

O Level

Physics

Session: 1984 June
Type: Question paper
Code: 5050

PHYSICS

HOME
5050/1

ORDINARY LEVEL

PAPER I

(Two hours)

This question paper contains two parts: Part I is allotted 60 marks (4 marks for each question), Part II is allotted 30 marks.

Candidates are advised not to spend more than 80 minutes on Part I.

Answer **all** the questions.

Answers to Part I must be written on the question paper, and are to be handed in with the answers to Part II. The answers to both parts should be **TIED TOGETHER LOOSELY**.

Part II of the question paper should be **detached** and not handed in.

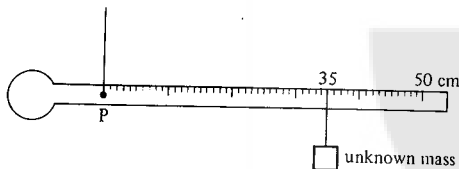
Mathematical tables and squared paper are provided.

All working must be shown.

In Part II the marks shown indicate the relative credit it is intended to give for each part of each question.

PART I

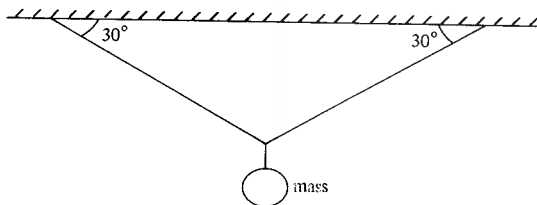
- 1 A non-uniform rod, with a centimetre scale marked on it, is suspended at a point P near one end. It is used to determine an unknown mass. The rod balances in a horizontal position when the unknown mass is hung 35.0 cm from P, as shown in the diagram below.



The rod also balances horizontally when a 140 g mass is hung 20.0 cm from P, the unknown mass having first been removed.

By taking moments about P, calculate the value of the unknown mass.

- 2 A mass of weight W is supported by two strings, as shown in the diagram. The tension in each string is 30 N.



By means of a scale diagram, find the resultant of the two tensions and hence the value of W .

Scale

- 3 An empty lift is counterbalanced by a heavy piece of metal. Some people of combined mass 350 kg enter the lift and operate it. The lift rises 50 m in 60 s. Calculate

(a) the work done in raising the people,

[Take the weight of 1 kg to be 10 N.]

(b) the power required to do this.

- 4 With the aid of a diagram, account briefly for the following observations:

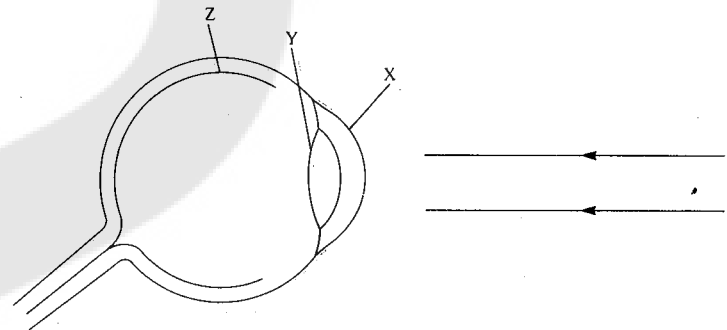
(a) on a sunny day, objects cast distinct shadows on the ground;

(b) the areas within the shadows are not black.

(a)

(b)

- 5 The diagram shows in simple form the structure of a normal human eye looking at a distant object.

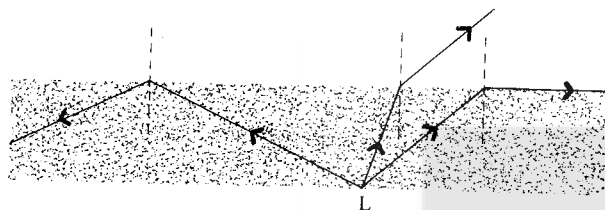


Name the components labelled X, Y and Z.

X Y Z

Continue the paths of the parallel rays on the diagram to show the action of the eye on the rays.

- 6 A small lamp L is placed at the bottom of a pool of water. The diagram shows the paths of three rays from the lamp.



On the diagram, mark the critical angle C for the water-air boundary. Measure C and from its value calculate the refractive index of water.

$C =$

- 7 A tall "deep freeze" unit has the freezing compartment at the top. What advantage is there in placing the freezing compartment in this position?

When the door of such a unit is opened for a short time, the cold air inside is replaced by warmer air. Why does this exchange of air have little effect on the temperature of the contents of the unit?

