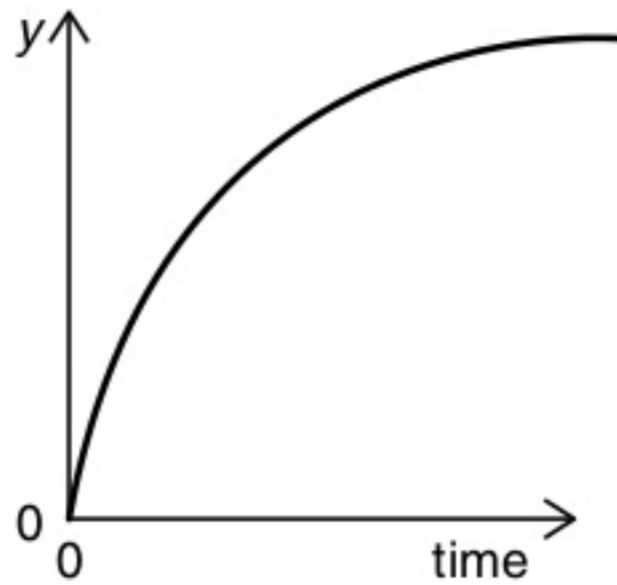**6** The graph relates to the motion of a falling body.

9702/1/M/J/02


Which is a correct description of the graph?

A y is distance and air resistance is negligible

B y is distance and air resistance is not negligible

C y is speed and air resistance is negligible

D y is speed and air resistance is not negligible

8 A stone is thrown upwards from the top of a cliff. After reaching its maximum height, it falls past the cliff-top and into the sea.

9702/1/M/J/02

The graph shows how the vertical velocity v of the stone varies with time t after being thrown upwards. R and S are the magnitudes of the areas of the two triangles.
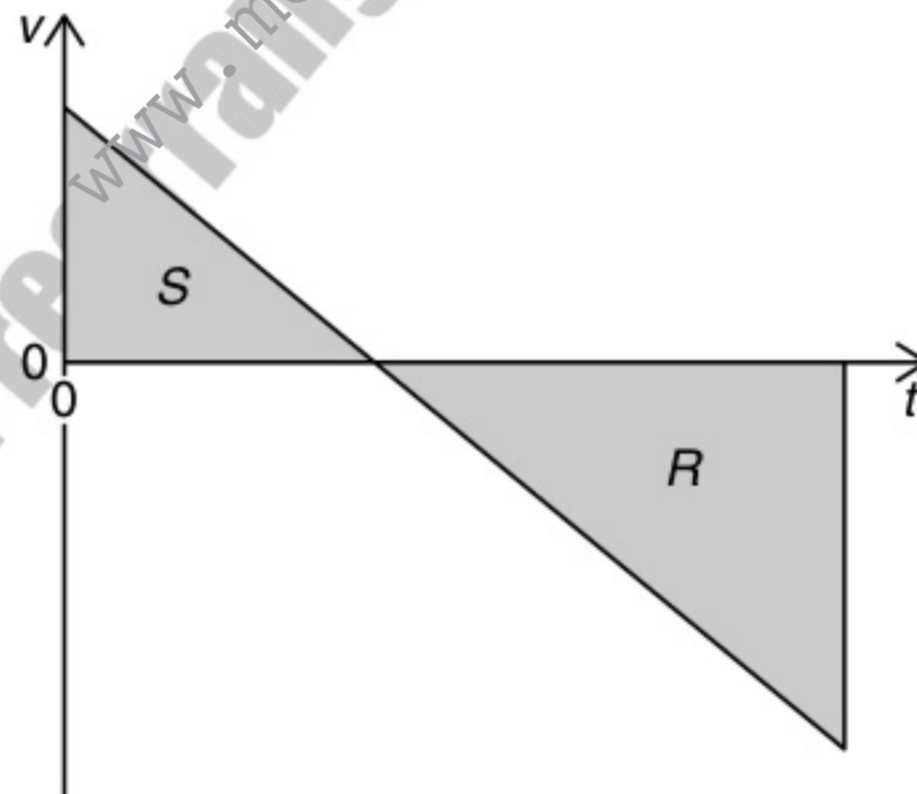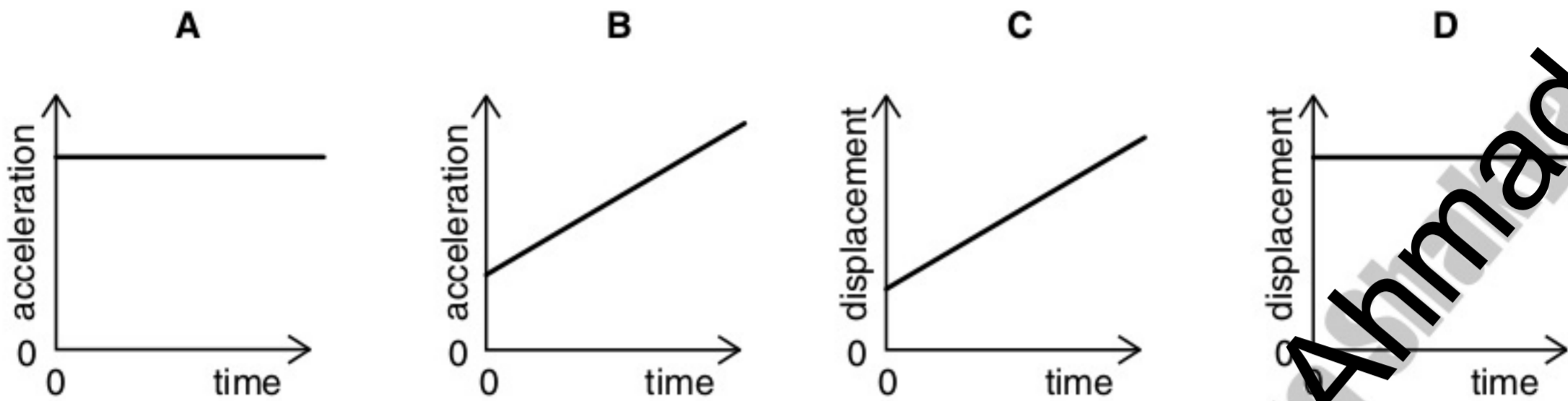

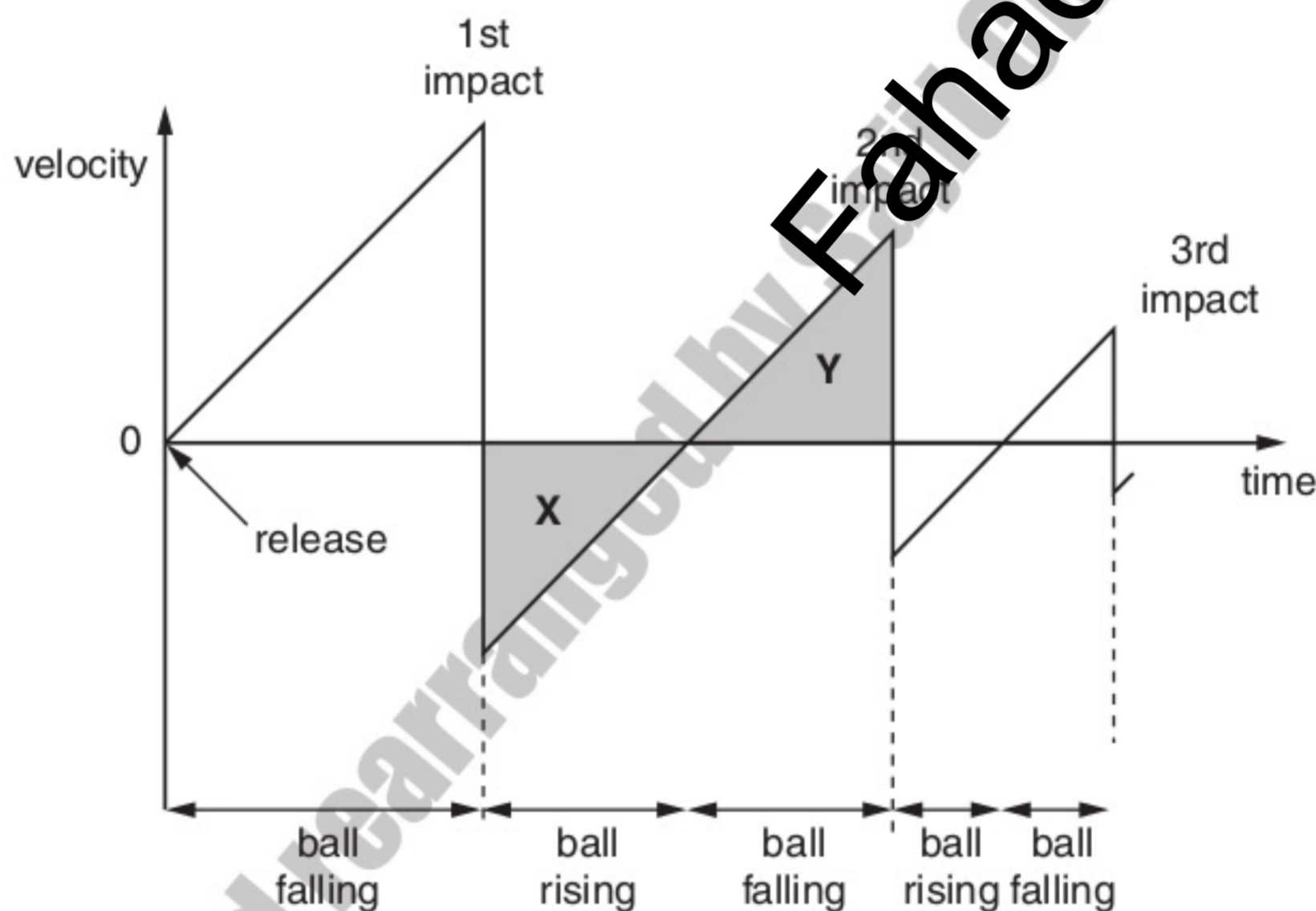What is the height of the cliff-top above the sea?

