O

GAN ENG SENG SCHOOL
Preliminary Examination 2024

CANDIDATE NAME			
CLASS		**INDEX NUMBER**	

PHYSICS
Paper 2

6091/02

28 August 2024
1 hour 45 minutes

Sec 4 Express

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
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**

Section A [70 marks]

Answer **all** the questions in this section.

1 In a car race called “demolition derby”, collisions between cars are common. Fig. 1.1 is a graph showing the motion of a car during the race.

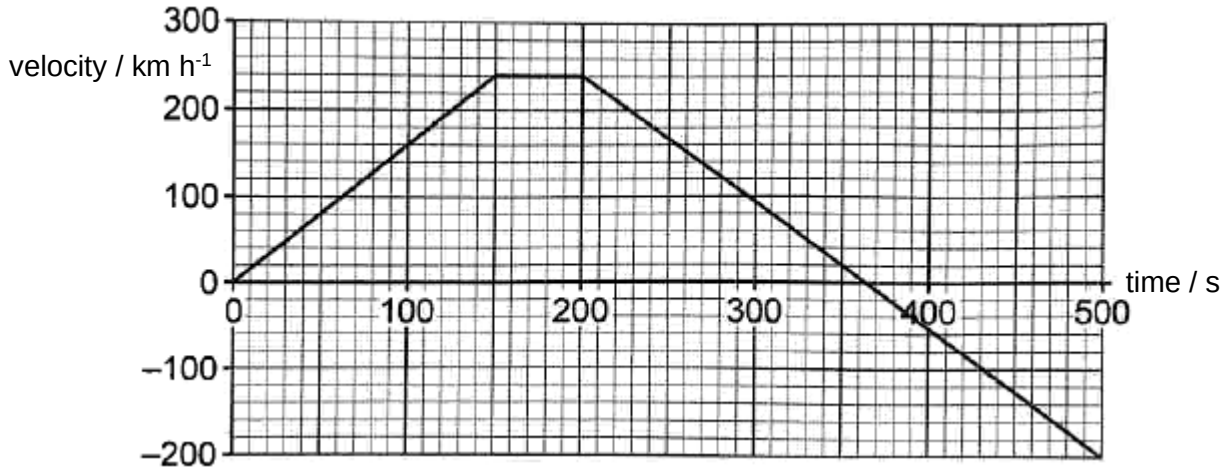

Fig. 1.1

(a) Estimate the displacement of the car at 500 s.

displacement = ... [2]

(b) Estimate the average speed of the car from 0 s to 500 s.

average speed = ... [2]

[Total: 4]

2 A rock of weight 20 N is thrown through the air. At a particular time, a force of 50 N acts on the rock at an angle of 45 ° to the vertical, as shown in Fig. 2.1.

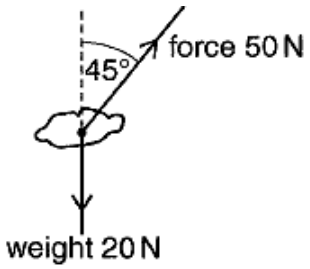

Fig. 2.1 (not to scale)

(a) Draw and label, with the letter *R*, the resultant force acting on the rock where a length of 1.0 cm represents 5.0 N. Determine the direction of the resultant force.

resultant force = ... [2]

direction ..... [1]

(b) When the rock reached the highest point at a height of 15.0 m above the ground, it momentarily stopped and then dropped down vertically. If air resistance is negligible, calculate the speed of the rock just before it hit the ground.

speed = ... [2]

[Total: 5]

3 The device shown in Fig. 3.1 is used to covert old newspapers into blocks that can be burnt.

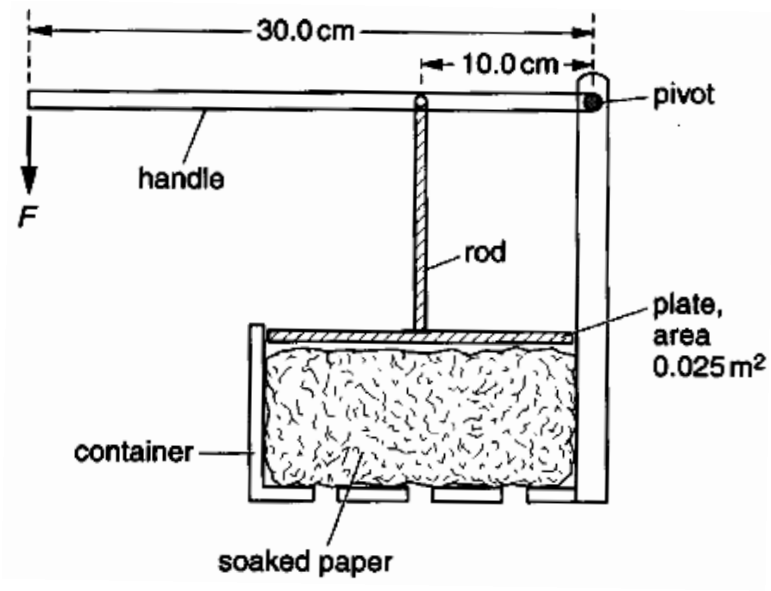

Fig. 3.1 (not to scale)

