NAME:	NO:	CLASS:

ADMIRALTY SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2024

SUBJECT	:	Physics
CODE/PAPER	:	6091/2
LEVEL/STREAM	:	Secondary 4 Express
DATE	:	22 Aug 2024
TIME	:	0800h – 0945h
DURATION	:	1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions.
Write your answers in the spaces provided.

Section B
Answer **one** question.
Write your answers in the spaces provided.

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	/ 70
Section B	/ 10
Total	/ 80

DO NOT TURN OVER THIS PAPER UNTIL YOU ARE TOLD TO DO SO.

This question paper consists of **26** printed pages including this cover page.

Section A

Answer all questions.

1 Fig. 1.1 shows the speed-time graph for a rocket from the moment the fuel starts to burn at t = 0 s.

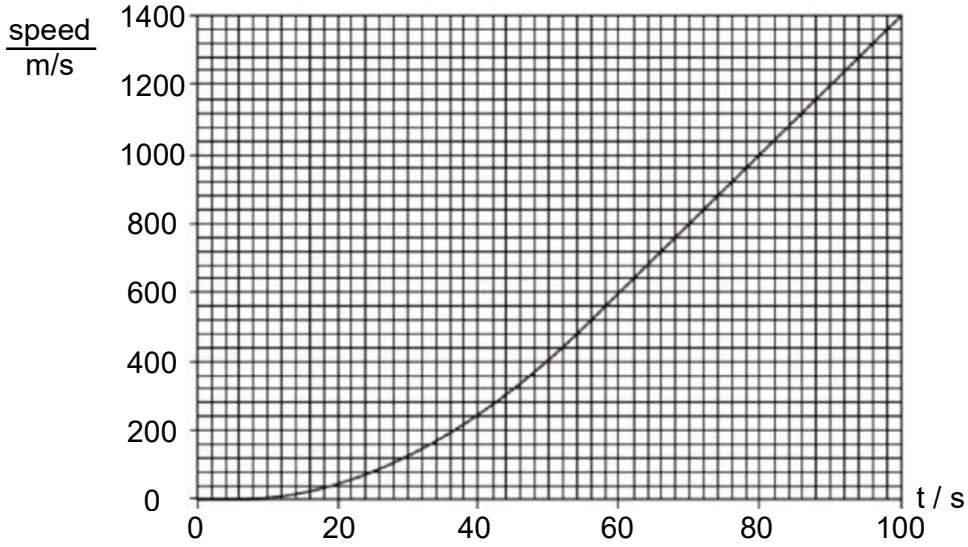


Fig. 1.1

(a) Describe the motion of the rocket between t = 5 s and t = 100 s.

.....

.....

.....

..... [3]

(b) The total mass of the rocket at t = 80 s is 1.6 x 10^6 kg.
Calculate the upward force on the rocket due to the burning fuel at this time.

upward force = ... [2]

2 A swing is made by connecting a car tyre to the wire using a rope and a hook. The wire hangs between two fixed points, as shown in Fig. 2.1.

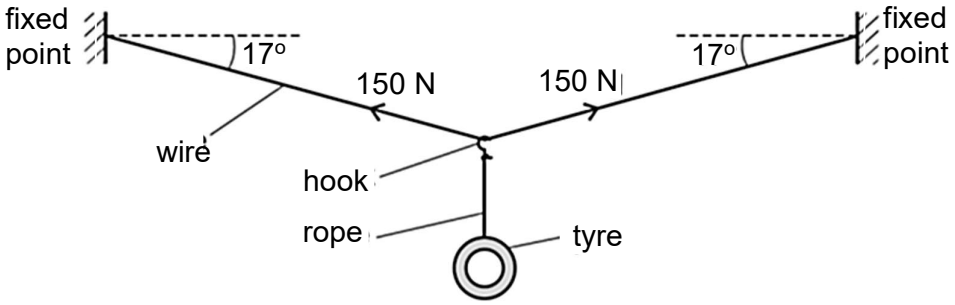


Fig. 2.1

The tyre is hanging in equilibrium with the wire hanging at an angle of 17° to the horizontal. The tension in the wire is 150 N. Assume that the rope and hook have negligible weight.