A R **B** S **C** $R + S$ **D** $R - S$

7 Which graph represents the motion of a car that is travelling along a straight road with a uniformly increasing speed?

9702/1/M/J/02

A   **B**   **C**   **D**

9 A ball is released from rest above a horizontal surface. The graph shows the variation with time of its velocity.

Areas **X** and **Y** are equal.

This is because

**A**   the ball's acceleration is the same during its upward and downward motion.

B   the speed at which the ball leaves the surface after an impact is equal to the speed at which it returns to the surface for the next impact.

C   for one impact, the speed at which the ball hits the surface equals the speed at which it leaves the surface.

D   the ball rises and falls through the same distance between impacts.

8 The graph of velocity against time for an object moving in a straight line is shown.

9702/01/M/J/03
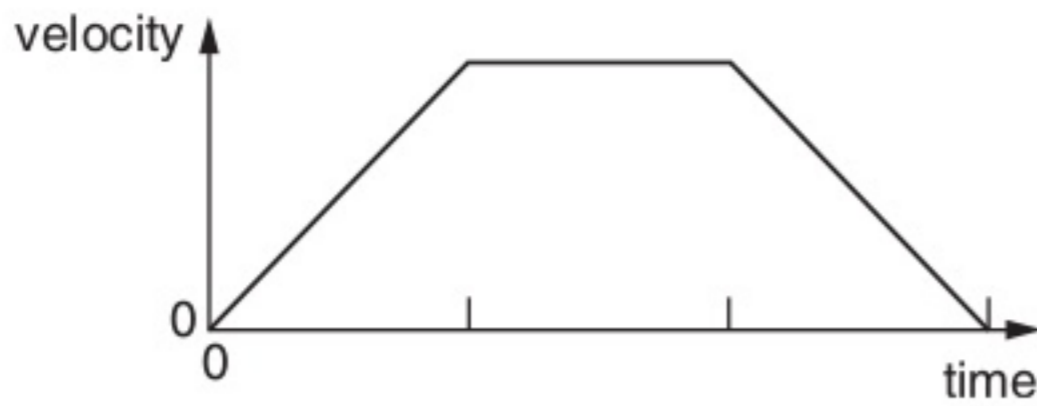
Which of the following is the corresponding graph of displacement against time?

A

B

C

D
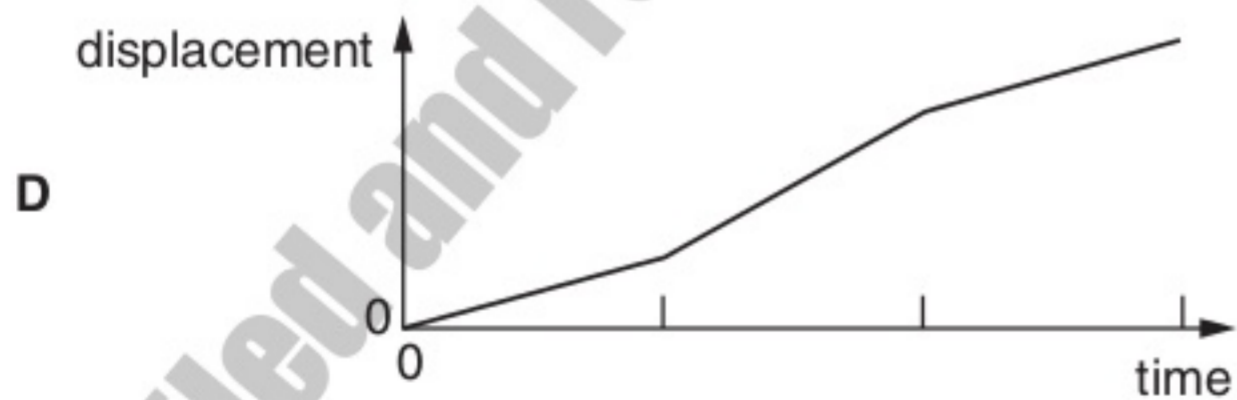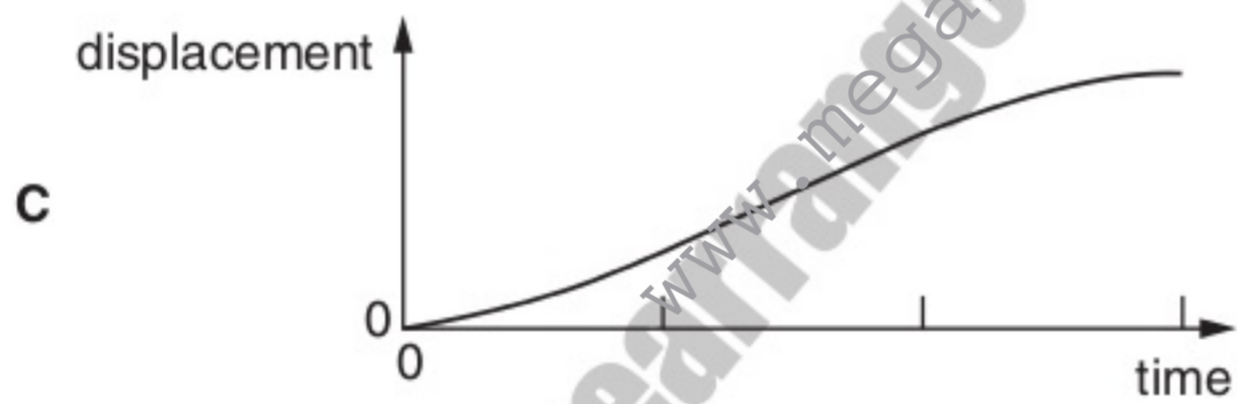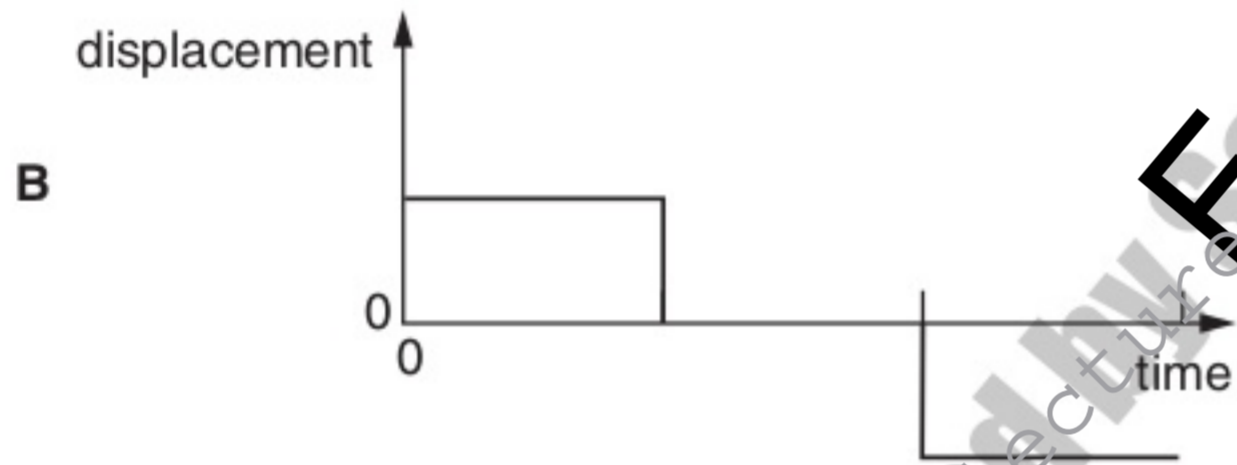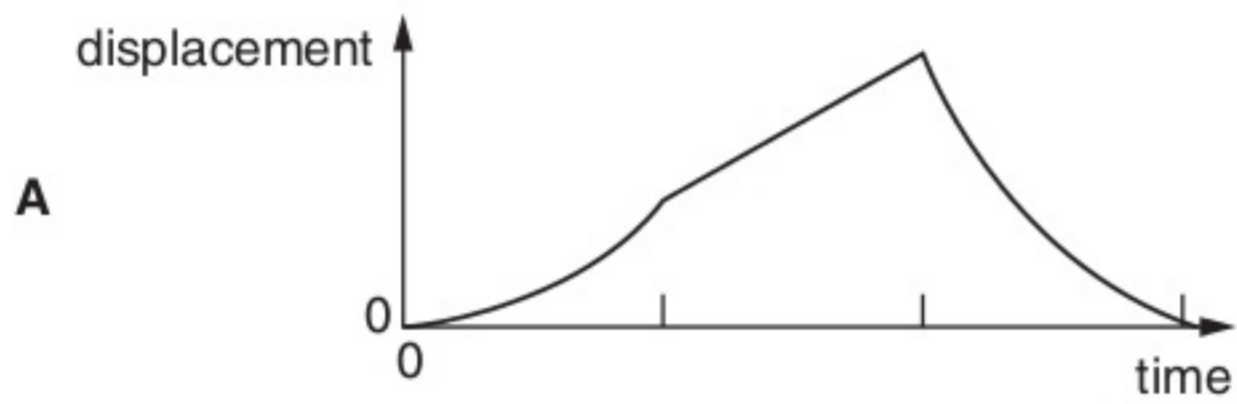
7 A car is travelling with uniform acceleration along a straight road. The road has marker posts every 100 m. When the car passes one post, it has a speed of $10\,\mathrm{m\,s^{-1}}$ and, when it passes the next one, its speed is $20\,\mathrm{m\,s^{-1}}$.