The newspapers are soaked in water. The soaked paper is packed into the container. When a force *F* is applied at the end of the handle, the plate squeezes the water out of the paper and leaves a block.

The area of the plate in contact with the paper is 0.025 m^2. The perpendicular distance from the pivot to the rod holding the plate is 10.0 cm. A force *F* is applied normal to the handle at a distance 30.0 cm from the pivot. A *pressure of 7.2 kPa* is needed to squeeze the water out of the paper.

(a) State what is meant by *pressure of 7.2 kPa*.

.....

..... [1]

(b) Calculate

(i) the force that is exerted by the rod to cause a pressure of 7.2 kPa on the paper,

force = ... [2]

(ii) the force *F* applied at the end of the handle to exert a pressure of 7.2 kPa on the paper.

force *F* = ... [2]

[Total: 5]

4 Fig. 4.1 shows a hand dryer.

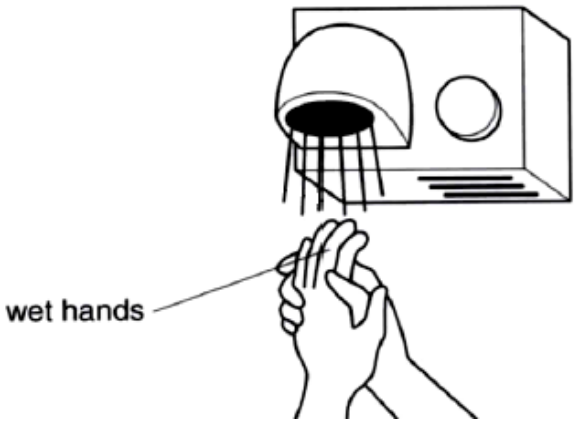

Fig. 4.1

The hot air that blows out of the dryer causes evaporation of water from the hands.

(a) Explain why the water on the hands evaporates rather than boils.

.....

..... [1]

(b) Describe, using the kinetic particle model of matter, what happens to the water on the hands as it evaporates.

.....

.....

.....

..... [2]

(c) State the main electromagnetic wave that transfers heat to the hand.

..... [1]

(d) State **one** difference and **one** similarity between this electromagnetic wave and sound produced by the dryer.

Difference .....

..... [1]

Similarity .....

..... [1]

(e) Singapore aims to achieve “net zero emissions by 2050”. Suggest and explain the renewable source of energy used to operate the dryer in Singapore.

.....

.....

.....

..... [2]

[Total: 8]

5 Four identical bulbs are labelled '1.5 V, 0.50 A' which describes the conditions for them to operate at normal brightness. A 12 V battery is connected to the bulbs as shown in Fig. 5.1.

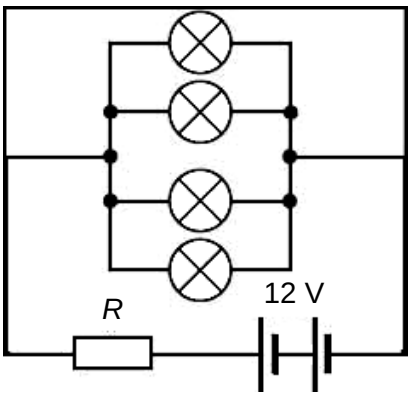

Fig. 5.1

(a) State and explain if light from the bulbs is a transverse or longitudinal wave.

.....

..... [1]

(b) State **one** difference between red light and green light.

.....

..... [1]

(c) Calculate the resistance of *R* if the bulbs are to operate at normal brightness.

R = ... [3]

(d) State how and explain why the bulbs are arranged as shown in Fig. 5.1.

.....

.....

..... [2]

[Total: 7]

6 An electric heater, labelled 230 V, 270 W, is placed near the surface of some water in a beaker. Two temperature sensors **A** and **B** are placed in the water. Sensor **A** is near the surface of the water and sensor **B** is at the bottom of the beaker, as shown in Fig. 6.1.

