Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

PHYSICS **5054/22**

Paper 2 Theory **May/June 2025**

1 hour 45 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.
- Take the weight of 1.0 kg to be 9.8 N (acceleration of free fall = 9.8 m / s^2).

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **20** pages. Any blank pages are indicated.

1 A ball is dropped by the side of a vertical scale that is marked in centimetres.

A video recording of the fall shows the position of the ball on the scale every 0.10 s.

The distance the ball falls is shown by the position on the scale.

Table 1.1 shows the results.

Table 1.1

time / s	0	0.10	0.20	0.30	0.40	0.50
distance / cm	0	5	20	44	78	123

(a) (i) On Fig. 1.1, plot the distance–time graph for the ball. Draw a suitable line.

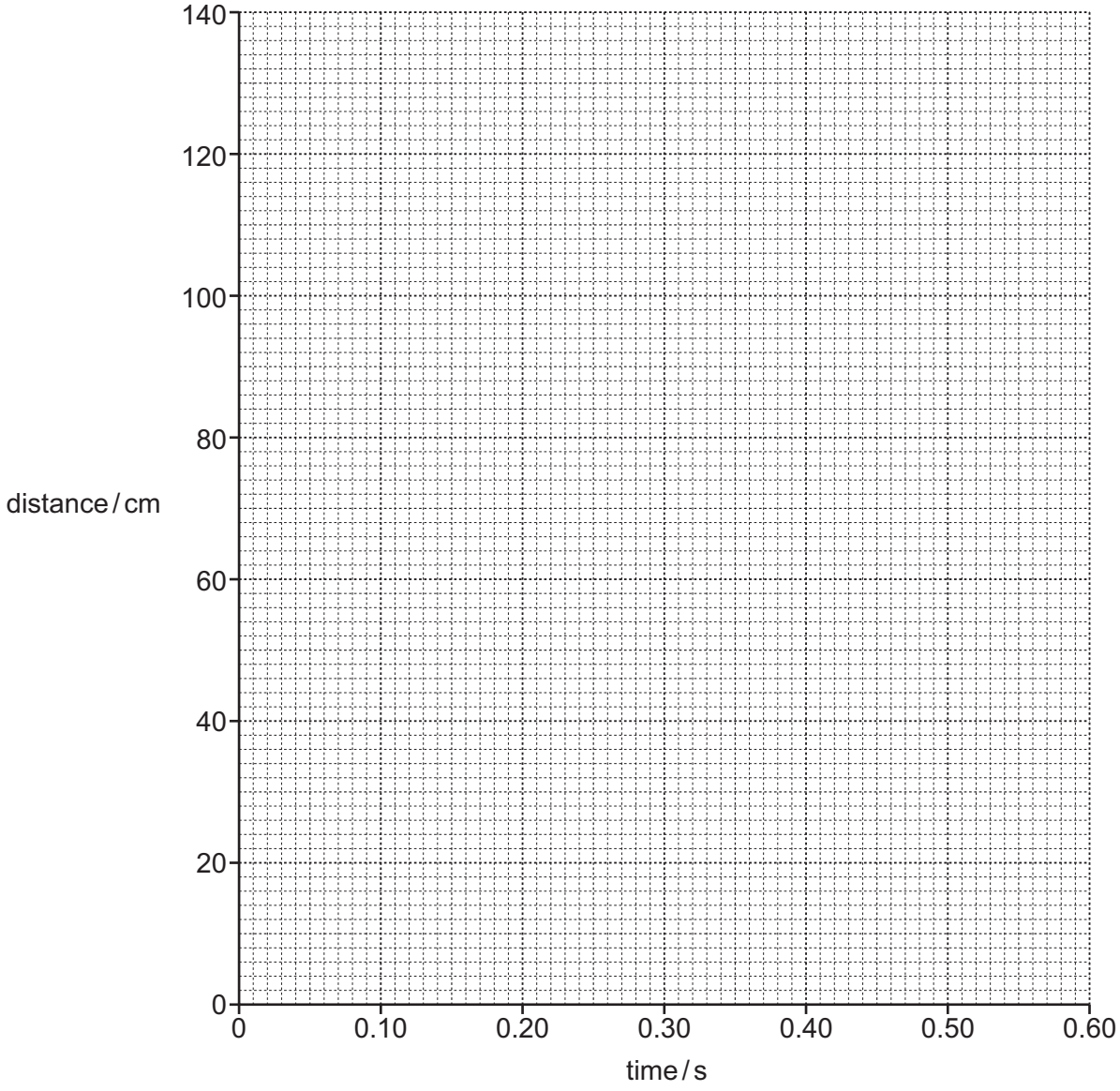

Fig. 1.1

[2]

(ii) Calculate the average speed of the ball between time $t = 0$ and time $t = 0.40$ s.

speed = ... cm / s [2]

(iii) Describe how to use the graph in Fig. 1.1 to determine the speed of the ball at time $t = 0.40$ s.