(a) In the space provided, draw a labelled diagram to show the resultant of the two tensions.

Determine the size of the resultant force and the direction between the resultant force and the horizontal.

scale = ……..

resultant force = ……..……

direction = ……... [4]

(b) State and explain the weight of the tyre.

……

……

…… [2]

3 Fig. 3.1 shows a trash bin with a lid opener mechanism. When the foot pedal is pressed, it pulls the rope downwards and exerts a tension force on the handle. This force creates a turning effect about the point X, allowing the lid to open.

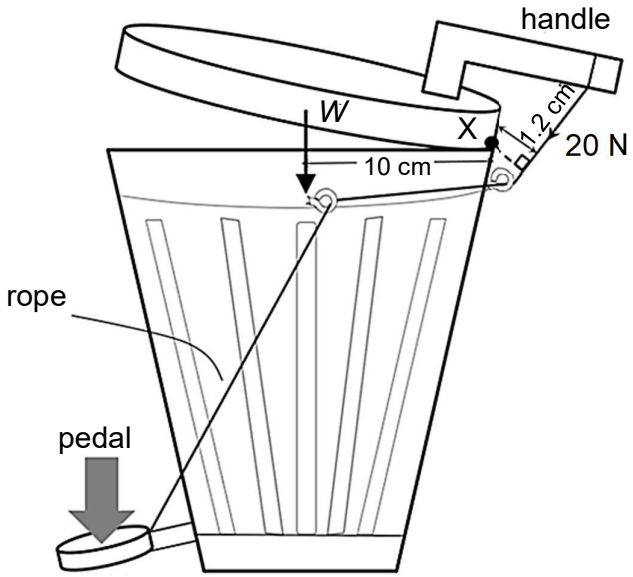


Fig. 3.1

(a) State what is meant by the "*Principle of Moments*".

……

……

…… [1]

(b) The perpendicular distance from the pivot X to the tension *T* in the rope is 1.2 cm.

Calculate the moment about X due to the tension in the rope.

moment = ... [2]

(c) The weight of the lid is *W*.

Hence, or otherwise, calculate the mass of the lid.

mass = ... [2]

(d) Suggest a modification to the design of this trash bin to improve its stability.

.....

..... [1]

4 Fig. 4.1 shows a manometer joined to a cylinder containing a gas.

The piston has a cross-sectional area of 0.050 m^2.

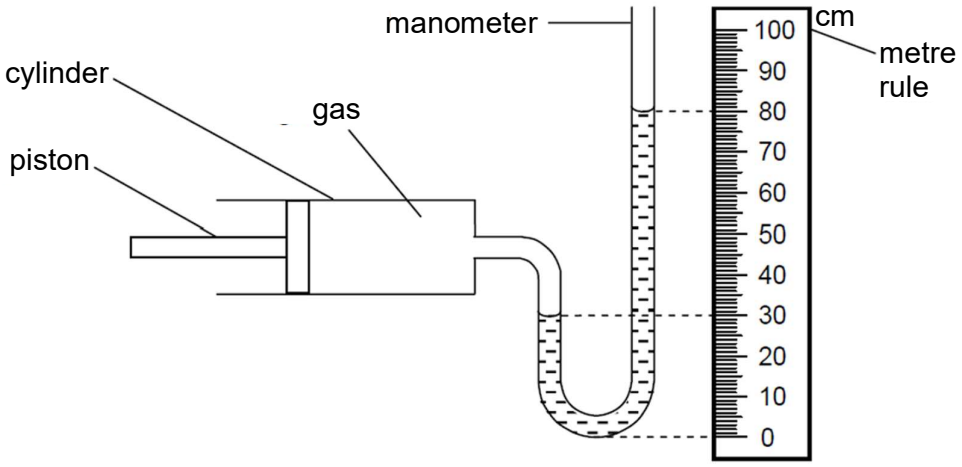


Fig. 4.1

A metre rule is placed beside the manometer.
The pressure exerted by the gas is 104 kPa. Take atmospheric pressure to be 100 kPa.
The gravitational field strength *g* is 10 N/kg.