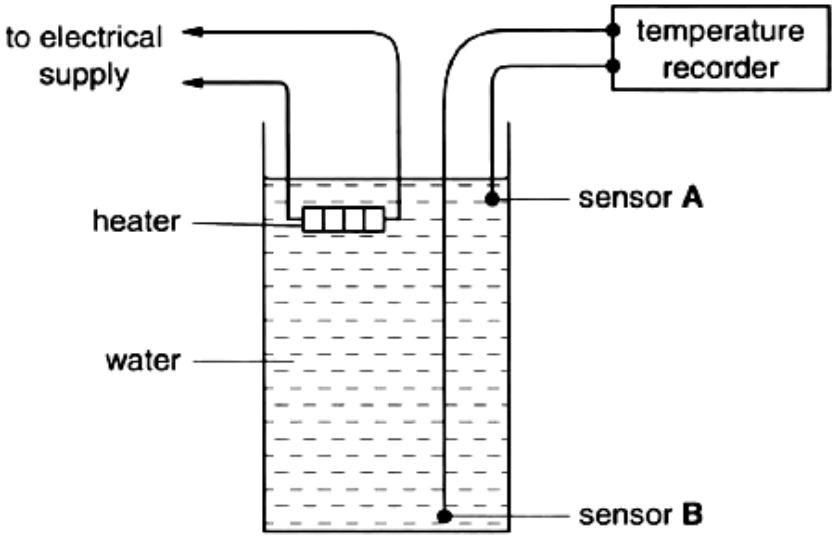

Fig. 6.1

Fig. 6.2 shows how the temperature recorded by each sensor changes with time.

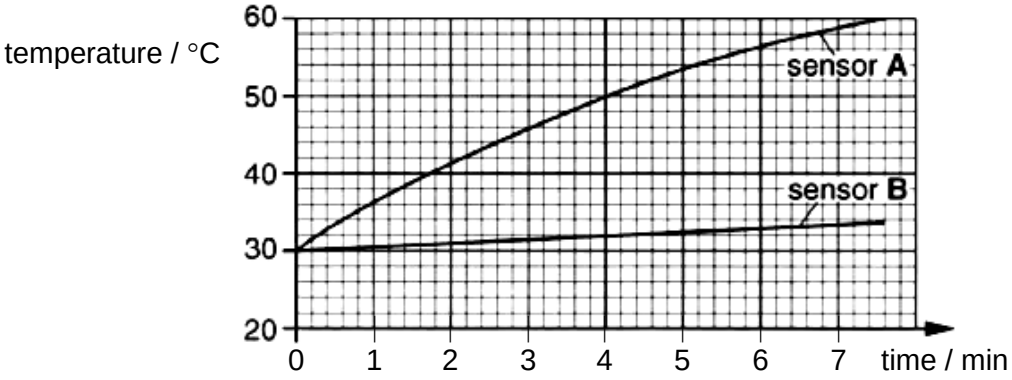

Fig. 6.2

(a) Explain why the temperature recorded by sensor **B** changes very little.

.....

.....

.....

..... [2]

(b) Suggest and explain where the heater should be placed so that both sensors record approximately the same temperature.

……..

……..

……..

…… [2]

(c) The specific heat capacity of water is 4 200 J kg^{-1} $°C^{-1}$. Using the readings of sensor **A** from Fig. 6.2, calculate the mass of water in the beaker at 6 minutes. State **one** assumption you have made in your calculation.

Assumption ……...

……..... [1]

mass = …… [2]

(d) Determine the current in the heater.

current = …… [2]

[Total: 9]

7 **(a)** State what is meant by an electric field.

……...

…… [1]

(b) Some students were asked to draw a diagram of the electric field in the region near an isolated point negative charge. Some of their answers are shown in Fig. 7.1.

