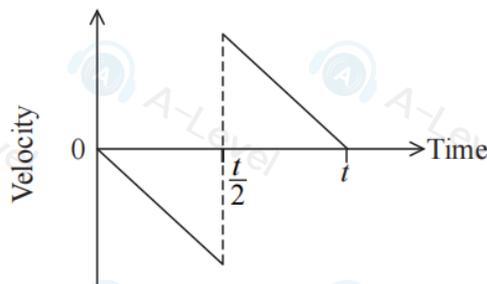
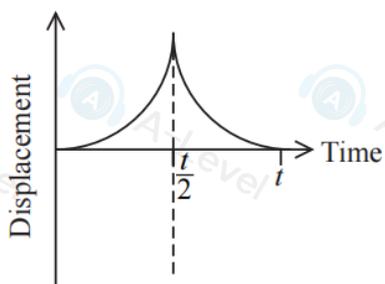


- 7 A ball is dropped, bounces once at time $\frac{t}{2}$ and is then caught at time t .

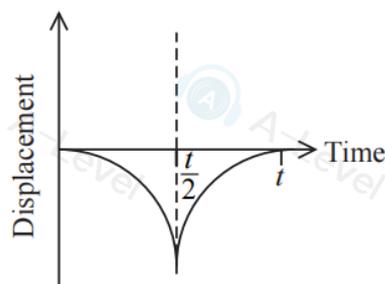
The velocity-time graph for the motion of the ball is shown.



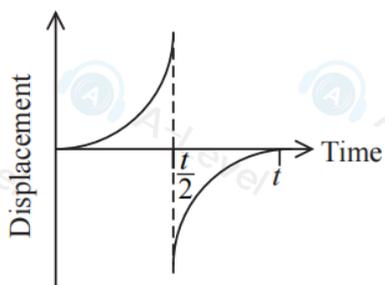
Assuming that the initial displacement of the ball is 0, which is the correct displacement-time graph for the motion of the ball?



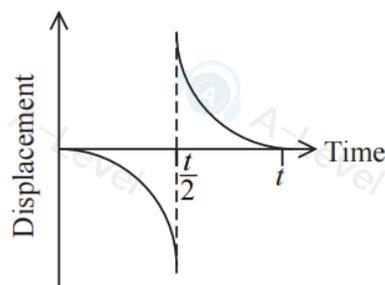
A



B



C



D

(Total for Question 7 = 1 mark)

Questions 5 and 6 refer to the information below.

Two groups of students were asked to perform an experiment to determine the acceleration of free-fall. Each group repeated their experiment three times to check their results. In each experiment a steel ball fell through a height of just under 1 m and the time for the ball to fall was measured.

- **Group 1** used a stopwatch to measure the time.
- **Group 2** used light gates connected to a data logger to measure the time.

5 The students measured the height the ball fell using a metre rule.

The height should be recorded as

- A 85 cm
- B 0.85 m
- C 0.850 m
- D 8.5×10^{-1} m

(Total for Question 5 = 1 mark)

7 A student drops a ball and measures the time taken for the ball to reach the ground. He repeats this for different heights.

He uses a graphical method to determine a value for g , the acceleration of free fall.

He plots height on the y -axis of his graph.

Which row of the table is correct for the student's graph?

	Quantity plotted on x -axis	Gradient of graph
<input type="checkbox"/> A	time	$\frac{1}{g}$
<input type="checkbox"/> B	time	g
<input type="checkbox"/> C	(time) ²	$\frac{g}{2}$
<input type="checkbox"/> D	(time) ²	$2g$

(Total for Question 7 = 1 mark)

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- 6 A ball is travelling horizontally at a speed of 7.0 m s^{-1} . The ball hits a vertical wall and rebounds along its initial path at a speed of 5.0 m s^{-1} . The ball has an acceleration of 300 m s^{-2} while in contact with the wall.

Which of the following expressions gives the time of contact t between the ball and the wall?

A $t = \frac{-5 - 7}{-300}$

B $t = \frac{5 - 7}{-300}$

C $t = \frac{-5 - 7}{300}$

D $t = \frac{5 - 7}{300}$

(Total for Question 6 = 1 mark)

- 1 A car is moving towards a stop sign at a speed of 25 m s^{-1} . The driver applies the brakes 20 m before the sign and decelerates uniformly to rest just before the sign.

Which of the following gives the magnitude of the car's deceleration in m s^{-2} ?

