OCR
Oxford Cambridge and RSA

Friday 14 June 2024 – Afternoon

GCSE (9–1) Physics B (Twenty First Century Science)

J259/04 Depth in physics (Higher Tier)

Time allowed: 1 hour 45 minutes

You must have:
- a ruler (cm/mm)
- the Equation Sheet for GCSE (9–1) Physics B (inside this document)

You can use:
- a scientific or graphical calculator
- an HB pencil

H

* J 2 5 9 0 4 *

* 1 3 7 7 8 8 2 0 7 6 *

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

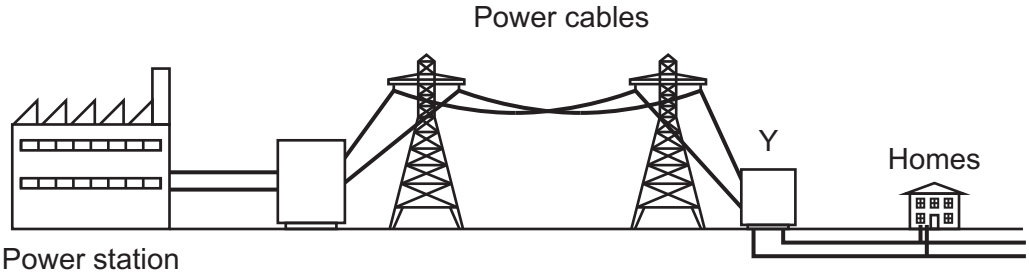
Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined page at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **24** pages.

ADVICE
- Read each question carefully before you start your answer.

1 The diagram below shows part of the National Grid.



(a)

(i) What is the domestic mains supply voltage to homes in the UK?

Tick (✓) **one** box.

60 V a.c. ☐

60 V d.c. ☐

230 V a.c. ☐

230 V d.c. ☐

[1]

(ii) The electricity is transmitted along the power cables at around 230 000 V.

Explain how this high voltage makes the energy transfer along the power cables more efficient.

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..... **[2]**

(iii) Name the device at Y.

..... **[1]**

(b) Many different energy resources are used to generate electricity.

(i) State **two** types of **renewable** energy resources used to generate electricity.

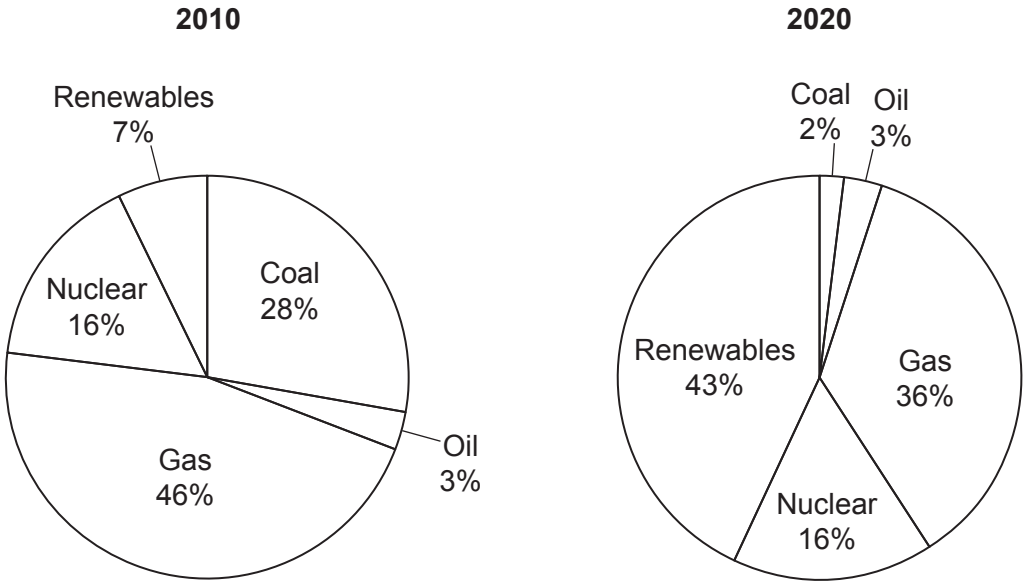
1 .....

2 .....

[2]

(ii)* **Fig. 1.1** shows the percentage of electricity generated by different energy resources in the UK in 2010 and 2020.

Fig. 1.1



Describe how the trends in the use of energy resources in the UK changed between 2010 and 2020.

