1 This question is about the Solar System.

(a) The object at the centre of our Solar System is

(1)

- ☒ **A** a comet
- ☒ **B** the Earth
- ☒ **C** the Moon
- ☒ **D** the Sun

(b) Earth and Mars are planets in our Solar System.

The table shows some data for these planets.

planet	radius of orbit in km	time of orbit in days
Earth	150 000 000	365
Mars	250 000 000	690

(i) Calculate the orbital speed of Mars in km / day.

(2)

speed = ... km / day

(ii) The distance between Earth and Mars varies between 100 million km and 400 million km.

Explain why this distance is not constant.

You may draw a diagram to help your answer.

(2)

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(c) Visible light from Mars reaches the Earth.

The speed of light is 300 000 km/s.

(i) Show that when the planets are 170 000 000 km apart, it takes about 600 s for light to travel this distance.

(3)

(ii) Scientists land a remote-controlled vehicle on Mars.

The vehicle sends images back to Earth showing its surroundings on Mars.

Sometimes these images show rocks ahead that could damage the vehicle.

A scientist on Earth sends radio signals that control this vehicle.

The speed of the vehicle is limited to 0.04 m/s.

Suggest why the speed is kept low.

(2)

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(Total for Question 1 = 10 marks)

2 The table shows information about three isotopes of uranium.

Isotope	Proton number	Neutron number	Half-life	Amount in natural uranium
Uranium-234	92	142	0.0002 billion years	0.005%
Uranium-235		143	0.7 billion years	0.7%
Uranium-238	92		4.5 billion years	99%

(a) (i) Complete the table by filling in the missing numbers.

(2)

(ii) Explain what is meant by the term **half-life**.

(2)

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(iii) Suggest why uranium-238 is the most common isotope of uranium.

(1)

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(b) Nuclear power stations use a uranium isotope as fuel.

What are the products of the fission of uranium nuclei?

(3)

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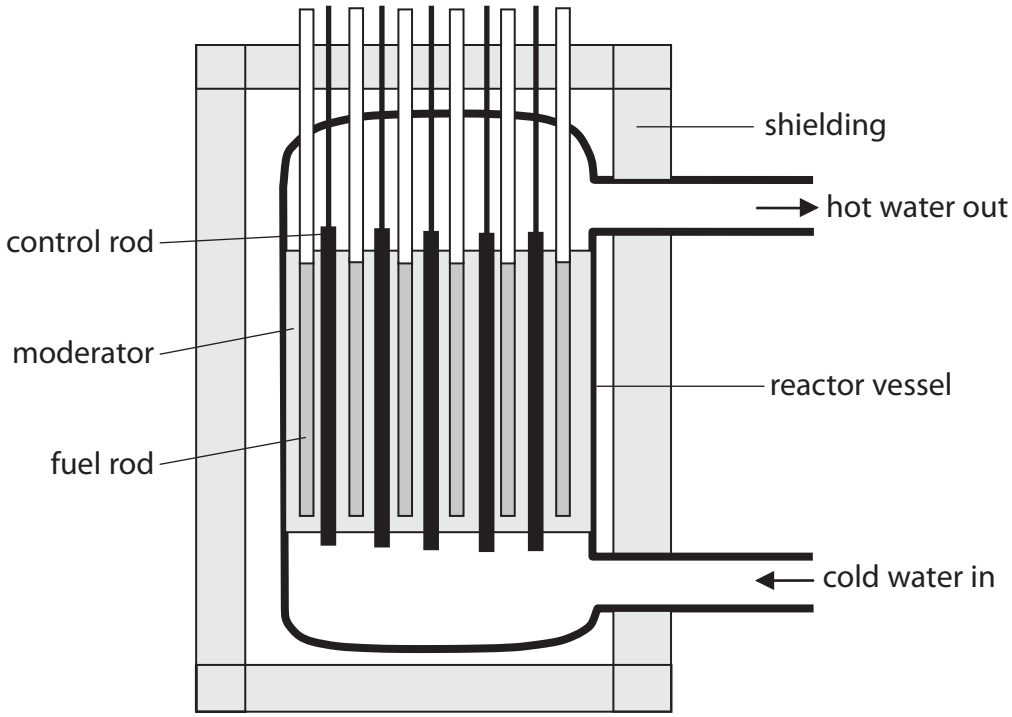
(c) The diagram shows the reactor in a nuclear power station.



