AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.5.4.1.5

Acceleration

Past-paper questions

Tier	**Higher**
Question groups	**14**
Available paper years	**2018–2024**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

6.5.4.1.5 Acceleration

Question 01

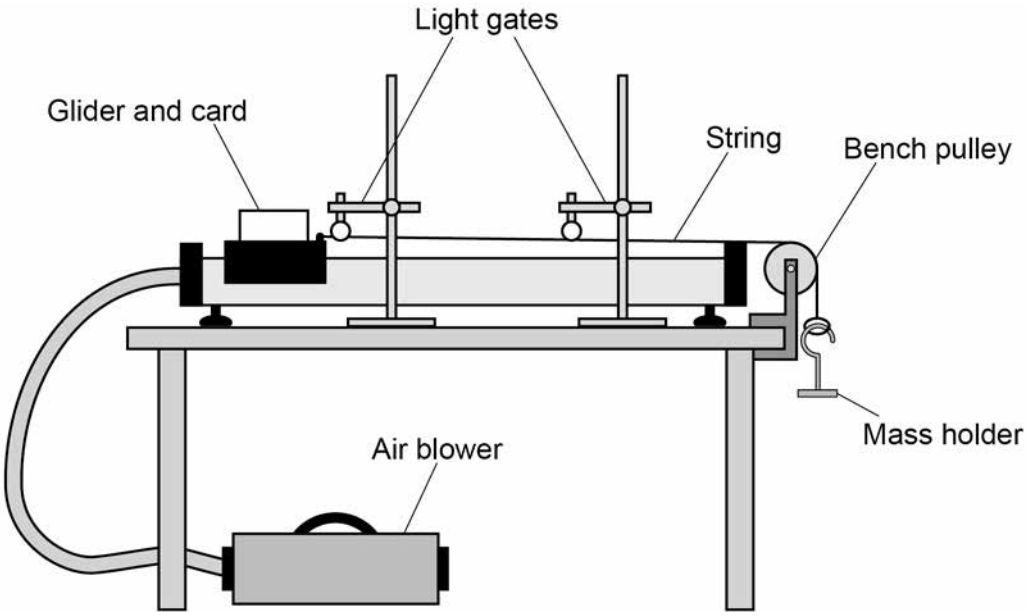
June 2018 | 8464/P/2H | Original Q1

0 1 A student investigated acceleration using gliders, an air track and light gates.

The air track reduces friction between the glider and the track to zero.

Figure 1 shows the apparatus.

Figure 1



The glider was released from rest and moved along the track.

The mass holder hit the ground before the card passed through the second light gate.

0 1 . 1 Which **two** statements describe the effect this would have on the glider?

[2 marks]

Tick **two** boxes.

- Its acceleration would decrease to zero. ☐
- Its acceleration would increase. ☐
- The resultant force on it would decrease to zero. ☐
- The resultant force on it would increase. ☐
- Its speed would increase. ☐

6.5.4.1.5 Acceleration

Question 01 · continued

0 1 . 2 The mass holder should **not** hit the ground before the card passes through the second light gate.

Suggest **one** way that the student could stop this happening.

[1 mark]

Question 1 continues on the next page

6.5.4.1.5 Acceleration

Question 01 · continued

The student increased the resultant force acting on the glider by adding more masses to the mass holder.

She calculated the acceleration of the glider for each resultant force.

Each test was done three times.

Table 1 shows the results.

Table 1

Resultant force in N	Acceleration in m/s^2			Mean acceleration in m/s^2
	Test 1	Test 2	Test 3	
0.20	1.3	1.2	1.3	1.26667
0.39	2.6	2.5	2.6	2.6
0.59	3.8	3.8	3.9	3.8
0.78	5.1	5.1	5.1	5.1
0.98	6.4	7.2	6.4	6.7

0 1 . 3 The student made **two** mistakes in the mean acceleration column.

Identify the mistakes the student made.

Suggest how each mistake can be corrected.

[4 marks]

Mistake _____

_____

Correction _____

_____

Mistake _____

_____

Correction _____

_____

6.5.4.1.5 Acceleration

Question 01 · continued

0 1 . 4 Write a conclusion for this investigation.

Use the data in **Table 1**

[1 mark]

Question 1 continues on the next page

6.5.4.1.5 Acceleration

Question 01 · continued

0 1 . 5 The student used a constant resultant force to accelerate the glider.

The student changed the mass of the glider and calculated the new acceleration.

She repeated this for different masses of the glider, keeping the resultant force constant.

The results are shown in **Table 2**

Table 2

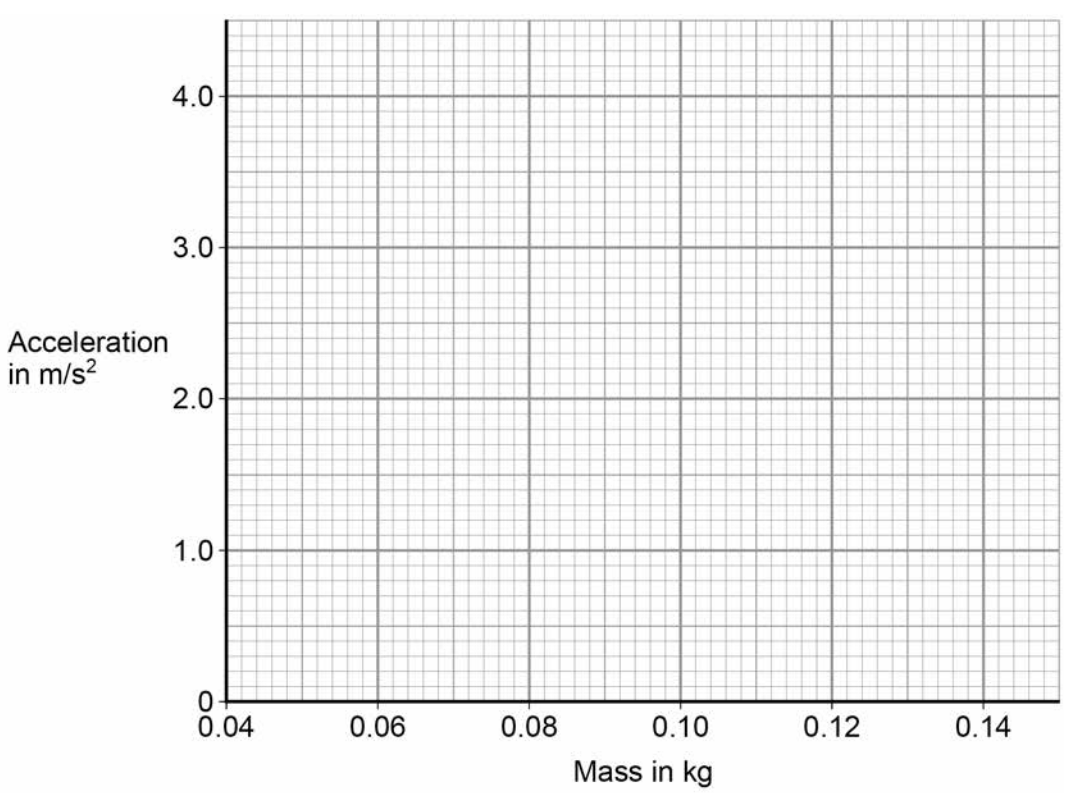
Mass of the glider in kg	Acceleration in m/s^2
0.060	3.5
0.080	2.6
0.10	2.0
0.12	1.7
0.14	1.4

Plot the results on **Figure 2**

Draw a line of best fit.