Suggest reasons for these changes.

Use the data in **Fig. 1.1** in your answer.

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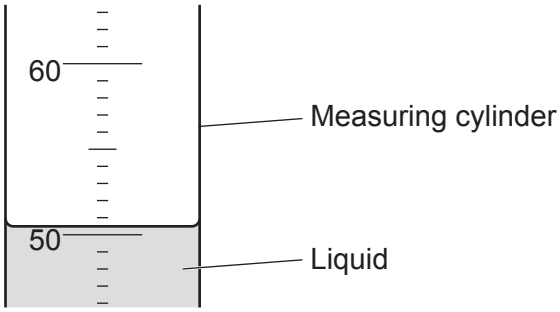
2 A student is doing an experiment to find the density of an unknown liquid.

They pour some of the liquid into a measuring cylinder and measure the volume in cm^3.

Fig. 2.1 shows a close-up of the liquid in the measuring cylinder.

Fig. 2.1

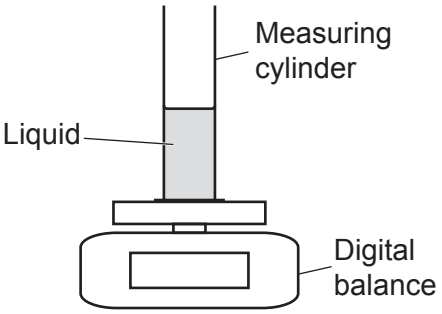


(a) What is the volume of the liquid?

Use **Fig. 2.1**.

