TANJONG KATONG SECONDARY SCHOOL

Preliminary Examination 2024

Secondary 4

NAME

CLASS

INDEX NUMBER

PHYSICS 6091/02

Paper 2 **19 August 2024**

1 hour 45 minutes

Candidates answer on the Question Paper.

No Addtional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class in the spaces at the top of this page and on all separate answer paper used.
Write in dark blue or black pen.
You may use a HB pencil for any diagrams, graphs, or rough working.
Do not use staples, paper clips, glue, or correction fluid.

Section A
Answer **all** the questions in the spaces provided.

Section B
Answer only **one** out of these two questions..

Answer **all** questions in the space 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.

My Predicted Grade

Before doing assessment:	After doing assessment:

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

This document consist of **22** printed pages, and 2 blank pages.

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Section A
Answer **all** questions.

1 A stone falls from the top of a cliff into the sea, as shown in Fig. 1.1a.
The speed time graph for the stone is shown in Fig. 1.1b.

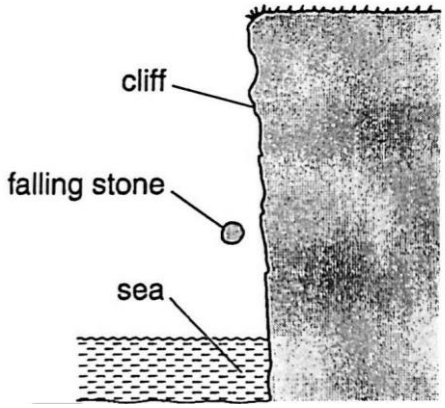

Fig. 1.1a

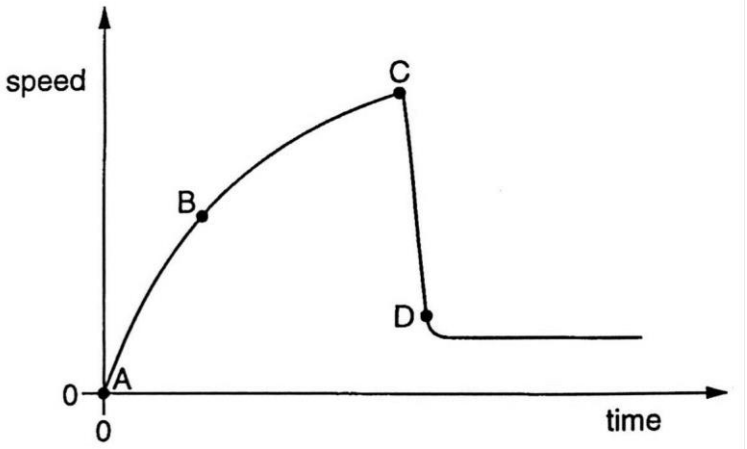

Fig. 1.1b

(a) Describe how the acceleration of the stone changes between point A and point D.

……

……

……[2]

(b) Explain, in terms of the forces acting, why the acceleration changes between point A and point B.

……

……

……

……[3]

(c) Explain how Fig. 1.1b shows that the stone does not reach terminal velocity in the air.

……

……[1]

[Total: 6]

