OCR
Oxford Cambridge and RSA

F

Monday 23 November 2020 – Morning

GCSE (9–1) Physics A (Gateway Science)

J249/02 Paper 2 (Foundation Tier)

Time allowed: 1 hour 45 minutes

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

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

J249/02

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 pages 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.

SECTION A

Answer **all** the questions.

You should spend a maximum of 30 minutes on this section.

Write your answer to each question in the box provided.

1 A motor has an input energy of 800 J. The useful output energy is 500 J.

What is the wasted energy?

A 300 J

B 500 J

C 800 J

D 1300 J

Your answer ☐ **[1]**

2 Which statement about alpha particles is correct?

A They are fast moving electrons.

B They are less penetrating than beta particles.

C They can pass through lead.

D They have less mass than beta particles.

Your answer ☐ **[1]**

3 A radiator has a power of 2 kilowatts (2 kW).

Convert 2 kW into watts.

A 0.002 W

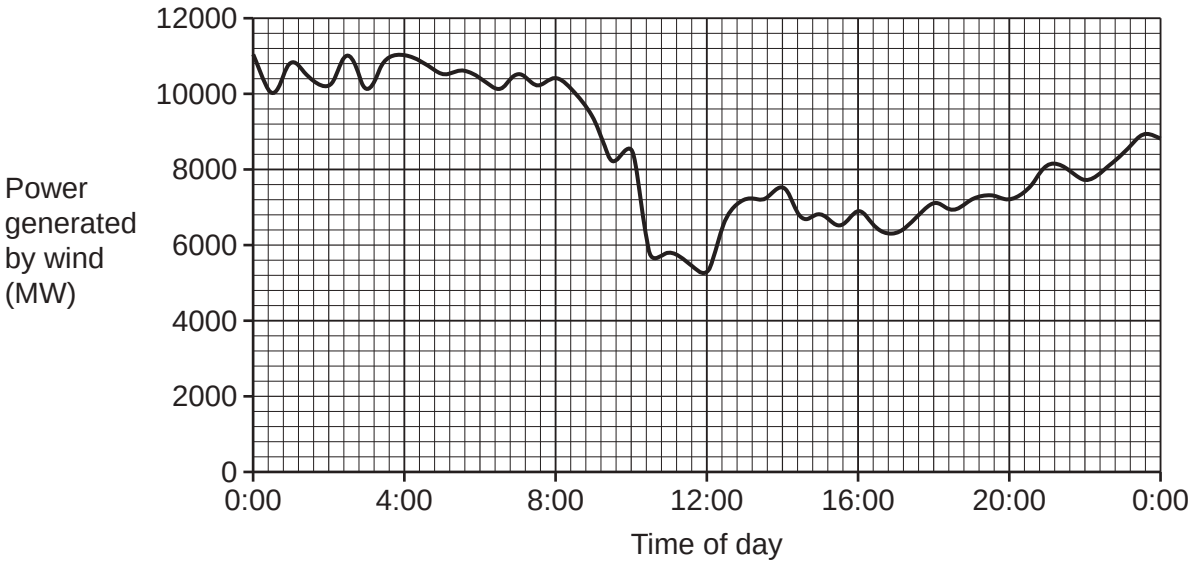
B 200 W

C 2000 W

D 2 000 000 W

Your answer ☐ **[1]**

4 The graph shows how the power generated by the wind in the UK varied over one day.



Which row in the table is correct?

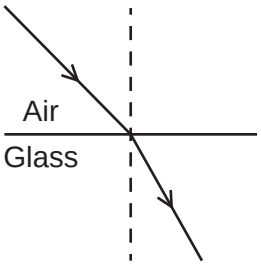
	Maximum power generated (MW)	Reliability of wind power
A	5200	Reliable
B	5200	Unreliable
C	11 000	Reliable
D	11 000	Unreliable

Your answer ☐ **[1]**

5 A light ray passes from air into glass.

Which diagram shows the **refraction** of this light ray?

