AQA GCSE Physics | 8463

SPECIFICATION POINT 4.5.6.1.5

Acceleration

Past-paper questions

Tier	**Higher**
Question groups	**50**
Available paper years	**2003–2025**

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:** _____

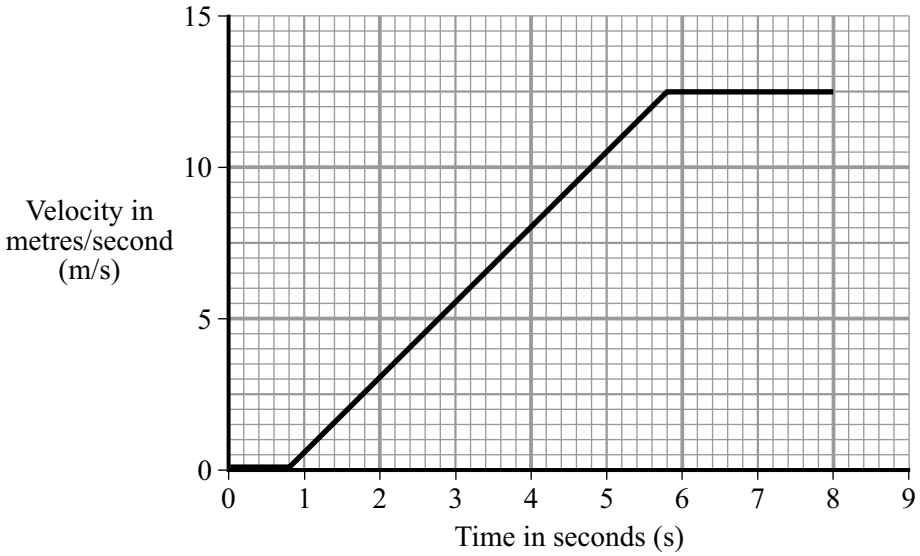
Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.5.6.1.5 Acceleration

Question 01

June 2003 | 3451H | Original Q10 | Legacy

10 A car travelling along a straight road has to stop and wait at red traffic lights. The graph shows how the velocity of the car changes after the traffic lights turn green.



(a) Between the traffic lights changing to green and the car starting to move there is a time delay. This is called the reaction time. Write down **one** factor that could affect the driver's reaction time.

.....

(1 mark)

(b) Calculate the distance the car travels while accelerating. Show clearly how you work out your answer.

.....

.....

Distance = ...metres

(3 marks)

(c) Calculate the acceleration of the car. Show clearly how you work out your final answer and give the units.

.....

.....

.....

Acceleration = ...

(4 marks)

4.5.6.1.5 Acceleration

Question 01 · continued

MARGIN BLANK

(d) The mass of the car is 900 kg.

(i) Write down the equation that links acceleration, force and mass.

.....

(1 mark)

(ii) Calculate the force used to accelerate the car. Show clearly how you work out your final answer.

.....

.....

Force = ...newtons

(2 marks)

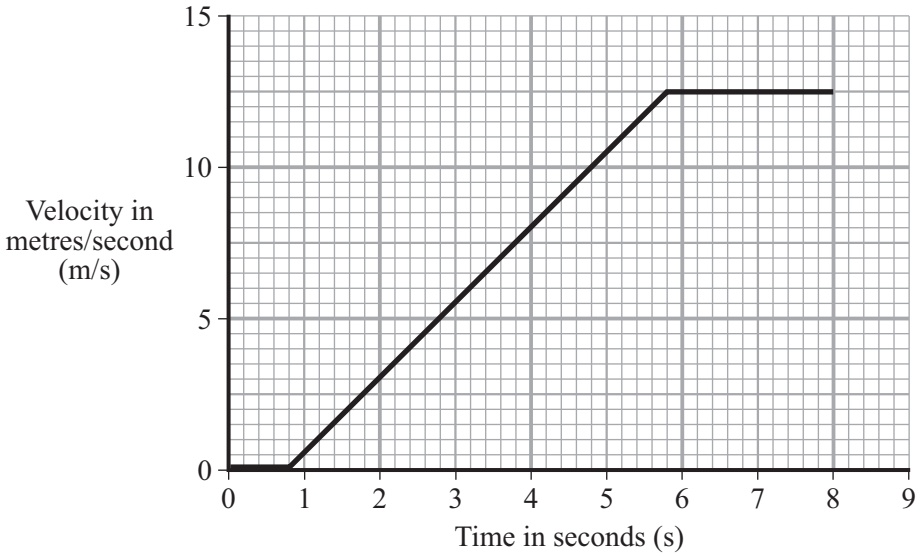
11

4.5.6.1.5 Acceleration

Question 02

June 2003 | 3462H3 | Original Q8 | Legacy

8 A car travelling along a straight road has to stop and wait at red traffic lights. The graph shows how the velocity of the car changes after the traffic lights turn green.



(a) Between the traffic lights changing to green and the car starting to move there is a time delay. This is called the reaction time. Write down **one** factor that could affect the driver's reaction time.

.....

(1 mark)

(b) Calculate the distance the car travels while accelerating. Show clearly how you work out your answer.

.....

.....

Distance = ...metres

(3 marks)

(c) Calculate the acceleration of the car. Show clearly how you work out your final answer and give the units.

.....

.....

.....

Acceleration = ...

(4 marks)

4.5.6.1.5 Acceleration

Question 02 · continued

1 /

MARGIN BLANK

(d) The mass of the car is 900 kg.

(i) Write down the equation that links acceleration, force and mass.

.....

(1 mark)

(ii) Calculate the force used to accelerate the car. Show clearly how you work out your final answer.

.....

.....

Force = ...newtons

(2 marks)

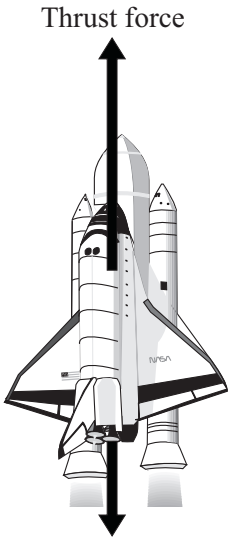
11

4.5.6.1.5 Acceleration

Question 03

June 2004 | 3451H | Original Q5 | Legacy

5 (a) The arrows in the diagram represent the size and direction of the forces on a space shuttle, fuel tank and booster rockets one second after launch. The longer the arrow the bigger the force.



(i) Describe the upward motion of the space shuttle one second after launch.

.....

(1 mark)

(ii) By the time it moves out of the Earth's atmosphere, the total weight of the space shuttle, fuel tank and booster rockets has decreased and so has the air resistance.

How does this change the motion of the space shuttle? (Assume the thrust force does not change).

.....

(1 mark)

(b) The space shuttle takes 9 minutes to reach its orbital velocity of 8100 m/s.

(i) Write down the equation that links acceleration, change in velocity and time taken.

.....

(1 mark)

(ii) Calculate, in m/s^2, the average acceleration of the space shuttle during the first 9 minutes of its flight. Show clearly how you work out your answer.

.....

.....

average acceleration =.....m/s^2

(2 marks)

4.5.6.1.5 Acceleration

Question 03 · continued

MARGIN BLANK

(iii) How is the velocity of an object different from the speed of an object?

.....

.....

(1 mark)

(c) The space shuttle can stay in orbit around the Earth for several weeks.



Not to scale

Explain why the space shuttle stays in orbit and does not fall to the Earth.

.....

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.....

.....

(2 marks)

(d) As the shuttle returns to Earth, friction causes its outside temperature to go as high as 1200°C.

Why is the underneath of the shuttle covered with black tiles?

.....

.....

(1 mark)

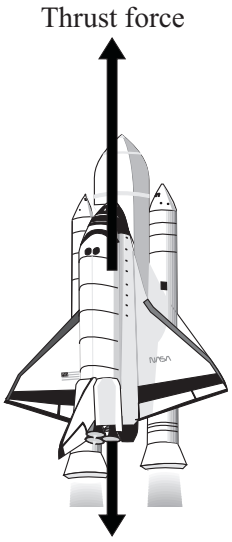
9

4.5.6.1.5 Acceleration

Question 04

June 2004 | 3462H3 | Original Q5 | Legacy

5 (a) The arrows in the diagram represent the size and direction of the forces on a space shuttle, fuel tank and booster rockets one second after launch. The longer the arrow the bigger the force.



(i) Describe the upward motion of the space shuttle one second after launch.

.....

(1 mark)

(ii) By the time it moves out of the Earth's atmosphere, the total weight of the space shuttle, fuel tank and booster rockets has decreased and so has the air resistance.

How does this change the motion of the space shuttle? (Assume the thrust force does not change).

.....

(1 mark)

(b) The space shuttle takes 9 minutes to reach its orbital velocity of 8100 m/s.

(i) Write down the equation that links acceleration, change in velocity and time taken.

.....

(1 mark)

(ii) Calculate, in m/s^2, the average acceleration of the space shuttle during the first 9 minutes of its flight. Show clearly how you work out your answer.

.....

.....

average acceleration =.....m/s^2

(2 marks)

4.5.6.1.5 Acceleration

Question 04 · continued

MARGIN BLANK

(iii) How is the velocity of an object different from the speed of an object?

.....

.....

(1 mark)

(c) The space shuttle can stay in orbit around the Earth for several weeks.



Not to scale

Explain why the space shuttle stays in orbit and does not fall to the Earth.

.....

.....

.....

.....

(2 marks)

(d) As the shuttle returns to Earth, friction causes its outside temperature to go as high as 1200°C.

Why is the underneath of the shuttle covered with black tiles?

.....

.....

(1 mark)

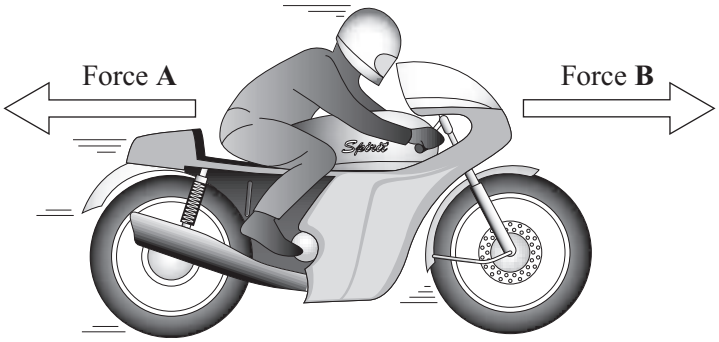
9

4.5.6.1.5 Acceleration

Question 05

June 2005 | 3451 | Original Q4 | Legacy

4 (a) The diagram shows the horizontal forces that act on a **moving** motorbike.



(i) Describe the movement of the motorbike when force **A** equals force **B**.

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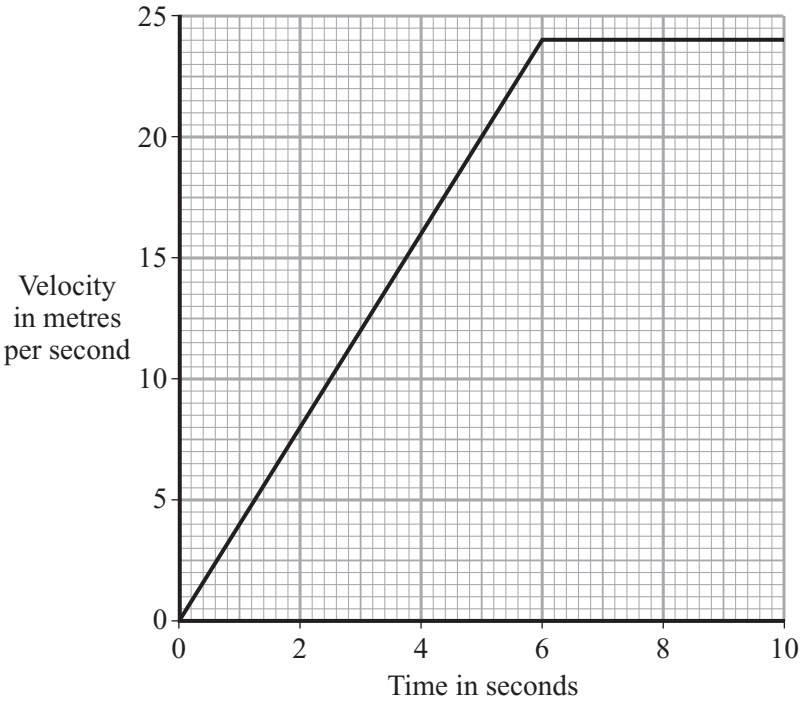
(2 marks)

(ii) What happens to the speed of the motorbike if force **B** becomes smaller than force **A**?

.....

(1 mark)

(b) The graph shows how the velocity of a motorbike changes when it is travelling along a straight road.



4.5.6.1.5 Acceleration

Question 05 · continued

MARGIN BLANK

(i) What was the change in velocity of the motorbike in the first 5 seconds?

.....

(1 mark)

(ii) Write down the equation which links acceleration, change in velocity and time taken.

.....

(1 mark)

(iii) Calculate the acceleration of the motorbike during the first 5 seconds. Show clearly how you work out your answer and give the unit.

.....

.....

Acceleration = ...

(3 marks)

(c) A car is travelling on an icy road.

Describe and explain what might happen to the car when the brakes are applied.

.....

.....

.....

.....

(2 marks)

(d) Name **three** factors, other than weather conditions, which would increase the overall stopping distance of a vehicle.

1 .....

.....

2 .....

.....

3 .....

.....

(3 marks)

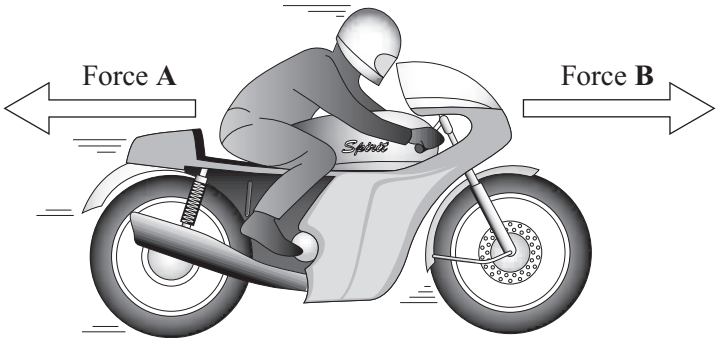
13

4.5.6.1.5 Acceleration

Question 06

June 2005 | 3462 | Original Q4 | Legacy

4 (a) The diagram shows the horizontal forces that act on a **moving** motorbike.



(i) Describe the movement of the motorbike when force **A** equals force **B**.

.....

.....

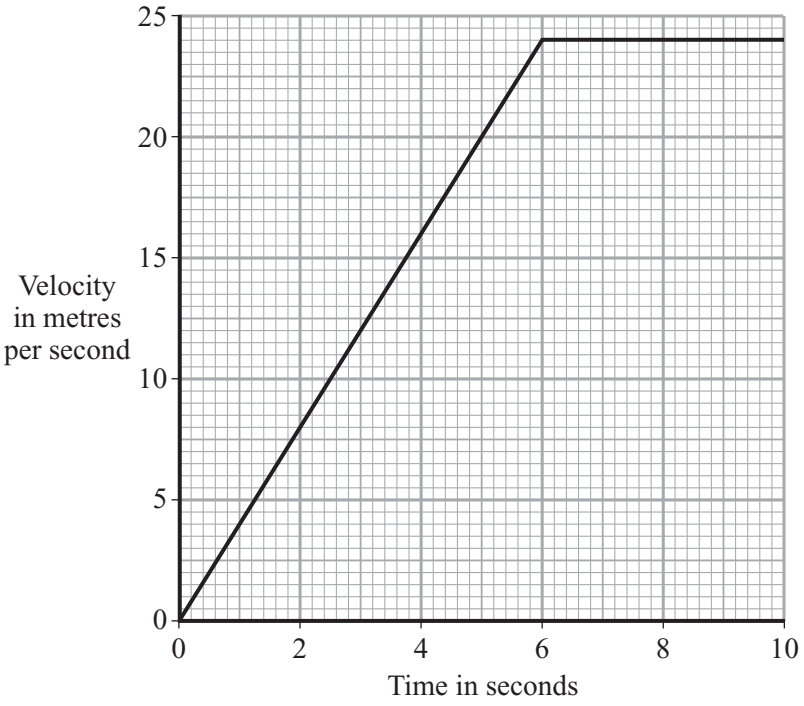
(2 marks)

(ii) What happens to the speed of the motorbike if force **B** becomes smaller than force **A**?

.....

(1 mark)

(b) The graph shows how the velocity of a motorbike changes when it is travelling along a straight road.



4.5.6.1.5 Acceleration

Question 06 · continued

MARGIN BLANK

(i) What was the change in velocity of the motorbike in the first 5 seconds?

.....

(1 mark)

(ii) Write down the equation which links acceleration, change in velocity and time taken.

.....

(1 mark)

(iii) Calculate the acceleration of the motorbike during the first 5 seconds. Show clearly how you work out your answer and give the unit.

.....

.....

Acceleration = ...

(3 marks)

(c) A car is travelling on an icy road.

Describe and explain what might happen to the car when the brakes are applied.

.....

.....

.....

.....

(2 marks)

(d) Name **three** factors, other than weather conditions, which would increase the overall stopping distance of a vehicle.

1 .....

.....

2 .....

.....

3 .....

.....

(3 marks)

13

4.5.6.1.5 Acceleration

Question 07

June 2006 | 3451 | Original Q12 | Legacy

12 (a) The diagram shows an athlete accelerating.



The athlete has a mass of 65 kg and produces a constant forward force of 364 N.

(i) Write down the equation that links acceleration, force and mass.

.....

(1 mark)

(ii) Calculate the maximum acceleration of the athlete.

Show clearly how you work out your answer.

.....

.....

Acceleration = ... m/s^2

(2 marks)

(b) The athlete's forward force is the same throughout the race.

Explain why the acceleration of the athlete decreases to zero during the race.

.....

.....

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(2 marks)

5

4.5.6.1.5 Acceleration

Question 08

June 2006 | 3462 | Original Q10 | Legacy

10 (a) The diagram shows an athlete accelerating.



The athlete has a mass of 65 kg and produces a constant forward force of 364 N.

(i) Write down the equation that links acceleration, force and mass.

.....

(1 mark)

(ii) Calculate the maximum acceleration of the athlete.

Show clearly how you work out your answer.

.....

.....

Acceleration = ... m/s^2

(2 marks)

(b) The athlete's forward force is the same throughout the race.

Explain why the acceleration of the athlete decreases to zero during the race.

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.....

(2 marks)

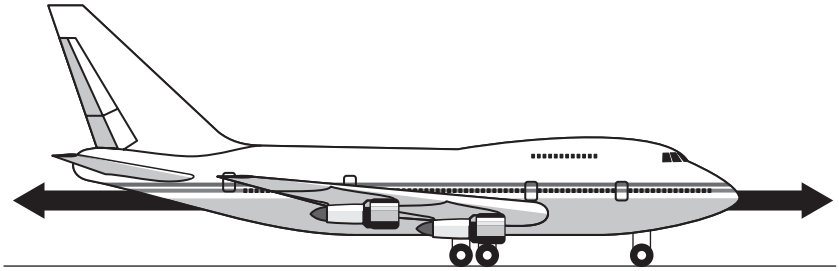
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4.5.6.1.5 Acceleration

Question 09

January 2008 | PHY2H | Original Q5 | Legacy

5 (a) The diagram shows an aircraft and the horizontal forces acting on it as it moves along a runway. The *resultant force* on the aircraft is zero.



(i) What is meant by the term *resultant force*?

.....

.....

(1 mark)

(ii) Describe the movement of the aircraft when the resultant force is zero.

.....

.....

(1 mark)

(b) The aircraft has a take-off mass of 320 000 kg. Each of the 4 engines can produce a maximum force of 240 kN.

Use the equation in the box to calculate the maximum acceleration of the aircraft.

resultant force = mass × acceleration

Show clearly how you work out your answer and give the unit.

.....

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Acceleration = ...

(3 marks)

4.5.6.1.5 Acceleration

Question 09 · continued

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(c) As the aircraft moves along the runway to take off, its acceleration decreases even though the force from the engines is constant.

Explain why.

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.....

(2 marks)

7

Turn over for the next question

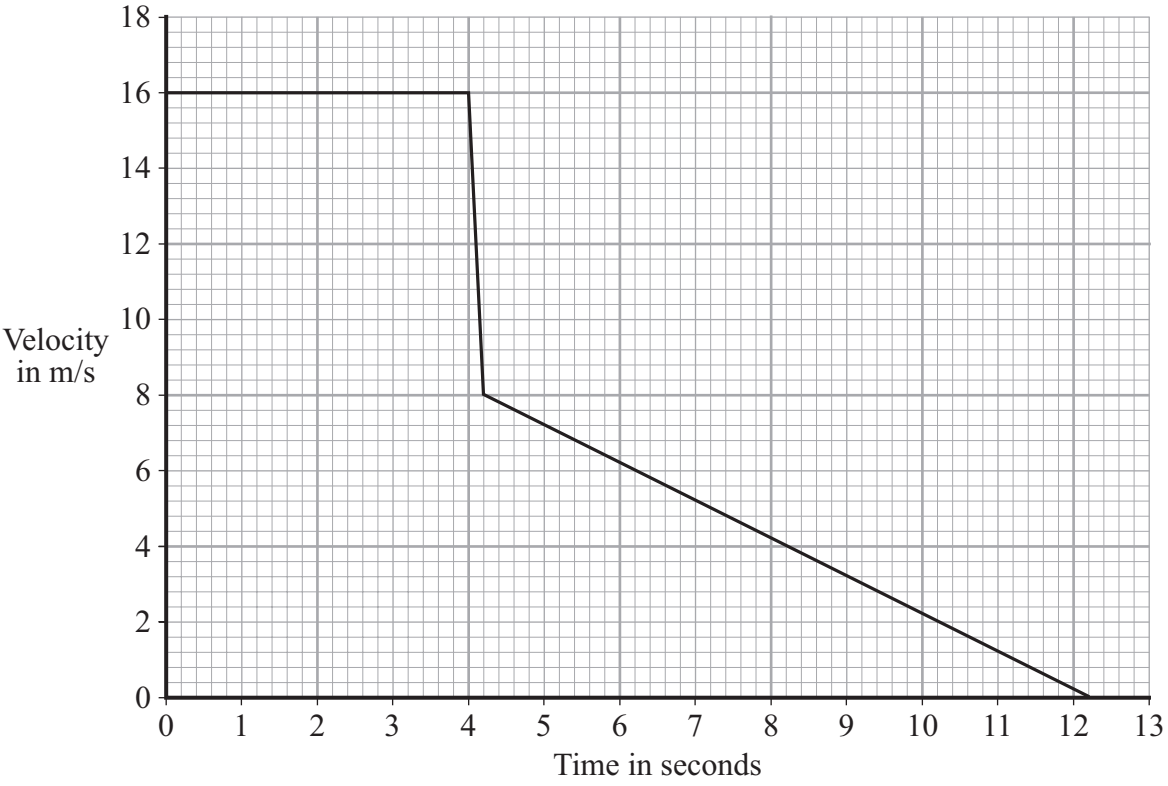
4.5.6.1.5 Acceleration

Question 10

January 2008 | PHY2H | Original Q6 | Legacy

6 In an experiment at an accident research laboratory, a car driven by remote control was crashed into the back of an identical stationary car. On impact the two cars joined together and moved in a straight line.

(a) The graph shows how the *velocity* of the remote-controlled car changed during the experiment.



(i) How is the *velocity* of a car different from the speed of a car?

.....

(1 mark)

(ii) Use the graph to calculate the distance travelled by the remote-controlled car before the collision.

Show clearly how you work out your answer.

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.....