2 A ramp of weight 165 N and length 260 cm is fixed to a lorry, as shown in Fig. 2.1.

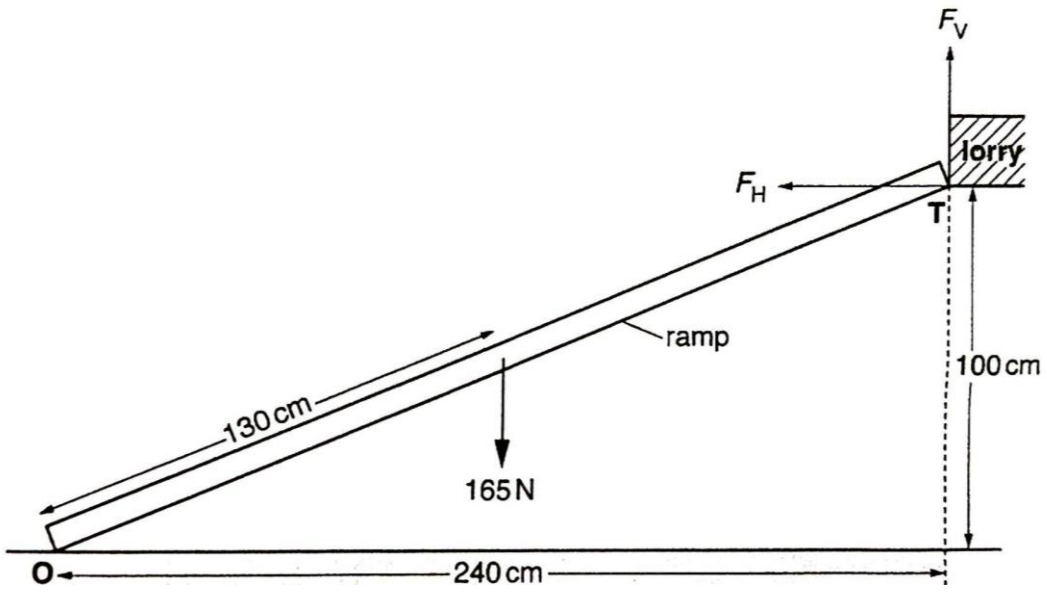

Fig. 2.1

The end O of the ramp is 240 cm horizontally away from the end of the lorry. The top T of the ramp is 100 cm above the ground. The weight of the ramp acts through the mid-point of the ramp. The lorry exerts a horizontal force F_H and a vertical force F_V on the ramp at T, as shown in Fig. 2.1.

(a) Calculate the clockwise moment about the end O of the ramp.

moment = ……[2]

(b) A man standing on the ramp begins to climb the ramp.

(i) State and explain how the clockwise moments about point O change, if at all, as the man moves up the ramp.

……

……

……

……[2]

(ii) Suggest the point at which another force must act on the ramp.

……[1]

(iii) By considering moments about the top T of the ramp, explain why this other force is necessary.

……..……..…

……..……..…

……..……..…

……..[2]

[Total: 7]

3 Students A and B are preparing for a talent show. In the show, a water balloon will be dropped on student B's head from different heights. Student A lifts the water balloon to a height 5.0 m above student B's head using a pulley as shown in Fig. 3.1.

The mass of the water balloon is 1.6 kg.

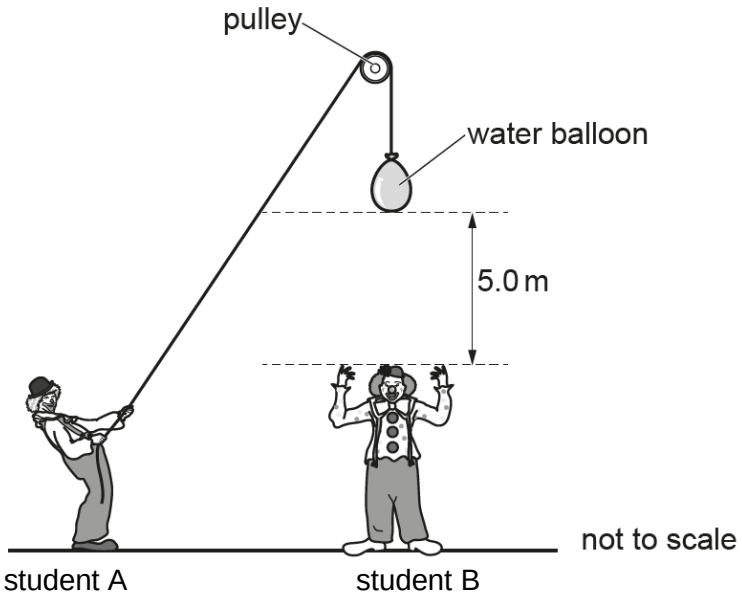

Fig. 3.1

(a) Assuming the balloon does not change shape, explain how the Principle of Conservation of Energy applies during the impact when the water balloon hits student B's head.

……

……

……

……

……

……..[3]

(b) Calculate the minimum work that must be done by student A to lift the water balloon a height of 5.0 m.

work done = ……[2]

(c) Use your answer to **(b)** to calculate the maximum possible speed of the water balloon when it hits student B's head.

speed = ……[2]

[Total: 7]

4 A page of printed text as shown by the line AB is placed 18 cm from a converging lens of focal length 35 cm.

Fig. 4.1 is a scale diagram of the arrangement with each of the two principal focal points of the lens labelled F.