A



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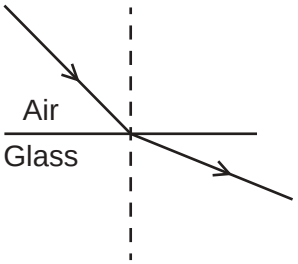

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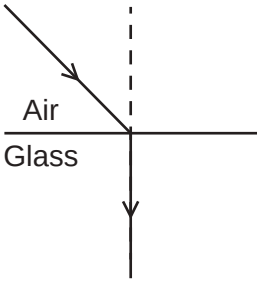

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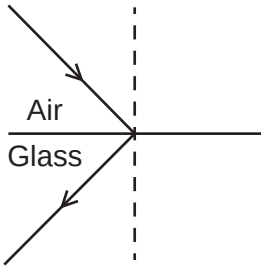
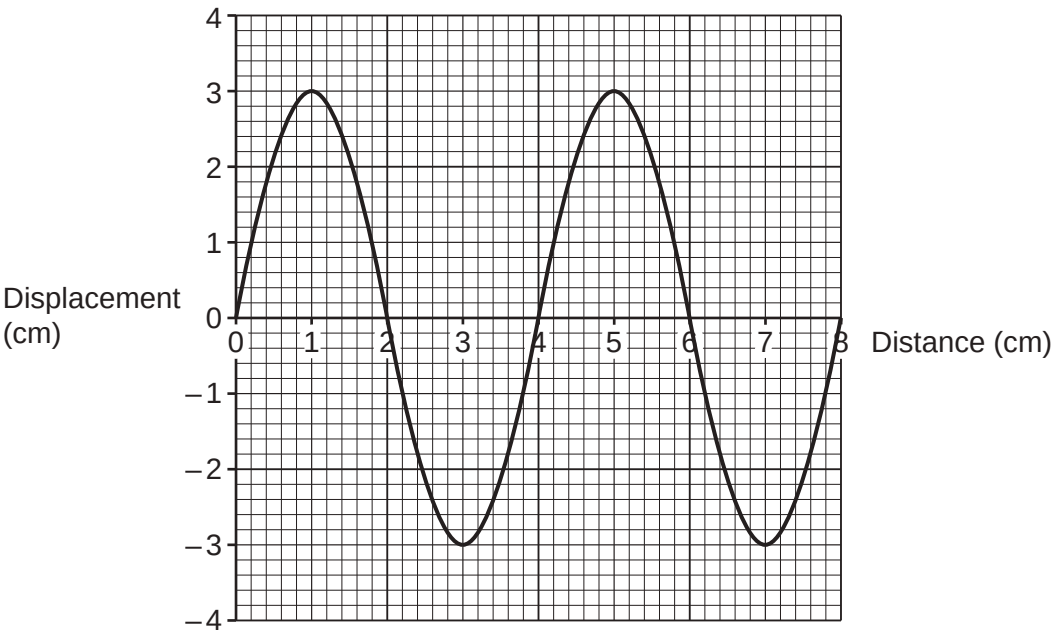


Your answer ☐ **[1]**

6 Look at the diagram of a wave.



What is the wavelength of the wave?

A 2 cm

B 3 cm

C 4 cm

D 6 cm

Your answer ☐ **[1]**

7 The speed of the wind is measured to be 5.555 m / s.

What is 5.555 m / s written to **2** significant figures?

A 5.5 m / s

B 5.55 m / s

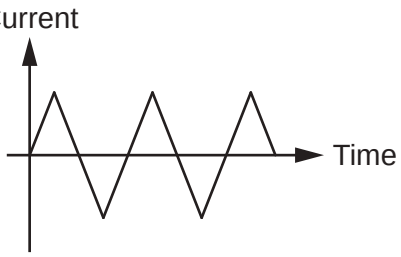
C 5.56 m / s

D 5.6 m / s

Your answer ☐ **[1]**

8 Which graph shows an alternating current (a.c.)?

A



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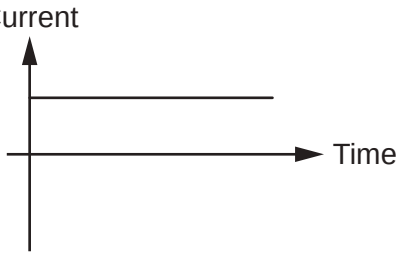

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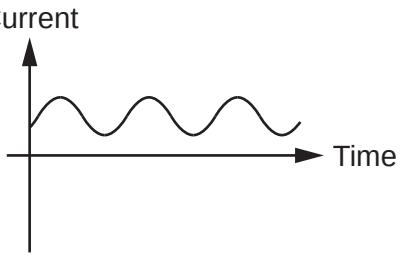

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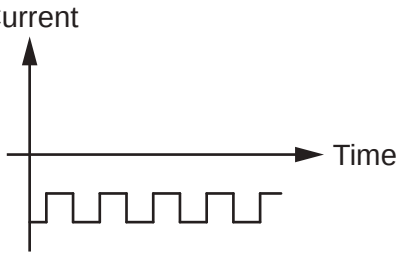


Your answer ☐ **[1]**

9 A car travels at a speed of 60 mph (miles per hour).

1 mph = 0.45 m/s.