A $\frac{25}{40}$

B $\frac{25}{20}$

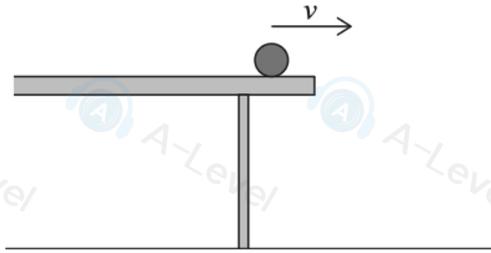
C $\frac{25^2}{40}$

D $\frac{25^2}{20}$

(Total for Question 1 = 1 mark)

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3: The diagram shows a ball of mass m moving at speed v along a horizontal table.



The ball leaves the table. The time taken between the ball leaving the table and landing on the floor is t .

A second ball of mass $2m$ moves at speed $2v$ along the table.

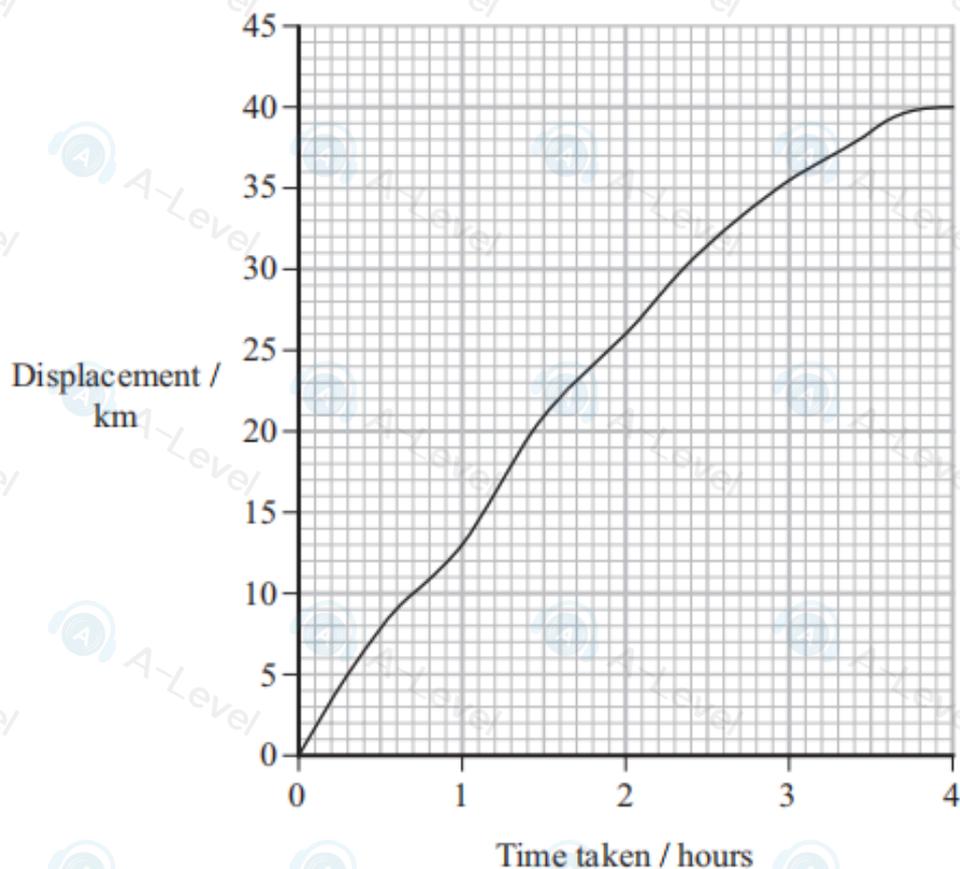
Which of the following gives the time taken between the second ball leaving the table and landing on the floor?

- A $2t$
- B t
- C $\frac{t}{2}$
- D $\frac{t}{4}$

(Total for Question 3 = 1 mark)



3 The displacement-time graph for a person running a race is shown.



Which of the following gives the average velocity of the person?

- A area between the curve and the x -axis from 0 hours to 4 hours
- B gradient of a tangent to the curve at 4 hours
- C gradient of a tangent to the curve at 2 hours
- D displacement at 4 hours divided by a time of 4 hours

(Total for Question 3 = 1 mark)

4 A projectile is launched at an angle θ to the horizontal and takes a time t to reach its maximum height.

Which of the following equations could be used to determine the initial velocity u of the projectile?

- A $u = \frac{gt}{\cos \theta}$
- B $u = \frac{-gt}{\cos \theta}$
- C $u = \frac{gt}{\sin \theta}$
- D $u = \frac{-gt}{\sin \theta}$

(Total for Question 4 = 1 mark)

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9 A student used a falling sphere to determine the acceleration of free fall.

A camera produced images of the sphere at constant time intervals as it fell.

The positions of the sphere in the first two images are shown. Image 1 shows the sphere's position at the instant it was released.

