^{-1}$ under a tension of 40·0 kgm. wt. is required to give a note of frequency 43·2 cycles sec.$^{-1}$ when vibrating transversely? What device is adopted in a piano to obtain such a low frequency using a wire limited in length to 150 cm.?

A stretched string of cross sectional area a and length l is made of a material of density ρ and Young's modulus E. What is the frequency of its fundamental mode of (a) longitudinal, (b) transverse vibration? Show that the former is much greater than the latter.

10. Describe the determination of the frequency of a tuning fork by a method which does not involve the use of a sonometer or resonance column.

What determines the musical interval between two notes? Describe briefly how you would demonstrate the truth of your statement.

If the frequency of the note c (doh) is 261·0 cycles sec.$^{-1}$ what is the frequency of g (soh) (a) on the diatonic scale and (b) on the scale of equal temperament?

11. Describe how you would determine the velocity of sound in air at room temperature, pointing out the precautions you would take in order to obtain an accurate value.

A ship at sea sends out simultaneously a wireless signal above the water and a sound signal through the water, the temperature of the water being 4° C. These signals are received by two stations, A and B, 20 miles apart, the intervals between the arrival of the two signals being 13·2 sec. at A and 17·6 sec. at B. Find the bearing from A of the ship relative to AB. The velocity of sound in sea-water at t° C.=4,756+11t ft. sec.$^{-1}$.

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Advanced Level

SUMMER, 1954

PHYSICS.—II

Examiners:

F. G. LUTON, Esq., B.Sc., M.A.
R. W. B. STEPHENS, Esq., B.Sc., PH.D.

TUESDAY, June 15.—*Afternoon*, 2 *to* 5

[*Answer* SIX *questions, and not more than six.*]

[g=981 cm. sec.$^{-2}$.]

1. What do you understand by the 'dimensions' of a physical quantity? Find the dimensions of (a) the gravitational constant G and (b) the coefficient of viscosity.

A small liquid drop freely suspended in air can be made to vibrate about its spherical form. Assuming that the period of vibration T depends only on the radius a of the drop and on the surface tension S and the density ρ of the liquid, show that

$$T=K\sqrt{\frac{\rho a^3}{S}},$$

where K is a constant.

Explain in what circumstances you would expect gravity to exert appreciable control on the shape of a liquid drop.

2. State Hooke's law, indicating its limitation. How would you demonstrate this limitation experimentally using a fine wire or fibre ?

Define Young's modulus (E) and rigidity modulus (n).

A silver wire 0·032 cm. diameter and 200 cm. long is hung vertically and elongates by 0·100 cm. on applying a load of 320 gm. wt. Calculate E for silver and assuming $n=2{\cdot}86\times10^{11}$ dyne. cm.$^{-2}$, use the following formula to find the value of Poisson's ratio (σ) for silver :—

$$E/2n=(\sigma+1).$$

What would be the change in the diameter of the silver wire when stretched in the above experiment ?

(Poisson's ratio is defined as the ratio of the fractional contraction in diameter to the fractional increase in length.)

3. Define *capacitance* of a condenser.

Describe how you would compare the capacitances of two condensers using an electrometer.

A uniform slab of glass of thickness 0·25 cm. is inserted between the charged insulated plates of a parallel plate air condenser. Will it be necessary to increase or decrease the distance between the plates, and by how much, in order to maintain the same difference of potential between them ? You are to assume that the area of the slab is at least equal to that of each of the plates and that the dielectric constant of the glass is 5·0.

4. Discuss as fully as you can the function of *four* of the following :—

(a) The suspension in (i) a moving coil and (ii) a moving magnet galvanometer.

(b) The horizontal scale of a dip circle.

(c) The keeper of a horseshoe magnet.

(d) The starting resistance in series with a D.C. motor.

(e) The "dummy" leads of a platinum resistance thermometer.

(f) The tapping keys and the variable ratio arms in a post-office resistance box.

5. What is meant by the magnetic field (H) and the magnetic induction (B) inside a bar of iron ? How is magnetic permeability (μ) defined ?

Describe the magnetometer method of finding the relation between induction and magnetizing field for soft iron.

Sketch a B–H curve for soft iron and derive from it the form of a μ–H curve using the same scale of H.

6. Describe an experiment to show how the heating effect of a given electric current depends on the resistance of the conductor.

Assuming that the rate of heat loss from the surface of a bare wire, heated electrically, obeys Newton's law of cooling, show how the final temperature difference set up between the wire and its surroundings depends on (a) the value I of the steady electric current in the wire, (b) the resistivity ρ of the material of the wire and (c) the diameter d of the wire.

Would you expect the same wire carrying the same current to attain the same temperature if it is covered by insulating material ? Give reasons for your answer.

7. State the laws of electromagnetic induction. Hence derive an expression for the time variation of the electromotive force induced in a single turn of wire rotating about an axis in its plane, the axis being perpendicular to a uniform magnetic field. Explain the action of a simple alternating current generator.

What modification of this generator is required to produce a direct current ? Indicate by a sketch how the e.m.f. across the output terminals of a single coil would vary with time in the case of (a) an a.c. and (b) a d.c. generator. How may a more uniform output e.m.f. be obtained in the latter case ?

A rectangular coil of wire having 100 turns, of dimensions 30 cm. $\times$ 40 cm., is rotated at a constant speed of 600 r.p.m. in a magnetic field of 10^3 gauss, the axis of rotation being in the plane of the coil and perpendicular to the field. Calculate the maximum induced e.m.f.

[P. T. O.

8. What is a thermocouple ?

Explain the use of a potentiometer to measure the small electromotive forces developed by a thermocouple.

What are the relative advantages and disadvantages of a thermocouple used as a thermometer as compared with the resistance thermometer ?

9. Define *magnetic flux* and *coefficient of self-inductance.* A current of i e.m.u. is passed through a solenoid of N turns and of length l c.m. Assuming the length is large compared with the diameter, derive an expression for the value of the magnetic field at the centre of the solenoid. (You may assume if necessary that the work done in taking a unit magnetic pole once round a circuit carrying a current i e.m.u. is $4\pi i$ ergs.) Hence deduce an expression for the total flux linking each turn and obtain an expression for the coefficient of self-inductance of the solenoid.

Explain why an iron core is used in an induction coil and why it is in the form of a bundle of iron wires. What is the reason for winding the secondary coil in sections ?

10. State Faraday's laws of electrolysis and describe how you would verify them by experiment.

A copper refining cell consists of two parallel copper plate electrodes, 6 cm. apart and each 1 metre square, immersed in a copper sulphate solution of resistivity 1·20 ohm cm. Calculate the potential difference which must be established between the plates to provide a constant current to deposit 480 gm. of copper on the cathode in one hour.

(e.c.e. of copper$=0{\cdot}00329$ gm. coulomb^{-1}.)

11. How are cathode rays produced and what are their properties ? An electron starts from rest and moves freely in an electric field of intensity 0·080 e.s.u. of potential per cm. Determine (a) the force on the electron, (b) its acceleration, and (c) the kinetic energy acquired and the velocity attained if the electron moves through a potential difference of 0·300 e.s.u.

(Charge of an electron$=4{\cdot}81\times10^{-10}$ e.s.u., mass of an electron$=9{\cdot}12\times10^{-28}$ gm.)

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

SUMMER, 1954

PHYSICS

Examiners :
H. L. W. SHARMAN, Esq., B.Sc.
A. VENABLES, Esq., M.Sc.

TUESDAY, June 15.—*Morning* 9.30 *to* 12.30

[*Not more than* SEVEN *questions are to be answered and of these* TWO *are to be answered from each of two of the Sections and* THREE *from the remaining Section.*]

[*The value of* π *when required should be taken as* $3\frac{1}{7}$.]

SECTION A

1. Define *average speed, acceleration.*

A train starts from station A, accelerates at the rate of 22/45 ft. per sec. per sec. and reaches its maximum speed in 3 minutes. It maintains this speed for 25 minutes and then retards uniformly to rest at station B, after a further 5 minutes.

Find its maximum speed in miles per hour and the distances gone during each of the three stages.

Draw a graph of the motion, plotting the velocity in MILES PER HR., against the time in HOURS and verify that the total distance gone is equal to the distance represented by the area of the trapezium enclosed by the graph and the time axis.

(Use a scale of 2 in. to represent 10 minutes ($\frac{1}{6}$hr.) on your time axis.)

2. State the parallelogram law for forces. Describe an experiment to illustrate it and show how the law may be applied to resolve a force into two perpendicular components.

A nail projects horizontally from a vertical wall and a cord attached to its head is pulled at an angle of 30 degrees to the wall, with a force of 12 lb. wt. By a scale drawing, or otherwise, find (a) the force tending to bend the nail, (b) the force tending to pull it out of the wall.

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3. State Boyle's law and describe an experiment to verify it for air.

A fairly wide, strong walled glass tube, closed at its upper end, cylindrical in shape, 2 ft. long and open at its lower end, was weighted and lowered vertically into the bed of a river until it touched the bottom. When withdrawn, it was found that the water had risen $7\frac{1}{2}$ in. inside the tube. Find the depth of the river.

(Atmospheric pressure at the surface of the river may be taken as that due to 33 ft. of river water.)

4. Define *specific gravity* and hence obtain an expression for the specific gravity of a liquid in terms of its density.

Describe with a sketch, Hare's inverted U-tube apparatus for finding the specific gravity of a liquid. Indicate clearly the measurements taken and show how the result is obtained from them.

In such an experiment to determine the specific gravity of methylated spirit, the length of the column of water was 11·6 cm. and that of the methylated spirit 14·5 cm. Calculate the specific gravity of the liquid. If the length of the water column was then altered to 15 cm., what would be the height of the column of methylated spirit?

5. Answer any *two* of the following:—

(*a*) Describe any two experiments which show that air exerts a considerable pressure.

(*b*) Explain, with sketches, the part played by friction in walking, and describe in detail one other example in which friction is a necessary factor.

(*c*) Two pieces of clean, dry capillary tubing are placed upright, one in a beaker of mercury and the other in a beaker of water. Each tube is pushed well down, raised a little and then clamped. Draw sketches to show the liquid surfaces inside and outside the tubes.

Describe another effect due to the force responsible for those shown in your sketches.

Section B

6. Give a short account of the methods by which a vessel containing a hot liquid loses its heat.

Draw a diagram of a vacuum flask and explain how the rate of loss of heat by a hot liquid placed in the flask is reduced to a minimum.

7. What is understood by (i) S.T.P., (ii) absolute gas scale of temperature?

A fixed mass of air is heated, (*a*) without altering the pressure, and (*b*) without altering the volume. State in each case the law governing the change which takes place.

Three litres of air at 0°C. and a pressure of 1 atmosphere are heated in such a way as to keep its volume unchanged. Calculate the temperature of the air when its pressure becomes 5 atmospheres.

The temperature is now kept constant and the pressure reduced again to 1 atmosphere. What will be the resulting volume?

If, finally, this last pressure be maintained, calculate the temperature for which the volume will be reduced to 2 litres.

8. Answer any *three* of the following:—

(*a*) A stone floor feels very cold to bare feet in the winter, but a carpet in the same room feels comfortably warm. Why is this?

(*b*) A glass of cold water becomes misty on the outside when brought into a warm room. Explain this.

(*c*) Why does a metal badge become hot when rubbed vigorously against a coat sleeve?

(*d*) A watch glass containing ether is placed on a wet block of wood. Air is blown gently across the surface of the ether and it is found that, after a few minutes, the watch glass and the wooden block have become frozen together. Give a reason for this.

9. Describe an experiment to establish the relation between angles of incidence and the corresponding angles of refraction for glass. State the conclusion to be drawn from the experiment.

A parallel beam of white light is passed through a 60° glass prism and is received on a white screen. Draw a diagram to illustrate the experiment. What changes would you make to produce a pure spectrum on the screen and how would the screen differ in appearance in the two instances?

10. Define *principal focus* and *focal length* for a lens. Describe how the latter may be determined for (*a*) a converging lens, (*b*) a diverging lens.

An object, $\frac{3}{4}$ in. in height, is placed on and perpendicular to the principal axis of a converging lens whose focal length is 10 in. Draw ray diagrams to show the formation of the image when the object is (*a*) 18 in., (*b*) 5 in. from the lens. From these diagrams, or otherwise, find the size and position of the image in each instance. In what other ways do the images differ?

[P.T.O.

11. Describe an experiment to demonstrate that the prongs of a tuning fork vibrate when it emits sound and explain the increased loudness of the sound when the stem of the vibrating fork is held in contact with a table.

A tuning fork has the number 256 stamped on it. What does this signify? A sonometer wire is adjusted to be in unison with this fork. State exactly two different ways in which the wire could be readjusted so as to be in unison with a fork marked 384.

SECTION C

12. What is meant by a line of magnetic force? Describe how such lines may be plotted using (*a*) a compass needle, (*b*) iron filings. Point out any advantage each method may have, compared with the other and explain why iron filings indicate the lines of force.

Two bar magnets, long enough for the effect of their S. poles to be ignored, are placed vertically with their N. poles 9 cm. apart on a horizontal plane. A neutral point is formed 3 cm. from one of the poles which has a pole strength of 100 c.g.s. units. Sketch the lines of force (ignoring the effect of the earth's magnetism) and calculate the strength of the other pole.

13. Describe a gold leaf electroscope and a method by which you could give it a permanent positive charge. State and explain what happens when the following are placed, in turn, near the plate of the charged electroscope:—

(*a*) a glass rod rubbed with silk,

(*b*) an ebonite rod rubbed with fur,

(*c*) an uncharged metal rod.

14. Describe an experiment to show how the quantity of heat produced by an electric current flowing in a conductor, depends upon the strength of the current. State the conclusion to which the experiment would lead.

Two wires, *P* and *Q*, of 4 and 6 ohms resistance respectively, are connected first in series and then in parallel with a battery of e.m.f. 8 volts and of negligible internal resistance. In each instance, (*a*) draw the circuit, (*b*) calculate the value of the current through each wire, (*c*) compare the quantities of heat produced per sec. in the two wires, stating clearly in which of the two wires (*P* or *Q*) the quantity is the greater.

15. State the laws of electrolysis.

A current is passed through two voltameters connected in series. One is designed for copper plating an object, the other for electrolysing water. Draw a diagram of the voltameters indicating the complete circuit. State what happens at each of the four electrodes. If 0·12 gm. of copper is liberated in the one voltameter, calculate the volumes at S.T.P. of the gases liberated in the other. (Chemical equivalent of copper=31·5; density of hydrogen at S.T.P.=0·09 gm. per litre.)

16. Answer *two* of the following:—

(*a*) What is meant by *local action* and *polarisation* in connection with a simple cell? How are they minimised in the Leclanché cell? Draw a diagram of this cell in its dry form.

(*b*) Describe how a galvanometer, a coil of wire and a bar magnet may be used to demonstrate the production of induced currents. What further experiments could be made with this apparatus to discover something about the magnitude and direction of such currents? State the results you would expect to obtain.

(*c*) Describe a simple electric motor. Explain the function of the commutator.

53/1818

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

AUTUMN, 1953

PHYSICS

Examiners:

A. S. M. SYMONS, Esq., B.Sc., Ph.D.
A. VENABLES, Esq., M.Sc.

MONDAY, November 16.—*Morning*, 9.30 *to* 12.30

[*Not more than* SEVEN *questions are to be answered and of these* TWO *are to be answered from each of two of the Sections and* THREE *from the remaining Section.*]

[The value of g when required should be taken as 32 ft. per sec. per sec.]

SECTION A

1. Define *centre of gravity* and explain how its location in a freely suspended object determines the position of rest of the object.

A straight uniform metal rod AB of length 14 in. is bent at C, 6 in. from A, to form a right angle. Draw a diagram of the bent rod, marking the positions of the centres of gravity of the portions AC and CB. Hence find the distance of the centre of gravity of the bent rod ACB from the mid-point of the section AC. Describe an experiment to verify your answer.

2. Explain what is meant by (*a*) a parallelogram of forces, (*b*) the law of moments for a body in equilibrium. Describe a simple experiment in each instance to illustrate your answer.

$ABCD$ is a square of side 4 in. Forces of 5 lb.-wt. and 8 lb.-wt. act at A towards B and D respectively. Determine, by a scale drawing or otherwise, the magnitude of the resultant force and its moment about the point C.

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3. A pile driver operates by means of a mass of 5 cwt. which falls freely from rest through a distance of 16 ft. Use this as an example to illustrate the terms *potential energy* and *kinetic energy*, and to explain the principle of the conservation of energy. Calculate (*a*) the time of fall of the mass, (*b*) the velocity of the mass as it strikes the pile and (*c*) the average resisting force in lb.-wt. if the pile penetrates a further 6 in. into the ground at each impact.

4. State Boyle's law, and describe an experiment to illustrate it.

A J-tube, of uniform cross section, has the top of its shorter limb sealed and at a height of 20 cm. above the bench on which the tube stands vertically. Mercury is poured into the open limb and is adjusted so that it fills the bend of the tube. The levels are found to be 5 cm. and 4 cm. above the bench in the closed and open limbs respectively. What is the pressure, expressed in cm. of mercury, of the air in the closed limb, if the barometric height is 75 cm.? More mercury is now added to make the levels the same in each limb. Find their height above the bench.

5. Answer *two* of the following:—

(*a*) Explain what is meant by the *surface tension* of a liquid. Describe experiments to demonstrate its existence in (i) water, (ii) mercury.

(*b*) Describe briefly an experiment to investigate how the stretching force affects the length of a spiral spring. What result would you expect?

When a piece of aluminium is suspended in air from the lower end of a vertical spiral spring, of unstretched length 30·6 cm., its length is 35·0 cm. On surrounding the aluminium with water the length of the spring becomes 33·0 cm. Find the specific gravity of the aluminium.

(*c*) Define *work, power* and *efficiency.*

A crane which is 60% efficient raises a mass of 15 cwt. through a vertical height of 20 ft. in 10 sec. Calculate the horse-power at which the crane is working. (1 horse-power=550 ft. lb.-wt. per sec.)

Section B

6. Distinguish between boiling and evaporation.

State the effect on the boiling point of a liquid of (*a*) changing the pressure on its surface, (*b*) adding a soluble solid to it. Describe one experiment in each instance to support your answer.

7. Define *latent heat of fusion* of a substance. Describe how you would determine by experiment its value for ice.

A copper calorimeter of mass 70 gm. contains 200 gm. of water at 30°C. Assuming that the calorimeter is thermally insulated, state the final conditions attained when (*a*) 10 gm., (*b*) a further 80 gm., of ice at its melting point are added. (Take the specific heat of copper as 0·10 cal. per gm. per deg. C., and the latent heat of fusion of ice as 80 cal. per gm.)

8. Describe experiments to determine which is the greater in each of the following:—

(*a*) the thermal conductivity of wood or of copper,

(*b*) the coefficient of linear expansion of iron or of copper,

(*c*) the radiating power of a brightly polished metal surface or of a dull black surface.

State the result you would expect in each experiment, and mention a practical application of each result.

9. Describe briefly *two* methods for the determination of the focal length of a concave mirror.

Draw ray diagrams showing the formation of a magnified *erect* image of a small object by (*a*) a concave mirror, (*b*) a converging lens.

A converging lens produces a *virtual* image, having a magnification of six, of a small object set 3 in. away from the lens on, and at right angles to, its principal axis. What is the focal length of the lens? How far, and in which direction, must the object be moved to produce a *real* image of the same height?

10. Describe briefly the structure and use of any *two* of the following: (*a*) a prismatic periscope, (*b*) a microscope, (*c*) a spectroscope, (*d*) a photometer. Point out clearly the optical principles involved and illustrate your answers with clearly drawn diagrams.

11. Define *frequency,* and describe how a sonometer can be used to determine the frequency of a tuning fork.

The wave-length in air of the sound from a tuning fork is 170 cm. when the velocity of sound in the air is 340 metres per sec. What is the frequency of the tuning fork? If the fork is held over an adjustable resonance tube, closed at one end, containing air and the length of the air column in the tube is gradually increased from zero, calculate approximately its length when the tube is first in resonance with the fork. Explain this resonance and why the result is only approximate.

[P.T.O.

Section C

12. Describe how you would use a small compass needle to locate a neutral point in the neighbourhood of a bar magnet.

A short bar magnet has a pole strength of 200 unit-poles and the distance between the poles is 5 cm. When set with its magnetic axis horizontal in the magnetic meridian with its south pole pointing North, a neutral point occurs at a distance of 20 cm. from the nearer pole. What is the strength of the horizontal component of the magnetic field of the earth? Draw a diagram showing approximately the shape of the lines of magnetic force around the magnet and indicate clearly the positions of the neutral points.

13. Describe the structure of a simple form of electroscope.

Explain briefly how you would use it to show (*a*) that the charge on a hollow conductor is entirely on the outside surface, (*b*) that the capacity of a charged conductor is increased when an earthed conductor is brought near, (*c*) that "points" on a conductor facilitate its discharge.

14. Define *ampere, ohm.*

Describe and explain how you would determine the resistance of a coil of wire using (*a*) a voltmeter and an ammeter, (*b*) some form of Wheatstone bridge. Draw circuit diagrams of the experimental arrangements proposed.

15. State the laws of electrolysis.

Two cells, each of e.m.f. 1·10 volts and internal resistance 1·50 ohms, joined in series, supply current to a copper voltameter of resistance 1·40 ohms. Draw a circuit diagram of the arrangement, mark the polarity of the cells, and indicate clearly the electrode on which copper is deposited in the voltameter. Calculate (*a*) the current through the voltameter, (*b*) the electrochemical equivalent of copper, if 0·60 gm. of copper is deposited per hour.

16. Describe with the aid of diagrams, and explain clearly the principle of action of, *two* of the following: (*a*) a moving coil galvanometer, (*b*) any one type of primary cell, (*c*) a dynamo, (*d*) a transformer.

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

SUMMER, 1953

PHYSICS

Examiners:
A. S. M. SYMONS, Esq., B.Sc., Ph.D.
A. VENABLES, Esq., M.Sc.

FRIDAY, June 12.—*Morning,* 9.30 *to* 12.30

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[*The value of* π *when required should be taken as* $\frac{22}{7}$.]

SECTION A

1. A body moves from rest along a straight line with an acceleration of a ft. per sec. per sec. Derive from first principles its displacement after t sec.

The displacement s, at various times t, of a body moving from rest down an inclined plane is as follows:—

t sec.	0	0·5	1·0	1·5	2·0	2·5
s ft.	0	0·6	2·4	5·4	9·6	15

Draw a displacement-time graph for the body and use it to determine the value of t at which the displacement is 12 ft. What is the acceleration of the body?

2. Define *work, power, efficiency of a machine.*

Explain why a machine can never have an efficiency of 100%.

A machine having an efficiency of 30% is used to raise a load of 240 lb. through a height of 150 ft. in 90 sec. Calculate (*a*) the useful work done per min. on the load, (*b*) the energy supplied per min. to the machine, (*c*) the wasted horse-power. (1 horse-power = 550 ft. lb.-wt. per sec.)

3. Define *pressure* and obtain a value for the pressure due to a liquid of density d gm. per c.c. at a depth h cm. below its surface. How would you demonstrate experimentally the variation of pressure with depth?

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Calculate the mass of air in a classroom of capacity 290 cu. metres when the barometric height is 75 cm. of mercury and the temperature of the room is 17°C. (The density of air at standard temperature and pressure is 1·29 gm. per litre.)

5. Answer *two* of the following:—

(*a*) Describe and explain how you would determine by experiment the position of the centre of gravity of a sheet of cardboard of uniform thickness but of irregular shape.

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12. Describe and explain the magnetisation acquired by a soft iron rod when placed vertically and hammered.

Sketch the magnetic field in a horizontal plane through the N pole of a very long vertical bar magnet and calculate its pole strength if the neutral point is formed at a distance of 12 cm. from the pole. (H=0·18 dyne per unit pole.)

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UNIVERSITY OF LONDON

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PHYSICS

Examiners:

A. S. M. SYMONS, Esq., B.Sc., PH.D.
A. VENABLES, Esq., M.Sc.

FRIDAY, June 12.—*Morning,* 9.30 *to* 12.30

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C.P. 52/1928 5/2/2/12000 **[P.T.O.**

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A mercury-in-glass thermometer has a bulb of internal volume 0·30 c.c. and a tube of internal cross-sectional area $2{\cdot}5 \times 10^{-4}$ sq. cm. If the 0°C. division on the tube is just above the bulb find (*a*) the apparent increase in volume of the mercury when the temperature of the thermometer rises from 0°C. to 100°C., (*b*) the distance between the 0°C. and 100°C. divisions. (The coefficient of apparent expansion of mercury in glass may be taken as 16×10^{-5} per deg. C.)

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[P.T.O.

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UNIVERSITY OF LONDON

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Ordinary Level

SUMMER, 1953

PHYSICS

Examiners:

A. S. M. SYMONS, Esq., B.Sc., Ph.D.
A. VENABLES, Esq., M.Sc.

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C.P. 52/1928 2250R **[P.T.O.**

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UNIVERSITY OF LONDON

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Ordinary Level

Summer, 1951

PHYSICS

Examiners:

L. R. Middleton, Esq., B.Sc., M.A.
A. S. M. Symons, Esq., B.Sc., Ph.D.

FRIDAY, June 8.—*Morning,* 9.30 *to* 12.30

[*Answer not more than* SEVEN *questions, of which* THREE *may be chosen from any one section and* TWO *from each of the remaining sections.*]

[The value of *g* when required should be taken as 32 ft. per sec. per sec.]

Section A

1. Draw a *velocity-time* graph for a body falling freely from rest. From the graph deduce the distance fallen in the fourth second.

Describe an experiment to demonstrate that a body moving freely down an inclined plane has a uniform acceleration.

2. Explain the meaning of the term *moment of a force about an axis*. Illustrate your answer by an example.

A uniform ladder AB of length 12 ft. and of mass 28 lb. lies on a horizontal path with the end A against a vertical wall. Find the force which (*a*) applied vertically at the end B will just lift B off the ground, (*b*) will support the ladder at an angle of 30° to the horizontal when applied at right angles to the ladder at a point 4 ft. from A.

3. State the law relating the pressure of a gas to its volume at constant temperature and describe how the law may be verified for air.

A football bladder initially flat is joined to a bicycle pump by a suitable valve connection. Find the number of strokes required to produce a pressure of 2 atmospheres in the bladder which then has a volume of 7·5 litres. The barrel of the pump is 25 cm. long and 6 sq. cm. in cross section. Assume that no change of temperature occurs.

4. Describe and explain the use of Hare's apparatus for the determination of the specific gravity of a liquid such as turpentine.

A U-tube of uniform bore is set up with the tubes vertical. When turpentine is poured into one limb the level of water already in the tube falls in that limb by 5 cm. If the column of turpentine is 12 cm. long find the specific gravity of this liquid.

5. Answer *two* of the following:—

(*a*) State Archimedes' principle and explain the procedure you would adopt to determine whether a given sample of copper is solid or hollow.

(*b*) Explain the principle of action, and the use, of the screw jack. What is the efficiency of such a machine which requires a force of 28 lb.-wt. to raise a load of 5 cwt., the velocity ratio being 60?

(*c*) Describe an experiment to illustrate the theorem of the parallelogram (or triangle) of forces.

A body of mass 56 lb. is held at rest on a smooth plane inclined at 20° to the horizontal by a rope parallel to the plane. Find the tension in the rope.

(*d*) Describe an experiment to show that hydrogen or coal gas diffuses through the walls of a porous pot more rapidly than air.

SECTION B

6. State what is meant by a centigrade scale of temperature.

Describe fully how you would mark the fixed points on the stem of an ungraduated mercury-in-glass thermometer and then use it to determine the temperature of the room.

A faulty Fahrenheit thermometer registers 133° when an accurate centigrade thermometer registers 55°. What is the error in the reading of the Fahrenheit thermometer?

7. Define *calorie* and *specific heat*.

Describe an experiment to determine the specific heat of a liquid such as paraffin oil assuming that a solid of known specific heat is provided. Explain how the result is calculated from the observations.

A mass of 30 gm. of aluminium at a temperature of 100°C. is transferred to an aluminium calorimeter of mass 20 gm. containing 80 gm. of paraffin oil at a temperature of 15·0°C. The maximum temperature reached by the calorimeter and contents is 25·2°C. Find the specific heat of the aluminium assuming the specific heat of the paraffin to be 0·50 cal. per gm. per deg. C.

8. Explain the following:—

(*a*) The surface of a polished metal "cold" tap in a bathroom is dull and the "hot" tap is bright when both are being used to supply water for a hot bath.

(*b*) A piece of metal feels hotter to the touch than a piece of wood when both are exposed to the sun in summer, but the metal feels colder than the wood when they are handled in frost in winter.

(*c*) Water surrounding a beaker containing ether may be frozen by bubbling air through the ether.