(a) Determine the density of the liquid in the manometer.

density = ... [2]

(b) The cylinder is heated and the piston is allowed to move a distance of 8.0 cm. The pressure of the gas in the cylinder remains constant.

(i) Calculate the work done by the gas to move the piston.

work done = ... [2]

(ii) Explain, using the kinetic model of matter, why the pressure of the gas remains constant even though the cylinder is heated.

……..

……..

……..

…….. [3]

5 Fig. 5.1 shows a log sliding down an earth slope from X to Y to Z.

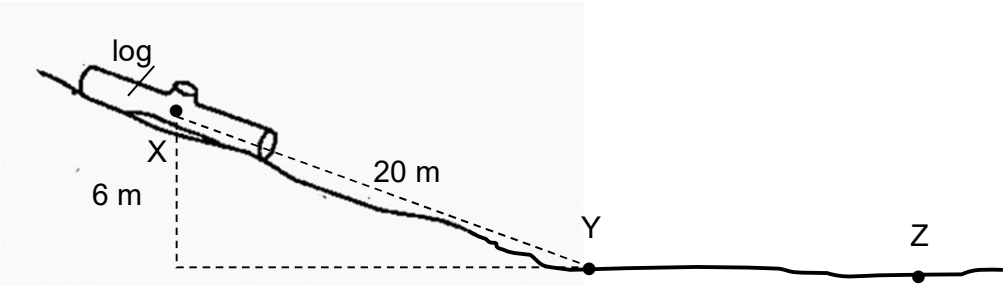


Fig. 5.1

(a) The log has a mass of 500 kg and its speed at point Y is 5.5 m/s. The gravitational field strength *g* is 10 N/kg.

(i) Calculate the energy in the kinetic store of the log at point Y.

energy in the kinetic store = ... [1]

(ii) Calculate the amount of work done against friction between X and Y.

work done = ... [2]

(b) The log stops at point Z.
Explain, using energy transfer, why the log stops.

……

……

…… [2]

6 In a particular experiment, a student suspended a 600 W immersion heater in a beaker of boiling water. He ensured that the heater was completely submerged in the water but did not touch the bottom of the beaker as shown in Fig. 6.1.

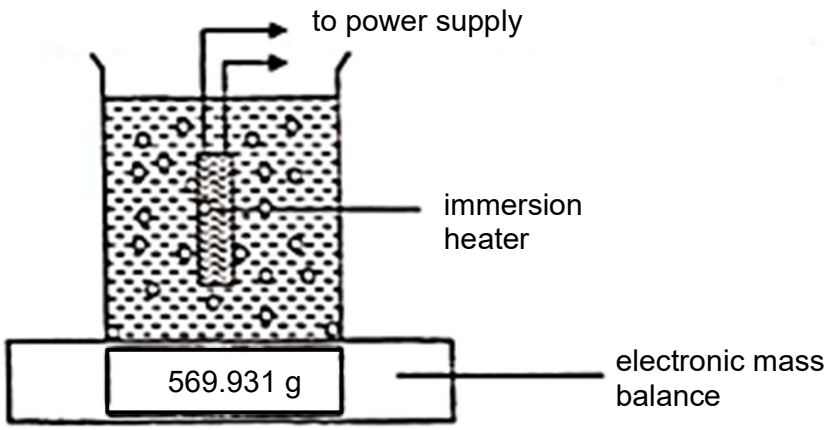


Fig. 6.1

He then placed the beaker with the immersion heater on an electronic mass balance and obtained the following readings:

reading on the mass balance when water started to boil = 569.931 g
reading on the mass balance after water boiled for one minute = 569.016 g

(a) (i) Calculate a value for the specific latent heat of vaporization of water, l_V.

l_V = ... [2]

(ii) State and explain whether you would expect the answer in part **(a)(i)** to be an overestimation or an underestimation of the actual value of l_V.

.....

.....

..... [2]

(b) The student repeats the experiment and inserts a thermometer at 30 °C into the boiling water using the same immersion heater for 1 minute.

The heat capacity of the thermometer is 28.5 J K^{-1}.