- Image 1
- Image 2
- P
- Q
- R
- S

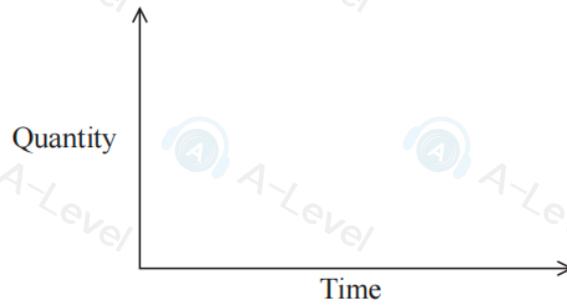
Which of the positions P, Q, R or S will the sphere be at in Image 3?

- A P
- B Q
- C R
- D S

(Total for Question 9 = 1 mark)



1 Graphs can be used to represent the motion of an object.



Which row in the table gives a quantity plotted on the y -axis and the corresponding quantity represented by the gradient of the graph?

	Quantity plotted on y -axis	Gradient of graph
<input checked="" type="checkbox"/> A	displacement	acceleration
<input checked="" type="checkbox"/> B	velocity	acceleration
<input checked="" type="checkbox"/> C	acceleration	velocity
<input checked="" type="checkbox"/> D	acceleration	displacement

(Total for Question 1 = 1 mark)

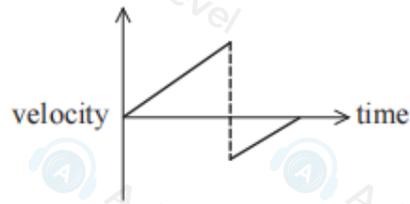
2 A coin and a feather are dropped from the same height, through air.

Which row of the table is correct as the coin and feather fall to the ground?

	Initial acceleration	Time taken to reach the ground
<input checked="" type="checkbox"/> A	Greater for coin	Less for coin
<input checked="" type="checkbox"/> B	Greater for coin	Same for coin and feather
<input checked="" type="checkbox"/> C	Same for coin and feather	Less for coin
<input checked="" type="checkbox"/> D	Same for coin and feather	Same for coin and feather

(Total for Question 2 = 1 mark)

The velocity-time graph for the motion of a ball is shown.



9 Which of the following correctly describes the motion of the ball?

- A The ball is dropped and rebounds to its original position.
- B The ball is dropped and rebounds to a lower position.
- C The ball is thrown upwards and is caught at its original position.
- D The ball is thrown upwards and is caught at a higher position.

(Total for Question 9 = 1 mark)

10: A toy train of mass $3m$ is moving with a speed v .

A toy truck of mass m is moving with a speed $2v$ in the opposite direction, as shown.



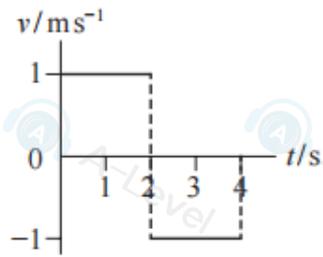
The train and truck collide and move off together.

Which of the following expressions gives the new speed of the train and truck?

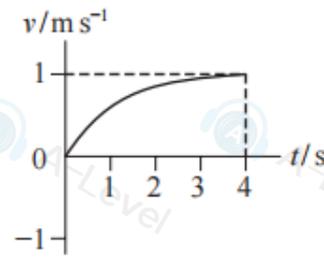
- A $\frac{v}{4}$
- B $\frac{4v}{5}$
- C v
- D $\frac{5v}{4}$

(Total for Question 10 = 1 mark)

- 5 Two objects P and Q are at the same position at time $t = 0$ s. The graphs show how the velocity v varies with time t for each object.



object P



object Q

Which of the following statements describes the positions of P and Q at $t = 4$ s?

- A P and Q are both at the initial position.
- B P and Q are the same distance from the initial position.
- C P is further from the initial position than Q.
- D Q is further from the initial position than P.

(Total for Question 5 = 1 mark)

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- 4 A student measures the time t taken for a ball bearing to fall different measured distances s from rest. The student uses his measurements to plot a graph with a gradient equal to the acceleration due to gravity g .