9702/01/M/J/04

What is the car's acceleration?

A $0.67\,\mathrm{m\,s^{-2}}$ **B** $1.5\,\mathrm{m\,s^{-2}}$ **C** $2.5\,\mathrm{m\,s^{-2}}$ **D** $6.0\,\mathrm{m\,s^{-2}}$

8 A tennis ball is released from rest at the top of a tall building.

9702/01/M/J/04

Which graph best represents the variation with time t of the acceleration a of the ball as it falls, assuming that the effects of air resistance are appreciable?

A

B

C

D
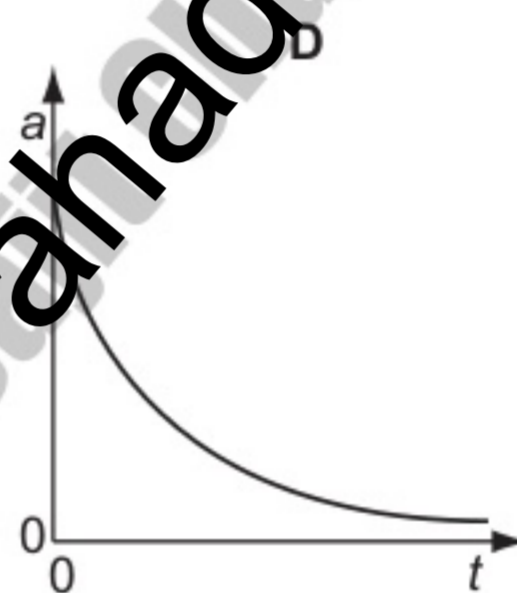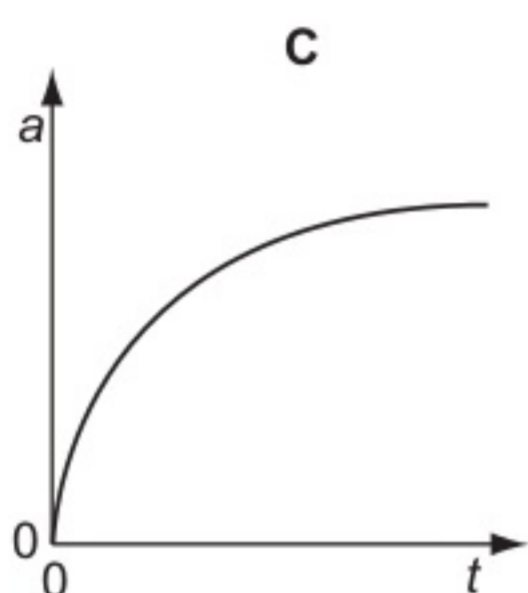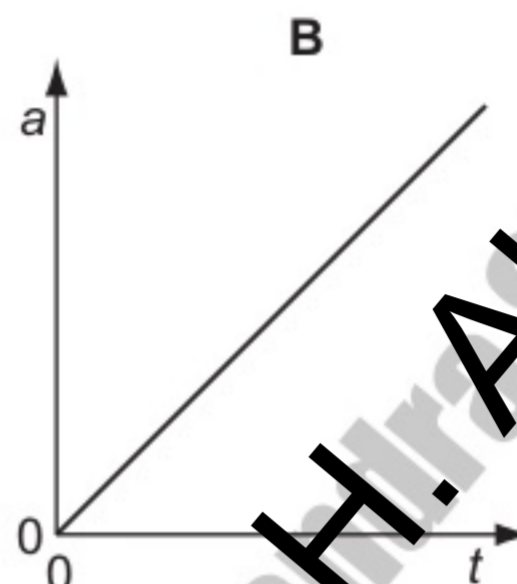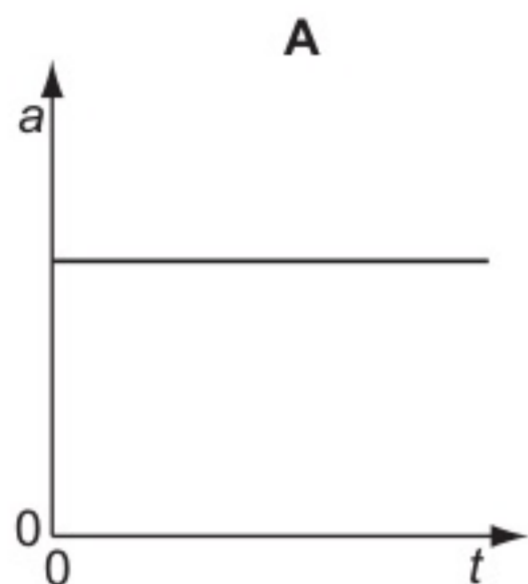
9 A motorcycle stunt-rider moving horizontally takes off from a point 1.25 m above the ground, landing 10 m away as shown.