Assuming the thermometer reaches 100 °C at the end of the experiment, calculate the change in the mass of the boiling water.

mass = ……..…….. [3]

7 Fig. 7.1 shows the pressure-time graph of a sound wave with a frequency of 500 Hz.

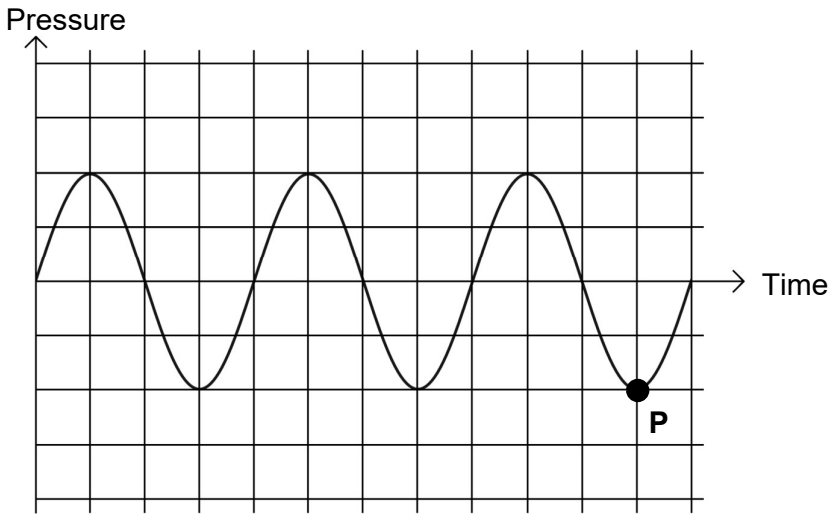


Fig. 7.1

(a) **(i)** Name the region of space represented by point P.

…….. [1]

(ii) On Fig. 7.1, draw the pressure-time graph of one period, a sound wave that is half as loud with frequency 250 Hz. [2]

(b) A sonar rangefinder on a boat emits a pulse of sound in water and detects an echo from the seabed 1.2 s later. The depth of the seabed is 900 m.

Calculate the speed of sound in water.

speed of sound = …… [2]

8 Fig. 8.1 shows an electrostatic precipitator. These are fitted in the chimneys of power stations fuelled by fossil fuels. They remove smoke from the waste gases and help to reduce pollution.

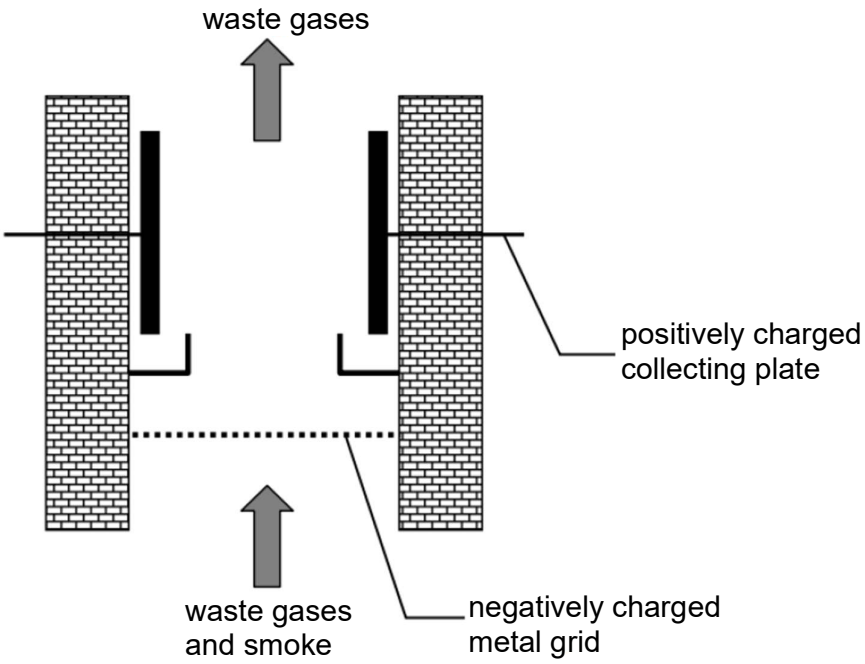


Fig. 8.1

(a) Explain why smoke rise up the chimney.