Which row of the table shows a graph with a gradient equal to g ?

	y-axis	x-axis
A	s	t^2
B	$2s$	t^2
C	t^2	s
D	t^2	$2s$

(Total for Question 4 = 1 mark)

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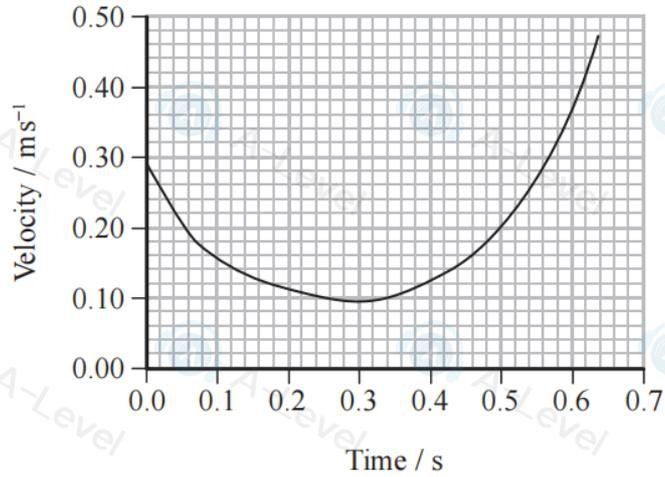
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13 A ball bearing moves across a horizontal bench towards a magnet as shown.



The velocity-time graph for the horizontal motion of the ball bearing up to the point of contact with the magnet is shown.



(a) Explain the shape of the graph.

(3)

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(b) Calculate the maximum acceleration of the ball bearing.

(3)

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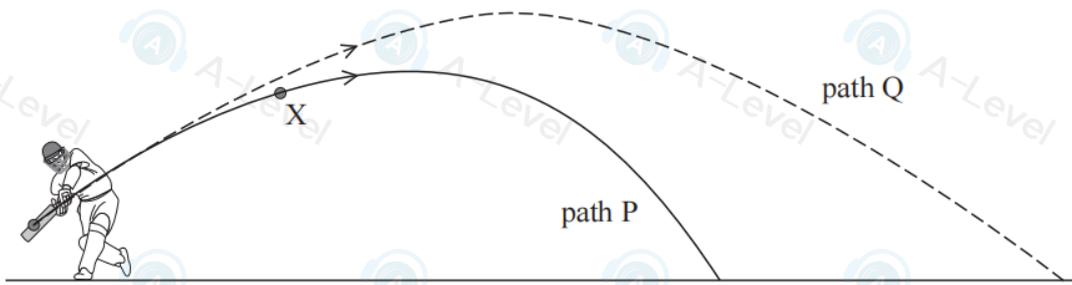
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Maximum acceleration =

15 In a game of cricket, a player hits the ball, which takes path P.

Air resistance acted on the ball as it travelled through the air. If there was no air resistance, the ball would have followed path Q.



(a) (i) Draw a free-body force diagram for the ball when at the position marked X on path P.

(2)

*(ii) Explain the differences between path P and path Q.

(4)

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- (b) The ball was given an initial velocity of 35 m s^{-1} at an angle of 25° to the horizontal. The horizontal distance from the player to the 'boundary' is 85 m. The player scores six 'runs' if the ball lands beyond the 'boundary' before it bounces.

Determine whether six 'runs' will be scored. Ignore the effects of air resistance.

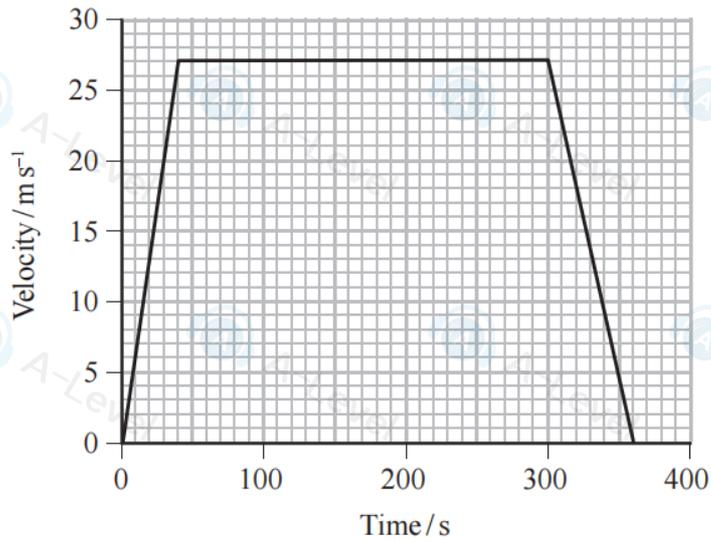
(4)

Handwriting practice area consisting of 10 horizontal dotted lines.

(Total for Question 15 = 10 marks)

14 A train moves between two stations.

(a) A simplified velocity-time graph for the motion of the train is shown.