Distance = ... m

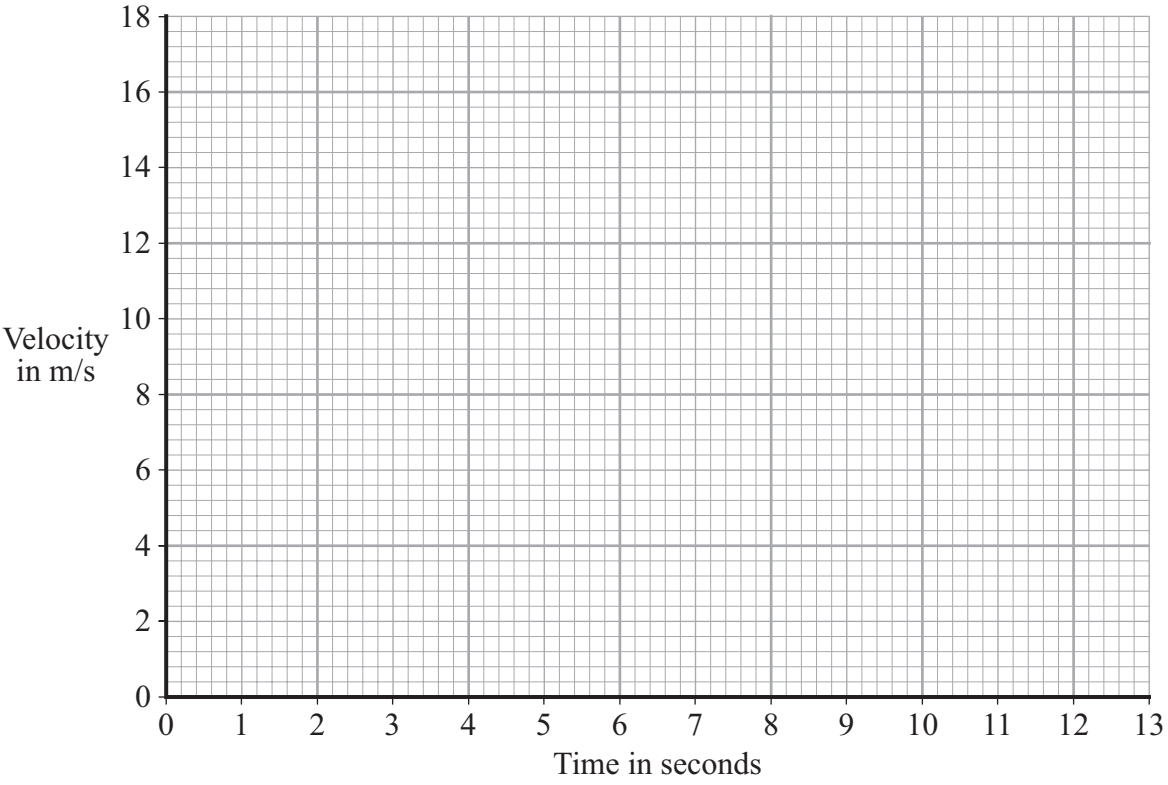
(2 marks)

4.5.6.1.5 Acceleration

Question 10 · continued

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(iii) Draw, on the grid below, a graph to show how the velocity of the second car changed during the experiment.



(2 marks)

(iv) The total momentum of the two cars was not conserved.

What does this statement mean?

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.....

(1 mark)

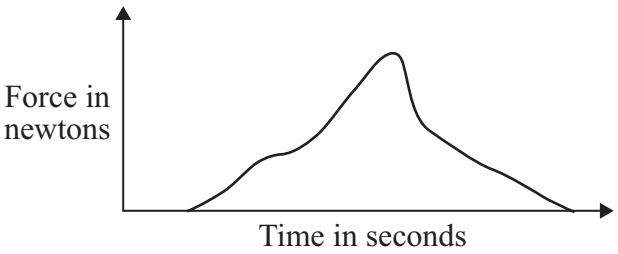
Question 6 continues on the next page

4.5.6.1.5 Acceleration

Question 10 · continued

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(b) The graph line shows how the force from a seat belt on a car driver changes during a collision.



Scientists at the accident research laboratory want to develop a seat belt that produces a constant force throughout a collision.

Use the idea of momentum to explain why this type of seat belt would be better for a car driver.

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(2 marks)

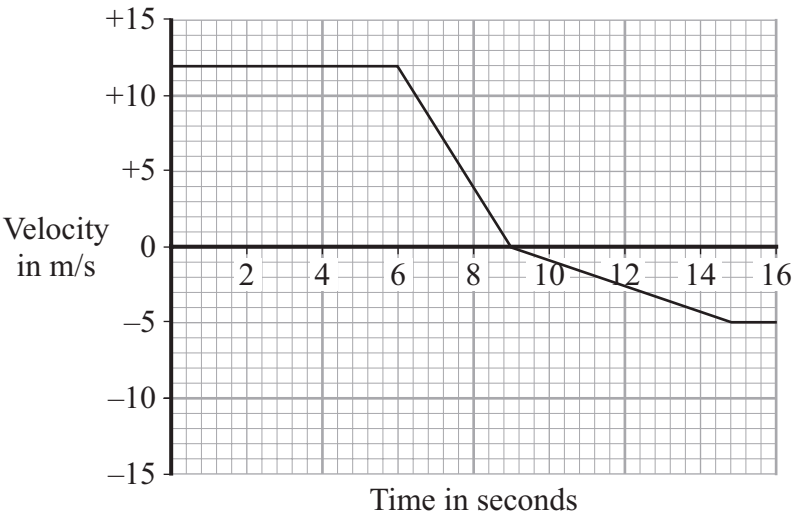
8

4.5.6.1.5 Acceleration

Question 11

June 2008 | PHY2H | Original Q5 | Legacy

5 A car is driven along a straight road. The graph shows how the velocity of the car changes during part of the journey.



5 (a) Use the graph to calculate the deceleration of the car between 6 and 9 seconds.

Show clearly how you work out your answer and give the unit.

.....

.....

.....

Deceleration = ...

(3 marks)

5 (b) At what time did the car change direction?

..... seconds

(1 mark)

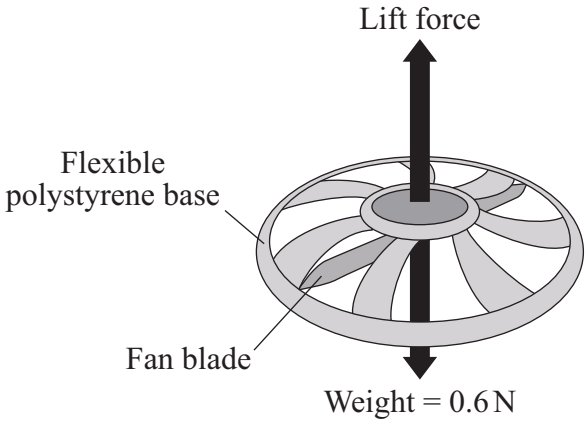
4

4.5.6.1.5 Acceleration

Question 12

June 2008 | PHY2H | Original Q7 | Legacy

7 The diagram shows a small, radio-controlled, flying toy. A fan inside the toy pushes air downwards creating the lift force on the toy.



When the toy is hovering in mid-air, the fan is pushing 1.5 kg of air downwards every 10 seconds. Before the toy is switched on, the air is stationary.

7 (a) Use the equations in the box to calculate the velocity of the air when the toy is hovering.

$$\text{momentum} = \text{mass} \times \text{velocity}$$

$$\text{force} = \frac{\text{change in momentum}}{\text{time taken for the change}}$$

Show clearly how you work out your answer.

.....

.....

.....

Velocity = ... m/s

(3 marks)

Question 7 continues on the next page

4.5.6.1.5 Acceleration

Question 12 · continued

for mark

7 (b) Explain why the toy accelerates upwards when the fan rotates faster.

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.....

(2 marks)

7 (c) The toy is not easy to control so it often falls to the ground.

Explain how the flexible polystyrene base helps to protect the toy from being damaged when it crashes into the ground.

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(3 marks)

8

4.5.6.1.5 Acceleration

Question 13

June 2008 | PHY3H | Original Q8 | Legacy

8 The London Eye is the largest observation wheel in the world.



The passengers ride in capsules. Each capsule moves in a circular path and accelerates.

8 (a) Explain how the wheel can move at a steady speed and the capsules accelerate at the same time.

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.....

.....

(2 marks)

8 (b) In which direction does each capsule accelerate?

.....

(1 mark)

8 (c) What is the name of the resultant force that causes the capsules to accelerate?

.....

(1mark)

4.5.6.1.5 Acceleration

Question 13 · continued

for mark

8 (d) The designers of the London Eye had to consider **three** factors which affect the resultant force described in part (c).

Two factors that increase the resultant force are

- an increase in the speed of rotation
- an increase in the total mass of the wheel, the capsules and the passengers.

Name the other factor that affects the resultant force and state what effect it has on the resultant force.

.....

.....

(1 mark)

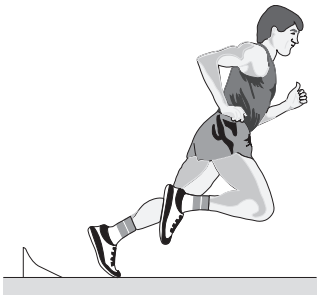
5

4.5.6.1.5 Acceleration

Question 14

January 2009 | PHY2H | Original Q2 | Legacy

2 (a) The diagram shows an athlete at the start of a race. The race is along a straight track.



In the first 2 seconds, the athlete accelerates constantly and reaches a speed of 9 m/s.

2 (a) (i) Use the equation in the box to calculate the acceleration of the athlete.

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken for change}}$$

Show clearly how you work out your answer.

.....

.....

.....

Acceleration = ...

(2 marks)

2 (a) (ii) Which **one** of the following is the unit for acceleration?

Draw a ring around your answer.

J/s **m/s** **m/s^2** **Nm**

(1 mark)

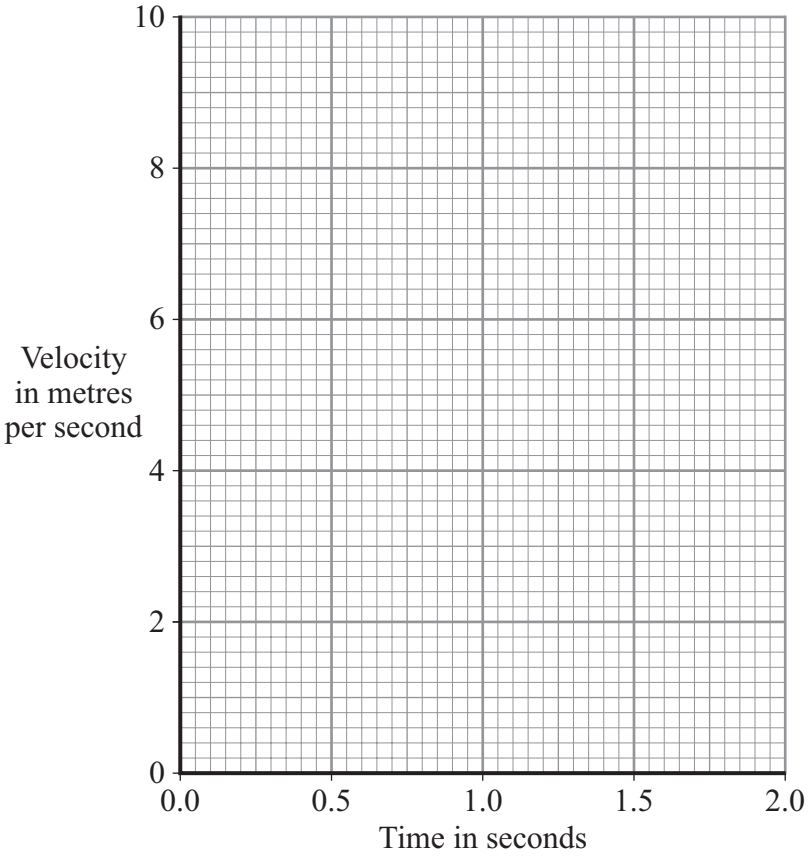
Question 14 · continued

for mark

2 (a) (iii) Complete the following sentence.

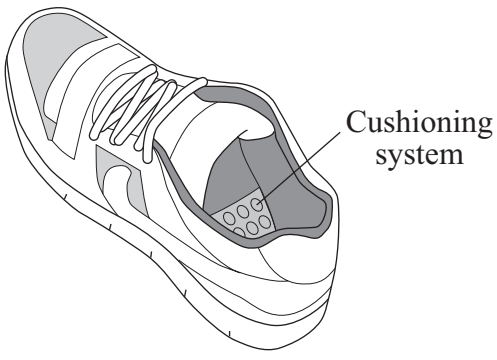
The velocity of the athlete is the ..... of the athlete in a given direction. *(1 mark)*

2 (a) (iv) Complete the graph to show how the velocity of the athlete changes during the first 2 seconds of the race.



(2 marks)

2 (b) Many running shoes have a cushioning system. This reduces the impact force on the athlete as the heel of the running shoe hits the ground.



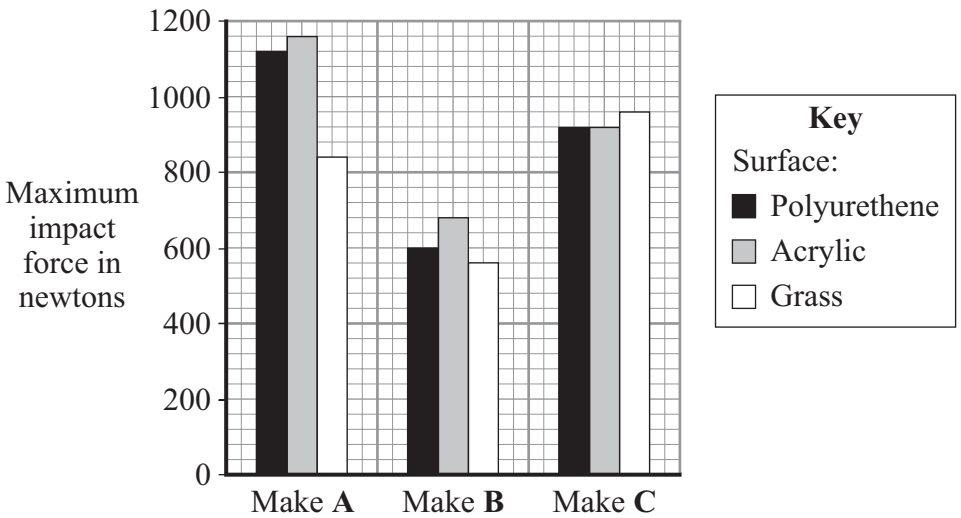
Question 2 continues on the next page

4.5.6.1.5 Acceleration

Question 14 · continued

for mark

The bar chart shows the maximum impact force for three different makes of running shoe used on three different types of surface.



2 (b) (i) Which **one** of the three makes of running shoe, **A**, **B** or **C**, has the best cushioning system?

.....

Explain the reason for your answer.

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.....

.....

(3 marks)

2 (b) (ii) The data needed to draw the bar chart was obtained using a robotic athlete fitted with electronic sensors.

Why is this data likely to be more reliable than data obtained using human athletes?

.....

.....

(1 mark)

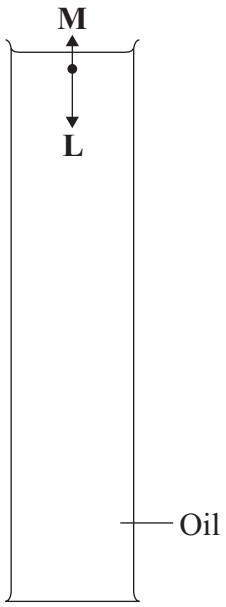
10

4.5.6.1.5 Acceleration

Question 15

June 2009 | PHY2H | Original Q3 | Legacy

3 (a) The diagram shows a steel ball-bearing falling through a tube of oil.
The forces, **L** and **M**, act on the ball-bearing.



What causes force **L**?

.....

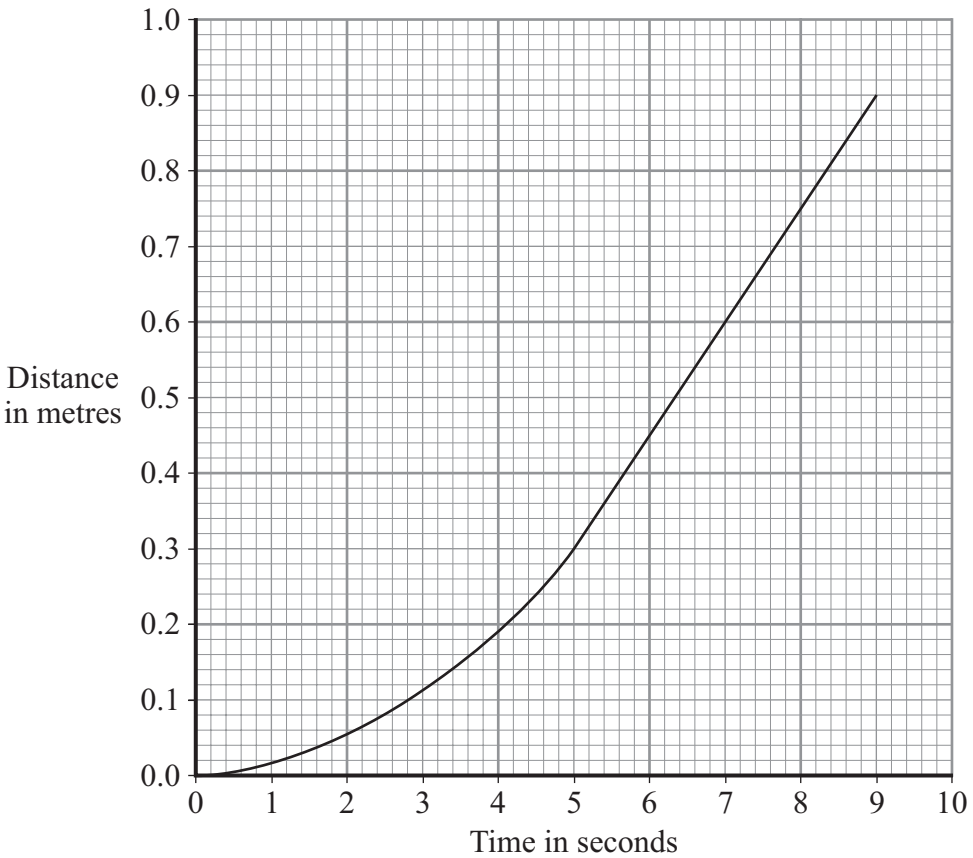
(1 mark)

Question 3 continues on the next page

Question 15 · continued

for mark

3 (b) The distance–time graph represents the motion of the ball-bearing as it falls through the oil.



3 (b) (i) Explain, in terms of the forces, **L** and **M**, why the ball-bearing accelerates at first but then falls at constant speed.

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(3 marks)

3 (b) (ii) What name is given to the constant speed reached by the falling ball-bearing?

.....

(1 mark)

4.5.6.1.5 Acceleration

Question 15 · continued

for mark

3 (b) (iii) Calculate the constant speed reached by the ball-bearing.

Show clearly how you use the graph to work out your answer.

.....

.....

.....

Speed = ... m/s

(2 marks)

7

Turn over for the next question

4.5.6.1.5 Acceleration

Question 16

June 2009 | PHY2H | Original Q4 | Legacy

4 The diagram shows a child on a playground swing.
The playground has a rubber safety surface.



4 (a) The child, with a mass of 35 kg, falls off the swing and hits the ground at a speed of 6 m/s.

4 (a) (i) Use the equation in the box to calculate the momentum of the child as it hits the ground.

momentum = mass × velocity

Show clearly how you work out your answer and give the unit.

.....

.....

.....

Momentum = ...

(3 marks)

4.5.6.1.5 Acceleration

Question 16 · continued

for mark

4 (a) (ii) After hitting the ground, the child slows down and stops in 0.25 s.
Use the equation in the box to calculate the force exerted by the ground on the child.

$$\text{force} = \frac{\text{change in momentum}}{\text{time taken for the change}}$$

Show clearly how you work out your answer.

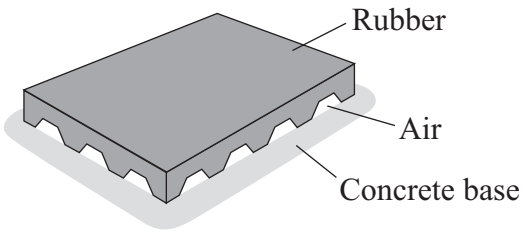
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.....

Force = ... N

(2 marks)

4 (b) The diagram shows the type of rubber tile used to cover the playground surface.



Explain how the rubber tiles reduce the risk of children being seriously injured when they fall off the playground equipment.

.....

.....

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.....

.....

(3 marks)

Question 4 continues on the next page

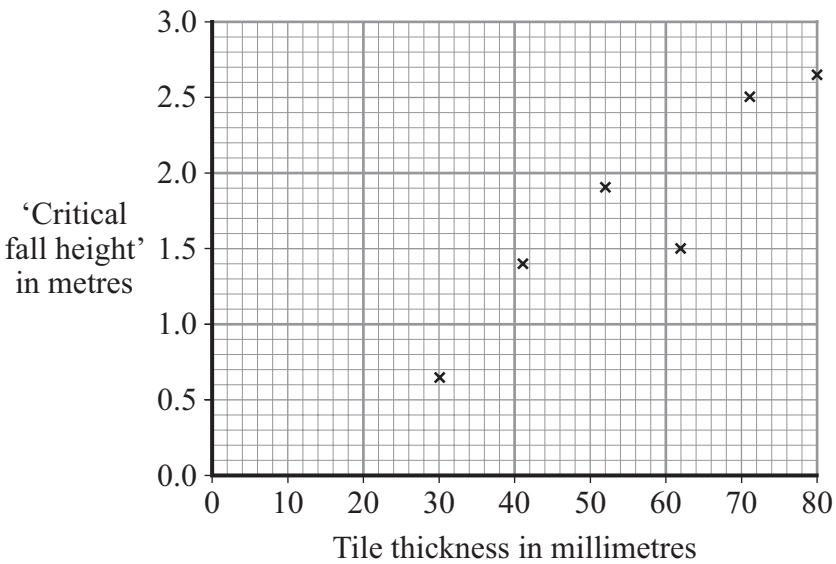
4.5.6.1.5 Acceleration

Question 16 · continued

for mark

4 (c) The 'critical fall height' is the height that a child can fall and **not** be expected to sustain a life-threatening head injury.
A new type of tile, made in a range of different thicknesses, was tested in a laboratory using test dummies and the 'critical fall height' measured. Only one test was completed on each tile.

The results are shown in the graph.



The 'critical fall height' for playground equipment varies from 0.5 m to 3.0 m.

Suggest **two** reasons why more tests are needed before this new type of tile can be used in a playground.

1.....

.....

2.....

.....

(2 marks)

4 (d) Developments in technology allow manufacturers to make rubber tiles from scrap car tyres.

Suggest why this process may benefit the environment.

.....

.....

(1 mark)

11

4.5.6.1.5 Acceleration

Question 17

January 2010 | PHY2H | Original Q1 | Legacy

1 A cyclist travelling along a straight level road accelerates at 1.2 m/s^2 for 5 seconds. The mass of the cyclist and the bicycle is 80 kg.

1 (a) Use the equation in the box to calculate the resultant force needed to produce this acceleration.

resultant force = mass × acceleration

Show clearly how you work out your answer and give the unit.