.....

.....

..... [2]

(b) As the ball falls, the acceleration of the ball decreases and eventually becomes zero before it reaches the ground.

(i) Explain, in terms of the forces acting, why the acceleration decreases, and why it eventually becomes zero.

.....

.....

.....

.....

.....

..... [3]

(ii) Describe the appearance of a distance–time graph when the acceleration of the ball is zero.

..... [1]

[Total: 10]

2 Fig. 2.1 shows a fork-lift truck used to lift a load.

Fig. 2.1

When lifting the load, the electric motor on the fork-lift truck has a useful output power of 600 W.

(a) Define 'power'.

.....

..... [1]

(b) The efficiency of the motor is 70%.

Calculate the input power to the motor.

input power = ...W [2]

(c) The fork-lift truck lifts a load with mass of 50 kg through a vertical distance of 2.3 m.

(i) Calculate the work done in lifting the load.

work done = ... J [2]

(ii) Calculate the time taken to lift the load.

time taken = ... s [2]

(d) Describe how energy is transferred to thermal energy as the load is lifted by the fork-lift truck.

.....

..... [1]

[Total: 8]

3 Fig. 3.1 shows a flat tyre on a car. The tyre needs to be inflated.

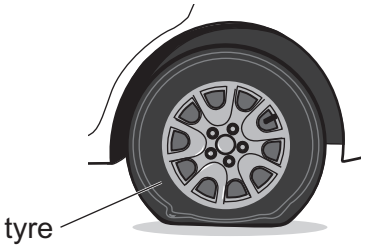

Fig. 3.1

(a) The force exerted by the flat tyre on the road is 1350 N.

The area of the flat tyre in contact with the road is 0.0070 m^2.

(i) Calculate the pressure exerted by the flat tyre on the road.

pressure = ... Pa [2]

(ii) Air is pumped into the tyre to inflate it. This increases the pressure inside. The force exerted by the tyre on the road does not change.

State how the area of the tyre in contact with the road changes.

..... [1]

(b) Inside the inflated tyre, a particle of air collides against the wall of the tyre.

(i) Define 'momentum'.

..... [1]

(ii) Using ideas about momentum, explain why there is a force on the wall of the tyre as the particle collides with it.

.....

.....

..... [2]

(c) As the car moves, the temperature of the air inside the tyre increases. The increase in temperature causes an increase in the pressure of the air.

Using ideas about particles, explain why the pressure increases.

.....

.....

..... [2]

[Total: 8]

4 A sound wave from a vibrating tuning fork is displayed on the oscilloscope shown in Fig. 4.1. The sound wave is detected using a microphone.

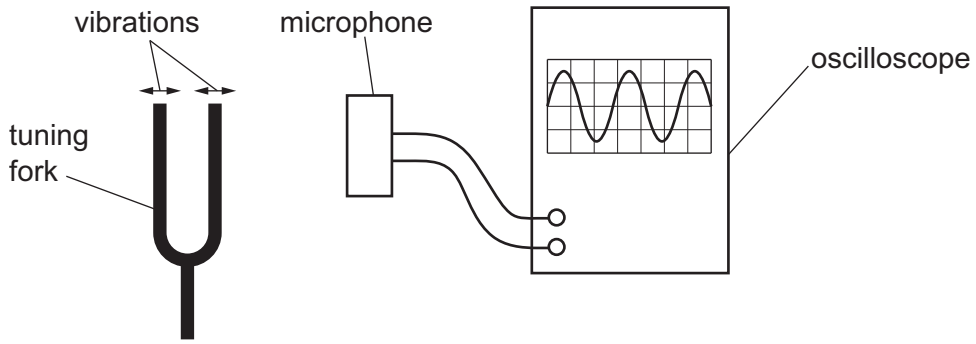

Fig. 4.1

(a) Describe the motion of the air particles as the sound wave passes from the tuning fork to the microphone.