[3 marks]

Figure 2



6.5.4.1.5 Acceleration

Question 01 · continued

0 1 . 6 Describe the relationship between mass and acceleration.

[1 mark]

12

Turn over for the next question

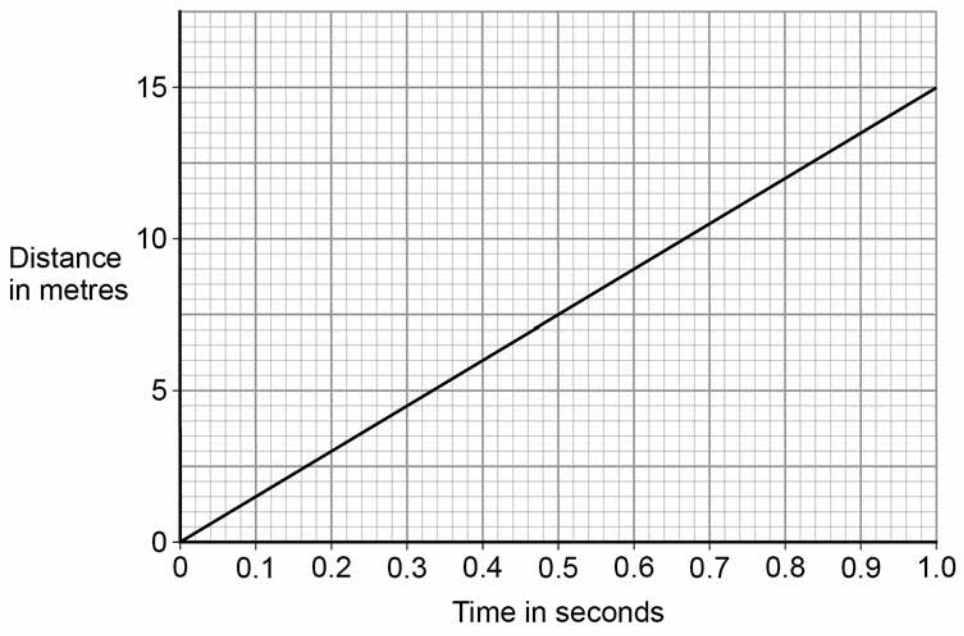
6.5.4.1.5 Acceleration

Question 02

June 2018 | 8464/P/2H | Original Q6

0 6 . 1 **Figure 8** shows the distance-time graph for a car travelling at 15 m/s

Figure 8



When the driver is tired, his reaction time increases from 0.50 seconds to 0.82 seconds.

Determine the **extra** distance the car would travel before the driver starts braking.

[2 marks]

Distance = _____ m

0 6 . 2 When the brakes are used, the temperature of the brakes increases.

Explain why. Use ideas about energy in your explanation.

[2 marks]

Question 6 continues on the next page

6.5.4.1.5 Acceleration

Question 02 · continued

0 6 . 3 A lorry travels 84 m with a constant acceleration of 2.0 m/s^2 to reach a velocity of 19 m/s

Calculate the initial velocity of the lorry.

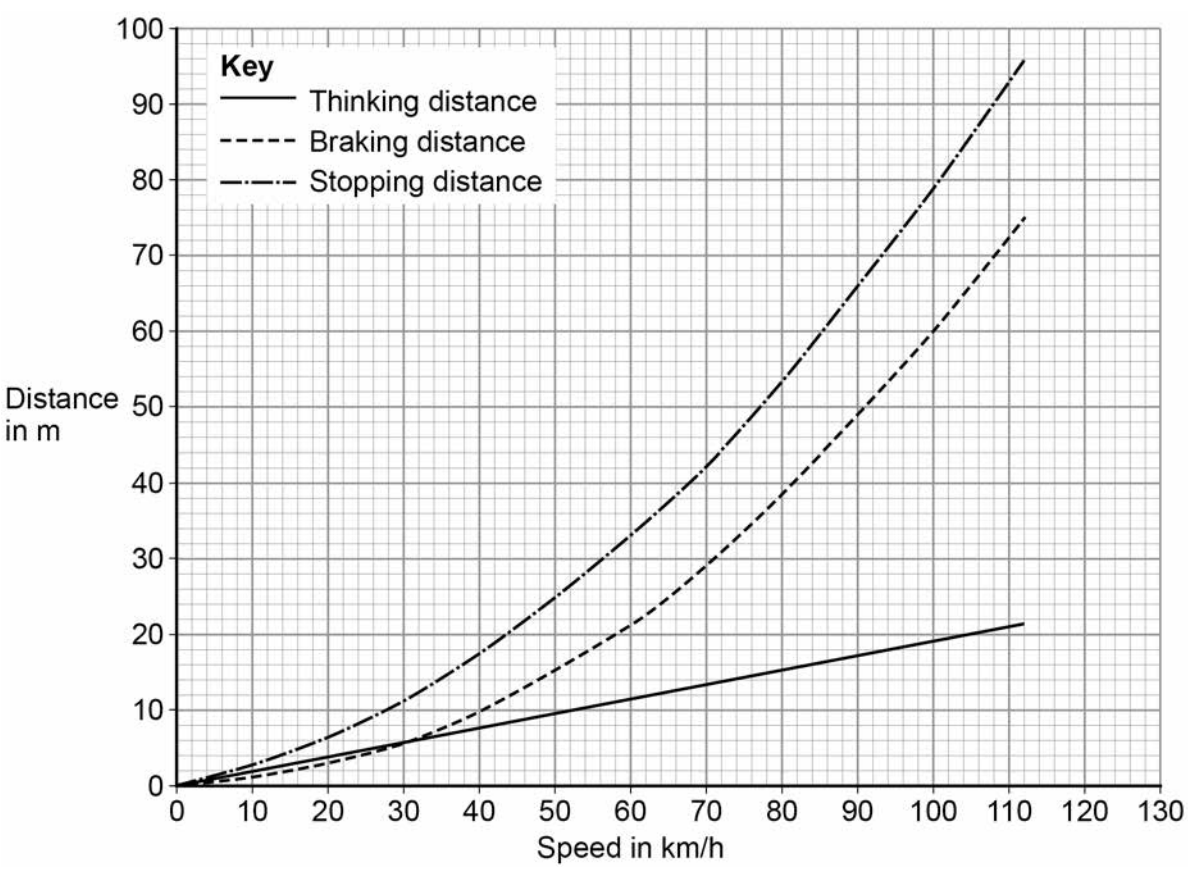
Use the Physics Equations Sheet.

[3 marks]

Initial velocity = _____ m/s

0 6 . 4 **Figure 9** shows how the thinking distance, braking distance and stopping distance for a car vary with the speed of the car.

Figure 9



6.5.4.1.5 Acceleration

Question 02 · continued

Describe the relationships shown in **Figure 9**

You should include factors that would affect the gradient of the lines.