- 8 A mixture of 1 kg of water and 1 kg of ice, both initially at 0°C , is used to keep some medical supplies cool. Calculate the heat that the mixture absorbs in reaching a temperature of 10°C . [The specific latent heat of ice is $336\,000\text{ J/kg}$ and the specific heat capacity of water is 4200 J/kg K .]

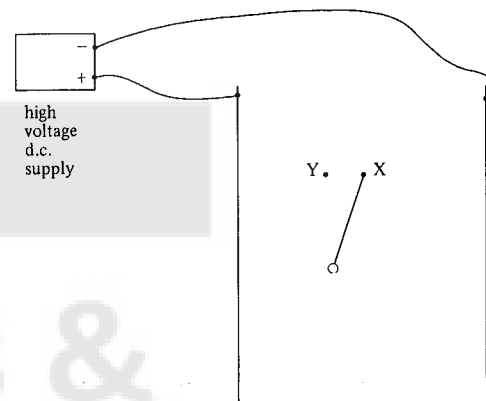
- 9 A popular speaker is addressing a very large crowd of people. The public address loudspeakers are mounted on the front of the speaker's platform. The speech is also broadcast by radio.

An observer in the crowd notices that he receives the radio broadcast on his radio 1.6 s before he hears the same word from the loudspeakers.

Estimate the distance of the observer from the platform. State any assumption that you make in arriving at your estimate.

[Take the speed of sound in air to be 330 m/s .]

- 10 A light, charged sphere is suspended vertically by an insulating thread. It is placed between two metal plates that are connected to the terminals of a high voltage d.c. supply.



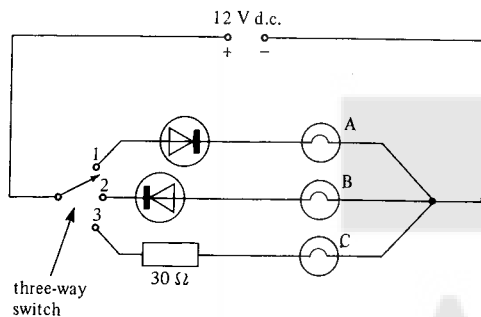
Explain

- (a) why the sphere moves to the position shown in the diagram,

- (b) why it remains at rest in this position.

When the point of suspension is moved to Y shown in the diagram, the angle to the vertical at which the thread hangs remains the same as it was at X . Give a reason for this.

11 Each of the lamps A, B and C in the circuit below has the same rating, 12 V 6 W. The diode in series with lamp A is connected in the forward direction.



Without carrying out any calculations, state and explain whether each lamp will light brightly, dimly or not at all when the three-way switch is moved successively into positions 1, 2 and 3.

Switch in position 1, lamp A:

.....

.....

Switch in position 2, lamp B:

.....

.....

Switch in position 3, lamp C:

.....

.....

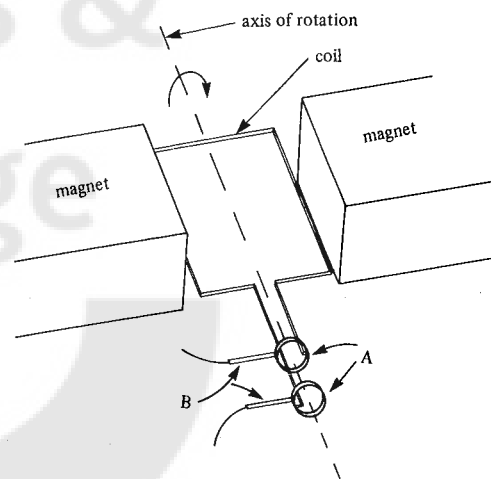
12 In each of the diagrams below, the dot represents a narrow beam of electrons travelling, in a vacuum, upwards out of the plane of the paper.

Indicate on the diagrams how you would arrange suitable apparatus to produce a deflection of the beam (a) by an electric field, (b) by a magnetic field. Indicate the direction of the resulting deflection on each diagram.

(a) Deflection by an electric field

(b) Deflection by a magnetic field

13 The diagram shows the structure of a simple a.c. generator.



(a) Name the components A, and state their function.

.....

.....

Name the components B, and state their function.

.....

.....

(b) State *two* ways of increasing the peak voltage produced by such a generator

(i)

(ii)

14 Radiation from the Sun falling on a photoelectric cell enables the cell to supply 11 mW of power to the radio-transmitter of a spacecraft. The active area of the cell is 2.2 cm^2 . The intensity of the radiant energy incident on the cell is 0.05 W/cm^2 .

Calculate

(a) the energy incident on the cell per second,

(b) the efficiency of the cell.