.....

.....

..... [2]

(b) Fig. 4.2 shows the trace seen on the oscilloscope when the tuning fork vibrates.

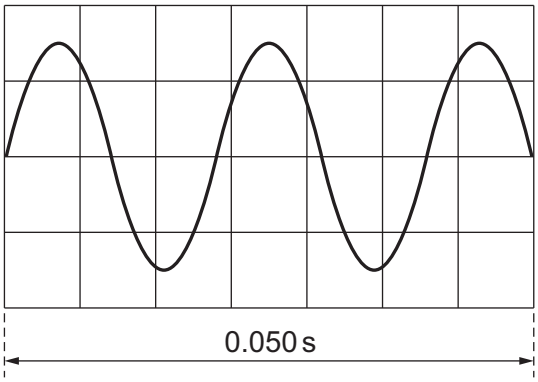

Fig. 4.2

The frequency of the sound is constant.

(i) State what is meant by 'frequency'.

.....

..... [1]

(ii) The trace shown on Fig. 4.2 is produced in 0.050 s.

Calculate the frequency of the sound wave.

frequency = ... Hz [2]

(iii) A student near the tuning fork observes the trace and listens to the sound. He notices that the amplitude of the trace decreases.

State how the sound heard by the student changes.

..... [1]

(iv) The tuning fork is replaced by a new tuning fork that produces a sound wave of half the frequency. The controls on the oscilloscope are not changed.

On Fig. 4.3, draw the trace obtained with the new tuning fork. The trace obtained with the original tuning fork is shown.

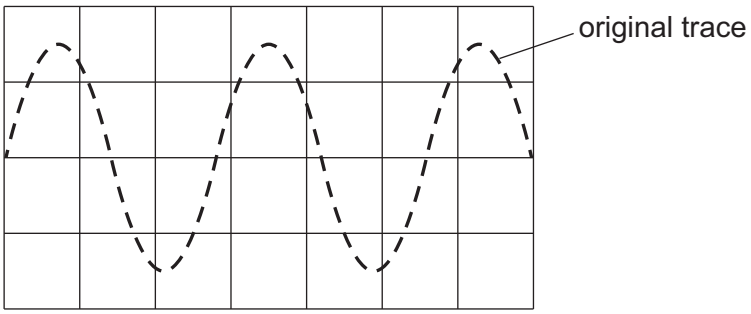

Fig. 4.3

[1]

(c) Fig. 4.4 shows three adjacent wavefronts of the sound wave as the wavefronts move towards a gap in a wall created by an open door.

Another student, standing at P on the other side of the wall, hears the sound.

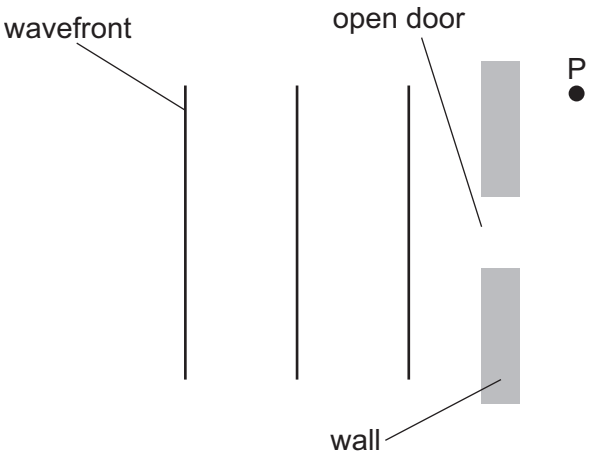

Fig. 4.4

(i) On Fig. 4.4, draw the three wavefronts after they pass through the gap. [2]

(ii) State the name of the process involved as the wavefronts pass through the gap and reach P.

..... [1]

[Total: 10]

5 A student sets up the circuit shown in Fig. 5.1 to measure the resistance of a length of wire. The circuit contains four identical cells.