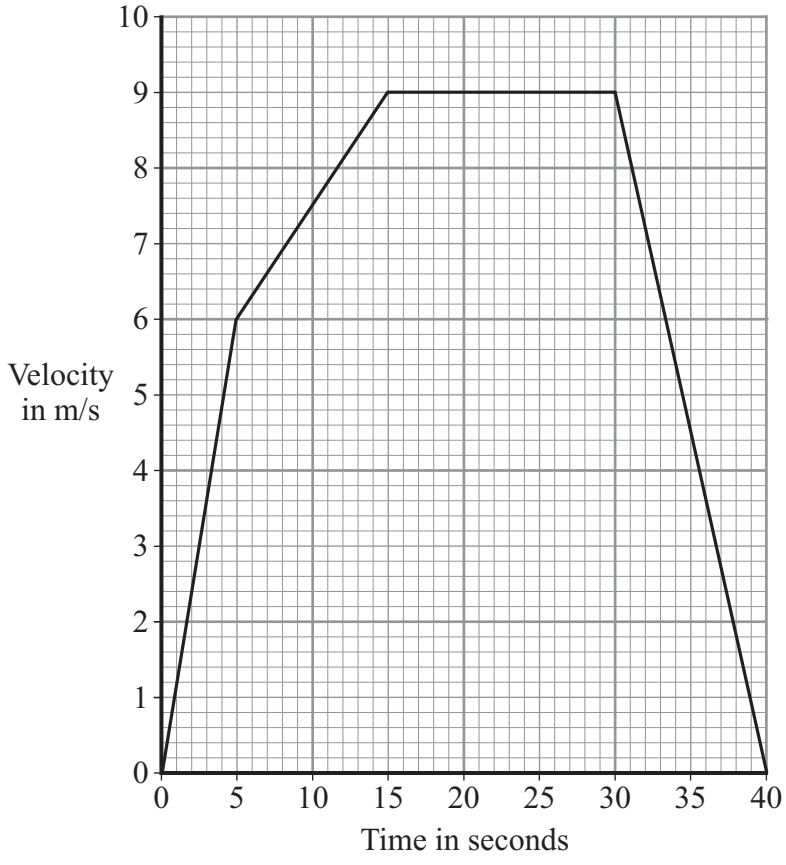
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.....

Resultant force = ...

(3 marks)

1 (b) The graph shows how the velocity of the cyclist changes with time.



4.5.6.1.5 Acceleration

Question 17 · continued

for mark

1 (b) (i) Complete the following sentence.

The velocity includes both the speed and the ..... of the cyclist.

(1 mark)

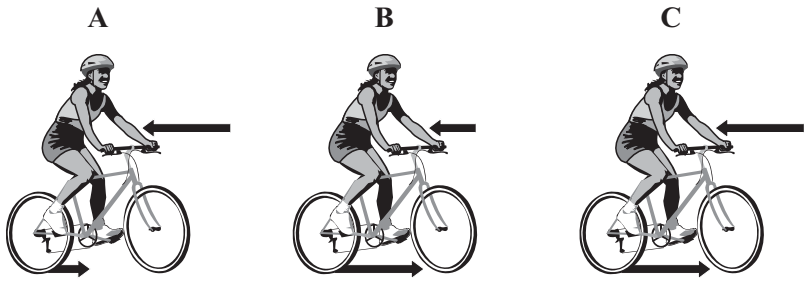
1 (b) (ii) Why has the data for the cyclist been shown as a line graph instead of a bar chart?

.....

.....

(1 mark)

1 (b) (iii) The diagrams show the horizontal forces acting on the cyclist at three different speeds. The length of an arrow represents the size of the force.



Which **one** of the diagrams, **A**, **B** or **C**, represents the forces acting when the cyclist is travelling at a constant 9 m/s?

.....

Explain the reason for your choice.

.....

.....

.....

.....

.....

.....

(3 marks)

8

4.5.6.1.5 Acceleration

Question 18

January 2019 | PHY3H | Original Q1 | Legacy

1 A student collects data from the Internet about planets in the solar system.
She arranges the data into a table.

Name of the planet	Distance from the Sun in millions of kilometres	Time taken for one orbit of the Sun in years	Time taken to spin on its axis in hours	Average temperature on the side facing the Sun in ^{o}C
Mercury	60	0.24	1400	+430
Venus	110	0.60	5800	+470
Earth	150	1	24	+20
Mars	230	2	25	–20
Jupiter	780	12	10	–150
Saturn	1400	30	10	–180
Uranus	2900	84	17	–220
Neptune	4500	160	16	–230

1 (a) Name the **two** variables in the student's table which **always** have the relationship:

As one increases, so does the other.

..... and .....

(1 mark)

1 (b) (i) Give an example of **two** variables in the student's table which **generally** have the relationship:

As one increases, the other decreases.

..... and .....

(1 mark)

4.5.6.1.5 Acceleration

Question 18 · continued

for mark

1 (b) (ii) Which piece of data does not seem to fit the relationship in (b)(i)?

.....

(1 mark)

1 (c) Scientists plan to launch a satellite which will orbit Mars above its equator.
It will be a geostationary satellite.

How many hours will it take to orbit Mars?

..... hours

(1 mark)

1 (d) Mars has two moons.

Neither of them is in a geostationary orbit and they both take different times to orbit the planet.

Which **one** of these statements is correct.
Put a tick (✓) in the box next to your answer.

The two moons will always be above the same point on the surface of Mars. ☐

The two moons will be in different positions at different times. ☐

You can never see both moons at the same time. ☐

(1 mark)

1 (e) Use words from the box to complete the **three** spaces in the passage.

circular	**direction**	**friction**	**gravitational**	**speed**	**universal**

The moons of the planet Neptune move in circular paths around the planet.

They continuously accelerate towards the centre of Neptune.

The acceleration changes the ..... of each moon but does not change its ..... . The force causing the acceleration is a ..... force.

(2 marks)

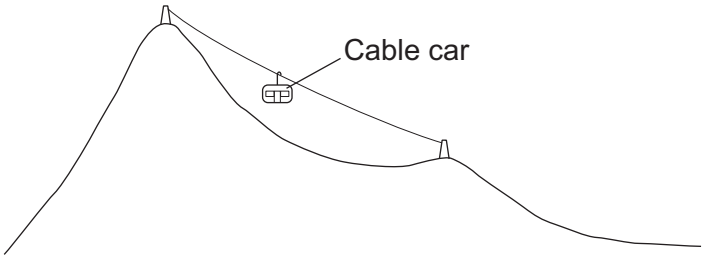
7

4.5.6.1.5 Acceleration

Question 19

June 2010 | PHY2H | Original Q1 | Legacy

1 (a) The diagram shows a cable car used to take skiers to the top of a mountain.



1 (a) (i) The total mass of the cable car and skiers is 7500 kg.

Use the equation in the box to calculate the weight of the cable car and skiers.

weight = mass × gravitational field strength

gravitational field strength = 10 N/kg

Show clearly how you work out your answer and give the unit.

.....

.....

Weight = ...

(3 marks)

4.5.6.1.5 Acceleration

Question 19 · continued

1 (a) (ii) The cable car moves at a constant speed. It lifts skiers through a vertical height of 800 metres in 7 minutes.

Use the following equation to calculate the work done to lift the cable car and skiers.

work done = force applied × distance moved in the direction of force

Show clearly how you work out your answer.

.....

.....

Work done = ... J

(2 marks)

1 (b) The diagram shows a skier who is accelerating down a steep ski slope.



1 (b) (i) Draw an arrow on the diagram to show the direction of the resultant force acting on the skier.

(1 mark)

1 (b) (ii) How and why does the kinetic energy of the skier change?

.....

.....

.....

.....

(2 marks)

Question 1 continues on the next page

4.5.6.1.5 Acceleration

Question 19 · continued

1 (c) Last year, 18 000 skiers suffered a head injury. It is thought that nearly 8000 of these injuries could have been avoided if the skier had been wearing a helmet. However, at present, there are no laws to make skiers wear helmets.

Suggest why skiers should be made aware of the benefits of wearing a helmet.

.....

.....

(1 mark)

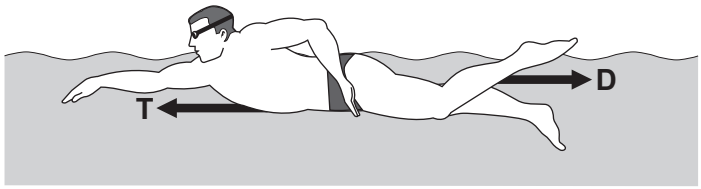
9

4.5.6.1.5 Acceleration

Question 20

January 2011 | PHY2H | Original Q1 | Legacy

1 (a) The diagram shows the horizontal forces acting on a swimmer.



1 (a) (i) The swimmer is moving at constant speed.
Force **T** is 120 N.

What is the size of force **D**?

..... N
(1 mark)

1 (a) (ii) By increasing force **T** to 140 N, the swimmer accelerates to a higher speed.

Calculate the size of the initial resultant force acting on the swimmer.

.....

.....

Initial resultant force = ... N
(1 mark)

1 (a) (iii) Even though the swimmer keeps the force **T** constant at 140 N, the resultant force on the swimmer decreases to zero.

Explain why.

.....

.....

.....

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.....

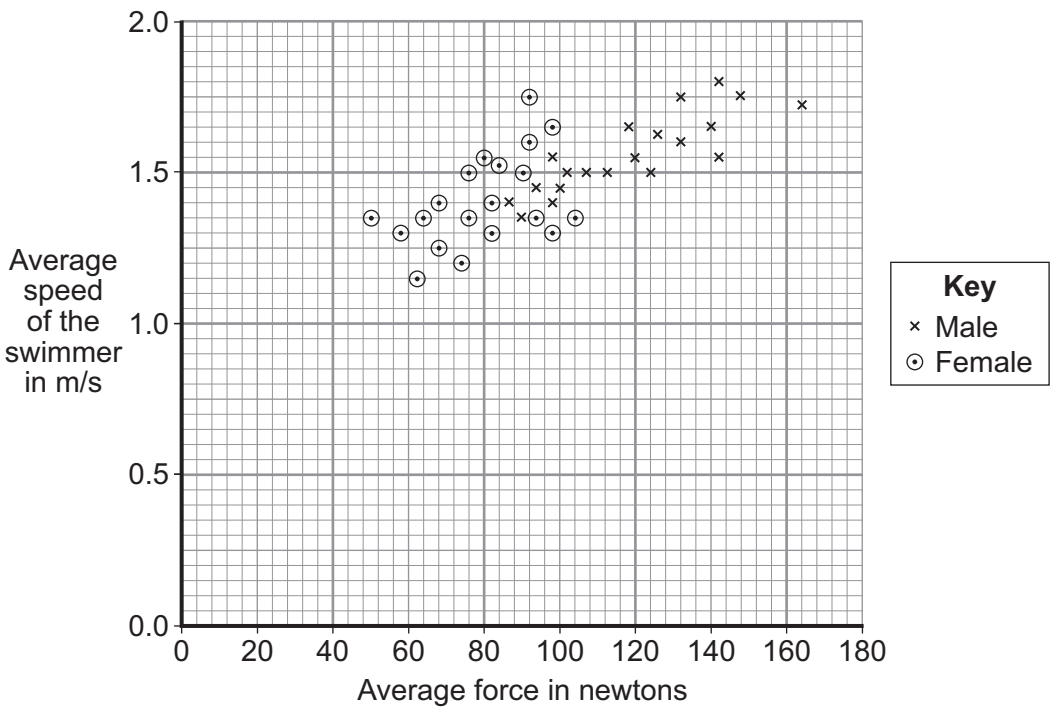
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(3 marks)

Question 1 continues on the next page

Question 20 · continued

1 (b) A sports scientist investigated how the force exerted by a swimmer's hands against the water affects the swimmer's speed.
The investigation involved 20 males and 20 females swimming a fixed distance.
Sensors placed on each swimmer's hands measured the force 85 times every second over the last 10 metres of the swim.
The measurements were used to calculate an average force.
The average speed of each swimmer over the last 10 metres of the swim was also measured.

The data from the investigation is displayed in the graph.



1 (b) (i) What was the dependent variable in this investigation?

.....

(1 mark)

1 (b) (ii) Explain **one** advantage of measuring the force 85 times every second rather than just once or twice every second.

.....

.....

.....

.....

(2 marks)

4.5.6.1.5 Acceleration

Question 20 · continued

1 (b) (iii) Give **one** way in which the data for the male swimmers is different from the data for the female swimmers.

.....

.....

(1 mark)

1 (b) (iv) Considering only the data from this investigation, what advice should a swimming coach give to swimmers who want to increase their average speed?

.....

.....

(1 mark)

10

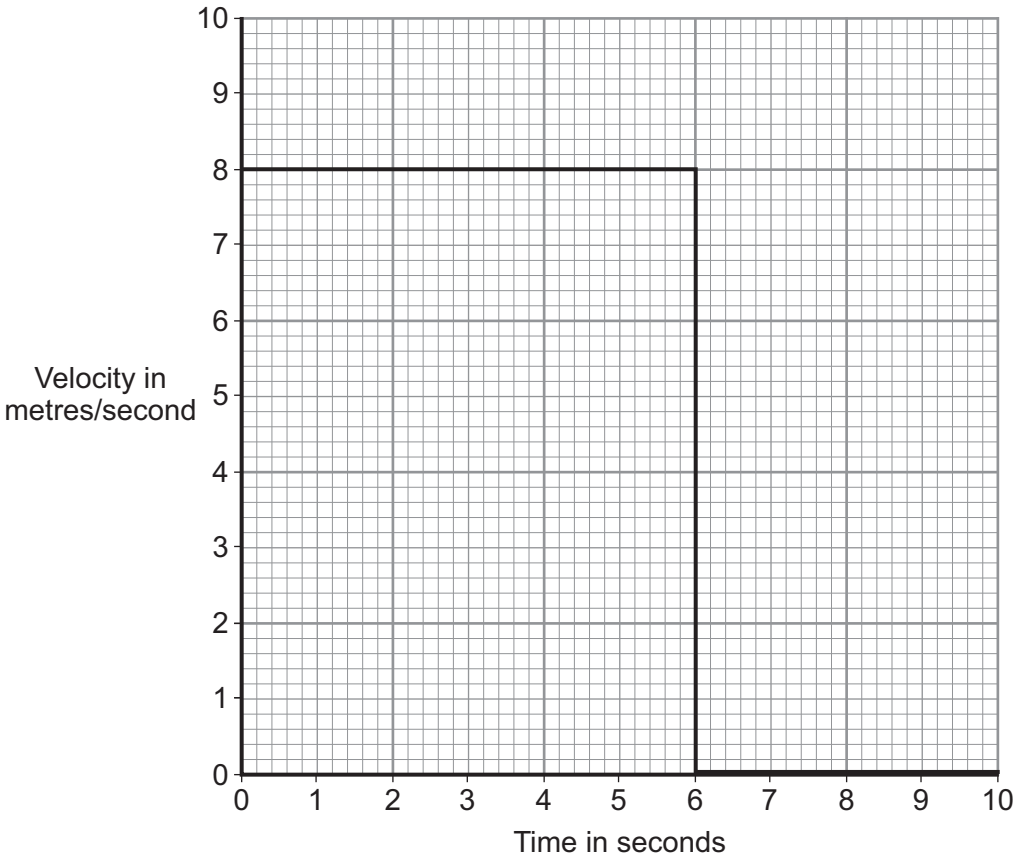
Turn over for the next question

4.5.6.1.5 Acceleration

Question 21

June 2011 | PHY2H | Original Q5 | Legacy

5 The diagram shows the velocity-time graph for an object over a 10 second period.



5 (a) Use the graph to calculate the distance travelled by the object in 10 seconds.

Show clearly how you work out your answer.

.....

.....

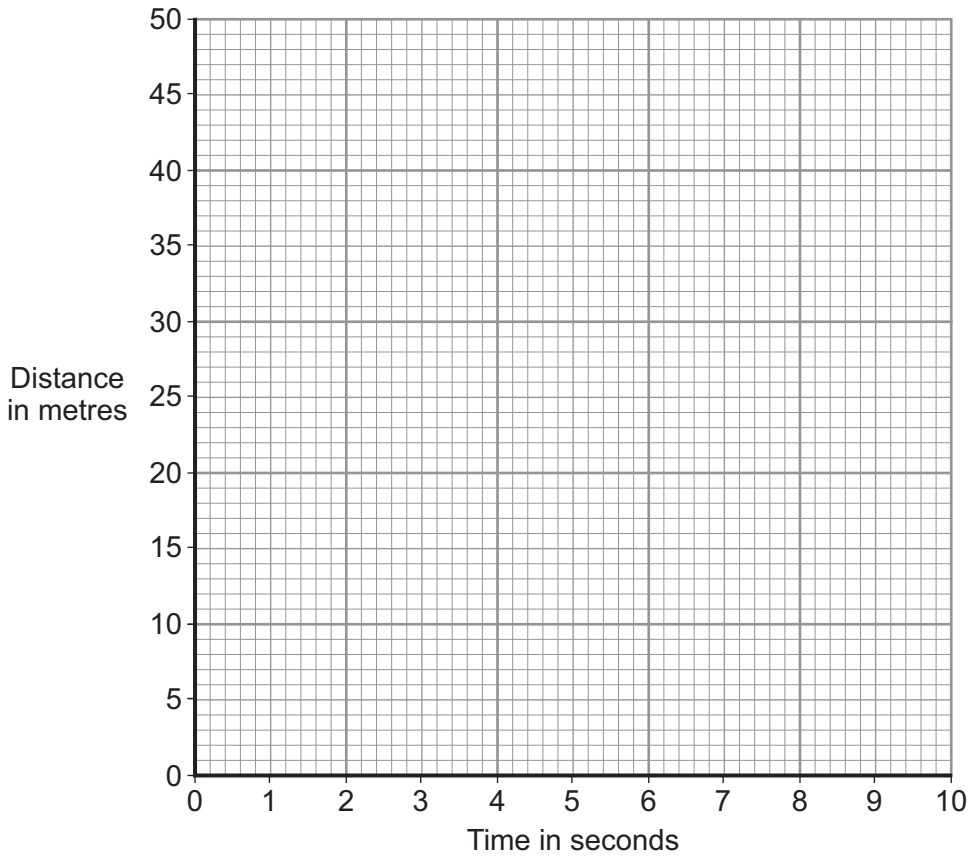
Distance = ... m

(2 marks)

4.5.6.1.5 Acceleration

Question 21 · continued

5 (b) Complete the distance-time graph for the object over the same 10 seconds.



(2 marks)

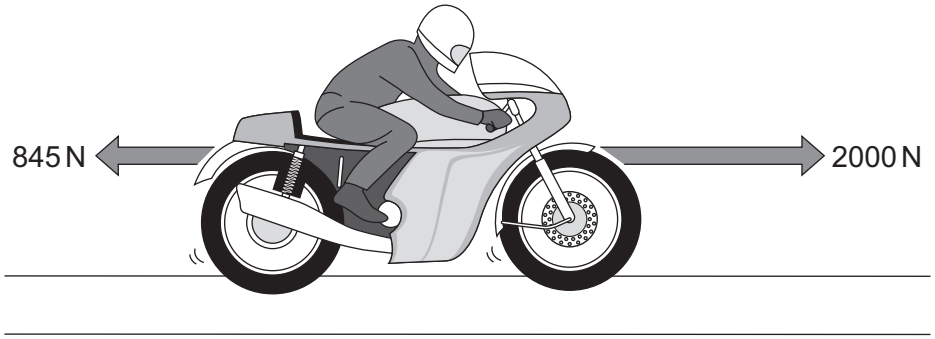
4

4.5.6.1.5 Acceleration

Question 22

June 2011 | PHY2H | Original Q7 | Legacy

7 The arrows in the diagram represent the horizontal forces acting on a motorbike at one moment in time.



7 (a) The mass of the motorbike and rider is 275 kg.

Use the equation in the box to calculate the acceleration of the motorbike at this moment in time.

resultant force = mass × acceleration

Show clearly how you work out your answer.

.....

.....

.....

.....

.....

Acceleration = ... m/s ^{2}

(3 marks)

4.5.6.1.5 Acceleration

Question 22 · continued

7 (b) A road safety organisation has investigated the causes of motorbike accidents.

The main aim of the investigation was to find out whether there was any evidence that young, inexperienced riders were more likely to be involved in an accident than older, experienced riders.

Data obtained by the organisation from a sample of 1800 police files involving motorbike accidents, is summarised in the table.

Size of motorbike engine	Percentage of all motorbikes sold	Total number in the sample of 1800 accident files
up to 125 cc	36	774
126 to 350 cc	7	126
351 to 500 cc	7	162
over 500 cc	50	738

Most of the motorbikes with engines up to 125 cc were ridden by young people. The motorbikes with engines over 500 cc were ridden by older, more experienced riders.

7 (b) (i) In terms of the main aim of the investigation, is this data valid?

Draw a ring around your answer. **NO** **YES**

Explain the reason for your answer.

.....

.....

.....

.....

(2 marks)

Question 7 continues on the next page

4.5.6.1.5 Acceleration

Question 22 · continued

7 (b) (ii) The organisation concluded that:

"Young, inexperienced riders are more likely to be involved in a motorbike accident than older, experienced riders".

Explain how the data supports this conclusion.

.....

.....

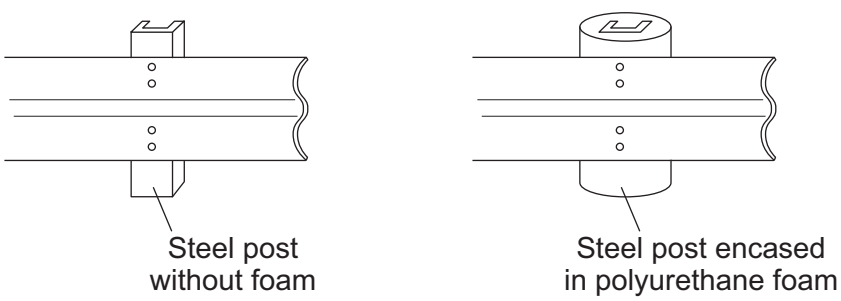
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(2 marks)

7 (c) Of particular concern to motorbike riders is the design of steel crash barriers. Riders falling off and sliding at high speed into a steel support post are often seriously injured.

One way to reduce the risk of serious injury is to cover the post in a thick layer of high impact polyurethane foam.



7 (c) (i) Use the ideas of momentum to explain how the layer of foam reduces the risk of serious injury to a motorbike rider sliding at high speed into the support post.

.....

.....

.....

.....

.....

(3 marks)

4.5.6.1.5 Acceleration

Question 22 · continued

7 (c) (ii) Crash barrier tests use dummies that collide at 17 m/s with the barrier. Each test costs about £12 000. New safety devices for crash barriers are tested many times to make sure that they will improve safety.

Do you think that the cost of developing the new safety devices is justified?

Draw a ring around your answer. **NO** **YES**

Give a reason for your answer.

.....

.....

(1 mark)

11

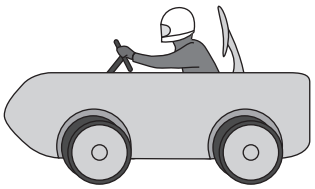
4.5.6.1.5 Acceleration

Question 23

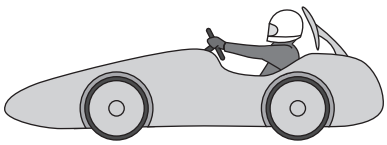
January 2013 | PH2HP | Original Q5 | Legacy

5 (a) Some students have designed and built an electric-powered go-kart. After testing, the students decided to make changes to the design of their go-kart.

First design **X**



Final design **Y**



The go-kart always had the same mass and used the same motor.

The change in shape from the first design (**X**) to the final design (**Y**) will affect the top speed of the go-kart.

Explain why.

.....

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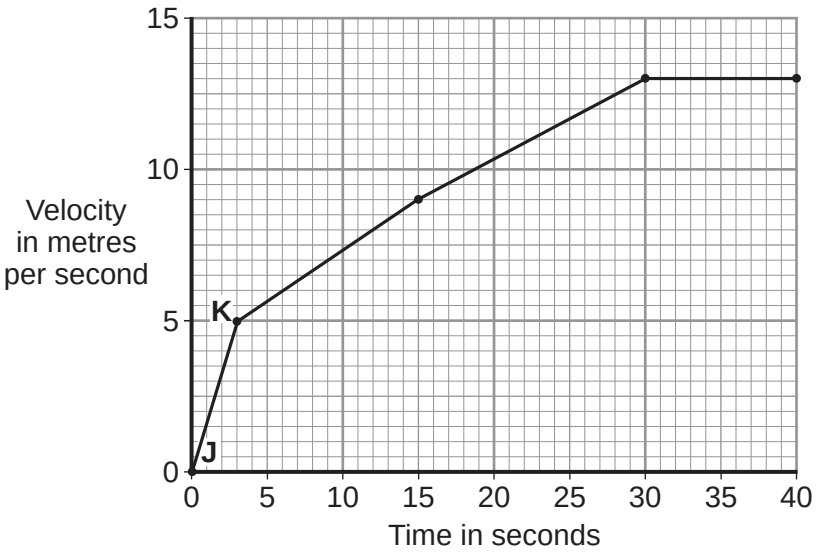
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(3 marks)

5 (b) The final design go-kart, **Y**, is entered into a race.