[6 marks]

13

6.5.4.1.5 Acceleration

Question 03

June 2019 | 8464/P/2H | Original Q1

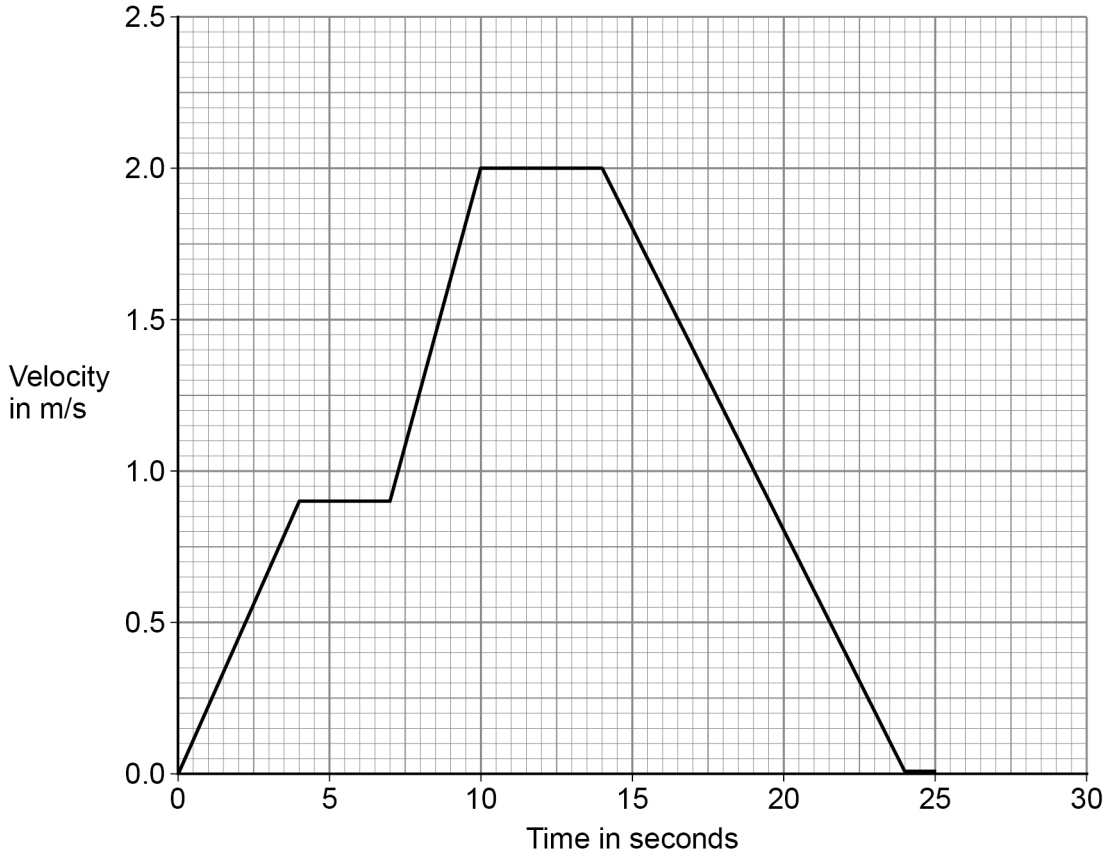
0 1 **Figure 1** shows a runner using a smart watch and a mobile phone to monitor her run.

Figure 1



Figure 2 is a velocity–time graph for part of the runner's warm-up.

Figure 2



6.5.4.1.5 Acceleration

Question 03 · continued

0 1 . 1 Determine the total time for which the velocity of the runner was increasing.

[2 marks]

Time = _____ s

0 1 . 2 Determine the deceleration of the runner.

[2 marks]

Deceleration = _____ m/s^2

Question 1 continues on the next page

6.5.4.1.5 Acceleration

Question 03 · continued

The smart watch and mobile phone are connected to each other by a system called Bluetooth.

Bluetooth is wireless and uses electromagnetic waves for communication.

0 1 . 3 Suggest why the phone and watch being connected by a wireless system is an advantage when running.

[1 mark]

0 1 . 4 Write down the equation that links frequency, wave speed and wavelength.

[1 mark]

0 1 . 5 The electromagnetic waves have a frequency of 2 400 000 000 Hz

The speed of electromagnetic waves is 300 000 000 m/s

Calculate the wavelength of the electromagnetic waves.

[3 marks]

Wavelength = _____ m

6.5.4.1.5 Acceleration

Question 03 · continued

0 1 . 6 **Table 1** shows some information about four types of Bluetooth.

Table 1

Type	Power in milliwatts	Range in metres
1	100	100
2	2.50	10.0
3	1.00	1.00
4	0.50	0.50

Mobile phones use type **2** Bluetooth to communicate with other devices.

Suggest **two** reasons why.

[2 marks]

1 _____

_____

2 _____

_____

11

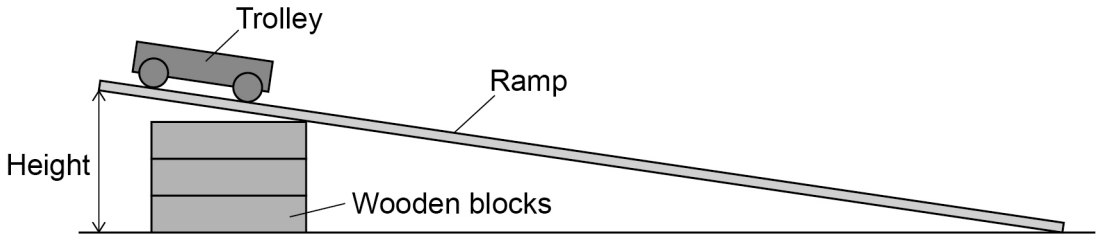
6.5.4.1.5 Acceleration

Question 04

0 2 A student investigated how the height of a ramp affects the acceleration of a trolley down the ramp.

Figure 3 shows some of the equipment used.

Figure 3



0 2 . 1 Plan an investigation to determine how the height of the ramp affects the acceleration of the trolley.

[6 marks]