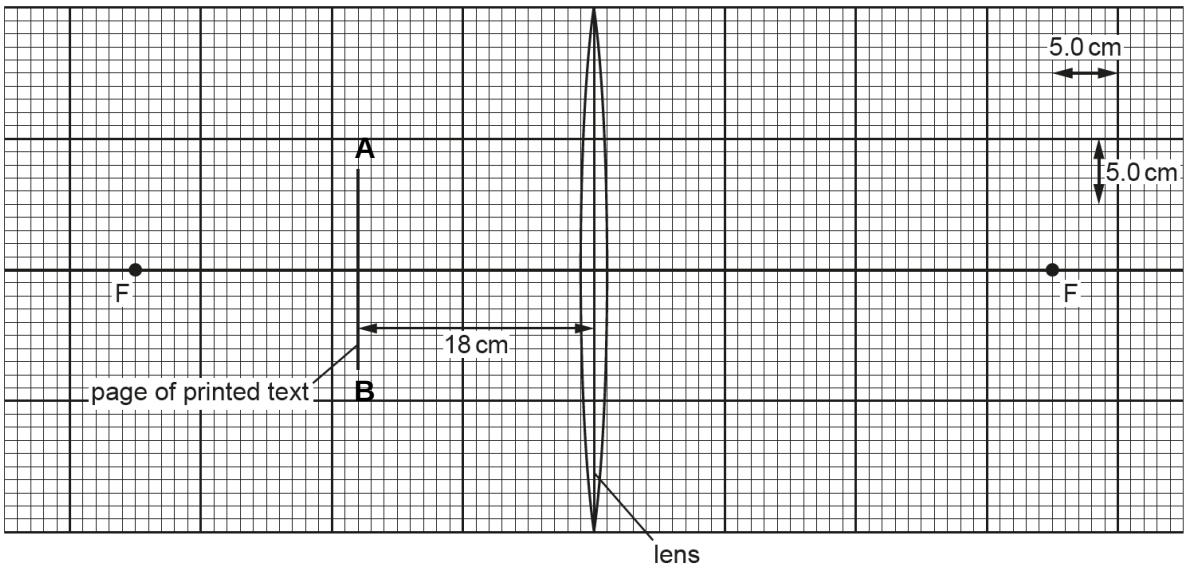

Fig. 4.1

(a) By drawing on Fig. 4.1, locate the image of the page AB produced by the lens and label it I. [3]

(b) Explain whether the image produced is real or virtual.

……

……[1]

(c) The object is moved away from the lens until the object distance is greater than the focal length. State two changes that this causes to the image.

……

……

……[2]

[Total: 6]

5 Fig. 5.1 shows a hydraulic press used to punch a hole in a thin sheet of metal.

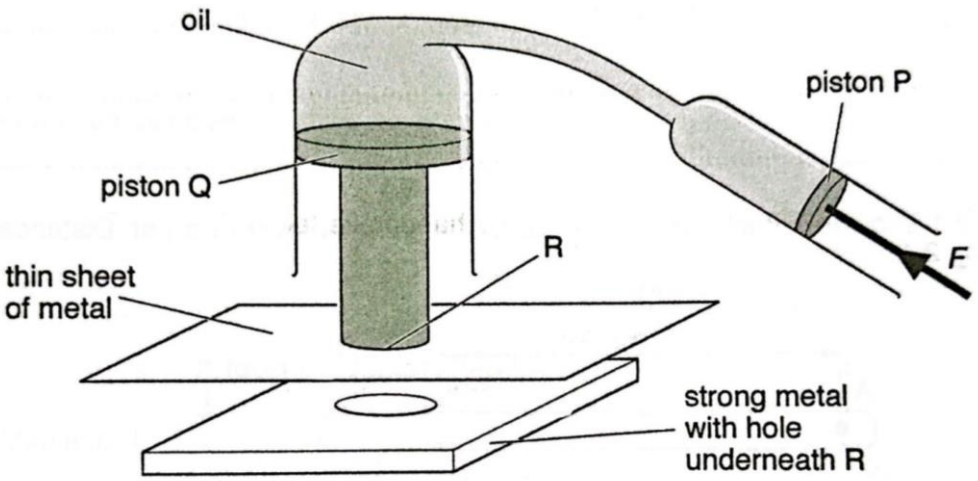

Fig. 5.1 (not to scale)

The operator exerts a force *F* on piston P. The atmosphere also exerts a force on P in the same direction as *F*. Piston P remains stationary.

The atmospheric pressure is 1.0×10^5 Pa and the pressure inside the oil is 4.0×10^5 Pa.
The cross-sectional area of piston P is 70 μm^2.
The weight of piston Q is negligible.

(a) Calculate

(i) the force that the atmosphere exerts on piston P,

force = …… [1]

(ii) the force that the oil exerts on piston P,

force = …… [2]

(iii) force *F.*

force = …… [1]

(b) A worker commented that the force exerted on the metal plate at R is smaller than *F*. State and explain if you agree with his comment.

……

……

……...……[2]

[Total: 6]

6 Fig. 6.1 shows a machine producing sandpaper using static electricity. Glue is sprayed onto the moving paper from the glue spray gun. As glue is forced out of the nozzle, glue breaks up into small negatively charged droplets and spread out evenly on the paper.

Next, the sticky paper passes between metal plates. Sand moving on a conveyor belt also passes between the metal plates. Sand moves upwards and sticks onto the paper as they pass through the metal plates.