State the energy conversion that occurs in the photoelectric cell when sunlight falls on it.

15 The uranium nuclide ${}_{92}^{238}\text{U}$ decays to thorium (Th) by the emission of α -particles. Write an equation to represent the decay of one atom of this nuclide.

Complete the following sentence by inserting *one* word in each gap. α -particles are much

..... penetrating than β -particles: in a given electric field, α -particles are deflected

..... than β -particles.

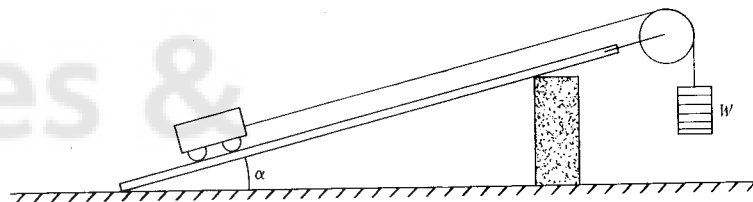
PART II [30 marks]

Answer **both** questions.

1 Answer **either** part A or part B.

A The diagram illustrates the equipment used in an experiment to determine how the force required to pull a trolley up a slope at steady speed varied with α , the angle of inclination of the slope to the horizontal.

A light string was fixed to the trolley and passed over a smooth pulley; different forces were applied to the trolley by varying the mass attached to the string. The mass was increased until its weight W was such that the trolley moved up the slope at a slow steady speed.



The experiment was repeated for different values of α and the following results were obtained.

W/N	8.0	11.7	14.5	17.0	19.5
$\sin \alpha$	0.26	0.43	0.57	0.71	0.82

(a) Plot a graph of W/N (y -axis) against $\sin \alpha$ (x -axis), starting the W/N scale at 2.0 and the $\sin \alpha$ scale at zero. [5]

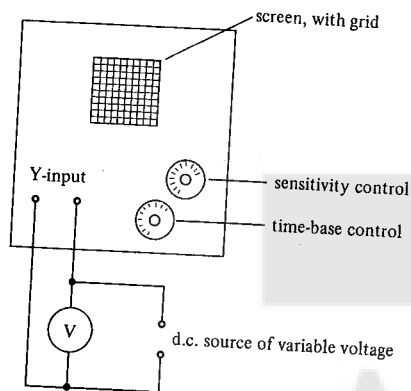
(b) From your graph, read off W_0 , the value of W for $\sin \alpha = 0$. Comment on the meaning of W_0 . [3]

(c) Suggest how you would
 (i) measure the angle α ,
 (ii) check that the speed of the trolley is constant. [4]

(d) What are the advantages and disadvantages of using such a slope to raise heavy masses compared with lifting them vertically? [3]

EXAMINATION PAPERS (ORDINARY LEVEL)

B

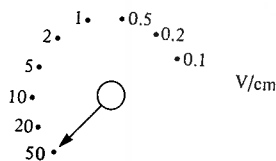


The diagram shows some of the essential features of a cathode-ray oscilloscope (c.r.o.) with a variable source of d.c. voltage connected to the Y-plate terminals. The time-base control was set so that a horizontal line appeared across the face of the screen.

An experiment was carried out to investigate how the vertical displacement D of this line varied with the d.c. voltage V . The displacement D was measured from the position of the line with $V = 0$ V: the sensitivity control was kept unchanged throughout the experiment. The following results were obtained:

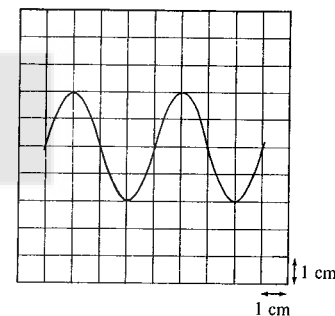
Voltage to Y-plates, V/V	0.3	0.6	0.9	1.2	1.5
Displacement, D/cm	1.4	3.1	4.3	6.1	7.6

- (a) Plot a graph of D/cm (y -axis) against V/V (x -axis). [5]
- (b) (i) Determine the gradient G of your graph, making clear the particular values you use to obtain your result.
- (ii) from your result, deduce which of the voltage sensitivity settings shown in the diagram below was used in the experiment. [4]



- (c) The maximum displacement obtainable is 8.0 cm. What setting of the voltage sensitivity is most appropriate for measuring a large d.c. voltage of about 75 V? [3]

- (d) The d.c. source was disconnected and an a.c. source connected to the Y-plates. The time-base control was set at 5 ms/cm: the diagram below shows the stationary trace obtained on a centimetre square grid.