Convert 60 mph into m/s (metres per second).

A 0.45 m/s

B 7.5 m/s

C 27 m/s

D 130 m/s

Your answer ☐ **[1]**

10 Which statement about nuclear **fission** is correct?

A An example is when hydrogen is converted to helium.

B It may happen when a nucleus absorbs a neutron.

C The Sun uses fission to generate its energy.

D Two nuclei join to make a heavier nucleus.

Your answer ☐ **[1]**

11 The table shows the current and potential difference for four different lamps.

Which lamp has the highest **power**?

Use the equation: power = potential difference × current

	Current (A)	**Potential difference (V)**
A	2	5
B	3	4
C	4	2
D	5	1

Your answer ☐ **[1]**

12 A boy of mass 65 kg climbs a ladder of height 3.0 m.

Calculate the gain in potential energy of the boy.

Use the equation: potential energy = mass × height × gravitational field strength

Gravitational field strength = 10 N / kg.

A 30 J

B 195 J

C 650 J

D 1950 J

Your answer ☐ **[1]**

13 The kinetic energy of motorbike **X** is 10 kJ.

Motorbike **Y** has the same speed but double the mass.

What is the kinetic energy of motorbike **Y**?

Use the equation: kinetic energy = 0.5 × mass × $(\text{speed})^2$

A 5 kJ

B 10 kJ

C 20 kJ

D 40 kJ

Your answer ☐ **[1]**

14 Which row in the table is correct for a **step-down** transformer?

	Current	Potential difference
A	Decreases	Decreases
B	Decreases	Increases
C	Increases	Decreases
D	Increases	Increases

Your answer ☐ **[1]**

15 Four students measure the time it takes a wave to travel the length of a ripple tank.

Each student collects three measurements of the time.

Student	Time taken (s)		
	1st measurement	2nd measurement	3rd measurement
A	2	2	1
B	2.1	2.1	2.4
C	2.1	2.0	2.2
D	2.11	2.49	2.23

Which student collected the **most** precise data?

Your answer ☐ **[1]**

SECTION B

Answer **all** the questions.

16 This question is about X-rays and visible light.

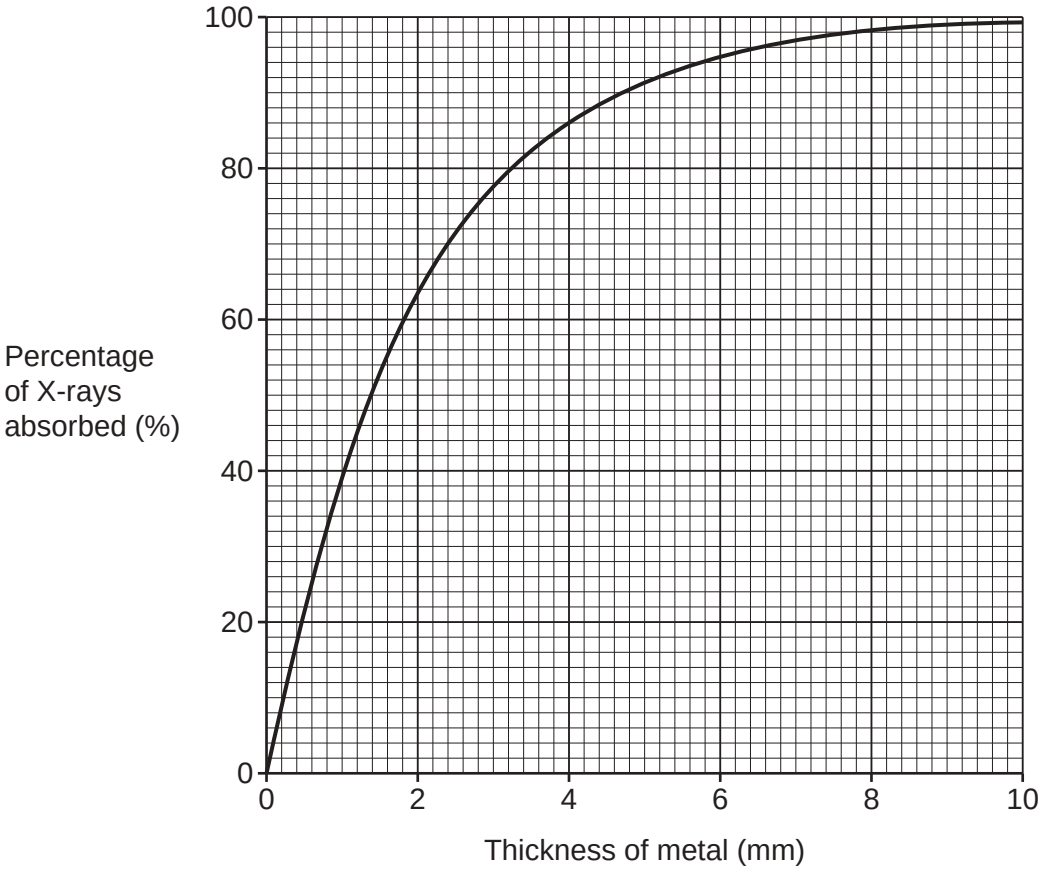
(a) State one **similarity** and one **difference** between X-rays and visible light.

