SERANGOON SECONDARY SCHOOL
PRELIMINARY EXAMINATION
SECONDARY 4 EXPRESS

CANDIDATE NAME					( )	CLASS		
CENTRE NUMBER	S					INDEX NUMBER		

SCIENCE PHYSICS

5086/02

Paper 2 **(Section A)**

26 Aug 2024
1 hour 15 minutes

Candidates answer on the Question Paper.

Setter(s):

READ THESE INSTRUCTIONS FIRST

Write your Centre number, 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 staplers, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

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

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

For examiner's use	
Section A	**55**

This question paper consists of **18** printed pages, including this **cover** page.

Section A [55 marks]

Answer **all** questions.

1 Fig. 1.1 shows a 9.6 m uniform beam that is in equilibrium. The beam is supported at its centre by a pivot.

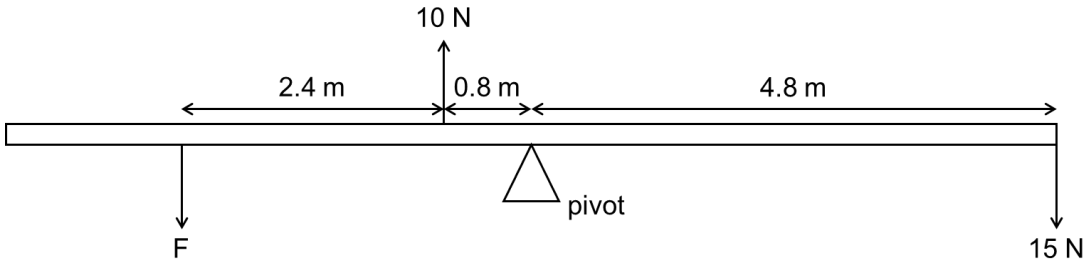

Fig. 1.1

(a) State the *principle of moments*.

……

……

……

…… [1]

(b) Calculate the value of F.

F = …… N [2]

[Total: 3]

2 Fig. 2.1 shows a ride at the amusement park. The carriage is pulled up the slope by an electric motor. Once the carriage reaches point A, the motor is switched off and the carriage will go through points B and C before coming to a stop at the bottom of the track.

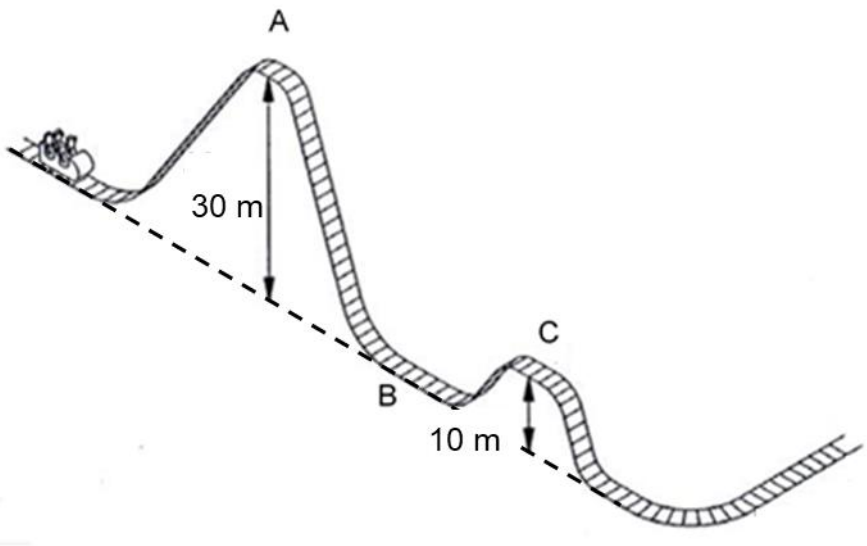

Fig. 2.1

The vertical height is 30 m at A and 10 m at C. The combined mass of the carriage and passengers is 450 kg. Assume that the friction between the carriage and track is negligible. The gravitational field strength *g* is 10 N/kg.