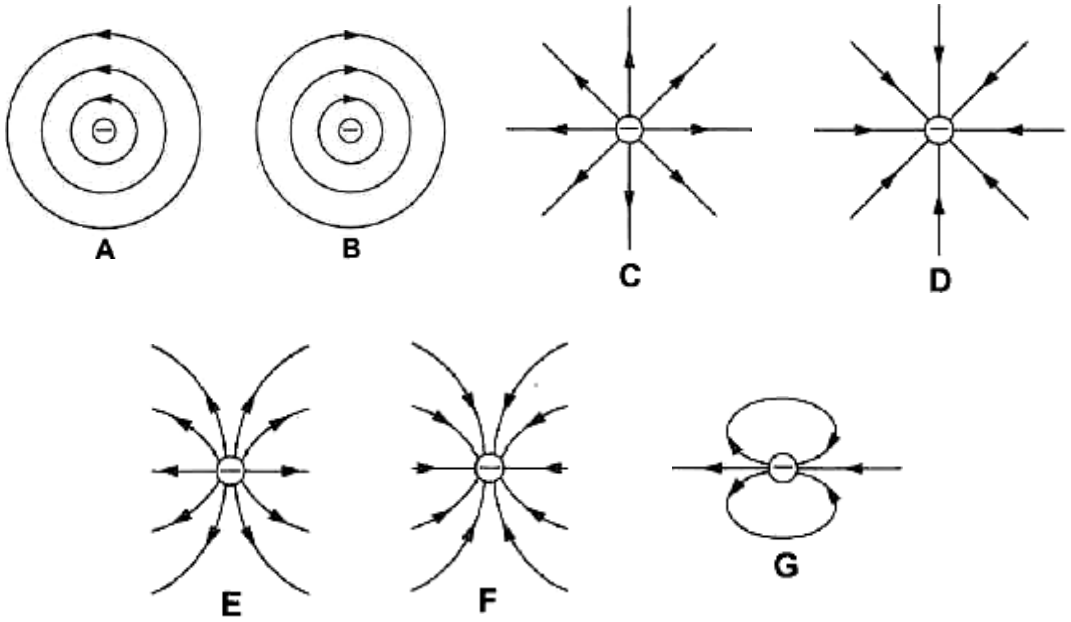

Fig. 7.1

State and explain which diagram (**A** to **G**) in Fig. 7.1 is correct.

……...

……

……..

…….... [2]

(c) Fig. 7.2 shows a magnet, two compasses and two nails.

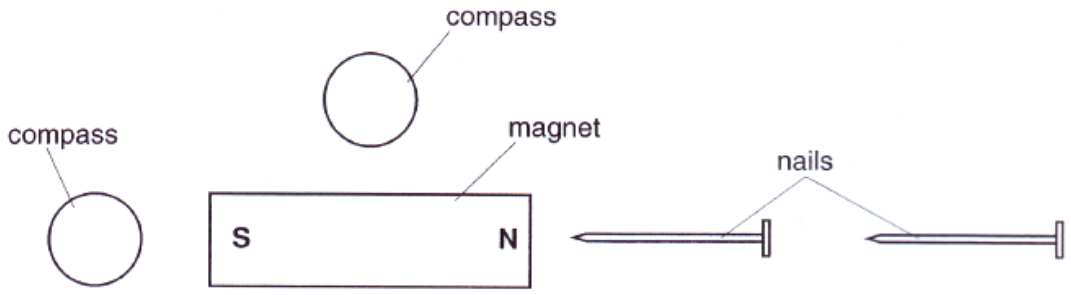

Fig. 7.2

(i) On Fig. 7.2, draw an arrow in each compass to show the direction of the magnetic field of the magnet at the two positions. [1]

(ii) The magnet causes the nails to become magnetised by induction. Both ends of each nail becomes magnetic poles. On Fig. 7.2, mark an N or S at both ends of each nail to show the magnetic poles. [1]

(iii) When the magnet is removed, the nails are still magnetised. Describe how to test whether the nails are still magnetised when they are away from the magnet.

.....

.....

.....

..... [1]

[Total: 6]

8 Fig. 8.1 shows a microphone and a tuning fork.

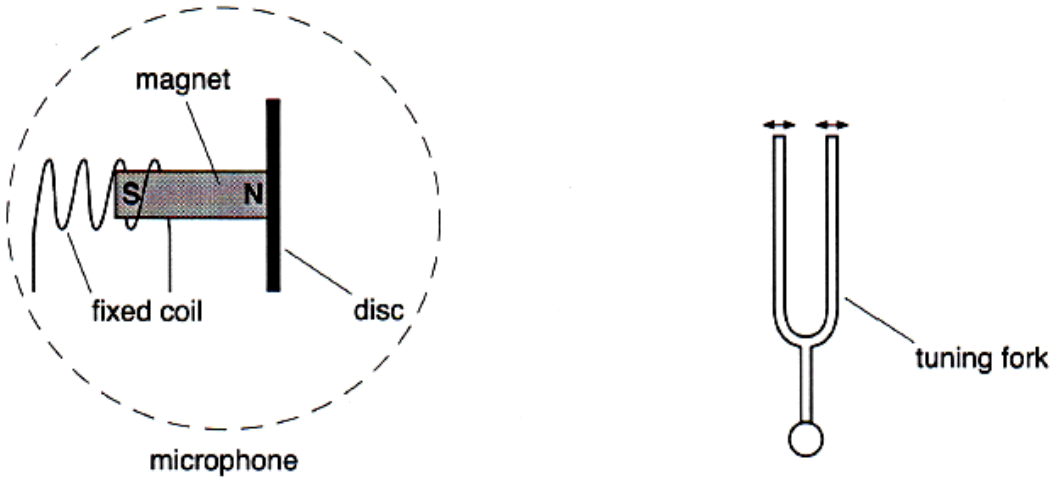

Fig. 8.1

The microphone contains a small disc attached to a magnet. The coil inside the microphone is fixed in position and does not move.