……..

…….. [1]

(b) When smoke particles pass through the metal grid near the bottom, they become negatively charged. Explain how the metal grid and the collecting plate help to remove the smoke particles from the waste gases.

……..

……..

……..

…….. [2]

(c) On Fig. 8.2, draw the electric field pattern outside a smoke particle.

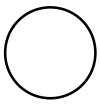


Fig. 8.2 [1]

9 **(a)** A student activated a Geiger Muller (GM) counter in a classroom. It was observed that the counter on the GM counter gave a reading even though there was no known source of radioactive emission.

(i) State what is meant by *radioactivity*.

……

…… [1]

(ii) Explain his observations.

……

…… [1]

(b) Uranium-234 (^{234}U) is a radioactive element. Fig. 9.1 shows the number of protons and neutrons in the nuclei of the elements formed when Uranium-234 decays.

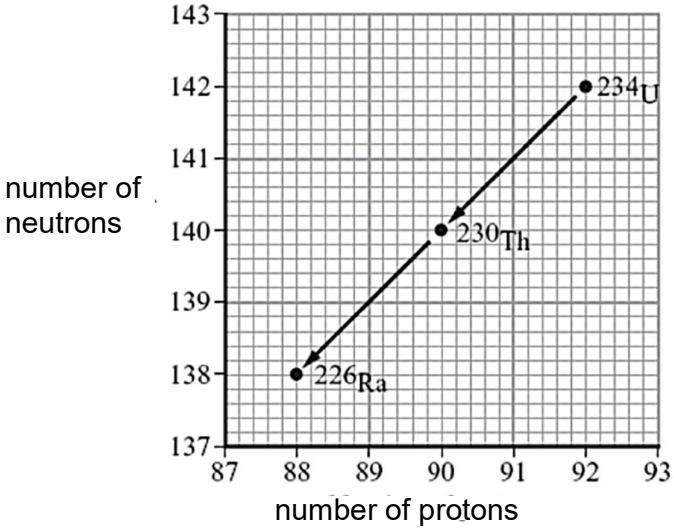


Fig. 9.1

Explain how Fig. 9.1 shows that uranium-234 (^{234}U) and thorium-230 (^{230}Th) emit alpha particles.

……..

…….. [1]

(c) The reading on a detector placed near a radioactive material is 536 counts per second. The background count rate is 44 counts per second. The half-life of the radioactive material is 34 hours.

Calculate the reading on the detector after 68 hours.

count rate = …… [2]

10 A student investigates the relationship between the potential difference (p.d.) across two electrical components, silicon diode and tungsten wire, and the current flowing through them.

(a) The p.d. across each component is increased gradually. The current is measured at various values of p.d. Table 10.1 shows the readings obtained.

	silicon diode	tungsten wire
p.d. / V	current / A	current / A
– 0.40	-1×10^{-10}	– 0.10
– 0.20	-1×10^{-10}	– 0.05
0.20	1×10^{-10}	0.10
0.40	1×10^{-8}	0.20
0.60	1×10^{-5}	0.30
0.80	0.10	0.40
1.00	0.60	0.50
1.20	1.20	0.55
1.40	0	0.58

Table 10.1

(i) Using data from Table 10.1, describe the relationship between the current and p.d. across the silicon diode for V = –0.40 V to 1.20 V.

……..

……..

……..

…….. [2]

(ii) The student then connects both components together in the circuit in parallel as shown in Fig. 10.1A, and in series as shown in Fig. 10.1B.

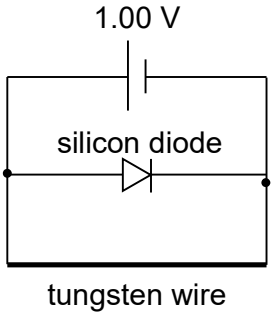


Fig. 10.1A

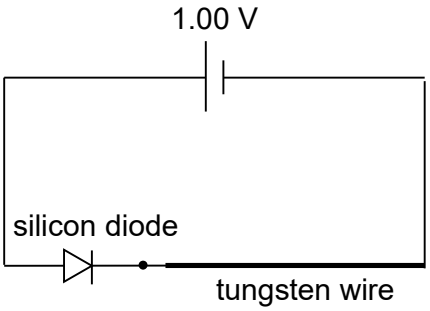


Fig. 10.1B

Using information from Table 10.1, calculate

1. the current flowing through the battery when the components are connected in parallel,

current = …… [2]

2. a possible value for the resistance of the diode when the components are connected in series.

resistance = …… [2]

(iii) Suggest a reason why the current flowing through the silicon diode is 0 A when the p.d. across it is 1.40 V.