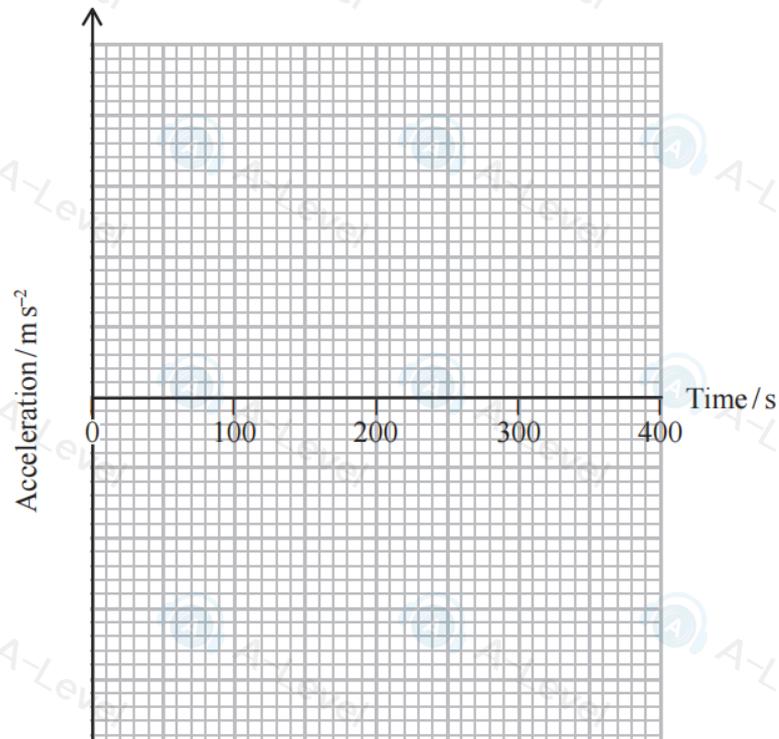


Draw a corresponding acceleration-time graph for the motion of the train. Show all working in the space below. (6)

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- (b) While the train is moving at a constant speed, a passenger throws a ball horizontally out of a window, as shown in Figure 1.

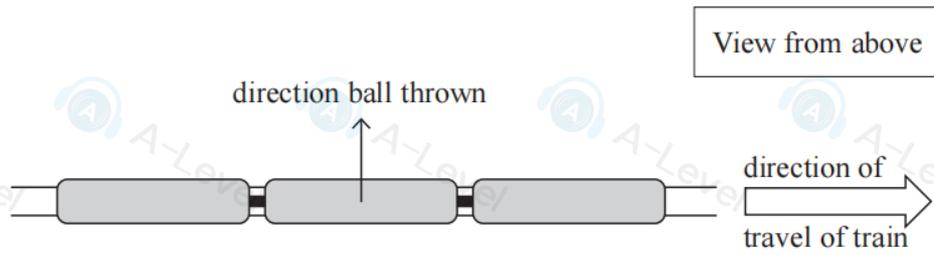


Figure 1

- (i) The path of the ball when viewed from above is shown in Figure 2. Any effects of the air have been ignored.

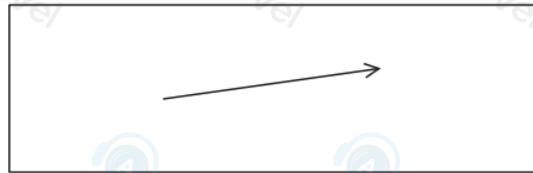


Figure 2

Explain the shape of this path.

(2)

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- (ii) The path of the ball when viewed from the side is shown in Figure 3. The effect of air resistance has been ignored.

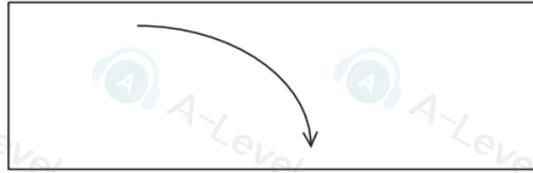


Figure 3

Explain the shape of this path.

(2)

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- (iii) Figures 2 and 3 are shown again below. Add to these figures the path of the ball if the effect of air resistance is not ignored.

(2)

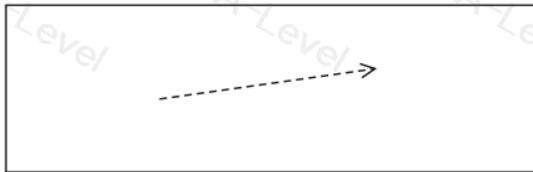


Figure 2

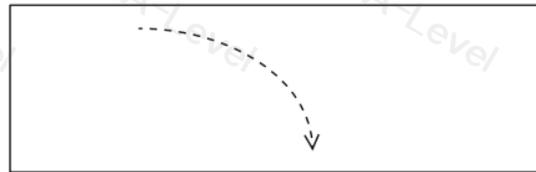


Figure 3

(Total for Question 14 = 12 marks)

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12 An aluminium sphere collides head-on with a stationary steel sphere. The two spheres move off separately after the collision.