What was the frequency of the a.c. source? [3]

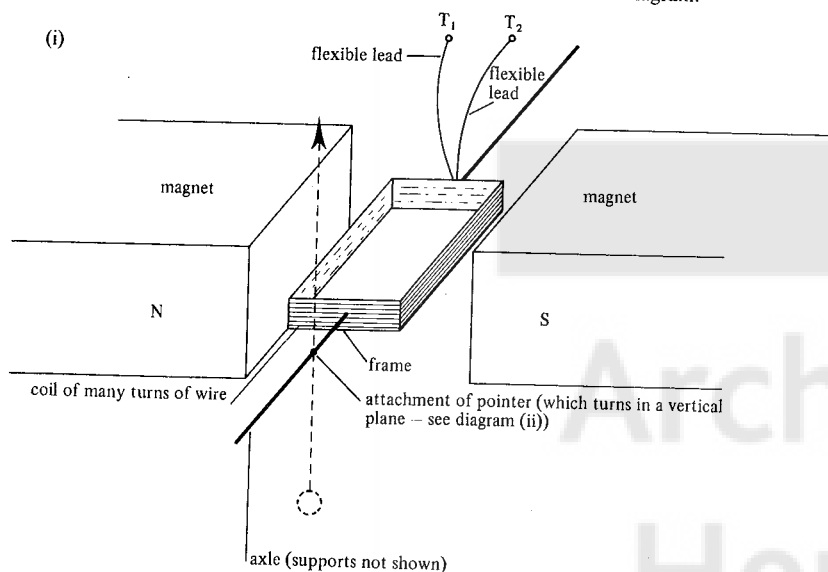
2 Answer either part A or part B.

A Given an irregularly shaped flat sheet of aluminium, about 0.5 mm thick and of approximate dimensions 200 mm by 200 mm, describe how you would determine

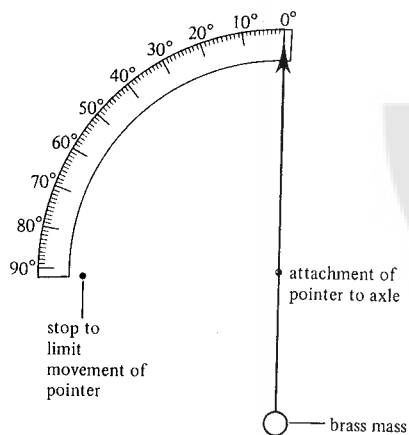
- (a) the position of the centre of gravity of the sheet, [6]
- (b) the thickness of the metal, [3]
- (c) the density of the metal. [6]

In each case, make clear how you would obtain the result and how you would attempt to make the result as accurate as possible.

B A student constructed the current-measuring device shown in the diagram.



(ii)



The device consists of a coil of insulated wire of many turns wound round a frame that is mounted on an axle which is free to turn in its supports so that the pointer fixed to the axle moves over a scale.

- (a) Draw a circuit diagram to show how, using terminals T_1 and T_2 of the coil, you would connect a variable d.c. supply and an ammeter so that readings of current I through the coil can be taken (in order to calibrate the device).

Describe the procedure you would use to obtain different readings of current I and the corresponding angles of deflection θ of the pointer. [6]

- (b) Explain the purpose of the brass mass attached to the pointer. [2]

- (c) It is found that the graph of I against θ is not a straight line.

Suggest *one* reason for this.

State *one* disadvantage of the fact that the relationship between I and θ is not linear. [3]

- (d) State and explain *one* way in which the device may be modified so that it becomes more sensitive, i.e. it gives a larger deflection θ for a given current I . Why would this make the measurement of small currents more accurate? [4]

PHYSICS

5050/2

ORDINARY LEVEL

PAPER 2

(Two and a half hours)

This question paper contains two parts each allotted 50 marks.

Answer five questions from Part I and three questions from Part II.

Answers to Part I should be written on the question paper in the spaces provided and are to be handed in with the answers to Part II.

*The answers to both parts should be **TIED TOGETHER LOOSELY.***

*Part II of the question paper should be **detached** and not handed in.*

Mathematical tables are available.

All working must be shown.