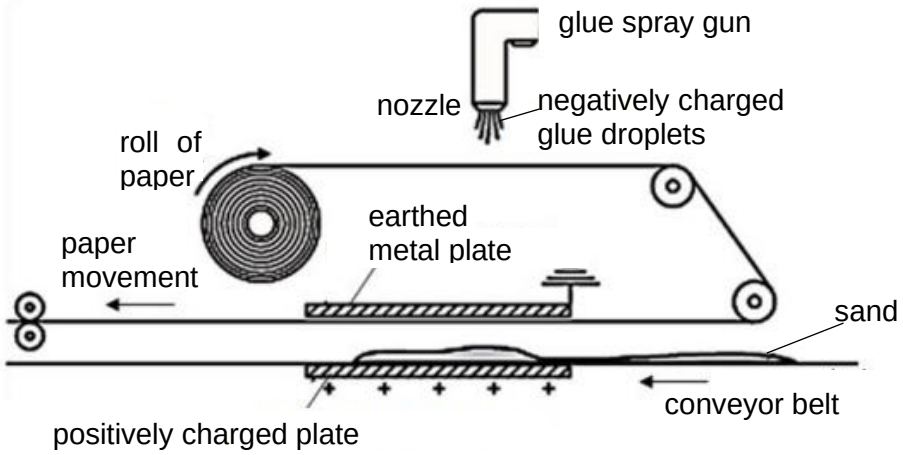

Fig. 6.1

(a) Describe and explain why glue becomes negatively charged after passing through the nozzle of the glue spray gun.

……

……

……..…….[2]

(b) Explain why glue droplets spread out evenly after leaving the nozzle.

……

……..…….[1]

(c) Describe and explain why sand moves upwards and sticks onto the paper as they pass through the metal plates.

……

……

……

……..…….[2]

[Total: 5]

7 The voltage of a power supply P varies with time as shown in Fig. 7.1.

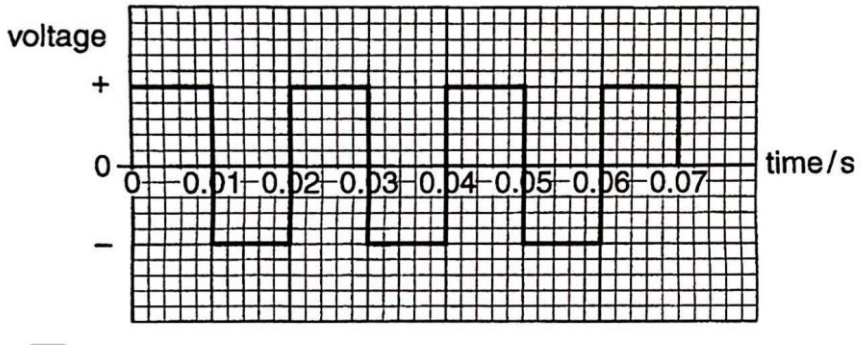

Fig. 7.1

The direction of the voltage changes every 0.01 s.

A coil of wire is wrapped around an iron core and connected to power supply P. An iron rod is suspended close to one end of the core and a small bar magnet is suspended close to the other end, as shown in Fig. 7.2.

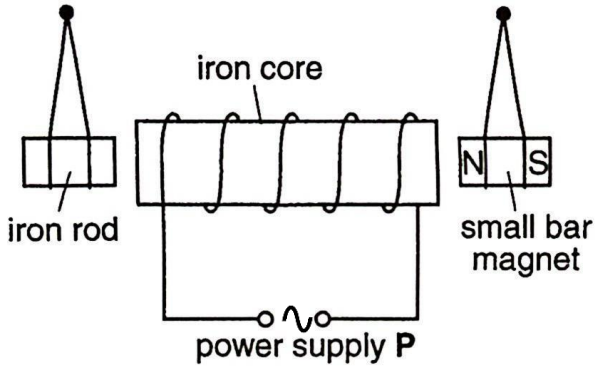

Fig. 7.2

(a) Power supply P is switched on.

Explain why the iron rod is always attracted to the iron core but the force on the bar magnet varies.

……

……

……

……

……

……[3]

(b) The iron rod is removed and the bar magnet is attached to a cone of paper to make a simple loudspeaker using the same power supply P, as shown in Fig. 7.3.

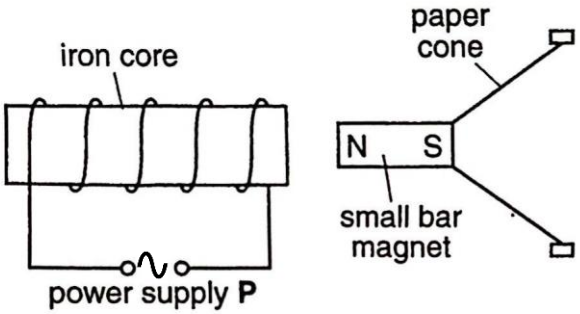

Fig. 7.3

The magnet causes the paper cone to vibrate, producing a sound wave in the air.

