CAMBRIDGE
International Education

# Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

*1636706893*

**PHYSICS** **5054/21**

Paper 2 Theory **May/June 2026**

**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. Do **not** use correction fluid or tape.
- 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.


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**1** A bus starts a journey with a uniform acceleration for the first 20 s.

**(a) (i)** State what is meant by 'uniform acceleration'.

.....

..... [1]

**(ii)** The bus starts from rest at time $t = 0$ and reaches a speed of 16 m/s at $t = 20$ s.

Calculate the acceleration of the bus.

acceleration = .....m/s$^2$ [2]

**(b)** At $t = 20$ s, the acceleration of the bus changes.

- From $t = 20$ s to $t = 100$ s, the acceleration of the bus is zero.
- From $t = 100$ s to $t = 120$ s, the bus decelerates with an acceleration of −0.30 m/s$^2$.

On Figure 1.1, plot a speed–time graph for the first 120 s of the journey.

Use the space provided for any calculations.

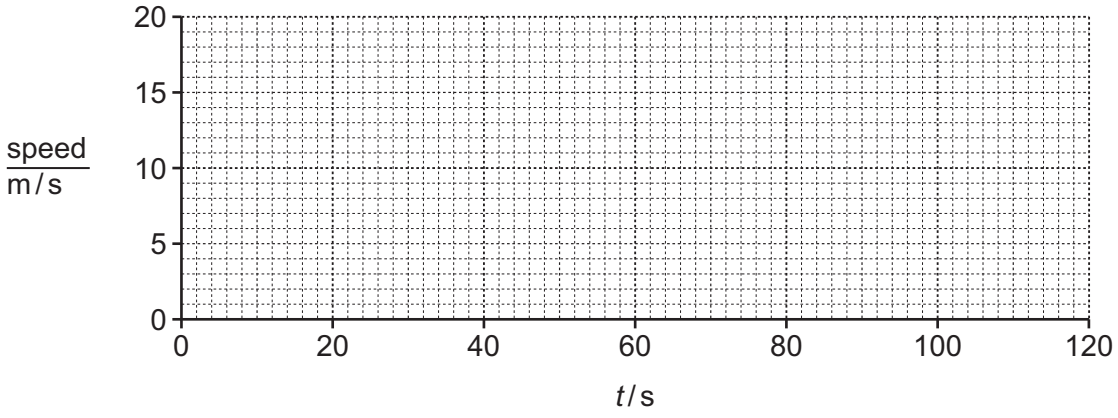


**Figure 1.1**

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**(c)** Explain, by referring to the relative magnitudes and directions of the forces on the bus, why the bus initially accelerates and later decelerates.

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..... [2]

[Total: 8]

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**2** Figure 2.1 shows a waterfall.

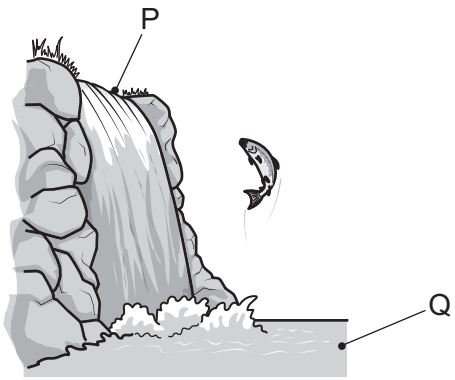


**Figure 2.1**

**(a)** The speed of the water flow at points P and Q is the same.

**(i)** Describe the transfers of energy that occur as the water moves from point P to point Q.

.....

.....

.....

..... [2]

**(ii)** The particles of water move at random as well as moving with the water flow past point P and point Q.

Compare the temperature of the water at point P with the temperature of the water at point Q, and compare the average speed of the random movement of particles at point P with the average speed of the random movement of the particles at point Q.

the temperature at point P compared with point Q is .....

the average speed of particles at point P compared with point Q is .....
[1]

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**(b)** A fish of mass 2.5 kg rises vertically, leaving the water at a speed of 8.0 m / s.

**(i)** Calculate the kinetic energy of the fish as it leaves the water.

kinetic energy = ..... J [3]

**(ii)** Calculate the maximum height above the surface of the water that the fish reaches.

height = ..... m [2]

[Total: 8]

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**3** A syringe containing air is connected to a pressure sensor in a school laboratory as shown in Figure 3.1.