6.5.4.1.5 Acceleration

Question 04 · continued

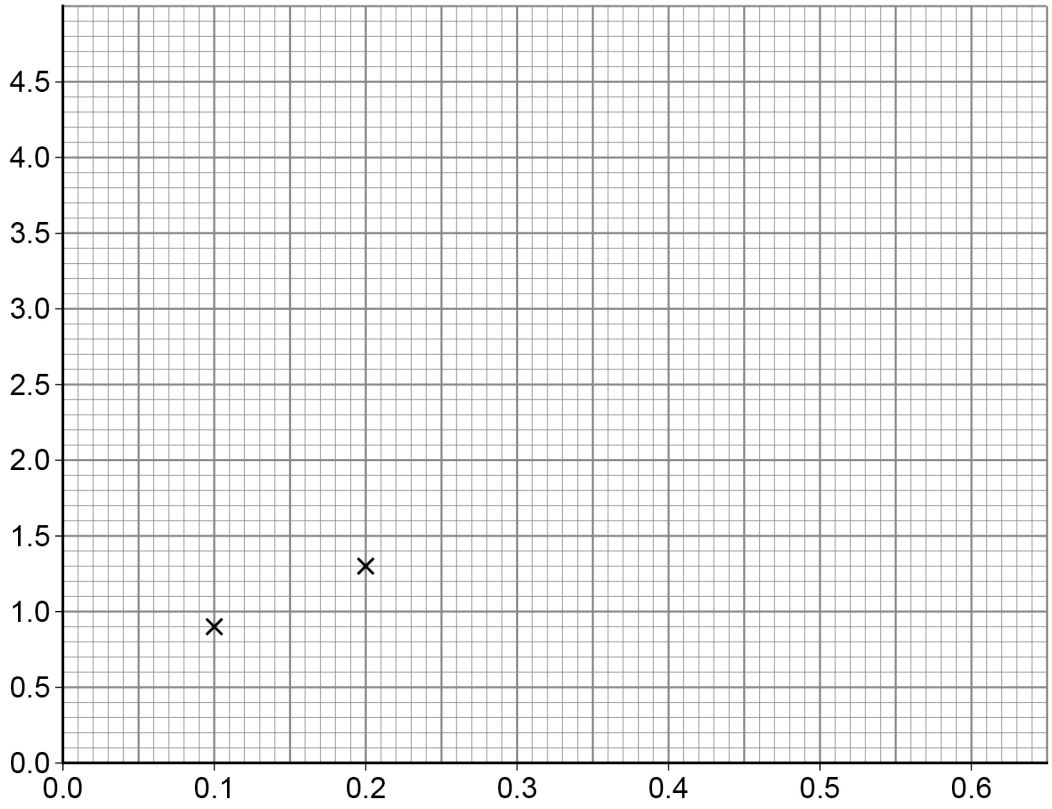
Table 1 shows the results.

Table 1

Height of ramp in metres	0.1	0.2	0.3	0.4	0.5	0.6
Acceleration in m/s^2	0.9	1.3	2.1	3.2	3.9	4.3

The first two results have been plotted on **Figure 4**.

Figure 4



0 2 . 2 Complete **Figure 4**.

You should:

- label the axes
- plot the remaining results from **Table 1**
- draw a line of best fit.

[4 marks]

Question 2 continues on the next page

6.5.4.1.5 Acceleration

Question 04 · continued

0 2 . 3 Write down the equation that links acceleration (a), mass (m) and resultant force (F).

[1 mark]

0 2 . 4 When the resultant force on the trolley was 0.63 N the acceleration of the trolley was 2.1 m/s^2

Calculate the mass of the trolley.

[3 marks]

Mass of trolley = _____ kg

14

6.5.4.1.5 Acceleration

Question 05

0 2 Professional rugby players wear a tracking device that measures their velocity and acceleration.

Figure 2 shows a player wearing a tracking device.

The player is tackling another player who is running with the ball.

Figure 2



0 2 . 1 Velocity and acceleration are both vector quantities.

What is a vector quantity?

[1 mark]

Tick (✓) **one** box.

A quantity with both magnitude and direction ☐

A quantity with direction only ☐

A quantity with magnitude only ☐

6.5.4.1.5 Acceleration

Question 05 · continued

0 2 . 2 Which of the following is a vector quantity?

[1 mark]

Tick (✓) **one** box.

Displacement ☐

Distance ☐

Time ☐

Work done ☐

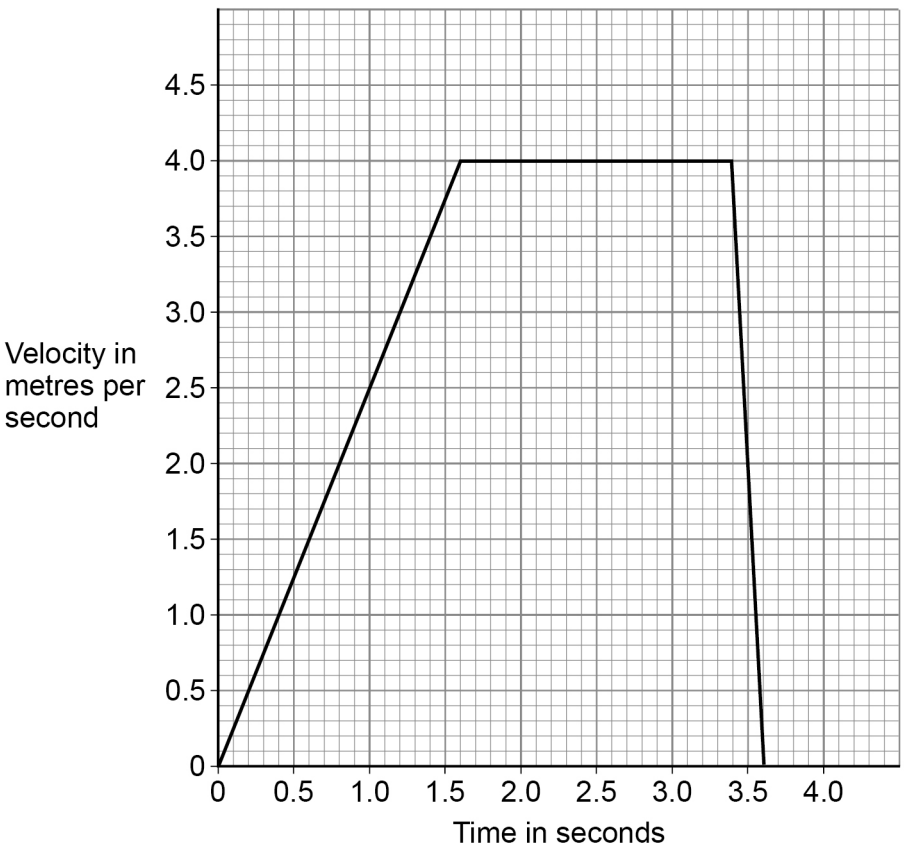
Question 2 continues on the next page

6.5.4.1.5 Acceleration

Question 05 · continued

Figure 3 shows a velocity–time graph for the player running with the ball.

Figure 3



0 2 . 3 Determine the acceleration of the player between 0 and 1.6 s.

[2 marks]

Acceleration = _____ m/s^2

0 2 . 4 Describe the motion of the player between 3.4 s and 3.6 s.

[1 mark]

6.5.4.1.5 Acceleration

Question 05 · continued

The force exerted on the player when she is tackled causes her to accelerate.

0 2 . 5 Write down the equation which links acceleration (*a*), mass (*m*) and resultant force (*F*).

[1 mark]

0 2 . 6 The player accelerates at 25 m/s^2 when a resultant force of 1800 N acts on her.

Calculate the mass of the player.

[3 marks]

Mass = _____ kg

0 2 . 7 The tracking device sends data to a computer during the game.

Suggest **one** advantage of the data being sent during the game.