(i) What is the purpose of the moderator?

(1)

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(ii) Describe what happens in the reactor when a control rod is removed.

(2)

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(d) There have been several accidents at nuclear power stations.

The most serious accident caused an explosion in the reactor.

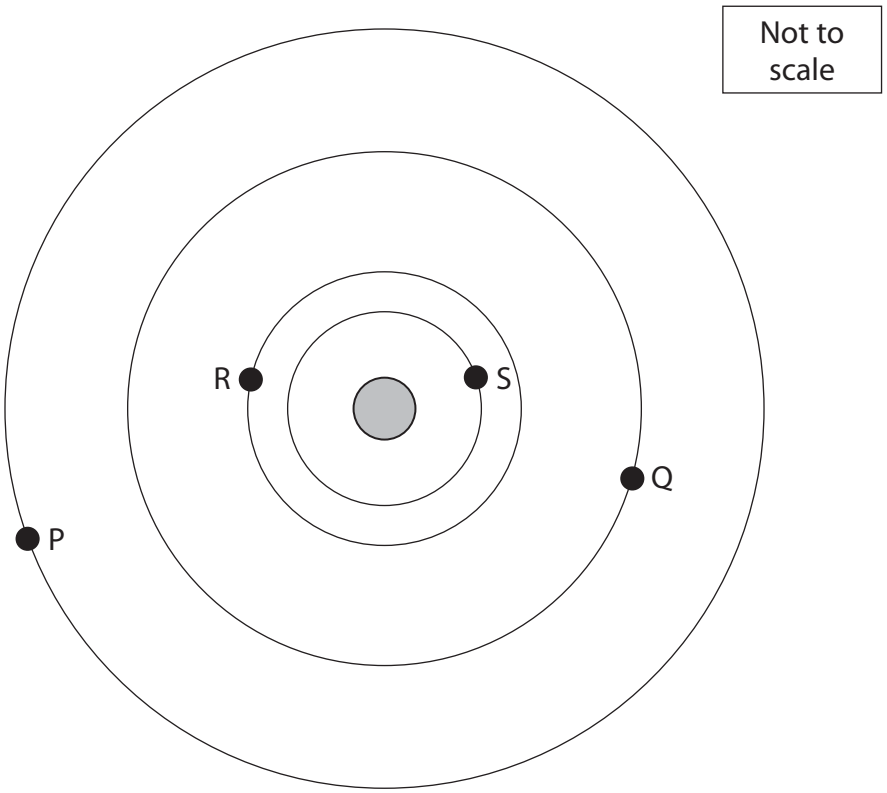
This explosion spread material from inside the reactor to the surrounding area.

Explain why it is difficult to make the surrounding area safe again after a serious nuclear accident.

(5)

(Total for Question 2 = 16 marks)

3 The diagram shows four planets, P, Q, R and S, orbiting a star.



(a) This combination of planets and a star is most like

(1)

- ☒ **A** a galaxy
- ☒ **B** the Milky Way
- ☒ **C** the Solar System
- ☒ **D** the universe

(b) Planet Q has a moon.

On the diagram, draw the orbit of this moon.

(1)

(c) On the diagram, draw the orbit of a comet.

(2)

(d) Planets nearer to the star take less time to orbit the star.

(i) Suggest why.

(1)

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(ii) Planet P makes one complete orbit.