(a) State the principle of conservation of momentum.

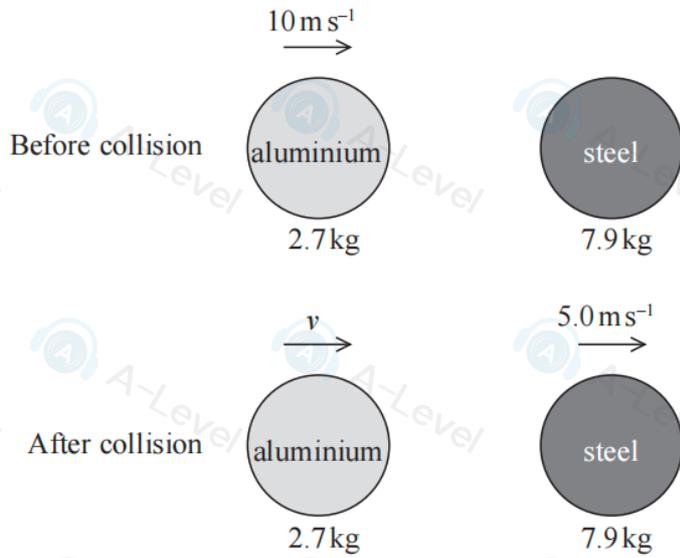
(2)

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(b) The aluminium sphere has an initial velocity of 10.0 m s^{-1} . Immediately after the collision the velocity of the steel sphere is 5.0 m s^{-1} .



Calculate the velocity v of the aluminium sphere immediately after the collision.

mass of aluminium sphere = 2.7 kg

mass of steel sphere = 7.9 kg

(3)

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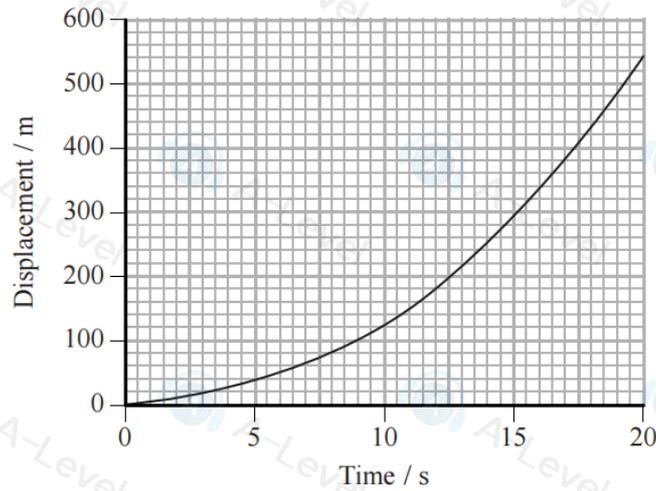
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$v =$

(Total for Question 12 = 5 marks)

15 The graph shows how the displacement of a racing car along a straight track varies with time.



(a) A student used the graph to calculate the velocity of the car at 15 s.

The student wrote:

$$\begin{aligned}\text{Velocity} &= \text{displacement} / \text{time} \\ &= 300/15 \\ &= 20\text{m s}^{-1}\end{aligned}$$

State why this value is incorrect and calculate the correct velocity at 15 s.

(3)

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Velocity of the car at 15 s =

(b) The gradient of the graph continued to increase as the car travelled along the track. After 20 s the rate of increase of the gradient began to decrease.

Explain why the rate of increase of the gradient decreased.

(2)

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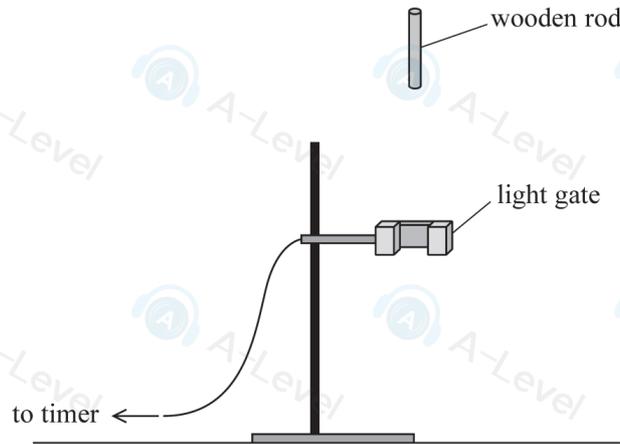
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(Total for Question 15 = 5 marks)

12 A student carries out an experiment to determine a value for g , the acceleration of free fall. A short wooden rod is released above a light gate. A timer connected to the light gate is used to measure the time taken for the wooden rod to pass through the light gate.

The experimental arrangement is shown.