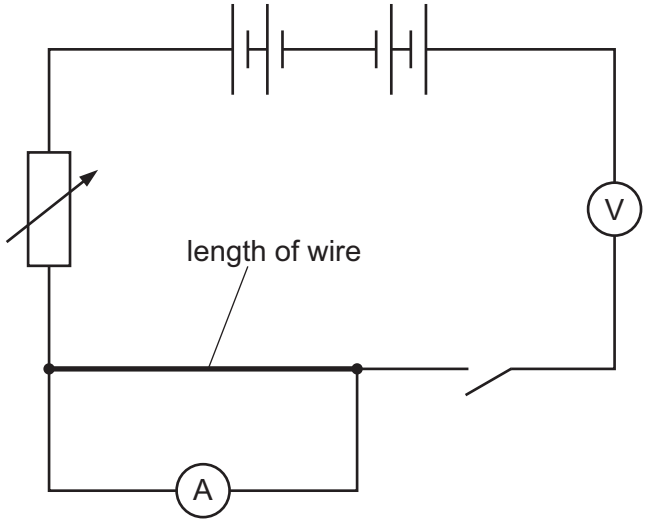

Fig. 5.1

The student finds that both meters read zero when the switch is closed. This is because the circuit shown in Fig. 5.1 is not suitable for the measurement.

(a) Describe **all** the changes to the circuit in Fig. 5.1 that are needed so that the meters produce readings that can be used to calculate the resistance of the length of wire.

.....

.....

.....

..... [2]

(b) Fig. 5.2 shows the current–voltage graph for a 9.0 cm length of wire (line P) and for a different length of the same wire with the same cross-sectional area (line Q).

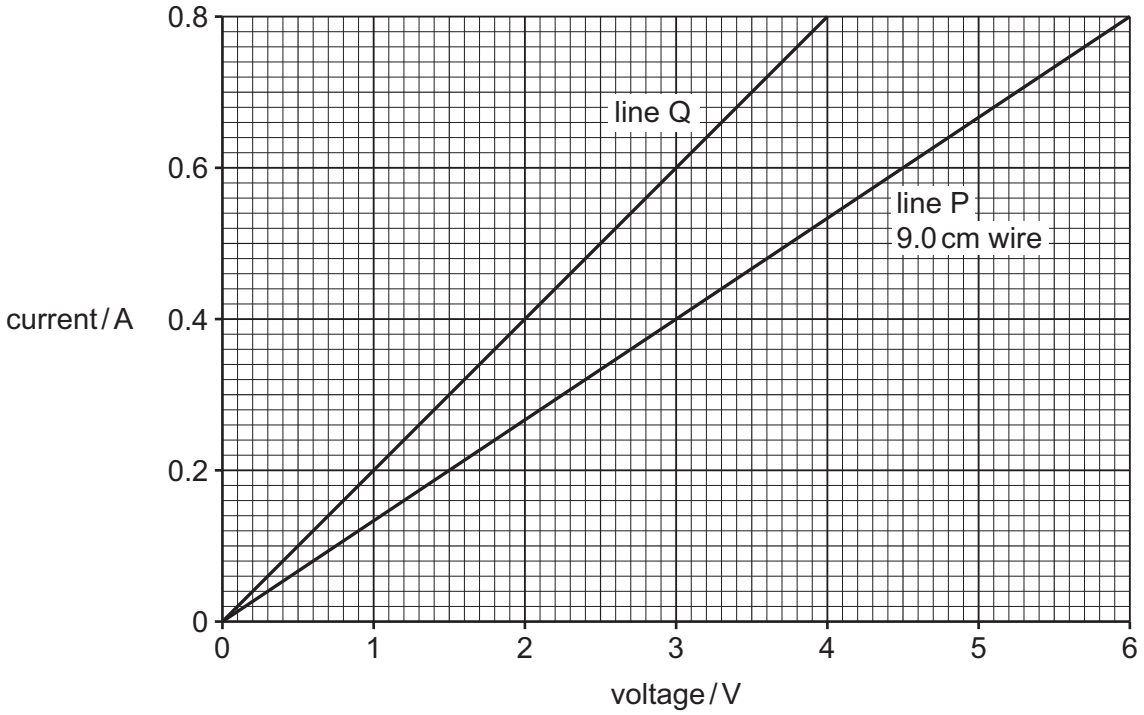

Fig. 5.2

(i) Calculate the resistance of the 9.0 cm length of wire.

resistance = ... Ω [2]

(ii) Explain whether line Q is obtained with a length of wire that is longer or shorter than 9.0 cm.

.....