[1 mark]

10

6.5.4.1.5 Acceleration

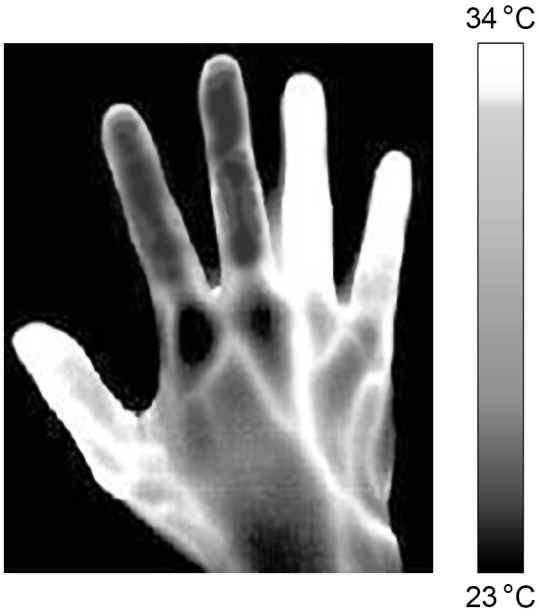
Question 06

November 2021 | 8464/P/2H | Original Q5

0 5 Different parts of the electromagnetic spectrum are used in medical imaging.

Figure 8 shows an image of a person's hand taken with an infrared camera.

Figure 8



0 5 . 1 Explain why the infrared camera is able to show that parts of the hand are at different temperatures.

[2 marks]

Question 5 continues on the next page

6.5.4.1.5 Acceleration

Question 06 · continued

0 5 . 2 Infrared has a range of wavelengths from 700 nm to 1 mm.

Which part of the electromagnetic spectrum would have waves with a wavelength of 6.5×10^{-7} m?

[1 mark]

Tick (✓) **one** box.

Infrared ☐

Microwaves ☐

Radio waves ☐

Visible light ☐

6.5.4.1.5 Acceleration

Question 06 · continued

0 5 . 3 **Figure 9** shows X-rays and gamma rays being used for medical imaging.

Figure 9

X-rays **Gamma rays**



To use X-rays for medical imaging, a machine produces a very brief burst of X-rays.

To use gamma rays for medical imaging, a radioactive isotope is injected into the patient's blood. The isotope is circulated around the body in the blood. The isotope emits gamma rays.

Compare the potential risks to a patient of using X-rays and gamma rays for medical imaging.

[4 marks]

Question 5 continues on the next page

6.5.4.1.5 Acceleration

Question 06 · continued

X-rays are produced by colliding high-energy electrons into a metal target.

The electrons have high energy because they are accelerated to high speeds.

Only a small proportion of the kinetic energy of an electron is converted into an X-ray when it collides with the metal target.

0 5 . 4 An electron is accelerated through a distance of 15 mm.

The work done on the electron is 1.2×10^{-13} J.

Calculate the force on the electron.

[3 marks]

Force = _____ N

0 5 . 5 The metal target is made from tungsten.

Tungsten has the highest melting point of any metal.

Explain why using tungsten as the metal target enables the X-ray machine to be more powerful.

[3 marks]

13

6.5.4.1.5 Acceleration

Question 07

November 2021 | 8464/P/2H | Original Q6

0 6 Scientists are developing a hypersonic aeroplane that will travel much faster than normal aeroplanes.

0 6 . 1 An aeroplane accelerates from a low speed to a high speed with the engines at maximum power.

Explain why the acceleration is **not** constant.

[5 marks]

Question 6 continues on the next page

6.5.4.1.5 Acceleration

Question 07 · continued

0 6 . 2 The hypersonic aeroplane will have jet engines and a rocket engine.

The speed of aeroplanes can be measured on a uniform scale called the Mach scale.

Mach 1 = 330 m/s

The jet engines will accelerate the aeroplane to Mach 5.5.

The rocket engine will accelerate the aeroplane from Mach 5.5 to Mach 25.5 in 300 s.

The average resultant force on the aeroplane when the rocket engine is used will be 630 000 N.

Calculate the mass of the hypersonic aeroplane.

Give your answer to 2 significant figures.

[6 marks]

Mass (2 significant figures) = _____ kg

11

6.5.4.1.5 Acceleration

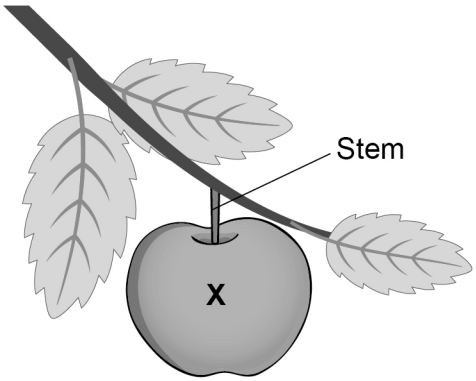
Question 08

June 2022 | 8464/P/2H | Original Q7

0 7 **Figure 11** shows a stationary apple hanging from a tree.

The **X** marks the centre of mass of the apple.

Figure 11



0 7 . 1 Draw **two** arrows on **Figure 11** to show the forces acting on the apple.

[2 marks]

Question 7 continues on the next page

6.5.4.1.5 Acceleration

Question 08 · continued

0 7 . 2 It takes 0.50 s for the apple to fall to the ground.

The initial velocity of the apple is 0 m/s

acceleration due to gravity = 9.8 m/s^2

Calculate the distance fallen by the apple.

Use the Physics Equations Sheet.

[6 marks]

Distance = _____ m

6.5.4.1.5 Acceleration

Question 08 · continued

0 7 . 3 In Question **07.2** it was assumed that the acceleration was a constant 9.8 m/s^2

Evaluate this assumption.

[4 marks]

12

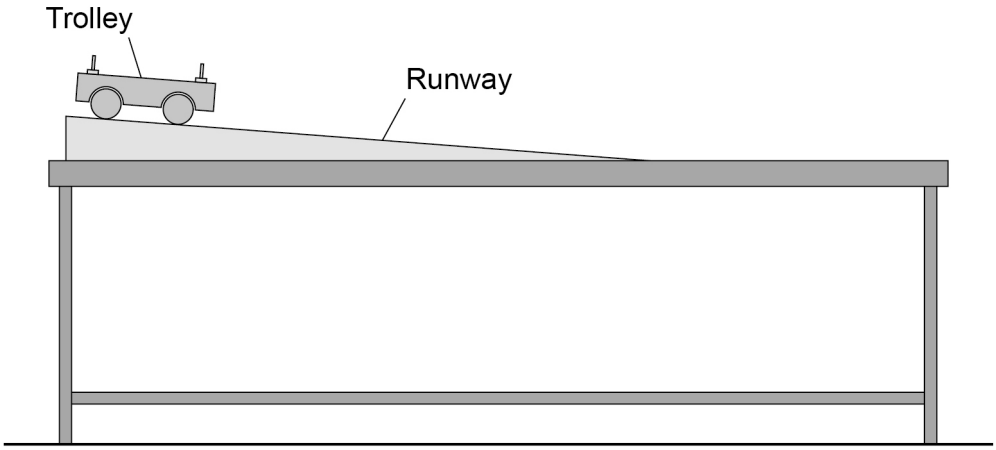
6.5.4.1.5 Acceleration

Question 09

0 2 A student investigated how the acceleration of a trolley is affected by the force acting on the trolley.

Figure 3 shows some of the equipment used.

Figure 3



6.5.4.1.5 Acceleration

Question 09 · continued

0 2 . 1 Describe a method the student could use.