(a) Calculate the amount of energy transferred to the gravitational potential store of the carriage at point A.

gravitational potential energy = …… J [2]

(b) Calculate the amount of energy in the kinetic store of the carriage at point C.

kinetic energy = …… J [2]

(c) Hence, calculate the speed of the carriage at point C.

speed = …… m/s [2]

[Total: 6]

3 Fig. 3.1 shows the positions of particles in an undisturbed medium.

Fig. 3.2 and Fig. 3.3 shows the position of the particles at t = 0 s and t = 0.2 s respectively when a sound wave passes through the medium.

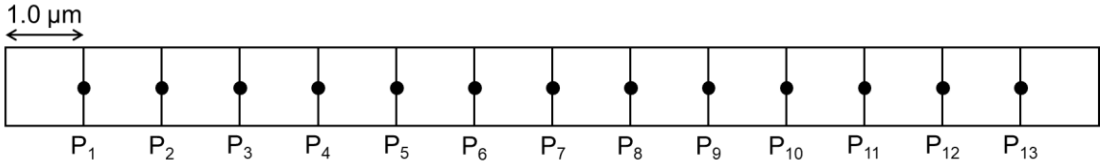

Fig. 3.1

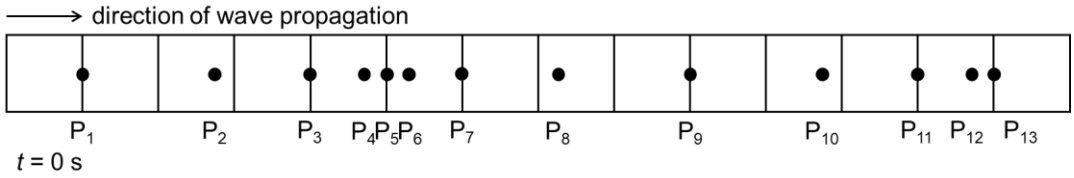

Fig. 3.2

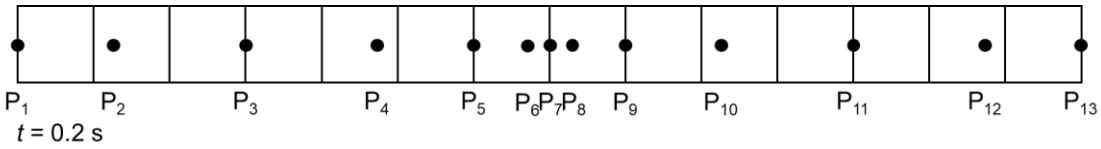

Fig. 3.3

(a) In terms of the direction of wave travel and the medium's particle vibration, describe how Fig. 3.2 shows that sound is a longitudinal wave.

……

…… [1]

(b) The particles executed a quarter of the oscillation between t = 0 s and t = 0.2 s. Calculate the frequency of the wave.

frequency = …… Hz [2]

(c) On Fig. 3.3, mark the wavelength of the sound wave using a double headed arrow "←→". Label it with the symbol λ. [1]

(d) Calculate the speed of the wave.

speed of wave = …… m/s [2]

[Total: 6]