Similarity .....

Difference .....

[2]

(b) This graph shows how the absorption of X-rays changes with the thickness of metal.



(i) What percentage of X-rays is absorbed by 4 mm of metal?

Percentage of X-rays absorbed = ... % **[1]**

(ii) Calculate the percentage of X-rays passing **through** 4 mm of metal.
Use your answer to **16(b)(i)** to help you.

Percentage of X-rays = ... % **[2]**

(c) Use the words from the list to complete the sentences about the Universe.

You may use each word once, more than once, or not at all.

Big-Bang **Contracting** **CMBR** **Expanding**

LDR **Red giant** **Red shift** **Solar system**

The ..... is a model of how the universe began.

Light from distant galaxies has a longer wavelength when it reaches Earth than when it was emitted.

This is called ..... .

Distant galaxies are moving away faster so the universe is

..... .

[3]

17 Ripples are made on the surface of the water. The ripples can be used to model waves.

(a) (i) State the type of wave modelled by the ripples.

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

(ii) Describe how the water molecules move as the wave travels across the pond.

.....

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

(iii) 10 ripples hit the side of the pond in 20 seconds.

Calculate the frequency of the ripples.

Frequency = ...Hz **[2]**

(b) Student **A** and student **B** drop stones into a pond.

(i) Student **A** measures the frequency and wavelength of the water ripples. **Table 17.1** shows his results:

Frequency (Hz) of ripples	0.6
Wavelength (m) of ripples	0.1

Table 17.1

Calculate the wave speed of the ripples.

Use the equation: wave speed = frequency × wavelength

Wave speed = ...m/s **[2]**

(ii) Student **B** measures the same ripples as student **A**.

She measures:

- The distance one ripple travels.
- The time it takes the ripple to travel this distance.

Table 17.2 shows student **B**'s results:

Distance ripple travels (m)	2.40
Time taken (s)	30.0

Table 17.2

Name the equipment student **B** uses to measure the distance and time.

Distance .....

Time .....

[2]

(iii) Use results in **Table 17.2** to calculate the wave speed of the ripples.

Wave speed = ...m/s **[3]**

(iv) Student **A** and student **B** obtained different answers for the wave speed of the ripples.

Suggest why.

.....

.....

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

18 **(a)** Some isotopes of cobalt are radioactive.

The isotope cobalt-60 (Co-60) has the symbol:

$^{60}_{27}Co$

The isotope cobalt-57 (Co-57) has the symbol:

$^{57}_{27}Co$

(i) State the number of protons in a nucleus of Co-60.

Number of protons = ... **[1]**

(ii) Give **one** similarity and **one** difference between the nucleus of Co-57 and the nucleus of Co-60.

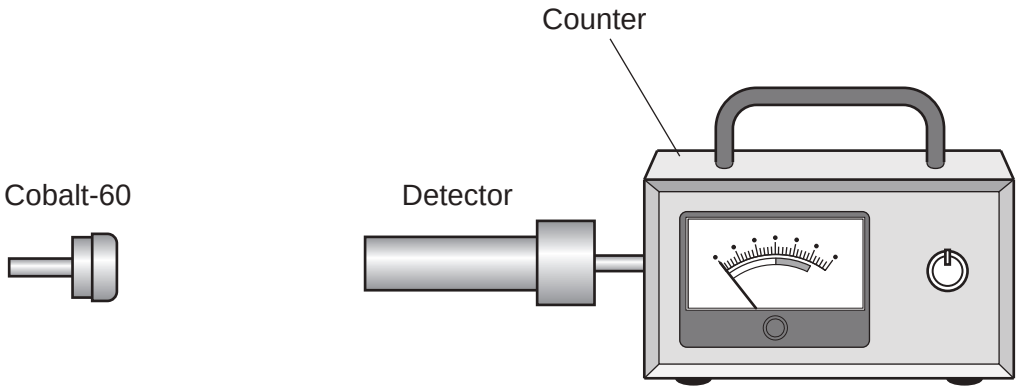
Similarity .....