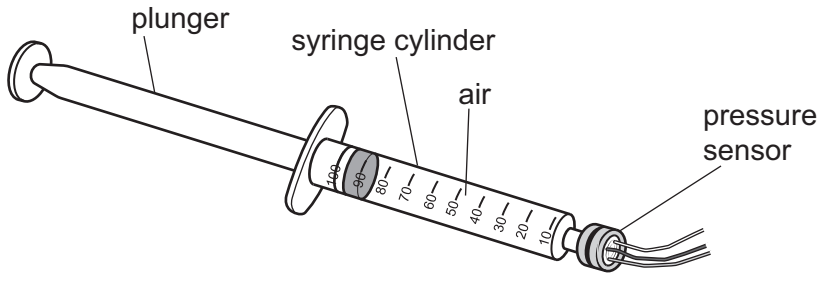


**Figure 3.1**

The pressure of the air in the syringe cylinder is $1.0 \times 10^5$ Pa. There is no friction between the plunger and the walls of the syringe cylinder.

**(a) (i)** The internal cross-sectional area of the syringe cylinder is $1.2 \times 10^{-4}\,m^2$.

Calculate the force exerted on the plunger by the air inside the syringe cylinder.

force = ..... N [2]

**(ii)** The plunger does not move, even though the force in **3(a)(i)** acts on the plunger.

Explain why the plunger does not move.

.....

..... [1]

**(iii)** An air particle has a mass of $4.7 \times 10^{-26}$ kg and moves with a speed of 500 m / s.

Calculate the momentum of the air particle. Give the unit of your answer.

momentum = ..... unit ..... [2]

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**(iv)** Explain, using ideas about particles, how air exerts a large pressure on the wall of the syringe cylinder, even though the momentum of each particle is very small.

.....

.....

.....

..... [2]

**(b)** The volume of air in the syringe cylinder is initially 90 $cm^3$.

The plunger is pushed inwards so that the volume of air decreases by 40 $cm^3$. The temperature of the air in the syringe cylinder remains unchanged.

Calculate the new pressure of the air in the syringe cylinder.

pressure = .....Pa [3]

[Total: 10]

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**4** **(a)** All electromagnetic waves transfer energy.

State **two** other properties that are the same for all electromagnetic waves.

1 .....

.....

2 .....

.....

[2]

**(b)** Figure 4.1 shows an X-ray image of healthy teeth.

The detector used to create the image is placed inside the mouth, behind the teeth.

A source of X-rays is placed outside the mouth, in front of the teeth.

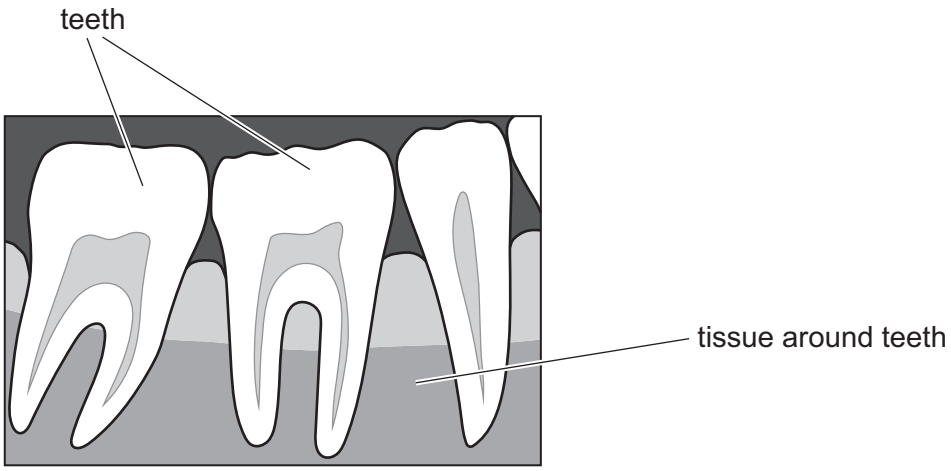


**Figure 4.1**

Explain why the X-rays produce an image that shows white teeth, grey tissue around the teeth and a black background.

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**(c)** Ultrasound is another type of wave used in hospitals to produce medical images.

A scanner placed on the skin of a patient emits an ultrasound wave.