When the tuning fork vibrates, an alternating e.m.f. is induced in the coil.

(a) Explain in detail how the vibration of the tuning fork induces an e.m.f. in the coil.

……

……

……

……

……

……

……

…… [4]

(b) The tuning fork is replaced by one that produces a sound of lower loudness but the same pitch. State and explain what happens to the amplitude of the induced e.m.f..

……

……

……

…… [2]

[Total: 6]

9 Fig. 9.1 shows two of the towers that support a single cable of total length 5.0 km, which links a factory to the electrical grid.

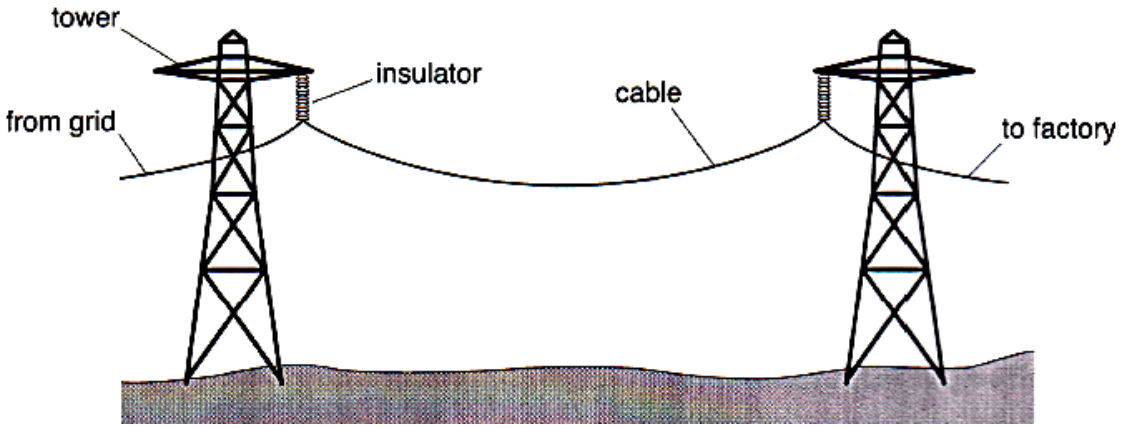

Fig. 9.1

If the weight of the cable between the two towers is larger than a given force *F*, then the cable breaks. The value of *F* depends on the material from which the cable is made. Fig. 9.2 gives the value of *F* and other data for three cables made from different materials.

cable	material	*F* / N	resistance of 1 km of cable / Ω	density / kg m^{-3}	cross-sectional area / m^2
1	Aluminium	6 000	0.075	2 700	3.0×10^{-4}
2	Copper	9 000	0.050	8 900	3.0×10^{-4}
3	Steel	27 000	210	7 800	3.0×10^{-4}

Fig. 9.2

(a) Assuming that *g* is 10 N/kg, calculate the mass of a copper cable of length 5.0 km,

mass = ... [2]

(b) The cable used is actually made from aluminium and the current in it is 500 A.

For this cable, calculate

(i) the potential difference between the grid and the factory;

potential difference = ... [1]

(ii) the power loss in the cable; and

power = ... [2]

(iii) the cost each day of power loss. 1 kWh costs 33 cents.

cost = ... [2]

(c) Using data from Fig. 9.2, explain why

(i) aluminium is a more suitable material than copper for the cable; and

.....

.....

.....

..... [2]

(ii) steel is an unsuitable material for the cable.

.....

..... [1]

[Total: 10]

10 There are many isotopes of the element molybdenum (Mo).

(a) State what the nuclei of different molybdenum isotopes have in common.

……..

…….... [1]

(b) The isotope molybdenum-99 is produced inside some nuclear power stations from the nuclear fission of uranium-235. State what will happen during the process of nuclear fission.

……..

……..……. [1]

(c) When the nucleus of a molybdenum-99 atom decays, it emits radiation and changes into a nucleus of technetium-99.

$$^{99}_{42}\mathrm{Mo} \longrightarrow {}^{99}_{43}\mathrm{Tc} + \text{Radiation}$$

State and explain the type of radiation emitted by molybdenum-99.