The student uses the equation $v^2 = u^2 + 2as$, where $u = 0$, and a graphical method to determine a value for g .

(a) State the additional measurements the student should take. (2)

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(b) Describe how the velocity v of the wooden rod as it passes through the light gate can be determined accurately. (2)

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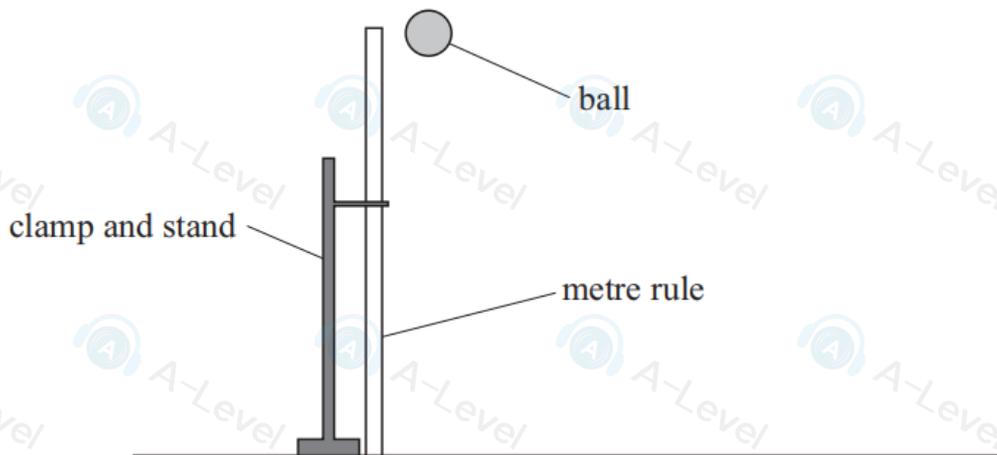
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14 A student clamped a metre rule so that it was vertical. She dropped a ball from rest near the top of the metre rule, as shown.



A strobe emits flashes of light. The time interval between flashes is constant.

The student photographed the falling ball using strobe lighting. The ball can be seen at different heights in the photograph, as shown.



(Source: © sciencephotos/Alamy Stock Photo)

For each flash of light, the student determined the distance fallen by the ball.

- (a) She took one photograph using a strobe app on a mobile phone.
She took a second photograph using a laboratory strobe.

The time interval between flashes was the same for the strobe app and for the laboratory strobe. Each flash of light from the laboratory strobe has a smaller duration than each flash from the mobile phone.

Explain how the smaller duration of each flash from the laboratory strobe affected the uncertainty in the measurement of the distance fallen.

(2)

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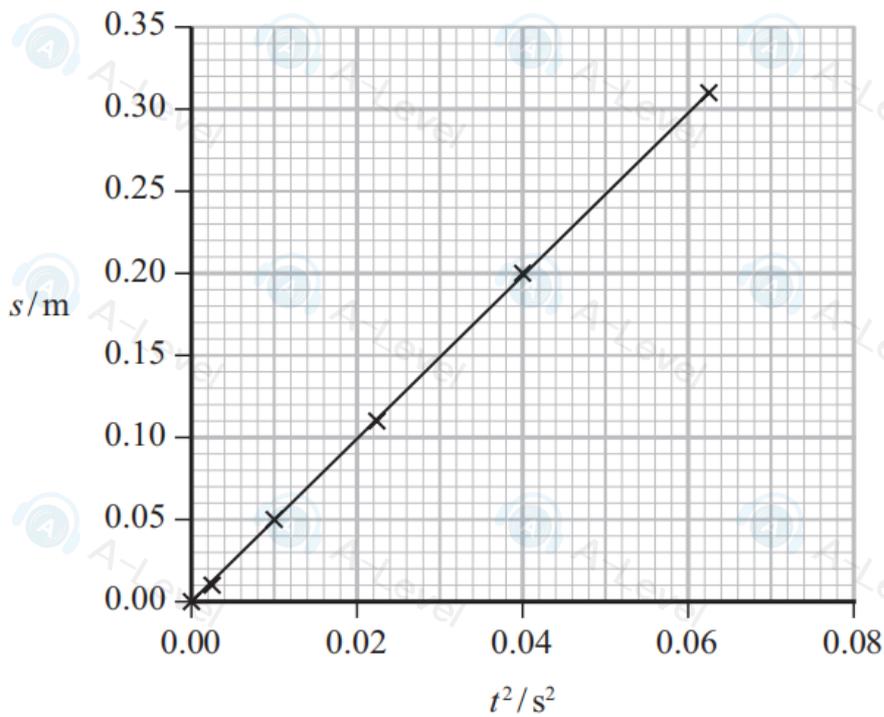
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(b) The student recorded the distances s fallen by the ball and corresponding values of the time t .