9. Draw clear diagrams to show how a thin converging (convex) lens can be used to form (*a*) a magnified erect image, (*b*) a magnified inverted image, of a small object.

A sharp image of a small object is formed on a screen by a lens of focal length 15 cm. placed 75 cm. away from the screen. Find by a graphical method or by calculation (i) the distance of the object from the lens, (ii) the magnification of the image.

[P.T.O.

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12. Explain the meaning of *line of magnetic force*.

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8035 (CP 50/1845)

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

SUMMER, 1951

PHYSICS

Examiners :
L. R. MIDDLETON, Esq., B.Sc., M.A.
A. S. M. SYMONS, Esq., B.Sc., Ph.D.

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استلمت اوراق الاسئلة التالية

Chemistry

Summer 1961
" 1962
January 1962
January 1963
Summer 1965
January 1965
January 1966
{ Section B
January 1967 }
{ Summer 1970
Section B }

صالح نعيم

١٤/٧/٧٣

UNIVERSITY OF LONDON

General Certificate of Education Examination

SUMMER 1972 **ORDINARY LEVEL**

Chemistry 1

Two hours

Answer FOUR questions, TWO from Section A and TWO from Section B. All questions carry equal marks. Marks will be given for correct equations and for good diagrams where these add to the clearness of the answer.

Candidates are reminded of the necessity for good English and orderly presentation in their answers.
Graph paper is provided.

USEFUL DATA. You may use the following figures in any question where you need them.
The gramme-molecular volume (molar volume) of a gas is 24 000 cm^3 at room temperature and pressure.
Atomic weights (relative atomic masses) may be taken as:

Aluminium (Al)	27·0	Iron (Fe)	56·0
Carbon (C)	12·0	Nitrogen (N)	14·0
Chlorine (Cl)	35·5	Oxygen (O)	16·0
Hydrogen (H)	1·0		

PSE 72/654 4/100/R33,000

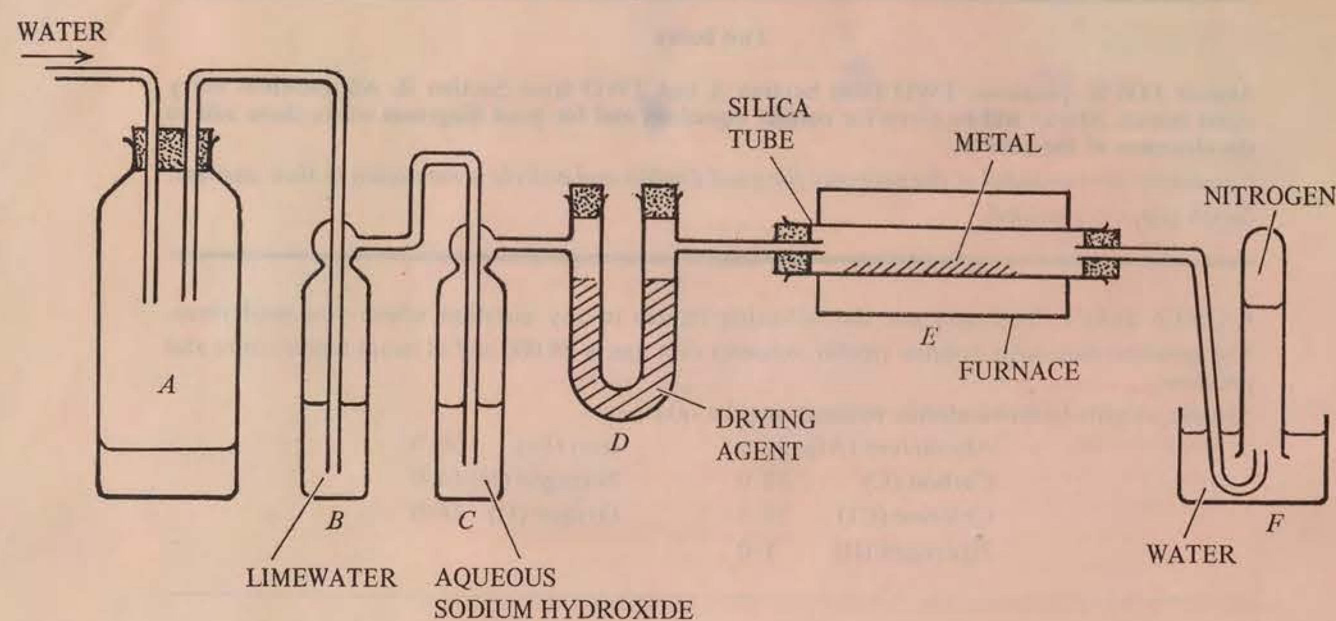
Turn over

SECTION A

Answer TWO questions.

Atomic weights (relative atomic masses) and other data will be found at the beginning of the question paper.

1. Air is a mixture of various gases. An experiment was carried out, using the apparatus shown below, to investigate the composition of air and to obtain a sample of nitrogen from it. The metal in *E* was strongly heated and then water was slowly run into *A* to displace air. The first bubbles of gas escaping at *F* were not collected.



(*a*) Why were the first bubbles of gas escaping at *F* not collected?

(*b*) The limewater in *B* changes in appearance during the experiment. Describe this change and explain why it occurs.

(*c*) What is the reason for using aqueous sodium hydroxide in bottle *C*?

(*d*) Concentrated sulphuric acid is frequently used to dry a gas. Explain why it would not be used in the U-tube *D*.

(*e*) Name a suitable drying agent which *could* be used in the U-tube *D*.

(*f*) Copper is a suitable metal to use in *E*. What conclusion would you come to if the copper turned black during the experiment?

(*g*) Explain why platinum and mercury are unsuitable metals to use in the silica tube in *E*.

(*h*) Nitrogen is a diatomic gas. What does diatomic mean?

(*i*) What is the density of pure nitrogen at room temperature and pressure in grammes per litre?

(*j*) The sample of nitrogen collected in the experiment has a greater density than expected. What conclusion can be made about the gas?

(*k*) In a further experiment the nitrogen produced was then passed over heated magnesium, which combines with nitrogen to form a non-volatile solid. A very small volume of gas was then collected. What do you think this gas could be?

---

2. Choose FIVE of the following statements and in each case
(i) give a simple explanation of the statement,
(ii) describe briefly *one* experiment which illustrates the statement.

(*a*) Elements in the same group in the Periodic Table frequently react in a similar way.

(*b*) Water which has been shaken with sodium chloride contains chloride ions, while water which has been shaken with carbon tetrachloride does not contain chloride ions.

(*c*) The pH of pure water changes when hydrogen chloride gas is dissolved in it.

(*d*) Ethane and ethylene (ethene) are both hydrocarbons, but they differ in many of their chemical reactions.

(*e*) Potassium bromide is an electrolyte, while ethanol is a non-electrolyte.

(*f*) The volumes in which gaseous substances react are in a simple ratio at constant temperature and pressure. (Consider one example of your choice and interpret it in terms of molecules.)

---

3. (*a*) Aluminium and iron form oxides with similar formulae. These oxides are used on the large scale as sources of the metals, but different methods of extraction have to be used. Give a brief account of both extraction processes, emphasising the chemical principles involved. Technical details are not required.

(*b*) Calculate the masses of aluminium and iron which could be obtained from 1000 tons of each oxide. Explain why these masses are different.

(*c*) Choose one large scale use of both aluminium and iron. Explain how each use is related to the properties of the metal.

---

4. (*a*) Name *one* element, *one* oxide, and *two* salts derived from different acids, which react with dilute hydrochloric acid. In each case name *all* the products of the reaction and write the equation.

(*b*) Name *three* gases which react with aqueous sodium hydroxide. In each case name *all* the products of the reaction and write the equation.

(*c*) What volume of ammonia gas, measured at room temperature and pressure, would be needed to neutralise 25 cm^3 of molar (1M) hydrochloric acid?

SECTION B

Answer TWO questions.

Atomic weights (relative atomic masses) and other data will be found at the beginning of the question paper.

5. Describe briefly how you would determine whether a crystalline solid which apparently did not dissolve in water was in fact slightly soluble.

A solid acid can be represented by the formula H_2X, and it has a formula weight of 130. From a reference book it was learned:

at 25 °C, 10 g of the acid would dissolve in 100 g of water,

at 85 °C, 30 g of acid would dissolve in 100 g of water.

The following experiments were carried out to determine the solubilities at two other temperatures:

I 25 g of a saturated solution of the acid in water at 70 °C were evaporated to dryness. The residue of acid had a mass of 5 g.

II 25 g of a saturated solution of the acid in water at 40 °C needed 50 cm³ of molar (1 M) sodium hydroxide for complete neutralisation. The equation for this neutralisation reaction is:

$$H_2X + 2\,NaOH \rightarrow Na_2X + 2\,H_2O$$

(*a*) Determine the mass of acid which would dissolve in 100 g of water at 70 °C and at 40 °C.

(*b*) Plot a graph of the number of grammes of acid dissolving in 100 g of water against the temperature. Use a scale of 1 inch (or 2 cm) for 10 °C along the *x* axis (the horizontal axis), and 1 inch (or 2 cm) for 5 g along the *y* axis.

(*c*) Use your graph to predict:

(i) the maximum mass of acid which would dissolve in 100 g of water at 0 °C,

(ii) the mass of acid which would separate out if 100 g of water saturated with acid at 55 °C were cooled to 10 °C.

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6. What do you understand by the term 'atomic number'?

The symbols of the elements of atomic number 6–17 inclusive are:

C, N, O, F, Ne, Na, Mg, Al, Si, P, S, Cl.

(*a*) Choose any *four* of these elements and give the formula of a chloride of each of them, indicating whether the bonding in the chloride is ionic or covalent in each case.

(*b*) Choose any *four* of these elements and give the name and formula of a covalent compound of each with hydrogen.

(*c*) Choose any *four* of these elements and write equations to show how an oxide of each reacts with water.

(*d*) Choose *two* of these elements, each of which can exist in two different crystalline forms. Indicate by a simple diagram the arrangement of the atoms in *one* form of *one* of these elements.

(*e*) Give the names and formulae of *two* compounds which each contain three of these elements.

(*f*) Atoms of some of these elements form ions which have identical electronic configurations. Atoms of another element in the list also have this electronic configuration. Name this other element, and write the symbols for *three* of the ions in the manner Br^-, Cu^{2+}.

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7. (*a*) The reaction represented by the following equation is said to be *reversible*:

$$Ag^+(aq) + Fe^{2+}(aq) \rightleftharpoons Ag(c) + Fe^{3+}(aq)$$

This question is concerned with the experiments which might be carried out to decide whether this reaction really is reversible.

(i) What chemicals would you mix to make the reaction take place from left to right, and what would you expect to observe if they do react?

(ii) Outline briefly any further tests and observations which could be made on the reaction mixture to decide whether reaction had taken place, at least partly, from left to right.

(iii) What chemicals would you mix to make the reaction take place from right to left, and what would you expect to observe if they do react?

(iv) Outline briefly any further tests and observations which could be made on this second reaction mixture to decide whether reaction had taken place, at least partly, from right to left.

(*b*) Hydrogen peroxide, a colourless liquid, decomposes slowly in aqueous solution. The equation for the decomposition is given below.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

This decomposition is said to be catalysed by certain metal oxides, including copper(II) oxide and chromium(III) oxide. Outline the experiments you would carry out to investigate whether copper(II) oxide and chromium(III) oxide do catalyse this decomposition. How would you decide which of these two oxides is the better catalyst?

---

8. This is a question about the element fluorine, symbol F. It is a member of the halogen family, and is more reactive than chlorine. You will not be familiar with the chemistry of fluorine, but you should be able to predict some of its important properties from what you know about the properties of the other halogens.

(*a*) What physical properties would you expect fluorine to have?

(*b*) How would you expect fluorine to occur in nature?

(*c*) Suggest a method which might be used to obtain fluorine as the free element.

(*d*) What would you expect to see if fluorine was reacted with aqueous solutions of potassium chloride, potassium bromide and potassium iodide? Write an equation for any *one* of these reactions.

(*e*) How would you expect fluorine to react with water? Predict the approximate pH of the resulting liquid.

(*f*) How would you expect fluorine to react with hydrogen? Name the product of this reaction and write an equation for its formation. What properties would you expect this product to have?

(*g*) Fluorine reacts with sodium to form sodium fluoride. What properties would you expect this compound to have?

Turn over

9. The following table gives information about some properties of compounds in the homologous series of alcohols:

Name	*Molecular formula*	*Melting point in °C*	*Boiling point in °C*	*Heat of combustion per gramme-molecule in kcal*	*Heat of combustion per gramme-molecule in kJ*
Methanol	CH_3OH	−98	65	−174	−730
Ethanol	C_2H_5OH	−115	79	−327	−1370
Propanol	C_3H_7OH	−127	97	−481	−2010
Butanol	C_4H_9OH	−90	117	−639	−2670
Pentanol	$C_5H_{11}OH$	−79	138	−794	−3320
Hexanol	$C_6H_{13}OH$	−52	157	−949	−3970
Heptanol	$C_7H_{15}OH$	−35	176	−1105	−4620
Octanol	$C_8H_{17}OH$	−16	195	−1262	−5280
Nonanol	$C_9H_{19}OH$	−5	213	−1418	−5930

(*a*) The next member of the homologous series of alcohols is decanol. What will be the molecular formula of decanol?

(*b*) The members of the homologous series of alcohols would all be expected to have similar chemical properties. Name *two* substances that are likely to react with decanol, and describe briefly what will be observed during these reactions.

(*c*) Predict the melting point, boiling point and heat of combustion of decanol. You must show clearly how you have made these predictions. You may work in either kcal or kJ units when predicting the heat of combustion.

(*d*) Describe briefly the essential steps by which you would check experimentally whether your predictions in part (*c*) are correct.

Chem 1
080

UNIVERSITY OF LONDON

General Certificate of Education Examination

SUMMER 1971 **ORDINARY LEVEL**

Chemistry 1

Two hours

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Graph paper is provided.

USEFUL DATA. You may use the following figures in any question where you need them.
The gramme-molecular volume of a gas is 24 000 cm^3 at room temperature and pressure.
Avogadro Number, $N = 6 \times 10^{23}$
Atomic weights (relative atomic masses) may be taken as:

Carbon (C)	12·0	Nitrogen (N)	14·0
Chlorine (Cl)	35·5	Oxygen (O)	16·0
Hydrogen (H)	1·0	Selenium (Se)	79·0
Iron (Fe)	56·0	Sodium (Na)	23·0
Mercury (Hg)	200	Sulphur (S)	32·0

TSE 71/52 4/100/32860

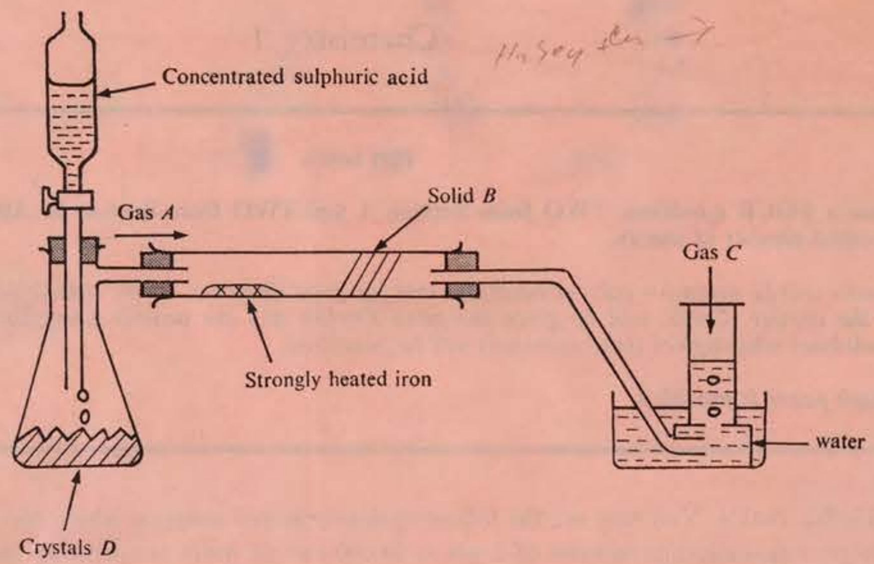
Turn over

SECTION A

Answer TWO questions.

Atomic weights (relative atomic masses) and other data will be found at the beginning of the question paper.

1. In an experiment illustrated below, a solid *B* and a gas *C* are produced from the colourless gas *A* and the iron. The gas *C* forms an explosive mixture with air.



(*a*) Suggest what the substances *D*, *A*, *B* and *C* respectively might be.

(*b*) Write the equation for the reaction by which the gas *A* is formed.

(*c*) Write the equation for the reaction of the iron with the gas *A*.

(*d*) Suggest a reason for solid *B* collecting at the place shown and not near or on the heated iron.

(*e*) What must be done to prevent too much of gas *A* being unreacted after passage over the iron?

(*f*) Explain why none of the gas *A* will be collected over the water along with gas *C* even if some of it does not react with the iron.

(*g*) How would you test the solid *B* for the two ions of which it is composed?

(*h*) If one gramme of solid *B* is produced, estimate the approximate volume of the gas *C* collected and say why you cannot give a more exact answer.

2. (*a*) What mass of pure sulphuric acid is needed to make 500 cm^3 of 2M solution?

(*b*) What mass of mercury contains 10 times as many atoms as 4 g of oxygen?

(*c*) Assuming that sodium sulphate is completely ionised when dissolved in water, calculate the number of sodium ions present in 10 litres of a 2M solution.

(*d*) The oxide of a metal E, of atomic weight 52, contains 31·6% by mass of oxygen. Calculate the relative number of g-atoms of E and of oxygen which are combined together, and hence deduce the simplest formula for the oxide of E.

(*e*) Ethanol will burn in air according to the equation

$$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O\,;$$

for this reaction $\triangle H = -326$ kcal (i.e., -1360 kJ) per g-equation. Calculate the heat change when 92 g of ethanol is completely burnt in air. State whether this heat is evolved or absorbed.

3. (*a*) Describe, in outline, one method in each case by which each of the changes numbered 1 to 4 below could be brought about. Give the essential conditions for the reactions involved and mention briefly how each product would be isolated in those cases where a solid is produced.

$$Cu(c) \underset{2}{\overset{1}{\rightleftharpoons}} Cu^{2+}(aq) \xrightarrow{3} CuCl(c)$$

$$Cu^{2+}(aq) \xrightarrow{4} Cu(OH)_2(c)$$

(*b*) Describe briefly TWO ways in which solid copper(I) chloride differs from solid copper(II) chloride.

4. Select *five* of the following six mixtures, and describe and explain what happens when each of the mixtures you select is heated.

(*a*) Ammonium chloride and sodium chloride.

(*b*) Ethanol and acetic acid in the presence of a catalyst.

(*c*) Chromium oxide, Cr_2O_3, and aluminium powder.

(*d*) Calcium hydroxide and ammonium chloride.

(*e*) Concentrated sulphuric acid and sodium nitrate.

(*f*) Ethanol and an oxidising agent, such as acidified potassium dichromate solution.

Turn over

SECTION B

Answer TWO questions.

Atomic weights (relative atomic masses) and other data will be found at the beginning of the question paper.

5. Ammonia is manufactured by the combination of nitrogen and hydrogen in the presence of finely divided iron as a catalyst at a temperature of about 500 °C and under a pressure of about 200 atm. The conversion of nitrogen and hydrogen to ammonia is not complete, and the ammonia is separated from the uncombined gases.

(*a*) Name the sources from which the nitrogen and hydrogen are obtained.

(*b*) In what ratio by volume would the nitrogen and hydrogen be mixed? Explain why this ratio is used.

(*c*) What is the purpose of the catalyst?

(*d*) Why is the catalyst in a finely divided form?

(*e*) Give one reason for the fact that the conversion of nitrogen and hydrogen to ammonia is not complete.

(*f*) The conversion to ammonia can be increased by operating the process at a pressure higher than 200 atm. Suggest a reason why a higher pressure increases the conversion to ammonia.

(*g*) How can the ammonia be separated from the uncombined nitrogen and hydrogen?

(*h*) What happens to the uncombined nitrogen and hydrogen after removal of the ammonia?

(*i*) State *two* important uses of ammonia.

(*j*) The composition of the gaseous mixture after passing over the catalyst was investigated by bubbling 2000 cm³ of the gas at room temperature and pressure through 100 cm³ of 0·3M hydrochloric acid. The final concentration of the hydrochloric acid was found to be 0·2M. Calculate the percentage of ammonia by volume in the mixture.

---

6. A 2 molar solution of a certain fully ionised acid was added in portions to 20 cm³ of 2 molar sodium hydroxide. The temperature was recorded after each addition of acid. Both solutions were initially at room temperature. The readings obtained are given in the following table.

Volume of 2M acid added (cm³)	*Temperature of mixture (°C)*
2	20·5
4	23·5
6	26·0
8	27·8
11	27·7
12	26·5
14	24·2
16	22·0

(*a*) Plot a graph of temperature of mixture against volume of acid added. The temperature scale should run from 14 °C to 30 °C along the y axis (the vertical axis) using a scale of 1 inch (or 2 cm) for a temperature interval of 2 °C. The volume of acid should run from 0 to 16 cm³ using a scale of 1 inch (or 2 cm) for 4 cm³ of acid.

(*b*) Use your graph to estimate room temperature at the time of the experiment.

(*c*) Why did the temperature rise when the first portions of acid were added?

(*d*) Give *two* reasons for the fall in temperature during the later additions of acid.

(*e*) Use your graph to decide the volume of 2M acid which would be required to neutralise 20 cm³ of 2M sodium hydroxide. How many moles (g-formulae) of acid are present in this volume?

(*f*) Calculate the number of moles (g-formulae) of NaOH contained in 20 cm³ of 2M solution.

(*g*) Use your answers to (*e*) and (*f*) to calculate the number of moles (g-formulae) of NaOH which would neutralise 1 mole (1 g-formula) of the acid.

(*h*) Suggest which common acid was being used in this experiment, and explain how you have made your choice.

---

7. Selenium (symbol Se) is a solid non-metallic element. It forms a gaseous compound with hydrogen called hydrogen selenide. This question is concerned with an investigation of hydrogen selenide.

(*a*) Analysis of hydrogen selenide shows that 2·47% by mass of the compound is hydrogen. What information does this give about the formula of hydrogen selenide?

(*b*) The mass of 96 cm³ of hydrogen selenide at room temperature and pressure is found to be 0·324 g. What information does this give about the formula of hydrogen selenide?

(*c*) Hydrogen selenide can be decomposed completely into hydrogen and selenium by passing the gas through a heated tube. Write an equation for this decomposition.

(*d*) Calculate the volume of hydrogen which would be obtained by the complete decomposition of 100 cm³ of hydrogen selenide (all gaseous volumes being measured at room temperature and pressure).

(*e*) You have been asked to devise an experiment to find if your answer to part (*d*) of this question is correct. Sketch the apparatus you would set up, and describe briefly how you would use it.

---

8. You have been provided with samples of a metallic element and the oxide and chloride of this element, together with the usual resources of a school laboratory. You have been asked to find the approximate position of this element in the electrochemical (activity) series. Describe a total of about five experiments that you would carry out using each of the materials above at least once. Explain how you would use your observations to solve the problem.

---

9. In the Periodic Table shown below, lithium, carbon, oxygen and neon have been placed in their correct positions. The positions of nine other elements have been represented by letters. These letters are not the real symbols for the elements concerned.

I	II	III	IV	V	VI	VII	O
Lithium			Carbon		Oxygen	L	Neon
X			J		G	Q	
Y						R	
Z						T	

By reference to this table, answer the following questions.

(*a*) Give the letter of the most reactive metal.

(*b*) Give the letter of the most reactive non-metal.

(*c*) Name the 'family of elements' represented by L, Q, R and T.

(*d*) Name one element in each case occurring in groups II, III and V.

(*e*) The element Q forms a compound with lithium and a compound with carbon. Suggest formulae for these two compounds (using Q as the symbol for the element), and compare

(i) their solubilities in water,

(ii) their relative melting points,

(iii) their electrical conductivities when molten.

(*f*) Discuss briefly the bonding present in the compound formed between lithium and Q. Your answer should include a diagram to show what has happened to the electrons in the outer shell of atoms of each of these elements.

(*g*) Suggest a possible shape for a molecule of the compound formed between J and R.

UNIVERSITY OF LONDON

General Certificate of Education Examination

SUMMER 1971 **ORDINARY LEVEL**

Chemistry 1

Two hours

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TSE 71/52 4/100/32860

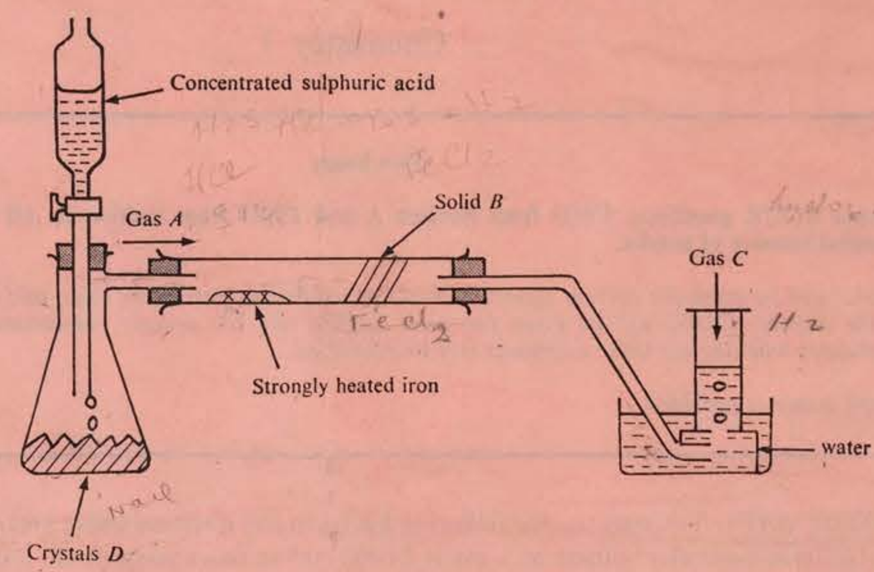
Turn over

SECTION A

Answer TWO questions.

Atomic weights (relative atomic masses) and other data will be found at the beginning of the question paper.

1. In an experiment illustrated below, a solid B and a gas C are produced from the colourless gas A and the iron. The gas C forms an explosive mixture with air.



(*a*) Suggest what the substances D, A, B and C respectively might be.

(*b*) Write the equation for the reaction by which the gas A is formed.

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(*d*) Suggest a reason for solid B collecting at the place shown and not near or on the heated iron.

(*e*) What must be done to prevent too much of gas A being unreacted after passage over the iron?

(*f*) Explain why none of the gas A will be collected over the water along with gas C even if some of it does not react with the iron.

(*g*) How would you test the solid B for the two ions of which it is composed?

(*h*) If one gramme of solid B is produced, estimate the approximate volume of the gas C collected and say why you cannot give a more exact answer.

2. (*a*) What mass of pure sulphuric acid is needed to make 500 cm³ of 2M solution?

(*b*) What mass of mercury contains 10 times as many atoms as 4 g of oxygen?

(*c*) Assuming that sodium sulphate is completely ionised when dissolved in water, calculate the number of sodium ions present in 10 litres of a 2M solution.

(*d*) The oxide of a metal E, of atomic weight 52, contains 31·6% by mass of oxygen. Calculate the relative number of g-atoms of E and of oxygen which are combined together, and hence deduce the simplest formula for the oxide of E.

(*e*) Ethanol will burn in air according to the equation

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for this reaction $\triangle H = -326$ kcal (i.e., -1360 kJ) per g-equation. Calculate the heat change when 92 g of ethanol is completely burnt in air. State whether this heat is evolved or absorbed.

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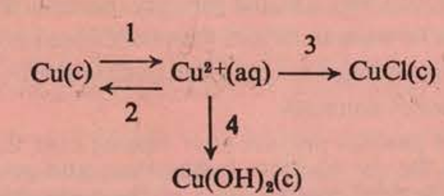

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Turn over

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Answer TWO questions.

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(*a*) Name the sources from which the nitrogen and hydrogen are obtained.

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6. A 2 molar solution of a certain fully ionised acid was added in portions to 20 cm³ of 2 molar sodium hydroxide. The temperature was recorded after each addition of acid. Both solutions were initially at room temperature. The readings obtained are given in the following table.

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---

metal + $H_2O \rightarrow H_2$ Li, Na, K.