……..

……..

……..

……..…… [2]

(d) Technetium-99 has a short *half-life* and emits gamma radiation. State what is meant by the term *half-life*.

……..

……..….. [1]

(e) Technetium-99 is used by doctors as a medical tracer. In hospitals, it is produced inside a technetium generator by the decay of molybdenum-99 nuclei.

(i) Fig. 10.1 shows how the number of nuclei in a sample of molybdenum-99 changes with time as the nuclei decay.

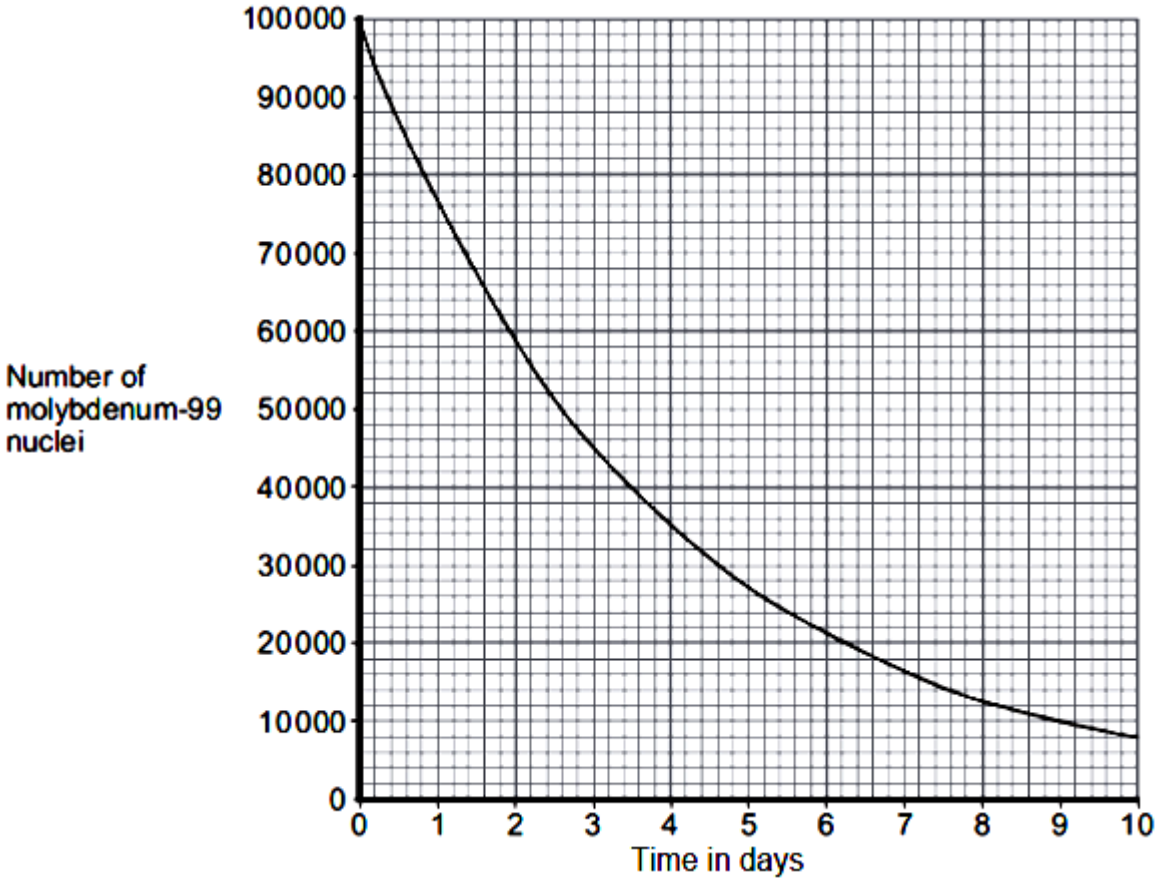

Fig. 10.1

A technetium generator will continue to produce sufficient technetium-99 until 80 % of the original molybdenum nuclei have decayed.

Determine the number of days after which a source of molybdenum-99 inside a technetium-99 generator needs replacement. Clearly show your calculation and how you use Fig. 10.1 to obtain your answer.

Number of days = ... [2]

(ii) Medical tracers are injected into a patient's body. This involves some risk to the patient's health. Explain the risk to the patient of using a radioactive substance as a medical tracer.

……

……

……

…… [2]

(iii) Suggest why doctors frequently use radioactive substances for medical diagnosis and treatments even though there may be a risk.