Calculate the frequency of the sound wave.

frequency = ……[1]

(c) Power supply P is now replaced with a second power supply Q that causes the speaker to produce a sound wave of frequency 240 Hz.

(i) The speed of sound in air is 330 m/s. Calculate the wavelength of this new sound wave.

wavelength = …… [1]

(ii) The current in the coil from power supply Q is reduced.

Describe and explain the change in the sound produced by power supply Q.

……..……..

……..……..

……..……[2]

[Total: 7]

8 A radioactive source, which emits beta-particles, is used as shown in Fig. 8.1 to detect whether cartons on a conveyor belt have the required volume of pineapple detergent in them.

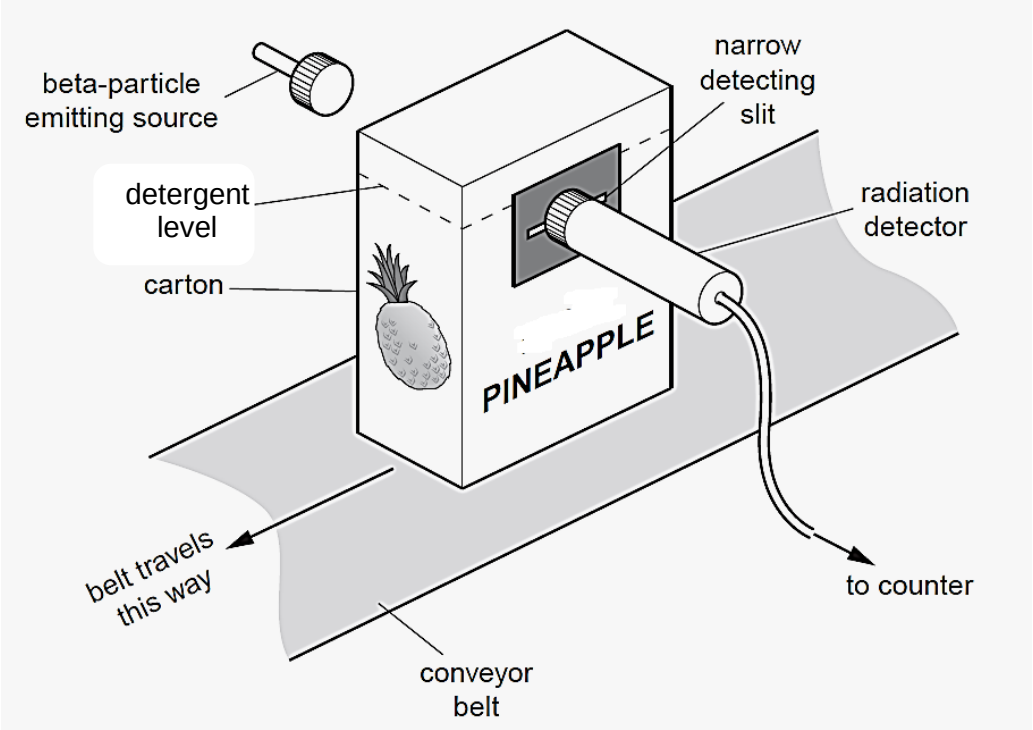

Fig. 8.1

(a) State why a gamma-emitting source would not be suitable for this application.

……..[1]

(b) Table 8.1 shows 2 choices of beta-emitting sources that are used by the factory.

Table. 8.1

source	half-life
barium - 139	85 minutes
strontium - 90	28 years

Suggest an advantage for each of the two sources to be used in the factory.

barium - 139: ……..……..

……..

strontium - 90: ……..

……..[2]

(c) The equipment is set to give a reading of 150 counts / s when there is a carton with the correct amount of pineapple detergent between the source and the detector.

Tick the appropriate boxes in Table 8.2 to indicate what reading would be expected in each situation.

Table 8.2

	reading		
	more than 150 counts / s	150 counts / s	less than 150 counts / s
carton containing too little detergent			
carton containing too much detergent			
no carton at all			

[3]

[Total: 6]