) 3

Chem 1
080

UNIVERSITY OF LONDON

General Certificate of Education Examination

SUMMER 1971 **ORDINARY LEVEL**

Chemistry 1

Two hours

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TSE 71/52 4/100/32860

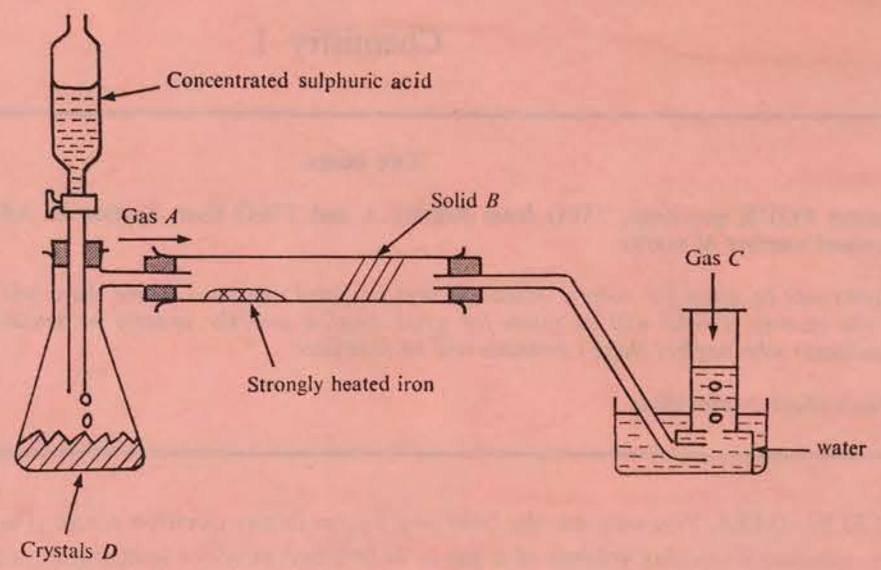
Turn over

SECTION A

Answer TWO questions.

Atomic weights (relative atomic masses) and other data will be found at the beginning of the question paper.

1. In an experiment illustrated below, a solid *B* and a gas *C* are produced from the colourless gas *A* and the iron. The gas *C* forms an explosive mixture with air.



(*a*) Suggest what the substances *D*, *A*, *B* and *C* respectively might be.

(*b*) Write the equation for the reaction by which the gas *A* is formed.

(*c*) Write the equation for the reaction of the iron with the gas *A*.

(*d*) Suggest a reason for solid *B* collecting at the place shown and not near or on the heated iron.

(*e*) What must be done to prevent too much of gas *A* being unreacted after passage over the iron?

(*f*) Explain why none of the gas *A* will be collected over the water along with gas *C* even if some of it does not react with the iron.

(*g*) How would you test the solid *B* for the two ions of which it is composed?

(*h*) If one gramme of solid *B* is produced, estimate the approximate volume of the gas *C* collected and say why you cannot give a more exact answer.

2. (*a*) What mass of pure sulphuric acid is needed to make 500 cm^3 of 2M solution?

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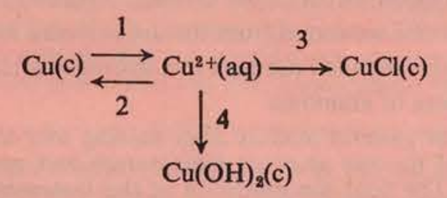
3. (*a*) Describe, in outline, one method in each case by which each of the changes numbered 1 to 4 below could be brought about. Give the essential conditions for the reactions involved and mention briefly how each product would be isolated in those cases where a solid is produced.



(*b*) Describe briefly TWO ways in which solid copper(I) chloride differs from solid copper(II) chloride.

4. Select *five* of the following six mixtures, and describe and explain what happens when each of the mixtures you select is heated.

(*a*) Ammonium chloride and sodium chloride.

(*b*) Ethanol and acetic acid in the presence of a catalyst.

(*c*) Chromium oxide, Cr_2O_3, and aluminium powder.

(*d*) Calcium hydroxide and ammonium chloride.

(*e*) Concentrated sulphuric acid and sodium nitrate.

(*f*) Ethanol and an oxidising agent, such as acidified potassium dichromate solution.

Turn over

SECTION B

Answer TWO questions.

Atomic weights (relative atomic masses) and other data will be found at the beginning of the question paper.

5. Ammonia is manufactured by the combination of nitrogen and hydrogen in the presence of finely divided iron as a catalyst at a temperature of about 500 °C and under a pressure of about 200 atm. The conversion of nitrogen and hydrogen to ammonia is not complete, and the ammonia is separated from the uncombined gases.

(*a*) Name the sources from which the nitrogen and hydrogen are obtained.

(*b*) In what ratio by volume would the nitrogen and hydrogen be mixed? Explain why this ratio is used.

(*c*) What is the purpose of the catalyst?

(*d*) Why is the catalyst in a finely divided form?

(*e*) Give one reason for the fact that the conversion of nitrogen and hydrogen to ammonia is not complete.

(*f*) The conversion to ammonia can be increased by operating the process at a pressure higher than 200 atm. Suggest a reason why a higher pressure increases the conversion to ammonia.

(*g*) How can the ammonia be separated from the uncombined nitrogen and hydrogen?

(*h*) What happens to the uncombined nitrogen and hydrogen after removal of the ammonia?

(*i*) State *two* important uses of ammonia.

(*j*) The composition of the gaseous mixture after passing over the catalyst was investigated by bubbling 2000 cm^3 of the gas at room temperature and pressure through 100 cm^3 of 0·3M hydrochloric acid. The final concentration of the hydrochloric acid was found to be 0·2M. Calculate the percentage of ammonia by volume in the mixture.

---

6. A 2 molar solution of a certain fully ionised acid was added in portions to 20 cm^3 of 2 molar sodium hydroxide. The temperature was recorded after each addition of acid. Both solutions were initially at room temperature. The readings obtained are given in the following table.

Volume of 2M acid added (cm^3)	*Temperature of mixture (°C)*
2	20·5
4	23·5
6	26·0
8	27·8
11	27·7
12	26·5
14	24·2
16	22·0

(*a*) Plot a graph of temperature of mixture against volume of acid added. The temperature scale should run from 14 °C to 30 °C along the y axis (the vertical axis) using a scale of 1 inch (or 2 cm) for a temperature interval of 2 °C. The volume of acid should run from 0 to 16 cm^3 using a scale of 1 inch (or 2 cm) for 4 cm^3 of acid.

(*b*) Use your graph to estimate room temperature at the time of the experiment.

(*c*) Why did the temperature rise when the first portions of acid were added?

(*d*) Give *two* reasons for the fall in temperature during the later additions of acid.

(*e*) Use your graph to decide the volume of 2M acid which would be required to neutralise 20 cm^3 of 2M sodium hydroxide. How many moles (g-formulae) of acid are present in this volume?

(*f*) Calculate the number of moles (g-formulae) of NaOH contained in 20 cm^3 of 2M solution.

(*g*) Use your answers to (*e*) and (*f*) to calculate the number of moles (g-formulae) of NaOH which would neutralise 1 mole (1 g-formula) of the acid.

(*h*) Suggest which common acid was being used in this experiment, and explain how you have made your choice.

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7. Selenium (symbol Se) is a solid non-metallic element. It forms a gaseous compound with hydrogen called hydrogen selenide. This question is concerned with an investigation of hydrogen selenide.

(*a*) Analysis of hydrogen selenide shows that 2·47% by mass of the compound is hydrogen. What information does this give about the formula of hydrogen selenide?

(*b*) The mass of 96 cm^3 of hydrogen selenide at room temperature and pressure is found to be 0·324 g. What information does this give about the formula of hydrogen selenide?

(*c*) Hydrogen selenide can be decomposed completely into hydrogen and selenium by passing the gas through a heated tube. Write an equation for this decomposition.

(*d*) Calculate the volume of hydrogen which would be obtained by the complete decomposition of 100 cm^3 of hydrogen selenide (all gaseous volumes being measured at room temperature and pressure).

(*e*) You have been asked to devise an experiment to find if your answer to part (*d*) of this question is correct. Sketch the apparatus you would set up, and describe briefly how you would use it.

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8. You have been provided with samples of a metallic element and the oxide and chloride of this element, together with the usual resources of a school laboratory. You have been asked to find the approximate position of this element in the electrochemical (activity) series. Describe a total of about five experiments that you would carry out using each of the materials above at least once. Explain how you would use your observations to solve the problem.

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9. In the Periodic Table shown below, lithium, carbon, oxygen and neon have been placed in their correct positions. The positions of nine other elements have been represented by letters. These letters are not the real symbols for the elements concerned.

I	II	III	IV	V	VI	VII	O
Lithium			Carbon		Oxygen	L	Neon
X			J		G	Q	
Y						R	
Z						T	

By reference to this table, answer the following questions.

(*a*) Give the letter of the most reactive metal.

(*b*) Give the letter of the most reactive non-metal.

(*c*) Name the 'family of elements' represented by L, Q, R and T.

(*d*) Name one element in each case occurring in groups II, III and V.

(*e*) The element Q forms a compound with lithium and a compound with carbon. Suggest formulae for these two compounds (using Q as the symbol for the element), and compare

(i) their solubilities in water,

(ii) their relative melting points,

(iii) their electrical conductivities when molten.

(*f*) Discuss briefly the bonding present in the compound formed between lithium and Q. Your answer should include a diagram to show what has happened to the electrons in the outer shell of atoms of each of these elements.

(*g*) Suggest a possible shape for a molecule of the compound formed between J and R.

Chem 1

080

UNIVERSITY OF LONDON

General Certificate of Education Examination

SUMMER 1971 **ORDINARY LEVEL**

Chemistry 1

Two hours

Answer FOUR questions, TWO from Section A and TWO from Section B. All questions carry an equal number of marks.

Marks will be given for correct equations and for good diagrams where these add to the clearness of the answer. Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

Graph paper is provided.

USEFUL DATA. You may use the following figures in any question where you need them.

The gramme-molecular volume of a gas is 24 000 cm^3 at room temperature and pressure.

Avogadro Number, $N = 6 \times 10^{23}$

Atomic weights (relative atomic masses) may be taken as:

Carbon (C)	12·0	Nitrogen (N)	14·0
Chlorine (Cl)	35·5	Oxygen (O)	16·0
Hydrogen (H)	1·0	Selenium (Se)	79·0
Iron (Fe)	56·0	Sodium (Na)	23·0
Mercury (Hg)	200	Sulphur (S)	32·0

TSE 71/52 4/100/32860

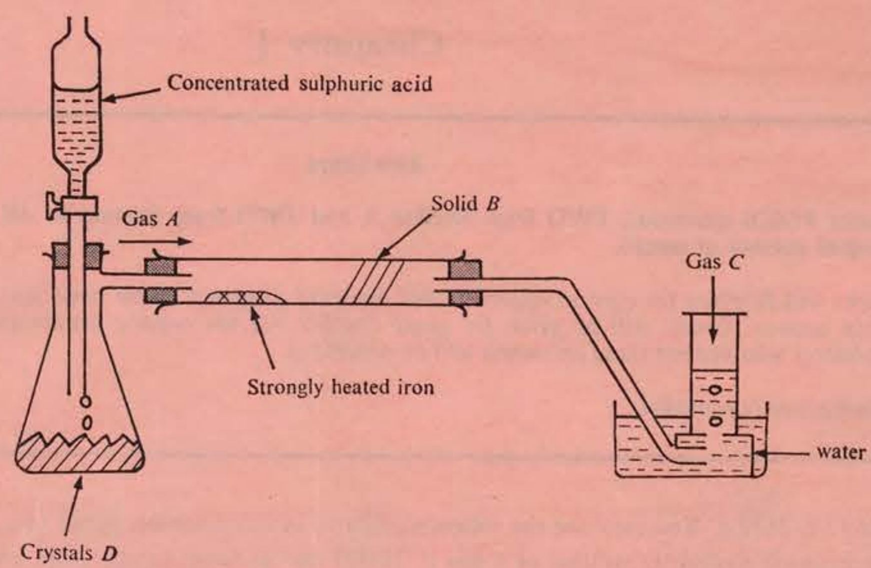
Turn over

SECTION A

Answer TWO questions.

Atomic weights (relative atomic masses) and other data will be found at the beginning of the question paper.

1. In an experiment illustrated below, a solid *B* and a gas *C* are produced from the colourless gas *A* and the iron. The gas *C* forms an explosive mixture with air.



(*a*) Suggest what the substances *D*, *A*, *B* and *C* respectively might be.

(*b*) Write the equation for the reaction by which the gas *A* is formed.

(*c*) Write the equation for the reaction of the iron with the gas *A*.

(*d*) Suggest a reason for solid *B* collecting at the place shown and not near or on the heated iron.

(*e*) What must be done to prevent too much of gas *A* being unreacted after passage over the iron?

(*f*) Explain why none of the gas *A* will be collected over the water along with gas *C* even if some of it does not react with the iron.

(*g*) How would you test the solid *B* for the two ions of which it is composed?

(*h*) If one gramme of solid *B* is produced, estimate the approximate volume of the gas *C* collected and say why you cannot give a more exact answer.

---

2. (*a*) What mass of pure sulphuric acid is needed to make 500 cm³ of 2M solution?

(*b*) What mass of mercury contains 10 times as many atoms as 4 g of oxygen?

(*c*) Assuming that sodium sulphate is completely ionised when dissolved in water, calculate the number of sodium ions present in 10 litres of a 2M solution.

(*d*) The oxide of a metal E, of atomic weight 52, contains 31·6% by mass of oxygen. Calculate the relative number of g-atoms of E and of oxygen which are combined together, and hence deduce the simplest formula for the oxide of E.

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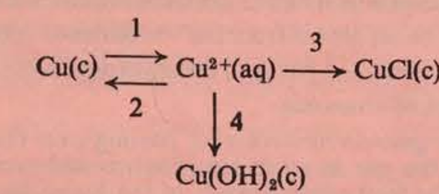

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Turn over

SECTION B

Answer TWO questions.

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5. Ammonia is manufactured by the combination of nitrogen and hydrogen in the presence of finely divided iron as a catalyst at a temperature of about 500 °C and under a pressure of about 200 atm. The conversion of nitrogen and hydrogen to ammonia is not complete, and the ammonia is separated from the uncombined gases.

(*a*) Name the sources from which the nitrogen and hydrogen are obtained.

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Chem 1
080

UNIVERSITY OF LONDON

General Certificate of Education Examination

SUMMER 1971 **ORDINARY LEVEL**

Chemistry 1

Two hours

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USEFUL DATA. You may use the following figures in any question where you need them.
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TSE 71/52 4/100/32860

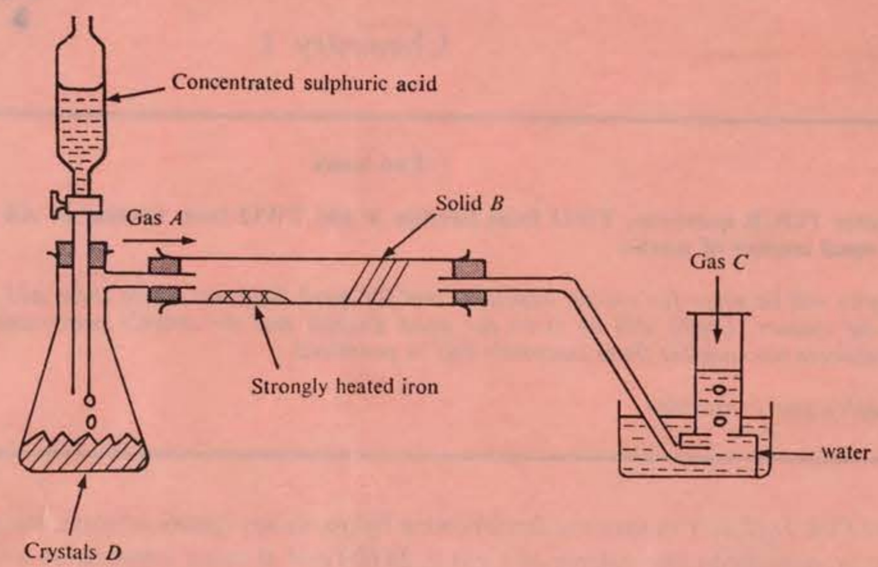
Turn over

SECTION A

Answer TWO questions.

Atomic weights (relative atomic masses) and other data will be found at the beginning of the question paper.

1. In an experiment illustrated below, a solid *B* and a gas *C* are produced from the colourless gas *A* and the iron. The gas *C* forms an explosive mixture with air.



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2. (*a*) What mass of pure sulphuric acid is needed to make 500 cm³ of 2M solution?

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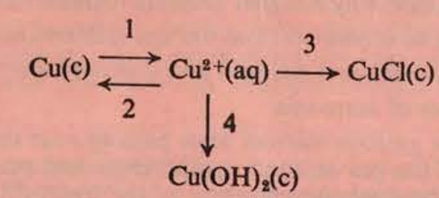

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SECTION B

Answer TWO questions.

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Chem 1

80

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

SUMMER 1970

Ordinary Level

CHEMISTRY 1

Two hours

Answer FOUR questions, TWO from Section A and TWO from Section B. All questions carry an equal number of marks.

Marks will be given for correct equations and for good diagrams where these add to the clearness of the answer. Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

Graph paper is provided.

ATOMIC WEIGHTS. You may use the following values in any question where you need them.

Hydrogen (H)	1·0	Sulphur (S)	32·0
Carbon (C)	12·0	Chlorine (Cl)	35·5
Nitrogen (N)	14·0	Copper (Cu)	63·5
Oxygen (O)	16·0	Zinc (Zn)	65·4

TSE 70/1229 2/100/33905

Turn Over

Section A

Answer TWO questions.

Atomic weights will be found at the beginning of the question paper.

1. A specimen of sulphur trioxide, SO_3, can be made in the laboratory by passing a mixture of oxygen and sulphur dioxide (obtained from cylinders) over heated platinised asbestos. The sulphur trioxide is condensed to a solid by cooling.

The sulphur trioxide can be converted to sulphuric acid by the addition of water.

(*a*) Sketch the apparatus you would use to make sulphur trioxide by the method outlined above, and write the equation for the reaction taking place.

(*b*) It is necessary to make certain that the apparatus and gases are completely dry during the preparation of sulphur trioxide. Suggest one reason why this is so.

(*c*) Platinised asbestos is finely divided platinum supported by asbestos wool. What is the function of the platinum and why is it 'finely divided'?

(*d*) In what ratio by volume would you arrange for the oxygen and sulphur dioxide to mix during the preparation of sulphur trioxide? Explain your reason for choosing this volume ratio.

(*e*) Sulphur trioxide dissolves in water to produce dilute sulphuric acid. Write the equation for this reaction. What tests would you carry out on the resulting liquid to show that dilute sulphuric acid had been formed?

(*f*) What is the maximum number of g-molecules of sulphuric acid that could be obtained from 0·1 g-molecules of oxygen and an unlimited supply of sulphur dioxide and water?

2. Choose FIVE of the following pairs of substances. For each of the five, describe a chemical test which would distinguish between the two substances. The results of the test on both members of each pair should be clearly stated.

(*a*) Two aqueous solutions, one of which contains iron(II) ions and the other iron(III) ions.

(*b*) Two aqueous solutions, one of which contains chloride ions and the other iodide ions.

(*c*) Two gases, one of which is ethane, C_2H_6, and the other ethylene, C_2H_4.

(*d*) Two gases, one of which is hydrogen and the other carbon monoxide.

(*e*) Two black solids, one of which is carbon and the other manganese dioxide, MnO_2.

(*f*) Two solids, one of which is sodium chloride and the other ammonium chloride.

(*g*) Two liquids, one of which is a solution of hydrogen chloride in water and the other a solution of hydrogen chloride in toluene.

3. (*a*) Describe the essential steps by which you would convert:

EITHER a copper(II) salt to a sample of a copper(I) salt,

OR metallic iron to a sample of an iron(II) salt.

(*b*) Copper and iron are both called 'Transition Metals'. Indicate two or three ways in which the properties of these two metals and their compounds resemble each other.

(*c*) When dry ammonia gas was passed over 16·0 g of anhydrous copper(II) sulphate, 24·5 g of a violet solid was produced which was thought to have the formula $CuSO_4.5NH_3$. Do you think that the experimental observations are consistent with this formula for the violet solid?

4. Describe, in outline, one method in each case by which FIVE of the following could be obtained from the named starting materials. Give the essential conditions for the reaction or reactions involved and mention briefly how the product would be isolated.

(*a*) Sodium chloride from chlorine.

(*b*) Calcium hydroxide from calcium carbonate.

(*c*) Carbon monoxide from carbon dioxide.

(*d*) Acetic acid from ethanol.

(*e*) Hydrogen from water.

(*f*) A simple molecule from a polymer.

(*g*) A polymer from simple starting materials.

Section B

Answer TWO questions.

Atomic weights will be found at the beginning of the question paper.

5. The weights of equal volumes of certain gases were compared at the same temperature and pressure (N.B. This is NOT s.t.p.). The results are given in the table below.

Gas	*Weight of 1 litre of gas in grams.*
Methane, CH_4	0·40
Carbon dioxide, CO_2	1·10
Hydrogen, H_2	0·05
Sulphur dioxide, SO_2	1·60

(*a*) For the four gases in the table, plot a graph of molecular weight against weight of 1 litre. Molecular weight should be along the *x* axis (the horizontal axis) using a scale of 1 inch (or 2 cm) for a molecular weight of 10. Use a scale of 1 inch (or 2 cm) for a weight of 0·2 grams along the *y* axis.

(*b*) The weight of 1 litre of a hydrocarbon, C_xH_y, is 1·45 grams at the temperature and pressure of the experiment. Use the graph to estimate the molecular weight of this hydrocarbon. If *y* is 10, suggest a value of *x* which would fit the observations. Attempt to show how the atoms are arranged in a molecule of this compound (one isomer only).

(*c*) When ethanol vapour is passed over a heated catalyst, the following reaction can take place

$$\underset{\text{ethanol}}{C_2H_5OH(g)} \rightarrow \underset{\text{ethylene}}{C_2H_4(g)} + H_2O(g)$$

In an investigation of this reaction, the water vapour was removed from the gaseous product and a gas which was thought to be ethylene was collected. If the gas really was ethylene, what should the weight of 1 litre have been at the temperature and pressure at which the four gases in the table above were compared?

The weight of 1 litre of this gas was found in one experiment to be 0·30 grams at the same temperature and pressure. This is considerably lower than might have been expected. Can you suggest any reason for this?

Turn Over

6. Two uncommon *metallic* elements have the following properties:

Element X	**Element** Y
Low melting point	High melting point
Forms only one chloride, XCl	Forms two chlorides, XCl_2 and XCl_3
Usually occurs as the compound with chlorine	Usually occurs as the oxide, X_2O_3
The oxide reacts with water to form a soluble hydroxide	The oxide is not affected by water in any way

(*a*) Outline a method by which a sample of element X might be obtained from its compounds. Indicate why you have chosen this method.

(*b*) Outline a method by which a sample of element Y might be obtained from its compounds, and again indicate why you have chosen this method.

(*c*) What reaction, if any, would you expect to take place between these elements and cold water?

(*d*) What types of particle will be present in an aqueous solution of the chloride of X? How many of each type of particle will be present in 1 litre of molar XCl?

(*e*) 336 grams of the chloride of X contain 71 grams of chlorine. How many gram-atoms of chlorine are present in 71 grams? Suggest a value for the atomic weight of X.

7. (*a*) You have been provided with a small weighed sample of zinc. How would you measure the volume of hydrogen produced when this zinc dissolves completely in dilute hydrochloric acid?

(*b*) What weight of zinc would be required to produce 0·01 g-molecules of hydrogen?

(*c*) The addition of a little aqueous copper(II) sulphate to the zinc and hydrochloric acid is said to speed up the reaction. How would you test whether this is so? How would you decide whether the copper(II) sulphate had *catalysed* the reaction?

(*d*) It is thought that only one of the types of particle present in aqueous copper(II) sulphate is responsible for the increase in the rate of reaction. What type of particle do you think that this is? How would you test whether your suggestion is correct?

8. (*a*) Describe how you would attempt to find by experiment the quantity of heat liberated when one gram of the liquid methanol, CH_4O, is burnt in air.

(*b*) The table shows the heat liberated when 1·0 g of each of three alcohols is burnt in air.

	Heat evolved
Methanol, CH_4O	5·4 kcal (i.e., 22·6 kJ)
Ethanol, C_2H_6O	7·1·kcal (i.e., 29·7 kJ)
Propanol, C_3H_8O	8·0 kcal (i.e., 33·4 kJ)

For each of these alcohols, calculate the heat of combustion in kcal (or in kJ) per g-molecule.

(*c*) From your results in (*b*), estimate the heat of combustion of butanol, $C_4H_{10}O$.

(*d*) The substance dimethyl ether has the same molecular formula, C_2H_6O, as ethanol, but its heat of combustion is different. Suggest a reason for this difference.

9. The melting and boiling points of certain chlorides are given in the table below. Use this information to answer the questions that follow.

	NaCl	$MgCl_2$	$AlCl_3$	$SiCl_4$	PCl_3	SCl_2
Boiling point (°C)	1470	1420	180	60	75	60
Melting point (°C)	800	710	190	−70	−90	−80

(*a*) Which of these chlorides are liquid at room temperature?

(*b*) Suggest two chlorides which may possess a giant structure of ions at room temperature.

(*c*) Which chloride has the greatest temperature range over which it remains in the liquid state?

(*d*) Choose one chloride which you consider might have a simple molecular structure and suggest a possible shape for the molecule. Explain briefly why you have chosen this shape.

(*e*) The data indicate that one chloride might sublime on heating. Which chloride will this be? (Sublimation occurs when a solid vaporises without melting.)

(*f*) You have been provided with about 10 cm³ of a mixture of $SiCl_4$ and PCl_3. Describe very briefly one method by which you might attempt to separate this mixture into its two components.

(*g*) It is believed that when $SiCl_4$ is added to water, a reaction represented by the following equation takes place.

$$SiCl_4(l) + 2H_2O(l) \rightarrow SiO_2(c) + 4H^+(aq) + 4\,Cl^-(aq)$$

What observations and tests would you make on the reaction products to check whether a reaction of this type has taken place?

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

SUMMER 1970

Ordinary Level

CHEMISTRY 1

Two hours

Answer FOUR questions, TWO from Section A and TWO from Section B. All questions carry an equal number of marks.

Marks will be given for correct equations and for good diagrams where these add to the clearness of the answer. Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

Graph paper is provided.

ATOMIC WEIGHTS. You may use the following values in any question where you need them.

Hydrogen (H)	1·0	Sulphur (S)	32·0
Carbon (C)	12·0	Chlorine (Cl)	35·5
Nitrogen (N)	14·0	Copper (Cu)	63·5
Oxygen (O)	16·0	Zinc (Zn)	65·4

TSE 70/1229 2/100/33905

Turn Over

Section A

Answer TWO questions.

Atomic weights will be found at the beginning of the question paper.

1. A specimen of sulphur trioxide, SO_3, can be made in the laboratory by passing a mixture of oxygen and sulphur dioxide (obtained from cylinders) over heated platinised asbestos. The sulphur trioxide is condensed to a solid by cooling.

The sulphur trioxide can be converted to sulphuric acid by the addition of water.

(*a*) Sketch the apparatus you would use to make sulphur trioxide by the method outlined above, and write the equation for the reaction taking place.

(*b*) It is necessary to make certain that the apparatus and gases are completely dry during the preparation of sulphur trioxide. Suggest one reason why this is so.

(*c*) Platinised asbestos is finely divided platinum supported by asbestos wool. What is the function of the platinum and why is it 'finely divided'?

(*d*) In what ratio by volume would you arrange for the oxygen and sulphur dioxide to mix during the preparation of sulphur trioxide? Explain your reason for choosing this volume ratio.

(*e*) Sulphur trioxide dissolves in water to produce dilute sulphuric acid. Write the equation for this reaction. What tests would you carry out on the resulting liquid to show that dilute sulphuric acid had been formed?

(*f*) What is the maximum number of g-molecules of sulphuric acid that could be obtained from 0·1 g-molecules of oxygen and an unlimited supply of sulphur dioxide and water?

2. Choose FIVE of the following pairs of substances. For each of the five, describe a chemical test which would distinguish between the two substances. The results of the test on both members of each pair should be clearly stated.

(*a*) Two aqueous solutions, one of which contains iron(II) ions and the other iron(III) ions.

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3. (*a*) Describe the essential steps by which you would convert:

EITHER a copper(II) salt to a sample of a copper(I) salt,

OR metallic iron to a sample of an iron(II) salt.

(*b*) Copper and iron are both called 'Transition Metals'. Indicate two or three ways in which the properties of these two metals and their compounds resemble each other.

(*c*) When dry ammonia gas was passed over 16·0 g of anhydrous copper(II) sulphate, 24·5 g of a violet solid was produced which was thought to have the formula $CuSO_4.5NH_3$. Do you think that the experimental observations are consistent with this formula for the violet solid?

4. Describe, in outline, one method in each case by which FIVE of the following could be obtained from the named starting materials. Give the essential conditions for the reaction or reactions involved and mention briefly how the product would be isolated.