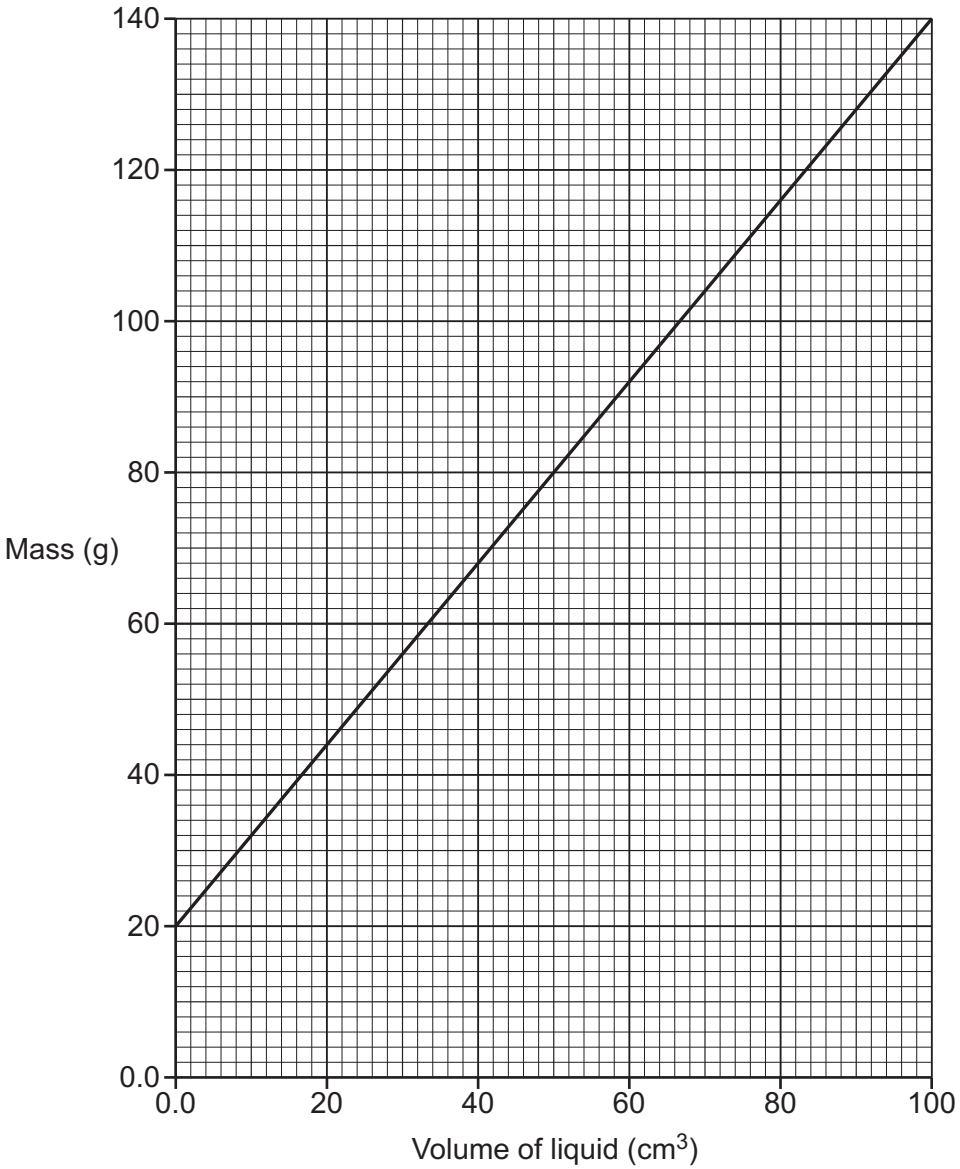
Volume = ... cm^3 **[1]**

(b) The student places the measuring cylinder on to a digital balance and measures the mass of the measuring cylinder and the liquid.



They increase the volume of the liquid and repeat the measurements.

The graph shows their results.



(i) What is the mass of the empty measuring cylinder?

Mass = ... g **[1]**

(ii) Calculate the density of the liquid.

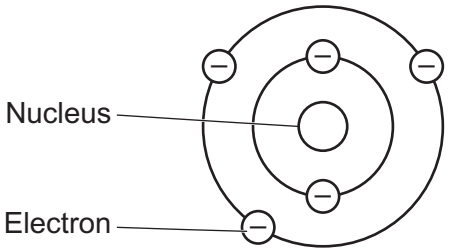
Use:

- data from the graph
- the equation: density = $\frac{\text{mass}}{\text{volume}}$

Density = ... g / cm^3 **[4]**

3 In 1910 the results of the Rutherford-Geiger-Marsden alpha particle scattering experiment provided evidence for the nuclear model of the atom.

The diagram shows the nuclear model of an atom.



(a) State **two** reasons why the model of the atom has changed over time.

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[2]

(b) Describe the structure of the nuclear model of the atom.

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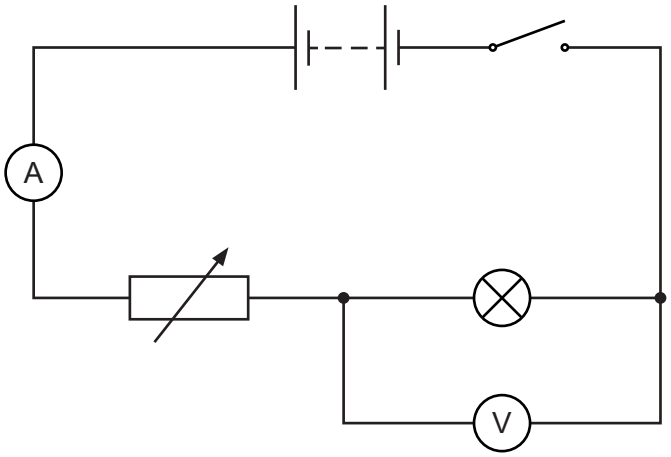
Turn over for the next question

4 A student investigates the I-V characteristics of a lamp.

(a) He builds this circuit.



(i) He observes that the battery runs down too quickly for him to get all the required measurements.

Suggest how the student can stop this from happening.

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(ii) Describe the transfer of energy in the circuit when the switch is closed.

Use ideas about energy stores in your answer.