During this time

(1)

- ☒ **A** planet R makes more orbits than S
- ☒ **B** planet R makes fewer orbits than Q
- ☒ **C** planet S makes more orbits than P
- ☒ **D** planet Q makes fewer orbits than P

(e) As the planets orbit the star, the distances between the planets change.

Planet **P** is 200 million km from the star and planet **R** is 50 million km from the star.

(i) Calculate the maximum distance between planet P and planet R.

(1)

maximum distance = ... million km

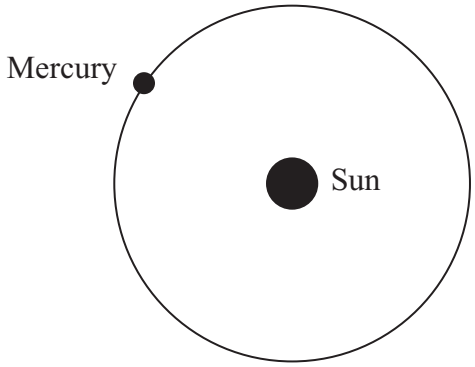
(ii) Calculate the minimum distance between planet P and planet R.

(1)

minimum distance = ... million km

(Total for Question 3 = 8 marks)

4 The planet Mercury orbits the Sun.



(a) Mercury takes 88 days to orbit the Sun.

The average radius of the orbit is 58 million km.

Calculate the average orbital speed of Mercury.

Give the unit.

(3)

Average orbital speed ..... Unit .....

(b) Comets also orbit the Sun.

(i) Name the force that causes comets and planets to orbit the Sun.

(1)

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(ii) Add to the diagram opposite to show the orbit of a typical comet.

(1)

(iii) The speed of a comet changes during its orbit.

On the orbit you have drawn, label with the letter **X** the position where the comet travels at its **fastest** speed.

(1)

(iv) Explain why the comet travels fastest at point **X**.

(2)

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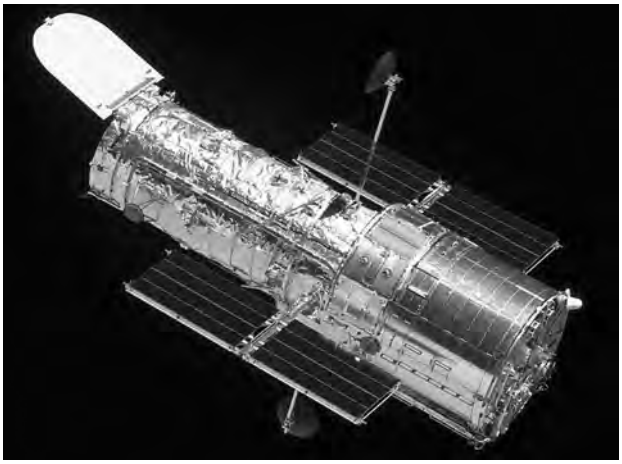
(Total for Question 4 8 marks)

5 The Hubble Space Telescope is in orbit around the Earth.

It detects visible light from distant objects.



(a) Name the force that keeps the telescope in orbit around the Earth.

(1)

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(b) The Hubble Space Telescope moves in a circular orbit.

Its distance above the Earth's surface is 560 km.

(i) The radius of the Earth is 6400 km.

Calculate the radius of the orbit of the Hubble Space Telescope.

(1)

Radius = ... km

(ii) The Hubble Space Telescope completes one orbit in 96 minutes.

Calculate its orbital speed in m/s.

(3)

Orbital speed = ... m/s

(c) The Chandra Telescope also orbits the Earth, but does not move in a circular orbit.

Its distance from the Earth and its speed change as it orbits the Earth.

It travels fastest when it is closest to the Earth.

Use ideas about energy to explain why.

(3)

(d) The Chandra Telescope detects X-rays from distant objects.

(i) State the name of the type of wave that includes X-rays and visible light.

(1)

(ii) Describe **two** differences between X-rays and visible light.

(2)

1

2

(Total for Question 5 = 11 marks)