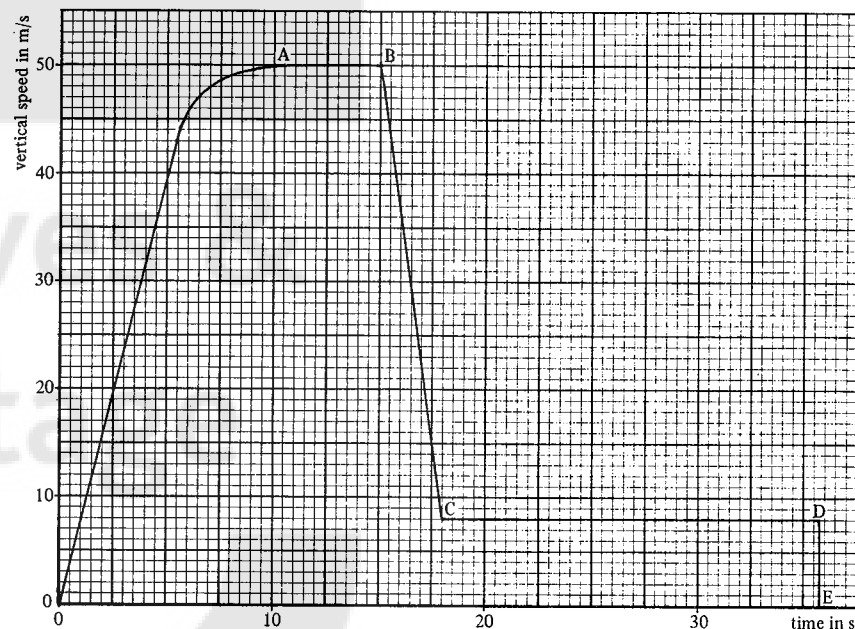
The marks shown indicate the relative credit it is intended to give for each part of each question.

SUMMER 1984

PART I [50 marks]

Answer five questions from Part I.

1 The graph below shows how the vertical speed of a parachutist falling from an aircraft varies with time until he reaches the ground.



- (a) Calculate
- the average speed of the parachutist during the first five seconds. [2]
 - the acceleration of the parachutist during this period. [2]
- (b) During the period AB, the speed of the parachutist is steady even though his parachute has not opened. Why is this? [2]
-
-
-
- (c) The parachute opens at B. Given that the mass of the parachutist is 120 kg, calculate the average force slowing him down during the period BC. [4]

- 2 (a) A sample of air that occupies 80 cm^3 at a temperature of 0°C is heated, at constant pressure, to a temperature of 65°C . Calculate the volume occupied by the sample at this higher temperature. [3]



The left-hand diagram above shows the equilibrium position, at 0°C , of a thin rubber sheet sealed over the open end of an empty wine glass.

The glass is placed in a heated cabinet in which the temperature is 65°C and the atmospheric pressure is unchanged.

- (i) Draw on the right-hand diagram above the approximate new equilibrium position of the rubber sheet. [1]

- (ii) Account for the change in the equilibrium position of the rubber sheet. [2]

.....

.....

.....

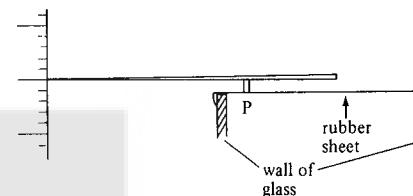
- (iii) Account for the fact that the change takes place slowly. [2]

.....

.....

.....

- (c) A light pointer is stuck to the rubber sheet so that it pivots about a point P near the rim of the glass, as shown (enlarged) below.



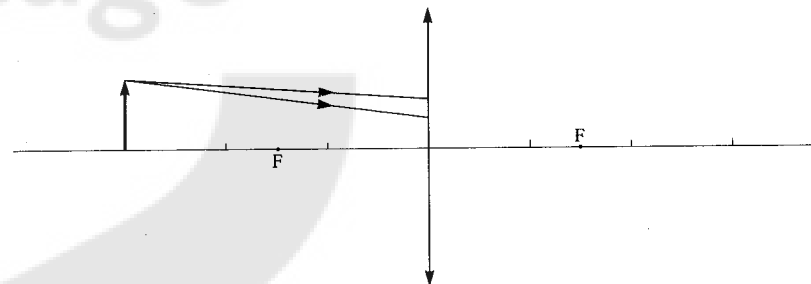
This arrangement acts as a simple thermometer. State *two* disadvantages of such a thermometer. [2]

.....

.....

.....

- 3 (a) The diagram shows an object placed 300 mm from a converging lens of focal length 150 mm .