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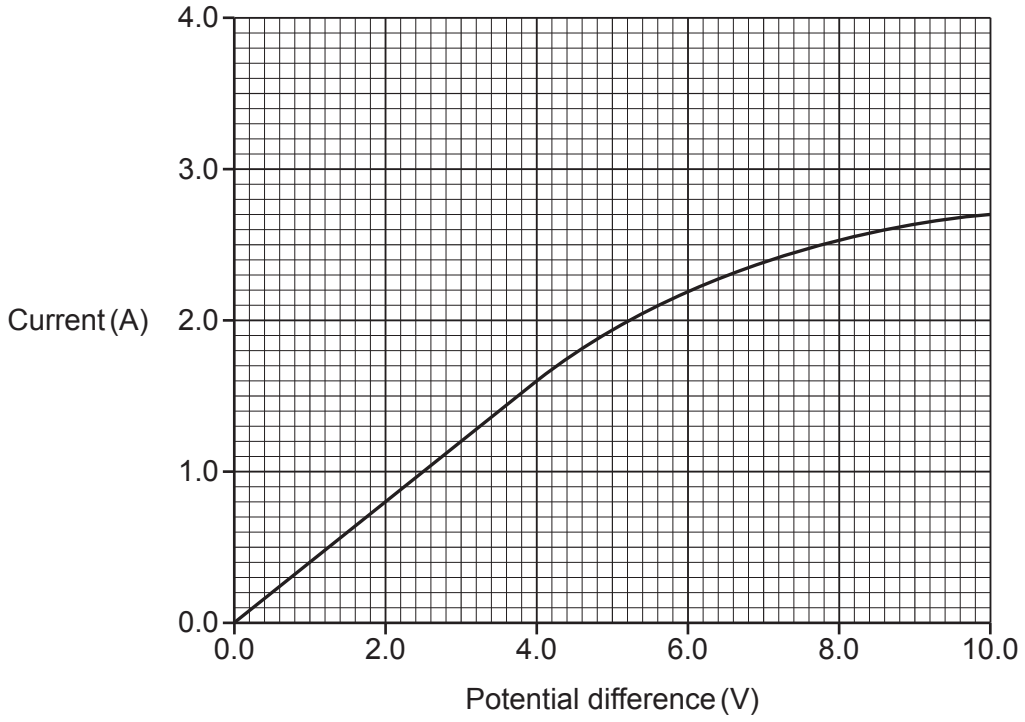
(b) The graph shows the student's results.



(i) Calculate the power dissipated by the lamp when the potential difference is 5 V.

Use the Equation Sheet.

Power = ... W **[3]**

(ii) The student writes this conclusion:

'As the potential difference increases, the resistance of the lamp increases.'

Determine whether the student is correct.

Use:
- data from the graph
- calculations
- the equation: potential difference = current × resistance

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..... **[4]**

(c) A current of 2.8 A passes through the lamp for 120 s.
The energy dissipated in the lamp is 4 kJ.

Calculate the potential difference across the lamp.

Use the equations:

charge = current × time

energy transferred = charge × potential difference

Give your answer to **1** decimal place.

Potential difference across the lamp = ... V **[5]**

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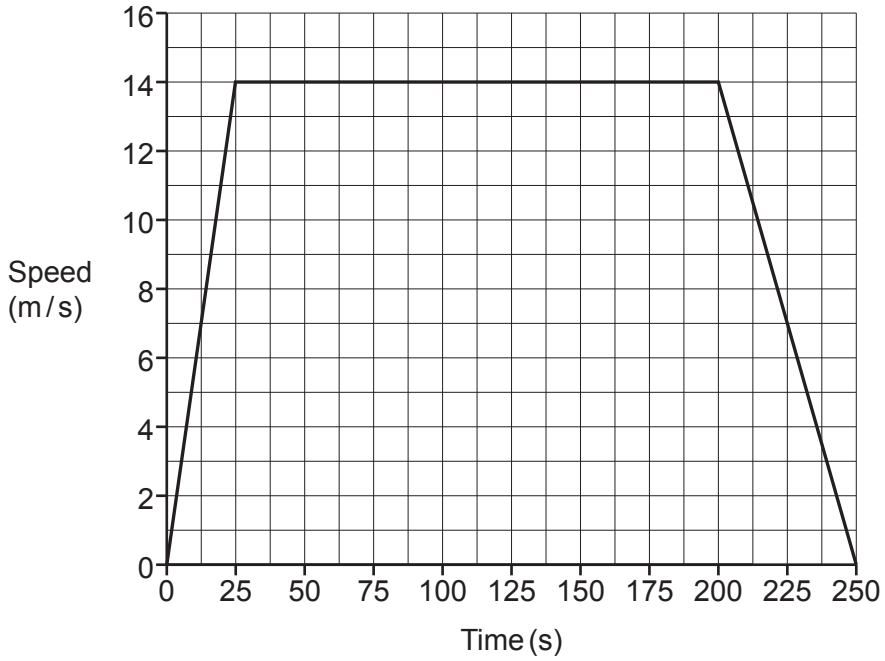
Turn over for the next question

5 Zayn owns an electric car.

(a) The speed–time graph shows part of a journey in the car.



(i) Describe the motion of the car for the first 200 s.

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..... **[2]**

(ii) Calculate the deceleration of the car between 200 and 250 seconds.