Your answer should include any extra equipment needed.

[6 marks]

Question 2 continues on the next page

6.5.4.1.5 Acceleration

Question 09 · continued

Table 1 shows one set of results for a similar investigation.

Table 1

Resultant force in newtons	Acceleration in m/s^2
1.2	1.6

0 2 . 2 Which of Newton's laws predicts that the acceleration of the trolley is proportional to the resultant force on the trolley?

[1 mark]

Tick (✓) **one** box.

First law ☐

Second law ☐

Third law ☐

0 2 . 3 Determine the acceleration of the trolley when the resultant force is 3.6 N.

Use **Table 1**.

[2 marks]

Acceleration = _____ m/s^2

6.5.4.1.5 Acceleration

Question 09 · continued

Use the Physics Equations Sheet to answer questions **02.4** and **02.5**.

0 2 . 4 Write down the equation that links acceleration (*a*), mass (*m*) and resultant force (*F*).

[1 mark]

0 2 . 5 A resultant force of 0.42 N acts on a different trolley.

The acceleration of the trolley is 1.2 m/s^2.

Calculate the mass of the trolley.

[3 marks]

Mass of trolley = _____ kg

13

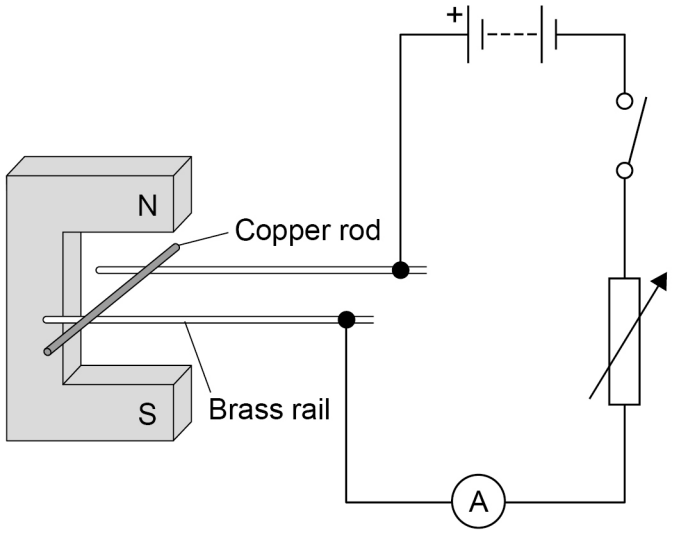
6.5.4.1.5 Acceleration

Question 10

0 4 A teacher demonstrated the motor effect.

Figure 5 shows the equipment used. The equipment includes a permanent magnet.

Figure 5



0 4 . 1 The copper rod remains stationary while the switch is open.

Complete the sentence.

[1 mark]

The tendency for an object to remain stationary is

called _____ .

6.5.4.1.5 Acceleration

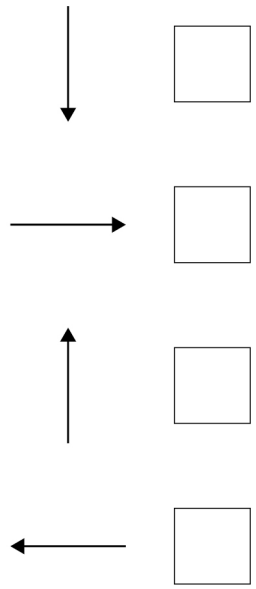
Question 10 · continued

When the switch is closed the copper rod accelerates.

0 4 . 2 In which direction will the copper rod accelerate?

[1 mark]

Tick (✓) **one** box.



0 4 . 3 Explain **one** way the teacher could increase the acceleration of the copper rod.

[2 marks]

Question 4 continues on the next page

6.5.4.1.5 Acceleration

Question 10 · continued

0 4 . 4 The magnet used in the demonstration was a permanent magnet.

Figure 6 shows an iron bar and a permanent magnet.

Figure 6



Iron bar

Permanent magnet

Describe how the permanent magnet could be used to test if the iron bar is also a permanent magnet.

[2 marks]

6.5.4.1.5 Acceleration

Question 10 · continued

0 4 . 5 **Figure 7** shows a magnetic compass used by walkers.

Figure 7



Explain how a magnetic compass provides evidence that the Earth has a magnetic field.

[2 marks]

8

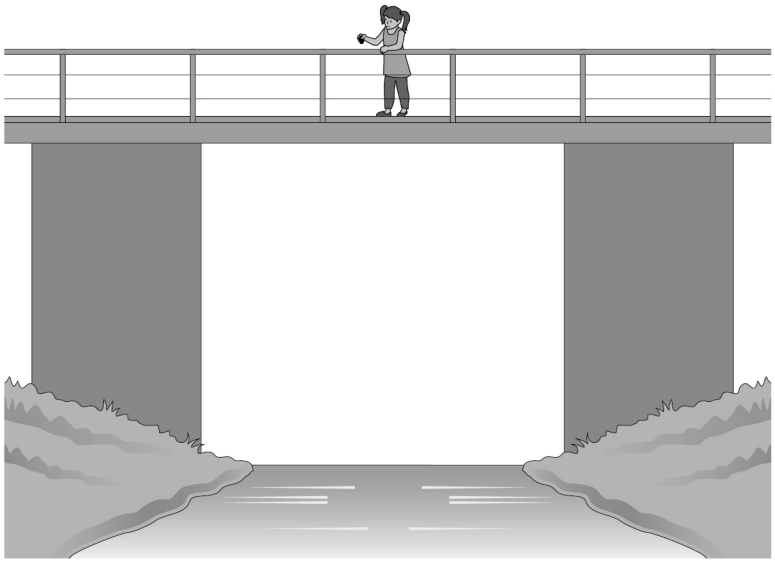
6.5.4.1.5 Acceleration

Question 11

June 2023 | 8464/P/2H | Original Q6

0 6 **Figure 9** shows a child dropping a stone into water.

Figure 9



0 6 . 1 When the child drops the stone it passes the child's feet with a velocity of 3.1 m/s.

The child's feet are 6.3 m above the water.

acceleration due to gravity = 9.8 m/s^2

Calculate the velocity of the stone as it hits the water.

Use the Physics Equations Sheet.

Give your answer to 2 significant figures.

[4 marks]

Velocity (2 significant figures) = _____ m/s

6.5.4.1.5 Acceleration

Question 11 · continued

0 6 . 2 Velocity is a vector.

Describe the velocity of the stone as it falls through the air.

Assume there is no air resistance.

[2 marks]

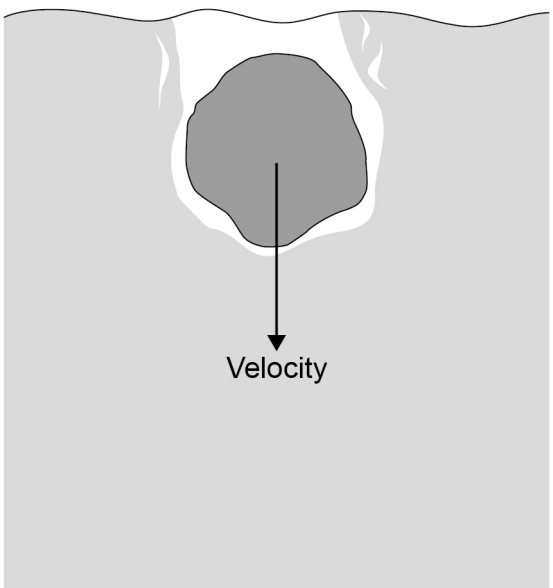
Question 6 continues on the next page

6.5.4.1.5 Acceleration

Question 11 · continued

0 6 . 3 **Figure 10** shows the stone just after it has entered the water.