The graph shows how the velocity of the go-kart changes during the first 40 seconds of the race.



4.5.6.1.5 Acceleration

Question 23 · continued

5 (b) (i) Use the graph to calculate the acceleration of the go-kart between points **J** and **K**.

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

.....

.....

.....

Acceleration = ... m/s^2

(2 marks)

5 (b) (ii) Use the graph to calculate the distance the go-kart travels between points **J** and **K**.

.....

.....

.....

Distance = ... m

(2 marks)

5 (b) (iii) What causes most of the resistive forces acting on the go-kart?

.....

(1 mark)

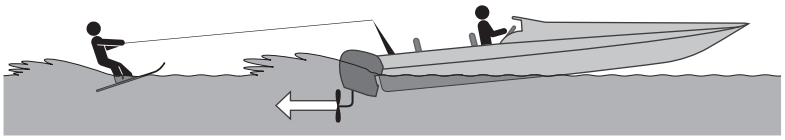
8

4.5.6.1.5 Acceleration

Question 24

June 2013 | PH2HP | Original Q1 | Legacy

1 The diagram shows a boat pulling a water skier.



1 (a) The arrow represents the force on the water produced by the engine propeller. This force causes the boat to move.

Explain why.

.....

.....

.....

.....

(2 marks)

1 (b) The boat accelerates at a constant rate in a straight line. This causes the velocity of the water skier to increase from 4.0 m/s to 16.0 m/s in 8.0 seconds.

1 (b) (i) Calculate the acceleration of the water skier and give the unit.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

Acceleration = ...

(3 marks)

4.5.6.1.5 Acceleration

Question 24 · continued

1 (b) (ii) The water skier has a mass of 68 kg.

Calculate the resultant force acting on the water skier while accelerating.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

Resultant force = ... N

(2 marks)

1 (b) (iii) Draw a ring around the correct answer to complete the sentence.

The force from the boat pulling the water skier forwards

will be | less than / the same as / greater than | the answer to part **(b)(ii)**.

Give the reason for your answer.

.....

.....

(2 marks)

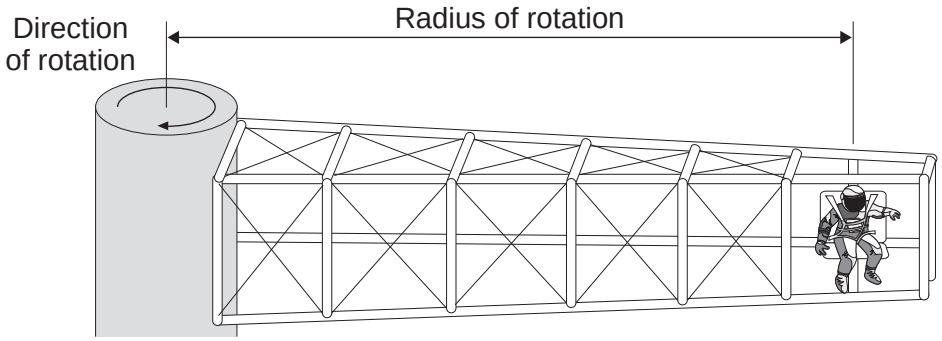
9

4.5.6.1.5 Acceleration

Question 25

June 2013 | PH3HP | Original Q5 | Legacy

5 The diagram shows a 'G-machine'. The G-machine is used in astronaut training.



The G-machine moves the astronaut in a horizontal circle.

5 (a) When the G-machine is rotating at constant speed, the astronaut is accelerating.

State the name and direction of the force causing the astronaut to accelerate.

Name of force .....

Direction of force .....

.....

(2 marks)

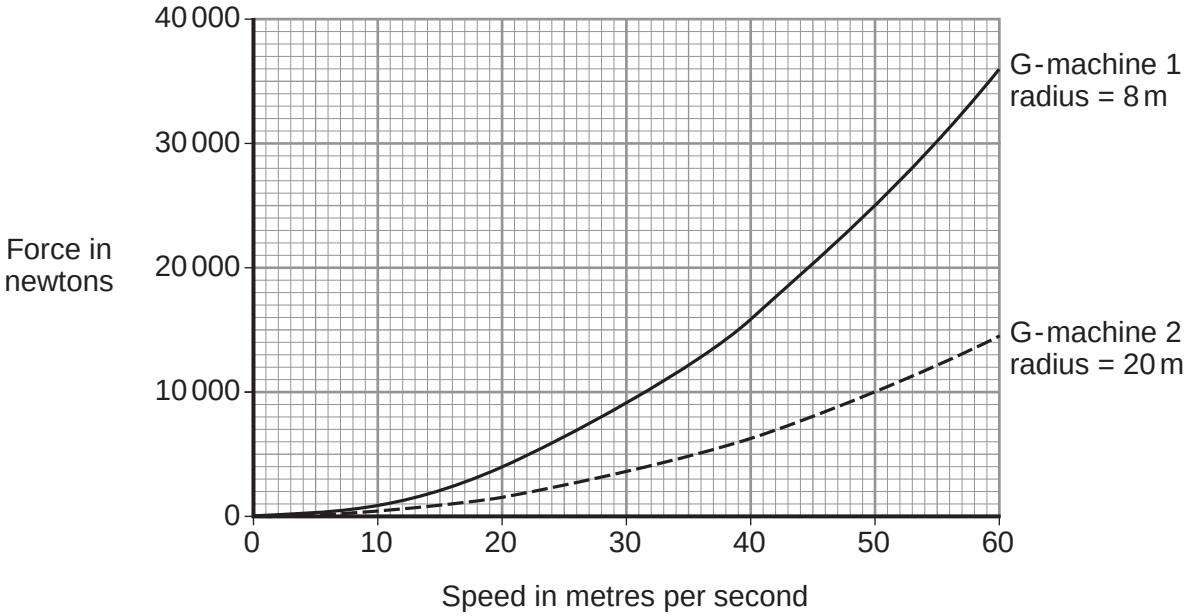
4.5.6.1.5 Acceleration

Question 25 · continued

5 (b) The force causing the astronaut to move in a circle is measured.

The graph shows how the speed of the astronaut affects the force causing the astronaut to move in a circle for two different G-machines.

The radius of rotation of the astronaut is different for each G-machine.



5 (b) (i) State **three** conclusions that can be made from the graph.

1 .....

.....

2 .....

.....

3 .....

.....

(3 marks)

5 (b) (ii) The speed of rotation of G-machine 1 is increased from 20 m/s to 40 m/s.

Determine the change in force on the astronaut.

.....

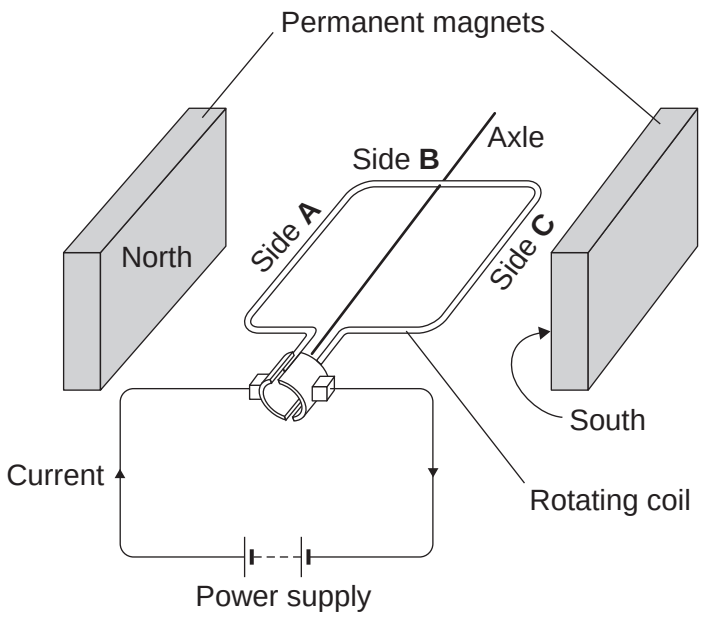
Change in force = ... N

(1 mark)

4.5.6.1.5 Acceleration

Question 25 · continued

5 (c) Each G-machine is rotated by an electric motor. The diagram shows a simple electric motor.



5 (c) (i) A current flows through the coil of the motor.

Explain why side **A** of the coil experiences a force.

.....

.....

.....

.....

(2 marks)

5 (c) (ii) Draw arrows on the diagram to show the direction of the forces acting on side **A** of the coil and side **C** of the coil.

(1 mark)

5 (c) (iii) When horizontal, side **B** experiences no force.

Give the reason why.

.....

.....

(1 mark)

4.5.6.1.5 Acceleration

Question 25 · continued

5 (d) While a G-machine is rotating, the operators want to increase its speed.

What can the operators do to make the G-machine rotate faster?

.....

.....

(1 mark)

5 (e) The exploration of space has cost a lot of money.

Do you think spending lots of money on space exploration has been a good thing?

Draw a ring around your answer.

Yes **No**

Give a reason for your answer.

.....

.....

(1 mark)

12

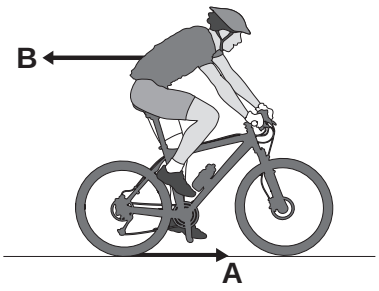
4.5.6.1.5 Acceleration

Question 26

June 2014 | PH2HP | Original Q3 | Legacy

3 (a) **Figure 2** shows the horizontal forces acting on a moving bicycle and cyclist.

Figure 2



3 (a) (i) What causes force **A**?

Draw a ring around the correct answer.

[1 mark]

friction **gravity** **weight**

3 (a) (ii) What causes force **B**?

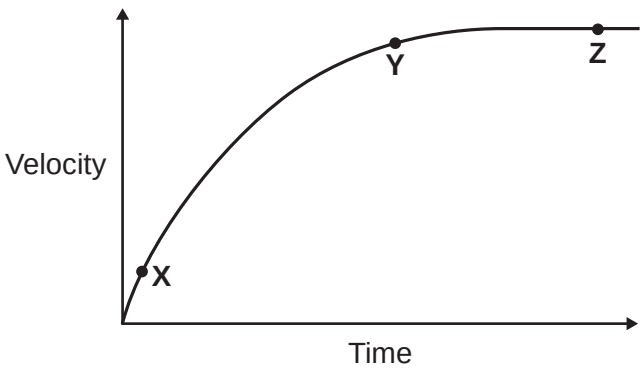
[1 mark]

.....

3 (a) (iii) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Figure 3 shows how the velocity of the cyclist changes during the first part of a journey along a straight and level road. During this part of the journey the force applied by the cyclist to the bicycle pedals is constant.

Figure 3



4.5.6.1.5 Acceleration

Question 26 · continued

Describe how **and** explain, in terms of the forces **A** and **B**, why the velocity of the cyclist changes:

- between the points **X** and **Y**
- and between the points **Y** and **Z**, marked on the graph in **Figure 3**.

[6 marks]

Extra space .....

4.5.6.1.5 Acceleration

Question 26 · continued

3 (b) (i) The cyclist used the brakes to slow down and stop the bicycle.

A constant braking force of 140 N stopped the bicycle in a distance of 24 m.

Calculate the work done by the braking force to stop the bicycle. Give the unit.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

.....

.....

.....

Work done = ...

3 (b) (ii) Complete the following sentences.

[2 marks]

When the brakes are used, the bicycle slows down. The kinetic energy of the bicycle ..... .

At the same time, the ..... of the brakes increases.

13

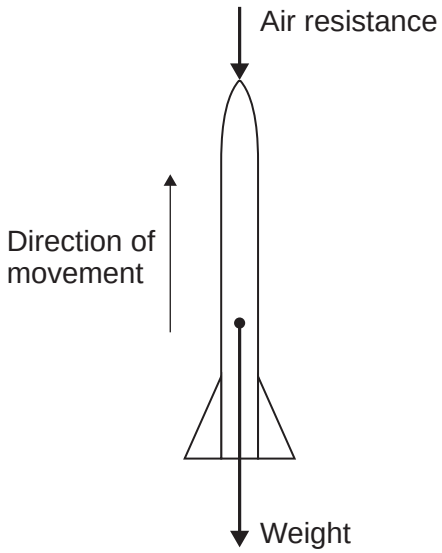
4.5.6.1.5 Acceleration

Question 27

June 2015 | PH2HP | Original Q6 | Legacy

6 (a) **Figure 7** shows the forces acting on a model air-powered rocket just after it has been launched vertically upwards.

Figure 7



6 (a) (i) How does the velocity of the rocket change as the rocket moves **upwards**?

[2 marks]

.....

Give a reason for your answer.

.....

.....

6 (a) (ii) The velocity of the rocket is not the same as the speed of the rocket.

What is the difference between the velocity of an object and the speed of an object?

[1 mark]

.....

.....

.....

4.5.6.1.5 Acceleration

Question 27 · continued

6 (b) The speed of the rocket just after being launched is 12 m/s.
The mass of the rocket is 0.05 kg.

6 (b) (i) Calculate the kinetic energy of the rocket just after being launched.

Use the correct equation from the Physics Equations Sheet.

[2 marks]

.....

.....

.....

Kinetic energy = ... J

6 (b) (ii) As the rocket moves upwards, it gains gravitational potential energy.

State the maximum gravitational potential energy gained by the rocket.

Ignore the effect of air resistance.

[1 mark]

Maximum gravitational potential energy = ... J

6 (b) (iii) Calculate the maximum height the rocket will reach.

Ignore the effect of air resistance.

Gravitational field strength = 10 N/kg.

Use the correct equation from the Physics Equations Sheet.

[2 marks]

.....

.....

.....

Maximum height = ... m

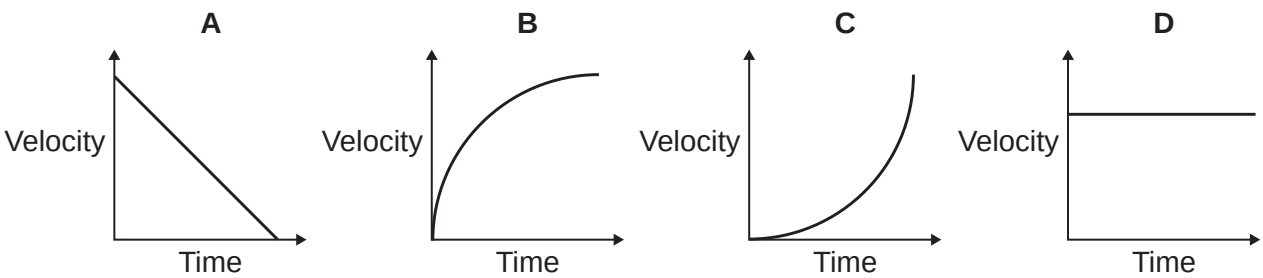
Question 6 continues on the next page

4.5.6.1.5 Acceleration

Question 27 · continued

6 (b) (iv) **Figure 8** shows four velocity–time graphs.

Figure 8



Taking air resistance into account, which graph, **A**, **B**, **C** or **D**, shows how the velocity of the rocket changes as it **falls** from the maximum height it reached until it just hits the ground?

[1 mark]

Write the correct answer in the box.

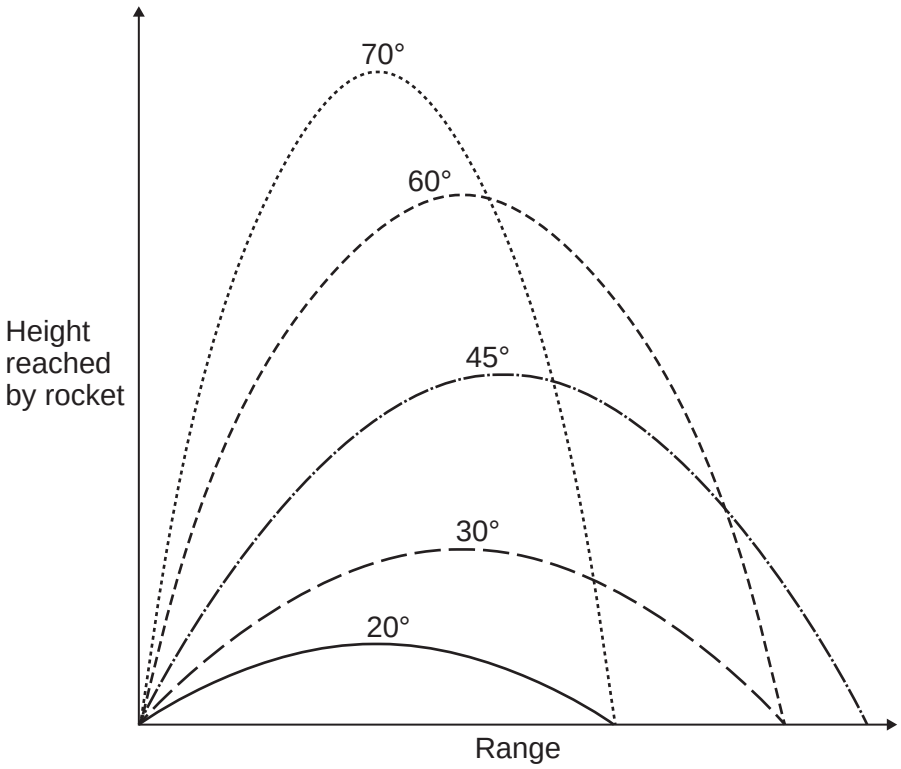
4.5.6.1.5 Acceleration

Question 27 · continued

6 (c) The rocket can be launched at different angles to the horizontal.
The horizontal distance the rocket travels is called the range.

Figure 9 shows the paths taken by the rocket when launched at different angles.
Air resistance has been ignored.

Figure 9



What pattern links the angle at which the rocket is launched and the range of the rocket?

[2 marks]

.....

.....

.....

.....

11

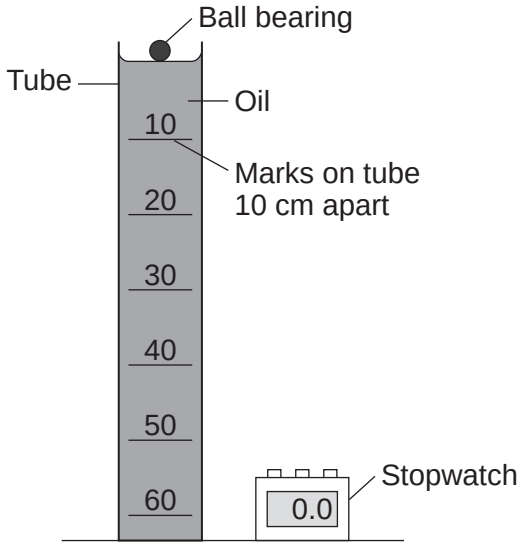
4.5.6.1.5 Acceleration

Question 28

June 2016 | PH2HP | Original Q1 | Legacy

1 A student investigated how the speed of a ball bearing changes as the ball bearing falls through a tube of oil.
Figure 1 shows the equipment the student used.

Figure 1



The student measured the time taken for the ball bearing to fall different distances.
Each distance was measured from the top of the oil.

1 (a) What is likely to have been the main source of error in this investigation?

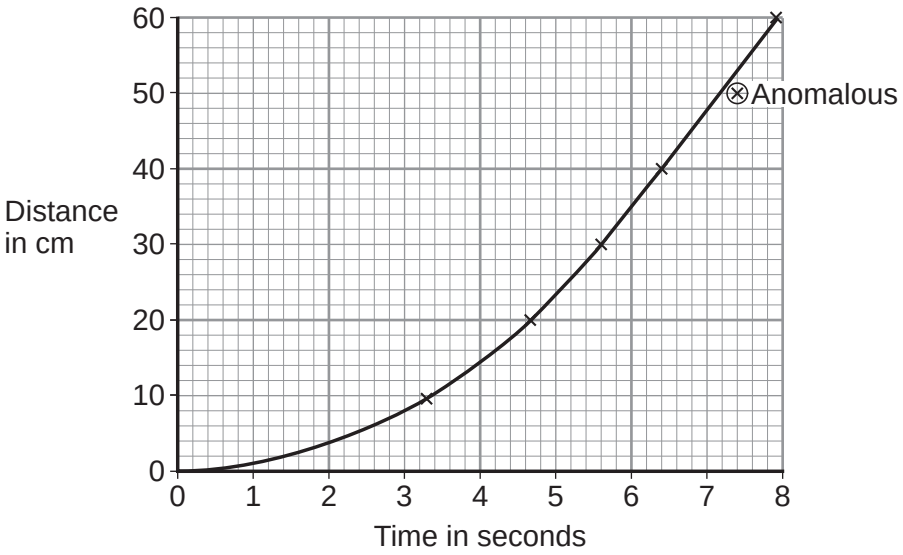
[1 mark]

4.5.6.1.5 Acceleration

Question 28 · continued

1 (b) **Figure 2** shows the student's results plotted as a graph.

Figure 2



1 (b) (i) The student has identified one of the results as being anomalous.

Use the correct answer from the box to complete the sentence.

[1 mark]

after	as	before

The anomalous result was caused by the stopwatch being started _____ the ball bearing was released.

1 (b) (ii) What can you conclude from the graph about the speed of the ball bearing during the first four seconds?

[1 mark]

_____

_____

1 (b) (iii) The graph shows that the ball bearing reached its terminal velocity.

Describe how the graph would be used to calculate the terminal velocity of the ball bearing.

[1 mark]

_____

_____

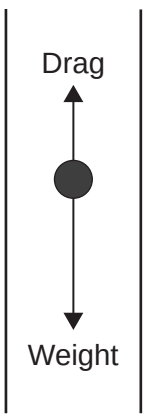
Question 1 continues on the next page

4.5.6.1.5 Acceleration

Question 28 · continued

1 (b) (iv) The directions of the two forces acting on the ball bearing as it falls through the oil are shown in **Figure 3**.

Figure 3



Explain, in terms of the forces shown in **Figure 3**, why the ball bearing reaches its terminal velocity.

[2 marks]

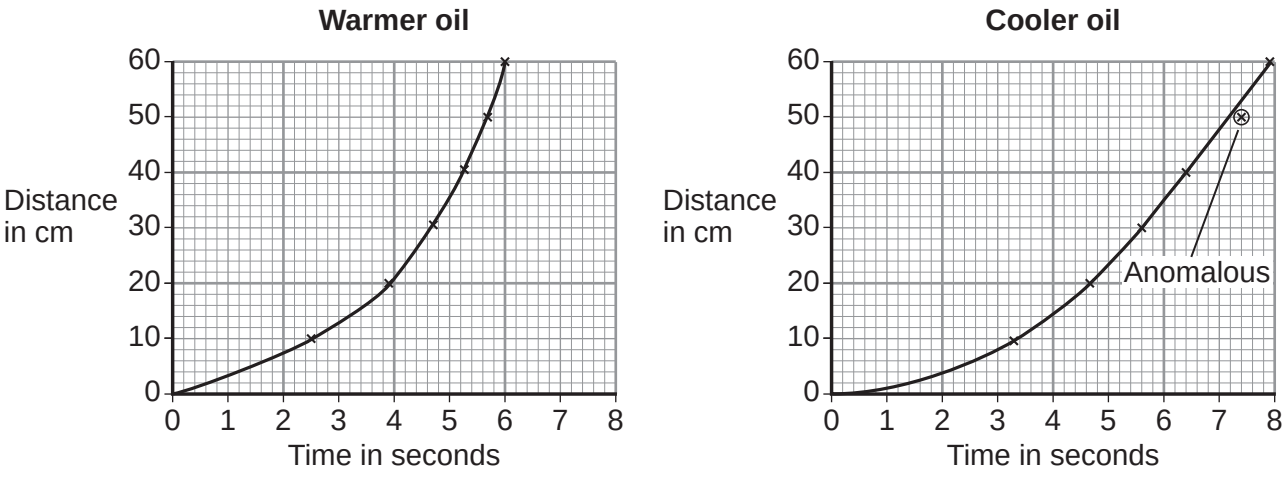
4.5.6.1.5 Acceleration

Question 28 · continued

1 (c) The student repeated the investigation using warmer oil.