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(*b*) Calcium hydroxide from calcium carbonate.

(*c*) Carbon monoxide from carbon dioxide.

(*d*) Acetic acid from ethanol.

(*e*) Hydrogen from water.

(*f*) A simple molecule from a polymer.

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Section B

Answer TWO questions.

Atomic weights will be found at the beginning of the question paper.

5. The weights of equal volumes of certain gases were compared at the same temperature and pressure (N.B. This is NOT s.t.p.). The results are given in the table below.

Gas	*Weight of 1 litre of gas in grams.*
Methane, CH_4	0·40
Carbon dioxide, CO_2	1·10
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Sulphur dioxide, SO_2	1·60

(*a*) For the four gases in the table, plot a graph of molecular weight against weight of 1 litre. Molecular weight should be along the *x* axis (the horizontal axis) using a scale of 1 inch (or 2 cm) for a molecular weight of 10. Use a scale of 1 inch (or 2 cm) for a weight of 0·2 grams along the *y* axis.

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$$\underset{\text{ethanol}}{C_2H_5OH(g)} \rightarrow \underset{\text{ethylene}}{C_2H_4(g)} + H_2O(g)$$

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The weight of 1 litre of this gas was found in one experiment to be 0·30 grams at the same temperature and pressure. This is considerably lower than might have been expected. Can you suggest any reason for this?

Turn Over

6. Two uncommon *metallic* elements have the following properties:

Element X	**Element Y**
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Forms only one chloride, XCl	Forms two chlorides, XCl_2 and XCl_3
Usually occurs as the compound with chlorine	Usually occurs as the oxide, X_2O_3
The oxide reacts with water to form a soluble hydroxide	The oxide is not affected by water in any way

(*a*) Outline a method by which a sample of element X might be obtained from its compounds. Indicate why you have chosen this method.

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(*c*) What reaction, if any, would you expect to take place between these elements and cold water?

(*d*) What types of particle will be present in an aqueous solution of the chloride of X? How many of each type of particle will be present in 1 litre of molar XCl?

(*e*) 336 grams of the chloride of X contain 71 grams of chlorine. How many gram-atoms of chlorine are present in 71 grams? Suggest a value for the atomic weight of X.

7. (*a*) You have been provided with a small weighed sample of zinc. How would you measure the volume of hydrogen produced when this zinc dissolves completely in dilute hydrochloric acid?

(*b*) What weight of zinc would be required to produce 0·01 g-molecules of hydrogen?

(*c*) The addition of a little aqueous copper(II) sulphate to the zinc and hydrochloric acid is said to speed up the reaction. How would you test whether this is so? How would you decide whether the copper(II) sulphate had *catalysed* the reaction?

(*d*) It is thought that only one of the types of particle present in aqueous copper(II) sulphate is responsible for the increase in the rate of reaction. What type of particle do you think that this is? How would you test whether your suggestion is correct?

8. (*a*) Describe how you would attempt to find by experiment the quantity of heat liberated when one gram of the liquid methanol, CH_4O, is burnt in air.

(*b*) The table shows the heat liberated when 1·0 g of each of three alcohols is burnt in air.

	Heat evolved
Methanol, CH_4O	5·4 kcal (i.e., 22·6 kJ)
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For each of these alcohols, calculate the heat of combustion in kcal (or in kJ) per g-molecule.

(*c*) From your results in (*b*), estimate the heat of combustion of butanol, $C_4H_{10}O$.

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9. The melting and boiling points of certain chlorides are given in the table below. Use this information to answer the questions that follow.

	NaCl	$MgCl_2$	$AlCl_3$	$SiCl_4$	PCl_3	SCl_2
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(*f*) You have been provided with about 10 cm^3 of a mixture of $SiCl_4$ and PCl_3. Describe very briefly one method by which you might attempt to separate this mixture into its two components.

(*g*) It is believed that when $SiCl_4$ is added to water, a reaction represented by the following equation takes place.

$$SiCl_4(l) + 2H_2O(l) \rightarrow SiO_2(c) + 4H^+(aq) + 4\,Cl^-(aq)$$

What observations and tests would you make on the reaction products to check whether a reaction of this type has taken place?

Chem 1

80

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

SUMMER 1970

Ordinary Level

CHEMISTRY 1

Two hours

Answer FOUR questions, TWO from Section A and TWO from Section B. All questions carry an equal number of marks.

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ATOMIC WEIGHTS. You may use the following values in any question where you need them.

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Nitrogen (N)	14·0	Copper (Cu)	63·5
Oxygen (O)	16·0	Zinc (Zn)	65·4

TSE 70/1229 2/100/33905

Turn Over

Section A

Answer TWO questions.

Atomic weights will be found at the beginning of the question paper.

1. A specimen of sulphur trioxide, SO_3, can be made in the laboratory by passing a mixture of oxygen and sulphur dioxide (obtained from cylinders) over heated platinised asbestos. The sulphur trioxide is condensed to a solid by cooling.

The sulphur trioxide can be converted to sulphuric acid by the addition of water.

(*a*) Sketch the apparatus you would use to make sulphur trioxide by the method outlined above, and write the equation for the reaction taking place.

(*b*) It is necessary to make certain that the apparatus and gases are completely dry during the preparation of sulphur trioxide. Suggest one reason why this is so.

(*c*) Platinised asbestos is finely divided platinum supported by asbestos wool. What is the function of the platinum and why is it 'finely divided'?

(*d*) In what ratio by volume would you arrange for the oxygen and sulphur dioxide to mix during the preparation of sulphur trioxide? Explain your reason for choosing this volume ratio.

(*e*) Sulphur trioxide dissolves in water to produce dilute sulphuric acid. Write the equation for this reaction. What tests would you carry out on the resulting liquid to show that dilute sulphuric acid had been formed?

(*f*) What is the maximum number of g-molecules of sulphuric acid that could be obtained from 0·1 g-molecules of oxygen and an unlimited supply of sulphur dioxide and water?

2. Choose FIVE of the following pairs of substances. For each of the five, describe a chemical test which would distinguish between the two substances. The results of the test on both members of each pair should be clearly stated.

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Section B

Answer TWO questions.

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Turn Over

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Chem 1

80

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

SUMMER 1970

Ordinary Level

CHEMISTRY 1

Two hours

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Turn Over

Section A

Answer TWO questions.

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(*d*) In what ratio by volume would you arrange for the oxygen and sulphur dioxide to mix during the preparation of sulphur trioxide? Explain your reason for choosing this volume ratio.

(*e*) Sulphur trioxide dissolves in water to produce dilute sulphuric acid. Write the equation for this reaction. What tests would you carry out on the resulting liquid to show that dilute sulphuric acid had been formed?

(*f*) What is the maximum number of g-molecules of sulphuric acid that could be obtained from 0·1 g-molecules of oxygen and an unlimited supply of sulphur dioxide and water?

2. Choose FIVE of the following pairs of substances. For each of the five, describe a chemical test which would distinguish between the two substances. The results of the test on both members of each pair should be clearly stated.

(*a*) Two aqueous solutions, one of which contains iron(II) ions and the other iron(III) ions.

(*b*) Two aqueous solutions, one of which contains chloride ions and the other iodide ions.

(*c*) Two gases, one of which is ethane, C_2H_6, and the other ethylene, C_2H_4.

(*d*) Two gases, one of which is hydrogen and the other carbon monoxide.

(*e*) Two black solids, one of which is carbon and the other manganese dioxide, MnO_2.

(*f*) Two solids, one of which is sodium chloride and the other ammonium chloride.

(*g*) Two liquids, one of which is a solution of hydrogen chloride in water and the other a solution of hydrogen chloride in toluene.

3. (*a*) Describe the essential steps by which you would convert:

EITHER a copper(II) salt to a sample of a copper(I) salt,

OR metallic iron to a sample of an iron(II) salt.

(*b*) Copper and iron are both called 'Transition Metals'. Indicate two or three ways in which the properties of these two metals and their compounds resemble each other.

(*c*) When dry ammonia gas was passed over 16·0 g of anhydrous copper(II) sulphate, 24·5 g of a violet solid was produced which was thought to have the formula $CuSO_4.5NH_3$. Do you think that the experimental observations are consistent with this formula for the violet solid?

4. Describe, in outline, one method in each case by which FIVE of the following could be obtained from the named starting materials. Give the essential conditions for the reaction or reactions involved and mention briefly how the product would be isolated.

(*a*) Sodium chloride from chlorine.

(*b*) Calcium hydroxide from calcium carbonate.

(*c*) Carbon monoxide from carbon dioxide.

(*d*) Acetic acid from ethanol.

(*e*) Hydrogen from water.

(*f*) A simple molecule from a polymer.

(*g*) A polymer from simple starting materials.

Section B

Answer TWO questions.

Atomic weights will be found at the beginning of the question paper.

5. The weights of equal volumes of certain gases were compared at the same temperature and pressure (N.B. This is NOT s.t.p.). The results are given in the table below.

Gas	*Weight of 1 litre of gas in grams.*
Methane, CH_4	0·40
Carbon dioxide, CO_2	1·10
Hydrogen, H_2	0·05
Sulphur dioxide, SO_2	1·60

(*a*) For the four gases in the table, plot a graph of molecular weight against weight of 1 litre. Molecular weight should be along the *x* axis (the horizontal axis) using a scale of 1 inch (or 2 cm) for a molecular weight of 10. Use a scale of 1 inch (or 2 cm) for a weight of 0·2 grams along the *y* axis.

(*b*) The weight of 1 litre of a hydrocarbon, C_xH_y, is 1·45 grams at the temperature and pressure of the experiment. Use the graph to estimate the molecular weight of this hydrocarbon. If *y* is 10, suggest a value of *x* which would fit the observations. Attempt to show how the atoms are arranged in a molecule of this compound (one isomer only).

(*c*) When ethanol vapour is passed over a heated catalyst, the following reaction can take place

$$\underset{\text{ethanol}}{C_2H_5OH(g)} \rightarrow \underset{\text{ethylene}}{C_2H_4(g)} + H_2O(g)$$

In an investigation of this reaction, the water vapour was removed from the gaseous product and a gas which was thought to be ethylene was collected. If the gas really was ethylene, what should the weight of 1 litre have been at the temperature and pressure at which the four gases in the table above were compared?

The weight of 1 litre of this gas was found in one experiment to be 0·30 grams at the same temperature and pressure. This is considerably lower than might have been expected. Can you suggest any reason for this?

6. Two uncommon *metallic* elements have the following properties:

Element X	**Element** Y
Low melting point	High melting point
Forms only one chloride, XCl	Forms two chlorides, XCl_2 and XCl_3
Usually occurs as the compound with chlorine	Usually occurs as the oxide, X_2O_3
The oxide reacts with water to form a soluble hydroxide	The oxide is not affected by water in any way

(*a*) Outline a method by which a sample of element X might be obtained from its compounds. Indicate why you have chosen this method.

(*b*) Outline a method by which a sample of element Y might be obtained from its compounds, and again indicate why you have chosen this method.

(*c*) What reaction, if any, would you expect to take place between these elements and cold water?

(*d*) What types of particle will be present in an aqueous solution of the chloride of X? How many of each type of particle will be present in 1 litre of molar XCl?

(*e*) 336 grams of the chloride of X contain 71 grams of chlorine. How many gram-atoms of chlorine are present in 71 grams? Suggest a value for the atomic weight of X.

7. (*a*) You have been provided with a small weighed sample of zinc. How would you measure the volume of hydrogen produced when this zinc dissolves completely in dilute hydrochloric acid?

(*b*) What weight of zinc would be required to produce 0·01 g-molecules of hydrogen?

(*c*) The addition of a little aqueous copper(II) sulphate to the zinc and hydrochloric acid is said to speed up the reaction. How would you test whether this is so? How would you decide whether the copper(II) sulphate had *catalysed* the reaction?

(*d*) It is thought that only one of the types of particle present in aqueous copper(II) sulphate is responsible for the increase in the rate of reaction. What type of particle do you think that this is? How would you test whether your suggestion is correct?

8. (*a*) Describe how you would attempt to find by experiment the quantity of heat liberated when one gram of the liquid methanol, CH_4O, is burnt in air.

(*b*) The table shows the heat liberated when 1·0 g of each of three alcohols is burnt in air.

	Heat evolved
Methanol, CH_4O	5·4 kcal (i.e., 22·6 kJ)
Ethanol, C_2H_6O	7·1 kcal (i.e., 29·7 kJ)
Propanol, C_3H_8O	8·0 kcal (i.e., 33·4 kJ)

For each of these alcohols, calculate the heat of combustion in kcal (or in kJ) per g-molecule.

(*c*) From your results in (*b*), estimate the heat of combustion of butanol, $C_4H_{10}O$.

(*d*) The substance dimethyl ether has the same molecular formula, C_2H_6O, as ethanol, but its heat of combustion is different. Suggest a reason for this difference.

9. The melting and boiling points of certain chlorides are given in the table below. Use this information to answer the questions that follow.

	NaCl	$MgCl_2$	$AlCl_3$	$SiCl_4$	PCl_3	SCl_2
Boiling point (°C)	1470	1420	180	60	75	60
Melting point (°C)	800	710	190	−70	−90	−80

(*a*) Which of these chlorides are liquid at room temperature?

(*b*) Suggest two chlorides which may possess a giant structure of ions at room temperature.

(*c*) Which chloride has the greatest temperature range over which it remains in the liquid state?

(*d*) Choose one chloride which you consider might have a simple molecular structure and suggest a possible shape for the molecule. Explain briefly why you have chosen this shape.

(*e*) The data indicate that one chloride might sublime on heating. Which chloride will this be? (Sublimation occurs when a solid vaporises without melting.)

(*f*) You have been provided with about 10 cm³ of a mixture of $SiCl_4$ and PCl_3. Describe very briefly one method by which you might attempt to separate this mixture into its two components.

(*g*) It is believed that when $SiCl_4$ is added to water, a reaction represented by the following equation takes place.

$$SiCl_4(l) + 2H_2O(l) \rightarrow SiO_2(c) + 4H^+(aq) + 4\,Cl^-(aq)$$

What observations and tests would you make on the reaction products to check whether a reaction of this type has taken place?

Chem 1
80

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

SUMMER 1970

Ordinary Level

CHEMISTRY 1

Two hours

Answer FOUR questions, TWO from Section A and TWO from Section B. All questions carry an equal number of marks.

Marks will be given for correct equations and for good diagrams where these add to the clearness of the answer. Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

Graph paper is provided.

ATOMIC WEIGHTS. You may use the following values in any question where you need them.

Hydrogen (H)	1·0	Sulphur (S)	32·0
Carbon (C)	12·0	Chlorine (Cl)	35·5
Nitrogen (N)	14·0	Copper (Cu)	63·5
Oxygen (O)	16·0	Zinc (Zn)	65·4

TSE 70/1229 2/100/33905

Turn Over

Section A

Answer TWO questions.

Atomic weights will be found at the beginning of the question paper.

1. A specimen of sulphur trioxide, SO_3, can be made in the laboratory by passing a mixture of oxygen and sulphur dioxide (obtained from cylinders) over heated platinised asbestos. The sulphur trioxide is condensed to a solid by cooling.

The sulphur trioxide can be converted to sulphuric acid by the addition of water.

(*a*) Sketch the apparatus you would use to make sulphur trioxide by the method outlined above, and write the equation for the reaction taking place.

(*b*) It is necessary to make certain that the apparatus and gases are completely dry during the preparation of sulphur trioxide. Suggest one reason why this is so.

(*c*) Platinised asbestos is finely divided platinum supported by asbestos wool. What is the function of the platinum and why is it 'finely divided'?

(*d*) In what ratio by volume would you arrange for the oxygen and sulphur dioxide to mix during the preparation of sulphur trioxide? Explain your reason for choosing this volume ratio.

(*e*) Sulphur trioxide dissolves in water to produce dilute sulphuric acid. Write the equation for this reaction. What tests would you carry out on the resulting liquid to show that dilute sulphuric acid had been formed?

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Section B

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Turn Over

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What observations and tests would you make on the reaction products to check whether a reaction of this type has taken place?

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Section B

Answer TWO questions.

3. Nitric acid may be prepared in the laboratory by the action of concentrated sulphuric acid on a suitable nitrate and distilling off the nitric acid. Describe in detail such a preparation and answer the following questions concerning this preparation.
   (*a*) Why is an apparatus consisting of glass only desirable for the preparation?
   (*b*) Nitric acid and sulphuric acid are both liquids. Why does nitric acid only distil off and not sulphuric acid?
   (*c*) Pure nitric acid is colourless but the product in this preparation is usually pale yellow or even brown. Why is this? What precaution would you take in the preparation to reduce this colouration to a minimum?
   (*d*) If your product was yellow or brown how would you obtain a colourless sample of nitric acid from it?

4. Describe in detail how you would prepare and collect several jars of carbon monoxide in the laboratory.
   Write out in table form *five* differences in properties between carbon monoxide and carbon dioxide.

5. What do you understand by 'the electrochemical series'?
   Arrange the metals iron, calcium, magnesium and copper in decreasing order of activity and justify your order by comparing their chemical reactions with (*a*) water (or steam) and (*b*) dilute hydrochloric acid.

6. Taking the reaction expressed by the equation
   $$Mg + H_2SO_4 + 7H_2O = MgSO_4.7H_2O + H_2$$
   state all that you can that is indicated by the equation.
   Describe in detail how you would prove experimentally that the equation correctly represents the amount of hydrogen obtainable using a given weight of magnesium.
   [Mg = 24, H = 1·00, S = 32, O = 16. One gram-molecule of a gas occupies 22·4 litres at s.t.p.]

Section C

Answer TWO questions.

7. State Gay-Lussac's law of volumes.
   The following results were obtained with a sample of the *air* expelled from tap-water by boiling. When 50 ml of the air was shaken with caustic soda solution a decrease in volume of 1·5 ml was observed. Excess hydrogen was then added to the residual gas and the mixture of gases was sparked electrically. When the remaining gases had cooled they were found to occupy 45 ml less than before sparking. All the volumes were measured at room temperature and pressure. Calculate the percentage composition by volume of the *air* which had been expelled from the tap-water.
   How does the composition of this *air* differ from that of ordinary air? What explanations can you offer for these differences?

Turn Over

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   How does the composition of this *air* differ from that of ordinary air? What explanations can you offer for these differences?

Turn Over

8. Answer *two* of the following:
   (*a*) Define 'reversible reaction'.
   Describe how you would discover experimentally whether the action of steam on magnesium was reversible or not.
   (*b*) Define 'catalyst'.
   Describe how you would prove experimentally that the decomposition of potassium chlorate by heat is catalysed by manganese dioxide.
   (*c*) Define 'solubility'.
   Describe how you would prove or disprove experimentally the statement: 'Calcium oxalate is insoluble in water'.

9. Hydrogen and oxygen are liberated by the electrolysis of water to which sulphuric acid has been added if platinum electrodes are used.
   (*a*) Explain in detail the part played by the sulphuric acid.
   (*b*) Carefully describe how you would prove experimentally that the whole of the sulphuric acid is still present after electrolysis has taken place.

10. Explain *five* of the following, giving equations where appropriate:
   (*a*) Drops of moisture form on the underside of a saucepan containing cold water soon after it is placed over a lighted gas ring but this does not happen with an electric hot plate.
   (*b*) Bottles containing sodium hydroxide solution are fitted with rubber stoppers rather than with glass stoppers.
   (*c*) Hydrated lime should not be added to the soil at the same time as ammonium sulphate.
   (*d*) The air supply to a bunsen burner should be reduced before the flame is lowered.
   (*e*) Stalactites and stalagmites are often found in caves in limestone districts.
   (*f*) Fire-foam should be used to extinguish a petrol fire rather than water.
   (*g*) Temporary but not permanent hardness in water can be removed by addition of slaked lime.

11. You are required to identify two substances *A* and *B* from the data given. Explain the reactions mentioned for each of them and where possible give the equations for those reactions.
   (*a*) Substance *A* was a blue crystalline solid which gave off a brown gas when heated and left a black solid residue. When excess of this black solid was warmed with dilute sulphuric acid and filtered, a blue filtrate was obtained. One portion of this filtrate on evaporation gave blue crystals which on gentle heating gave a white residue; when a few drops of water were added to this white residue it turned blue again. To another portion of the blue filtrate ammonium hydroxide was added until it was present in excess; at first a greenish-blue precipitate was formed but this later dissolved giving a deep blue solution.
   (*b*) Substance *B* was a white powder which when heated gave off a gas which turned lime-water milky; a yellow solid remained. When excess of this solid was warmed with dilute nitric acid and filtered, a colourless filtrate was obtained. To one portion of this filtrate dilute hydrochloric acid was added; a white crystalline precipitate was formed which dissolved on warming but reappeared on cooling. Another portion of the filtrate gave a white precipitate when dilute sulphuric acid was added to it. A third portion of the filtrate gave a black precipitate when hydrogen sulphide was passed into it.

8. Answer *two* of the following:

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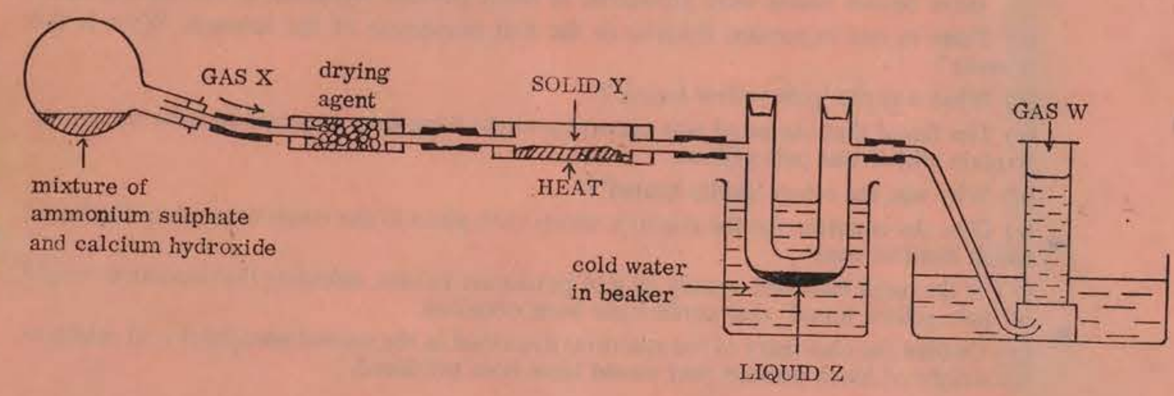
(*b*) Substance *B* was a white powder which when heated gave off a gas which turned lime-water milky; a yellow solid remained. When excess of this solid was warmed with dilute nitric acid and filtered, a colourless filtrate was obtained. To one portion of this filtrate dilute hydrochloric acid was added; a white crystalline precipitate was formed which dissolved on warming but reappeared on cooling. Another portion of the filtrate gave a white precipitate when dilute sulphuric acid was added to it. A third portion of the filtrate gave a black precipitate when hydrogen sulphide was passed into it.

Answers to Sections B and C must be written in the answer-book provided. Pages 7-9 may be detached.

Section B

Answer TWO questions.

3. In an experiment illustrated below, a liquid *Z* and a gas *W* are obtained. The gas *W* has a molecular weight of 28.



(*a*) Identify *W*, *X*, *Y* and *Z*.

(*b*) What can you say about the density of *W* relative to air?

(*c*) Is it necessary to heat the flask containing the ammonium salt and calcium hydroxide?

(*d*) Name the drying agent and explain why it acts as a drying agent.

(*e*) Write the equation for the reaction between gas *X* and solid *Y*.

(*f*) Write the equation for the formation of gas *X*.

(*g*) Calculate the maximum number of g-molecules of *W* that could be formed from 0·1 g-formula (g-molecule) of ammonium sulphate.

4. Salts can be prepared by the following methods, among others:

(*a*) neutralisation of an acid by a base,

(*b*) action of a metal on an acid,

(*c*) double decomposition.

For each of these three methods, select a salt from the list below for which the method would be suitable, and describe in detail how you would carry out the preparation. In each case you should say how you would obtain a pure dry specimen of the salt.

Barium sulphate, calcium carbonate, copper chloride, magnesium sulphate, sodium bicarbonate.

5. Here is an extract from a pupil's notebook. Read it and then answer the questions which follow.

'We put about 10 g of potassium nitrate in a retort. We poured in sufficient dilute sulphuric acid to cover the potassium nitrate and noticed that the mixture had become warm. When we gently heated the retort, a pale yellow liquid gradually distilled over and this was collected in a cooled flask.

We dropped some of the pale yellow liquid on to 1·00 g of copper in a weighed boiling tube. This reaction was carried out in a fume cupboard, and when the vigorous reaction was over and all the copper had dissolved we heated the mixture until no more brown fumes were produced. A black powder remained in the boiling tube.'

(*a*) There is one important mistake in the first paragraph of the account. What is this mistake?

(*b*) What was the 'pale yellow liquid'?

(*c*) The liquid that the pupil was preparing might have been expected to have no colour. Explain why it was pale yellow.

(*d*) Why was the retort 'gently heated'?

(*e*) Give the equation for the reaction which took place in the retort to produce the liquid which distilled over.

(*f*) If the pupil had used exactly 10 g of potassium nitrate, calculate the maximum weight of 'pale yellow liquid' that could have been obtained.

(*g*) Outline the chemistry of the reactions described in the second paragraph and calculate the weight of black powder that would have been produced.

6. (*a*) What is meant by a 'reversible reaction'? Give *three* examples. In *one* case, describe how you would show experimentally that the reaction is reversible.

(*b*) The rate of a chemical reaction increases with increasing temperature. Select one chemical reaction and describe how you would demonstrate that its rate is greater at a higher temperature.

(*c*) Ammonium chloride has a vapour density of 13·5 at 150° C, whereas from its formula (NH_4Cl, formula weight 53·5) the vapour density would be expected to be 26·7. What is the explanation for this discrepancy?

Section C

Answer TWO questions.

7. You have been provided with a mixture of cupric oxide and common salt. How would you obtain from this (*a*) pure dry sodium chloride, (*b*) pure copper, and (*c*) chlorine gas?

8. A pupil has been asked to determine experimentally the weight of carbon dioxide that would be produced by completely reacting 1·00 g of calcium carbonate with dilute hydrochloric acid. Outline *one* method by which the pupil might obtain an answer to this problem.

Write the equation for the reaction and use this to calculate the weight of carbon dioxide which should be formed in this reaction.

Calculate the minimum volume of molar (i.e., normal) hydrochloric acid required to react with 1·00 g of calcium carbonate. What volume of hydrogen chloride gas (measured at s.t.p.) would be needed to make this volume of acid?

11. Each of six unlabelled bottles was known to contain one of the following colourless liquids:

sodium carbonate (dilute)	hydrochloric acid (dilute)
sulphuric acid (dilute)	sodium hydroxide (dilute)
distilled water	lime water.

Describe a series of simple experiments by means of which correct labels could be assigned to the bottles. You are advised that full marks can be obtained only if in the end you give a positive test for each.

Answers to Sections B and C must be written in the answer-book provided.
Pages 7, 8 and 9 may be detached.

Section B

Answer TWO questions.

3. Describe in outline the manufacture of pig iron from haematite (Fe_2O_3) using the blast furnace.

Briefly explain

(*a*) how iron is converted into steel;
(*b*) two important differences between iron and steel;
(*c*) how iron may be converted into ferric chloride (anhydrous).

4. Explain what is meant by 'electrolysis' and state Faraday's laws of electrolysis.

How may electrolysis be used

(*a*) to find the equivalent weight of copper, given that of silver;
(*b*) to cover a piece of steel with a thin layer of copper;
(*c*) to make sodium hydroxide from brine?

5. Define the term 'equivalent weight'. Write down (*a*) the relation between the equivalent weight and the atomic weight of a metal, (*b*) the relation between the equivalent weight of an acid and its molecular weight.

Describe, with essential practical details, how you would determine the following equivalents:

(*i*) that of a metal such as magnesium by a method involving displacement;
(*ii*) that of a soluble weak base, given a decinormal solution of an acid.

(In (*i*) and (*ii*), be careful to explain your method of calculation.)

6. A large round-bottomed flask is completely filled with tap water and fitted with a rubber bung and delivery-tube which is also completely filled with the same water. The end of the delivery-tube is placed under water in a small trough and a graduated tube, also full of water, is placed over this end. The water in the large flask is heated until it boils, and the whole apparatus is allowed to cool to the original temperature. Some gas is found to have collected in the graduated tube. The latter tube is transferred to a tall jar of water and 'levelled'. The volume of gas collected is found to be 24 ml. A piece of white phosphorus on a long wire is inserted into the graduated tube, and left until no further change is apparent. On again levelling, the volume of gas left is found to be 16 ml.