……..

…….. [1]

(b) The tungsten can be used as a filament for a light bulb.

Table 10.2 gives some information about a tungsten filament.

input voltage	240 V
input current	0.50 A
efficiency	2.1 %

Table 10.2

(i) State what is meant by the *efficiency of the light bulb is 2.1%*.

……..

…….. [1]

(ii) Calculate the amount of energy transferred from the tungsten filament in 1 second.

energy = ……..…… [2]

11 (a) Fig. 11.1 shows a straight wire AB being moved across a magnetic field. A galvanometer is connected across the wire AB.

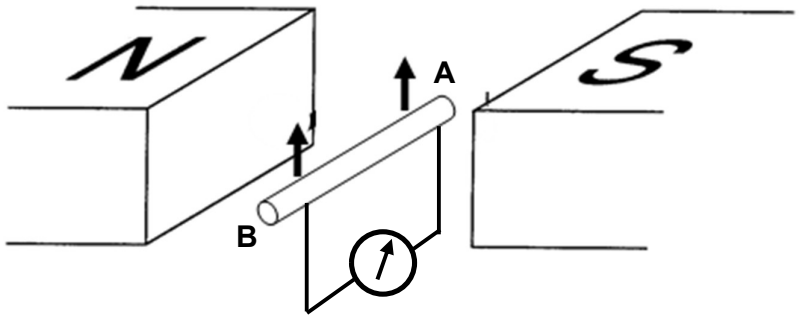


Fig. 11. 1

As wire AB is being moved upwards between the magnetic poles, the needle of the galvanometer connected across wire AB deflects to the right.

(i) State the direction of the induced current on wire AB as it is being moved downwards between the magnetic poles.

……

…… [1]

(ii) Explain what happens to the needle of the galvanometer when wire AB is held stationary between the magnetic poles.

……

…… [1]

(b) The wire AB is then replaced by a single loop of wire, which is rotated at a constant speed between the magnetic poles, as shown in Fig. 11.2.

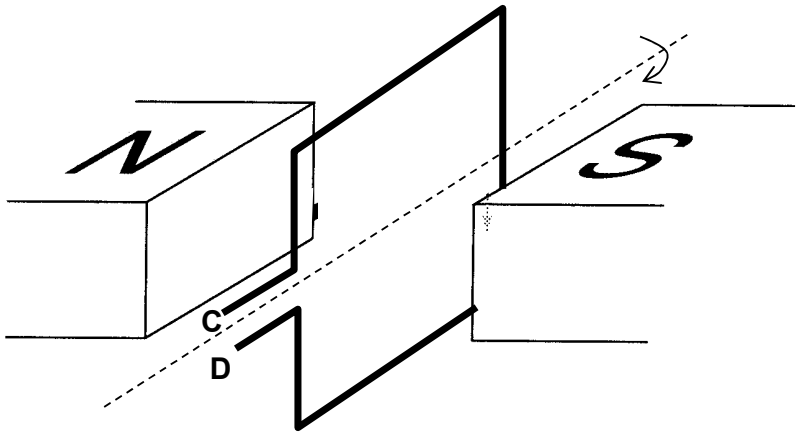
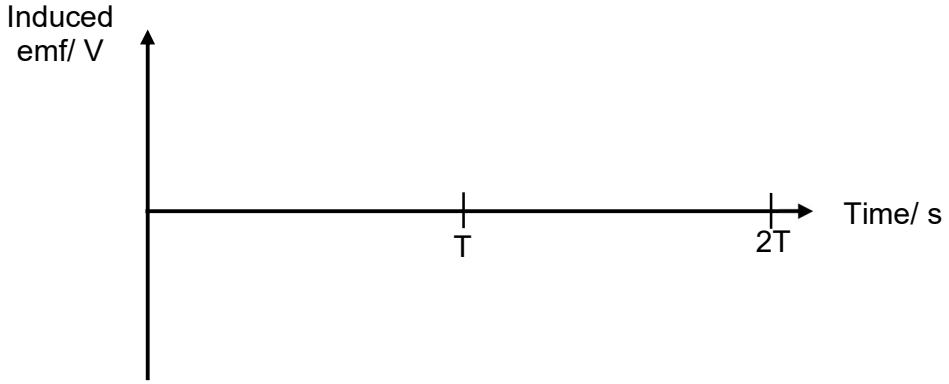