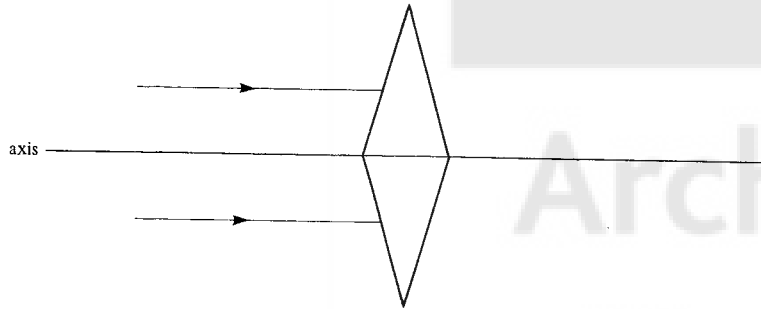


- (i) By drawing construction rays on the diagram, locate the position of the image.
 (ii) Given that the object is 50 mm high, determine the size of the image.

- (iii) Complete the paths of the two rays given on the diagram to show their passage through the lens and to the image.

[5]

- (b) The diagram shows two rays of white light incident upon two identical glass prisms. Complete the diagram to show the paths of the light through the prisms into the air. Mark the paths of the red and blue rays and continue their paths until they cross the axis. [3]

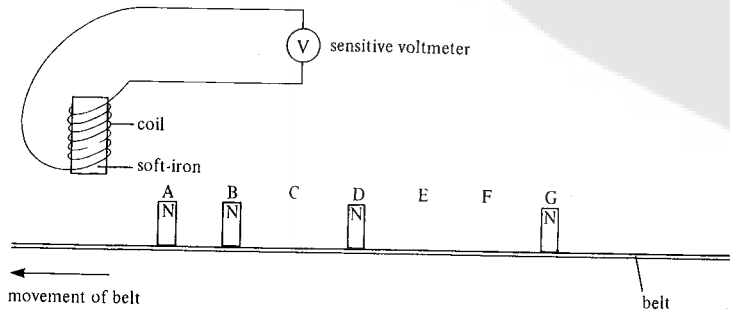


- (c) Point out a similarity and a difference between the effect of the two prisms and the effect of a thin converging lens on a beam of white light parallel to the axis incident on them. [2]

.....

.....

- 4 (a) The diagram shows an arrangement by which small permanent magnets, attached to a conveyor belt, are moved under a detecting device. This device consists of a coil of wire, wound on a soft-iron core, connected to a sensitive voltmeter.



As the conveyor belt moves along at constant speed, voltage pulses are recorded by the voltmeter.

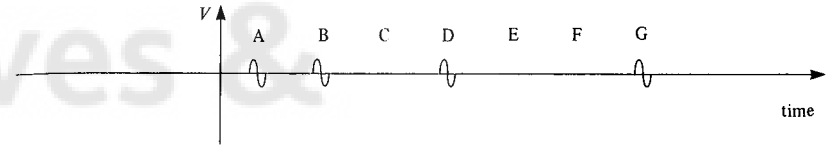
- (i) Explain why these pulses occur. [3]

.....

.....

.....

- (ii) The graph of voltmeter reading against time is shown below, the letters corresponding to the positions on the belt as each magnet passes under the coil.



Explain why the pulse produced by each magnet has a positive and a negative part. [3]

.....

.....

- (iii) What is the purpose of the soft-iron core inside the coil? [2]

.....

.....

- (b) **Either** (i) Suggest similarities between the arrangement described in (a) above and the use of a magnetised tape for putting information into, for example, a computer. [2]

.....

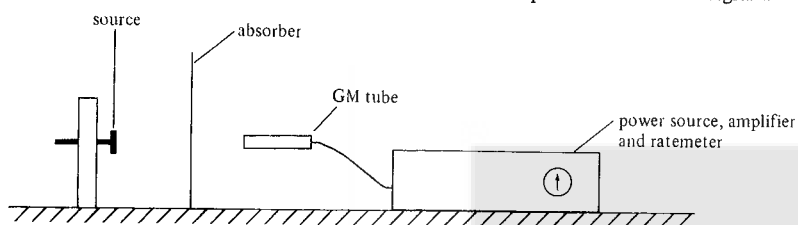
.....

Or (ii) State *two* ways in which the detecting device could be made more sensitive. [2]

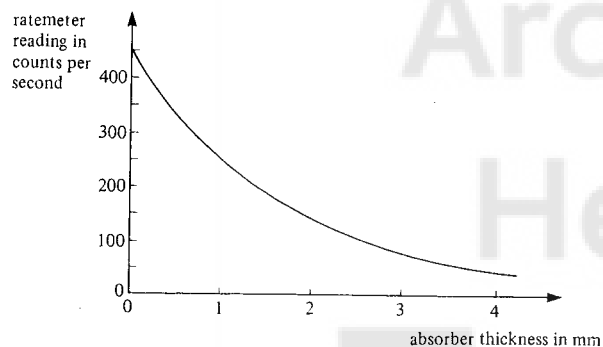
.....