(*a*) What do you think was the purpose of the experiment?
(*b*) Why was the delivery-tube also filled with water?
(*c*) Of what did the 24 ml of gas consist?
(*d*) Why was the graduated tube 'levelled'?
(*e*) What was the purpose of the white phosphorus?
(*f*) From the figures given calculate the percentage of one of the constituents of the gas in the tube.
(*g*) How does your result in (*f*) compare with that which you would expect to get with air?

Turn Over

Section C

Answer TWO questions.

7. The mineral *azurite* is a compound of copper carbonate ($CuCO_3$) and copper hydroxide ($Cu(OH)_2$). When 1·72 gm of azurite are heated 224 ml of carbon dioxide at s.t.p. and 0·090 gm of water are evolved, and a residue of copper oxide is left. Find the formula of azurite.

Sketch an apparatus which you could use to determine the weight of water formed in this experiment and explain how you would use it.

[Cu = 63·5; O = 16; C = 12; H = 1·00. Gram-molecular-volume is 22·4 litres at s.t.p.]

8. Identify the substances *A*, *B*, *C* and *D* as far as possible from the information given; point out the significance of each observation and where appropriate give the equations for the reactions.

(*a*) *A* was a pungent smelling gas which turned red litmus blue; when it was passed over hot copper oxide it left a reddish residue; droplets of a colourless liquid were deposited on the cooler parts of the apparatus and a gas was formed which could be collected over water. This gas was neutral, odourless, and generally unreactive but magnesium would burn in it. The action of water on the product gave the original gas, *A*.

(*b*) *B* was a deliquescent solid which dissolved in water giving out heat in the process. The solution gave a reddish precipitate when added to ferric chloride solution, and an alkaline gas when warmed with ammonium chloride. When the solution of *B* was added in suitable proportions to dilute hydrochloric acid and the solution evaporated, a white solid was obtained.

(*c*) *C* was a white crystalline solid. When it was heated brown fumes were evolved, and a glowing splint held in these fumes burst into flames. A yellow residue was obtained, which fused with the glass. *C* was soluble in water and the solution gave a dense white precipitate with dilute sulphuric acid.

(*d*) *D* was a crystalline solid readily soluble in water to give a pale green solution. When the solution was treated with ammonia solution a light-green coloured precipitate was obtained which darkened to olive-green, and then, particularly near the edges, to a brown colour. When *D* was heated a fine red powder was left in the tube and acid gases were evolved which (i) decolourised potassium permanganate and (ii) turned a drop of acidified barium chloride solution cloudy.

9. Find the formula of a gaseous oxide of nitrogen from the data given. 20 ml of the oxide were mixed with 30 ml of hydrogen and the mixture exploded by passing a spark. When the apparatus had cooled to the original temperature the volume of the mixture of nitrogen and hydrogen left was found to be 20 ml. 10 ml of oxygen were now added and the mixture again exploded. All the hydrogen combined with oxygen and 15 ml of a mixture of unchanged nitrogen and unused oxygen was left. All measurements were made at room temperature and pressure; under these conditions the volume of any water formed may be regarded as negligible.

10. The element *rubidium* (Rb), valency 1, resembles sodium and potassium in most of its properties, though it is more electropositive than either.

(*a*) How would you expect it to react with water?

(*b*) What would be the action of heat on rubidium nitrate?

(*c*) Will rubidium carbonate be soluble in water?

(*d*) What will be the action of heat on rubidium carbonate?

(*e*) How would you attempt to prepare the metal from rubidium chloride?

(*f*) When 1·000 gm of rubidium chloride is dissolved in water and added to excess of silver nitrate solution 1·186 gm of silver chloride is precipitated. Calculate the atomic weight of rubidium, given that the atomic weights of chlorine and silver are 35·46 and 107·9 respectively.

9. *A* is a light grey powder which reacts vigorously with dilute sulphuric acid to produce a gas *B* which extinguishes a glowing splint. Gas *B* burns in air but has no effect on lead acetate solution.

If the mixture remaining from the reaction with dilute sulphuric acid is filtered, a yellow residue, *C*, remains. The filtrate will produce a white precipitate, *D*, with sodium hydroxide solution. This precipitate is insoluble in excess sodium hydroxide solution.

When a small portion of *A* is heated in a test tube protected by a safety screen, a violent reaction occurs. The product of this reaction, *E*, reacts readily with dilute sulphuric acid to produce a gas, *F*, which burns in air. *F* reacts with lead acetate solution to give a black precipitate, *G*.

What are *A*, *B*, *C*, *D*, *E*, *F* and *G*? Discuss the chemistry of the reactions described.

10. (*a*) A steady current of 1 amp is passed between copper electrodes through a solution of copper sulphate for 1 hour. The cathode gains in weight by 1·19 g and the anode loses weight by the same amount.

In another experiment, a steady current of 2 amps is passed for 1 hour between copper electrodes in a warm alkaline solution of sodium chloride. The anode is found to lose in weight by 4·76 g.

Calculate the number of Faradays of electricity required to cause 1 g-atom of copper (63·6 g) to dissolve from the anode in each case, and comment on the answer.

[1 Faraday = 96,500 coulombs = 26·8 amp hours; 1 coulomb = 1 amp for 1 sec]

(*b*) Why is it inadvisable to examine the acid levels in a car battery by the light of a burning candle?

(*c*) The elements magnesium, nickel, hydrogen, copper and silver stand in that order in the electrochemical series (magnesium most active).

(i) What would you expect to happen at the cathode if an aqueous solution of nickel nitrate and silver nitrate is electrolysed with platinum electrodes?

(ii) Magnesium is placed in an aqueous solution of copper sulphate in one beaker. Copper is placed in an aqueous solution of magnesium sulphate in another beaker. What would you expect to happen in each beaker?

11. Describe briefly how you would obtain a sample of the first-named substance from each of the following mixtures.

(*a*) Sodium carbonate and calcium carbonate;

(*b*) Copper and zinc;

(*c*) Sodium bromide and ammonium bromide;

(*d*) Concentrated nitric acid and concentrated sulphuric acid;

(*e*) Oxygen and dinitrogen tetroxide;

(*f*) Nitrogen and carbon dioxide.

Chem
Overseas
7

Centre Number
Candidate Number
Surname

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

JANUARY 1967

Ordinary Level

CHEMISTRY

for Candidates Overseas

Three hours

In the spaces above write your centre number, your candidate number and your surname.

Answer SIX questions. Answer the TWO questions in Section A, TWO questions from Section B and TWO questions from Section C. All questions carry an equal number of marks.

In Sections B and C marks will be given for correct equations and for good diagrams where these add to the clearness of the answer. Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

Attach Section A *with string, loosely but securely,* **inside the front cover** *of your answer-book containing answers to Sections B and C.*

Turn Over

TE&S 65/17 6/2/2/100/8600

Section A *Answer BOTH questions in this section.*

1. Complete the following table:

	Sulphur dioxide	*Hydrogen sulphide*	*Chlorine*
(*a*) Formula			
(*b*) Odour			
(*c*) Action on water			
(*d*) Action on litmus paper			
(*e*) Action on lead nitrate solution	X		X
(*f*) Does it alter the colour of potassium dichromate?			
(*g*) Denser or less dense than air?			
(*h*) Method of collection			

For each gas, give

(*i*) the materials used to prepare it,

(*ii*) the equation for the preparation reaction.

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Turn Over

2. (*a*) State:

(i) the law of constant composition;

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(ii) Boyle's law;

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(iii) Graham's law of gaseous diffusion.

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(*b*) Calculate:

(i) The percentage of sodium in sodium thiosulphate crystals ($Na_2S_2O_3.5H_2O$);
[See p. 5 for atomic weights]

...NO.......................................

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(ii) The volume of oxygen, at s.t.p., required to burn 24 gm of carbon completely to carbon dioxide;

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(iii) The volume of oxygen required to burn 20 ml of carbon monoxide (CO) (measured at the same temperature and pressure as the oxygen) to carbon dioxide;

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(iv) The volume of carbon dioxide formed in (iii) (also measured at the temperature and pressure of the oxygen).

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(*c*) Give the name and chemical formula of:

(i) a dibasic acid;

....

(ii) a substance responsible for 'temporary hardness' in water;

....

(iii) two components of the air;

....

(iv) marble;

....

(v) an acid salt.

....

[Atomic weights: H = 1·00; C = 12; O = 16; Na = 23; S = 32. Gram-molecular-volume is 22·4 litres at s.t.p.]

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Pages 7, 8 and 9 may be detached.

Section B

Answer TWO questions.

3. Describe in outline the manufacture of pig iron from haematite (Fe_2O_3) using the blast furnace.

Briefly explain

(*a*) how iron is converted into steel;
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(In (*i*) and (*ii*), be careful to explain your method of calculation.)

6. A large round-bottomed flask is completely filled with tap water and fitted with a rubber bung and delivery-tube which is also completely filled with the same water. The end of the delivery-tube is placed under water in a small trough and a graduated tube, also full of water, is placed over this end. The water in the large flask is heated until it boils, and the whole apparatus is allowed to cool to the original temperature. Some gas is found to have collected in the graduated tube. The latter tube is transferred to a tall jar of water and 'levelled'. The volume of gas collected is found to be 24 ml. A piece of white phosphorus on a long wire is inserted into the graduated tube, and left until no further change is apparent. On again levelling, the volume of gas left is found to be 16 ml.

(*a*) What do you think was the purpose of the experiment?
(*b*) Why was the delivery-tube also filled with water?
(*c*) Of what did the 24 ml of gas consist?
(*d*) Why was the graduated tube 'levelled'?
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(*f*) From the figures given calculate the percentage of one of the constituents of the gas in the tube.
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Turn Over

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(*c*) Will rubidium carbonate be soluble in water?

(*d*) What will be the action of heat on rubidium carbonate?

(*e*) How would you attempt to prepare the metal from rubidium chloride?

(*f*) When 1·000 gm of rubidium chloride is dissolved in water and added to excess of silver nitrate solution 1·186 gm of silver chloride is precipitated. Calculate the atomic weight of rubidium, given that the atomic weights of chlorine and silver are 35·46 and 107·9 respectively.

11. Each of six unlabelled bottles was known to contain one of the following colourless liquids:

sodium carbonate (dilute)	hydrochloric acid (dilute)
sulphuric acid (dilute)	sodium hydroxide (dilute)
distilled water	lime water.

Describe a series of simple experiments by means of which correct labels could be assigned to the bottles. You are advised that full marks can be obtained only if in the end you give a positive test for each.

UNIVERSITY OF LONDON
SENATE HOUSE, WC1
TELEPHONE: MUSEUM 8000 TELEGRAMS: UNIVERSITY, LONDON

REVISED EXAMINATIONS IN ORDINARY AND ADVANCED LEVEL CHEMISTRY FROM SUMMER 1966

Dear Sir or Madam,

The University Entrance and School Examinations Council recently sponsored an evaluation of the present Ordinary and Advanced level examinations in Chemistry of the University of London. All the assessors of the G.C.E. examinations were critical of the emphasis in examination papers on 'capacity to recall' and stressed the need for more questions which would enable the candidates to display their ability to handle ideas. This is a recognition of a desire which both teachers and examiners have shared for some years.

The Council decided that a modified approach to examining should be encouraged, and set up a sub-committee to draft some specimen papers along these lines. As from 1966, students will be required to take the revised papers, but the Council is anxious to ensure that teachers and pupils are thoroughly familiar well in advance with the kind of question which will be asked in these papers. Meanwhile, the revision of Chemistry syllabuses is in hand.

Broadly speaking, the policy will be to provide examinations which seek to determine whether pupils are familiar with the appropriate ground work of the subject, and can organise and express their ideas. At the same time, candidates will be expected to demonstrate critical ability and imagination.

From Summer 1966 the Ordinary and Advanced level papers will be divided into three sections, as in the enclosed specimen papers. There will be one three hour paper at the Ordinary level and two three hour papers at the Advanced level. No substantial change in the Special Paper for home centres is envisaged.

Section A

This section will test the essential grammar of the subject. It will call for factual knowledge which it is expected that the candidates will have acquired from a familiarity with chemical substances and reactions in the laboratory or in demonstrations. Candidates will also be expected to be thoroughly familiar with basic concepts appropriate to the level of study. Questions in this section may often be set in tabular form.

Section B

Questions in this section will invite candidates to organise material and handle ideas. Candidates may be asked to summarize their knowledge of a particular topic, or to orient it from a specified view-point, or to draw attention to particular inter-relationships, and will be expected to express themselves systematically.

Section C

This section will be particularly concerned to offer candidates an opportunity to demonstrate critical and imaginative qualities. Naturally such questions will follow no particular pattern, but some general indications can be given. Questions may provide experimental information and ask for interpretation, or call for a critical assessment of a variety of statements. They may require the candidate to demonstrate his understanding by applying it in a slightly unfamiliar situation. Questions may also be set which will expect a candidate to show he has developed an investigational approach to the subject as a result of laboratory work.

It may happen that questions are set in a particular section which call for abilities spanning the whole range of chemical understanding.

The Advanced level specimen papers should not be taken as providing a set pattern in terms of the different areas of chemistry.

Advanced level Practical Examination

The practical examination will consist of two questions. The first will require a volumetric determination. The second will require the candidate to perform one or more simple investigations, to observe, record and infer.

Example

Three solutions, A, B and C, are provided. Candidates are required to complete the following table for each of A, B and C, recording observations and inferences.

Solution provided	Description	Result of Test with Litmus	Action of H_2S	Action of NaOH	Suggest a possible identification	Suggest a confirmatory test	Result of confirmatory test and inference

It is hoped that these changes in the practical examination will release time, and allow teachers greater freedom, to develop in their pupils an investigational approach through their laboratory work.

Yours faithfully,

G. Bruce

Secretary to the Council

Chem

School or Centre No.
Candidate Number
Candidate's Surname

1st SPECIMEN PAPER

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

SUMMER 1966

Ordinary Level

CHEMISTRY

Three hours

In the spaces above write your school or centre number, your candidate number and your surname.

Answer SIX questions. Answer the TWO questions in Section A, TWO questions from Section B and TWO questions from Section C.

In Sections B and C marks will be given for correct equations and for good diagrams where these add to the clearness of the answer. Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

Attach Section A *with string, loosely but securely, to the* **front** *of your answer-book containing answers to Sections B and C.*

TE&S 64/1250 8/8/4000

Turn Over

Section A

Answer BOTH questions in this section.

1. Write equations for the reactions (if any) of the metals given below with the reagents (*a*), (*b*), (*c*), and (*d*), indicating in each case the nature of the reaction (e.g. vigorous, smooth, slight) and the conditions under which it takes place:

Reagent	Magnesium	Zinc	Copper
(*a*) Dilute sulphuric acid			
(*b*) Dilute nitric acid		Not required	
(*c*) Water			
(*d*) Dilute sodium hydroxide solution			

2. Complete the following table:

Gas	Equation for laboratory preparation	Method of collection	Distinctive test	A large scale use
Oxygen				
Carbon dioxide				
Ammonia				
Carbon monoxide				
Hydrogen				

Answers to Sections B and C must be written in the answer-book provided.

Section B

Answer TWO questions.

3. Describe any *two* simple experiments which give support to the idea of the existence of ions. Represent *three* of the following reactions by the simplest ionic equations:
   (i) Neutralisation of a strong acid by a strong alkali.
   (ii) Reaction between silver nitrate solution and the solution of a chloride.
   (iii) Action of zinc on copper sulphate solution.
   (iv) Effect of passing chlorine into a solution of potassium iodide.

4. Give an account of the chemistry underlying the production of iron in a blast furnace. Make clear the role of each of the carbon compounds to be found in the furnace.

5. Write down the formulae of *three* oxides of nitrogen. State a chemical reaction which could be used for the preparation of a sample in each case. Compare the properties of the three oxides.

6. Describe *one* process for the extraction of sulphur from the earth's crust. Starting from roll sulphur, how would *you* obtain (*a*) crystals of one allotrope of sulphur, (*b*) a solid metal sulphide, (*c*) crystals of a metal sulphite, (*d*) crystals of a metal sulphate?

Section C

Answer TWO questions.

7. Suggest *one* test by which each of the following pairs of chemical compounds could be distinguished from each other.
   (*a*) Sodium chloride and sodium iodide.
   (*b*) Lead sulphate and zinc sulphate.
   (*c*) Potassium carbonate and potassium sulphite.
   (*d*) Barium chloride and magnesium chloride.

   State the observations you would expect to make in each case and how you would interpret them.

8. Given a solution of potassium nitrate in water, explain how you would decide whether the solution is (*a*) unsaturated, (*b*) saturated, or (*c*) supersaturated.
   Describe experiments you would make to obtain the solubility curve of potassium nitrate in water from 0°C to 100°C.

9. Briefly explain *five* of the following, giving equations where appropriate:
   (*a*) Silver articles tarnish in ordinary air.
   (*b*) Lime must be slaked carefully.
   (*c*) When diluting sulphuric acid, the acid must be added to the water, *not* water to acid.
   (*d*) Metal spoons are not normally used when making pickle or marmalade. (Equations not required).
   (*e*) Washing soda will soften hard water.
   (*f*) Fur is deposited in kettles in some districts.
   (*g*) Plaster of Paris when moistened rapidly sets to a hard mass.

Turn Over

10. The following information is based on observations made when lithium perchlorate is heated.
(a) A gas is given off and a white solid is left.
(b) The gas is colourless and odourless, and will relight a glowing splint.
(c) The solid dissolves completely in water; when nitric acid followed by silver nitrate is added to this solution, a white precipitate is formed. The solution does not respond to other tests for acid radicals.
(d) When 2·13 g. of the lithium perchlorate is heated to constant weight, the residue weighs 0·85g. and 0·896 litres of gas (at S.T.P.) is given off.

State clearly what you can deduce from (b) and (c). From the figures find the formula of lithium perchlorate, and the equation for the reaction by which it decomposes on heating. (Lithium, Li, is a univalent metal with atomic weight 7·0. Cl = 35·5 O = 16; gram-molecular-volume at S.T.P. is 22·4 litres)

11. Lead monoxide (PbO) is insoluble in water. Lead nitrate is, and lead sulphate is not, soluble in water. Describe in detail how you would prepare a pure, dry specimen of lead sulphate from lead monoxide.

$LiClO_4$

Chemistry
Overseas
7

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

JANUARY 1966

Ordinary Level

CHEMISTRY

for Candidates Overseas

Three hours

Answer SIX questions.

Marks will be given for correct equations and for good diagrams where these add to the clearness of the answer.

Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

1. What do you understand by: (a) a salt, (b) the basicity of an acid, (c) an acid salt, (d) a normal salt?

Select two suitable acids and in each case give the names and formulae of one acid salt and of one normal salt which may be obtained from that acid.

The molecular weight of an acid is 254. An aqueous solution is made containing 20·0 gm of this acid per litre of solution. Twenty-five ml of this solution required for complete neutralisation 29·5 ml of N/5 sodium hydroxide solution. Find the basicity of the acid.

[Na = 23·0, H = 1·0, O = 16·0.]

TE&S 64/1401 6/2/8250

Turn Over

2. Describe a process by which zinc is obtained from one of its ores.

Name two important uses of metallic zinc and one important use of a named zinc compound.

Describe in detail how you would prepare crystals of zinc sulphate from granulated zinc or from zinc foil.

3. Explain the chemical reactions involved in the following:

(*a*) The setting of Plaster of Paris.

(*b*) The formation of stalactites and stalagmites.

(*c*) The softening of hard water by washing soda.

(*d*) The rusting of iron.

4. Describe one experiment in each case to illustrate the following statements:

(*a*) Insoluble salts can be made by double decomposition.

(*b*) The rate of a chemical reaction may be increased by the addition of a catalyst.

(*c*) The luminosity of a candle flame is caused by the presence of incandescent carbon particles.

(*d*) Less dense gases diffuse more rapidly than more dense gases.

5. Describe in detail a method by means of which you would prepare and collect several jars of chlorine in the laboratory.

Carefully describe and explain what you would observe on passing chlorine into potassium iodide solution; explain why the chlorine is acting as an oxidising agent.

Compare and contrast the action of chlorine as a bleaching agent with that of sulphur dioxide.

Why is chlorine used for sterilising water?

6. Describe in detail a method which you would use in the laboratory to prepare and collect several jars of hydrogen.

Briefly describe the manufacture of:

(*a*) water gas,

(*b*) hydrogen from water gas.

Name a source of hydrogen which is becoming increasingly important and which is replacing method (*b*).

Name two important substances for whose manufacture hydrogen is a basic raw material.

7. What is meant by the statement 'phosphorus is an allotropic element'?

Describe the manufacture of white phosphorus from calcium phosphate with special reference to the chemical reactions which take place in the process.

Briefly describe how white phosphorus is converted into red phosphorus.

Give in tabular form four important differences between white and red phosphorus.

8. Write the equations for the reactions which occur when:

(*a*) Phosphorus burns in excess oxygen.

(*b*) Heated magnesium burns in steam.

(*c*) Barium peroxide is treated with cold dilute sulphuric acid.

(*d*) Copper reacts with concentrated nitric acid which has been diluted with an equal volume of water.

(*e*) Sodium sulphite is warmed with dilute hydrochloric acid.

(*f*) Iron is strongly heated in steam.

In each of these reactions an oxide is formed (in some cases with water as well). Classify these six oxides as acidic, basic, neutral, etc., giving in each case one good reason for your classification.

Turn Over

9. Carefully describe what you would observe when crystals of lead nitrate are heated in a test-tube.

Briefly describe how from the products of the above reaction you would obtain: (*a*) metallic lead, (*b*) nitrogen.

Excluding the action of heat, describe two tests by means of which you would identify lead nitrate.

State two important uses of metallic lead or of two of its named compounds.

10. Give a large fully labelled diagram of the apparatus you would use to determine the composition of water *by weight*. Do not describe the experiment but point out any precautions which you would take in carrying out the experiment. Show how the result is calculated.

Two litres of hydrogen at 17° C and 740 mm pressure were used in the reduction of some black copper oxide. Find (*a*) the weight of the oxide reduced, and (*b*) the weight of water formed.

[Gram-molecular volume = 22·4 litres at S.T.P., H = 1·00. O = 16·0, Cu = 63·0.]

Chemistry
7

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

SUMMER 1965

Ordinary Level

CHEMISTRY

Three hours

Answer SIX questions.

Marks will be given for correct equations and for good diagrams where these add to the clearness of the answer.

Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

1. Define 'solubility'. Describe in detail how you would measure the solubility of a salt such as sodium chloride in water at room temperature.

Potassium chlorate is much less soluble than potassium chloride in water at room temperature. Describe how you would prepare a specimen of pure potassium chlorate from a mixture of the two salts. How would you test the purity of your product?

2. State (*a*) Gay Lussac's law of volumes, (*b*) Avogadro's hypothesis (law). Describe one experiment which illustrates the law of volumes.

Calor gas consists of 95% butane (C_4H_{10}) and 5% pentane (C_5H_{12}) by volume. Assuming that air contains 20% of oxygen by volume, calculate the volume of air needed for the complete combustion of 100 litres of calor gas. All measurements are made at the same temperature and pressure.

TE&S 63/1919 6/2/25/30100

Turn Over

3. Explain what is meant by the 'equivalent weight' of an element.

When 0·12 g. of a metal was dissolved in excess of dilute sulphuric acid, 115 ml. of dry hydrogen were evolved, measured at 12°C and 770 mm. pressure. Calculate the equivalent weight of the metal. The density of hydrogen at N.T.P. is 0·090 g. per litre.

Describe in detail how you would carry out the above determination in the laboratory.

4. What do you understand by an acid? Describe *two* tests, other than the action of indicators, that you would carry out on a colourless aqueous solution to show that it was acidic.

Describe in detail how you would prepare a specimen of nitric acid in the laboratory. Explain how you would carry out the 'brown ring' test for a nitrate.

5. Describe what you would see, and explain the chemistry of the reactions involved when:

(*a*) concentrated nitric acid is added a little at a time to copper turnings in a beaker until no further change takes place;

(*b*) the solution from (*a*) is carefully evaporated to dryness, after which the residue is strongly heated until no further change occurs;

(*c*) part of the residue from (*b*) is heated in a stream of hydrogen until there is no further change;

(*d*) the remainder of the residue from (*b*) is added a little at a time to dilute sulphuric acid, the mixture being warmed and stirred, until the residue is present in excess. The excess is then filtered off;

(*e*) to the filtrate from (*d*) pieces of zinc foil are added and the mixture is well stirred.

6. Describe how you would prepare a dilute solution of hydrogen peroxide in the laboratory.

Describe and explain what you would observe when:

(*a*) dilute hydrogen peroxide is added to a solution of potassium permanganate acidified with dilute sulphuric acid;

(*b*) hydrogen peroxide solution is added to a suspension of lead sulphide in water;

(*c*) powdered manganese dioxide is sprinkled into hydrogen peroxide solution.

Suggest a reason for the use of hydrogen peroxide as a constituent of rocket propellents.

7. Give an account of the principal reactions that occur in a coke fire.

What are the main constituents of (*a*) coal-gas, (*b*) water-gas, and (*c*) producer-gas? Describe in outline how the last two are manufactured.

Why is it undesirable to run the engine of a motor car in a closed garage?

8. Name *one* ore from which zinc is extracted and explain the chemistry involved in the method of extraction. State one important use of the metal zinc.

What are the relative positions of the metals calcium, sodium, iron and zinc in the electrochemical or activity series? Justify your answer by comparing the reactions of these metals with water.

9. Give an account, illustrated by a diagram, of the laboratory preparation of hydrogen sulphide. What would be the most likely impurity in your specimen? Why is concentrated sulphuric acid not a suitable drying agent for hydrogen sulphide?

Describe what you would see, and give the equations for the reactions which occur, when hydrogen sulphide is (i) bubbled through a solution of lead nitrate, (ii) bubbled through ferric chloride solution.

10. What do you understand by (*a*) water of crystallisation, and (*b*) efflorescence?

A sample of washing soda which had been exposed to the air for some time weighed 1·71 g. The sample was dissolved in water and the solution made up to 250 ml; 25 ml of this final solution required 27·5 ml of deci-normal sulphuric acid solution for neutralisation, methyl orange being used as indicator. Calculate (i) the normality of the sodium carbonate solution, (ii) the percentage of anhydrous sodium carbonate in the sample, and (iii) the value of x if the formula of the substance can be written as $Na_2CO_3.xH_2O$.

(Na = 23; C = 12; O = 16; H = 1·0.)

Chemistry
7

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

SUMMER 1965

Ordinary Level

CHEMISTRY

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TE&S 63/1919 6/2/25/30100

Turn Over

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($Na = 23$; $C = 12$; $O = 16$; $H = 1{\cdot}0$.)

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Advanced Level

SUMMER, 1960

CHEMISTRY.—II

WEDNESDAY, June 22.—Morning, 9.30 to 12.30

Answer FIVE *questions, of which* ONE *at least must be from* SECTION A. *Definite chemical changes should be represented by equations and diagrams should be given wherever possible.*

Credit will be given for good English and orderly presentation of material. Candidates who neglect these essentials will be penalised.

SECTION A

1. Describe the laboratory preparation of diethyl ether from ethyl alcohol.

Name the impurities likely to be present in the crude product and state how they would be removed in order to obtain a pure dry specimen of the ether.

By what properties and reactions can diethyl ether be distinguished from the isomeric methyl propyl ether ?

2. Describe the preparation of phenol from benzenesulphonic acid. How, and under what conditions, does phenol react with (*a*) bromine, (*b*) caustic soda, (*c*) ferric chloride, (*d*) benzene-diazonium chloride ?

SECTION B

3. Give the name and formula of one ore of mercury. How is the metal (i) extracted from this ore, (ii) purified ?

Starting from the metal, how would you prepare specimens of (iii) mercurous chloride, (iv) mercuric chloride ?

What deductions have been made from a study of the vapour density of mercurous chloride at different temperatures ?

4. Describe the laboratory preparation and collection of pure sulphur dioxide.

How, and under what conditions, does sulphur dioxide react with (*a*) chlorine, (*b*) caustic soda, (*c*) lead dioxide, (*d*) potassium dichromate ?

5. What is the importance of vapour density measurements in the determination of molecular weights ?

Describe Victor Meyer's method for the determination of the vapour density of a volatile compound.

2·768 g. of phosphorus pentachloride when completely vaporized, at 250° C. and 760 mm. of mercury pressure, occupied 764·6 c.c. What deduction can be made from this observation ?

[H = 1·00; P = 31·0; Cl = 35·5; 1·0 litre of hydrogen at N.T.P. weighs 0·089 g.]

6. Give an account, with reference to the underlying principles, of a method for the qualitative separation of zinc, manganese, and nickel (*a*) from other metals, (*b*) from each other.

7. Explain carefully *five* of the following terms, illustrating your answer, in each case, by reference to an experiment you have seen or performed : (i) catalysis, (ii) protective colloid, (iii) allotrope, (iv) mixed crystals, (v) cataphoresis, (vi) common ion effect, (vii) transition point.