9 A student sets up the circuit shown in Fig. 9.1.

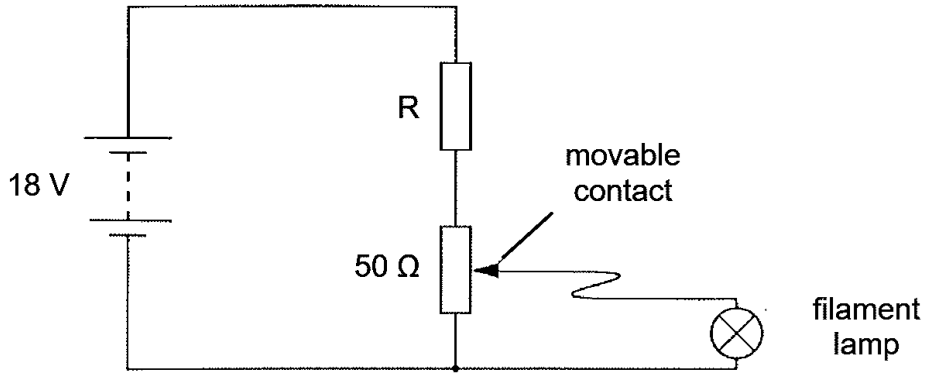

Fig. 9.1

R is a fixed resistor in the circuit. The filament lamp is marked 12 V, 0.25 A. The circuit is used to produce a current-voltage graph for the filament lamp. The ammeter and voltmeter needed are not shown. To obtain different readings of the ammeter and voltmeter, the student changes the position of the movable contact.

(a) Explain what is meant by *current is 0.25 A* in the lamp.

……

……....[1]

(b) Explain why it is sensible to include resistor R in this circuit.

……

……

……....[2]

(c) **(i)** On Fig. 9.2, sketch a current-voltage graph for the lamp.

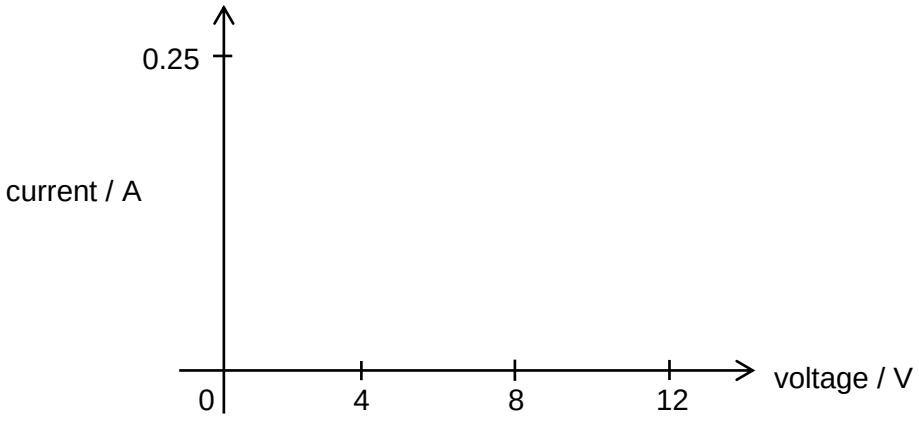

Fig. 9.2 [1]

(ii) State and explain how a current-voltage graph for a fixed resistor is different from the graph of a filament lamp.

……..……..…

……..[1]

(d) Fig. 9.3 shows the position of the movable contact when the voltage across the lamp is 12 V and the current in the lamp is 0.25 A.

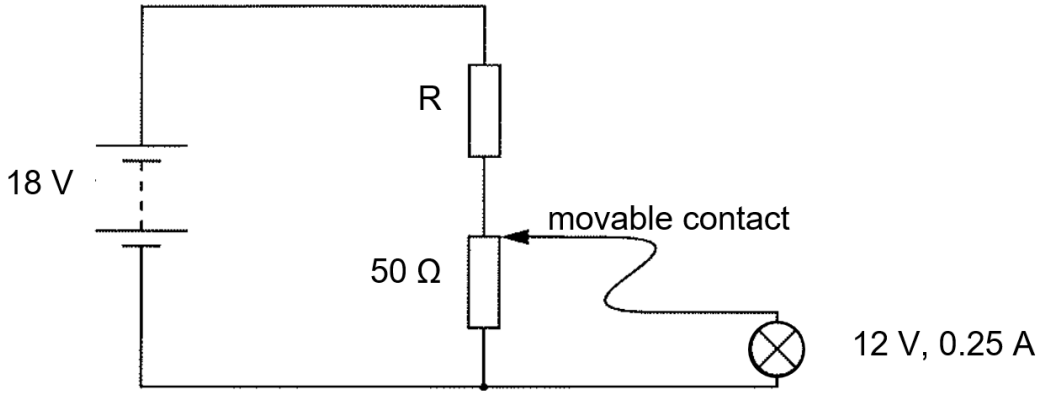

Fig. 9.3

Determine

(i) the current in the 50 Ω resistor,

current = ……[2]

(ii) the current in R,

current = ……[1]

(iii) the potential difference across R,

potential difference = ……[1]

(iv) the resistance of R.

resistance = ……[1]

[Total: 10]