4 Fig. 4.1 shows a ray of light travelling from air into a rectangular glass block with refractive index of 1.50.

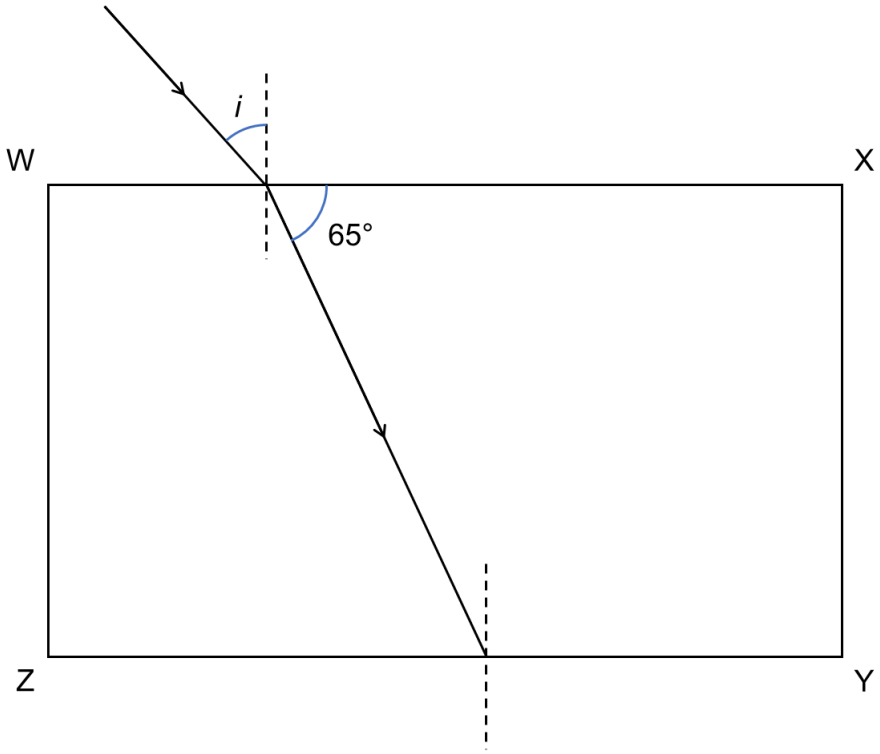

Fig. 4.1

(a) Calculate the angle of incidence, *i*.

angle of incidence, *i* = ……° [2]

(b) On Fig. 4.1, draw how the ray of light emerges from the side YZ. [1]

[Total: 3]

5 Fig. 5.1 shows an object placed at a distance of 40 cm in front of a converging lens with focal length 10 cm.

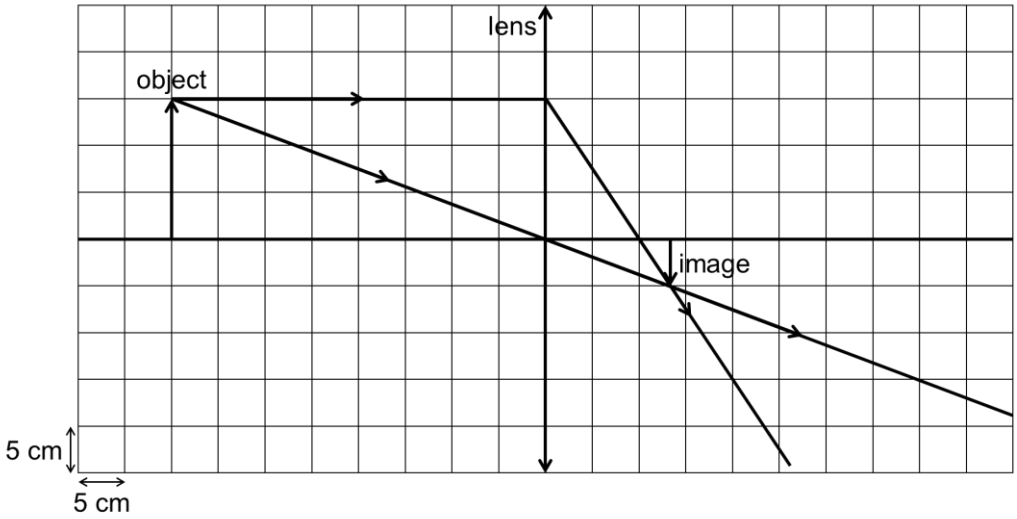

Fig. 5.1

(a) The magnification factor of a converging lens can be calculated using the formula

$$\text{magnification factor} = \frac{\text{size of image}}{\text{size of object}}$$

Using Fig. 5.1, determine the magnification factor of the converging lens.

magnification factor = …… [2]

(b) State a real world application for this lens in Fig. 5.1.

……

…… [1]

(c) State two changes that would be observed about the image when the object is placed at a distance of 15 cm in front of the lens.

……

…… [2]

[Total: 5]

6 Fig. 6.1 shows a circuit with a 12.0 V supply. All the resistors in the circuit are identical with a resistance of 5.0 Ω each.