9702/01/M/J/04

1.25 m

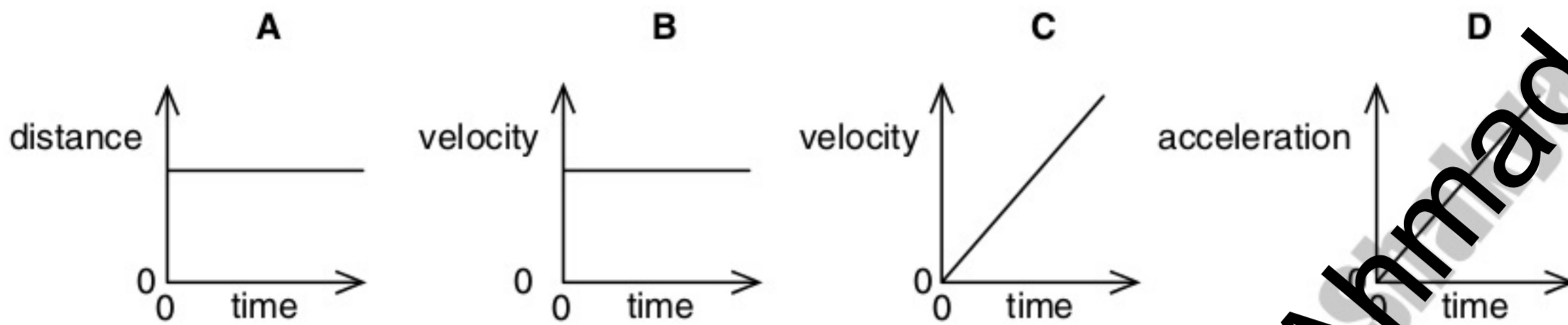10 m
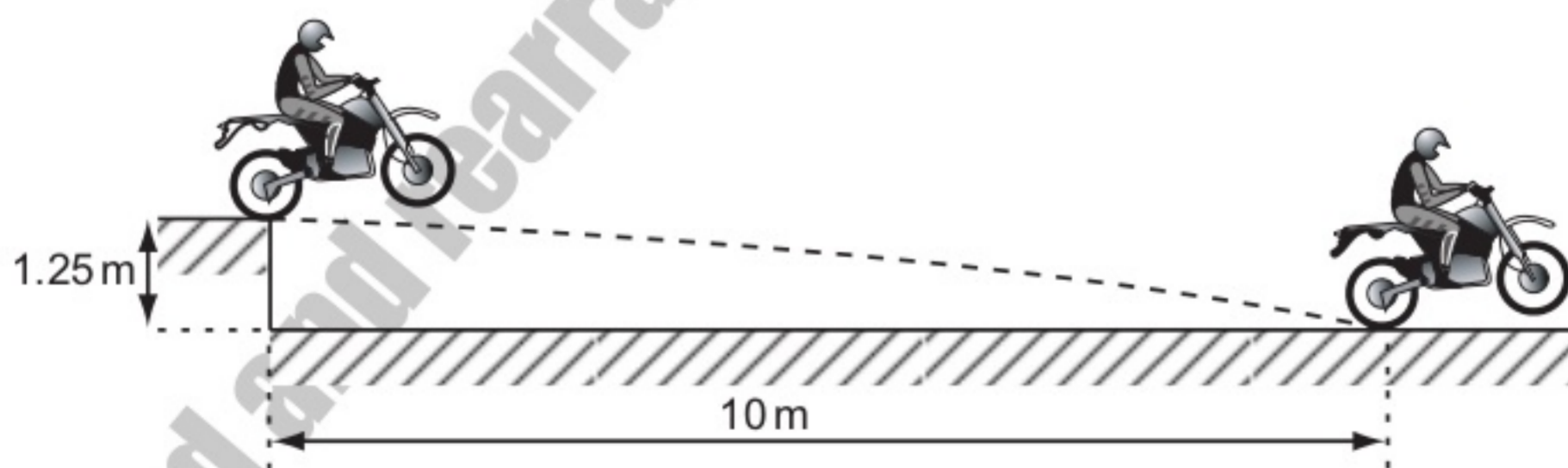
What was the speed at take-off?

A 5 m s⁻¹ **B** 10 m s⁻¹ **C** 15 m s⁻¹ **D** 20 m s⁻¹

2 A particle is moving in a straight line with uniform acceleration.

9702/1/O/N/02
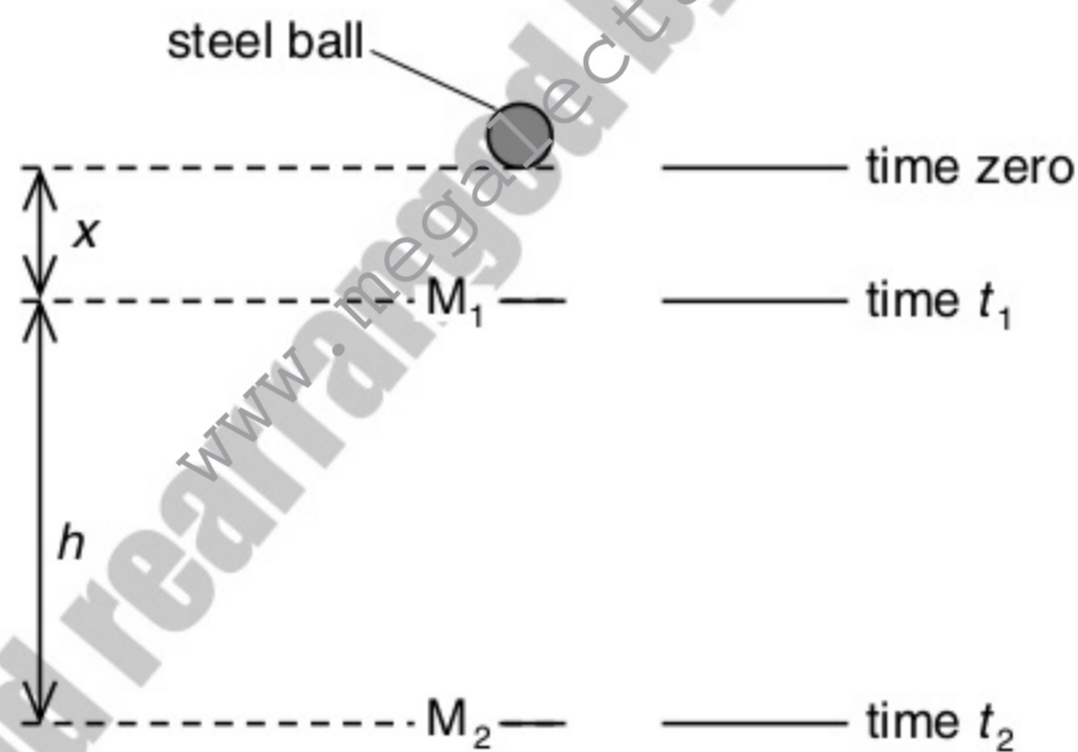
Which graph represents the motion of the particle?

4 What is meant by the weight of an object?   9702/1/O/N/02

A the gravitational field acting on the object

B the gravitational force acting on the object

C the mass of the object multiplied by gravity

D the object's mass multiplied by its acceleration

9 Two markers M_1 and M_2 are set up a vertical distance h apart.
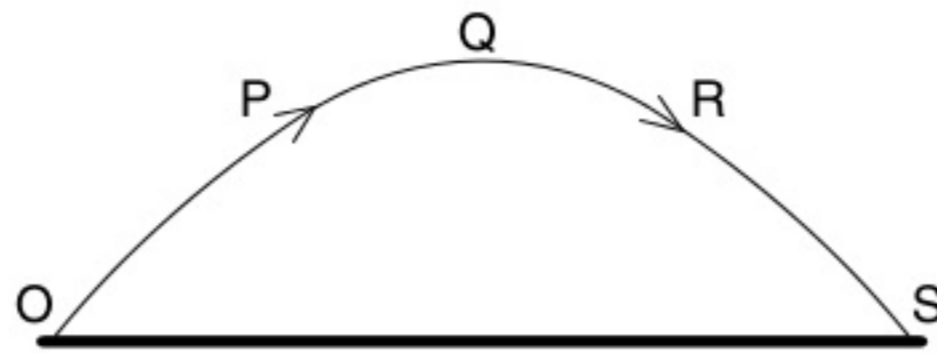
9702/1/O/N/02

When a steel ball is released from rest from a point a distance x above M_1, it is found that the ball takes time t_1 to reach M_1 and time t_2 to reach M_2.

Which expression gives the acceleration of the ball?