Figure 4 shows the set of results using the warmer oil **and** the set of results using the cooler oil.

Figure 4



Compare the two graphs in **Figure 4**.

Use the correct phrase from the box to complete the sentence.

[3 marks]

less than	**equal to**	**greater than**

After falling 40 cm, the drag force on the ball bearing in the warmer oil is

_____ the drag force on the ball bearing in the cooler oil.

Explain the reason for your answer.

_____

_____

_____

_____

9

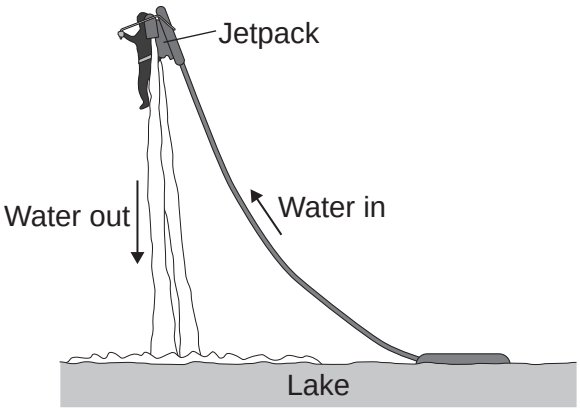
4.5.6.1.5 Acceleration

Question 29

June 2016 | PH2HP | Original Q7 | Legacy

7 **Figure 14** shows a person using a device called a jetpack. Water is forced downwards from the jetpack and produces an upward force on the person.

Figure 14



7 (a) State the condition necessary for the person to be able to remain stationary in mid-air.

[1 mark]

_____

_____

7 (b) The person weighs 700 N and the jetpack weighs 140 N.

7 (b) (i) Calculate the combined mass of the person and the jetpack.

Gravitational field strength = 10 N/kg

Use the correct equation from the Physics Equations Sheet.

[2 marks]

_____

_____

_____

Combined mass = _____ kg

4.5.6.1.5 Acceleration

Question 29 · continued

7 (b) (ii) Increasing the upward force to 1850 N causes the person to accelerate upwards.

Calculate the acceleration of the person and the jetpack. Give the unit.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

Acceleration = _____ Unit _____

6

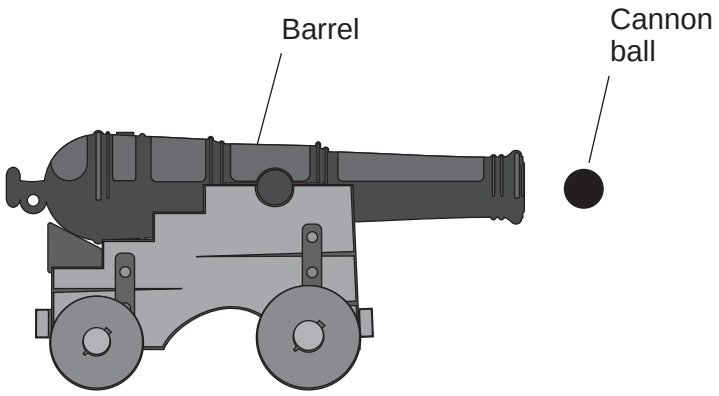
4.5.6.1.5 Acceleration

Question 30

June 2017 | PH2HP | Original Q7 | Legacy

7 **Figure 9** shows one type of cannon.

Figure 9



7 (a) When the cannon is fired, there is an explosion inside the barrel. The explosion causes the cannon ball to move forwards and the cannon to move backwards.

Explain, using the idea of momentum, why the cannon moves backwards after firing.

[3 marks]

Question 7 continues on the next page

4.5.6.1.5 Acceleration

Question 30 · continued

7 (b) When the cannon is fired, the cannon ball accelerates at 2500 m/s^2 for 0.05 seconds. The cannon ball has a mass of 8 kg

Calculate the momentum of the cannon ball 0.05 seconds after the cannon is fired.

Use the correct **equations** from the Physics Equations Sheet.

[3 marks]

Momentum = _____ kg m/s

6

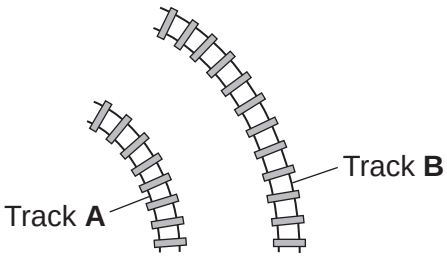
4.5.6.1.5 Acceleration

Question 31

June 2017 | PH3HP | Original Q8 | Legacy

8 **Figure 7** shows two train tracks, **A** and **B**.

Figure 7



8 (a) (i) A train moves at constant speed along track **A**.

Explain how the train can be accelerating while travelling at a constant speed.

[3 marks]

8 (a) (ii) Two identical trains travel on the tracks, one on track **A** and one on track **B**.

Explain which train can travel at the highest maximum speed.

[2 marks]

4.5.6.1.5 Acceleration

Question 31 · continued

8 (b) One type of train is designed to tilt as it goes around bends. Tilting the train more increases the centripetal force that acts on the train.

8 (b) (i) Suggest **one** advantage of creating a train which can vary the amount it tilts as it goes around bends.

[1 mark]

_____

_____

8 (b) (ii) The tilting train is designed so that the line of action of the weight of the train always lies between the two rails.

State why the train does not topple.

[1 mark]

_____

_____

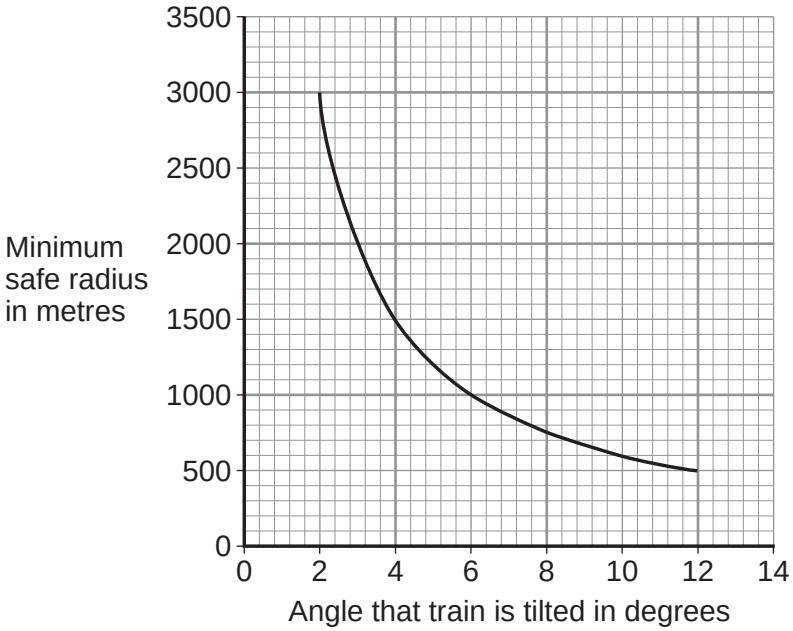
Question 8 continues on the next page

4.5.6.1.5 Acceleration

Question 31 · continued

8 (c) An engineer built a small scale model to predict the minimum safe radius of curved track that the tilted train could safely go round at 250 km/hour. The results predicted using the small scale model are shown in **Figure 8**.

Figure 8



8 (c) (i) The engineer described the relationship between the angle that the train tilted and the minimum safe radius at 250 km/hour as inversely proportional.

Use data from the graph to explain why the engineer is correct.

[2 marks]

8 (c) (ii) The engineer also created a computer simulation of the tilting train.

Suggest **one** benefit of using a computer simulation over using a small scale model.

[1 mark]

10

4.5.6.1.5 Acceleration

Question 32

June 2018 | 8463/2H | Original Q1

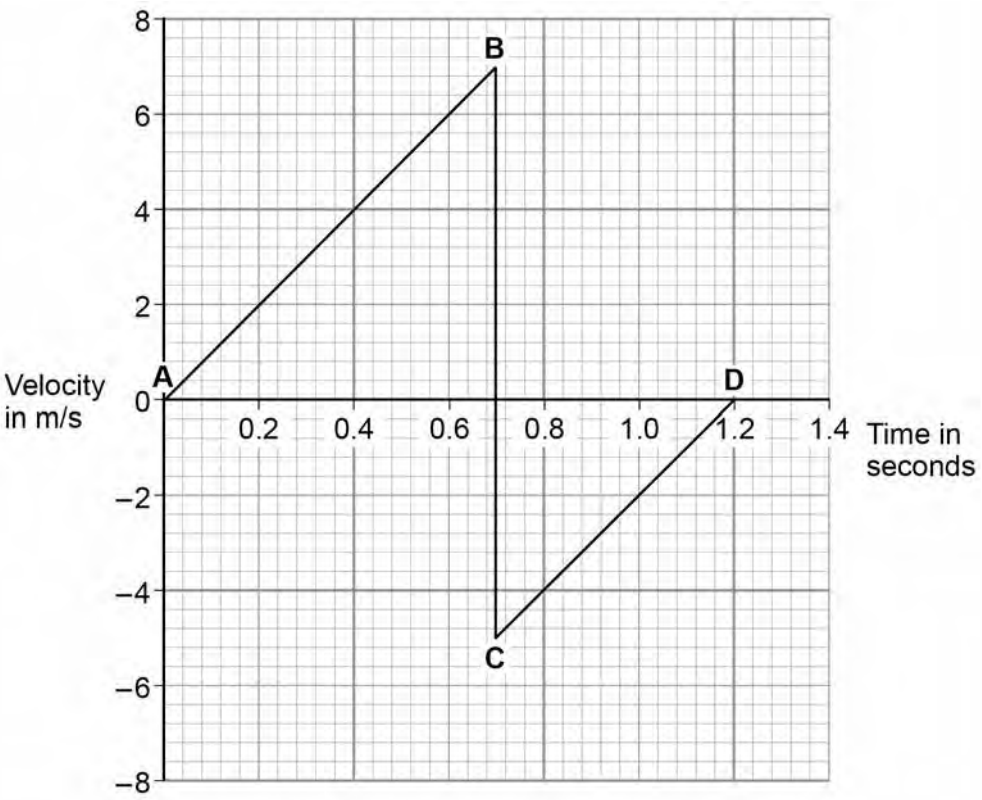
0 1 A child drops a ball.

The ball hits the ground and bounces.

Figure 1 shows the velocity-time graph for the ball from when the ball is dropped until when the ball reaches the top of its first bounce.

Air resistance has been ignored.

Figure 1



0 1 . 1 Describe the motion of the ball between points **A** and **B** on **Figure 1**.

[2 marks]

0 1 . 2 What direction is the ball moving between points **C** and **D** on **Figure 1**?

[1 mark]

4.5.6.1.5 Acceleration

Question 32 · continued

0 1 . 3 The ball and the Earth form a system.

What is meant by 'a system'?

Tick **one** box.

[1 mark]

A group of objects that interact. ☐

Objects with big differences in mass. ☐

Objects with gravitational potential energy. ☐

0 1 . 4 When the ball hits the ground, energy is transferred from the ball to the Earth.

Explain how the data in **Figure 1** shows this energy transfer.

[4 marks]

8

4.5.6.1.5 Acceleration

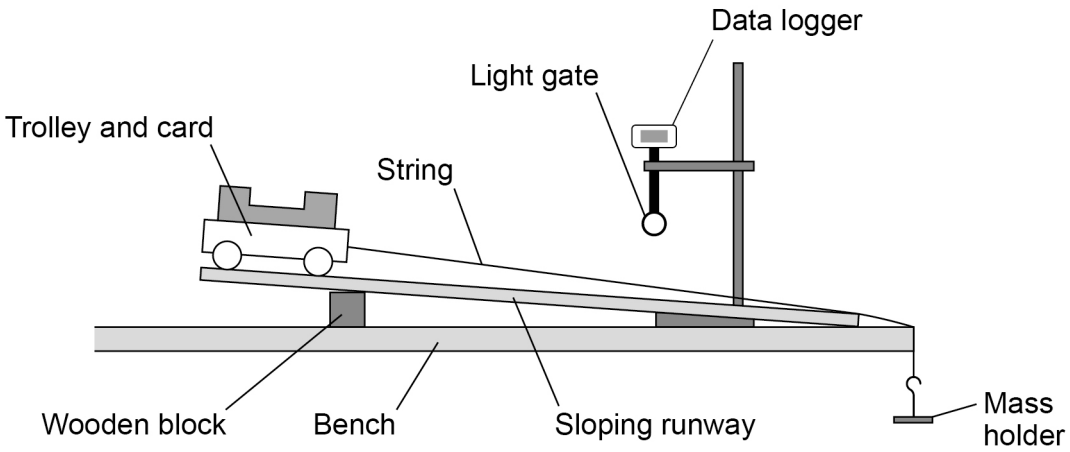
Question 33

November 2020 | 8463/2H | Original Q1

0 1 A student investigated the acceleration of a trolley.

Figure 1 shows how the student set up the apparatus.

Figure 1



0 1 . 1 Before attaching the mass holder the student placed the trolley at the top of the runway. The trolley rolled down the runway without being pushed.

What change to the apparatus in **Figure 1** could be made to prevent the trolley from starting to roll down the runway?

[1 mark]

Tick (✓) **one** box.

Move the wooden block to the left. ☐

Shorten the length of the runway. ☐

Use a taller wooden block. ☐

0 1 . 2 The student attached the mass holder to the string.

The string rubbed along the edge of the bench as the mass holder fell to the floor.

Suggest what the student could do to prevent the string from rubbing.

[1 mark]

Question 33 · continued

The light gate and data logger were used to determine the acceleration of the trolley.

The student increased the resultant force on the trolley and recorded the acceleration of the trolley.

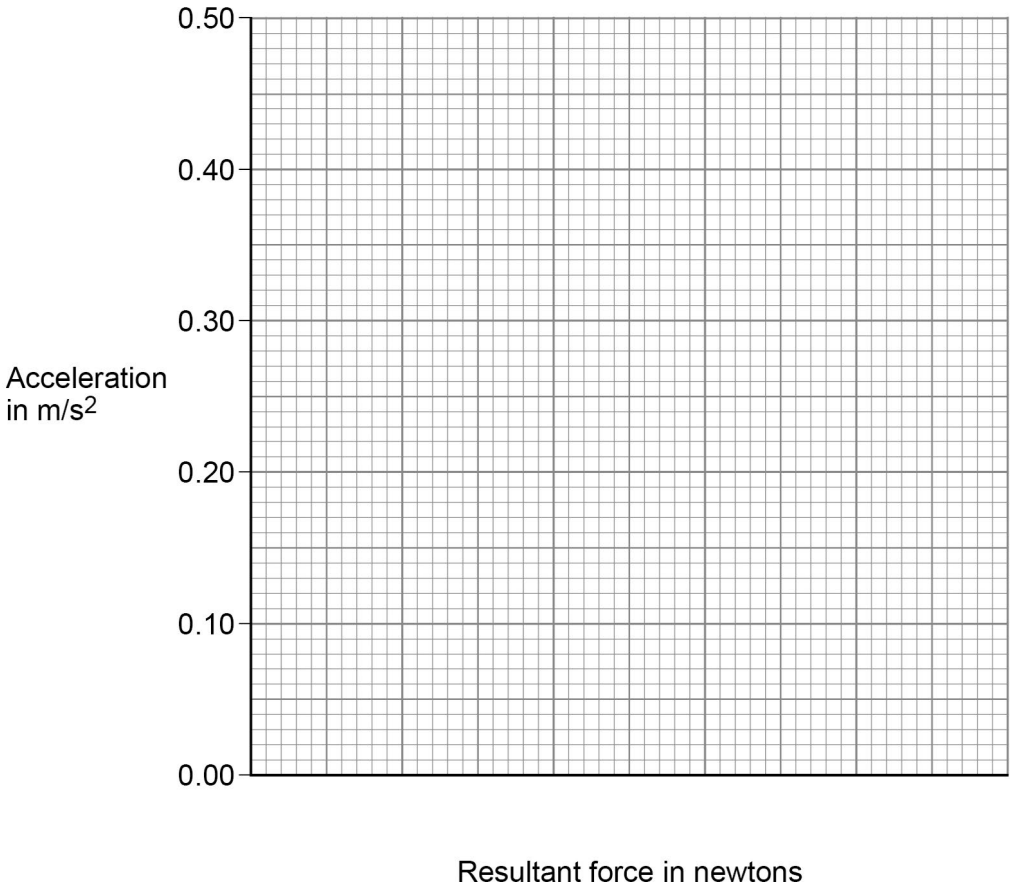
Table 1 shows the results.

Table 1

Resultant force in newtons	Acceleration in m/s^2
0.05	0.08
0.10	0.18
0.15	0.25
0.20	0.32
0.25	0.41

Figure 2 is an incomplete graph of the results.

Figure 2



0 1 . 3 Complete **Figure 2**.

- Choose a suitable scale for the x-axis.
- Plot the results.
- Draw a line of best fit.

[4 marks]

4.5.6.1.5 Acceleration

Question 33 · continued

0 1 . 4 Describe the relationship between the resultant force on the trolley and the acceleration of the trolley.

[1 mark]

0 1 . 5 Describe how the investigation could be improved to reduce the effect of random errors.

[2 marks]

0 1 . 6 Write down the equation that links acceleration (*a*), mass (*m*) and resultant force (*F*).

[1 mark]

0 1 . 7 The resultant force on the trolley was 0.375 N.

The mass of the trolley was 0.60 kg.

Calculate the acceleration of the trolley.

Give your answer to 2 significant figures.

[4 marks]

Acceleration (2 significant figures) = _____ m/s^2

14

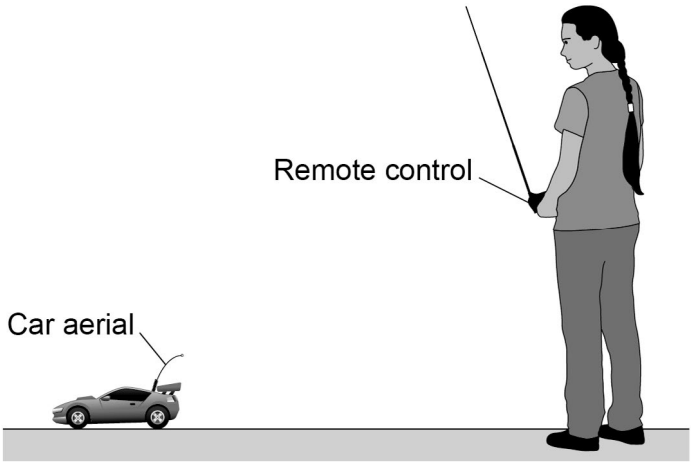
4.5.6.1.5 Acceleration

Question 34

November 2020 | 8463/2H | Original Q6

0 6 **Figure 8** shows a student playing with a remote-controlled car.

Figure 8



0 6 . 1 The remote control transmits radio waves to the car aerial.

The transmitted radio waves have a frequency of 320 MHz.

speed of radio waves = 3.0×10^8 m/s

Calculate the wavelength of the radio waves.

Give the unit.

[5 marks]

Wavelength = _____ Unit _____

4.5.6.1.5 Acceleration

Question 34 · continued

0 6 . 2 The car aerial is connected to an electrical circuit in the car.

Describe what happens in the electrical circuit when the car aerial absorbs radio waves.

[2 marks]

0 6 . 3 The car produces sound waves.

Give **two** ways in which radio waves are different to sound waves.

[2 marks]

1

2

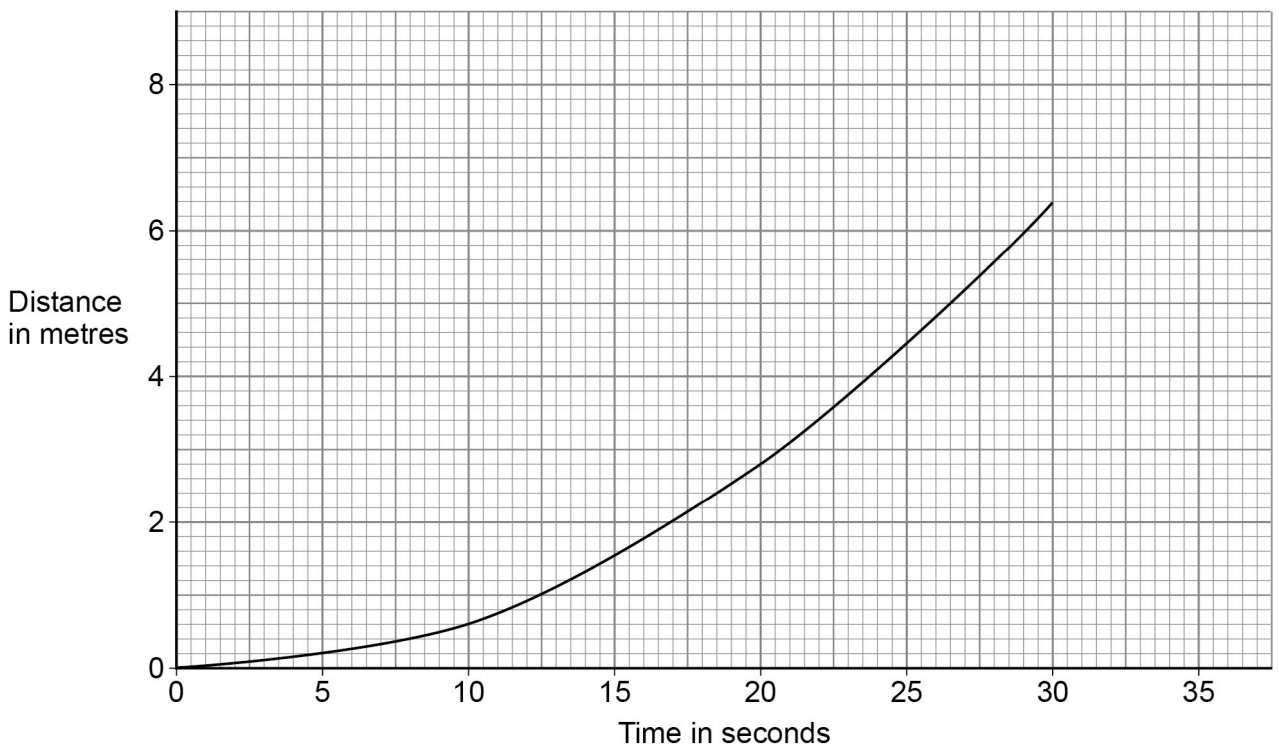
Question 6 continues on the next page

4.5.6.1.5 Acceleration

Question 34 · continued

Figure 9 shows the distance-time graph for the first 30 seconds of the car's motion.

Figure 9



0 6 . 4 Describe the motion of the car during the first 30 seconds.

[1 mark]

0 6 . 5 Determine the speed of the car 20 seconds after it started to move.

[4 marks]

Speed = _____ m/s

4.5.6.1.5 Acceleration

Question 34 · continued

0 6 . 6 A different car accelerated from 0.12 m/s to 0.52 m/s.

The acceleration of the car was 0.040 m/s^2.

The work done to accelerate the car was 0.48 J.

Calculate the resultant force needed to accelerate the car.

[6 marks]

Resultant force = _____ N

0 6 . 7 Explain why the car has a maximum speed.