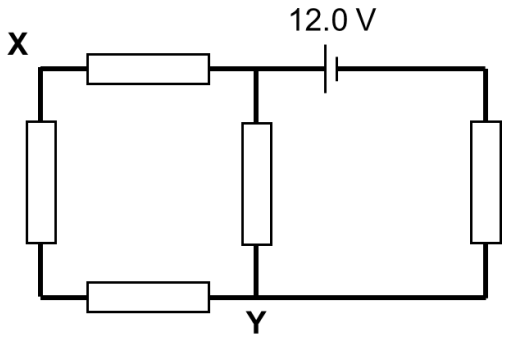

Fig. 6.1

(a) **(i)** Calculate the effective resistance of the whole circuit shown in Fig. 6.1.

effective resistance of whole circuit = …… Ω [2]

(ii) Calculate the current supplied by the battery.

current = …… A [2]

(b) Fig. 6.2 shows the same circuit with a wire added to connect points **X** and **Y**.

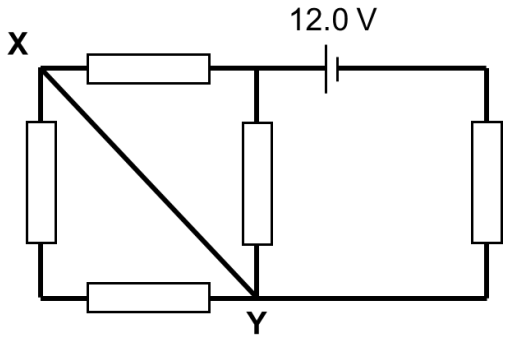

Fig. 6.2

Determine the effective resistance of the new circuit.

effective resistance of whole circuit = …… Ω [2]

[Total: 6]

7 Manganese arsenide is an electrical conductor.

It is also a magnetic material when its surrounding temperature, **T**, is lower than 45 °C. It becomes a non-magnetic material when its surrounding temperature is 45 °C or higher.

Fig. 7.1 shows a fire alarm that contains a permanent magnet held in its fixed position and a moveable slab of manganese arsenide when the surrounding temperature is at 30 °C.

No fire, T = 30 °C	**Fire occurs, T = 75 °C**
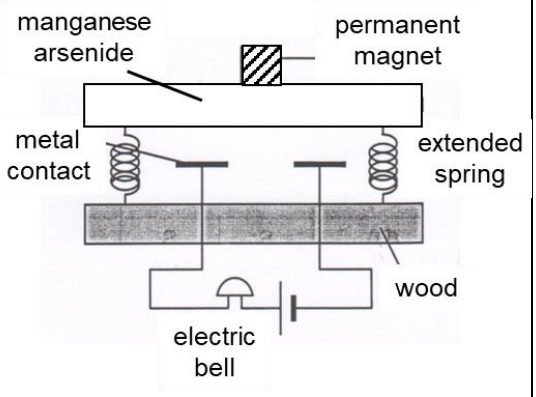	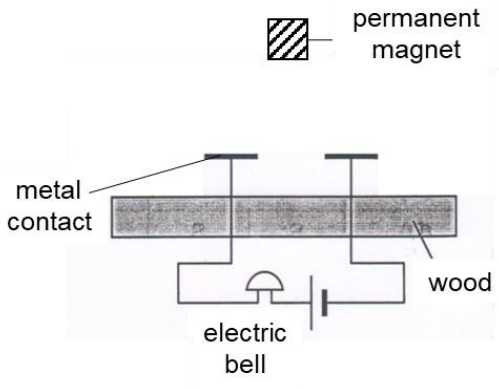
Fig. 7.1	**Fig. 7.2**

(a) In Fig. 7.2, complete the diagram of the fire alarm when there is a fire and the surrounding temperature is 75 °C. [1]

(b) Hence, explain how the fire alarm works during a fire which increases the surrounding temperature to 45 °C or higher.

……

……

……

…… [2]

[Total: 3]

8 Fig. 8.1 shows two identical cylindrical iron rods, **A** and **B**, placed inside a solenoid that has a circular cross section. The solenoid is connected to a battery and a switch.