……

…… [1]

[Total: 10]

Section B [10 marks]

Answer **one** question from this section.

11 **(a)** Light travelling from glass into air is incident on the surface at an angle of 42 °, as shown in Fig. 11.1.

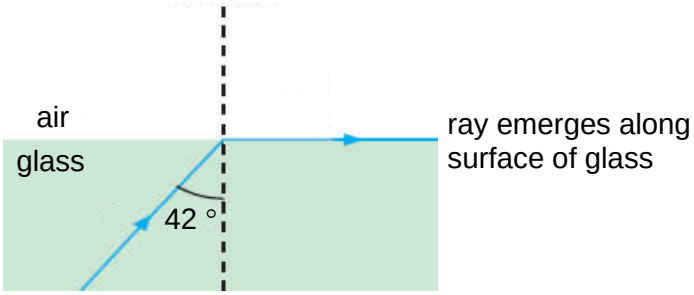

Fig. 11.1

The light emerges into the air along the surface of the glass. Calculate the refractive index of the glass for this light.

refractive index = ... [2]

(b) Fig. 11.2 shows light entering one face of a right-angled prism at point **P**. The light travels along **PQ** in the prism. The refractive index of the glass is the same as in **(a)**.

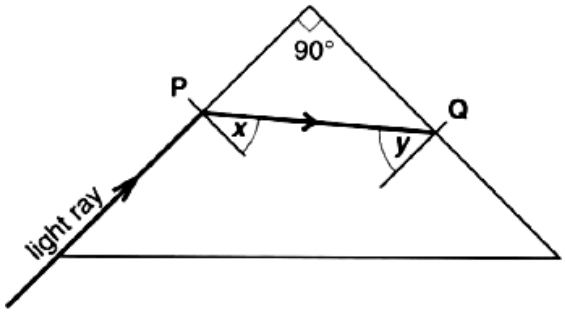

Fig. 11.2

(i) State the value of the angle ***x*** in the prism.

..... [1]

(ii) Suggest whether angle ***y*** is greater than, smaller than or equal to angle ***x***.

..... [1]

(iii) State and explain the path of the ray after it is incident at point **Q**.

……

……

……

…… [2]

(e) An object **O** is placed 25.0 cm in front of a thin converging lens, as shown in the ray diagram of Fig. 11.3.

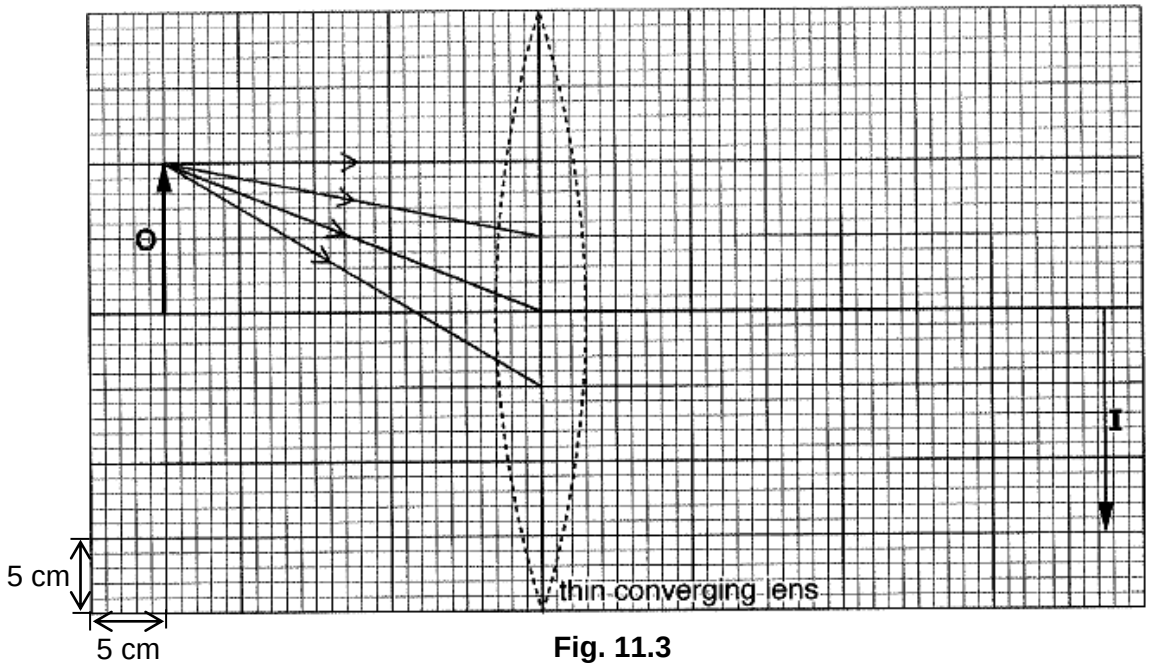

Fig. 11.3

The diagram is drawn to scale where the length of 5 small squares represent 5 cm. The lens forms an image **I** of the object **O**, as shown in Fig. 11.3.