.....

- 5 An apparatus for detecting radioactive emission is set up as shown in the diagram.



- (a) Plastic absorbers of increasing thickness are inserted successively in the position shown and ratemeter readings are taken for each one. The graph of the results is shown below.



Given that the source has a long half-life and emits only one type of radiation, deduce whether the source is an α -, a β - or a γ -emitter. Explain your reasoning. [3]

.....

.....

.....

- (b) It is found that even when absorbers several centimetres thick are placed in position, the ratemeter still records a very small reading. Explain why this is so. [3]

.....

.....

.....

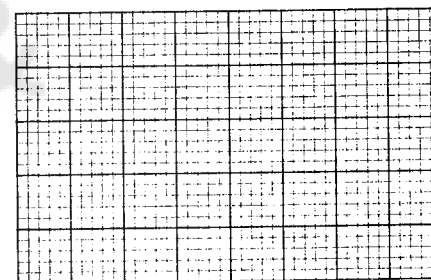
- (c) Suggest how a manufacturer of plastic sheeting 0.5 mm thick might use the above arrangement as the basis of a device for monitoring the thickness of his product. [2]

.....

.....

.....

- (d) Using the apparatus with a different source and without any absorber the ratemeter reading is observed at intervals. The initial reading was 400 counts per second and the half-life of the source was 0.5 h. On the grid below, plot a graph of the ratemeter reading against time from 0 h to 2 h. [2]

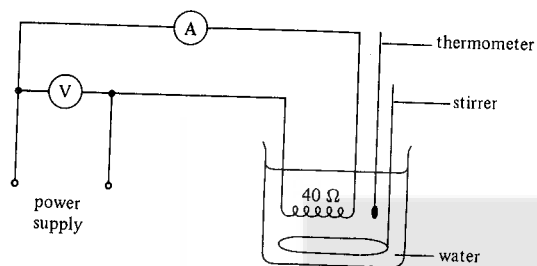


- 6 (a) A current of 2.3 A flows through a small immersion heater of resistance 40 Ω . Calculate

(i) the charge transferred in 60 s.

(ii) the energy dissipated in the same time. [4]

- (b) Wishing to check the answer to (a) (ii) experimentally, a student used the apparatus shown in the diagram to determine this energy, i.e. by measuring the increase in temperature of the calorimeter and water. The calorimeter and water had a total heat capacity of 960 J/K.



- (i) Calculate the voltmeter reading when the current in the circuit is 2.3 A .
- (ii) Calculate the expected increase in temperature in 60 s .
- (iii) Given that the calorimeter and contents were initially at room temperature, explain why the observed increase in temperature was less than the calculated value. [6]

PART II [50 marks]

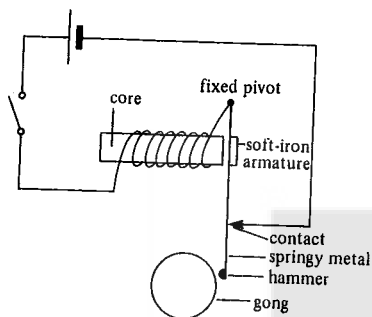
Answer three questions from Part II.

- 7 (a) What is meant by (i) *pressure*, (ii) *atmospheric pressure*? [4]
 Explain in terms of the movement of molecules why the atmospheric pressure at the top of a mountain is less than at sea level. [3]
 Draw a labelled diagram of a simple mercury barometer. Indicate clearly how the value of atmospheric pressure is read from the barometer.
 Explain briefly why the value obtained is the same when the cross-sectional area of the tube is increased. [6]
- (b) Calculate
- (i) the weight of mercury in a tank, given that the area of the base of the tank is 0.5 m^2 , that the depth of mercury is 0.3 m and that the density of mercury is $13\,600 \text{ kg/m}^3$;
- (ii) the pressure that the mercury exerts on the base of the tank. [4]
 [Take the weight of 1 kg to be 10 N .]