A $\dfrac{2h}{t_2^2}$ **B** $\dfrac{2h}{(t_2 + t_1)}$ **C** $\dfrac{2h}{(t_2 - t_1)^2}$ **D** $\dfrac{2h}{(t_2^2 - t_1^2)}$

8   A projectile is launched at point O and follows the path OPQRS, as shown. Air resistance may be neglected.

9702/1/O/N/02

Which statement is true for the projectile when it is at the highest point Q of its path?

A   The horizontal component of the projectile's acceleration is zero.

B   The horizontal component of the projectile's velocity is zero.

C   The kinetic energy of the projectile is zero.

D   The momentum of the projectile is zero.

10   A body falls from rest in a vacuum near the Earth's surface. The variation with time t of its speed v is shown below.

9702/1/O/N/02
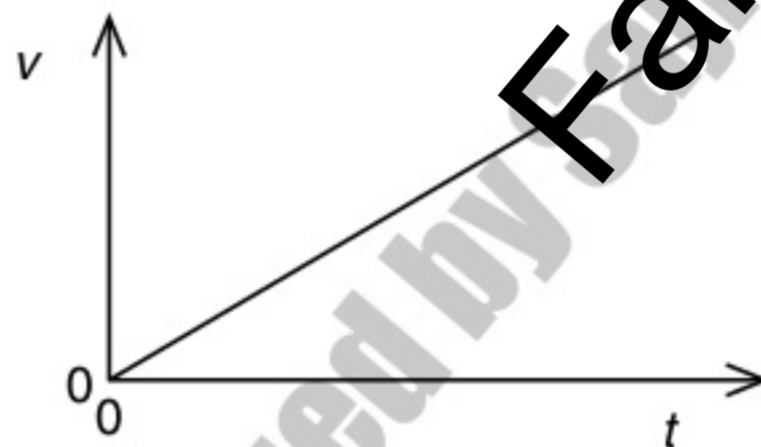
Which graph shows the variation with time t of the speed v of the same ball falling in air at the same place on Earth?
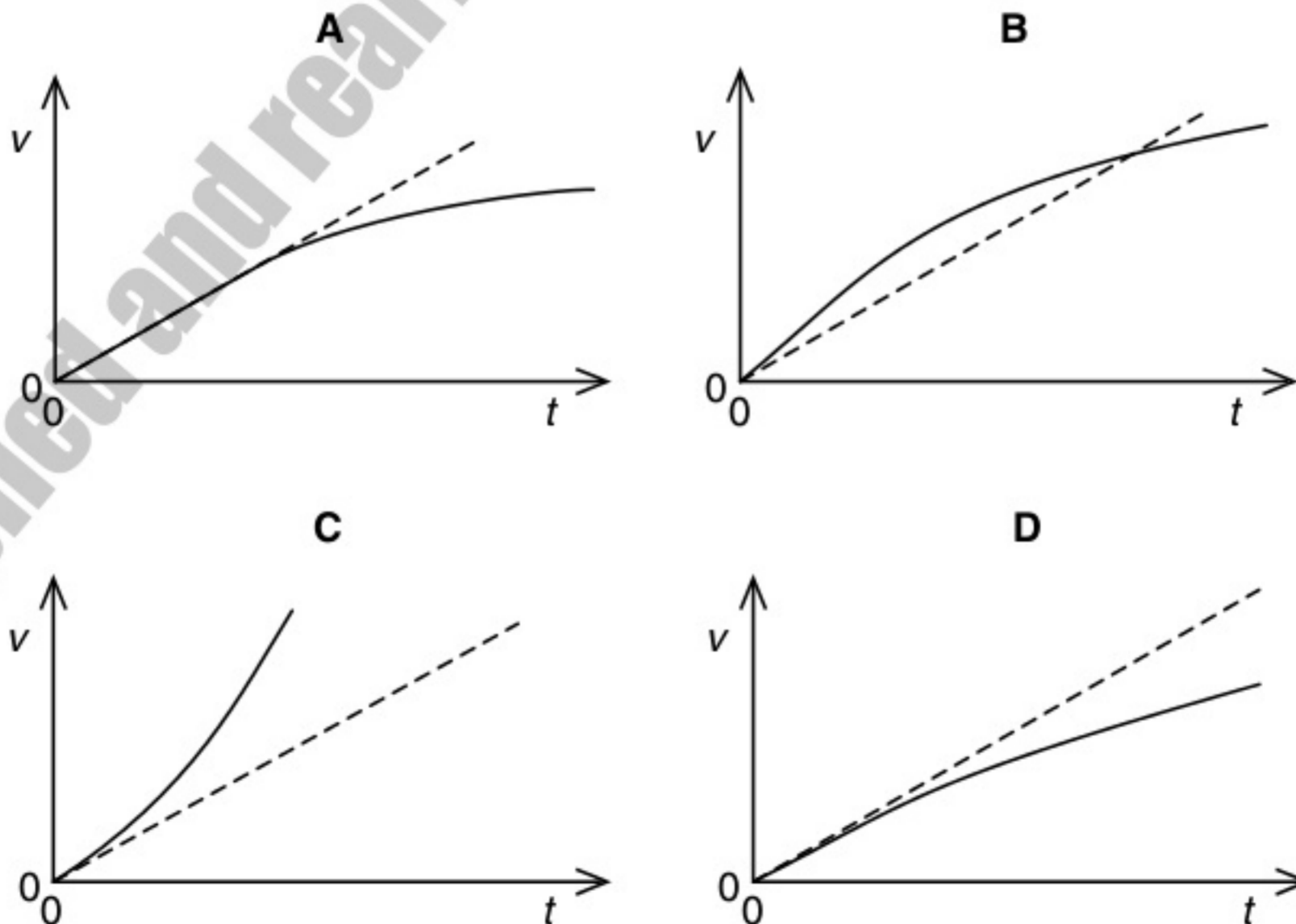
7 A car at rest in a traffic queue moves forward in a straight line and then comes to rest again. The graph shows the variation with time of its displacement.

9702/01/O/N/03
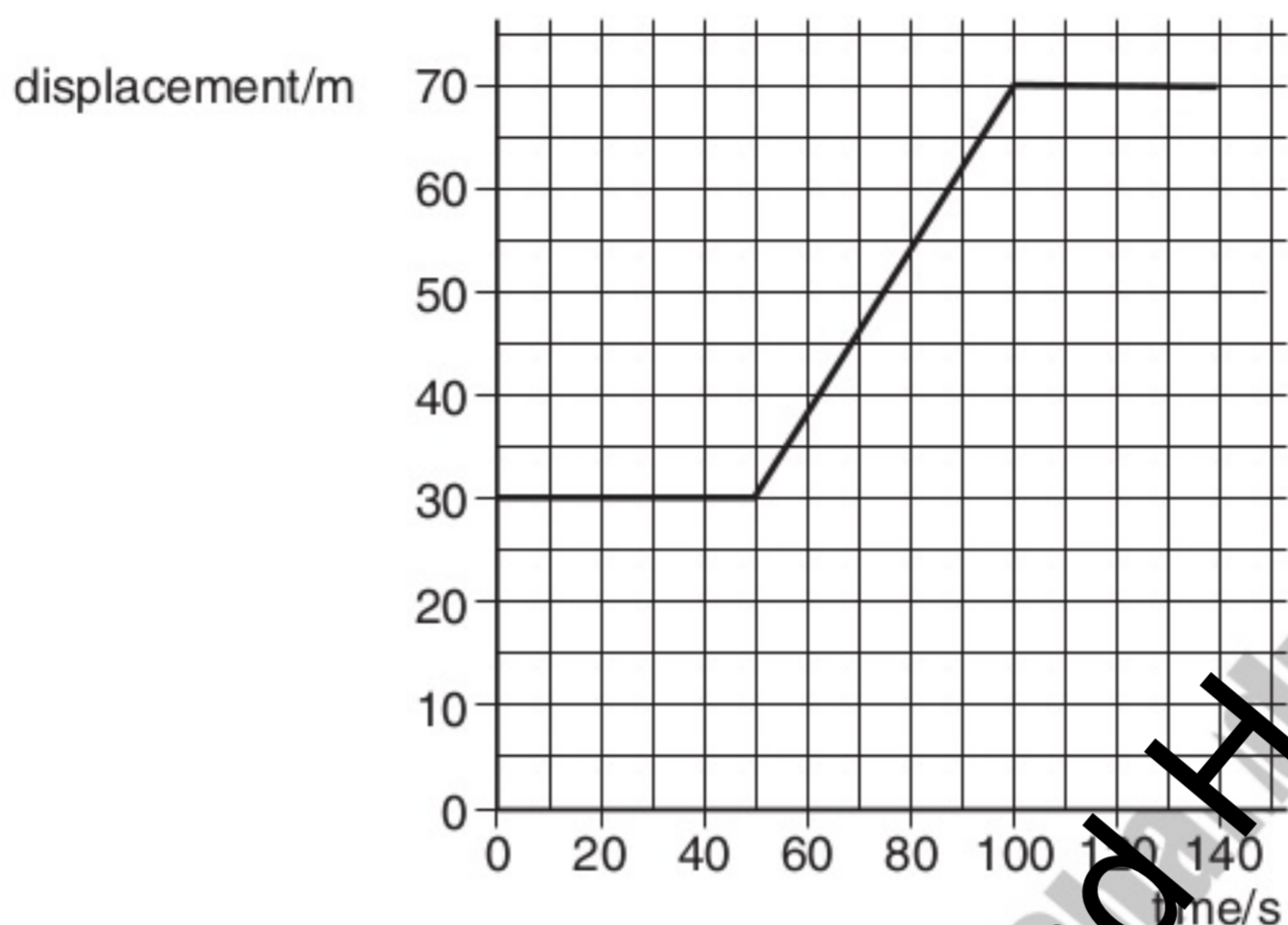
What is its speed while it is moving?