**(i)** The ultrasound wave causes a motion of the particles in the tissue of the patient.

Describe this motion.

.....

.....

..... [2]

**(ii)** The ultrasound wave is reflected from a bone in the patient and arrives back at the scanner $8.0 \times 10^{-5}$ s after it was emitted.

The speed of ultrasound in the patient is 1500 m / s.

Calculate the distance between the scanner and the bone.

distance = ..... m [2]

**(iii)** Some of the ultrasound passes through the patient and emerges into the air.

The speed of ultrasound in air is smaller than the speed of ultrasound in the patient.

State and explain the change in wavelength as ultrasound travels from the patient into the air.

change in wavelength .....

explanation .....

.....

.....

.....

[2]

[Total: 10]

**5** Figure 5.1 shows a ripple tank used by a student.

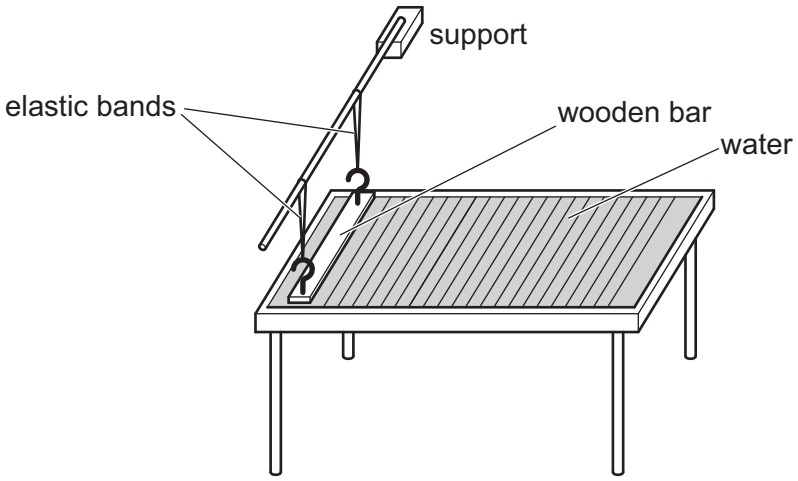


**Figure 5.1**

**(a) (i)** Describe how the student uses the apparatus to create a wave.

.....

.....

..... [1]

**(ii)** Describe how the student can demonstrate diffraction of the wave using the ripple tank. You should refer to any other apparatus needed.

.....

.....

.....

..... [1]

**(iii)** The unit of frequency is the hertz (Hz).

Describe how the student can determine the frequency of the wave in the ripple tank in Hz.

.....

.....

.....

..... [2]

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**(b)** Figure 5.2 shows a side view of the wave on the surface of the water. The diagram also shows the surface of the water before it is disturbed by the wave.

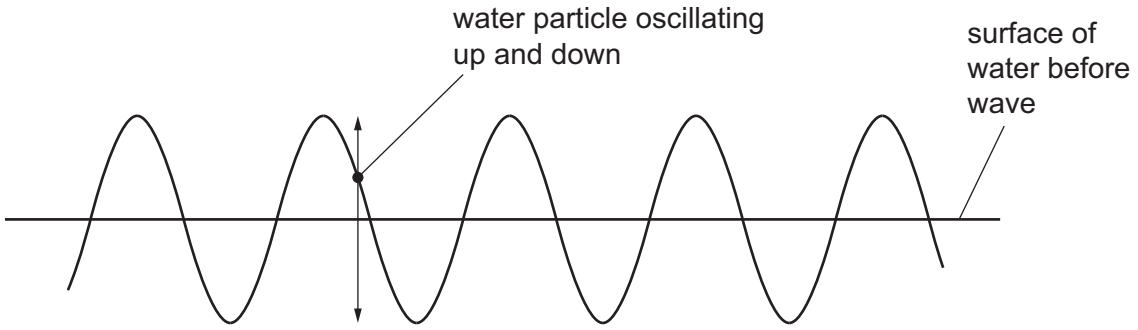


**Figure 5.2**

A water particle on the surface of the water oscillates up and down.

**(i)** On Figure 5.2, mark and label the amplitude of the wave. [1]

**(ii)** The frequency of the wave is 2.0 Hz.

Calculate the time taken for the water particle to move from the top of the wave to the bottom of the wave.

time = ..... s [2]

**(iii)** Describe how the speed of the particle changes as it moves from the top of the wave to the bottom of the wave.

.....