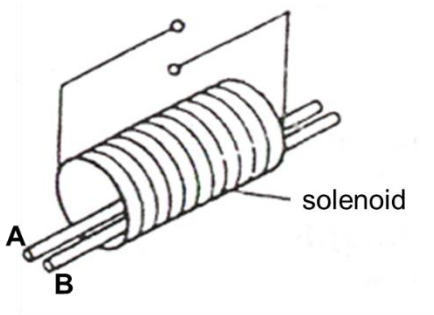

Fig. 8.1

(a) Describe and explain what happens to the iron rods when the switch is closed.

……

……

……

…… [2]

(b) Describe and explain what happens to the iron rods when the switch is opened.

……

……

……

…… [2]

[Total: 4]

9 Fig. 9.1 shows a diagram of a simple d.c. motor.

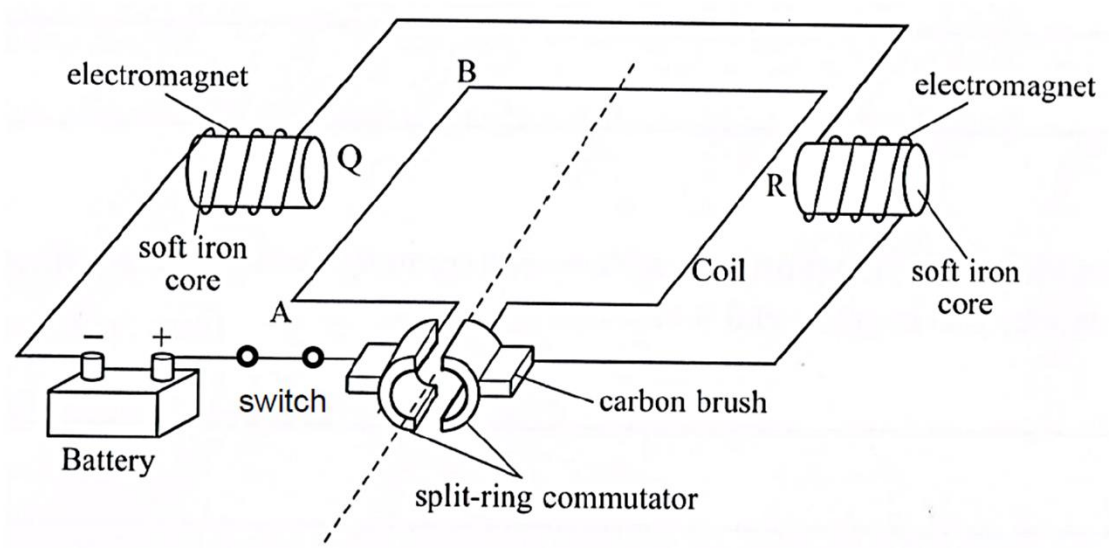

Fig. 9.1

Fig. 9.2 shows the front view of the d.c. motor.

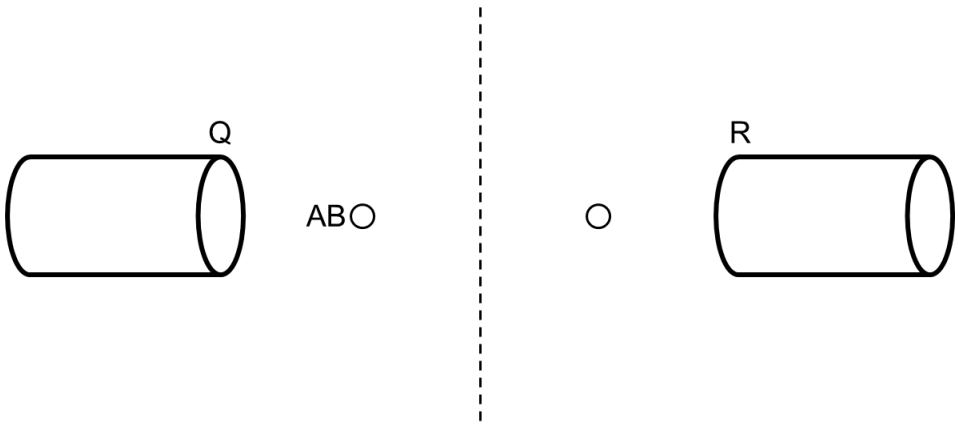

Fig. 9.2

(a) On Fig. 9.2, indicate the poles at Q and R. [1]

(b) On Fig. 9.2, draw an arrow to show the direction of the force acting on wire AB. [1]

(c) Explain why the coil turns when the switch is closed.