8. Describe the extraction of metallic aluminium from bauxite, explaining the chemical principles underlying the main steps in the process.

How, and under what conditions, does aluminium react with (*a*) water, (*b*) caustic soda, (*c*) chlorine, (*d*) sulphuric acid ?

9. Outline (*a*) an industrial method for obtaining oxygen from the atmosphere, (*b*) a laboratory method for preparing pure oxygen.

On what grounds is the formula O_3 assigned to the molecule of ozone ?

10. Give an account of the influence of temperature, pressure and the presence of foreign bodies on (i) the rate of a chemical reaction, (ii) the position of equilibrium in a reversible reaction, (iii) the rate of attainment of equilibrium in a reversible reaction.

Illustrate your answer by reference to the systems

$$CO_2 + H_2 \rightleftharpoons CO + H_2O - 12{,}000 \text{ calories.}$$

$$2SO_2 + O_2 \rightleftharpoons 2SO_3 + 45{,}000 \text{ calories.}$$

UNIVERSITY OF LONDON

General Certificate of Education Examination

January 1962

Ordinary Level

CHEMISTRY

Friday, 19 January: 9.30 to 12.30

Answer SIX questions. Marks will be given for correct equations and for good diagrams where these add to the clearness of the answer.

Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

1. State (*a*) the law of definite proportions and (*b*) the law of conservation of mass.

Describe fully experiments (one for each law) by which these laws can be illustrated in the laboratory.

2. Describe the laboratory preparation and collection of hydrogen.

How would you demonstrate that hydrogen diffuses faster than air ?

If 100 cc. of hydrogen diffuse in 25 secs., how long will it take 300 cc of chlorine (vapour density 36) to diffuse under the same conditions ?

3. Give labelled diagrams and equations for the preparation and collection in the laboratory of a few jars of (*a*) carbon dioxide, (*b*) carbon monoxide.

Compare the reactions (if any) of these oxides with (i) litmus, (ii) oxygen.

4. Describe how you would identify by simple chemical tests **five** of the following :—(i) baking soda, (ii) washing soda, (iii) common salt, (iv) sodium bisulphate, (v) chalk, (vi) powdered zinc, (vii) bleaching powder.

Turn Over

Th.P. 60/1263 8/4/10400

5. Describe and explain how metallic copper can be purified.

How would you prepare in the laboratory (*a*) pure cupric oxide from copper, (*b*) copper sulphate crystals from cupric oxide?

6. Describe in detail the laboratory preparation of a specimen of nitric acid. Outline how you could obtain from your specimen (*a*) sodium nitrate, (*b*) ammonium nitrate, (*c*) nitric oxide.

Give **one** chemical test by which you could distinguish between dilute nitric acid and dilute hydrochloric acid.

7. Define the ' equivalent weight ' of an element.

A, *B*, and *C* are three oxides of a metal *X*.

(i) 100 gm of *A* contained 20 gm of oxygen.

(ii) 9·00 gm of *B*, when completely reduced in a stream of hydrogen, left a residue of 8·00 gm.

(iii) When *C* was converted to a solution of the corresponding neutral salt and 3·25 gm of zinc was added, 3·2 gm of metal *X* was deposited.

Calculate the equivalent weight of *X* in each oxide. If the formula of *A* is XO, what are the formulae of *B* and *C* ?

[Equivalent weight of zinc = 32·5.]

8. Describe what you would see, name the products and give the equations for the reactions which take place when:—

(*a*) a small piece of sodium is placed on water,

(*b*) water is added slowly to a lump of quicklime until the water is in excess,

(*c*) a lighted taper is placed in a jar of chlorine,

(*d*) concentrated sulphuric acid is heated with metallic copper.

9. Explain what is meant by the terms (*a*) saturated solution, (*b*) solubility, (*c*) solubility curve.

Describe laboratory experiments by which you could (i) determine accurately the solubility of potassium nitrate in water at room temperature, (ii) obtain pure water from potassium nitrate solution.

10. How would you prepare in the laboratory a dilute solution of hydrogen peroxide ?

Describe what takes place when hydrogen peroxide is added to (*a*) acidified potassium permanganate solution, (*b*) lead sulphide, (*c*) manganese dioxide. Give equations for the reactions in (*b*) and (*c*).

UNIVERSITY OF LONDON

General Certificate of Education Examination

Summer 1961

Ordinary Level

CHEMISTRY

Friday, 30 June: 9.30 to 12.30

Answer SIX questions. Marks will be given for correct equations and for good diagrams where these add to the clearness of the answer.

Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalized.

1. Give **two** characteristic properties of an acid and **two** characteristic properties of an alkali.

Describe with full experimental details how you would prepare in the laboratory (*a*) a solution of hydrochloric acid from common salt, (*b*) solid calcium hydroxide from calcium carbonate.

2. Describe how you could prepare and collect several jars of nitrogen from a suitable nitrogen compound. In what ways does ' atmospheric ' nitrogen differ from the gas so prepared ?

Give **two** reactions which distinguish carbon dioxide from nitrogen.

Describe **one** experiment in which carbon dioxide acts as a supporter of combustion.

3. Explain what is meant by the term catalyst.

Give an account of three reactions in which a catalyst is used, naming the reactants and products, giving equations, and stating the conditions under which the reactions take place.

4. Describe all that you would observe when the following substances are heated, also naming the products, giving equations, and indicating how any gaseous products could be identified:—

(*a*) potassium nitrate, (*b*) ferrous sulphate crystals, (*c*) mercuric oxide, (*d*) copper nitrate.

5. Explain what is meant by (*a*) electrolysis, (*b*) anode, (*c*) ion.

Describe and explain how electrolysis may be used (i) to purify copper, (ii) to produce sodium hydroxide on a large scale.

Turn Over

Th.P. 60/1214 8/4/23500

6. State (*a*) Gay Lussac's law, (*b*) Avogadro's hypothesis (law).

(i) Calculate the volume of carbon dioxide, measured at 20° C. and 750 mms. pressure, which would be obtained by the action of excess dilute hydrochloric acid on 5·00 gm. of calcium carbonate.

(ii) If the carbon dioxide so obtained was passed through a large quantity of red-hot carbon, what gas would be formed, and what would be its volume measured at 20° C. and 750 mms. pressure ?

[C = 12, O = 16, Ca = 40. One gram-molecule of a gas occupies 22·4 litres at N.T.P.]

7. Describe how pig iron is obtained from iron ore, paying special attention to the chemical reactions involved. [NO DIAGRAM IS REQUIRED.]

How would you prepare from iron (*a*) anhydrous ferric chloride, (*b*) ferrous sulphate crystals ?

8. What is meant by:—(*a*) water of crystallisation, (*b*) hardness of water ?

Give the names and formulae of **three** salts containing water of crystallisation.

If the formula of Epsom Salts is $MgSO_4, xH_2O$ and the percentage of water is 51·22, what is the value of x ?

[H = 1, O = 16, Mg = 24, S = 32.]

9. How would you show experimentally that sulphur dioxide 'contains its own volume of oxygen' ? What does this tell us about the formula of sulphur dioxide ? What further evidence is required to establish the complete formula, and how is that evidence used ?

Discuss the reactions of sulphur dioxide with (*a*) water, (*b*) hydrogen sulphide, (*c*) lead dioxide.

10. What is meant by a 'normal solution' of an acid ? Describe how you would use such a solution to find the weight of sodium carbonate in a litre of sodium carbonate solution.

If 30·0 cc. of decinormal hydrochloric acid were exactly neutralised by 25·0 cc. of a solution which contained 12·0 gm. of a base per litre, calculate the equivalent weight of the base.

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

SUMMER, 1960

CHEMISTRY

FRIDAY, July 1.—*Afternoon,* 2 *to* 5

Answer SIX *questions. Marks will be given for correct equations and for good diagrams where these add to the clearness of the answer.*

Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalised.

1. State the law of multiple proportions, and describe how the truth of this law could be illustrated in the laboratory in a particular case.

2·80 gm. of a metal combine with chlorine to form 8·125 gm. of a chloride which, on reduction, gave 6·35 gm. of another chloride of the metal. Show that these results illustrate the above law.

2. Describe carefully how you would separate a reasonably pure specimen of *one* of the constituents from each of the following mixtures:—

(*a*) common salt and potassium nitrate,
(*b*) chalk and ammonium chloride,
(*c*) hydrogen sulphide and hydrogen chloride.

In (*a*) and (*b*) state how you would show experimentally that the product obtained was free from the substance with which it was formerly mixed ?

Th.P. 59/1009 6/2/25700

[P.T.O.]

3. Describe experiments which show the reactions of water or steam with (*a*) sodium, (*b*) calcium, (*c*) iron. Give equations.

How could you identify the products in the reactions you describe in (*a*) and (*b*) ?

4. Draw labelled diagrams showing the apparatus and materials used in the preparation and collection of:—

(*a*) carbon dioxide, using a Kipp's apparatus,
(*b*) carbon monoxide from carbon dioxide,
(*c*) carbon dioxide from carbon monoxide.

Explain (*d*) why the overall percentage of carbon dioxide in air remains approximately constant, and (*e*) the way in which carbon monoxide acts as a poisonous gas.

5. Explain what you understand by a reducing agent.

Describe *one* reaction for each of the following which shows that the substance can act as a reducing agent:—

(*a*) hydrogen, (*b*) hydrogen chloride, (*c*) hydrogen sulphide, (*d*) sulphur dioxide, (*e*) ammonia.

6. Give *one* test in *each* case by which a solution of washing soda could be distinguished from a solution of (*a*) caustic soda, (*b*) sodium bicarbonate.

How may washing soda be converted in the laboratory to (*c*) caustic soda solution, (*d*) solid sodium bicarbonate ?

How and under what conditions does caustic soda react with (*e*) chlorine, (*f*) zinc, (*g*) sulphur dioxide ?

7. Describe how you would prepare nitric acid in the laboratory. How is nitric acid manufactured from ammonia ?

Describe experiments by which you could obtain from nitric acid (*a*) oxygen, (*b*) crystals of copper nitrate.

8. What do you understand by the terms (*a*) molecule, (*b*) atomicity ?

Describe experiments to show (*c*) that gases in contact mix completely, (*d*) that the rate of diffusion of a gas depends on its density. Explain what the results of these experiments are thought to indicate with regard to gases.

Using common salt as your example, explain what you understand by electrovalency.

9. Give *one* example of the use in the laboratory of each of the following reagents: (*a*) silver nitrate, (*b*) ferrous sulphate, (*c*) potassium iodide, (*d*) ammonium hydroxide, (*e*) potassium ferricyanide, (*f*) lead acetate (or nitrate).

10. Describe the preparation of crystals of two different salts from sulphuric acid and sodium hydroxide.

4·88 gm. of barium chloride crystals ($BaCl_2.2H_2O$) were dissolved in water. To the solution was added 100 cc. of a normal solution of sodium carbonate and the precipitate formed filtered, carefully washed and dried. Calculate (*a*) the weight of solid obtained, and (*b*) the volume of $\frac{N}{5}$ hydrochloric acid which would be required to react with the excess of sodium carbonate in the filtrate.

[Ba = 137, Cl = 35·5, H = 1, O = 16, Na = 23, C = 12.]

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

SUMMER, 1960

CHEMISTRY

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3. Describe experiments which show the reactions of water or steam with (*a*) sodium, (*b*) calcium, (*c*) iron. Give equations.

How could you identify the products in the reactions you describe in (*a*) and (*b*) ?

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[Ba = 137, Cl = 35·5, H = 1, O = 16, Na = 23, C = 12.]

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

SUMMER, 1959

CHEMISTRY

FRIDAY, *June* 19.—*Morning*, 9.30 *to* 12.30

Answer SIX *questions. Marks will be given for correct equations and for good diagrams, where these add to the clearness of the answer.*

Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalised.

1. State Avogadro's hypothesis.

Describe an experiment showing that carbon dioxide contains its own volume of oxygen.

50 cc. of a gas mixture containing carbon monoxide, carbon dioxide and nitrogen were shaken with caustic potash and the residual volume was 36 cc. To this residual mixture of gases was added 20 cc. (an excess) of oxygen and it was exploded by sparking. After cooling the new volume was 48 cc. Assuming all volumes were measured at the same room temperature and pressure, calculate the composition of the original mixture.

2. Give (*a*) *three* characteristic properties of a base, and (*b*) the meaning of the term "basicity" of an acid. Describe how you would prepare (*c*) a base from copper sulphate solution, (*d*) an acid from sodium nitrate, (*e*) crystals of a normal salt from sulphuric acid.

C.P. 58/1565 6/2/21M **[P.T.O.**

$CuSO_4$ + ~~Na_2CO_3~~ NaOH

3. Explain the following facts giving equations where possible:—

(*a*) When plaster of Paris is moistened with water, it sets to a hard mass.

(*b*) An orange layer is formed at the bottom of the test-tube if chlorine water and carbon tetrachloride are added to a solution of potassium bromide and the mixture shaken and then left to settle.

(*c*) When red lead is heated, a colourless gas is given off and an orange-red liquid is left which sets to a yellow solid on cooling.

(*d*) When sodium hydroxide solution is added slowly to zinc sulphate solution a white precipitate is first formed and then disappears.

(*e*) On heating ferrous sulphate solution with nitric acid in the presence of dilute sulphuric acid, the solution changes colour and a brown gas is given off.

4. Describe how you would prepare and collect a few gas jars of dry ammonia. Describe experiments by which you could show that (*a*) ammonia contains nitrogen, (*b*) ammonia will burn in oxygen.

136.5 cc. What volume of deci-normal nitric acid would be required to react with 380 cc. of ammonia gas measured at 27°C and 672 mms. pressure, and what weight of ammonium nitrate would be formed?

1.092

[H=1: N=14: O=16. The gram-molecular volume of a gas is 22·4 litres at N.T.P.].

5. Outline a method for preparing solid yellow phosphorus from calcium phosphate.

How would you convert (*a*) yellow phosphorus to red phosphorus, (*b*) red phosphorus to yellow phosphorus?

Describe fully the differences between yellow and red phosphorus.

6. Explain what you mean by (*a*) a saturated solution, (*b*) a supersaturated solution, (*c*) a solubility curve.

Describe one good method by which you could determine experimentally the solubility of potassium nitrate in water at 20°C, indicating how you would calculate your result.

The solubility of copper sulphate at 85°C is 60 gm. in 100 gm. of water and at 15°C is 18·8. If 120 gm. of solution saturated at 85°C are cooled to 15°C, what weight of copper sulphate crystals would be deposited?

188
12
96
96
12
2256

7. Describe fully one good laboratory method of preparing and collecting a few gas jars of chlorine.

Give a different experiment in each case to show that chlorine (*a*) supports combustion, (*b*) can act as an oxidising agent, (*c*) will react with a compound containing hydrogen.

8. Name *three* different naturally occurring forms of calcium carbonate.

Starting with one of them, how would you prepare in the laboratory (*a*) slaked lime, (*b*) calcium sulphate, (*c*) a solution of calcium bicarbonate.

Give *four* differences in properties between distilled water and calcium chloride solution.

9. Outline the production of coal gas, describing clearly the methods used to remove certain impurities naming in each case the substance removed.

Explain how from these materials (*a*) ammonium sulphate, (*b*) sulphuric acid, (*c*) benzene (for motor spirit) can be obtained.

10. Describe all that you would observe and formulate any reactions which take place when:—

(*a*) an excess of zinc is added to copper sulphate solution;

(*b*) crystalline copper nitrate is heated;

(*c*) magnesium is strongly heated in a current of carbon dioxide;

(*d*) some roll sulphur in a test tube is slowly heated up from room temperature to its boiling point and the tube then cooled slowly;

(*e*) an intimate mixture of iron filings with powdered sulphur is heated.

$NH_3 + HNO_3 \longrightarrow NH_4NO_3$

$Ca_3(PO_4)_2 + SiO_2 \longrightarrow 3CaSiO_3 + P_2O_5$

$Fe_2O_3 + H_2S \longrightarrow FeS + H_2O + S$

FeS

unpleasant smell

S1, les

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

SUMMER, 1959

CHEMISTRY

FRIDAY, *June* 19.—*Morning*, 9.30 *to* 12.30

Answer SIX *questions. Marks will be given for correct equations and for good diagrams, where these add to the clearness of the answer.*

Credit will be given for good English and the orderly presentation of material; candidates who neglect these essentials will be penalised.

1. State Avogadro's hypothesis.

Describe an experiment showing that carbon dioxide contains its own volume of oxygen.

50 cc. of a gas mixture containing carbon monoxide, carbon dioxide and nitrogen were shaken with caustic potash and the residual volume was 36 cc. To this residual mixture of gases was added 20 cc. (an excess) of oxygen and it was exploded by sparking. After cooling the new volume was 48 cc. Assuming all volumes were measured at the same room temperature and pressure, calculate the composition of the original mixture.

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C.P. 58/1565 6/2/21M

[P.T.O.

3. Explain the following facts giving equations where possible:—

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What volume of deci-normal nitric acid would be required to react with 380 cc. of ammonia gas measured at 27°C and 672 mms. pressure, and what weight of ammonium nitrate would be formed?

[H=1: N=14: O=16. The gram-molecular volume of a gas is 22·4 litres at N.T.P.].

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UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

SUMMER, 1959

CHEMISTRY

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Starting with one of them, how would you prepare in the laboratory (*a*) slaked lime, (*b*) calcium sulphate, (*c*) a solution of calcium bicarbonate.

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(*d*) some roll sulphur in a test tube is slowly heated up from room temperature to its boiling point and the tube then cooled slowly;

(*e*) an intimate mixture of iron filings with powdered sulphur is heated.

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

JANUARY, 1959

CHEMISTRY

FRIDAY, January 16.—Morning, 9.30 *to* 12.30

[*Attempt* SIX *questions. Answer concisely. Marks will be given for correct equations and also for good diagrams, where these add to the clearness of the answer.*]

1. Describe *laboratory* experiments by which you could obtain:—

(*a*) pure water from salt water,

(*b*) rhombic sulphur crystals from a mixture of iron filings, sulphur and potassium nitrate.

Describe how you could convert the rhombic sulphur to monoclinic (prismatic) sulphur.

2. State Gay-Lussac's law (the law of gaseous volumes) and describe fully any *one* experiment to illustrate it.

Deduce the relationship between the vapour density of a substance and its molecular weight, stating clearly any assumptions made.

When 4·73 gm. of a solid was heated, the residue weighed 4·10 gm. and 320 cc. of a gas (measured at N.T.P.) was evolved. Calculate the molecular weight of the gas.

[1,000 cc. hydrogen at N.T.P. weigh ·09 gm.]

3. Define the terms (*a*) saturated solution, (*b*) "hardness" of water, (*c*) water of crystallisation.

Describe how you would determine experimentally (i) the ratio of permanent to temporary hardness in a sample of water, (ii) the percentage of water of crystallisation in a hydrated salt.

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

SUMMER, 1958

CHEMISTRY

FRIDAY, June 20.—*Morning*, 9.30 *to* 12.30

[*Attempt* SIX *questions. Answer concisely. Marks will be given for correct equations and also for good diagrams, where these add to the clearness of the answer.*]

1. Write down *three* chemical properties characteristic of non-metals, illustrating your statements by taking carbon as a typical non-metal.

Name *three* different allotropic forms of carbon and give *one* important use of each.

Describe fully an experiment to show that each of these forms actually consists of carbon.

Give the reactions of carbon with (*a*) steam, and (*b*) ferric oxide.

2. Describe a common laboratory method of preparing and collecting a few jars of oxygen.

Outline how oxygen can be obtained on a large scale industrially and give *two* uses of it.

How can a sample of ozonised oxygen be obtained in the laboratory? Describe *two* tests by which the presence of ozone is indicated.

3. Define the term "equivalent weight" of an element.

Describe *one* laboratory experiment by which you could determine the equivalent weight of zinc, explaining how you would calculate the result.

1·50 gm. of a solid acid was dissolved in water and its solution made up to 250 cc. If 30·2 cc. of this acid solution neutralised 25 cc. of 0·115 N potassium hydroxide solution, calculate the equivalent weight of the acid.

4. Describe how hydrogen sulphide is usually prepared and collected in the laboratory. State its main physical properties.

Describe the reactions which take place when hydrogen sulphide is passed through aqueous solutions of (*a*) copper sulphate, (*b*) ferric chloride, (*c*) sulphur dioxide.

5. Outline *three* methods by which you could prepare cupric oxide from copper in the laboratory.

Describe fully two laboratory experiments which would enable you to show that the substance formed is cupric oxide.

6. Describe in detail all that you would observe, formulating the reactions which take place, when the following are heated:—

(*a*) ferrous sulphate crystals, (*b*) zinc carbonate, (*c*) lead nitrate, (*d*) mercuric oxide.

7. Give labelled diagrams showing the apparatus and materials you would use to prepare and collect from ammonium chloride (*a*) ammonia, (*b*) chlorine.

Describe how you would show experimentally that ammonia (i) burns in oxygen, (ii) is extremely soluble in water.

8. Describe simple *chemical* tests which would enable you to label correctly six test tubes containing the following solids: common salt, slaked lime, chalk, sodium sulphate, calcium nitrate and sodium nitrate.

9. Write down *four* properties you expect an acid to possess.

Describe in detail how you would prepare in the laboratory crystals of (*a*) zinc sulphate from zinc, (*b*) potassium nitrate from potassium hydroxide solution, (*c*) sodium carbonate from sodium.

10. What are the chief constituents of (*a*) water gas, (*b*) producer gas, (*c*) coal gas?

Without giving technical details, indicate the reactions by which water gas and producer gas are made, stating the conditions necessary for the reactions to take place.

How is hydrogen made on a large scale from water gas? Give *three* important commercial uses of hydrogen.

4. Describe experiments which show how the elements sodium, magnesium, and iron react with water or steam.

The reaction with iron is said to be "reversible". Explain what is meant by this statement and outline how you would show experimentally that it is true.

5. Describe how you would prepare in the laboratory (*a*) sulphur dioxide from sulphuric acid, (*b*) sulphur trioxide from sulphur dioxide.

State the reactions of dilute sulphuric acid on (i) black copper (cupric) oxide, (ii) sodium carbonate, and of concentrated sulphuric acid on (iii) sodium nitrate, (iv) oxalic acid.

6. With the aid of *one* experiment in each case, explain and illustrate the following terms: (*a*) sublimation, (*b*) deliquescence, (*c*) gaseous diffusion, (*d*) supersaturation.

7. Starting with common salt, how would you obtain in the laboratory (*a*) a few jars of hydrogen chloride, (*b*) concentrated hydrochloric acid, (*c*) a few jars of chlorine free from hydrogen chloride?

Explain the bleaching action of chlorine and contrast it with the bleaching action of sulphur dioxide.

8. What do you understand by "electrolysis"? Describe and explain how electrolysis can be used to purify impure copper.

State Faraday's laws of electrolysis.

The same quantity of electricity was passed through three voltameters, depositing copper in the first, silver in the second and liberating 200 cc. of hydrogen (measured at N.T.P.) in the third. Calculate the weights of copper and silver deposited.

[1 litre of hydrogen at N.T.P. weighs 0·09 gm.; equivalent weights, Cu = 31·8, Ag = 108.]

9. Describe the laboratory preparation and collection of nitric oxide.

How would you (*a*) distinguish nitric oxide from nitrous oxide, (*b*) remove some nitric oxide present as an impurity in nitrous oxide, (*c*) obtain nitrogen from nitric oxide?

10. Give an account of *one* method for the large scale production of washing soda from common salt.

Describe laboratory experiments by which washing soda can be converted to (*a*) a solution of caustic soda, (*b*) solid sodium bicarbonate.

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

AUTUMN, 1957

CHEMISTRY

FRIDAY, November 22.—*Morning*, 9.30 *to* 12.30

[*Attempt* SIX *questions. Answer concisely. Marks will be given for correct equations and also for good diagrams, where these add to the clearness of the answer.*]

1. Give definitions of the terms *saturated solution* and *solubility*.

Describe an experiment by which you could find the solubility of potassium nitrate in water at room temperature fairly accurately.

How would you show that tap water contains dissolved air? State how you would expect the composition of this "air" to differ from that of ordinary air, giving your reasons.

2. Describe all that you would observe and formulate the reactions which take place in *four* of the following, giving equations:

(*a*) a small piece of sodium is put into cold water;

(*b*) magnesium is strongly heated in a current of carbon dioxide;

(*c*) hydrogen sulphide is passed through ferric chloride solution;

(*d*) a burning candle is lowered into a jar of chlorine;

(*e*) solutions of hydrogen sulphide and sulphur dioxide are mixed.

3. Analysis of different samples of lead oxides gave the following results:

(*a*) 4·46 gm. of oxide contained 4·14 gm. of lead;

(*b*) 4·18 gm. of oxide contained 0·56 gm. of oxygen;

(*c*) 10·04 gm. of oxide contained 9·32 gm. of lead.

Calculate (to one decimal place) the equivalent of lead in each sample. Show how these equivalents illustrate two laws of chemistry, and state the two laws.

Calculate the simplest formula for the oxide (*b*).

(Pb = 207; O = 16).

4. Explain briefly how you would obtain a sample of any *four* of the following substances in the laboratory, describing the chemical or physical processes involved:

(*a*) sodium chloride from sodium hydroxide;

(*b*) a solution of sodium hydroxide from sodium carbonate;

(*c*) monoclinic (prismatic) sulphur from flowers of sulphur;

(*d*) carbon monoxide from carbon dioxide;

(*e*) precipitated chalk from quick lime.

5. Describe experiments by which you could show that:

(*a*) sulphuric acid is a dehydrating agent;

(*b*) chlorine is an oxidising agent;

(*c*) carbon dioxide contains its own volume of oxygen.

Explain how you could use the result in (*c*) to deduce the formula for carbon dioxide, knowing its vapour density.

6. Describe how nitric acid is usually prepared in the laboratory.

Outline the modern method by which this acid is now manufactured from ammonia.

What reactions take place when nitric acid acts upon

(*a*) sulphur,

(*b*) potassium iodide, and

(*c*) ferrous chloride in the presence of dilute hydrochloric acid?

State the conditions necessary for these reactions.

7. What properties do you regard as characteristic of (*a*) an acid, (*b*) a base? As many properties as possible should be included.

Describe in detail how you would (i) convert some metallic copper completely to a base, and (ii) form crystals of a copper salt from the base so obtained.

8. Given supplies of sodium nitrate, ammonium sulphate and slaked lime, outline how you could obtain four different gases. Water may be used, where needed, but no other reagents. Give equations for all reactions.

Describe *two* reactions or properties for each of the gases so prepared such that each could be distinguished from the others.

9. Give *three* chemical and *two* physical properties of phosphorus which you think support its classification as a non-metal.

How may yellow phosphorus (*a*) be obtained from calcium phosphate, (*b*) be converted to red phosphorus?

Name *three* respects in which the red and yellow forms show marked differences in behaviour.

State *one* use for phosphorus pentoxide and *one* use for calcium superphosphate.

10. Describe *one* experiment in each case to show

(*a*) that gases diffuse,

(*b*) that the rate of diffusion depends on the density of the gas.

State Graham's Law of diffusion of gases.

It was found that 5 cc. of a gas diffuse in half the time required for the diffusion of 15 cc. of oxygen under the same conditions. Calculate the molecular weight of the gas.

(O = 16).

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

SUMMER, 1955

CHEMISTRY

WEDNESDAY, June 15.—*Morning,* 9.30 *to* 12.30

[*Attempt* SIX *questions. Answer concisely. Marks will be given for correct equations and also for sketches, where these add to the clearness of the answer.*]

1. Describe *chemical* tests, *two* in each case, that would distinguish between: (*a*) nitrogen and carbon dioxide, (*b*) oxygen and nitrous oxide, (*c*) hydrogen and carbon monoxide.

Which of these six gases are *both* heavier than air *and* fairly soluble in cold water? Which of them can be used as reducing agents?

2. In *four* of the following pairs of terms, distinguish carefully between the terms in each pair and explain the meaning of each term: (*a*) *atom* and *ion,* (*b*) *evaporation* and *distillation* of a solution, (*c*) *hydrocarbon* and *carbohydrate,* (*d*) *hydrate* and *hydroxide,* (*e*) *acid salt* and *normal salt.*

3. Describe how you would obtain a sample of nitric acid from sodium nitrate. Give a sketch of the apparatus you would use.

State briefly how this acid is obtained on a commercial scale from ammonia.

State very briefly, without sketches, how you would obtain from nitric acid samples of (*a*) oxygen, (*b*) nitric oxide, (*c*) nitrogen tetroxide, N_2O_4.

4. A blue crystalline substance was gently heated in a hard-glass tube. Moisture was seen to condense on the side of the tube, and the substance lost its crystalline shape and blue colour. When heated more strongly, the residue darkened in colour, and dense white fumes were evolved.