Use the Equation Sheet.

Deceleration = ... m/s^2 **[3]**

(iii) Calculate the distance travelled between 0 and 25 seconds.

Distance travelled = ... m **[2]**

(b) When fully charged the battery of the electric car stores 58 kWh.

(i) Zayn has a 7 kW car charger.

Calculate the time it would take to charge the battery.

Use the equation: energy transferred = power × time

Give your answer to **2** significant figures.

Time = ... h **[4]**

(ii) Zayn completes a 420 km journey using all the energy stored in the fully charged battery.

Sara completes the same journey in a petrol car. The petrol car uses 32 litres of petrol.

Sara says that the journey cost her more than twice as much as it cost Zayn.

Show that Sara is **correct**.

Use calculations in your answer.

Use this information:
- electricity costs 34p per kWh
- petrol costs 145p per litre.

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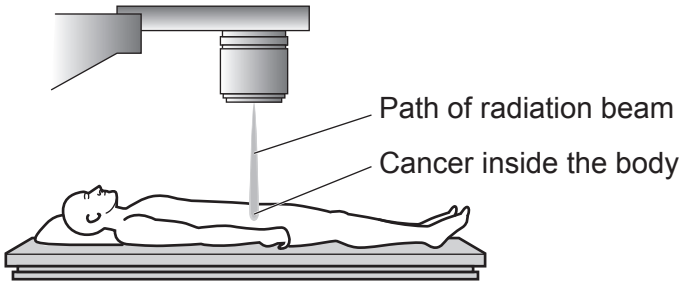
6* External beam radiotherapy is a method which uses radiation to treat cancer inside the body.



The table describes external beam radiotherapy.

	External Beam Radiotherapy
What it is	A radiation beam from outside the body is focused on the cancer and rotated around the body
Typical length of treatment	5 minutes once per day for 5 days

There are three types of radiation: alpha, beta and gamma.

Discuss the suitability of each type of radiation for use in the radiation beam.

Include in your answer how damage to healthy cells is reduced during treatment.

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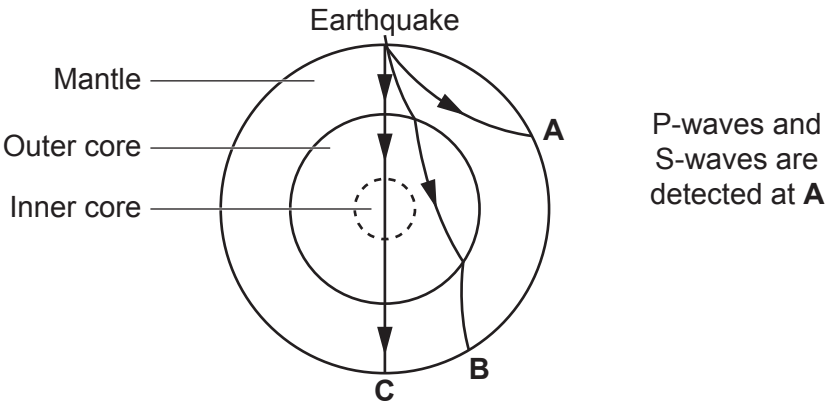
7 During an earthquake, P-waves and S-waves travel through the Earth from the earthquake zone.

Scientists study P-waves and S-waves to find out about the structure of the Earth.

(a) The diagram shows three locations **A**, **B** and **C** that detect the waves from an earthquake.



(i) P-waves can travel through solids and liquids.

S-waves can only travel through solids.

Complete the table to show what conclusions scientists make about the structure of the Earth from this evidence.

Use the diagram to help you.

Tick (✓) **one** box in each row.

	Liquid	**Solid**	**Cannot tell**
Mantle			
Outer core			
Inner core			

[3]

(ii) The density of the mantle is **not** constant.

Suggest why the path of the waves from the earthquake to **A** is curved.