Fig. 11.2

(i) Sketch a graph of the induced e.m.f. across CD, the two ends of the loop, against time when the coil is rotated from the initial position, as shown in Fig. 11.2 when it makes two complete rotations.

Assume that the magnetic field within which the loop rotates in is uniform and the time taken for one complete rotation is “T”. [2]



(ii) On the graph drawn in **(bi)**, sketch a second graph in dotted lines when the coil is rotated in the opposite direction and at two times the speed within 2T. [2]

(c) Describe an experiment to check the relationship between the number of turns of wire and the magnitude of the induced current generated.

In your account

- draw a labelled diagram of the experiment,
- describe the procedure to be taken.

.....

.....

.....

.....

.....

.....

..... [4]

Section B

Answer **one** question from this section.

12 Fig. 12.1 shows the electrical wiring in a water heater. It consists of a heater coil rated '240 V, 2500 W' and an exhaust fan rated '240 V, 300 W'. The mains supply 240 V to the water heater.

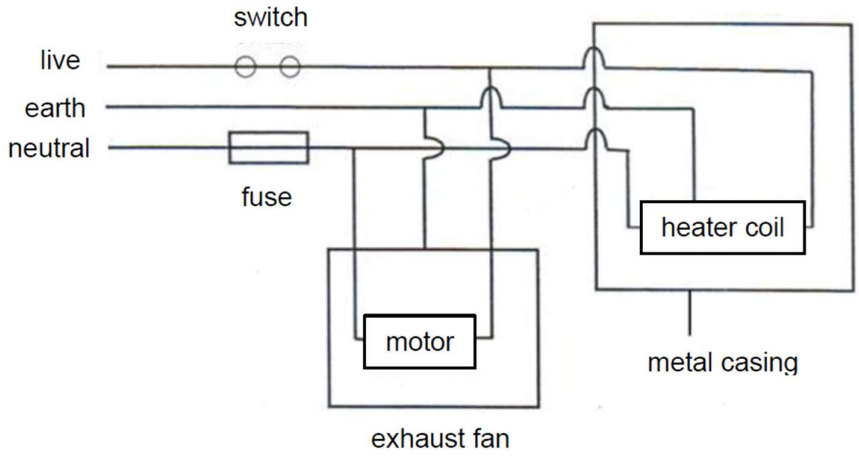


Fig. 12.1

(a) Identify **two** mistakes in the wiring of the circuit in Fig. 12.1 and describe how they should be corrected.

1. ……..

……..

2. ……..

…….. [2]

(b) The fuse rating of the fuse in Fig. 12.1 is 11 A.

(i) Explain the function of the fuse.

……..

……..

…….. [3]

(ii) Explain, with the help of calculations, why the fuse in this circuit is unsuitable.

……..

……..

…….. [3]

(c) Both appliances are used for 20 minutes each day. Each kWh of electrical energy costs 25 cents.

Calculate the total cost of electrical energy consumption for 30 days.

total cost = ……..……. [2]

13 An experiment to investigate the refractive indexes of four types of glasses P, Q, R and S is conducted as shown in Fig. 13.1.