.....

..... [2]

[Total: 9]

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**6** Figure 6.1 shows two identical car headlamps connected in parallel to the 12 V battery of a car. The lamps are filament lamps.

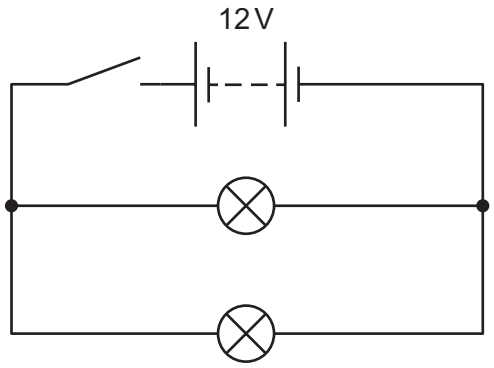


**Figure 6.1**

The switch is closed, and both lamps operate at normal brightness.

**(a)** The power of each lamp is 40 W.

**(i)** Calculate the current in each lamp and the current in the battery.

current in each lamp = ..... A

current in battery = ..... A
[3]

**(ii)** Calculate the resistance of the circuit when the lamps are operating at normal brightness.

resistance = ..... Ω [2]

**(iii)** When the circuit is first switched on, the current in each filament lamp is large and then quickly decreases.

Explain why the current in each lamp decreases.

.....

.....

..... [2]

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**(b)** During use, some metal atoms evaporate from the filament of a filament lamp and condense on the inside surface of the lamp. The inside surface of a lamp darkens where the metal atoms condense.

When there is a gas inside the lamp, the metal atoms condense mainly at the top of the lamp.

When there is a vacuum inside the lamp, the metal atoms condense uniformly over the inside surface.

A filament lamp with gas inside and a filament lamp with a vacuum inside are shown in Figure 6.2.

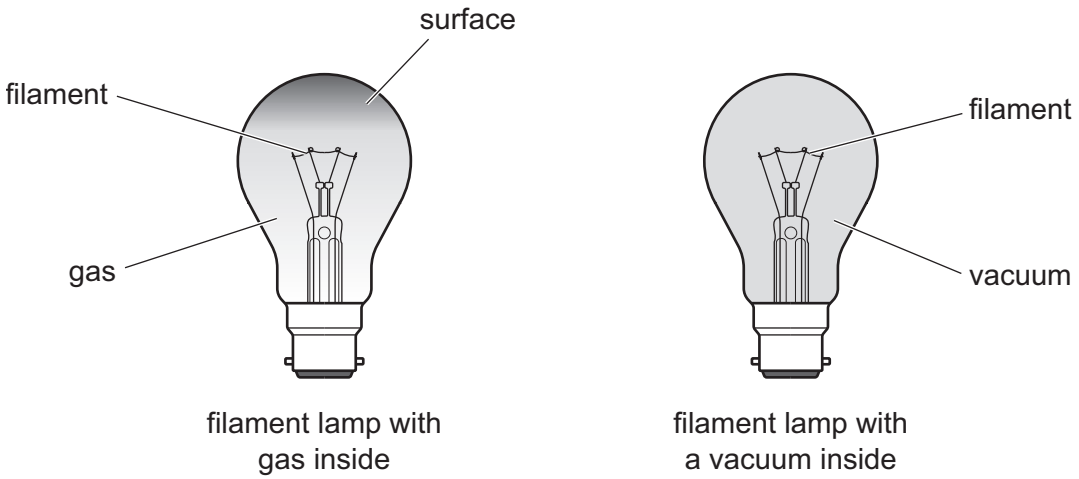


**Figure 6.2**

Explain why the metal atoms condense mainly at the top of the lamp when there is a gas inside the lamp.

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..... [2]

[Total: 9]

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**7** Figure 7.1 shows a bathroom heater connected to a 240 V a.c. supply. A relay is used to turn on the heater.

Parts of the relay are labelled in Figure 7.1.