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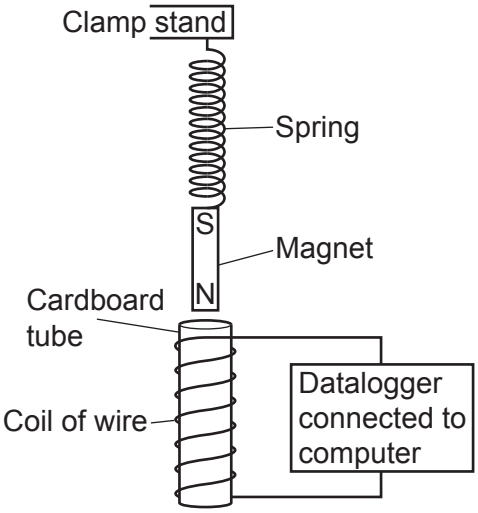
..... **[2]**

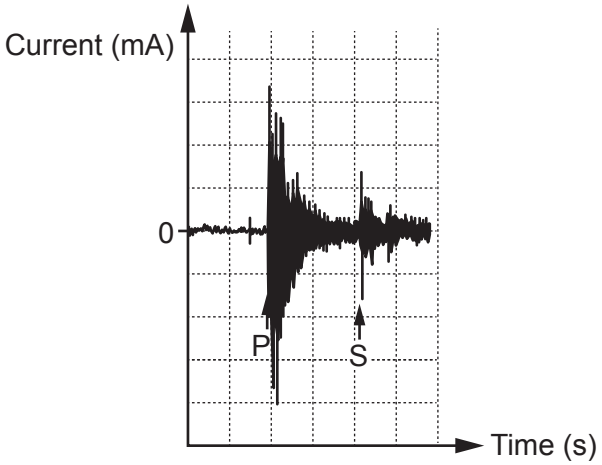
(b) Ryan builds an electromagnetic seismometer for detecting P-waves and S-waves.

He suspends a bar magnet from a spring and positions the magnet above a coil of wire.

The coil of wire is connected to a datalogger and computer.

The datalogger produces a trace showing the change in the electrical signal from the coil.





Trace produced by datalogger

(i) During an earthquake P-waves cause the magnet to move up and down inside the coil.

Explain how the movement of the magnet produces an electrical signal to the datalogger.

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(ii) S-waves cause the magnet to swing from side to side.

During the earthquake the P-waves and S-waves have a similar amplitude of vibration.

Explain why the trace of the S-wave from the datalogger is smaller than the trace of the P-wave.

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..... **[2]**

(iii) Ryan wants to make the amplitude of the trace larger when P-waves are detected.

Suggest **one** change Ryan can make to his apparatus to increase the signal to the datalogger.

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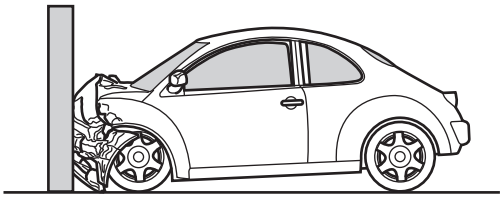
8 In a crash test, the safety of cars in a collision can be tested.



(a) In one test, a car travels at 14 m / s and collides into a solid barrier. The front of the car crumples whilst the car comes to a stop.

Momentum can be used to describe the motion of the car.

(i) Momentum is a vector quantity.

Describe what is meant by a vector quantity.

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..... **[1]**

(ii) The car has a mass of 1500 kg.

Calculate the momentum of the car just before it collides with the barrier.

Use the Equation Sheet.

Give the correct unit.

Momentum = ... unit ..... **[3]**

(iii) During the collision the resultant force on the car is 750 000 N.

Calculate the time that the resultant force acts.

Use the Equation Sheet.

Time the resultant force acts = ... s **[4]**

(b) Three cars, A, B and C, are tested further.

In this test, when the car collides with the barrier, the front of the car crumples and the car rebounds away.

Some of the kinetic energy store of the car before the collision is transferred to the internal energy store of the crumple zone.

The energy transferred to the crumple zone is the useful energy transferred.

The table shows the kinetic energy store of the cars before and after the collision.

Car	**Kinetic energy store of car before collision (kJ)**	**Kinetic energy store of car after collision (kJ)**	**Efficiency of the energy transfer to the crumple zone.**
A	199	146	
B	147	110	0.25
C	196	140	0.29