..... [1]

(iii) Calculate the length of the wire used to obtain line Q.

length = ... cm [1]

[Total: 6]

6 Fig. 6.1 shows part of a mains circuit that includes three lamps and a heater.

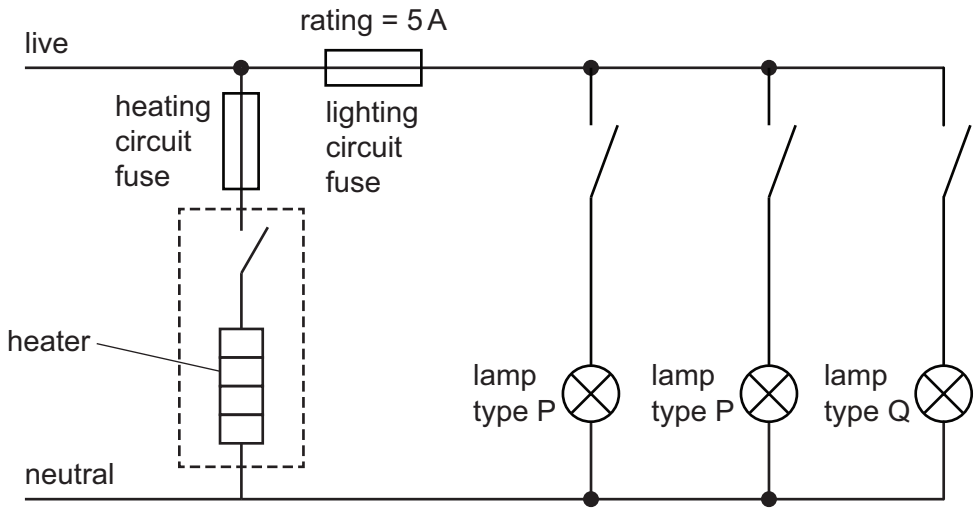

Fig. 6.1

(a) The mains voltage is 230 V, and the power of the heater is 2000 W.

There is a 5A fuse in the lighting circuit. Four fuses of different ratings are available for use in the heating circuit as shown in the list.

Underline the most suitable fuse value for the heating circuit fuse, and explain your choice.

Your answer must include a calculation.

available fuses: **5A** **8A** **13A** **30A**

calculation

explanation .....

.....

..... [3]

(b) Describe what happens to a fuse when the current is too large.

.....

..... [1]

(c) Table 6.1 shows the current in lamps of type P and type Q when connected to the mains supply.

Table 6.1

lamp type	current/A
P	0.26
Q	0.43

(i) Calculate the current in the lighting circuit fuse when all three lamps are switched on.

current = ...A [1]

(ii) The rating for the lighting circuit fuse in Fig. 6.1 is 5A.

The lamp of type Q is removed from the circuit.

Calculate the maximum number of additional lamps of type P that can now be connected in parallel to the lighting circuit.

number of additional lamps = ... [1]

(d) In some houses the lighting circuit is protected by a trip switch (circuit breaker) instead of a fuse.

State **two** advantages of using a trip switch rather than a fuse.

1 .....

.....

2 .....

.....

[2]

[Total: 8]