10 A student performed an experiment using the apparatus as illustrated in Fig. 10.1.

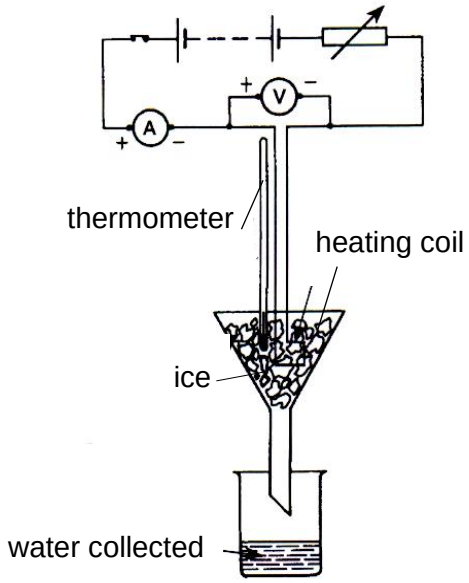

Fig. 10.1

A heating coil was placed in a filter funnel and surrounded by lumps of ice. The potential difference *V* across the heater and mass *m* of water collected in time t of 500 s were measured for various values of the heater current *I*.

The values were recorded and a spreadsheet was used to make calculations as shown in table 10.1.

Table 10.1

	A	**B**	**C**	**D**	**E**
	potential difference, *V* / V	current, *I* / A	mass of water collected, *m* / g	time taken, *t* / s	thermal energy supplied, *Q* / J
1	4.0	2.0	14.9	500	4000
2	6.0	3.0	29.8	500	9000
3	7.0	3.5	39.5	500	12 250
4	8.0	4.0	50.6	500	

(a) Determine the relationship between the potential difference and the current.

……

……[1]

(b) Calculate the thermal energy supplied when the mass of the water collected was 50.6 g.

thermal energy supplied = ……[1]

(c) The student wishes to find out the value of the specific latent heat of fusion of ice. He chose the data values from row 3 to do the calculation.

(i) State what is meant by *specific latent heat of fusion of ice*.

……

……[2]

(ii) Determine the value of the specific latent heat of fusion of ice.

specific latent heat of fusion of ice = ……[2]

(d) Later, the student discovered that four values of the specific latent heat of fusion of ice calculated from each row of data were less than the actual value of 336 J/g.

(i) Calculate the efficiency of the heating coil using row 1 data values using the actual value of specific latent heat of fusion of ice = 336 J/g.

efficiency = ……[2]

(ii) Explain how the answer in **(d)(i)** is sensible in terms of energy transfer.

……

……[1]

(iii) Suggest an improvement to the experiment to obtain a more accurate reading of specific latent heat of fusion of ice.

……

……[1]

[Total: 10]

Section B

Answer **one** question from this section.

11 Fig. 11.1 shows an 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.

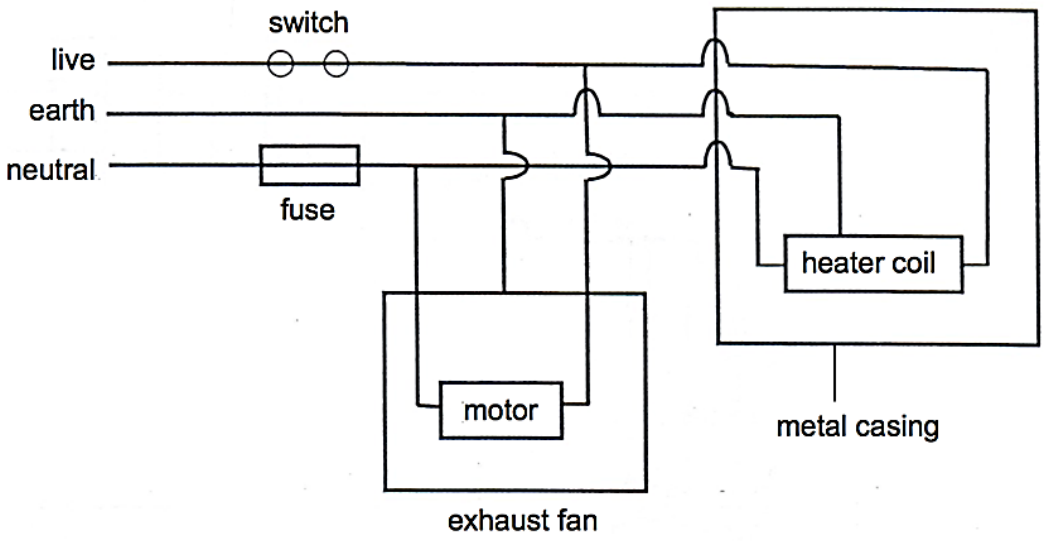

Fig 11.1

(a) Explain how a fuse protects the circuit.

……..……...

……..……...

……..……..……..……..[2]

(b) The fuse rating in Fig 11.1 is 11 A.