[4 marks]

24

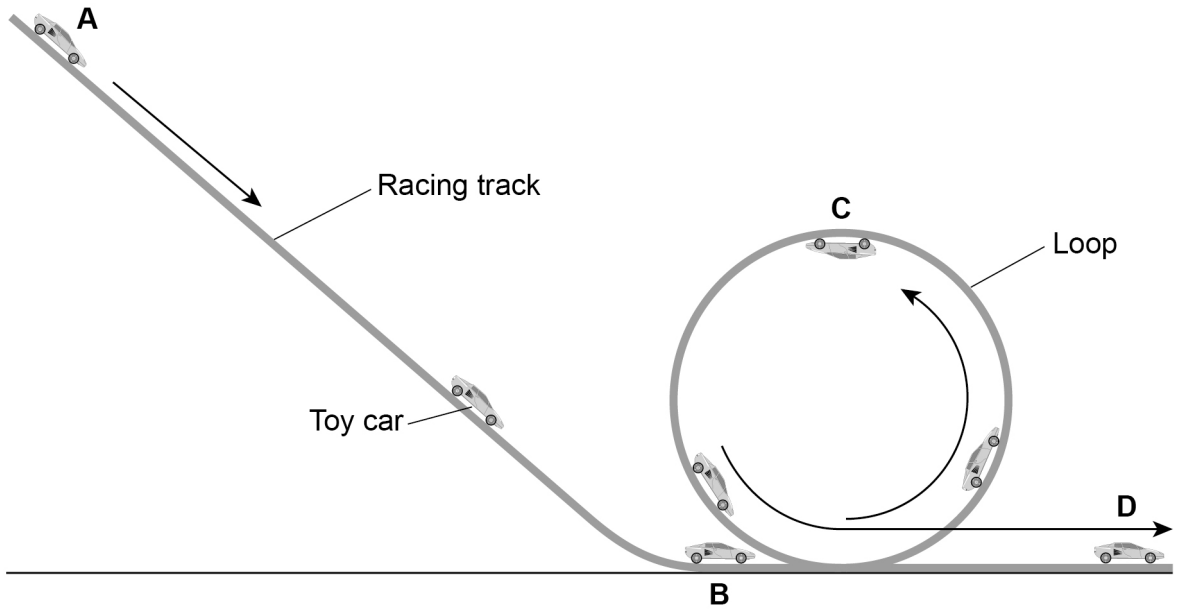
4.5.6.1.5 Acceleration

Question 35

November 2021 | 8463/1H | Original Q8

0 8 **Figure 11** shows a toy car in different positions on a racing track.

Figure 11



0 8 . 1 The toy car and racing track can be modelled as a closed system.

Why can the toy car and racing track be considered 'a closed system'?

[1 mark]

Tick (✓) **one** box.

The racing track and the car both have gravitational potential energy. ☐

The racing track and the car are always in contact with each other. ☐

The total energy of the racing track and the car is constant. ☐

4.5.6.1.5 Acceleration

Question 35 · continued

0 8 . 2 The car is released from rest at position **A** and accelerates due to gravity down the track to position **B**.

mass of toy car = 0.040 kg

vertical height between position **A** and position **B** = 90 cm

gravitational field strength = 9.8 N/kg

Calculate the maximum possible speed of the toy car when it reaches position **B**.

[5 marks]

Speed = _____ m/s

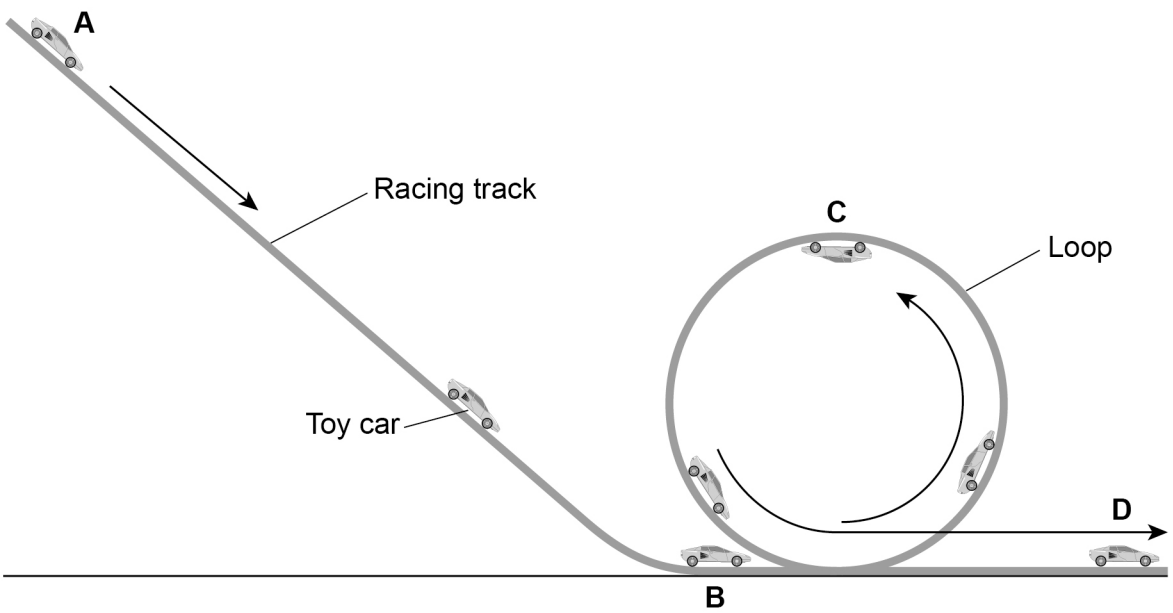
Question 8 continues on the next page

4.5.6.1.5 Acceleration

Question 35 · continued

Figure 11 is repeated below.

Figure 11



0 8 . 3 At position **C** the car's gravitational potential energy is 0.20 J greater than at position **B**.

How much kinetic energy does the car need at position **B** to complete the loop of the track?

Give a reason for your answer.

[2 marks]

Tick (✓) **one** box.

Less than 0.20 J ☐

Exactly 0.20 J ☐

More than 0.20 J ☐

Reason _____

_____

_____

8

4.5.6.1.5 Acceleration

Question 36

November 2021 | 8463/2H | Original Q1

0 1 The thinking distance and braking distance for a car vary with the speed of the car.

0 1 . 1 Explain the effect of **two** other factors on the **braking** distance of a car.

Do **not** refer to speed in your answer.

[4 marks]

Question 1 continues on the next page

4.5.6.1.5 Acceleration

Question 36 · continued

0 1 . 2 Which equation links acceleration (a), mass (m) and resultant force (F).

[1 mark]

Tick (✓) **one** box.

resultant force = mass × acceleration ☐

resultant force = mass × acceleration^2 ☐

resultant force = $\frac{\text{mass}}{\text{acceleration}^2}$ ☐

resultant force = $\frac{\text{mass}}{\text{acceleration}}$ ☐

0 1 . 3 The mean braking force on a car is 7200 N.

The car has a mass of 1600 kg.

Calculate the deceleration of the car.

[3 marks]

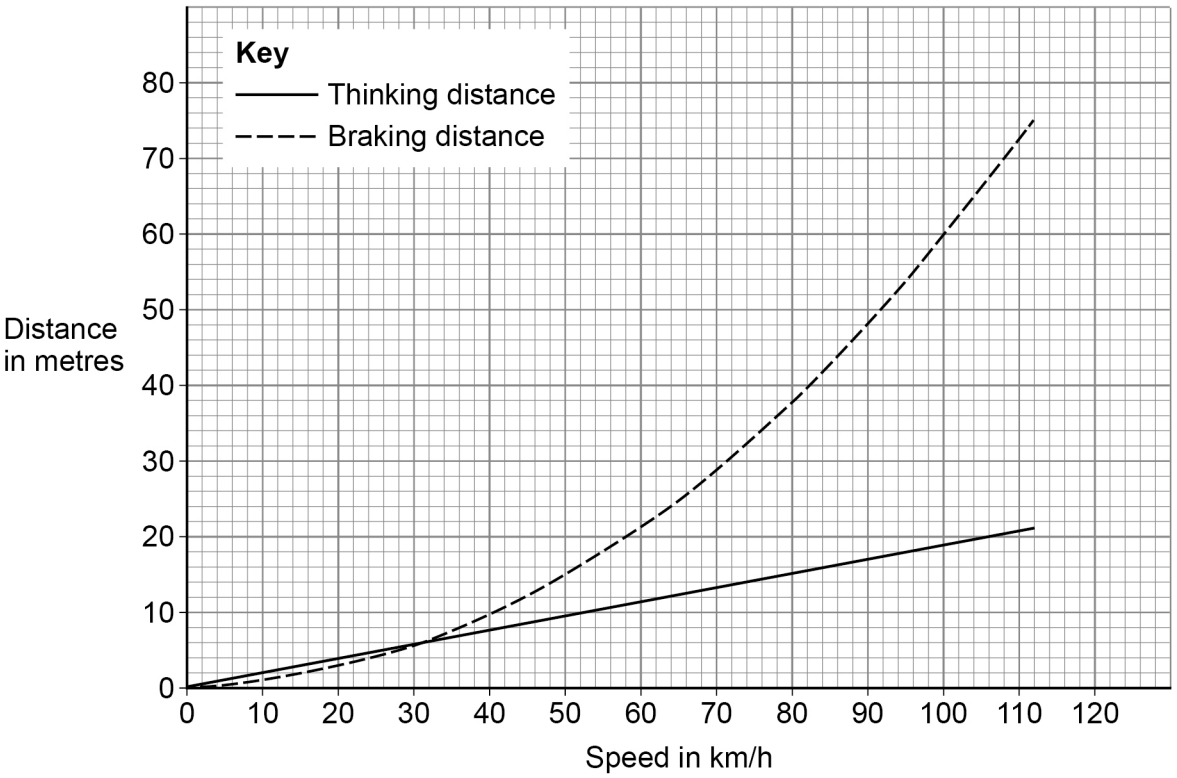
Deceleration = _____ m/s^2

4.5.6.1.5 Acceleration

Question 36 · continued

0 1 . 4 **Figure 1** shows how the thinking distance and braking distance for a car vary with the speed of the car.

Figure 1



Determine the stopping distance when the car is travelling at 80 km/h.

[2 marks]

Stopping distance = _____ m

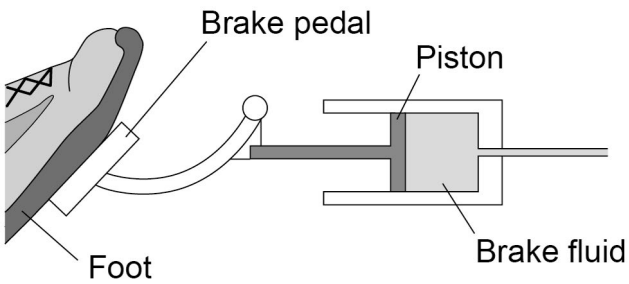
Question 1 continues on the next page

4.5.6.1.5 Acceleration

Question 36 · continued

Figure 2 shows part of the braking system for a car.

Figure 2



0 1 . 5 Which equation links area of a surface (A), the force normal to that surface (F) and pressure (p).

[1 mark]

Tick (✓) **one** box.

$p = F \times A$ ☐

$p = F \times A^2$ ☐

$p = \frac{F}{A}$ ☐

$p = \frac{A}{F}$ ☐

4.5.6.1.5 Acceleration

Question 36 · continued

0 1 . 6 When the brake pedal is pressed, a force of 60 N is applied to the piston.

The pressure in the brake fluid is 120 000 Pa.

Calculate the surface area of the piston.

Give your answer in standard form.

Give the unit.

[5 marks]

Surface area (in standard form) = _____ Unit _____

16

4.5.6.1.5 Acceleration

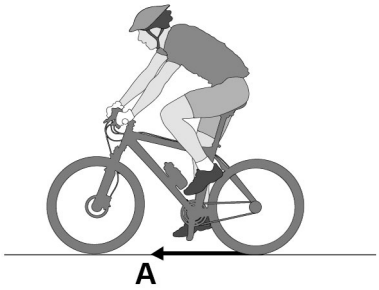
Question 37

November 2021 | 8463/2H | Original Q7

0 7 **Figure 11** shows a cyclist riding a bicycle.

Force **A** causes the bicycle to accelerate forwards.

Figure 11

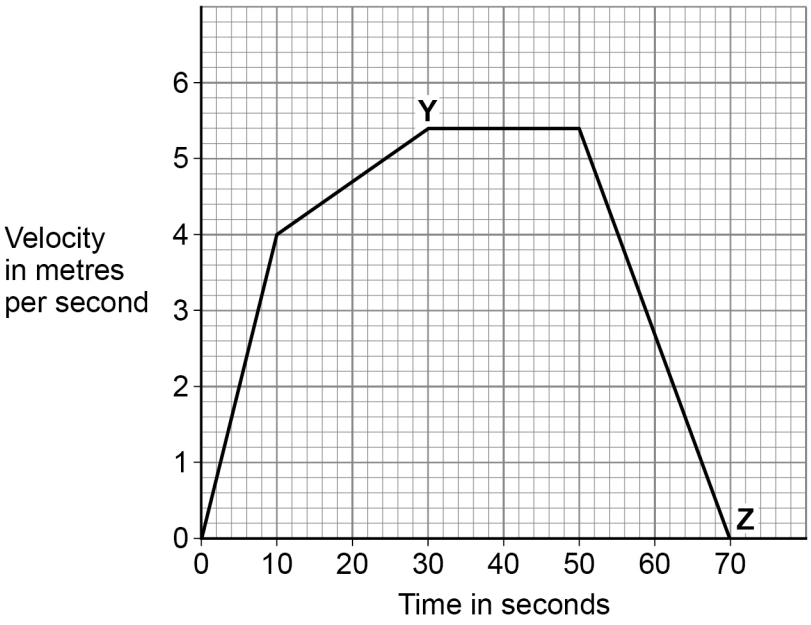


0 7 . 1 What name is given to force **A**?

[1 mark]

Figure 12 shows how the velocity of the cyclist changes during a short journey.

Figure 12



4.5.6.1.5 Acceleration

Question 37 · continued

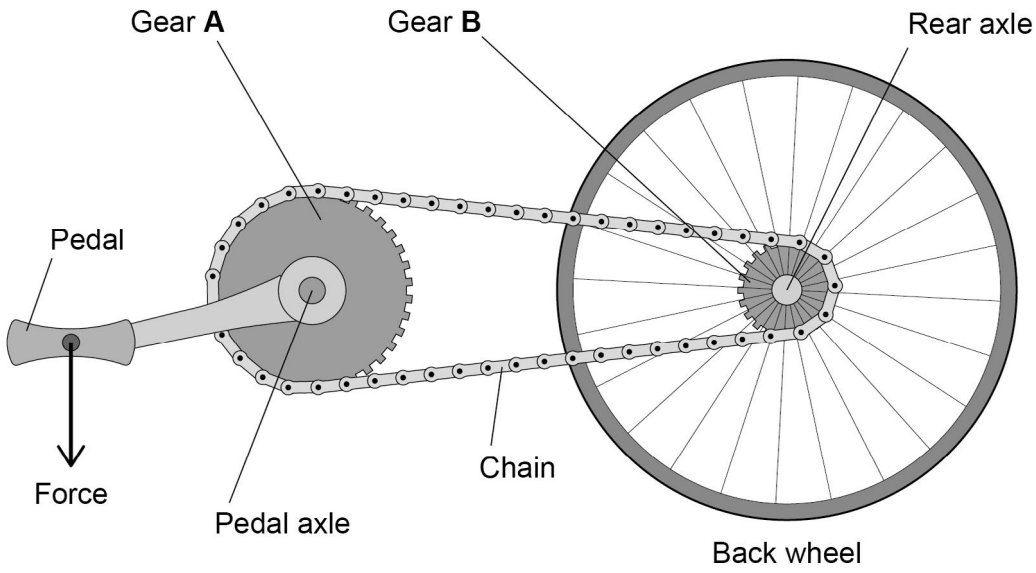
0 7 . 2 Determine the distance travelled by the cyclist between **Y** and **Z**.

[3 marks]

Distance travelled by the cyclist between **Y** and **Z** = _____ m

0 7 . 3 **Figure 13** shows the gears on the bicycle.

Figure 13



Describe how the force on the pedal causes a moment about the rear axle.

[2 marks]

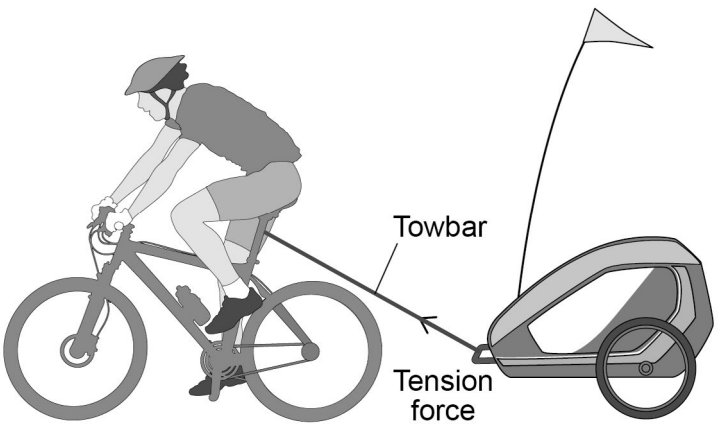
Question 7 continues on the next page

4.5.6.1.5 Acceleration

Question 37 · continued

Figure 14 shows a different cyclist towing a trailer.

Figure 14



0 7 . 4 The speed of the cyclist and trailer increased uniformly from 0 m/s to 2.4 m/s.

The cyclist travelled 0.018 km while accelerating.

Calculate the initial acceleration of the cyclist.

[3 marks]

Acceleration = _____ m/s^2

4.5.6.1.5 Acceleration

Question 37 · continued

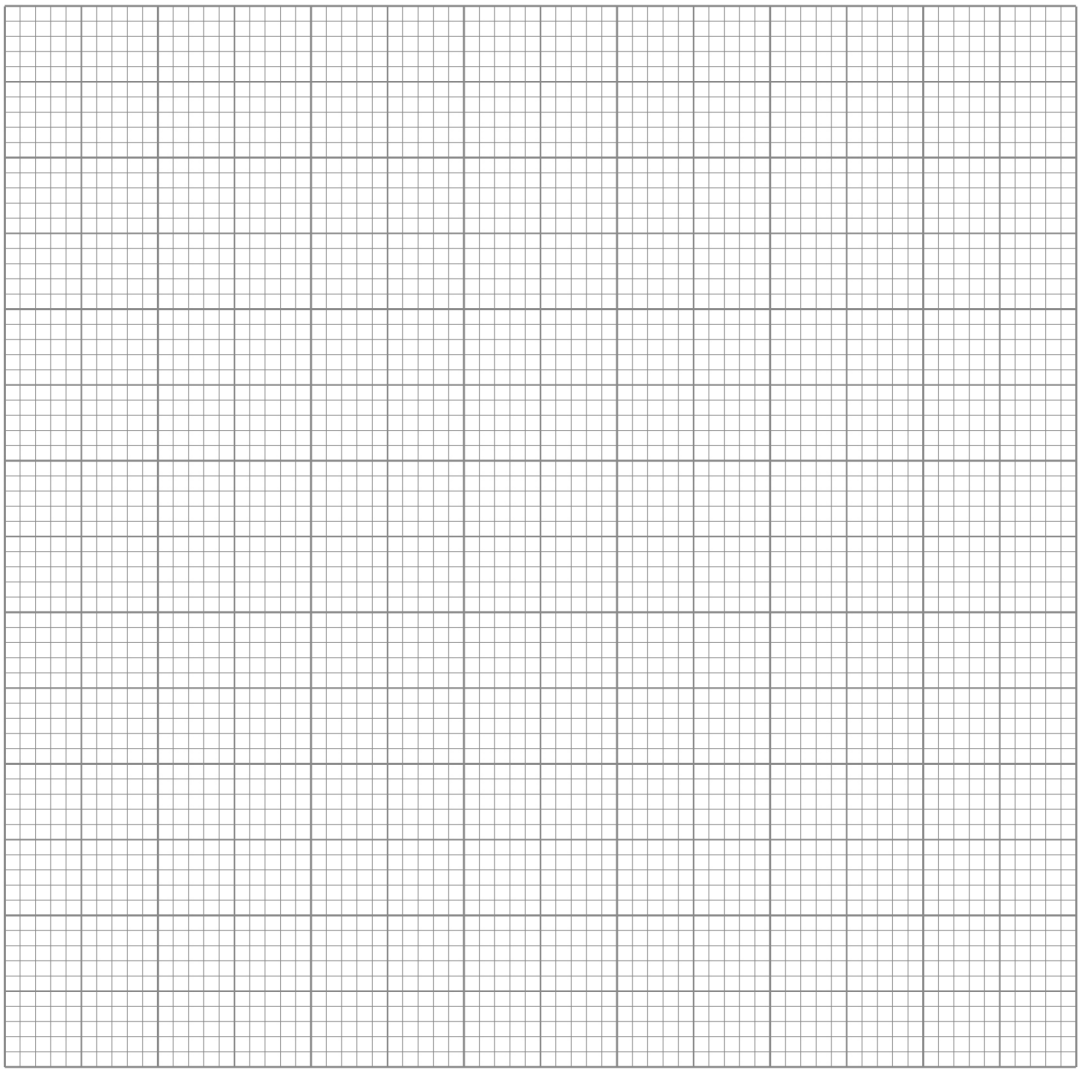
0 7 . 5 The resultant force of the towbar on the trailer has a horizontal component and a vertical component.

horizontal force = 200 N

vertical force = 75 N

Determine the magnitude and direction of the resultant force of the towbar on the trailer by drawing a vector diagram.

[4 marks]



Magnitude of force = _____ N

Direction of force = _____ degrees

13

4.5.6.1.5 Acceleration

Question 38

November 2021 | 8463/2H | Original Q9

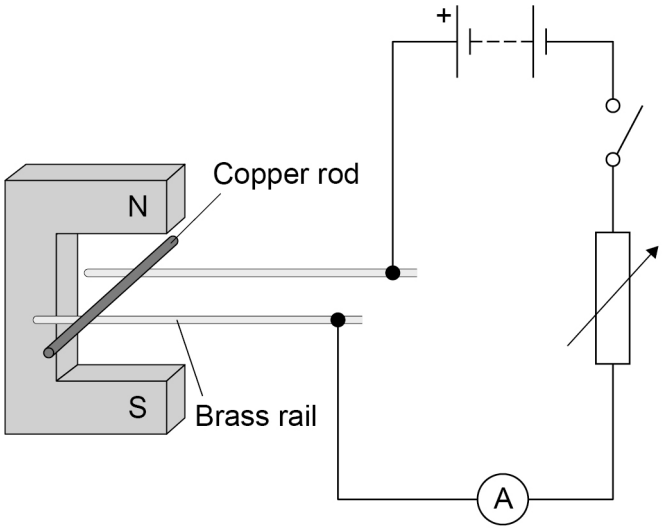
0 9 A teacher demonstrated how a magnetic field can cause a copper rod to accelerate.

The teacher placed the copper rod on two brass rails in a magnetic field.

The copper rod was able to move.

Figure 16 shows the equipment used.

Figure 16



4.5.6.1.5 Acceleration

Question 38 · continued

0 9 . 1 The teacher closes the switch and the copper rod accelerates.

Explain how Fleming's left hand rule can be used to predict the direction in which the copper rod will move.

[5 marks]

0 9 . 2 Suggest **two** changes to the equipment that would increase the force on the copper rod.

[2 marks]

1

2

Question 9 continues on the next page

4.5.6.1.5 Acceleration

Question 38 · continued

0 9 . 3 The teacher closed the switch and the copper rod accelerated uniformly from rest for 0.15 s.

The current in the copper rod was 1.7 A.

mass of copper rod = 4.0 g

length of copper rod in the magnetic field = 0.050 m

magnetic flux density = 0.30 T

Calculate the maximum possible velocity of the copper rod when it left the magnetic field.

[6 marks]

Maximum velocity = _____ m/s

13

4.5.6.1.5 Acceleration

Question 39

0 1 **Figure 1** shows an electric super-car.

Figure 1



0 1 . 1 The battery in an electric car needs to be recharged.

Suggest **two** factors that affect the distance an electric car can travel before the battery needs to be recharged.

[2 marks]

1 _____

2 _____

4.5.6.1.5 Acceleration

Question 39 · continued

Use the Physics Equations Sheet to answer questions **01.2** and **01.3**.

0 1 . 2 Write down the equation which links acceleration (a), change in velocity (Δv) and time taken (t).