7 Fig. 7.1 shows a simple d.c. motor. The poles at the ends of the magnets are not labelled.

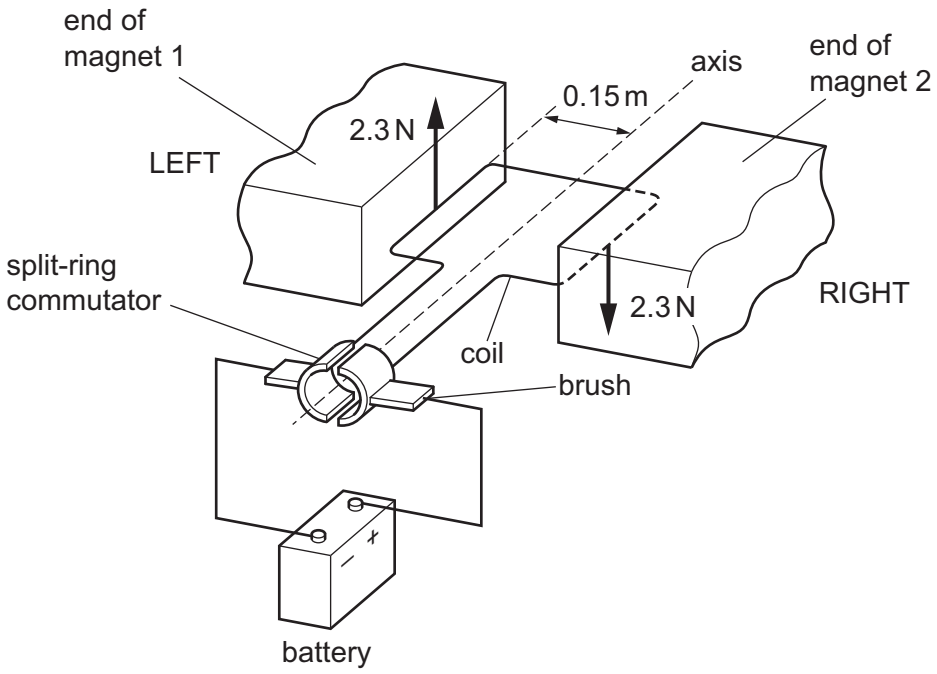

Fig. 7.1

(a) State the purpose of the split-ring commutator and the brushes.

split-ring commutator .....

.....

.....

brushes .....

.....

[3]

(b) There is an upward force shown on the left side of the coil.

There is a magnetic field in the space between the ends of the magnets.

State the direction of this magnetic field.

Explain how you determined this direction.

direction .....

explanation .....

.....

.....

.....

[3]

(c) State what happens to the rotation of the coil if the magnetic field and the current in the coil are both reversed at the same time.

.....

..... [1]

(d) In Fig. 7.1, the coil is horizontal. The force upward on the left side and the force downward on the right side are each 2.3 N.

The distance between the sides of the coil and the axis is 0.15 m.

(i) Calculate the total moment exerted on the coil by these forces.

Give the unit of your answer.

moment = ...

unit = ...
[3]

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

.....

.....

..... [1]

[Total: 11]

8 Fig. 8.1 is a diagram of a nuclear reactor.

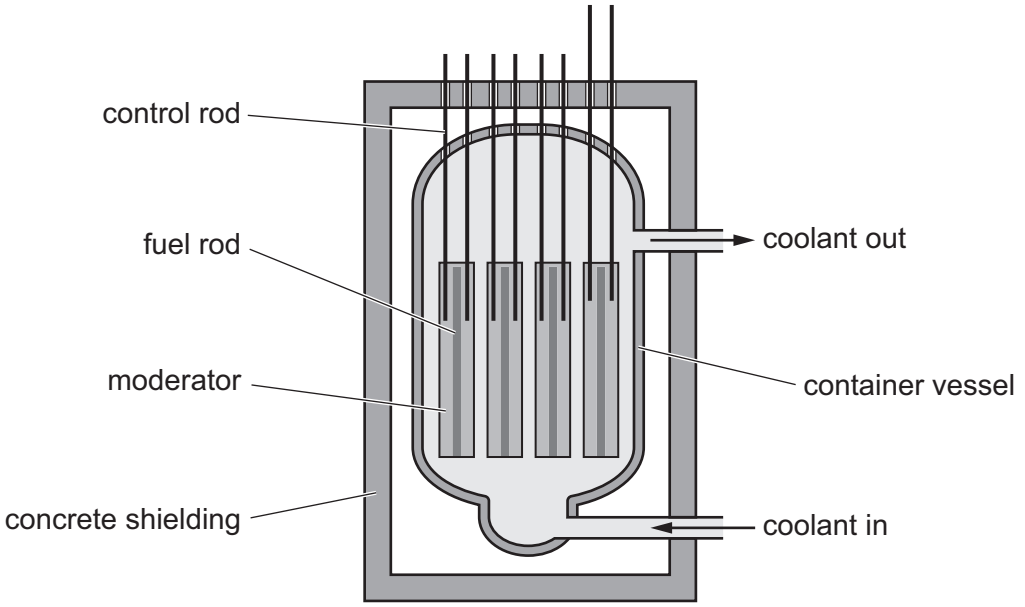

Fig. 8.1

Nuclear fission occurs within the fuel rods which become hotter as a result. The thermal energy is transferred to the coolant circulating around the rods.

(a) In Table 8.1 state the purpose of each part of the reactor.

Table 8.1

part	purpose
container vessel	to withstand high pressures and temperatures and make sure no coolant escapes
concrete shielding	....
control rods	....
moderator	....