(i) State **all** the three characteristics of this image.

…… [1]

(ii) Complete the four rays from the top of the object to show the formation of the image. [1]

(iii) Define focal length.

……

…… [1]

(iv) Determine the focal length of the lens.

focal length = …… [1]

[Total: 10]

12 **(a)** Fig. 12.1 shows a solenoid carrying a current.

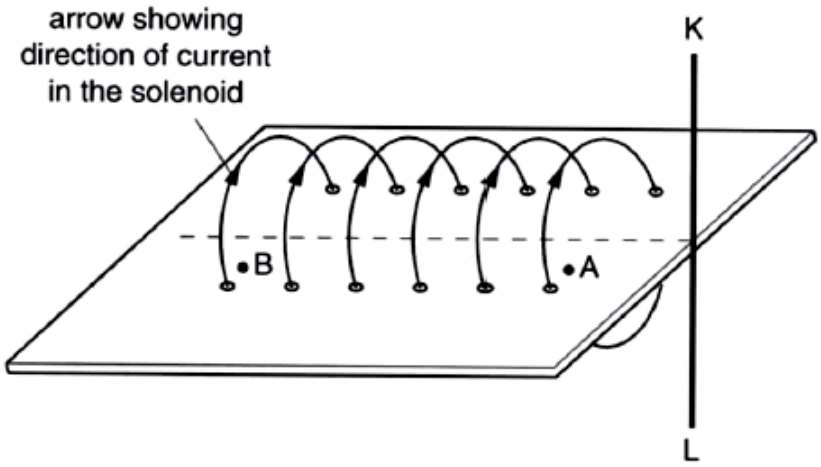

Fig. 12.1

The current in the solenoid creates a magnetic field.

(i) The current in the solenoid is reversed. State the effect this has on the strength and direction of the magnetic field.

strength .....

direction ..... [1]

(ii) State how the pattern of the magnetic field lines inside the solenoid changes when the strength of the magnetic field decreases.

..... [1]

(iii) Fig. 12.1 shows a vertical wire KL next to the end of the solenoid. The wire is connected to a current and there is a current upwards in the wire, from L to K. The current in the solenoid is as shown in Fig. 12.1.

1. On Fig. 12.1, draw an arrow to show the direction of the force on the wire KL. [1]

2. Describe what enables you to find the direction of this force.

.....

.....

.....

..... [2]

(b) Fig. 12.2 shows a simple d.c. motor in a toy car.

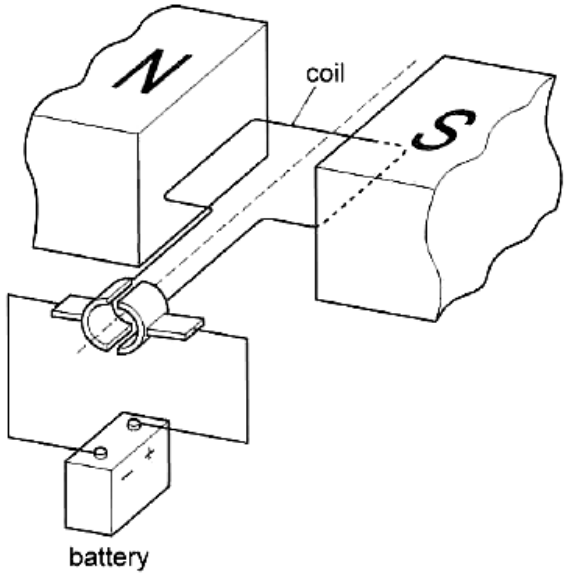

Fig. 12.2

(i) Explain why the turning effect becomes smaller as the coil becomes more vertical.

.....

..... [1]

(ii) Explain why there is an induced e.m.f. in the coil when the motor turns.

.....

.....

..... [1]

(iii) Explain why the induced e.m.f. is in a direction which reduces the current in the coil.

.....

..... [1]

(iv) The toy car is connected to a 3.0 V battery and the resistance of the motor is 45 Ω. Calculate the power produced in the motor when it is first turned on.

power = ... [2]

[Total: 10]

END OF PAPER