Difference .....

[2]

(b) A teacher measures the radiation emitted by Co-60.

She uses this equipment:



The teacher's results are shown in **Table 18.1**.

	Count-rate (counts per minute)
Measurement 1	191
Measurement 2	224
Measurement 3	212

Table 18.1

(i) Explain why the teacher's three measurements are **not** the same.

.....

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

(ii) Use the teacher's results in **Table 18.1** to calculate the mean count-rate for Co-60.

Count-rate = ... counts per minute **[2]**

(iii) Co-60 emits gamma radiation.

The teacher puts thin aluminium foil between Co-60 and the detector.

State what happens to the count-rate.

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

(c) (i) Explain what is meant by the half-life of a radioactive isotope.

.....

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

(ii) The half-life of Co-60 is 5 years.

The count-rate of a sample of Co-60 is 160 counts per minute.

Calculate the count-rate of the Co-60 after 10 years.

Count-rate = ... counts per minute **[3]**

(d) A radioactive isotope can be used as a tracer in a patient's body. It is monitored by a radiation detector outside the body.

Four possible radioactive isotopes are shown in **Table 18.2**.

Radioactive isotope	Type of radiation emitted	Half-life
Radon-222	Alpha	4 days
Iodine-131	Gamma	8 days
Cobalt-60	Gamma	5 years
Plutonium-238	Alpha	88 years

Table 18.2

(i) Doctors wear a lead apron when they use radioactive isotopes.

Explain why.

.....

.....

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

(ii) Which radioactive isotope from **Table 18.2** is best to use as a radioactive tracer in a patient's body?

Tick (✓) **one** box.

Radon-222 ☐

Iodine-131 ☐

Cobalt-60 ☐

Plutonium-238 ☐

Explain your answer.

.....

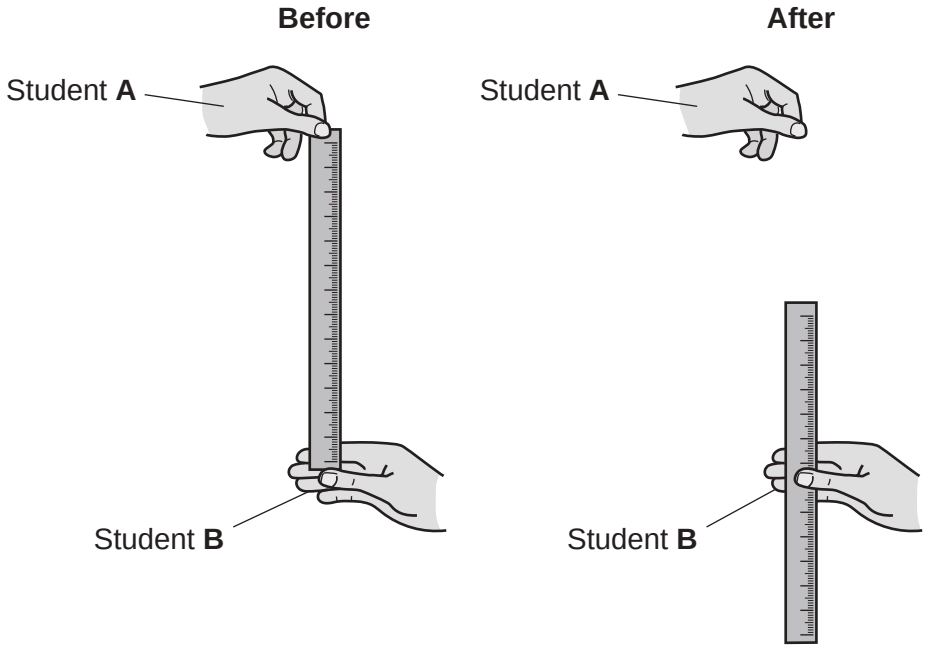
.....

.....

.....

[3]

19 (a) The diagram shows a ruler being used to estimate a student's reaction time.



(i) Describe how the ruler can be used to estimate student **B**'s reaction time.

.....

.....

.....

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

(ii) Why do the students repeat the experiment several times?

.....

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

(iii) Student **B** is very tired when they try this experiment.

Suggest how this might affect student **B**'s reaction time.

.....