……

……

……

…… [2]

[Total: 4]

10 Household smoke alarms use alpha radiation sources to detect smoke. Fig. 10.1 shows an example of a smoke alarm. Radiation from the source passes through air and is detected by the detector. If the reading on the detector does not change, the alarm will not sound.

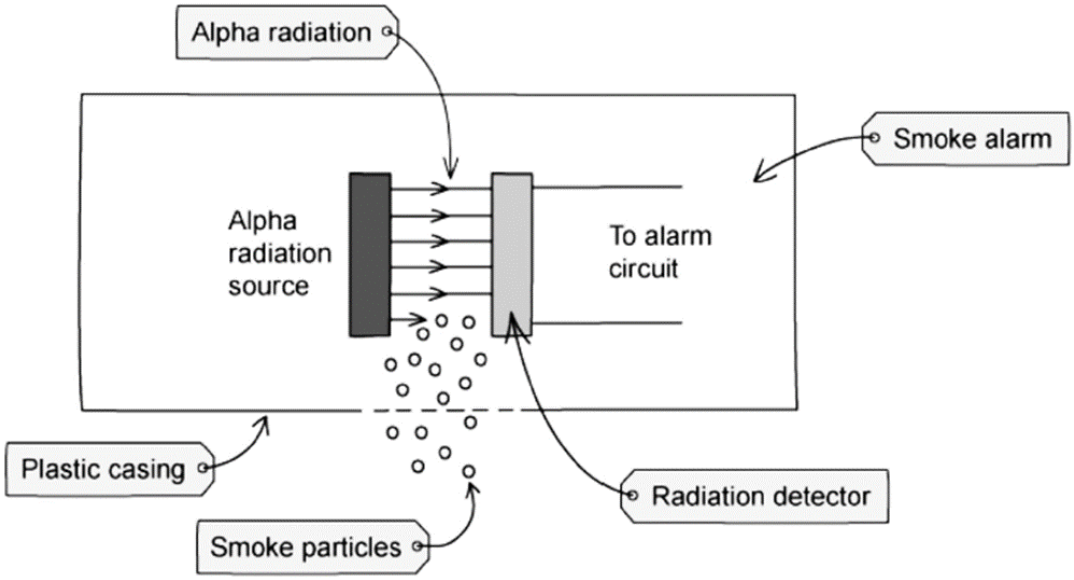

Fig. 10.1

(a) The nuclide notation for an α-particle is ${}^{4}_{2}\alpha$.

State the number of protons and neutrons in an α-particle.

protons = ……

neutrons = …… [1]

(b) Fig. 10.2 shows how the count rate of the alpha radiation source in the smoke alarm varies with time.