A $0.70\,\mathrm{m\,s^{-1}}$ B $0.80\,\mathrm{m\,s^{-1}}$ C $1.25\,\mathrm{m\,s^{-1}}$ D $1.40\,\mathrm{m\,s^{-1}}$
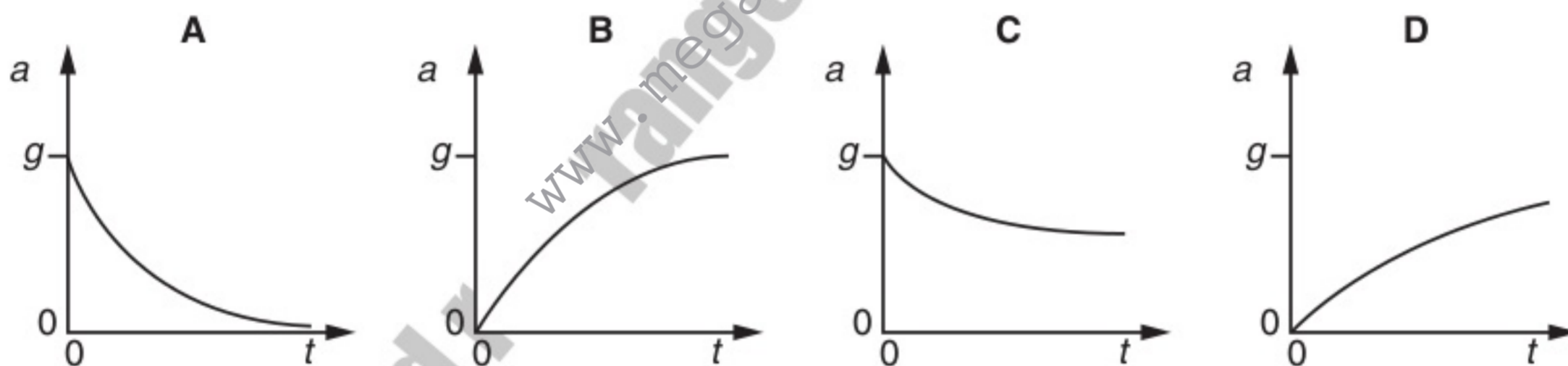
8 An object is dropped from a great height and falls through air of uniform density.

9702/01/O/N/03

The acceleration of free fall is g.

Which graph could show the variation with time t of the acceleration a of the object?

6 Four students each made a series of measurements of the acceleration of free fall g. The table shows the results obtained.

9702/01/O/N/04

Which student obtained a set of results that could be described as precise but not accurate?

student	results, g / m s^{-2}			
A	9.81	9.79	9.84	9.83
B	9.81	10.12	9.89	8.94
C	9.45	9.21	8.99	8.76
D	8.45	8.46	8.50	8.41

7 In the absence of air resistance, a stone is thrown from **P** and follows a parabolic path in which the highest point reached is **T**. The stone reaches point **Q** just before landing.   9702/01/O/N/04
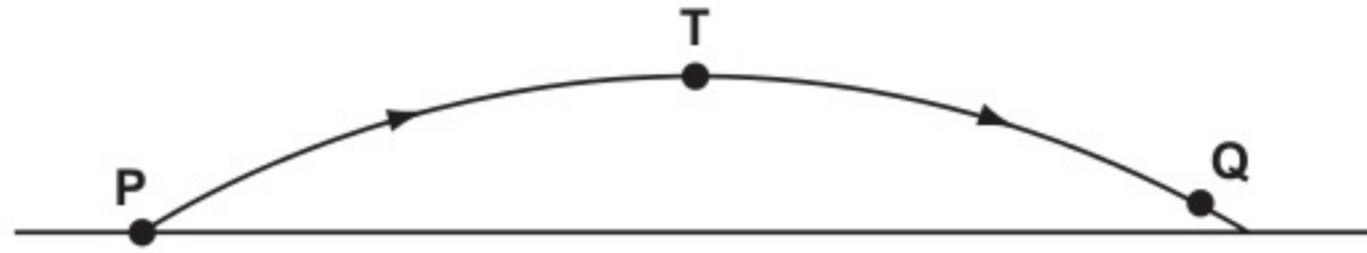
The vertical component of acceleration of the stone is

A zero at **T**.

B greatest at **T**.

C greatest at **Q**.

D the same at **Q** as at **T**.