Figure 10



As the stone moves through the water, the stone slows to a constant velocity.

Explain why.

[4 marks]

10

6.5.4.1.5 Acceleration

Question 12

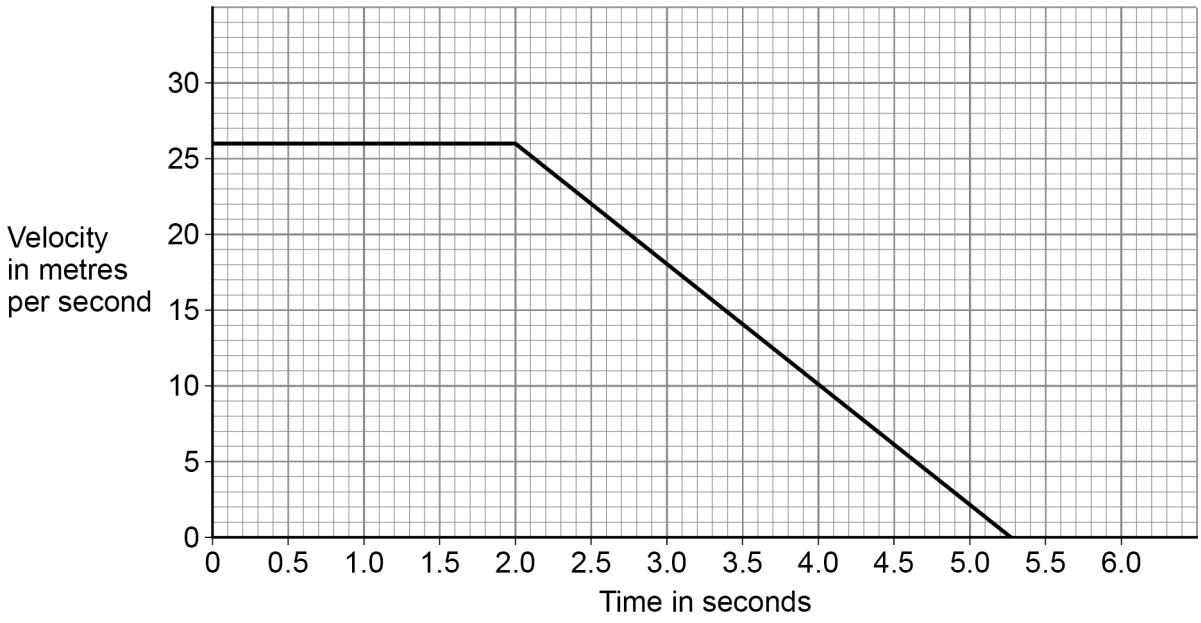
June 2023 | 8464/P/2H | Original Q7

0 7 A car contains a device called a black box. The black box records the velocity and acceleration of the car.

The car was travelling at a constant velocity. The driver then reacted to a hazard.

Figure 11 shows the velocity–time graph for the car.

Figure 11



0 7 . 1 Determine the deceleration of the car.

Give the unit.

[3 marks]

Deceleration = _____ Unit _____

6.5.4.1.5 Acceleration

Question 12 · continued

0 7 . 2 The driver of the car has a reaction time of 0.75 s.

Determine the stopping distance of the car.

Use the Physics Equations Sheet.

Use **Figure 11**.

[5 marks]

Stopping distance = _____ m

0 7 . 3 If the black box records large decelerations, it identifies that the driving may be dangerous.

Explain why large decelerations may be dangerous.

[2 marks]

10

6.5.4.1.5 Acceleration

Question 13

0 5 A safety test was carried out to determine how the speed of a car affects the stopping distance of the car.

0 5 . 1 At the start of the test the car was moving slowly.

Then the car accelerated at 5.8 m/s^2 for 2.5 s.

The final velocity of the car was 20 m/s.

Calculate the initial velocity of the car.

Use the Physics Equations Sheet.

[4 marks]

Initial velocity = _____ m/s

0 5 . 2 The reaction time of the driver was measured.

How can the reaction time of the driver be used to calculate the thinking distance?

[1 mark]