A solution of the original substance was made in distilled water, and successive portions reacted as follows:—

(*a*) caustic soda solution produced a light blue gelatinous precipitate that turned black when the mixture was heated;

(*b*) sodium carbonate solution produced a greenish-blue precipitate;

(*c*) ammonia solution (·88) first produced a light blue precipitate that dissolved in an excess of the reagent giving a deep blue coloured solution;

(*d*) barium chloride solution produced a white precipitate that proved to be insoluble in an excess of hydrochloric acid.

Give the chemical name and formula of the original blue crystalline substance, and account for all the changes described giving equations where possible.

5. Name *three* solid non-metallic elements that are practically insoluble in cold water, and in each case name a liquid that will dissolve the element without changing it chemically.

Define "solubility" of a substance and describe how you would determine the solubility of potassium chloride in water at 60°C.

6. Given a piece of sodium about the size of a pea, state clearly how you would safely prepare from it first a dilute solution of sodium hydroxide, and then, from this, a sample of pure common salt.

Outline the most interesting properties, both physical and chemical, of metallic sodium.

7. What volume of oxygen (calculated at N.T.P.) may be obtained by heating 4·9 gm. of potassium chlorate fairly strongly until decomposition is complete? What would be the weight and chemical nature of the residue? How would the reaction be affected if some manganese dioxide were previously mixed with the chlorate?

What would be evolved if a little concentrated sulphuric acid were warmed with (*a*) the residue after the chlorate alone had been decomposed, and (*b*) the residue after the mixture of chlorate and dioxide had ceased to give oxygen? Give equations where possible.

$K = 39$, $Cl = 35{\cdot}5$, $O = 16$: 1 gram molecule of oxygen occupies 22·4 litres at N.T.P.

8. What uses of sulphur make this element of commercial importance? How would you prepare in the laboratory from ordinary rhombic sulphur (*a*) monoclinic (prismatic) sulphur, (*b*) plastic sulphur, (*c*) sulphurous acid solution?

Name, and describe briefly, the allotropic forms of *two* other elements.

9. What materials and apparatus would you require, and what method would you use, to determine *three* of the following:—

(*a*) the concentration of bench dilute hydrochloric acid;

(*b*) the percentage by weight of water in pure crystalline barium chloride;

(*c*) the percentage by volume of oxygen in the air;

(*d*) the relative hardness of two different waters?

10. Describe the flame produced by a bunsen burner when its air-hole is open. Account, as fully as you can, for what is observed when the air-hole is slowly closed. Under what conditions does a burner "strike back"? Describe an experiment to show that it is possible to burn air in an atmosphere of coal-gas.

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

SUMMER, 1955

CHEMISTRY

WEDNESDAY, June 15.—*Morning,* 9.30 *to* 12.30

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C.P. 54/1804 5/2/14M

[P.T.O.

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What would be evolved if a little concentrated sulphuric acid were warmed with (*a*) the residue after the chlorate alone had been decomposed, and (*b*) the residue after the mixture of chlorate and dioxide had ceased to give oxygen? Give equations where possible.

K=39, Cl=35·5, O=16: 1 gram molecule of oxygen occupies 22·4 litres at N.T.P.

8. What uses of sulphur make this element of commercial importance? How would you prepare in the laboratory from ordinary rhombic sulphur (*a*) monoclinic (prismatic) sulphur, (*b*) plastic sulphur, (*c*) sulphurous acid solution?

Name, and describe briefly, the allotropic forms of *two* other elements.

9. What materials and apparatus would you require, and what method would you use, to determine *three* of the following:—

(*a*) the concentration of bench dilute hydrochloric acid;

(*b*) the percentage by weight of water in pure crystalline barium chloride;

(*c*) the percentage by volume of oxygen in the air;

(*d*) the relative hardness of two different waters?

10. Describe the flame produced by a bunsen burner when its air-hole is open. Account, as fully as you can, for what is observed when the air-hole is slowly closed. Under what conditions does a burner "strike back"? Describe an experiment to show that it is possible to burn air in an atmosphere of coal-gas.

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

AUTUMN, 1955

CHEMISTRY

WEDNESDAY, November 16.—*Morning,* 9.30 *to* 12.30

[*Attempt* SIX *questions. Answer concisely. Marks will be given for correct equations and also for sketches, where these add to the clearness of the answer.*]

1. How would you obtain crystals of Epsom salt from a mixture of Epsom salt and sand?

From this salt ($MgSO_4.7H_2O$) how would you prepare (*a*) magnesium hydroxide, (*b*) magnesium oxide?

How would you show that Epsom salt (*c*) contains water of crystallisation, (*d*) is a sulphate?

2. Give a labelled diagram of the apparatus you would use to produce some jars of dry ammonia, and describe the reaction involved.

How would you demonstrate the great solubility of the gas in water?

What are the reactions beween ammonia and (*a*) hydrogen chloride, (*b*) hot copper oxide?

3. Describe the Frasch method of extracting sulphur from the underground deposits in Texas and Louisiana.

Describe and explain what happens when hydrogen sulphide is passed (*a*) into bromine water, (*b*) into a solution of sulphur dioxide, (*c*) over paper moistened with lead acetate solution.

C.P. 54/1805 5/2/51C

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4. Describe how you would prepare specimens of *three* of the following substances:—

(*a*) zinc sulphate crystals from zinc carbonate;

(*b*) caustic soda from sodium carbonate solution;

(*c*) copper sulphide from copper carbonate;

(*d*) silica from sodium silicate (water glass).

5. Draw a labelled diagram of a Kipp's apparatus suitably charged to prepare carbon dioxide. Give the equation for the reaction.

How does carbon dioxide react with (*a*) hot caustic soda solution, (*b*) red hot carbon?

What would be the volume at 17°C. and 720 mms. of a quantity of carbon dioxide the volume of which was 560 c.c. at N.T.P.?

6. Briefly describe the reactions between:—

(*a*) potassium bromide and concentrated sulphuric acid;

(*b*) hydrogen peroxide and freshly precipitated lead sulphide;

(*c*) tin and concentrated nitric acid;

(*d*) ferric oxide and carbon monoxide.

In each case state which substance (if either) acts as an oxidising agent, and give your reason.

7. Of the following substances name *three* that are elements: quicklime, quicksilver, oleum, argon, ice, silica, red lead, graphite.

Say how you would prepare from lead nitrate a specimen of each of the elements it contains.

8. Draw a labelled diagram of the apparatus you would use to produce from hydrochloric acid some jars of pure, dry chlorine. Give the equation for the reaction.

What reactions occur between chlorine and (*a*) a solution of potassium iodide, (*b*) a cold solution of caustic soda, (*c*) red hot iron, (*d*) a burning candle?

9. Give simple chemical explanations of the following facts:—

(*a*) zinc oxide is classed as an amphoteric oxide;

(*b*) common bottle glass is frequently green;

(*c*) sodium is usually kept under naphtha;

(*d*) it is unwise to allow mercury to fall into a sink drained by a lead pipe;

(*e*) gunpowder is made using potassium nitrate although the corresponding sodium salt contains more oxygen and is cheaper.

10. Arrange chalk, calcium chloride, and gypsum in order of decreasing solubility.

How would you make a rough comparison of the hardness of samples of two waters?

Starting with lime water how would you prepare some water with temporary hardness?

Write equations for the reaction between calcium hydroxide and (*a*) hydrochloric acid, (*b*) nitric acid.

In titrating lime water with standard acid, 50 c.c. of the lime water required 35 c.c. of 0·06 N. acid for neutralisation. Calculate the normality of the lime water, and also its concentration in grams of calcium hydroxide per litre.

($H=1$; $O=16$; $Ca=40$).

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

SUMMER, 1954

CHEMISTRY

Examiners:
H. J. CAVELL, Esq., M.SC., PH.D.
J. H. WHITE, Esq., M.SC., PH.D.

THURSDAY, June 17.—*Morning*, 9.30 *to* 12.30

[*Answer concisely and attempt* SIX *questions. Marks will be given for correct equations and also for sketches, where these add to the clearness of the answer.*]

1. Describe an experiment to determine the composition of water by weight. Sketch the apparatus, and mention the weighings you would make and the deductions you would draw.

What is the action of water on (*a*) calcium, (*b*) calcium carbide, (*c*) phosphorus trichloride?

2. Give a labelled diagram of the apparatus you would use to prepare and collect some jars of hydrogen. Give an equation.

How would you show that hydrogen diffuses more rapidly than air? Sketch the apparatus.

Calculate the equivalent weight of the metal 1·3 gm. of which displace 448 c.c. of hydrogen at N.T.P.

What would be the volume of this hydrogen at 17°C. and 740 mm.?

[1 gm. mol. of any gas occupies 22·4 litres at N.T.P.]

3. How would you prepare some jars of pure, dry chlorine from common salt?

How is chlorine used to manufacture (*a*) hydrochloric acid and (*b*) bleaching powder?

Describe the action of chlorine on aqueous solutions of (*c*) sodium iodide and (*d*) hydrogen sulphide.

4. Name *three* naturally occurring forms of calcium carbonate.

From marble chippings how would you obtain specimens of: (*a*) quick lime, (*b*) anhydrous calcium chloride, (*c*) calcium sulphate?

From pieces of quick lime how would you prepare: (*d*) slaked lime, (*e*) milk of lime, (*f*) lime water?

5. Describe how you would prepare:—
(*a*) red phosphorus from yellow phosphorus;
(*b*) phosphorus trichloride from red phosphorus. (Give a diagram);
(*c*) a solution of phosphoric acid from calcium phosphate, $Ca_3(PO_4)_2$.

What deduction concerning the number of atoms in the molecule of phosphorus can be made from the fact that the vapour density of phosphorus is 62?

Calculate the weight of phosphorus contained in 50 gm. of calcium phosphate.

[O=16 P=31 Ca=40.]

6. Pig iron may be made from haematite (Fe_2O_3) in a blast furnace. Name the other materials put into the furnace, and outline the chemical reactions in which they take part.

From iron filings how would you prepare specimens of (*a*) ferrous sulphide and (*b*) triferric tetroxide?

Describe the effect of hydrochloric acid on these two substances.

7. Describe the action of heat on the following substances mentioning any colour changes that occur and giving equations for any chemical decompositions that take place:—

(*a*) zinc carbonate, (*b*) lead dioxide, (*c*) washing soda, (*d*) potassium nitrate, (*e*) hydrated copper nitrate, (*f*) gelatinous silicic acid.

8. How would you prepare a dilute solution of hydrogen peroxide?

Describe the reactions that occur between hydrogen peroxide and (*a*) freshly precipitated lead sulphide, (*b*) a solution of hydriodic acid, (*c*) a solution of sulphurous acid, (*d*) a solution of ferrous sulphate acidified with sulphuric acid.

9. Describe briefly the ammonia-soda process for the manufacture of sodium bicarbonate.

What is the effect of carbon dioxide on (*a*) a cold concentrated solution of caustic soda, (*b*) a hot solution of caustic soda?

A solution of sodium bicarbonate (10·08 gm. per litre) is titrated with dilute sulphuric acid: 25 c.c. of the alkali require 15 c.c. of the acid. Calculate the normality and concentration of the acid.

[C=12 O=16 Na=23 S=32.]

10. Explain what is meant by the following terms, and give *one* example of each: (*a*) double decomposition, (*b*) catalytic decomposition, (*c*) thermal dissociation, (*d*) incandescence, (*e*) exothermic reaction, (*f*) a hydrocarbon.

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

SUMMER, 1953

CHEMISTRY

Examiners:

W. CAMERON WALKER, Esq., M.SC., PH.D.
H. J. CAVELL, Esq., M.SC., PH.D.

WEDNESDAY, June 17.—*Morning,* 9.30 *to* 12.30

[*Answer concisely and attempt* SIX *questions. Marks will be given for correct equations and also for sketches, where these add to the clearness of the answer.*]

1. Describe the laboratory preparation and collection of *either* (*a*) hydrogen, *or* (*b*) oxygen, mentioning any necessary precaution in the experiment you describe.

Draw a labelled diagram of the apparatus you would use to obtain a small quantity of water from hydrogen.

What *three* tests would enable you to identify the product as water?

Describe a simple *chemical* method of obtaining a test-tube full of hydrogen from cold water.

2. Arrange the following elements in parallel columns headed (*a*) metals, (*b*) non-metals: calcium, carbon, chlorine, iodine, iron, lead, nitrogen and zinc.

Describe the laboratory preparation and collection in a pure condition of one *gaseous* non-metal in the above list. Give *one* important industrial use of the gas you have chosen.

Starting with *one* of the metals listed, describe how you would prepare a pure dry sample of an oxide of the metal.

3. If you were provided with some marble chips, describe carefully each stage in the process you would use to prepare a specimen of pure dry precipitated chalk.

How would you use this chalk to prepare a specimen of hard water which contains both temporary and permanent hardness?

Write equations (no description is required) to show what happens when:—

(*a*) slaked lime is added to temporarily hard water,

(*b*) soap solution is added to permanently hard water.

4. Describe the experiments you would carry out to obtain from nitric acid, samples of (*a*) hydrogen, (*b*) oxygen, (*c*) nitrogen.

Explain why rain falling during a thunderstorm contains traces of nitric acid.

5. Why is strong ammonia solution termed "880 ammonia"?

Given 880 ammonia, how would you prepare and collect

(*a*) dry ammonia gas?

Given also nitric acid, how would you prepare a sample of

(*b*) laughing gas?

Carefully describe how you would verify *one* of the following statements:—

(*c*) dry ammonia contains hydrogen and nitrogen.

(*d*) laughing gas is an oxide of nitrogen.

6. Given some metallic copper, how would you prepare:—

(*a*) copper nitrate crystals from the metal,

(*b*) cupric oxide from the nitrate,

(*c*) copper sulphate crystals from the oxide.

Give equations for the reactions you describe.

If you used 10 gm. of copper in (*a*) and the whole of this was eventually turned into copper sulphate crystals ($CuSO_4.5H_2O$) what weight of crystals, to the nearest gram, would you obtain?

2·88 gm. of red oxide of copper (cuprous oxide) when reduced leaves 2·56 gm. of copper. Calculate (*d*) the equivalent weight, (*e*) the valency of copper in cuprous oxide.

(H=1; O=16; S=32; Cu=64.)

7. Give the formulæ and chemical names of (*a*) caustic soda, (*b*) washing soda, (*c*) baking soda.

How could you prepare crystals of washing soda from caustic soda?

Write equations to show what happens when:—

(*d*) caustic soda is heated with silica,

(*e*) washing soda crystals are strongly heated alone,

(*f*) a solution of baking soda is warmed.

Name the product in each case.

What happens when dilute hydrochloric acid is added to a solution of the product obtained in (*d*)?

8. If you were given three unlabelled bottles containing the three common dilute acids, what simple tests would you apply to identify the contents of each bottle?

How would you proceed to find by means of a normal solution of caustic soda, the normality of one of the acid solutions?

If 25 cc. of any one of the acids required 20 cc. of the caustic soda solution for neutralisation, what is the normality of each acid and what weight per litre of HCl, H_2SO_4 and HNO_3 respectively do the solutions contain?

(H=1; O=16: N=14; S=32: Cl=35·5).

9. Define the term allotrope.

Describe how you would convert (*a*) rhombic sulphur to plastic sulphur, (*b*) red phosphorus to white phosphorus, (*c*) oxygen to ozone. Give diagrams.

Mention an important everyday use, *one* for each, of sulphur, phosphorus and ozone.

10. Describe and explain what happens when:—

(*a*) copper sulphate solution is electrolysed between copper electrodes,

(*b*) dilute sulphuric acid is electrolysed between lead electrodes.

Mention important applications of (*a*) and (*b*).

If the two solutions are electrolysed for the same time, by connecting the electrodes in series, what volume of hydrogen at N.T.P. is liberated in (*b*) when 0·16 gm. of copper is deposited in (*a*)?

(H=1; Cu=64; 1 gram molecule of any gas at N.T.P. occupies 22·4 litres.)

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

AUTUMN, 1952

CHEMISTRY

Examiners:

W. CAMERON WALKER, Esq., M.Sc., Ph.D.
J. H. DAVIES, Esq., Ph.D.

WEDNESDAY, November 19.—*Morning*, 9.30 *to* 12.30

[*Answer concisely and attempt* SIX *questions. Marks will be given for correct equations and also for sketches, where these add to the clearness of the answer.*]

1. Write an account of the effect of heat on: (*a*) potassium chlorate, (*b*) sodium bicarbonate, (*c*) sodium nitrate, (*d*) ammonium nitrate, (*e*) copper nitrate, (*f*) temporarily hard water.

What is the effect of passing pure dry hydrogen over a sample of the residue in (*e*) heated strongly?

2. State (*a*) the law of Definite Proportions and (*b*) the law of Multiple Proportions.

Explain carefully how you would show experimentally EITHER (*c*) that the law of Definite Proportions applies to the compound magnesium oxide, OR (*d*) that the quantitative composition of two oxides of any metal with which you are familiar afford an example of the law of Multiple Proportions.

3. What do you understand by an ACID and an ACID SALT? Give *one* example of each.

How would you show by experiment that sulphuric acid has a basicity of at least 2?

Describe the preparation of a dry crystalline specimen of ferrous sulphate from iron.

What is the effect of heat on ferrous sulphate crystals, and to what use is the residue put?

4. Indicate briefly, giving equations, how you would obtain: (*a*) chlorine from common salt, (*b*) oxygen from bleaching powder, (*c*) lead from red lead, (*d*) nitrogen from nitric acid, (*e*) hydrogen from steam.

5. Describe an experiment to show that the terms "combustible substance" and "supporter of combustion" are interchangeable, e.g., in the interaction between coal gas and air. Hence define the term flame.

Explain briefly:—

(*a*) why a bunsen burner strikes back under certain conditions,

(*b*) why a non-luminous bunsen flame is cleaner and hotter than the luminous flame,

(*c*) how a non-luminous bunsen flame may be rendered luminous without closing the air-hole of the burner.

6. Describe a laboratory preparation of a specimen of dry hydrogen sulphide, starting from sulphur.

How and under what conditions does this gas react with (*a*) copper sulphate, (*b*) air in limited quantity, (*c*) sulphur dioxide, (*d*) ferric chloride?

7. Describe and explain what happens when concentrated sulphuric acid reacts with (*a*) sodium nitrate, (*b*) oxalic acid, (*c*) copper sulphate crystals, (*d*) carbon.

What is seen to happen, and why, when a mixture of sodium nitrate, copper filings and concentrated sulphuric acid is slightly heated?

8. Describe the laboratory preparation of a pure dry specimen of ammonia. How is ammonia recovered as a by-product in the manufacture of coal gas?

How and under what conditions does ammonia react with (*a*) chlorine, (*b*) heated copper oxide, (*c*) an aqueous solution of a ferric salt?

9. Define the Equivalent Weight of an element. How is the Equivalent Weight related to the Atomic Weight?

An element M has an atomic weight of 27 and an equivalent weight of 9. Write down the formulæ for its oxide and its sulphate.

An electric current was passed through two voltameters in series containing respectively copper sulphate solution and water rendered slightly acid by sulphuric acid. After the current had passed for a certain time 0·248 gm. of copper had been deposited on the cathode and 94 c.c. of hydrogen, measured at 15°C. and 740 mm. pressure had been liberated. Calculate the Equivalent Weight of copper.

[1 litre of hydrogen at N.T.P. weighs 0·09 gm.]

10. What is the chemical formula of silica? Name *two* varieties of silica which are found in nature.

What reasons have you for regarding silica as an acid-forming oxide? How would you prepare in the laboratory solution of silicic acid? Give details.

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

SUMMER, 1952

CHEMISTRY

Examiners:

W. CAMERON WALKER, Esq., M.Sc., Ph.D.

J. H. DAVIES, Esq., Ph.D.

WEDNESDAY, June 11.—*Morning,* 9.30 *to* 12.30

[*Answer concisely and attempt* SIX *questions. Marks will be given for correct equations and also for sketches, where these add to the clearness of the answer.*]

1. How would you prepare and collect a sample of pure water from tap water?

Describe the tests you would make to determine whether a sample of tap water contains permanent hardness. If it does, how would you find whether the hardness is due to dissolved sulphate?

Starting from distilled water and being provided with a supply of carbon dioxide and quicklime, how would you make a sample of temporarily hard water? What is the chemical reaction that occurs when soap solution is added gradually to temporarily hard water and what change is visible?

2. Describe the laboratory preparation and collection of pure dry chlorine.

How would you prepare from chlorine (*a*) hydrogen chloride, (*b*) ferric chloride, (*c*) bleaching powder?

What is the action (*d*) of ammonia gas on hydrogen chloride, (*e*) of ammonia solution on aqueous ferric chloride and (*f*) of hydrochloric acid on bleaching powder?

3. How would you prepare and collect some jars of nitric oxide?

State and explain what happens when nitric oxide is (*a*) passed through ferrous sulphate solution, (*b*) passed over red-hot copper, (*c*) mixed with oxygen. Describe the experiments you would perform to identify the gas produced in (*b*).

Describe and explain what occurs when the product in (*c*) is shaken up with water containing blue litmus.

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4. Explain what happens when a direct current is passed through:

(*a*) dilute sulphuric acid between platinum electrodes,

(*b*) aqueous caustic soda between platinum electrodes,

(*c*) copper sulphate solution between copper electrodes.

What *total* volume of gas, measured at N.T.P., would be liberated from dilute sulphuric acid by the current which, flowing for the same time, deposits 0·315 gm. of copper from copper sulphate solution?

(Gram molecular volume = 22·4 litres at N.T.P.; H = 1, Cu = 63)

5. How would you show that:

(*a*) sulphur dioxide is an acidic oxide,

(*b*) magnesium oxide is a basic oxide,

(*c*) zinc oxide is both basic and acidic?

How would you obtain:

(*d*) sulphur dioxide from sodium sulphite,

(*e*) magnesium oxide from magnesium nitrate,

(*f*) zinc oxide from zinc chloride?

6. Define the terms atom, molecule, atomic weight, and molecular weight.

State Avogadro's hypothesis and make use of it to deduce the relation between molecular weight and relative density.

Calculate the relative densities of *three* gases which are too soluble to be collected over water and show by simple diagrams how each gas should be collected by air displacement.

(Relative density of air = 14·4: H = 1, O = 16, C = 12, S = 32, N = 14, Cl = 35·5)

7. What do you understand by a normal solution of (*a*) an acid, (*b*) an alkali?

Given a supply of pure dry sodium carbonate and a standard solution of an acid, describe in detail how you would determine the weight of sodium hydroxide contained in a litre of a given solution of that substance.

A solution of caustic soda contains 49 gm. of sodium hydroxide per litre. How much water must be added to 100 c.c. of the solution to produce an accurately normal solution?

(H = 1, C = 12, N = 14, O = 16, Na = 23, S = 32, Cl = 35·5)

8. Given sal-ammoniac (ammonium chloride), sodium nitrite, and any other chemicals you require, how would you prepare and collect jars of (*a*) pure dry ammonia, (*b*) dry hydrogen chloride, (*c*) nitrogen? It will be sufficient to draw labelled diagrams of the apparatus in each preparation and to give the equations for the reactions which occur.

9. Describe the experiments you would carry out in the laboratory (*a*) to illustrate the contact process for preparing sulphuric acid, (*b*) to show that carbon dioxide is denser than hydrogen.

An aqueous solution may contain a salt of *one* of the metals iron, lead, or calcium. How would you find out which is present?

10. Name and give the formula for the principal source of phosphorus.

Describe the preparation of the element, giving equations for the several reactions which take place.

What evidence have we that yellow and red phosphorus are one and the same element?

Name *two* distinct uses of phosphorus in everyday life.

Starting from yellow phosphorus how would you prepare (*a*) red phosphorus, (*b*) phosphorus trichloride?

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

SUMMER, 1955

CHEMISTRY

WEDNESDAY, June 15.—*Morning,* 9.30 *to* 12.30

[*Attempt* SIX *questions. Answer concisely. Marks will be given for correct equations and also for sketches, where these add to the clearness of the answer.*]

1. Describe *chemical* tests, *two* in each case, that would distinguish between: (*a*) nitrogen and carbon dioxide, (*b*) oxygen and nitrous oxide, (*c*) hydrogen and carbon monoxide.

Which of these six gases are *both* heavier than air *and* fairly soluble in cold water? Which of them can be used as reducing agents?

2. In *four* of the following pairs of terms, distinguish carefully between the terms in each pair and explain the meaning of each term: (*a*) *atom* and *ion*, (*b*) *evaporation* and *distillation* of a solution, (*c*) *hydrocarbon* and *carbohydrate*, (*d*) *hydrate* and *hydroxide*, (*e*) *acid salt* and *normal salt*.

3. Describe how you would obtain a sample of nitric acid from sodium nitrate. Give a sketch of the apparatus you would use.

State briefly how this acid is obtained on a commercial scale from ammonia.

State very briefly, without sketches, how you would obtain from nitric acid samples of (*a*) oxygen, (*b*) nitric oxide, (*c*) nitrogen tetroxide, N_2O_4.

4. A blue crystalline substance was gently heated in a hard-glass tube. Moisture was seen to condense on the side of the tube, and the substance lost its crystalline shape and blue colour. When heated more strongly, the residue darkened in colour, and dense white fumes were evolved.

A solution of the original substance was made in distilled water, and successive portions reacted as follows:—

(*a*) caustic soda solution produced a light blue gelatinous precipitate that turned black when the mixture was heated;

(*b*) sodium carbonate solution produced a greenish-blue precipitate;

(*c*) ammonia solution (·88) first produced a light blue precipitate that dissolved in an excess of the reagent giving a deep blue coloured solution;

(*d*) barium chloride solution produced a white precipitate that proved to be insoluble in an excess of hydrochloric acid.

Give the chemical name and formula of the original blue crystalline substance, and account for all the changes described giving equations where possible.

5. Name *three* solid non-metallic elements that are practically insoluble in cold water, and in each case name a liquid that will dissolve the element without changing it chemically.

Define "solubility" of a substance and describe how you would determine the solubility of potassium chloride in water at 60°C.

6. Given a piece of sodium about the size of a pea, state clearly how you would safely prepare from it first a dilute solution of sodium hydroxide, and then, from this, a sample of pure common salt.

Outline the most interesting properties, both physical and chemical, of metallic sodium.

7. What volume of oxygen (calculated at N.T.P.) may be obtained by heating 4·9 gm. of potassium chlorate fairly strongly until decomposition is complete? What would be the weight and chemical nature of the residue? How would the reaction be affected if some manganese dioxide were previously mixed with the chlorate?

What would be evolved if a little concentrated sulphuric acid were warmed with (*a*) the residue after the chlorate alone had been decomposed, and (*b*) the residue after the mixture of chlorate and dioxide had ceased to give oxygen? Give equations where possible.

K = 39, Cl = 35·5, O = 16: 1 gram molecule of oxygen occupies 22·4 litres at N.T.P.

8. What uses of sulphur make this element of commercial importance? How would you prepare in the laboratory from ordinary rhombic sulphur (*a*) monoclinic (prismatic) sulphur, (*b*) plastic sulphur, (*c*) sulphurous acid solution?

Name, and describe briefly, the allotropic forms of *two* other elements.

9. What materials and apparatus would you require, and what method would you use, to determine *three* of the following:—

(*a*) the concentration of bench dilute hydrochloric acid;

(*b*) the percentage by weight of water in pure crystalline barium chloride;

(*c*) the percentage by volume of oxygen in the air;

(*d*) the relative hardness of two different waters?

10. Describe the flame produced by a bunsen burner when its air-hole is open. Account, as fully as you can, for what is observed when the air-hole is slowly closed. Under what conditions does a burner "strike back"? Describe an experiment to show that it is possible to burn air in an atmosphere of coal-gas.

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

SUMMER, 1955

CHEMISTRY

WEDNESDAY, June 15.—*Morning*, 9.30 *to* 12.30

[*Attempt* SIX *questions. Answer concisely. Marks will be given for correct equations and also for sketches, where these add to the clearness of the answer.*]

1. Describe *chemical* tests, *two* in each case, that would distinguish between: (*a*) nitrogen and carbon dioxide, (*b*) oxygen and nitrous oxide, (*c*) hydrogen and carbon monoxide.

Which of these six gases are *both* heavier than air *and* fairly soluble in cold water? Which of them can be used as reducing agents?

2. In *four* of the following pairs of terms, distinguish carefully between the terms in each pair and explain the meaning of each term: (*a*) *atom* and *ion*, (*b*) *evaporation* and *distillation* of a solution, (*c*) *hydrocarbon* and *carbohydrate*, (*d*) *hydrate* and *hydroxide*, (*e*) *acid salt* and *normal salt*.

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State briefly how this acid is obtained on a commercial scale from ammonia.