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

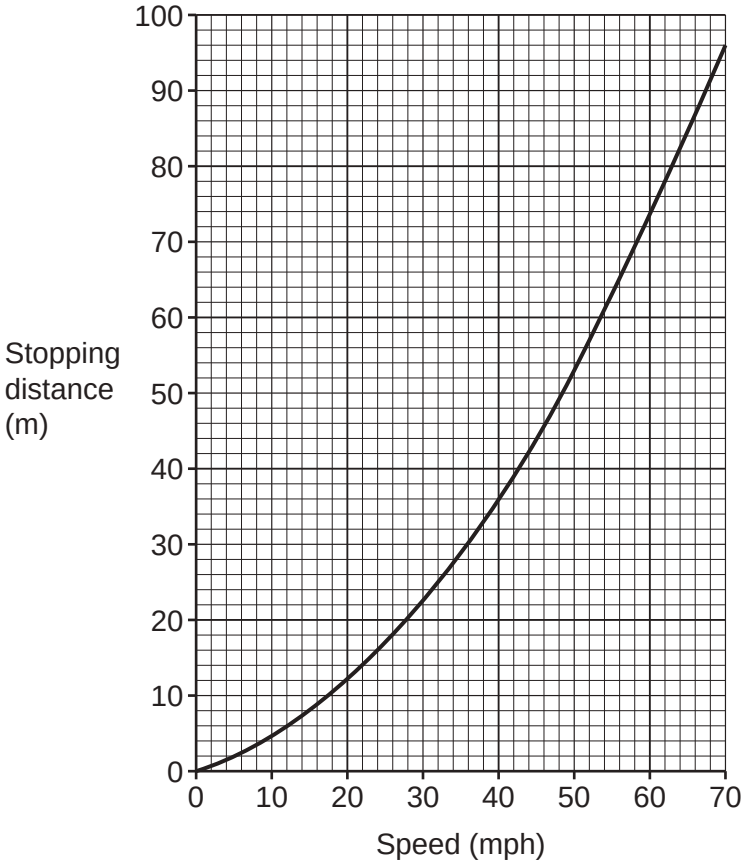
(b) The driver of a car makes an emergency stop.

The thinking distance is 9 m. The braking distance is 14 m.

(i) Calculate the total stopping distance of the car.

Stopping distance = ... m **[1]**

(ii) This graph shows how this driver's stopping distance changes with speed.



- A car is travelling at 50 mph.
- There is a barrier in the road 40 m in front of the car.
- The driver makes an emergency stop.

Use the graph to work out if the car hits the barrier.

Explain how you obtained your answer.

.....

.....

.....

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

(iii) State one factor, other than speed, that affects braking distance.

Explain how this factor changes braking distance.

Factor .....

Explanation .....

.....

.....

[3]

(c) (i) A car travels at a speed of 13 m / s. The car takes 4 s to stop after the brakes are applied.

Calculate the deceleration of the car.

Use the equation: acceleration = change in velocity ÷ time

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

(ii) The braking system of the car in **(c)(i)** is changed. The same car travelling at 13 m / s now takes 0.4 s to stop after the brakes are applied.

The driver says, 'The new braking system is ten times safer.'

Do you agree with the driver? Explain your answer.

Yes ☐

No ☐

.....

.....

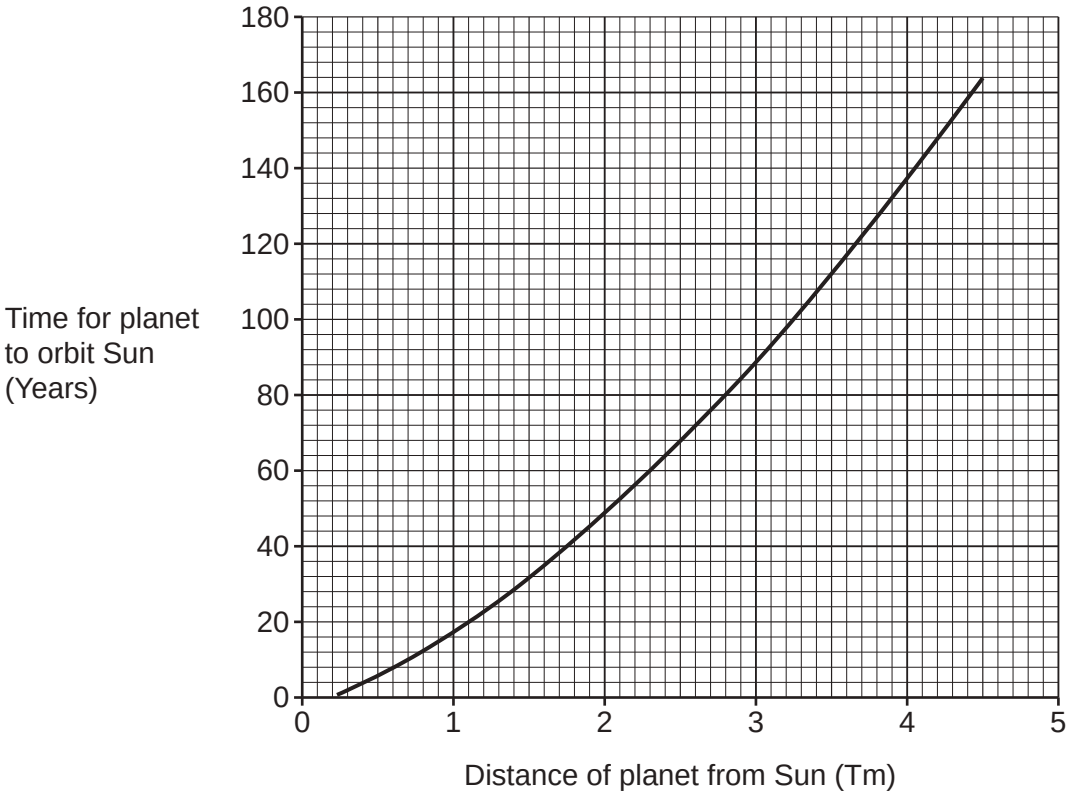
.....