[3]

(b) Describe what causes the fission of a single nucleus of uranium-235 in the fuel rods, and describe what happens during the fission.

.....

.....

.....

.....

..... [3]

(c) The specific heat capacity of the coolant is an important quantity in the design of the reactor.

(i) State what is meant by 'specific heat capacity'.

.....

.....

.....

..... [2]

(ii) Suggest and explain whether the coolant should have a large or a small specific heat capacity.

.....

.....

..... [1]

[Total: 9]

9 Fig. 9.1 shows the path of a comet, the orbit of Earth and the orbit of Jupiter around the Sun.

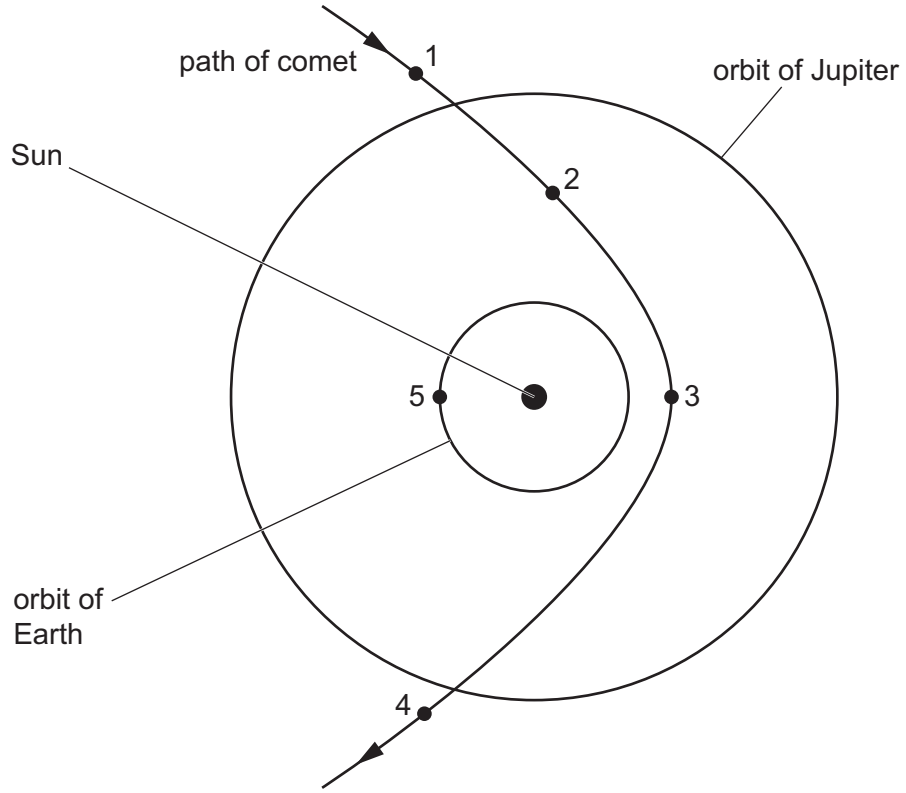

Fig. 9.1 (not to scale)

The comet is at position 3 when Earth is at position 5.

(a) On Fig. 9.1, draw the orbits of Mercury and Mars. Label each orbit. [2]

(b) Explain why the comet at position 3 cannot be seen from Earth when Earth is at position 5.

.....

..... [1]

(c) A force causes the comet to orbit the Sun.

(i) State the name of the force that acts on the comet.

..... [1]

(ii) Four positions of the comet are shown in Fig. 9.1.

On Fig. 9.1, mark the direction of the force that acts on the comet at each of the four positions shown. [1]

(iii) Describe how the strength of the force that acts on the comet changes as the comet moves from position 1 through position 3 to position 4.

Explain your answer.

description .....

.....

explanation .....

.....

[2]

(d) Table 9.1 gives the orbital radius and the orbital speed of Earth and of Jupiter as each moves around the Sun.

Table 9.1

	orbital radius / km	$\frac{\text{orbital speed}}{\text{km/s}}$
Earth	1.5×10^8	30
Jupiter	7.8×10^8	13

Earth completes more orbits of the Sun than Jupiter in the same time.

Calculate the number of orbits that Earth makes around the Sun in the time that Jupiter makes one orbit.

Show your working.

number of orbits = ... [3]

[Total: 10]

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