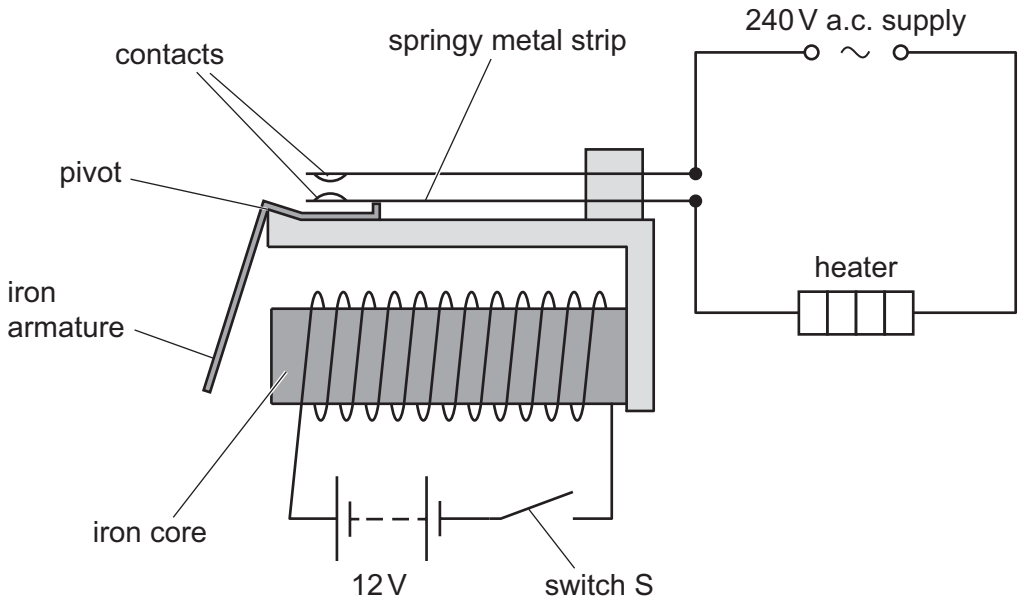


**Figure 7.1**

The armature and core are made of iron.

**(a)** When switch S is closed, the contacts come together to turn on the heater.

Explain why closing switch S causes the contacts to come together.

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.....

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.....

..... [3]

**(b)** Explain why the contacts move apart when switch S is opened.

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.....

.....

..... [2]

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**(c)** Explain why steel is an unsuitable material for the armature.

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..... [2]

**(d)** An alternative arrangement for switching on the heater is shown in Figure 7.2. The bathroom heater is connected in series with a 240 V power supply and switch S.

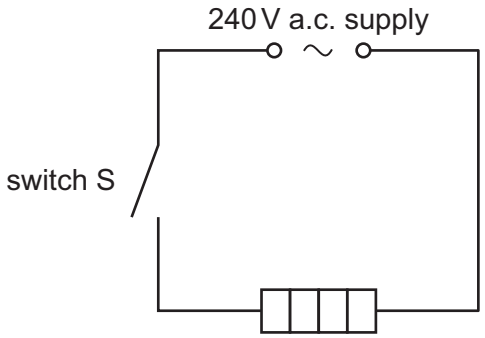


**Figure 7.2**

The circuit in Figure 7.2 should **not** be used to switch on a bathroom heater.

Suggest why it is safer to use the circuit in Figure 7.1 that contains a relay.

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..... [1]

[Total: 8]

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**8** A radioactive source emits alpha particles, beta particles and gamma radiation.

**(a)** The radiation emitted from the radioactive source causes ionisation.

**(i)** State **one** harmful effect of ionising radiation on living things.

.....

..... [1]

**(ii)** An alpha particle passes close to an atom in the air.

Explain how the alpha particle causes the atom to become a positive ion.

.....

.....

.....

..... [2]

**(iii)** Describe **one** way to reduce the risk of working with radioactive sources.

.....

..... [1]

**(b)** **(i)** An alpha particle is the nucleus of an atom of one of the isotopes of helium (He).

Complete the nuclide symbol for an alpha particle.

..... $\mathbf{He^{2+}}$ .....

[1]

**(ii)** An atom emits a beta particle.

Describe the effect of this emission on the composition of the nucleus of the atom.

.....

.....

.....

..... [2]

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**(c)** Figure 8.1 shows three arrangements of apparatus used to show the effect of different absorbers on the alpha radiation, beta radiation and gamma radiation from the radioactive source.

In arrangement 1, the radioactive source is 20 cm from the detector.

In arrangements 2 and 3, the source is 1 cm from the detector.