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

(iii) Suggest **one** safety feature in a car that can reduce injury in a crash.

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

20* This graph shows how a planet's orbit time changes with distance from the Sun in our solar system.



Describe and explain the relationship shown by the graph.

Use data from the graph and ideas about our solar system in your answer.

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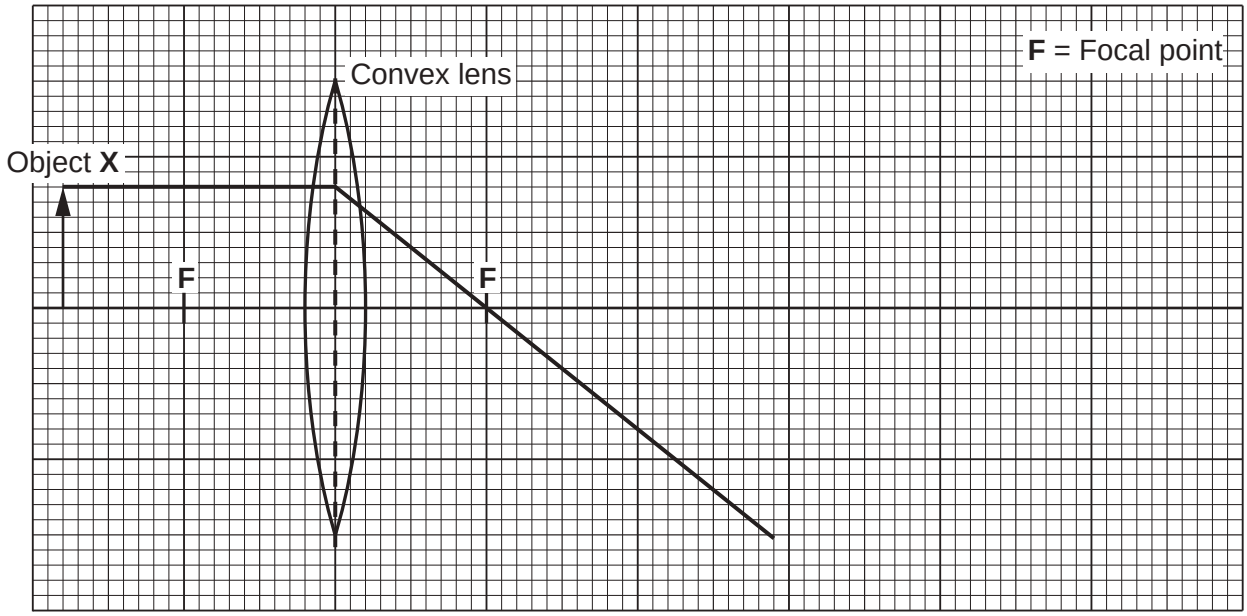
..... **[6]**

21 A projector is used to create a larger image of an object.

(a) The diagram shows one light ray as it passes through the convex lens.

Draw **one** more ray on the diagram to show where the image is formed. Label the image **Y**.



[2]

(b) The projector contains a white light source.

Explain how this white light source can be used to get **red** light.

.....

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

(c) **(i)** The projector is connected to the mains power supply. The projector has an earth wire.

State the potential difference between the earth wire and the live wire in normal use.

Potential difference = ... V **[1]**

(ii) A projector with a plastic case does not need an earth wire.
A projector with a metal case needs an earth wire.

Explain why.

.....

.....

.....