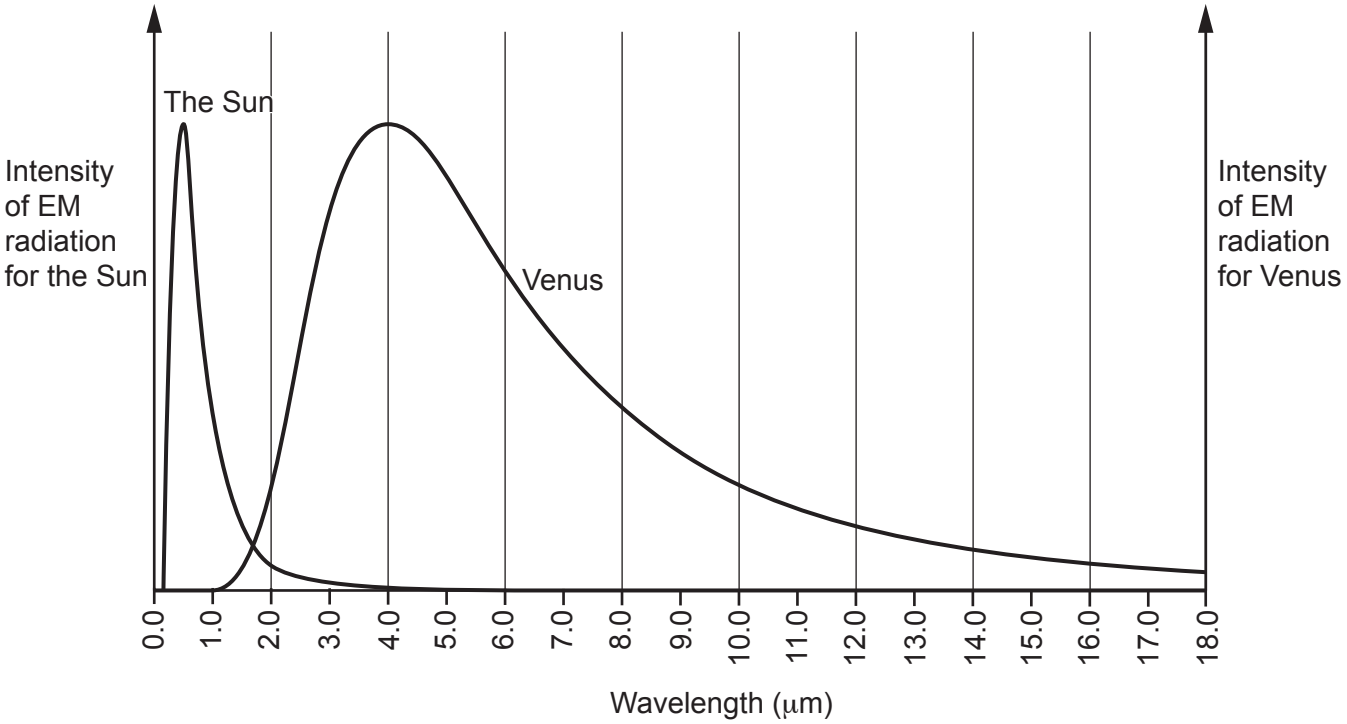
Complete the table to find out which car, A, B or C, has the most efficient crumple zone.

Use the equation: efficiency = $\frac{\text{useful energy transferred}}{\text{total energy transferred}}$

Car with the most efficient crumple zone ..... **[3]**

9 All hot bodies emit electromagnetic (EM) radiation.

The graph shows how the intensity of the emitted EM radiation varies with the wavelength, for the Sun and for the planet Venus.



(a) Explain why the EM radiation emitted from the Sun has a shorter wavelength than the EM radiation emitted from Venus.

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..... **[2]**

(b) The table shows the range of frequencies for different types of EM radiation.

Type of EM radiation	Approximate range of frequencies (Hz)
Radio and microwaves	3.0×10^3 to 3.0×10^{11}
Infrared	3.0×10^{11} to 4.3×10^{14}
Visible light	4.3×10^{14} to 7.9×10^{14}
Ultraviolet (UV)	7.9×10^{14} to 3.0×10^{17}
X rays and Gamma rays	3.0×10^{17} and above

Determine the type of EM radiation, emitted from **Venus**, that has the greatest intensity.

Use the graph and the table.

Use the Equation Sheet.

Speed of light in a vacuum = 3.0×10^8 m/s

Type of EM radiation = ... **[4]**

(c) The atmosphere of Venus is filled with carbon dioxide CO_2 which is a greenhouse gas.

The surface temperature of Venus is the highest of all the planets in the solar system.

Explain how the presence of CO_2 causes the high temperature on Venus.

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END OF QUESTION PAPER

EXTRA ANSWER SPACE

If you need extra space use this lined page. You must write the question numbers clearly in the margin.