Explain, with clear calculation, why the fuse is not suitable.

explanation: ……..……..……..……..[2]

(c) Identify two other faults in Fig 11.1 and describe how they should be corrected.

1…..……..…….……...

……...……...……..……..[1]

2…..……..…….……...

……...……...……..……..[1]

(d) Calculate the effective resistance of the whole circuit when both appliances are operating at the same time.

effective resistance = ……..….[2]

(e) Both appliances are used for 15 minutes daily. Calculate the cost of energy consumption for 30 days, assuming 1 kWh of energy costs 25 cents.

cost of energy consumption = …….[2]

[Total: 10]

12 Fig. 12.1 shows a type of motor. PQ and RS are solenoids. The solenoids and the coil ABCD are connected in parallel to a battery. The coil ABCD is rotating between solenoids PQ and RS which act as an electromagnet with unknown poles. The coil has a width of 5.0 cm.

When the coil rotates, it produces a resulting moment, M, as shown in Fig. 12.2.

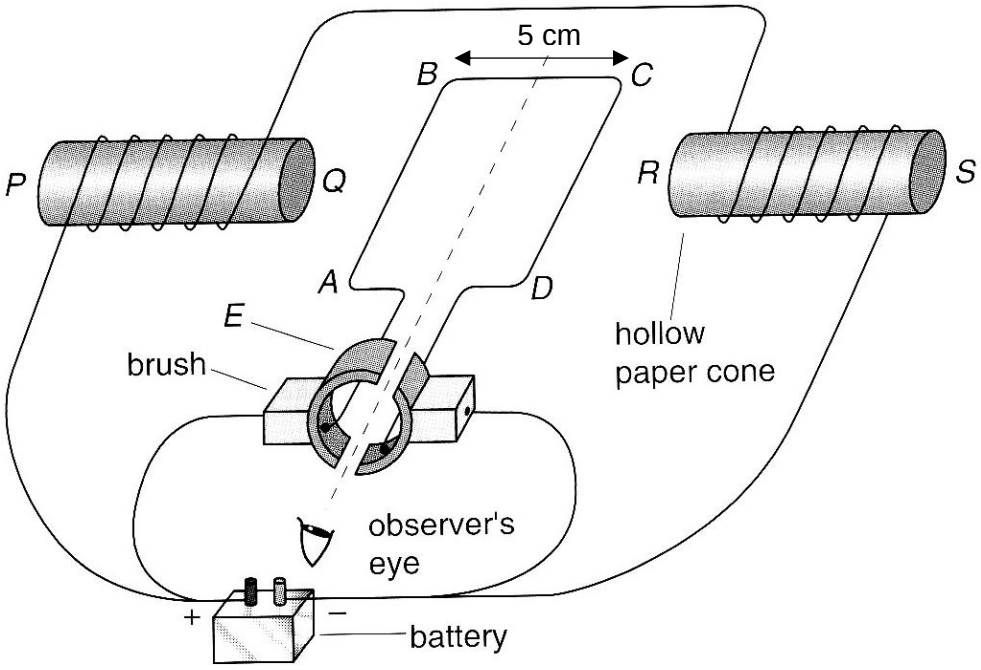

Fig. 12.1

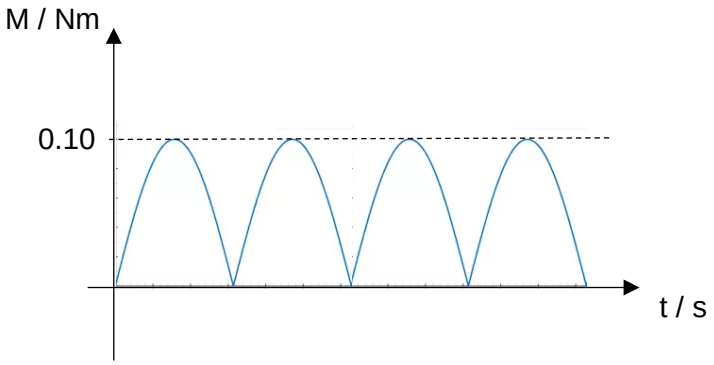

Fig. 12.2

(a) **(i)** State the polarity at end Q.

polarity at end Q = ……[1]

(ii) On Fig. 12.1, draw the direction of current at the side AB and CD. [1]

(iii) State and explain the direction of the force on the side CD of the coil.

……

……

……

……

……

……

……

……[3]

(b) **(i)** Using Fig. 12.2, calculate the maximum force F, on each side of the coil.

maximum force, F = ……[2]

(ii) Explain how Fig. 12.2 shows that the coil rotates continuously.

……

……[1]

(c) Identify part E and explain how it ensures that the rotation continues.

……

……

……

……

……

……[2]

End of Paper [Total: 10]

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