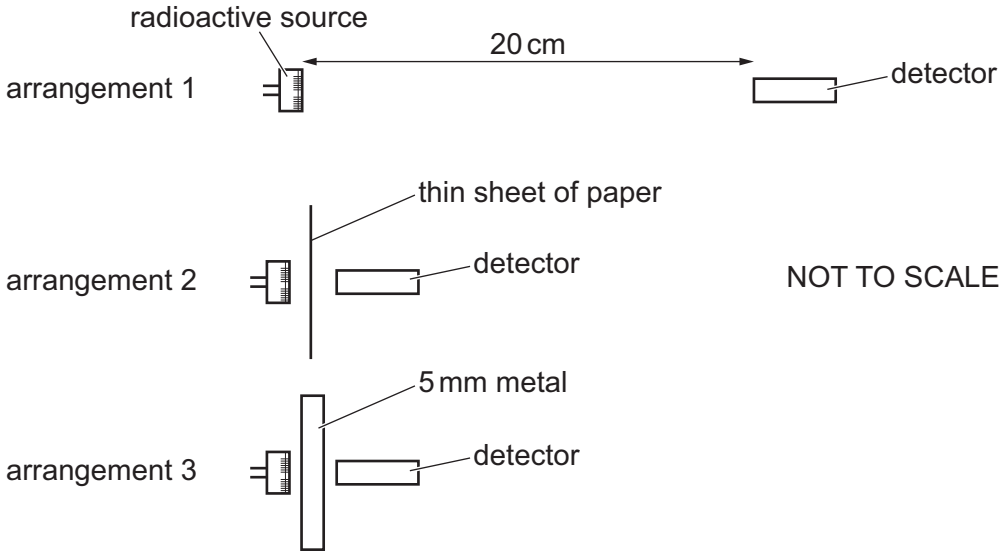


**Figure 8.1**

Table 8.1 is produced by a student to show which types of radiation from the source reach the detector in each arrangement.

Complete Table 8.1 by placing a tick (✓) in all the boxes where the named radiation reaches the detector in that arrangement.

One box has been ticked to show that gamma radiation emitted by the source reaches the detector in arrangement 1.

Where a radiation does not reach the detector, leave the box blank.

**Table 8.1**

| radiation from source | arrangement 1 | arrangement 2 | arrangement 3 |
|---|---|---|---|
| alpha particles | | | |
| beta particles | | | |
| gamma radiation | ✓ | | |

[3]

[Total:10]

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**9** Table 9.1 gives data about some of the planets in the Solar system.

**Table 9.1**

| planet | distance from Sun / km | orbital period / days | mass of planet / kg | average density / kg / m$^3$ |
|---|---|---|---|---|
| Mercury | $5.8 \times 10^7$ | 88 | $3.3 \times 10^{23}$ | 5400 |
| Venus | $1.1 \times 10^8$ | 220 | $4.9 \times 10^{24}$ | 5200 |
| Earth | $1.5 \times 10^8$ | 370 | $6.0 \times 10^{24}$ | 5500 |
| Mars | $2.3 \times 10^8$ | 690 | $6.4 \times 10^{23}$ | 3900 |
| Jupiter | $7.8 \times 10^8$ | 4 300 | $1.9 \times 10^{27}$ | 1300 |
| Saturn | $1.4 \times 10^9$ | 11 000 | $5.7 \times 10^{26}$ | 690 |

The orbital period is the time taken by a planet to make one orbit around the Sun.

**(a) (i)** The distance between Earth and Venus is not constant.

Explain why.

You may draw a diagram if you wish.

.....

.....

.....

..... [2]

**(ii)** Use Table 9.1 to determine the smallest distance between Earth and Venus.

smallest distance = ..... $\times 10^7$ km [1]

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**(b)** A student suggests that the larger the mass of the planet, the greater is its orbital period.

Using data from Table 9.1, suggest whether the student is correct or not.

Explain your answer.

.....

.....

.....

..... [2]

**(c)** Using data from Table 9.1, calculate the volume of the Earth.

volume = .....$m^3$ [2]

**(d)** A student uses data from Table 9.1 to find the orbital speed of a planet.

The student uses:

- the distance $R$ of the planet from the Sun
- the orbital period $T$ of the planet.

State the equation involving $R$ and $T$ that is used to find the orbital speed of the planet

orbital speed =

[1]

[Total: 8]

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