8 When a car driver sees a hazard ahead, she applies the brakes as soon as she can and brings the car to rest. The graph shows how the speed v of the car varies with time t after the hazard is seen.   9702/01/O/N/04
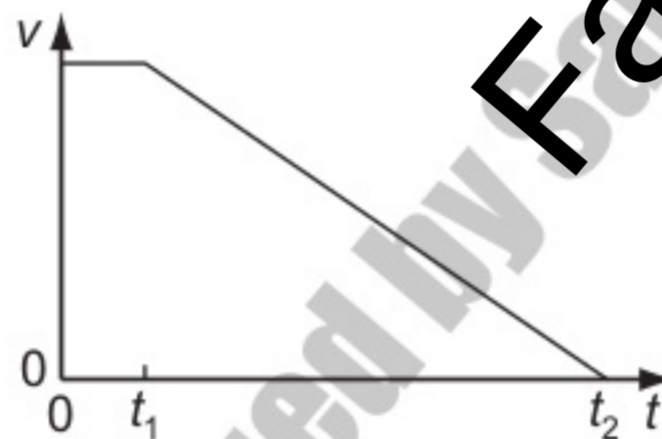
Which graph represents the variation with time t of the distance s travelled by the car after the hazard has been seen?
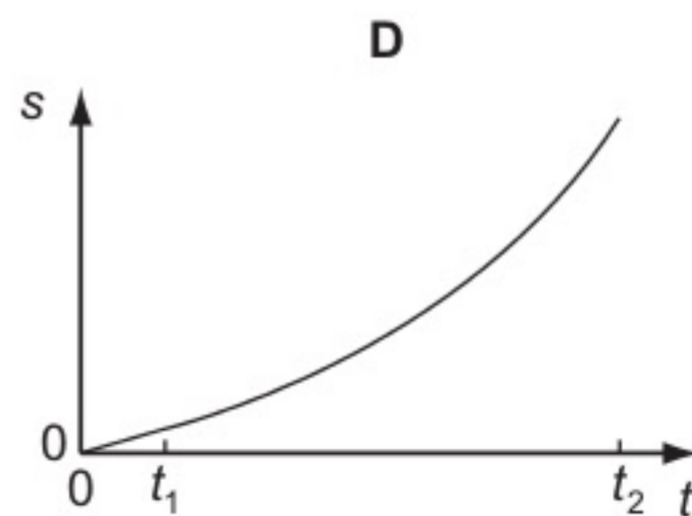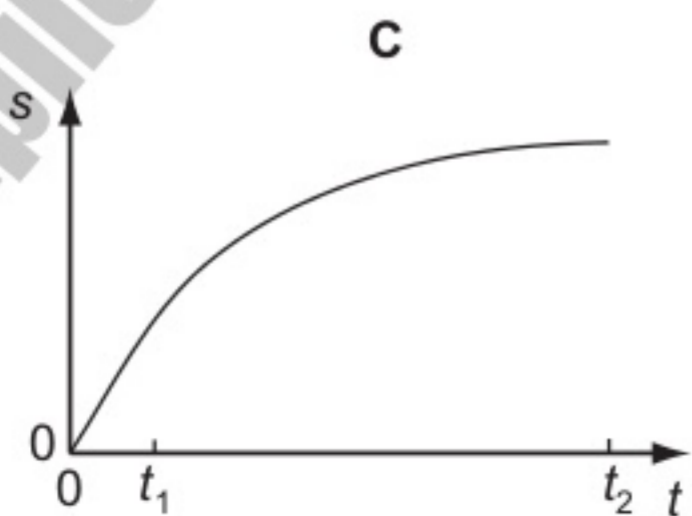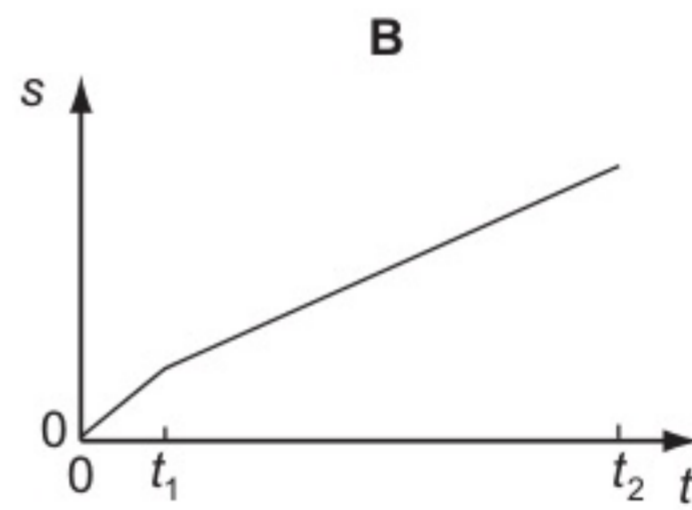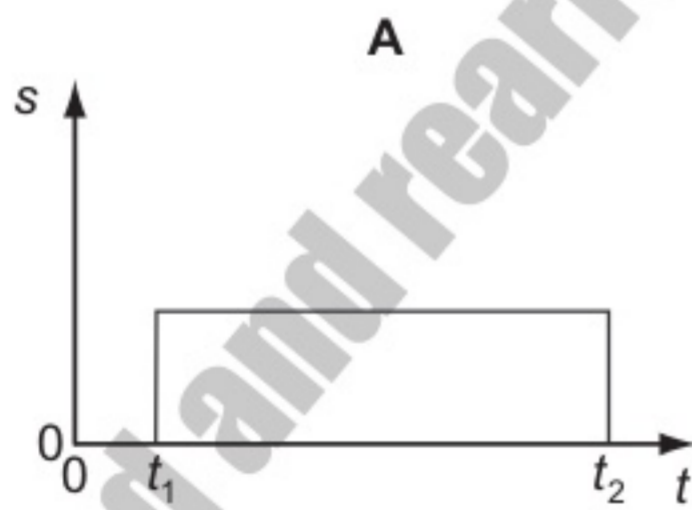
9 An object falls 10.0 m from rest before entering some water.

Assuming negligible air resistance, what is the time taken to reach the water and the speed with which the object reaches the water?

	time / ms	speed / m s^{-1}
A	1.02	10.0
B	1.02	14.0
C	1.43	10.0
D	1.43	14.0

10 A constant mass undergoes uniform acceleration.

Which of the following is a correct statement about the resultant force acting on the mass?

A It increases uniformly with respect to time.

B It is constant but not zero.

C It is proportional to the displacement from a fixed point.

D It is proportional to the velocity.

6 Which feature of a graph allows acceleration to be determined?

A the area under a displacement-time graph

B the area under a velocity-time graph

C the slope of a displacement-time graph

D the slope of a velocity-time graph

7 A boy throws a ball vertically upwards. It rises to a maximum height, where it is momentarily at rest, and falls back to his hands.
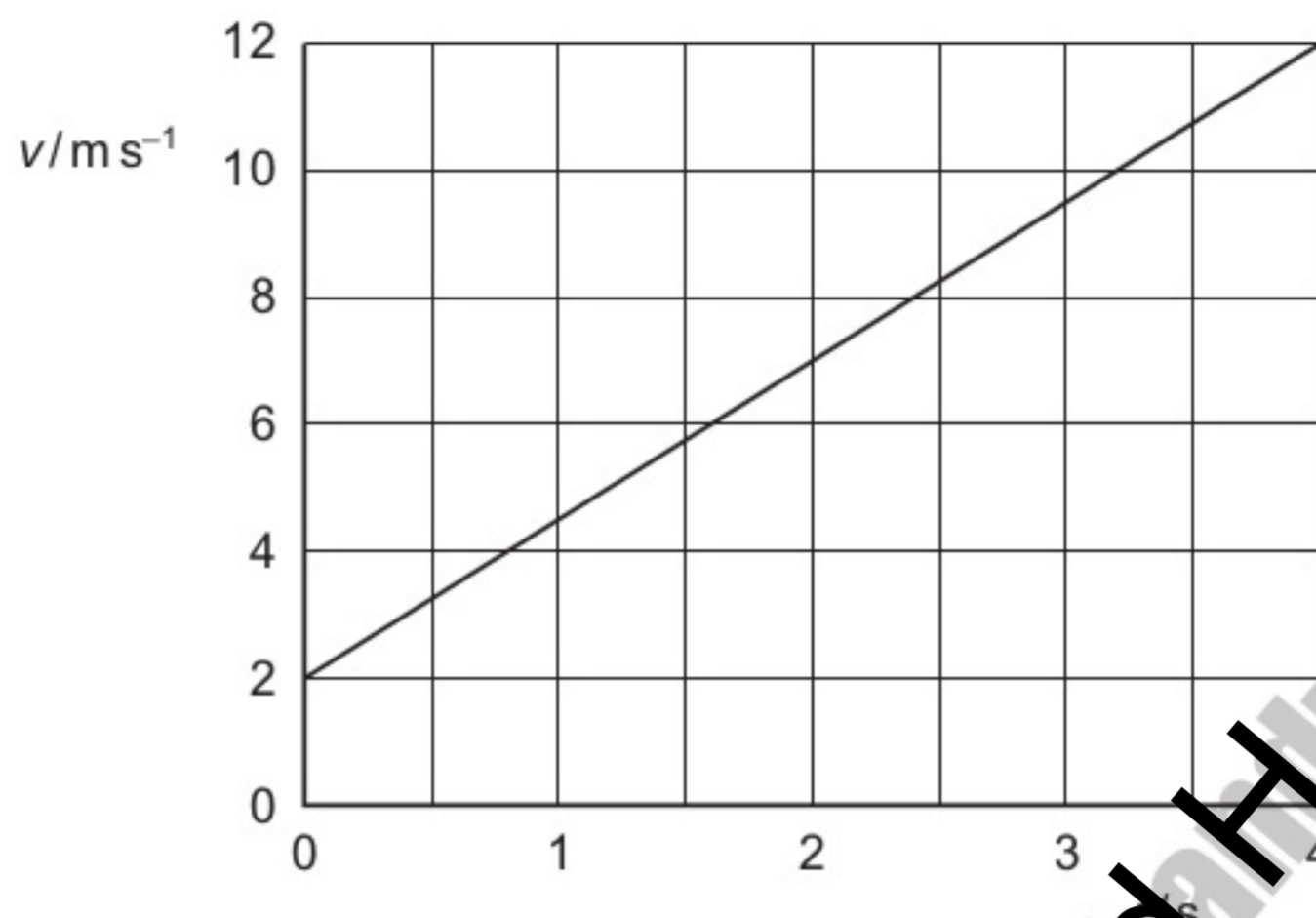
Which of the following gives the acceleration of the ball at various stages in its motion? Take vertically upwards as positive. Neglect air resistance.

	rising	at maximum height	falling
A	$-9.81\,\mathrm{m\,s^{-2}}$	0	$+9.81\,\mathrm{m\,s^{-2}}$
B	$-9.81\,\mathrm{m\,s^{-2}}$	$-9.81\,\mathrm{m\,s^{-2}}$	$-9.81\,\mathrm{m\,s^{-2}}$
C	$+9.81\,\mathrm{m\,s^{-2}}$	$+9.81\,\mathrm{m\,s^{-2}}$	$+9.81\,\mathrm{m\,s^{-2}}$
D	$+9.81\,\mathrm{m\,s^{-2}}$	0	$-9.81\,\mathrm{m\,s^{-2}}$

8 The diagram shows a velocity-time graph for a car.

What is the distance travelled between time $t = 0$ and $t = 4\,\text{s}$?