- 8 (a) Describe a method of determining the specific heat capacity of a metal, making clear how the result is calculated from the observations. [6]
- (b) (i) The heat capacity of a thermocouple is very small. Why is this an advantage when the thermocouple is used to measure a rapidly varying temperature?
 (ii) Why, when heating a quantity of water, is it an advantage to use a saucepan with a small heat capacity? [3]
- (c) In an experiment to determine the rate of heat production by a bunsen burner, a beaker of water is heated. It is found that the temperature of 1.5 kg of water rises from 15°C to 70°C in 500 s . The specific heat capacity of water is 4200 J/(kg K) and the heat capacity of the beaker itself is 50 J/K .
 Calculate a value for the rate of production of heat by the bunsen burner.
 Using this value, estimate the rate at which the water in the beaker will turn to steam once the temperature reaches 100°C . [8]
 [Take the specific latent heat of steam as 2250 kJ/kg .]
- 9 (a) Describe how you could use a ripple tank to illustrate the *interference* of waves on the surface of water. With the aid of a diagram, make clear the effects you would expect to observe. [7]
- (b) Calculate the *wavelength* in air of the light from a monochromatic source, given that the *speed* of light in air is $3.00 \times 10^8 \text{ m/s}$ and that the *frequency* of the light is $6.25 \times 10^{14} \text{ Hz}$. Which, if any, of the three quantities in *italics* change when the light enters a denser medium? [5]
- (c) Describe briefly a simple experiment to demonstrate the wave nature of light. Make clear the effects you observe which indicate the wave-like properties. [5]
- 10 A resistor has a resistance of 5Ω . What is meant by this statement? [2]
 You are given a constant 12 V d.c. source, a variable resistor, a suitable ammeter and a suitable voltmeter. Describe an experiment you would carry out to confirm that the resistance of the resistor is 5Ω . Draw a diagram of the circuit you would use, state clearly the readings you would take and show how the resistance could be obtained from them. [5]
 Three resistors of resistance 2Ω , 4Ω and 6Ω are connected in parallel. Calculate
- (a) the effective resistance of the combination,
 (b) the current drawn from a 12 V battery (of negligible internal resistance) connected across the combination. [4]
- Sketch a graph of current (*y*-axis) against potential difference (*x*-axis) for a semi-conductor diode. By reference to the graph, explain why it is not possible to quote a single value for the resistance of the diode. [6]
- 11 (a) Describe how you would determine experimentally
- (i) the magnetic field pattern round a bar magnet,
 (ii) the direction of the magnetic field at a particular point in the field. [5]
 Sketch the pattern of field lines you would expect to obtain. (Neglect the influence of the Earth's magnetic field.) [2]

EXAMINATION PAPERS (ORDINARY LEVEL)

(b)



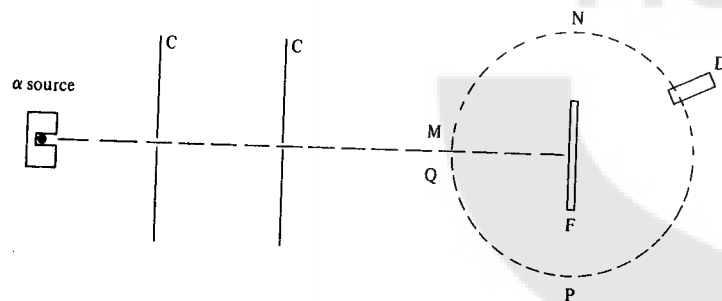
The diagram shows the essential features of a bell operated by a battery. Explain why the hammer repeatedly strikes the gong after the switch has been closed. [5]

A student decided to investigate the effect of using different materials to form the core. He used, successively, cores made of (i) plastic, (ii) steel, (iii) copper.

In each case, state and explain what happened when the switch was closed. [5]

12 (a) Draw a labelled diagram to show the structure of an atom of the nuclide $^{12}_6\text{C}$. Indicate how much larger the diameter of the atom is compared with that of the nucleus. [6]

(b) The diagram illustrates an arrangement, all of which is enclosed in a vacuum, to investigate the deflection of α -particles by a very thin gold foil F. The metal sheets C have small holes in them to ensure that the beam of α -particles incident on F is a fine one. The detector D, connected to a ratemeter, may be moved round the arc MNPQ. The detector D, connected to a ratemeter, may be moved round the arc MNPQ.



(i) Explain why it is necessary for the whole apparatus to be enclosed in a vacuum. [2]

(ii) Name a type of detector suitable for use in this experiment. [1]

(iii) Nearly all of the α -particles incident on F pass straight through it, but a very small proportion is detected to the left of F in the diagram. Given that the atoms in the gold foil are known to be packed closely together, explain how an idea of the size of the nucleus relative to the whole atom may be obtained from these observations. Explain how **one** other property of the nucleus may be deduced from the results of this experiment. [5]

(c) An α -particle carries a charge of 3.2×10^{-19} C. A given narrow beam of α -particles carries a current of 1.0×10^{-7} A. Calculate the number of α -particles passing any point in the beam in one second. [3]