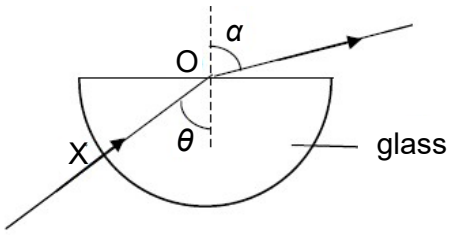


Fig. 13.1

Light is directed through the semicircular glass to the midpoint O. The angle of refraction α for every corresponding angle of incidence θ is recorded. The plots of $\sin\theta$ against $\sin\alpha$ of each glass are shown in Fig. 13.2.

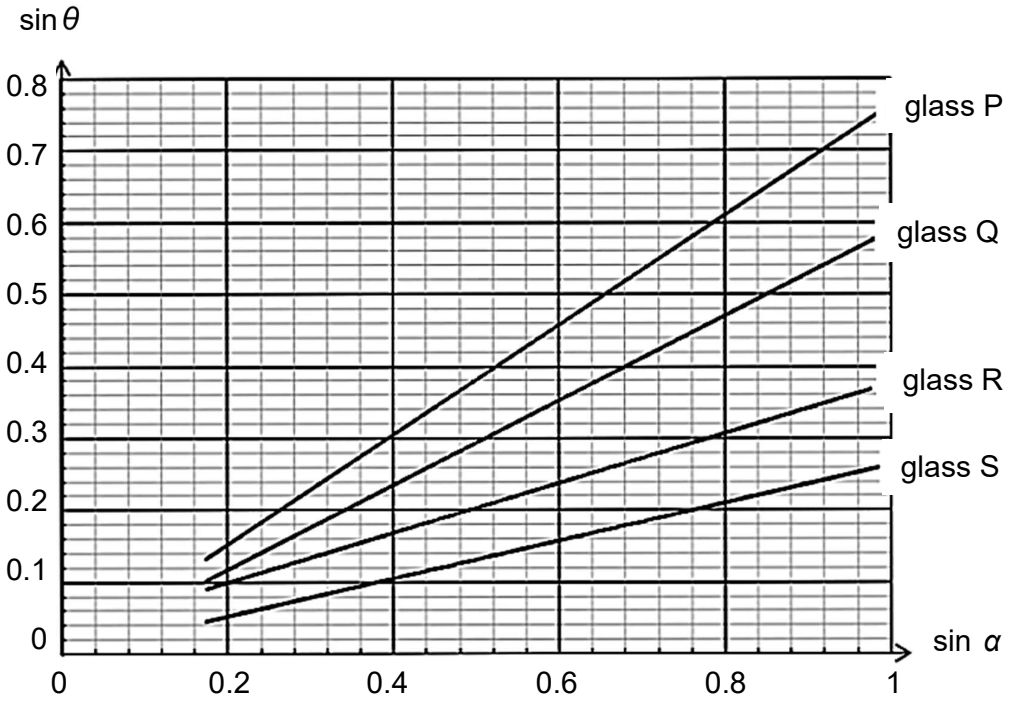


Fig. 13.2

(a) Define the term '*refractive index of glass*'.

.....

..... [1]

(b) Explain why the ray does not bend as it enters the glass at X, as shown in the figure.

……

…… [1]

(c) State and explain which type of glass, P, Q, R or S, causes the light to bend the least in the air when light ray emerges from the glass.

……

……

…… [2]

(d) Calculate the speed of light in glass Q.

speed = …… [2]

(e) There is an error in the data collected for glass R.
With reference to Fig. 13.2, state one evidence that suggests this error.

……

…… [1]

(f) The figure below shows glass R placed in silicone oil.

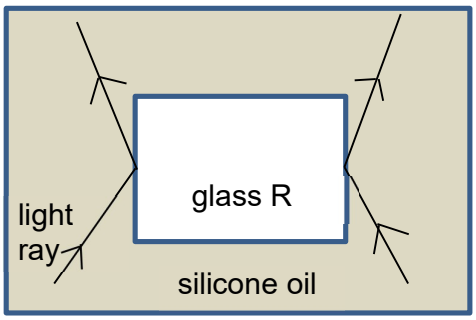


Fig. 13.3

Light is incident on the vertical faces of the piece of glass. The different paths of the light are shown in Fig. 13.3.

Explain why the rays of light do not enter the glass in Fig. 13.3.

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.....

.....

.....

..... [3]

END OF PAPER