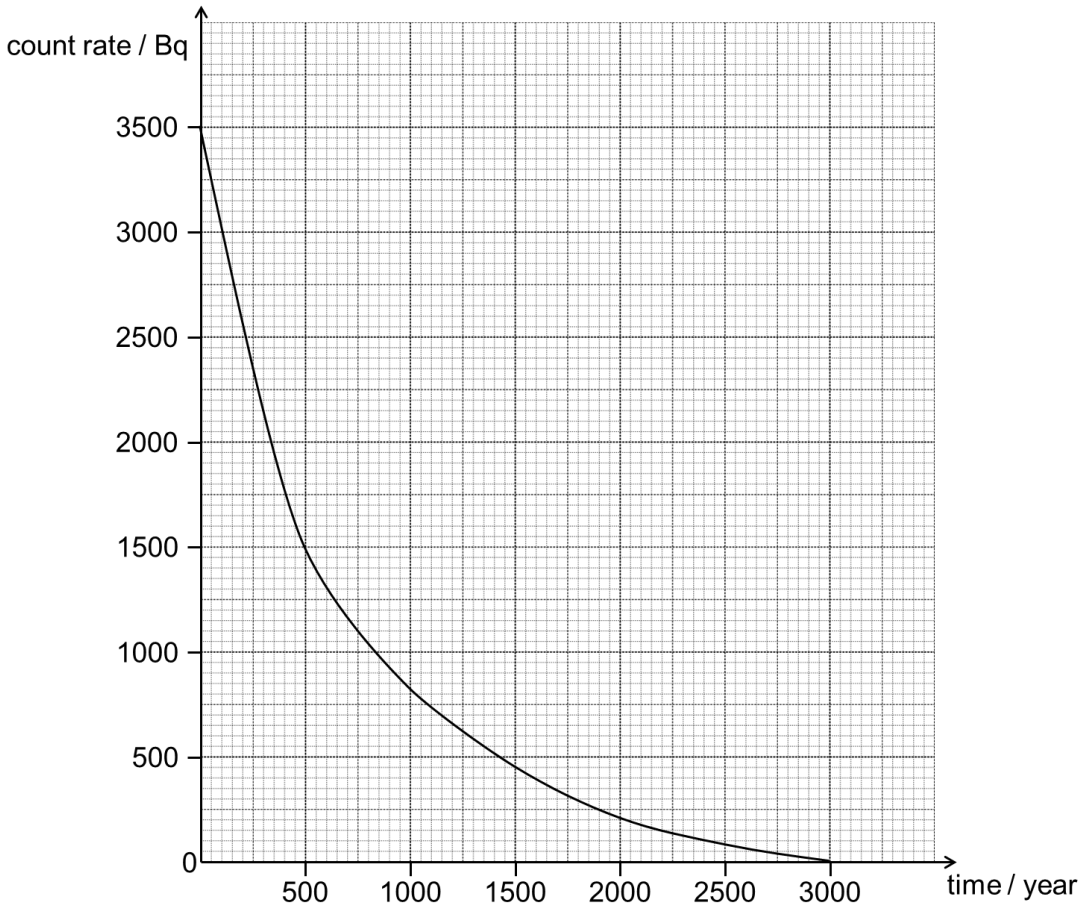

Fig. 10.2

(i) Determine the half-life of the alpha radiation source in the smoke alarm. Show on your graph how you arrive at your answer.

half life = …… years [2]

(ii) The smoke alarm will only sound when smoke particles are present and absorbs alpha radiation. This results in a change in the count rate detected by the radiation detector.

Explain why the smoke alarm would not work if the alpha radiation source were replaced by a beta or gamma radiation source.

……

……

……

…….. [2]

[Total: 5]

11 A heat sink is a passive heat exchanger that transfers the thermal radiation generated by an electronic device to a fluid medium, often air or a liquid coolant, where it is dissipated away from the device, thereby allowing regulation of the device's temperature at optimal levels. Fig. 11.1 shows two different types of heat sinks.

	
A heat sink transferring heat from an electronic board to air via a fan	A heat sink that has cooling fins

Fig. 11.1

(a) **(i)** State the process by which thermal energy is transferred from the electronic board to the heat sink.

…….. [1]

(ii) State the process by which thermal energy is transferred from the heat sink to the surrounding air.

…….. [1]

(b) The heat sink has three features that allow it to gain thermal energy faster from the electronic board and lose thermal energy faster to the surroundings.

(i) Explain why the heat sink has cooling fins (slices instead of a whole block).

…….

…….. [1]

(ii) Suggest a material that is suitable for manufacturing the heat sink. Explain your choice of material.

…….

…….

…….

…….. [2]

(iii) Suggest a colour that is suitable for painting the heat sink. Explain your choice of colour.

…….

…….

…….

…….. [2]

(c) Every heat sink is rated by its thermal resistance. This indicates how much the temperature of the heat sink will increase for every 1 W of power it gains from the electronic device.

A heat sink has a thermal resistance of 4 °C per watt. The electronic board dissipates 100 J of energy in 20 s.

Calculate the increase in temperature of the heat sink.

increase in temperature = …… °C [2]

(d) Although the electronic board emits thermal energy continuously, the temperature of the heat sink stops increasing after some time. Using your knowledge of the principle of conservation of energy, explain why this happens.

……

……

……

…… [1]

[Total: 10]