(i) Explain why a graph of s against t^2 gives a straight line.

(2)

(ii) The student plotted a graph of s against t^2 , as shown.



Determine the acceleration of free fall, g , using the student's graph.

(2)

$g =$ _____

(Total for Question 14 = 6 marks)

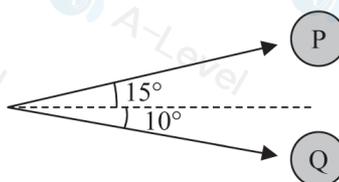
15 P and Q are identical spheres. Sphere P moves along a smooth horizontal surface and collides with sphere Q, which is initially stationary.

After the collision:

- sphere P moves off with a momentum of $0.096 \text{ kg m s}^{-1}$ in a direction of 15° to its initial direction.
- sphere Q moves off with a momentum of 0.14 kg m s^{-1} in a direction of 10° as shown.



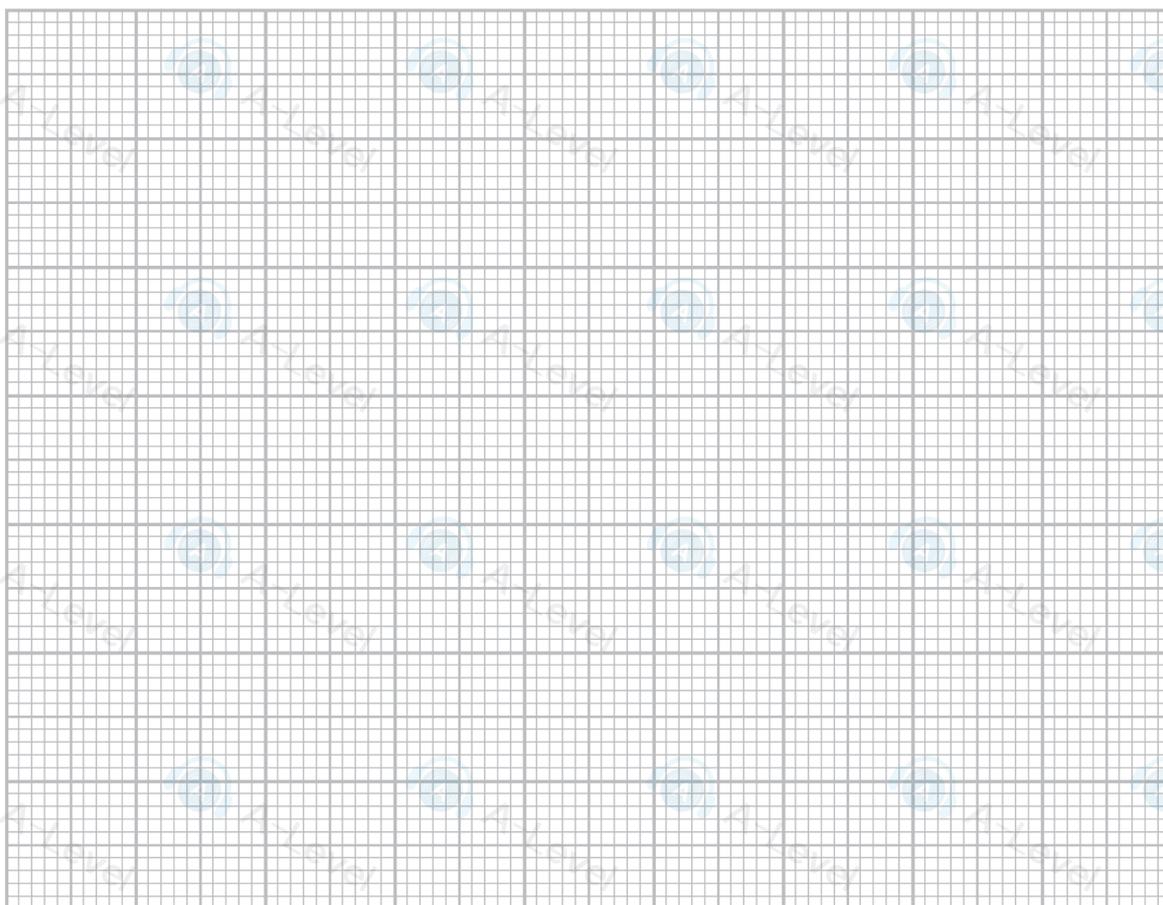
before the collision



after the collision

(a) Use a scaled vector diagram to show that the magnitude of the total momentum of spheres P and Q after the collision is about 0.2 kg m s^{-1} .

(4)



Total momentum of spheres P and Q after the collision =