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

22 A student investigates the rate of cooling using a cardboard box to model the walls of a building.

She puts a beaker of hot water into the cardboard box. She measures the temperature of the water every two minutes.

She investigates how the rate of cooling changes with the thickness of the walls.

(a) Describe a method she can use to do this investigation.

.....

.....

.....

.....

.....

..... **[3]**

(b) Here are the results of one of her experiments.

Time (minutes)	Temperature of water (°C)
0	90
2	75
4	63
6	54
8	47
10	41
12	37

(i) Plot the results on the grid in **Fig. 22.1**.

Two of the points have been plotted for you. **[2]**

(ii) Draw a line of best fit on your graph. **[1]**

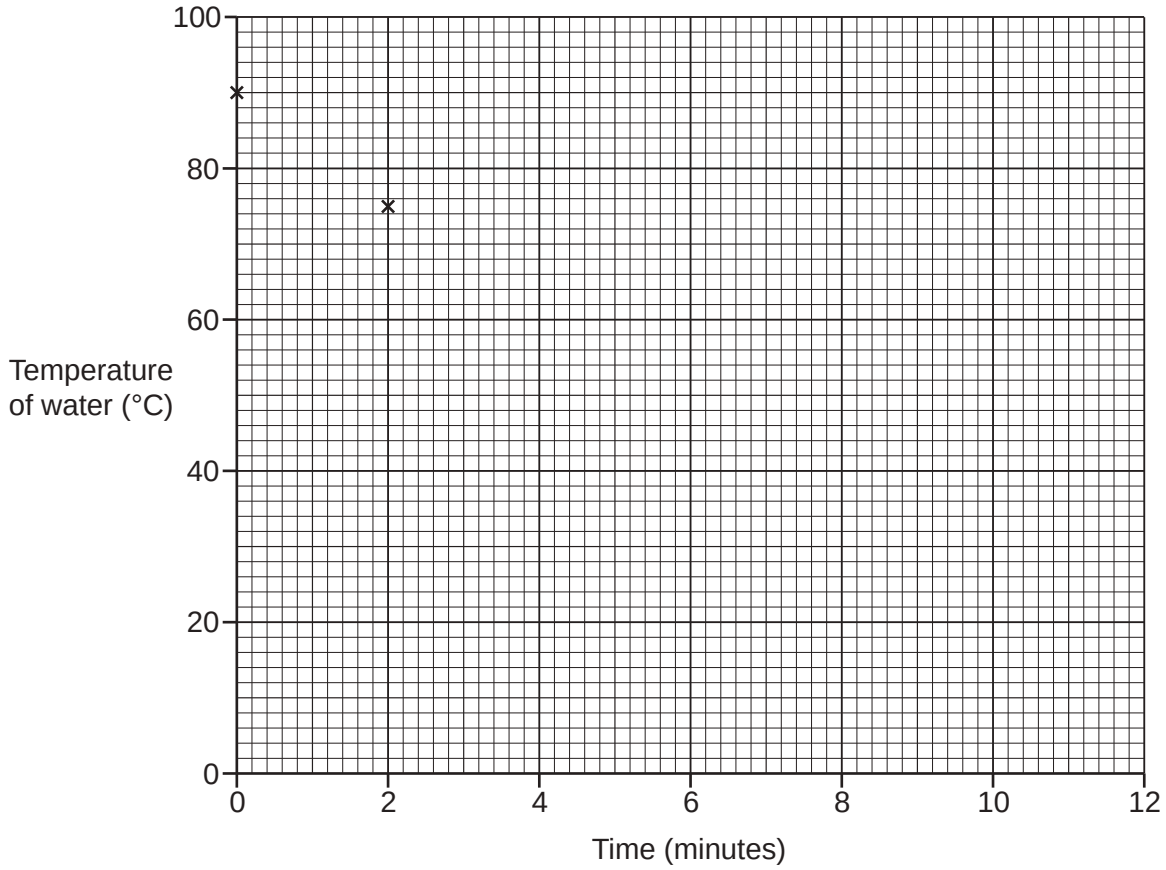


Fig. 22.1

(iii) Describe how the temperature of the water changes with time.
Use data from the graph in **Fig. 22.1** in your answer.

.....

.....

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

(iv) The thickness of the cardboard box is doubled. Everything else stays the same.

Sketch a line on the graph in **Fig. 22.1** to suggest what these new results may look like.
Label your line **Z**. **[1]**

(v) Suggest **one** way to improve the investigation.

.....

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

(c) Explain why the rate of cooling of a metal box is different to a cardboard box.
Assume the thickness of the walls is the same in both boxes.

.....

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

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).