Question 5 continues on the next page

6.5.4.1.5 Acceleration

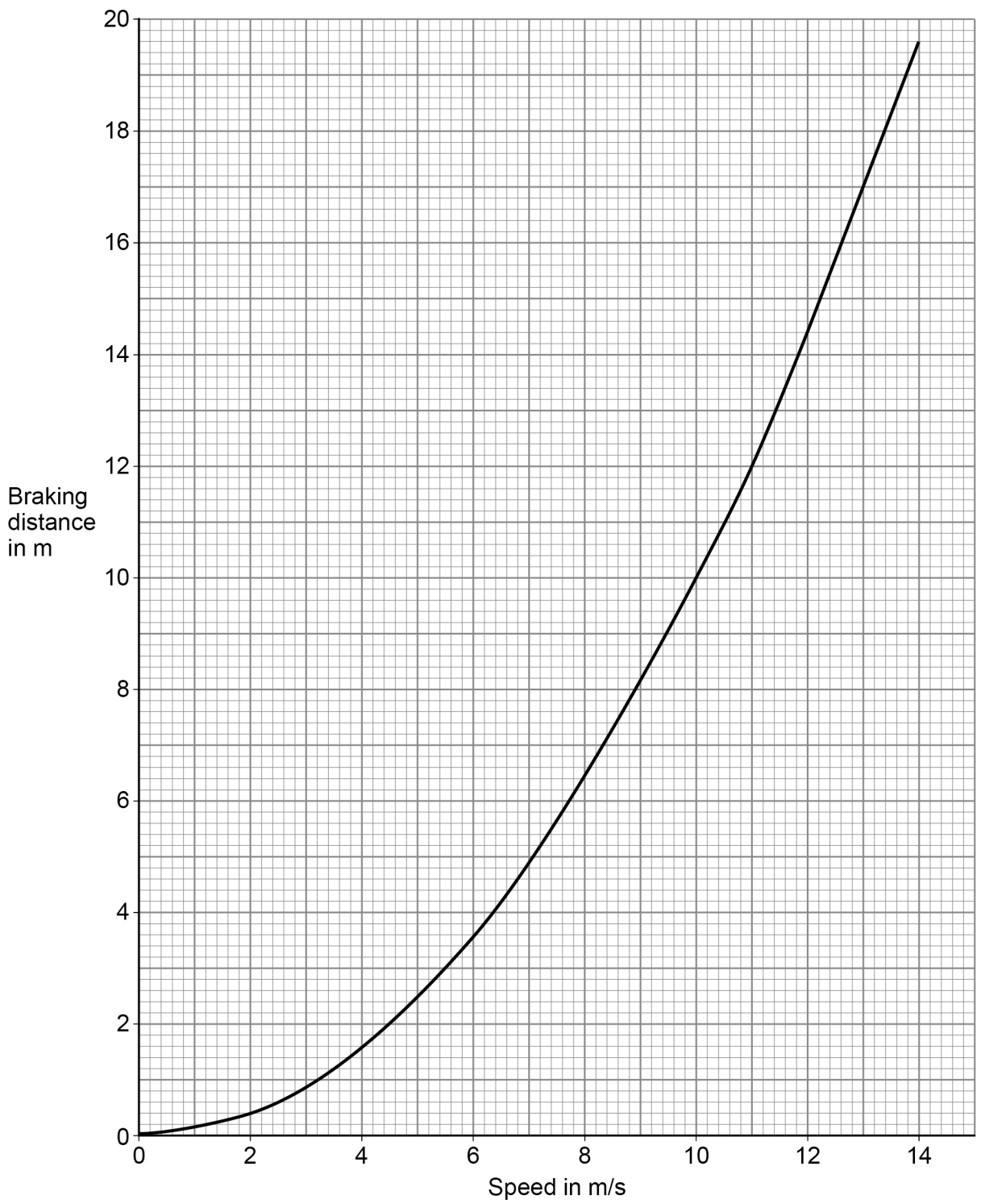
Question 13 · continued

The car was driven at a constant speed. The driver applied the maximum braking force, and the braking distance was measured.

The test was repeated at different speeds.

Figure 8 shows the results.

Figure 8



6.5.4.1.5 Acceleration

Question 13 · continued

0 5 . 3 Which of the following gives the relationship between the speed and the braking distance?

[1 mark]

Tick (✓) **one** box.

braking distance $\propto \frac{1}{\text{speed}}$ ☐

braking distance $\propto$ speed ☐

braking distance $\propto \text{speed}^2$ ☐

0 5 . 4 During one test the brakes were applied with a force of 6250 N.

The deceleration of the car was 5.0 m/s^2.

The braking distance of the car was 14.4 m.

Determine the momentum of the car before the brakes were applied.

Use the Physics Equations Sheet.

Use **Figure 8**.

[6 marks]

Momentum = _____ kg m/s

12

6.5.4.1.5 Acceleration

Question 14

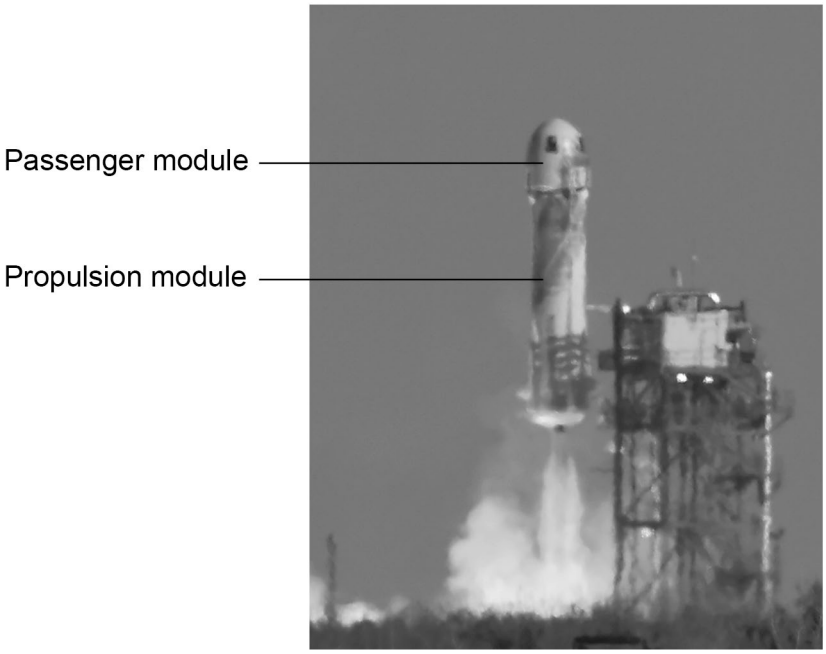
June 2024 | 8464/P/2H | Original Q6

0 6 Rockets have been developed so that people who are not trained astronauts can pay to travel to space.

Figure 9 shows the passenger module and the propulsion module of a rocket.

The propulsion module burns a large volume of fuel.

Figure 9



6.5.4.1.5 Acceleration

Question 14 · continued

0 6 . 1 The rocket was initially stationary on the ground.

Then the rocket accelerated upwards until it reached a height of 40 km.

The constant acceleration of the rocket was 6.48 m/s^2.

Calculate the velocity of the rocket at a height of 40 km.

Use the Physics Equations Sheet.

[4 marks]

Velocity = _____ m/s

0 6 . 2 Explain how the weight of the rocket changed as it accelerated upwards.

[3 marks]

Question 6 continues on the next page

6.5.4.1.5 Acceleration

Question 14 · continued

0 6 . 3 At a height of 40 km, the rocket stopped burning fuel.

The rocket continued upwards to its maximum height of 60 km.

Explain why the velocity of the rocket decreased between a height of 40 km and a height of 60 km.

[3 marks]

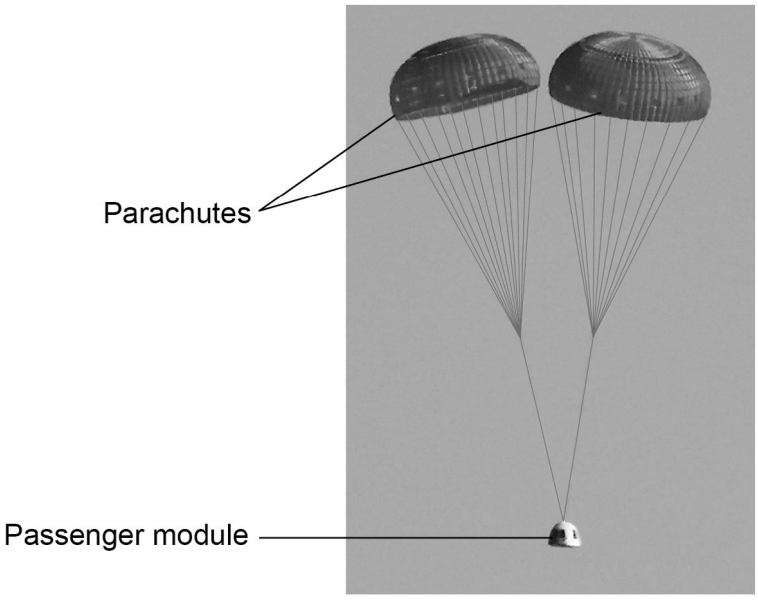
6.5.4.1.5 Acceleration

Question 14 · continued

0 6 . 4 At a height of 60 km the two modules of the rocket separated and the passenger module fell back to Earth.

Figure 10 shows the passenger module falling towards the Earth's surface.

Figure 10



Using parachutes causes the passenger module to fall with a lower terminal velocity than if parachutes were not used.

Explain why the parachutes allow the passenger module to fall with a lower terminal velocity.

[3 marks]

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