[1 mark]

0 1 . 3 The maximum acceleration of the car is 20 m/s^2.

Calculate the time taken for the speed of the car to change from 0 m/s to 28 m/s at its maximum acceleration.

[3 marks]

Time taken = _____ s

Question 1 continues on the next page

4.5.6.1.5 Acceleration

Question 39 · continued

0 1 . 4 In a trial run, the car accelerates at 10 m/s^2 until it reaches its final velocity.

distance travelled by the car = 605 m

initial velocity of the car = 0 m/s

Calculate the final velocity of the car.

Use the Physics Equations Sheet.

[3 marks]

Final velocity = _____ m/s

4.5.6.1.5 Acceleration

Question 39 · continued

Use the Physics Equations Sheet to answer questions **01.5** and **01.6**.

0 1 . 5 Write down the equation which links distance (*s*), force (*F*) and work done (*W*).

[1 mark]

0 1 . 6 When travelling at its maximum speed the air resistance acting on the car is 4000 N.

Calculate the work done against air resistance when the car travels a distance of 7.5 km at its maximum speed.

[3 marks]

Work done = _____ J

13

4.5.6.1.5 Acceleration

Question 40

June 2022 | 8463/2HR | Original Q4

0 4 Hailstones are small balls of ice. Hailstones form in clouds and fall to the ground.

Figure 7 shows different-sized hailstones.

Figure 7



A hailstone falls from a cloud and accelerates.

0 4 . 1 Why does the hailstone accelerate?

[1 mark]

0 4 . 2 The hailstone stops accelerating and reaches terminal velocity.

Explain why the hailstone reaches terminal velocity.

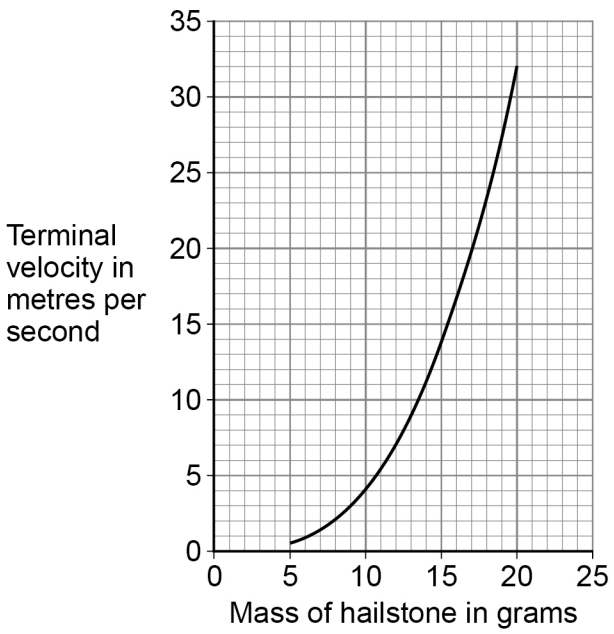
[3 marks]

Question 40 · continued

A scientist investigated how the mass of hailstones affects their terminal velocity.

Figure 8 shows the results.

Figure 8



0 4 . 3 Why does terminal velocity increase with mass?

[1 mark]

Tick (✓) **one** box.

As mass increases the cross-sectional surface area of a hailstone increases. ☐

As mass increases the volume of a hailstone increases. ☐

As mass increases the weight of a hailstone increases. ☐

4.5.6.1.5 Acceleration

Question 40 · continued

0 4 . 4 Explain the difference in the maximum kinetic energy of a hailstone with a mass of 10 g and a hailstone with a mass of 20 g.

[3 marks]

0 4 . 5 The kinetic energy of a hailstone is measured in joules.

Which of the following is the same as 1 joule?

[1 mark]

Tick (✓) **one** box.

1 N m ☐

1 N/m ☐

1 N/m^2 ☐

1 N m^2 ☐

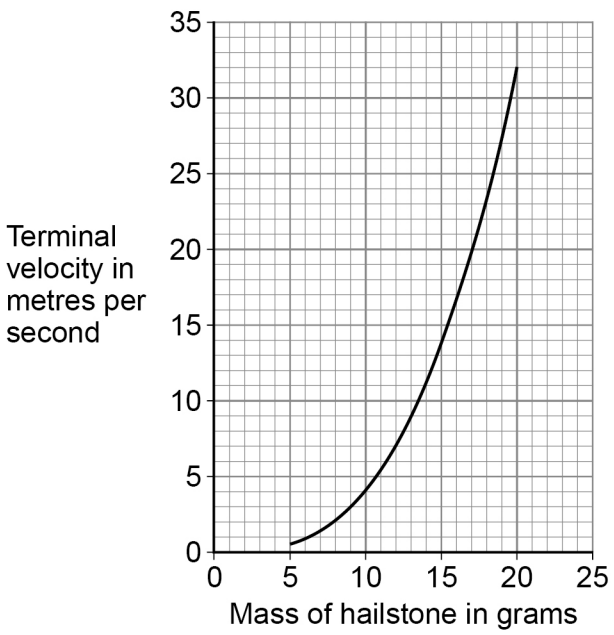
Question 4 continues on the next page

4.5.6.1.5 Acceleration

Question 40 · continued

Figure 8 is repeated below.

Figure 8



0 4 . 6 A hailstone hit the ground at its terminal velocity of 25 m/s.

The hailstone took 0.060 s to stop moving.

Determine the average force on the hailstone as it hit the ground.

Use information from **Figure 8**.

Use the Physics Equations Sheet.

[3 marks]

Average force = _____ N

12

4.5.6.1.5 Acceleration

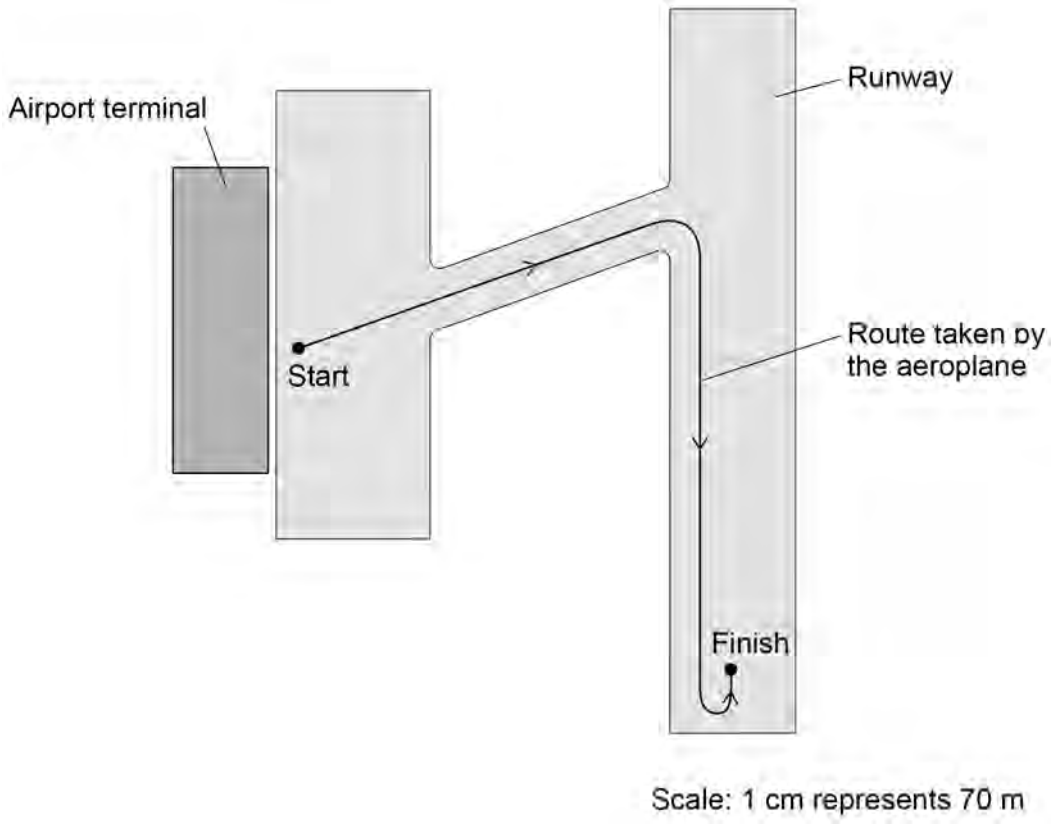
Question 41

June 2023 | 8463/2H | Original Q2

0 2 **Figure 3** shows the route an aeroplane takes as it travels from an airport terminal to the runway.

Figure 3 has been drawn to scale.

Figure 3



0 2 . 1 Determine the magnitude of the aeroplane's displacement from the start point to the finish point on **Figure 3**.

[2 marks]

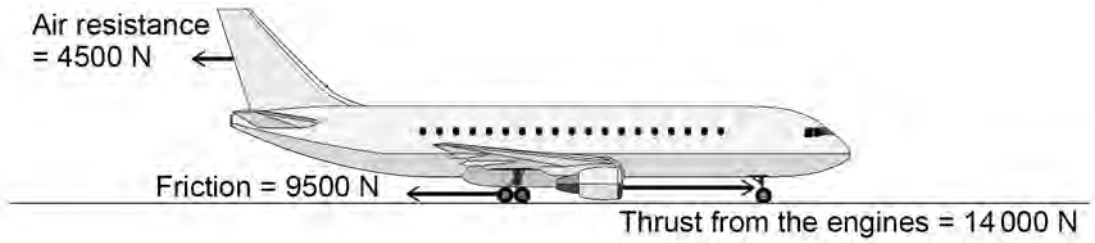
Displacement = _____ m

4.5.6.1.5 Acceleration

Question 41 · continued

Figure 4 shows the direction of the horizontal forces acting on the aeroplane as it moves in a straight line towards the runway.

Figure 4



0 2 . 2 Determine the magnitude of the resultant horizontal force on the aeroplane.

[1 mark]

Resultant horizontal force = _____ N

0 2 . 3 Describe the motion of the aeroplane as it moves towards the runway.

[1 mark]

0 2 . 4 Air resistance and friction are contact forces.

Give **one** other example of a contact force.

[1 mark]

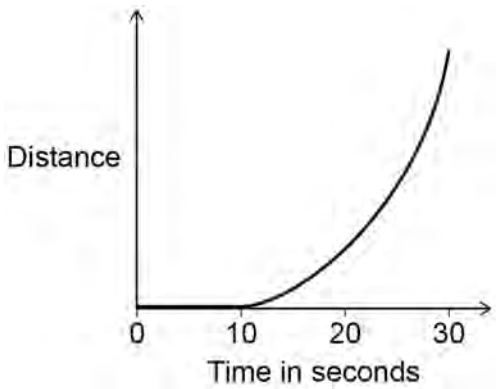
4.5.6.1.5 Acceleration

Question 41 · continued

0 2 . 5 The aeroplane stops for a short time and then accelerates along the runway.

Figure 5 shows a distance–time sketch-graph for this stage of the journey.

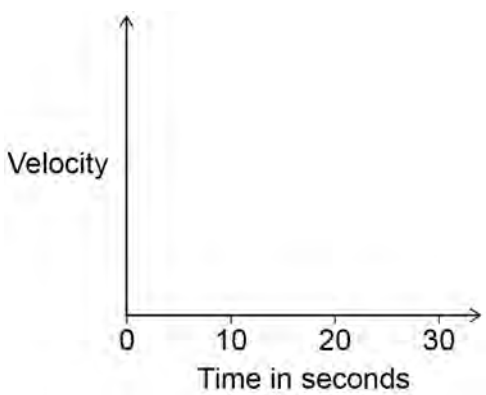
Figure 5



Draw the velocity–time sketch-graph for this stage of the journey on **Figure 6**.

[2 marks]

Figure 6



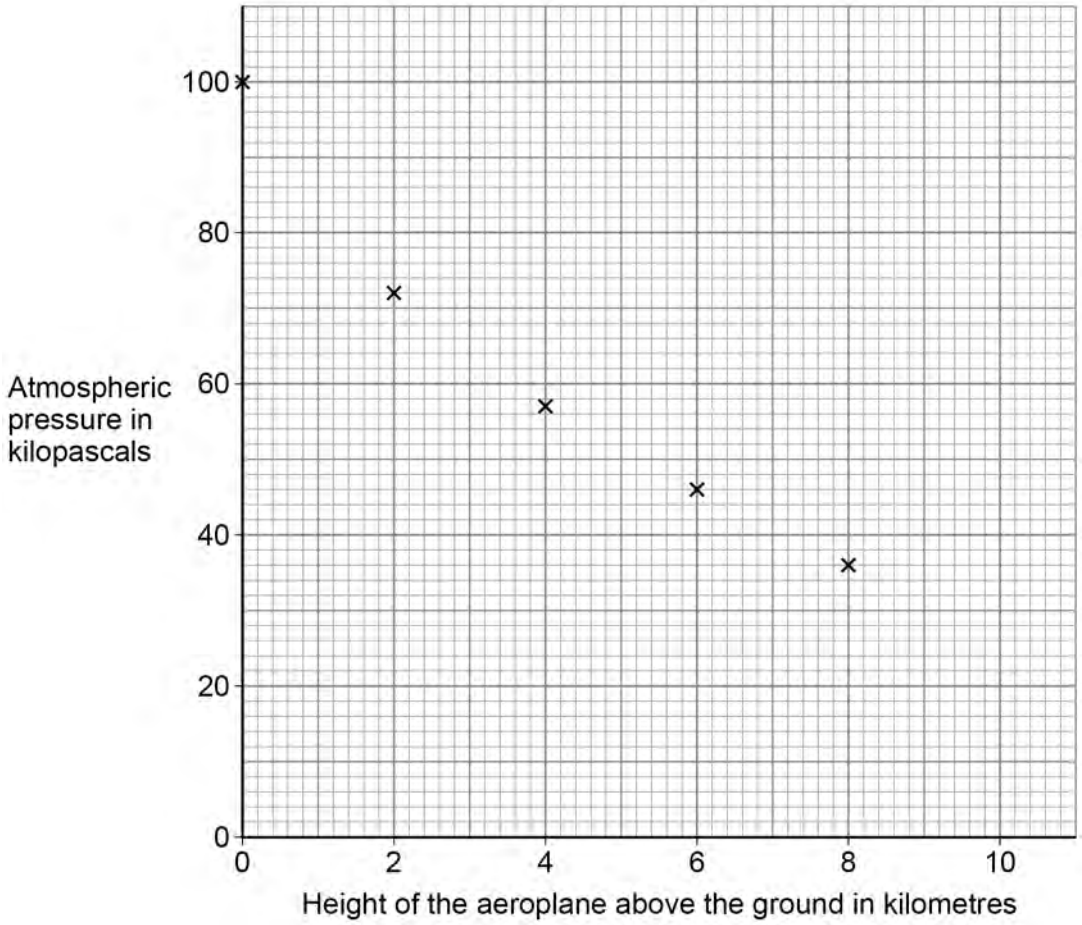
4.5.6.1.5 Acceleration

Question 41 · continued

0 2 . 6 The aeroplane takes off from the runway, so its height above the ground increases.

Figure 7 shows how atmospheric pressure varies with the height of the aeroplane above the ground.

Figure 7



Estimate the atmospheric pressure when the height of the aeroplane above the ground is 10 km.

[2 marks]

Atmospheric pressure = _____ kPa

Question 2 continues on the next page

4.5.6.1.5 Acceleration

Question 41 · continued

0 2 . 7 What happens to the air surrounding the aeroplane as the height of the aeroplane above the ground increases?

[1 mark]

Tick (✓) **one** box.

The average density of the air above the aeroplane decreases. ☐

The mass of air above the aeroplane increases. ☐

The temperature of the air increases. ☐

The volume of air below the aeroplane decreases. ☐

10

4.5.6.1.5 Acceleration

Question 42

June 2023 | 8463/2H | Original Q5

0 5 **Figure 14** shows some bumper cars.

Bumper cars are designed to withstand collisions at low speeds.

Figure 14



0 5 . 1 During a collision between a bumper car and the barrier, the bumper car and barrier act as a closed system.

What is meant by a 'closed system'?

[1 mark]

4.5.6.1.5 Acceleration

Question 42 · continued

0 5 . 2 How does Newton's Third Law of motion apply to the collision between the bumper car and the barrier?

[1 mark]

0 5 . 3 During the collision, the change in momentum of the bumper car is 700 kg m/s.

The time taken for the collision is 0.28 s.

Calculate the force on the bumper car during the collision.

Use the Physics Equations Sheet.

[2 marks]

Force = _____ N

Question 5 continues on the next page

4.5.6.1.5 Acceleration

Question 42 · continued

0 5 . 4 The bumper car has a flexible bumper.

Explain how the flexible bumper reduces the risk of injury to the people in the bumper car during the collision.

[3 marks]

0 5 . 5 A bumper car moved with an initial constant velocity and then accelerated at 2.0 m/s^2.

While accelerating, the bumper car travelled a distance of 1.5 m.

The final velocity of the bumper car was 2.5 m/s.

Calculate the initial constant velocity of the bumper car.

Use the Physics Equations Sheet.

[3 marks]

Initial constant velocity = _____ m/s

10

4.5.6.1.5 Acceleration

Question 43

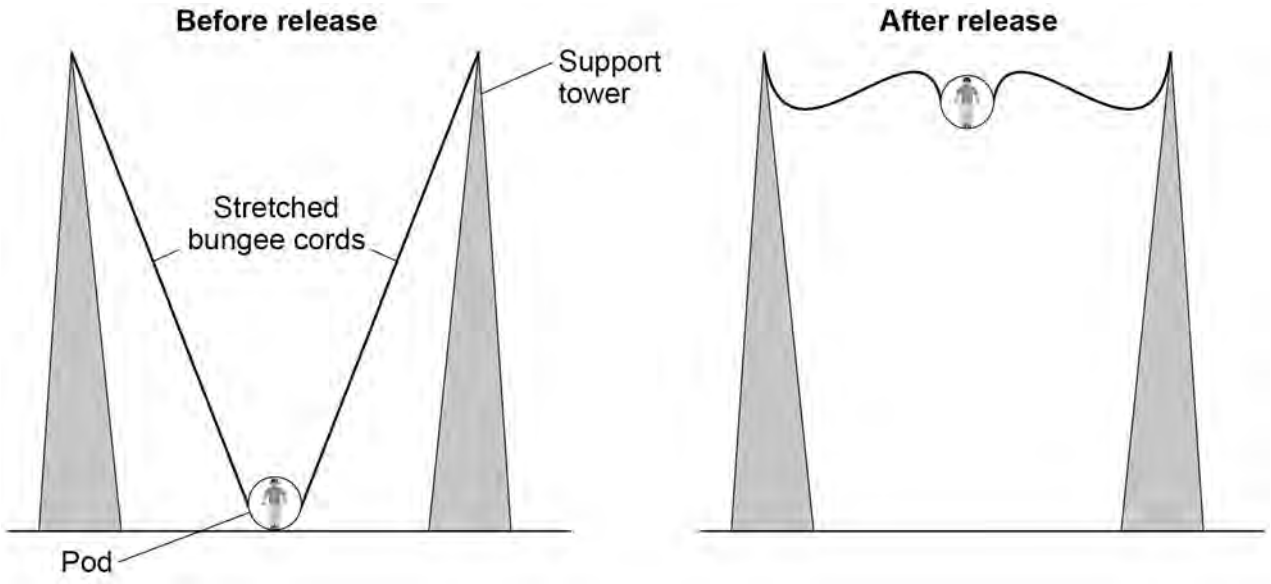
June 2024 | 8463/1H | Original Q6

0 6 In a ride at a theme park, a person is strapped into a pod that is attached to two stretched bungee cords.

The bungee cords behave like springs.

Figure 10 shows a person using the ride.

Figure 10



0 6 . 1 Which energy store increases as the bungee cords are stretched?

[1 mark]

4.5.6.1.5 Acceleration

Question 43 · continued

0 6 . 2 When the pod is released, the pod accelerates upwards.

Before the pod is released the extension of **each** of the two bungee cords is 8.0 m.

The spring constant of each bungee cord is 735 N/m.

The mass of the pod is 240 kg.

gravitational field strength = 9.8 N/kg

Calculate the maximum height reached by the pod.

Use the Physics Equations Sheet.

[6 marks]

Maximum height = _____ m

0 6 . 3 The actual maximum height reached by the pod will be lower than the correct answer to Question **06.2**

Explain why.

[2 marks]

9

4.5.6.1.5 Acceleration

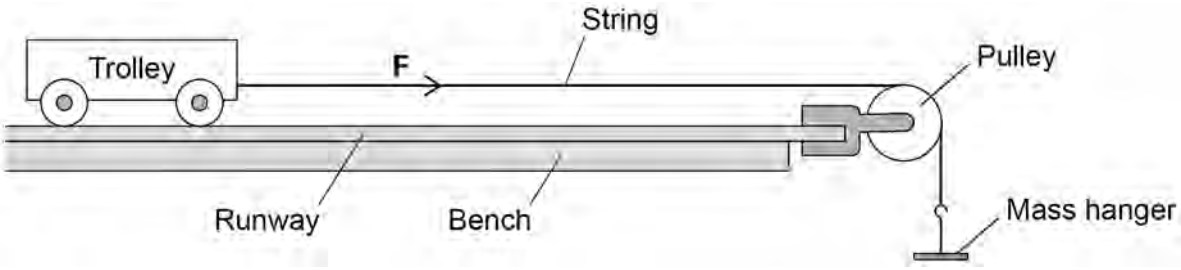
Question 44

June 2024 | 8463/2H | Original Q5

0 5 A student investigated how the acceleration of a trolley varies with the resultant force on the trolley.

Figure 10 shows some of the equipment used.

Figure 10



0 5 . 1 **Figure 10** shows the force **F** which acts through the string.

What name is given to force **F**?

[1 mark]

0 5 . 2 Give **one** variable that should have been a control variable in this investigation.

[1 mark]

Question 5 continues on the next page

4.5.6.1.5 Acceleration

Question 44 · continued

0 5 . 3 The student held the trolley stationary and then released it.

The trolley moved along the runway with a constant acceleration.

The student recorded the time taken for the trolley to travel a measured distance along the runway.

Describe how the acceleration of the trolley can be calculated using the time taken and distance travelled by the trolley.

[3 marks]

For one set of results, the force acting through the string was 2.0 N.

0 5 . 4 The student released the trolley three times and determined the following values for acceleration:

1.36 m/s^2 1.39 m/s^2 1.33 m/s^2

Calculate the uncertainty in the values of acceleration.

[2 marks]

Uncertainty = ± _____ m/s^2

4.5.6.1.5 Acceleration

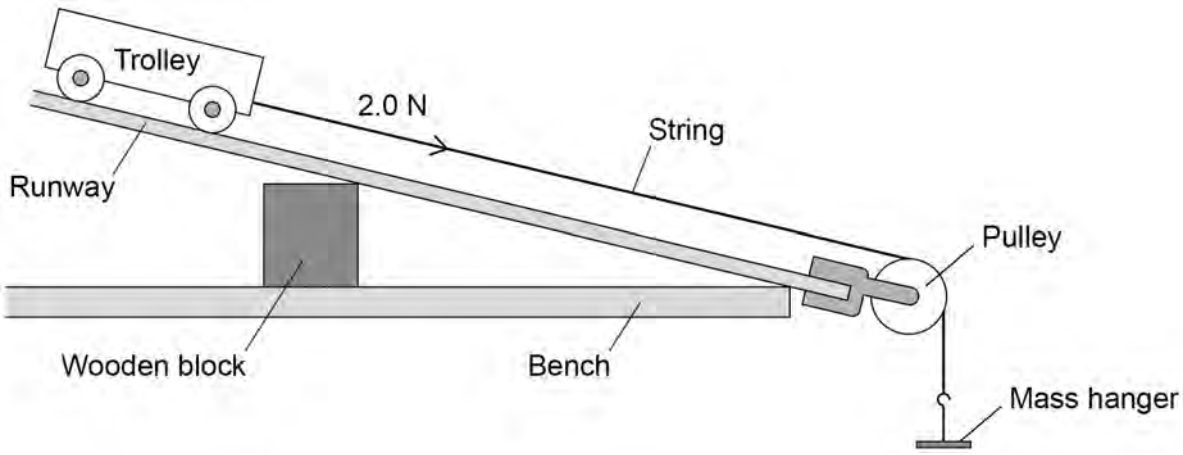
Question 44 · continued

0 5 . 5 The runway was then raised at one end.