State very briefly, without sketches, how you would obtain from nitric acid samples of (*a*) oxygen, (*b*) nitric oxide, (*c*) nitrogen tetroxide, N_2O_4.

C.P. 54/1804 5/2/14M

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5. Name *three* solid non-metallic elements that are practically insoluble in cold water, and in each case name a liquid that will dissolve the element without changing it chemically.

Define "solubility" of a substance and describe how you would determine the solubility of potassium chloride in water at 60°C.

6. Given a piece of sodium about the size of a pea, state clearly how you would safely prepare from it first a dilute solution of sodium hydroxide, and then, from this, a sample of pure common salt.

Outline the most interesting properties, both physical and chemical, of metallic sodium.

7. What volume of oxygen (calculated at N.T.P.) may be obtained by heating 4·9 gm. of potassium chlorate fairly strongly until decomposition is complete? What would be the weight and chemical nature of the residue? How would the reaction be affected if some manganese dioxide were previously mixed with the chlorate?

What would be evolved if a little concentrated sulphuric acid were warmed with (*a*) the residue after the chlorate alone had been decomposed, and (*b*) the residue after the mixture of chlorate and dioxide had ceased to give oxygen? Give equations where possible.

$K=39$, $Cl=35{\cdot}5$, $O=16$: 1 gram molecule of oxygen occupies 22·4 litres at N.T.P.

8. What uses of sulphur make this element of commercial importance? How would you prepare in the laboratory from ordinary rhombic sulphur (*a*) monoclinic (prismatic) sulphur, (*b*) plastic sulphur, (*c*) sulphurous acid solution?

Name, and describe briefly, the allotropic forms of *two* other elements.

9. What materials and apparatus would you require, and what method would you use, to determine *three* of the following:—

(*a*) the concentration of bench dilute hydrochloric acid;

(*b*) the percentage by weight of water in pure crystalline barium chloride;

(*c*) the percentage by volume of oxygen in the air;

(*d*) the relative hardness of two different waters?

10. Describe the flame produced by a bunsen burner when its air-hole is open. Account, as fully as you can, for what is observed when the air-hole is slowly closed. Under what conditions does a burner "strike back"? Describe an experiment to show that it is possible to burn air in an atmosphere of coal-gas.

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

SUMMER, 1954

CHEMISTRY

Examiners:
H. J. CAVELL, Esq., M.Sc., Ph.D.
J. H. WHITE, Esq., M.Sc., Ph.D.

THURSDAY, June 17.—*Morning*, 9.30 *to* 12.30

[*Answer concisely and attempt* SIX *questions. Marks will be given for correct equations and also for sketches, where these add to the clearness of the answer.*]

1. Describe an experiment to determine the composition of water by weight. Sketch the apparatus, and mention the weighings you would make and the deductions you would draw.

What is the action of water on (*a*) calcium, (*b*) calcium carbide, (*c*) phosphorus trichloride?

2. Give a labelled diagram of the apparatus you would use to prepare and collect some jars of hydrogen. Give an equation.

How would you show that hydrogen diffuses more rapidly than air? Sketch the apparatus.

Calculate the equivalent weight of the metal 1·3 gm. of which displace 448 c.c. of hydrogen at N.T.P.

What would be the volume of this hydrogen at 17°C. and 740 mm.?

[1 gm. mol. of any gas occupies 22·4 litres at N.T.P.]

3. How would you prepare some jars of pure, dry chlorine from common salt?

How is chlorine used to manufacture (*a*) hydrochloric acid and (*b*) bleaching powder?

Describe the action of chlorine on aqueous solutions of (*c*) sodium iodide and (*d*) hydrogen sulphide.

4. Name *three* naturally occurring forms of calcium carbonate.

From marble chippings how would you obtain specimens of: (*a*) quick lime, (*b*) anhydrous calcium chloride, (*c*) calcium sulphate?

From pieces of quick lime how would you prepare: (*d*) slaked lime, (*e*) milk of lime, (*f*) lime water?

C.P. 53/1813 1050R

[P.T.O.

UNIVERSITY OF LONDON

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1. Describe an experiment to determine the composition of water by weight. Sketch the apparatus, and mention the weighings you would make and the deductions you would draw.
What is the action of water on (*a*) calcium, (*b*) calcium carbide, (*c*) phosphorus trichloride?

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C.P. 53/1813 1050R

[P.T.O.

5. Describe how you would prepare:—
(*a*) red phosphorus from yellow phosphorus;
(*b*) phosphorus trichloride from red phosphorus. (Give a diagram);
(*c*) a solution of phosphoric acid from calcium phosphate, $Ca_3(PO_4)_2$.
What deduction concerning the number of atoms in the molecule of phosphorus can be made from the fact that the vapour density of phosphorus is 62?
Calculate the weight of phosphorus contained in 50 gm. of calcium phosphate.
[O=16 P=31 Ca=40.]

6. Pig iron may be made from haematite (Fe_2O_3) in a blast furnace. Name the other materials put into the furnace, and outline the chemical reactions in which they take part.
From iron filings how would you prepare specimens of (*a*) ferrous sulphide and (*b*) triferric tetroxide?
Describe the effect of hydrochloric acid on these two substances.

7. Describe the action of heat on the following substances mentioning any colour changes that occur and giving equations for any chemical decompositions that take place:—
(*a*) zinc carbonate, (*b*) lead dioxide, (*c*) washing soda, (*d*) potassium nitrate, (*e*) hydrated copper nitrate, (*f*) gelatinous silicic acid.

8. How would you prepare a dilute solution of hydrogen peroxide?
Describe the reactions that occur between hydrogen peroxide and (*a*) freshly precipitated lead sulphide, (*b*) a solution of hydriodic acid, (*c*) a solution of sulphurous acid, (*d*) a solution of ferrous sulphate acidified with sulphuric acid.

9. Describe briefly the ammonia-soda process for the manufacture of sodium bicarbonate.
What is the effect of carbon dioxide on (*a*) a cold concentrated solution of caustic soda, (*b*) a hot solution of caustic soda?
A solution of sodium bicarbonate (10·08 gm. per litre) is titrated with dilute sulphuric acid: 25 c.c. of the alkali require 15 c.c. of the acid. Calculate the normality and concentration of the acid.
[C=12 O=16 Na=23 S=32.]

10. Explain what is meant by the following terms, and give *one* example of each: (*a*) double decomposition, (*b*) catalytic decomposition, (*c*) thermal dissociation, (*d*) incandescence, (*e*) exothermic reaction, (*f*) a hydrocarbon.

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What deduction concerning the number of atoms in the molecule of phosphorus can be made from the fact that the vapour density of phosphorus is 62?

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[O = 16   P = 31   Ca = 40.]

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[C = 12   O = 16   Na = 23   S = 32.]

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UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Advanced Level

SUMMER, 1954

CHEMISTRY.—II

Examiners:

A. G. FOSTER, Esq., B.A., B.Sc., PH.D.
J. H. STRAWSON, Esq., M.A., B.Sc.

THURSDAY, June 17.—*Afternoon*, 2 *to* 5

[*Candidates must answer* FIVE *questions and no more, of which* ONE *at least and* NOT *more than* TWO *must be from* SECTION A.
Definite chemical changes should be represented by equations and diagrams should be given wherever possible.]

SECTION A

11. What elements other than carbon and hydrogen are *commonly* found in organic compounds? Describe *qualitative* tests for each of these elements, indicating the essential reactions on which each test is based, and outline briefly how any *one* of them may be determined *quantitatively* when present in an organic compound.

12. Describe the laboratory preparation of acetaldehyde. How may this substance be purified?

Compare the reactions of (i) acetaldehyde and (ii) acetone with (*a*) acidified potassium dichromate, (*b*) sodium bisulphite, (*c*) ammonia.

T. & F.—53/1156 6/2/9000

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13. On combustion, 0·177 grams of an organic solid gave 0·264 grams of carbon dioxide and 0·135 grams of water. Treated by Dumas' method, 1·00 gram gave 209·0 c.c. of nitrogen measured at 20° C. and 740 mm. The original solid on treatment with nitrous acid gave a liquid of vapour density 30. Derive empirical and molecular formulae for the solid and describe briefly how it could be prepared in the laboratory.

Section B

14. State Avogadro's hypothesis. Under what conditions would you expect it to be exactly true ?

Outline the experimental and theoretical considerations which led to the conclusion that the hydrogen molecule contains two, and only two, atoms. What is the significance of this in connection with the determination of (*a*) molecular weights, (*b*) atomic weights ?

15. Describe a convenient laboratory method for the preparation of reasonably pure samples of (*a*) nitric oxide and (*b*) nitrogen peroxide.

Give examples showing how each of these substances may act both as a reducing agent and as an oxidising agent.

How has the volume composition and molecular formula of nitric oxide been established ?

16. Describe in detail how you would (*a*) prepare crystalline potassium permanganate from pyrolusite, (*b*) determine the percentage purity of your product.

How does an acidified solution of permanganate react with solutions of (*a*) hydrogen sulphide, (*b*) sulphur dioxide, (*c*) hydrogen peroxide ?

17. Describe and explain the uses of *four* of the following substances as reagents in qualitative analysis :—

(*a*) yellow ammonium sulphide,
(*b*) nitric acid,
(*c*) ammonium hydroxide,
(*d*) sulphuric acid,
(*e*) sodium carbonate.

18. Explain what is meant by the following statements:—

(*a*) the *pH* of 0·1 N acetic acid is 2·88,
(*b*) the *ionic product* of water at 25° C. is $1{\cdot}0 \times 10^{-14}$,
(*c*) the *dissociation constant* of ammonium hydroxide at 25° C. is $1{\cdot}8 \times 10^{-5}$.

Calculate the pH of the following solutions :—

(*d*) 2·0 N hydrochloric acid,
(*e*) 0·1 N sodium hydroxide.

19. How would you determine the molecular weight of a non-volatile substance by freezing-point measurements ? Indicate briefly the chief sources of error in the method described. A solution containing 2·0 g. of urea (mol. wt. 60) in 40 g. of water freezes at −1·55° C. Calculate the freezing-point depression constant for water (expressed as degrees per mole per 1000 grams). If the density of the solution is 1·02, what will be its osmotic pressure at 25° C.?

20. How is mercury obtained from its chief ore ? What methods are usually employed for its laboratory purification ? On what physical and chemical properties are these methods based ? Indicate some of the more important uses of the metal. How would you prepare from the metal (*a*) mercuric sulphate, (*b*) mercurous chloride, (*c*) mercuric iodide ?

N.B.—The following data should be used in the calculation questions :—

H=1·01, C=12·0, N=14·0, O=16·0, Na=23·0, Cl=35·5, Gram molecular volume at N.T.P.=22·4 litres.

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GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

AUTUMN, 1953

CHEMISTRY

Examiners:
W. CAMERON WALKER, Esq., M.Sc., Ph.D.
H. J. CAVELL, Esq., M.Sc., Ph.D.

WEDNESDAY, November 18.—*Morning,* 9.30 *to* 12.30

[*Answer concisely and attempt* SIX *questions. Marks will be given for correct equations and also for sketches, where these add to the clearness of the answer.*]

1. Explain how it is that certain natural waters contain calcium bicarbonate.

Starting from lime water how would you prepare some water possessing temporary hardness?

Give *two* methods other than distillation, by which temporary hardness may be removed.

2. What is the effect of heat on (*a*) potassium nitrate, (*b*) ammonium nitrate?

Give a labelled diagram to show how you would prepare from potassium nitrate a fairly pure specimen of nitric acid.

How would you prepare and collect nitric oxide from nitric acid?

3. Give labelled diagrams to show how you would prepare the two common oxides of sulphur.

Describe briefly *three* reactions which indicate the affinity of sulphuric acid for water, or for the elements of water.

4. Give the formula of silica and name *two* naturally occurring forms of this substance.

Outline the method of manufacture of (*a*) water glass, (*b*) common glass. Why is common bottle glass often green or brown in colour?

Given water glass, how would you prepare a specimen of silica? Give equations.

5. Describe how you would prepare pure dry chlorine.

Using chlorine how would you distinguish between sodium bromide and sodium iodide?

Outline an experiment by which you would demonstrate the rate of diffusion of chlorine compared with that of air.

6. Name the materials you would use to prepare carbon dioxide. Give the equation for the reaction.

A blue flame is often seen above a clear fire. Explain fully how air and carbon produce this phenomenon.

When a mixture of 30 c.c. of oxygen and 30 c.c. of carbon monoxide is sparked what volume of gas will remain (*a*) after explosion and (*b*) after treating the product with sodium hydroxide solution?

7. Give the formulæ and colours of (*a*) cuprous oxide, (*b*) cupric oxide.

How would you determine experimentally the percentage of copper in cupric oxide?

State the law of multiple proportions.

Analysis shows that two oxides *A* and *B* of the same metal contain 20% and 11·11% respectively of oxygen. Show that these figures agree with the law of multiple proportions.

8. (*a*) 4·5 gm. of a metal *M* produce 6·3 gm. of the oxide of the metal. Calculate the equivalent of *M*.

(*b*) What volume of hydrogen (at N.T.P.) would you expect 7·5 gm. of the metal to displace from an excess of dilute acid?

(*c*) What would be the volume of this hydrogen at 17°C and 740 mm. pressure?

(*d*) Define atomic weight.

(*e*) How is atomic weight related to the equivalent weight of an element?

(*f*) Assuming the valency of *M* to be 2, calculate the atomic weight of the metal.

(*g*) Write the formulæ for the bromide, sulphide, hydroxide, nitrate, and sulphate of *M*.

9. How is red lead made from metallic lead?

Name *one* important use of red lead.

Describe how you would prepare from red lead, specimens of: (*a*) crystalline lead chloride, (*b*) lead dioxide, (*c*) lead sulphate.

10. Explain what happens when a direct current is passed (*a*) through a *very dilute* solution of common salt between platinum electrodes, (*b*) a *strong* solution of common salt between carbon electrodes.

A silver voltameter is connected in series with a copper voltameter. What weight of silver will be deposited in one voltameter whilst 0·16 gm. of copper is deposited in the other?

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C.P. 52/1927 5/2/4M

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1. Describe the laboratory preparation and collection of *either* (*a*) hydrogen, *or* (*b*) oxygen, mentioning any necessary precaution in the experiment you describe.

Draw a labelled diagram of the apparatus you would use to obtain a small quantity of water from hydrogen.

What *three* tests would enable you to identify the product as water?

Describe a simple *chemical* method of obtaining a test-tube full of hydrogen from cold water.

2. Arrange the following elements in parallel columns headed (*a*) metals, (*b*) non-metals: calcium, carbon, chlorine, iodine, iron, lead, nitrogen and zinc.

Describe the laboratory preparation and collection in a pure condition of one *gaseous* non-metal in the above list. Give *one* important industrial use of the gas you have chosen.

Starting with *one* of the metals listed, describe how you would prepare a pure dry sample of an oxide of the metal.

C.P. 52/1926 1750R [P.T.O.

3. If you were provided with some marble chips, describe carefully each stage in the process you would use to prepare a specimen of pure dry precipitated chalk.

How would you use this chalk to prepare a specimen of hard water which contains both temporary and permanent hardness?

Write equations (no description is required) to show what happens when:—

(*a*) slaked lime is added to temporarily hard water,

(*b*) soap solution is added to permanently hard water.

4. Describe the experiments you would carry out to obtain from nitric acid, samples of (*a*) hydrogen, (*b*) oxygen, (*c*) nitrogen.

Explain why rain falling during a thunderstorm contains traces of nitric acid.

5. Why is strong ammonia solution termed "880 ammonia"?

Given 880 ammonia, how would you prepare and collect

(*a*) dry ammonia gas?

Given also nitric acid, how would you prepare a sample of

(*b*) laughing gas?

Carefully describe how you would verify *one* of the following statements:—

(*c*) dry ammonia contains hydrogen and nitrogen.

(*d*) laughing gas is an oxide of nitrogen.

6. Given some metallic copper, how would you prepare:—

(*a*) copper nitrate crystals from the metal,

(*b*) cupric oxide from the nitrate,

(*c*) copper sulphate crystals from the oxide.

Give equations for the reactions you describe.

If you used 10 gm. of copper in (*a*) and the whole of this was eventually turned into copper sulphate crystals ($CuSO_4.5H_2O$) what weight of crystals, to the nearest gram, would you obtain?

2·88 gm. of red oxide of copper (cuprous oxide) when reduced leaves 2·56 gm. of copper. Calculate (*d*) the equivalent weight, (*e*) the valency of copper in cuprous oxide.

($H=1$; $O=16$; $S=32$; $Cu=64$.)

7. Give the formulæ and chemical names of (*a*) caustic soda, (*b*) washing soda, (*c*) baking soda.

How could you prepare crystals of washing soda from caustic soda?

Write equations to show what happens when:—

(*d*) caustic soda is heated with silica,

(*e*) washing soda crystals are strongly heated alone,

(*f*) a solution of baking soda is warmed.

Name the product in each case.

What happens when dilute hydrochloric acid is added to a solution of the product obtained in (*d*)?

8. If you were given three unlabelled bottles containing the three common dilute acids, what simple tests would you apply to identify the contents of each bottle?

How would you proceed to find by means of a normal solution of caustic soda, the normality of one of the acid solutions?

If 25 cc. of any one of the acids required 20 cc. of the caustic soda solution for neutralisation, what is the normality of each acid and what weight per litre of HCl, H_2SO_4 and HNO_3 respectively do the solutions contain?

($H=1$; $O=16$: $N=14$; $S=32$: $Cl=35{\cdot}5$).

9. Define the term allotrope.

Describe how you would convert (*a*) rhombic sulphur to plastic sulphur, (*b*) red phosphorus to white phosphorus, (*c*) oxygen to ozone. Give diagrams.

Mention an important everyday use, *one* for each, of sulphur, phosphorus and ozone.

10. Describe and explain what happens when:—

(*a*) copper sulphate solution is electrolysed between copper electrodes,

(*b*) dilute sulphuric acid is electrolysed between lead electrodes.

Mention important applications of (*a*) and (*b*).

If the two solutions are electrolysed for the same time, by connecting the electrodes in series, what volume of hydrogen at N.T.P. is liberated in (*b*) when 0·16 gm. of copper is deposited in (*a*)?

($H=1$; $Cu=64$; 1 gram molecule of any gas at N.T.P. occupies 22·4 litres.)

UNIVERSITY OF LONDON

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SUMMER, 1953

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(*a*) copper nitrate crystals from the metal,

(*b*) cupric oxide from the nitrate,

(*c*) copper sulphate crystals from the oxide.

Give equations for the reactions you describe.

If you used 10 gm. of copper in (*a*) and the whole of this was eventually turned into copper sulphate crystals ($CuSO_4.5H_2O$) what weight of crystals, to the nearest gram, would you obtain?

2·88 gm. of red oxide of copper (cuprous oxide) when reduced leaves 2·56 gm. of copper. Calculate (*d*) the equivalent weight, (*e*) the valency of copper in cuprous oxide.

(H=1; O=16; S=32; Cu=64.)

7. Give the formulæ and chemical names of (*a*) caustic soda, (*b*) washing soda, (*c*) baking soda.

How could you prepare crystals of washing soda from caustic soda?

Write equations to show what happens when:—

(*d*) caustic soda is heated with silica,

(*e*) washing soda crystals are strongly heated alone,

(*f*) a solution of baking soda is warmed.

Name the product in each case.

What happens when dilute hydrochloric acid is added to a solution of the product obtained in (*d*)?

8. If you were given three unlabelled bottles containing the three common dilute acids, what simple tests would you apply to identify the contents of each bottle?

How would you proceed to find by means of a normal solution of caustic soda, the normality of one of the acid solutions?

If 25 cc. of any one of the acids required 20 cc. of the caustic soda solution for neutralisation, what is the normality of each acid and what weight per litre of HCl, H_2SO_4 and HNO_3 respectively do the solutions contain?

(H=1; O=16: N=14; S=32: Cl=35·5).

9. Define the term allotrope.

Describe how you would convert (*a*) rhombic sulphur to plastic sulphur, (*b*) red phosphorus to white phosphorus, (*c*) oxygen to ozone. Give diagrams.

Mention an important everyday use, *one* for each, of sulphur, phosphorus and ozone.

10. Describe and explain what happens when:—

(*a*) copper sulphate solution is electrolysed between copper electrodes,

(*b*) dilute sulphuric acid is electrolysed between lead electrodes.

Mention important applications of (*a*) and (*b*).

If the two solutions are electrolysed for the same time, by connecting the electrodes in series, what volume of hydrogen at N.T.P. is liberated in (*b*) when 0·16 gm. of copper is deposited in (*a*)?

(H=1; Cu=64; 1 gram molecule of any gas at N.T.P. occupies 22·4 litres.)

UNIVERSITY OF LONDON

GENERAL CERTIFICATE OF EDUCATION EXAMINATION

Ordinary Level

AUTUMN, 1952

CHEMISTRY

Examiners:

W. CAMERON WALKER, Esq., M.Sc., Ph.D.
J. H. DAVIES, Esq., Ph.D.

WEDNESDAY, November 19.—*Morning*, 9.30 *to* 12.30

[*Answer concisely and attempt* SIX *questions. Marks will be given for correct equations and also for sketches, where these add to the clearness of the answer.*]

1. Write an account of the effect of heat on: (*a*) potassium chlorate, (*b*) sodium bicarbonate, (*c*) sodium nitrate, (*d*) ammonium nitrate, (*e*) copper nitrate, (*f*) temporarily hard water.

What is the effect of passing pure dry hydrogen over a sample of the residue in (*e*) heated strongly?

2. State (*a*) the law of Definite Proportions and (*b*) the law of Multiple Proportions.

Explain carefully how you would show experimentally EITHER (*c*) that the law of Definite Proportions applies to the compound magnesium oxide, OR (*d*) that the quantitative composition of two oxides of any metal with which you are familiar afford an example of the law of Multiple Proportions.

3. What do you understand by an ACID and an ACID SALT? Give *one* example of each.

How would you show by experiment that sulphuric acid has a basicity of at least 2?

Describe the preparation of a dry crystalline specimen of ferrous sulphate from iron.

What is the effect of heat on ferrous sulphate crystals, and to what use is the residue put?

4. Indicate briefly, giving equations, how you would obtain: (*a*) chlorine from common salt, (*b*) oxygen from bleaching powder, (*c*) lead from red lead, (*d*) nitrogen from nitric acid, (*e*) hydrogen from steam.

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5. Describe an experiment to show that the terms "combustible substance" and "supporter of combustion" are interchangeable, e.g., in the interaction between coal gas and air. Hence define the term flame.

Explain briefly:—

(*a*) why a bunsen burner strikes back under certain conditions,
(*b*) why a non-luminous bunsen flame is cleaner and hotter than the luminous flame,
(*c*) how a non-luminous bunsen flame may be rendered luminous without closing the air-hole of the burner.

6. Describe a laboratory preparation of a specimen of dry hydrogen sulphide, starting from sulphur.

How and under what conditions does this gas react with (*a*) copper sulphate, (*b*) air in limited quantity, (*c*) sulphur dioxide, (*d*) ferric chloride?

7. Describe and explain what happens when concentrated sulphuric acid reacts with (*a*) sodium nitrate, (*b*) oxalic acid, (*c*) copper sulphate crystals, (*d*) carbon.

What is seen to happen, and why, when a mixture of sodium nitrate, copper filings and concentrated sulphuric acid is slightly heated?

8. Describe the laboratory preparation of a pure dry specimen of ammonia. How is ammonia recovered as a by-product in the manufacture of coal gas?

How and under what conditions does ammonia react with (*a*) chlorine, (*b*) heated copper oxide, (*c*) an aqueous solution of a ferric salt?

9. Define the Equivalent Weight of an element. How is the Equivalent Weight related to the Atomic Weight?

An element M has an atomic weight of 27 and an equivalent weight of 9. Write down the formulæ for its oxide and its sulphate.

An electric current was passed through two voltameters in series containing respectively copper sulphate solution and water rendered slightly acid by sulphuric acid. After the current had passed for a certain time 0·248 gm. of copper had been deposited on the cathode and 94 c.c. of hydrogen, measured at 15°C. and 740 mm. pressure had been liberated. Calculate the Equivalent Weight of copper.

[1 litre of hydrogen at N.T.P. weighs 0·09 gm.]

10. What is the chemical formula of silica? Name *two* varieties of silica which are found in nature.

What reasons have you for regarding silica as an acid-forming oxide? How would you prepare in the laboratory a solution of silicic acid? Give details.

5. Describe an experiment to show that the terms "combustible substance" and "supporter of combustion" are interchangeable, e.g.; in the interaction between coal gas and air. Hence define the term flame.

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UNIVERSITY OF LONDON

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Ordinary Level

SUMMER, 1952

CHEMISTRY

Examiners:

W. CAMERON WALKER, Esq., M.Sc., Ph.D.

J. H. DAVIES, Esq., Ph.D.

WEDNESDAY, June 11.—*Morning*, 9.30 *to* 12.30

[*Answer concisely and attempt* SIX *questions. Marks will be given for correct equations and also for sketches, where these add to the clearness of the answer.*]

1. How would you prepare and collect a sample of pure water from tap water?

Describe the tests you would make to determine whether a sample of tap water contains permanent hardness. If it does, how would you find whether the hardness is due to dissolved sulphate?

Starting from distilled water and being provided with a supply of carbon dioxide and quicklime, how would you make a sample of temporarily hard water? What is the chemical reaction that occurs when soap solution is added gradually to temporarily hard water and what change is visible?

2. Describe the laboratory preparation and collection of pure dry chlorine.

How would you prepare from chlorine (*a*) hydrogen chloride, (*b*) ferric chloride, (*c*) bleaching powder?

What is the action (*d*) of ammonia gas on hydrogen chloride, (*e*) of ammonia solution on aqueous ferric chloride and (*f*) of hydrochloric acid on bleaching powder?

3. How would you prepare and collect some jars of nitric oxide?

State and explain what happens when nitric oxide is (*a*) passed through ferrous sulphate solution, (*b*) passed over red-hot copper, (*c*) mixed with oxygen. Describe the experiments you would perform to identify the gas produced in (*b*).

Describe and explain what occurs when the product in (*c*) is shaken up with water containing blue litmus.

4. Explain what happens when a direct current is passed through:

(*a*) dilute sulphuric acid between platinum electrodes,

(*b*) aqueous caustic soda between platinum electrodes,

(*c*) copper sulphate solution between copper electrodes.

What *total* volume of gas, measured at N.T.P., would be liberated from dilute sulphuric acid by the current which, flowing for the same time, deposits 0·315 gm. of copper from copper sulphate solution?

(Gram molecular volume = 22·4 litres at N.T.P.; H = 1, Cu = 63)

5. How would you show that:

(*a*) sulphur dioxide is an acidic oxide,

(*b*) magnesium oxide is a basic oxide,

(*c*) zinc oxide is both basic and acidic?

How would you obtain:

(*d*) sulphur dioxide from sodium sulphite,

(*e*) magnesium oxide from magnesium nitrate,

(*f*) zinc oxide from zinc chloride?

6. Define the terms atom, molecule, atomic weight, and molecular weight.

State Avogadro's hypothesis and make use of it to deduce the relation between molecular weight and relative density.

Calculate the relative densities of *three* gases which are too soluble to be collected over water and show by simple diagrams how each gas should be collected by air displacement.

(Relative density of air = 14·4: H = 1, O = 16, C = 12, S = 32, N = 14, Cl = 35·5)

7. What do you understand by a normal solution of (*a*) an acid, (*b*) an alkali?

Given a supply of pure dry sodium carbonate and a standard solution of an acid, describe in detail how you would determine the weight of sodium hydroxide contained in a litre of a given solution of that substance.

A solution of caustic soda contains 49 gm. of sodium hydroxide per litre. How much water must be added to 100 c.c. of the solution to produce an accurately normal solution?

(H=1, C=12, N=14, O=16, Na=23, S=32, Cl=35·5)

8. Given sal-ammoniac (ammonium chloride), sodium nitrite, and any other chemicals you require, how would you prepare and collect jars of (*a*) pure dry ammonia, (*b*) dry hydrogen chloride, (*c*) nitrogen? It will be sufficient to draw labelled diagrams of the apparatus in each preparation and to give the equations for the reactions which occur.

9. Describe the experiments you would carry out in the laboratory (*a*) to illustrate the contact process for preparing sulphuric acid, (*b*) to show that carbon dioxide is denser than hydrogen.

An aqueous solution may contain a salt of *one* of the metals iron, lead, or calcium. How would you find out which is present?

10. Name and give the formula for the principal source of phosphorus.

Describe the preparation of the element, giving equations for the several reactions which take place.

What evidence have we that yellow and red phosphorus are one and the same element?

Name *two* distinct uses of phosphorus in everyday life.

Starting from yellow phosphorus how would you prepare (*a*) red phosphorus, (*b*) phosphorus trichloride?

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