The force acting through the string remained the same.

Figure 11 shows this.

Figure 11



Explain how the acceleration was affected by raising the end of the runway.

[2 marks]

9

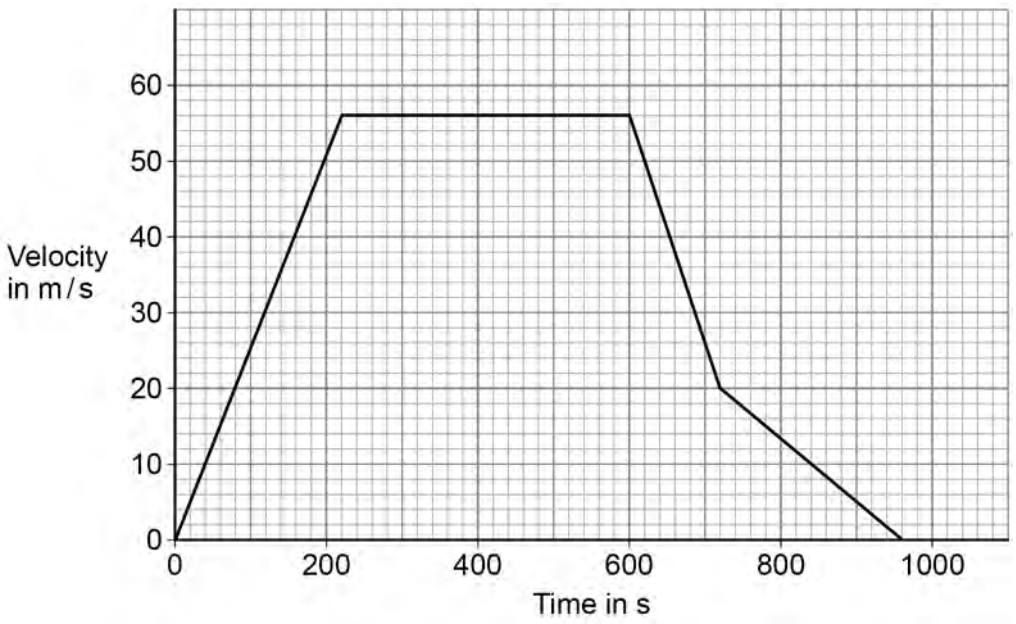
4.5.6.1.5 Acceleration

Question 45

June 2024 | 8463/2H | Original Q7

0 7 **Figure 12** shows a velocity–time graph for a train travelling between two stations.

Figure 12



0 7 . 1 Determine the distance travelled by the train in the first 600 s of the journey.

[3 marks]

Distance = _____ m

4.5.6.1.5 Acceleration

Question 45 · continued

0 7 . 2 Explain what happens to the braking force as the train decelerates.

Use information from **Figure 12**.

[3 marks]

0 7 . 3 Determine the maximum deceleration of the train.

[3 marks]

Deceleration = _____ m/s^2

Question 7 continues on the next page

4.5.6.1.5 Acceleration

Question 45 · continued

0 7 . 4 Another train travels at a speed of 60 m/s.

A constant braking force of 270 000 N causes the train to decelerate and stop.

mass of train = 240 000 kg

Calculate the distance travelled while the braking force is applied.

Use the Physics Equations Sheet.

[6 marks]

Distance travelled = _____ m

4.5.6.1.5 Acceleration

Question 45 · continued

0 7 . 5 It is illegal for train drivers to drink alcohol before driving a train.

Explain how drinking alcohol would affect the stopping distance of a train.

[3 marks]

18

Turn over for the next question

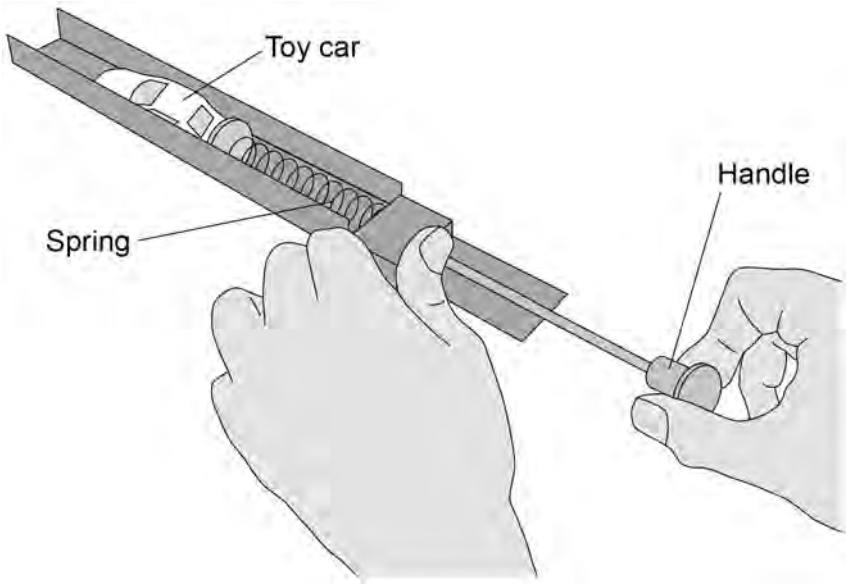
4.5.6.1.5 Acceleration

Question 46

June 2025 | 8463/1H | Original Q10

1 0 **Figure 12** shows a device that accelerates a toy car at the start of a race track.

Figure 12



4.5.6.1.5 Acceleration

Question 46 · continued

1 0 . 1 Pulling the handle compresses the spring in the device by 0.075 m.

When the handle is released, the energy stored in the compressed spring is transferred to the toy car.

spring constant = 64 N/m

mass of toy car = 0.052 kg

Calculate the maximum possible speed of the toy car just after the car starts to move.

Use the Physics Equations Sheet.

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

[6 marks]

Maximum possible speed (2 significant figures) = _____ m/s

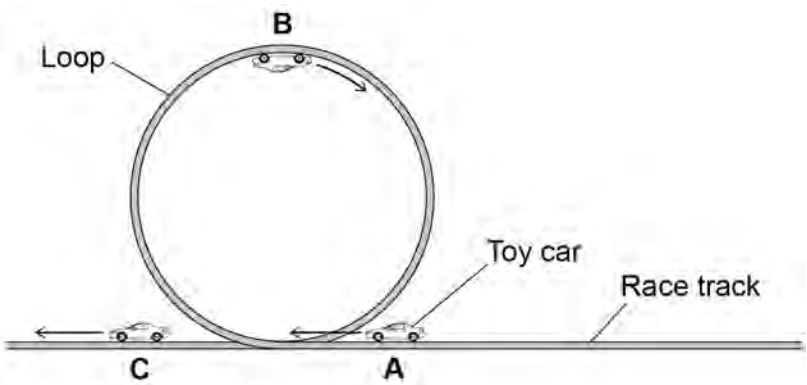
Question 10 continues on the next page

4.5.6.1.5 Acceleration

Question 46 · continued

1 0 . 2 **Figure 13** shows the path of the toy car along a loop section of the race track.

Figure 13



The car moves along the track from position **A** to position **B** and then to position **C**.

Describe how the energy stores of the car change as the car moves along the track from position **A** to position **C**.

Ignore the effects of friction and air resistance.

[3 marks]

4.5.6.1.5 Acceleration

Question 46 · continued

June 2025 | 8463/1H | Original Q10

10.3 At the end of the race track, the toy car passes through a light gate that measures the speed of the car.

Which **two** measurements are needed to determine the speed of the car?

[2 marks]

Tick (✓) **two** boxes.

- Length of the toy car ☐
- Mass of the toy car ☐
- Temperature of the room ☐
- Time for the toy car to pass the light gate ☐
- Total length of the race track ☐

11

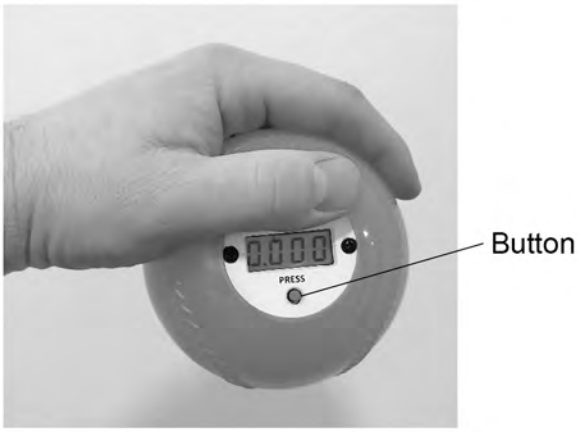
4.5.6.1.5 Acceleration

Question 47

0 3 A student investigated the acceleration of a ball dropped from different heights.

Figure 3 shows a 'gravity ball' that the student used.

Figure 3



The button on the gravity ball starts the stopwatch.

When the gravity ball hits the floor, the stopwatch stops.

This is the method used.

1. Measure a vertical height above the floor.
2. Hold the gravity ball at the measured height.
3. Start the stopwatch on the gravity ball and drop the gravity ball.
4. Record the time shown on the stopwatch.
5. Repeat steps 1 to 4 using the same height.
6. Repeat steps 1 to 5 using different heights.

4.5.6.1.5 Acceleration

Question 47 · continued

0 3 . 1 The student dropped the ball from the same height five times and recorded the following results.

0.49 s 0.51 s 0.58 s 0.56 s 0.61 s

Calculate the uncertainty in these measurements of time.

[2 marks]

Uncertainty = ± _____ s

0 3 . 2 What type of error caused the variation in the measurements of time?

[1 mark]

Tick (✓) **one** box.

- Random error ☐
- Systematic error ☐
- Zero error ☐

0 3 . 3 Suggest **one** reason for the error that caused the variation in the measurements of time.

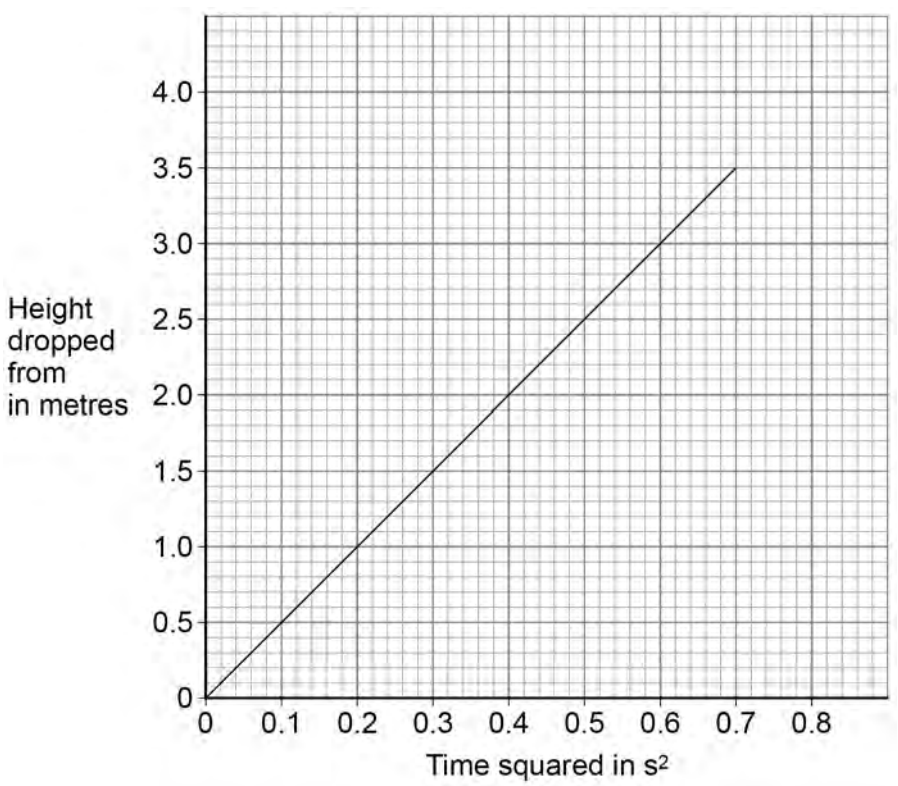
[1 mark]

Question 3 continues on the next page

Question 47 · continued

0 3 . 4 **Figure 4** shows a graph of the height the ball was dropped from against the time squared.

Figure 4



The acceleration of the ball can be calculated using the equation:

acceleration = 2 × (gradient of the graph)

Determine the acceleration of the ball.

[3 marks]

Acceleration of ball = _____ m/s²

7

4.5.6.1.5 Acceleration

Question 48

June 2025 | 8463/2H | Original Q5

0 5 In a world record attempt, a skydiver jumped from a height of 40 km above the Earth.

0 5 . 1 **Figure 6** shows an incomplete free-body diagram for the skydiver a few seconds after the start of the jump.

Figure 6



The skydiver has not reached terminal velocity.

Complete the free-body diagram in **Figure 6**.

[2 marks]

4.5.6.1.5 Acceleration

Question 48 · continued

0 5 . 2 During the first 2.5 minutes the mean acceleration of the skydiver was 0.64 m/s^2.

The initial velocity of the skydiver was 0 m/s.

Calculate the velocity of the skydiver 2.5 minutes after the start of the jump.

Use the Physics Equations Sheet.

[4 marks]

Velocity = _____ m/s

Question 5 continues on the next page

4.5.6.1.5 Acceleration

Question 48 · continued

0 5 . 3 The skydiver accelerated until reaching terminal velocity.

Explain why the skydiver reached terminal velocity.

[4 marks]

0 5 . 4 Explain why the atmospheric pressure acting on the skydiver increased as the skydiver fell.

[2 marks]

4.5.6.1.5 Acceleration

Question 48 · continued

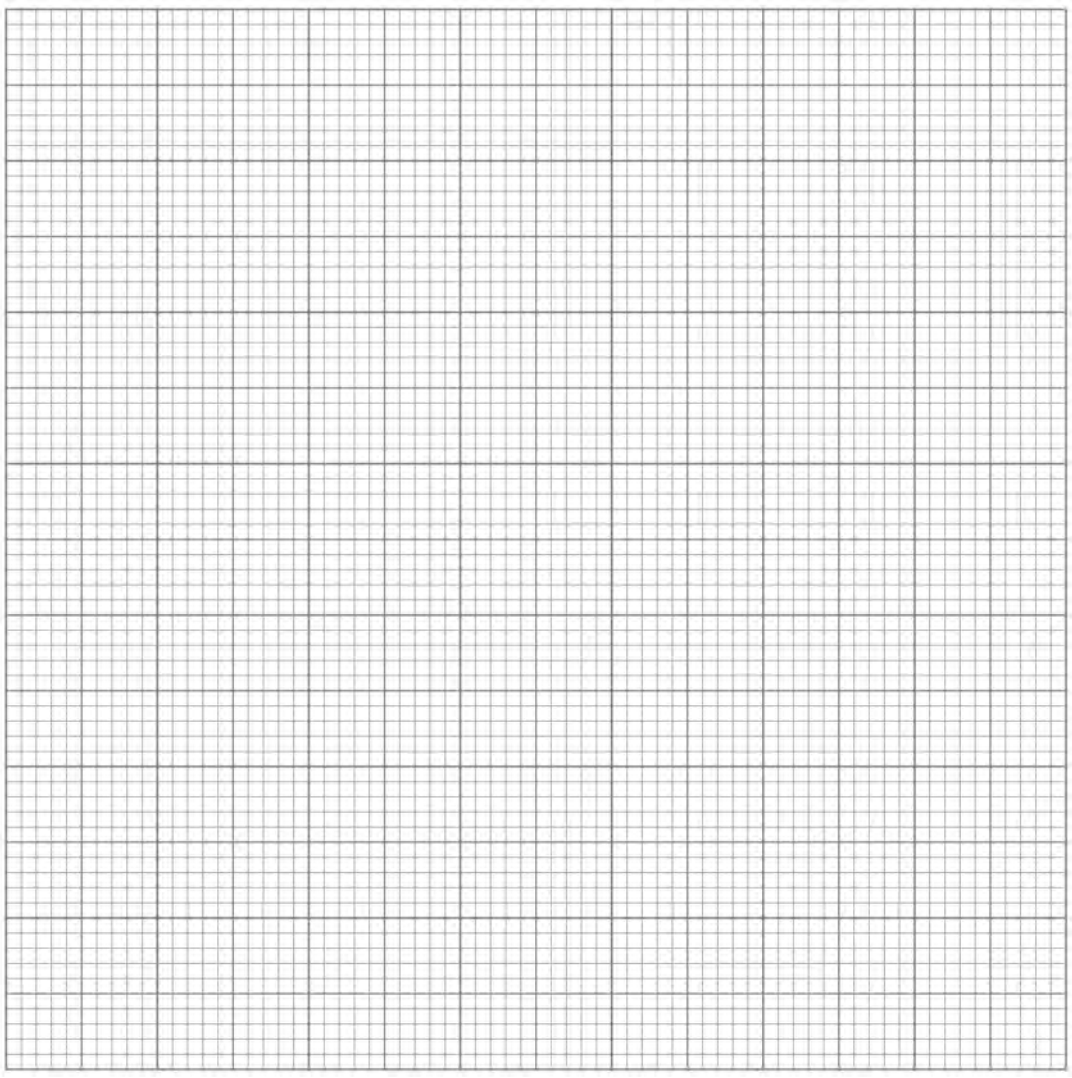
0 5 . 5 The skydiver opened his parachute.

A few seconds after opening the parachute, the resultant vertical force on the skydiver was 240 N upwards.

The wind caused a resultant horizontal force of 200 N to the left on the skydiver.

Draw a vector diagram to determine the resultant force on the skydiver.

[4 marks]



Magnitude of resultant force = _____ N

Angle to vertical of resultant force = _____ degrees

16

4.5.6.1.5 Acceleration

Question 49

June 2025 | 8463/2H | Original Q6

0 6 A car manufacturer makes two cars, **X** and **Y**.

The cars are identical, apart from their mass.

Car **X** has a greater mass than car **Y**.

0 6 . 1 How does the maximum acceleration of car **X** compare with the maximum acceleration of car **Y**?

[1 mark]

0 6 . 2 Cars have air bags that inflate to protect the driver if the car stops very suddenly.

Explain how air bags reduce the chance of injury to the driver.

[3 marks]

Question 6 continues on the next page

4.5.6.1.5 Acceleration

Question 49 · continued

0 6 . 3 Car **X** has a mass of 1400 kg and is travelling at 18 m/s.

The driver applies the brakes.

The car has a constant deceleration and comes to a stop in a distance of 24 m.

Calculate the resultant force on the car.

Use the Physics Equations Sheet.

[5 marks]

Resultant force = _____ N

0 6 . 4 Explain why braking causes an increase in the temperature of the brakes.

[2 marks]

4.5.6.1.5 Acceleration

Question 49 · continued

0 6 . 5 The driver of a car applies the brakes so the car has a large deceleration.

Give **two** possible risks of a large deceleration.

[2 marks]

1 _____

_____

2 _____

_____

13

Turn over for the next question

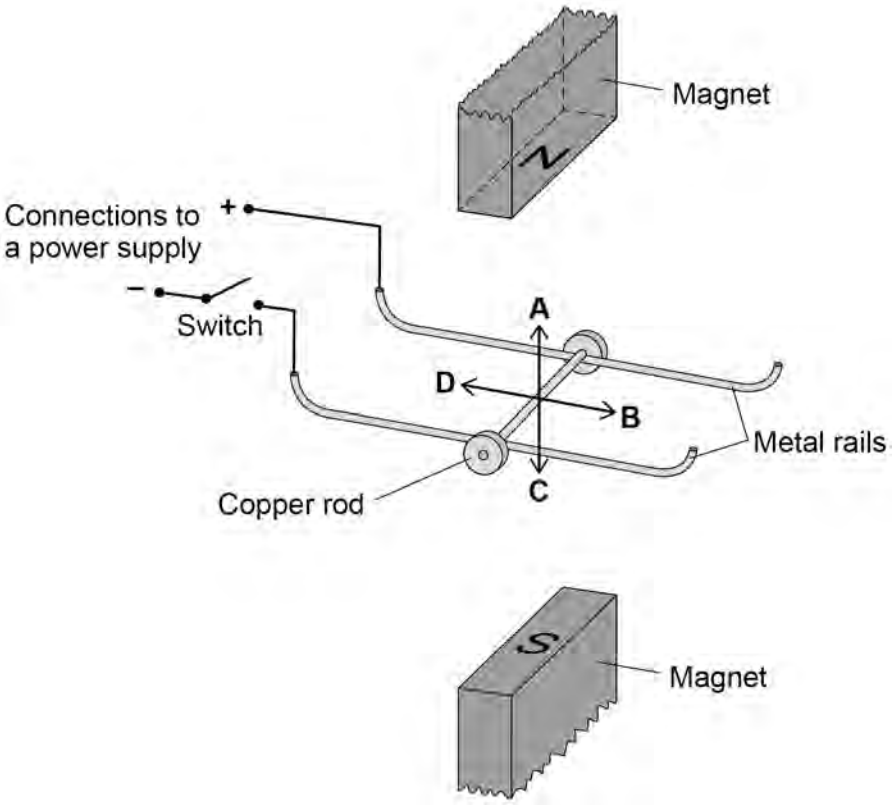
4.5.6.1.5 Acceleration

Question 50

June 2025 | 8463/2H | Original Q7

0 7 **Figure 7** shows some apparatus used to demonstrate the motor effect.

Figure 7



When the switch is closed the copper rod accelerates.

0 7 . 1 What direction is the acceleration of the copper rod?

[1 mark]

Tick (✓) **one** box.

A ☐

B ☐

C ☐

D ☐

4.5.6.1.5 Acceleration

Question 50 · continued

0 7 . 2 The copper rod has a mass of 5.0 g.

The length of the copper rod in the magnetic field is 0.070 m.

The magnetic flux density is 0.30 T.

Calculate the initial acceleration of the rod when the current in the rod is 2.0 A.

Use the Physics Equations Sheet.

[5 marks]

Initial acceleration = _____ m/s^2

Question 7 continues on the next page

4.5.6.1.5 Acceleration

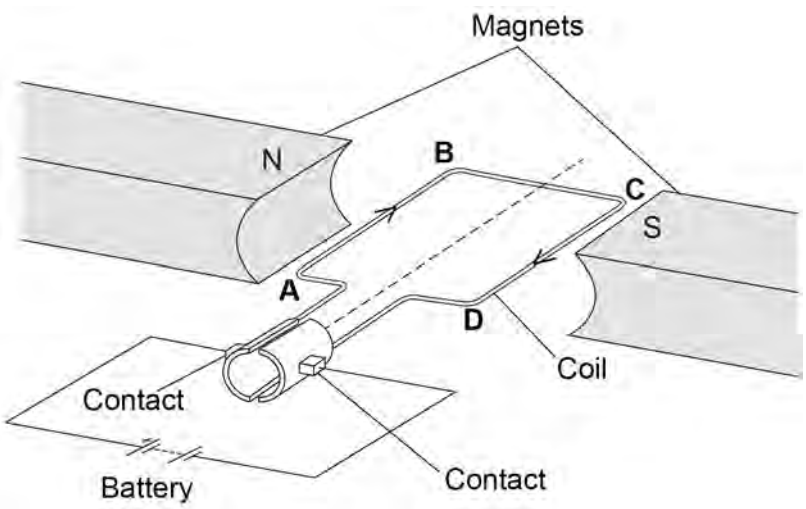
Question 50 · continued

Figure 8 shows a simple motor.

There is a magnetic field between the two permanent magnets.

When there is a current in the coil, a magnetic field is produced around the coil.

Figure 8



0 7 . 3 Explain how these magnetic fields cause the coil to continuously rotate.

[4 marks]

4.5.6.1.5 Acceleration

Question 50 · continued

0 7 . 4 In **Figure 8** the coil of the motor is in a horizontal position.

Explain why the resultant moment on the coil is zero when the coil is in a vertical position.

[2 marks]

12

Turn over for the next question