A 2.5 m **B** 3.0 m **C** 20 m **D** 28 m

9 A projectile is launched at point O and follows the path OPQRS, as shown. Air resistance may be neglected.

Which statement is true for the projectile when it is at the highest point Q of its path?

A The horizontal component of the projectile's acceleration is zero.

B The horizontal component of the projectile's velocity is zero.

C The kinetic energy of the projectile is zero.

D The momentum of the projectile is zero.

7 An experiment is done to measure the acceleration of free fall of a body from rest.

Which measurements are needed?

A the height of fall and the time of fall

B the height of fall and the weight of the body

C the mass of the body and the height of fall

D the mass of the body and the time of fall

6 A football is dropped from the top of a tall building.

9702/01/O/N/05

Which acceleration-time graph best represents the motion of the football through the air?

A

acceleration vs time

B

acceleration vs time

C

acceleration vs time

D

acceleration vs time
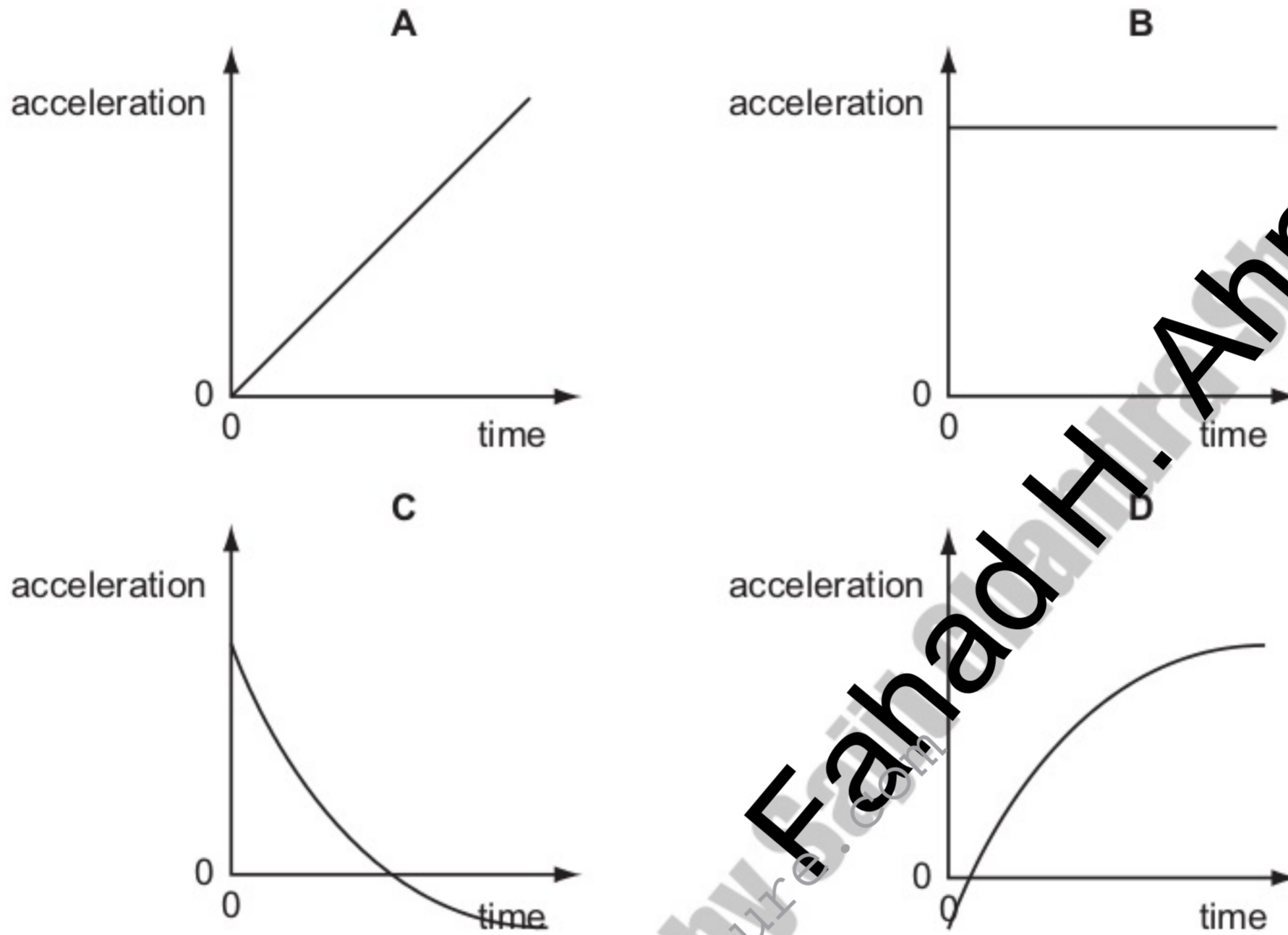
10 A force F is applied to a freely moving object. At one instant of time, the object has velocity v and acceleration a.
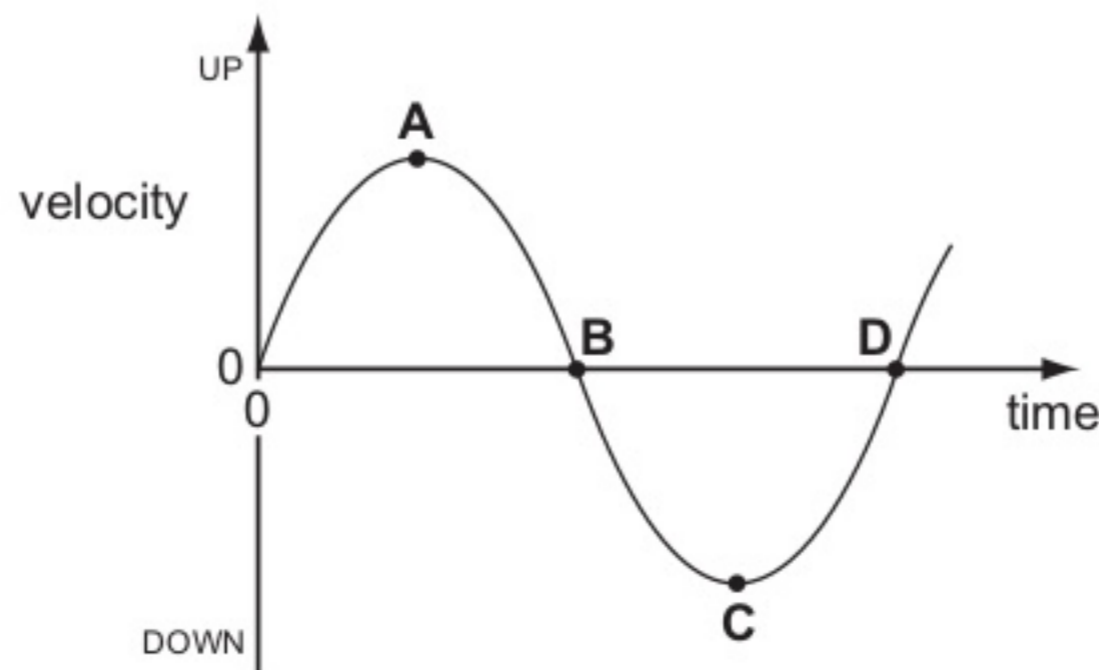
9702/01/O/N/06

Which quantities **must** be in the same direction?

A a and v only

B a and F only

C v and F only

D v, F and a

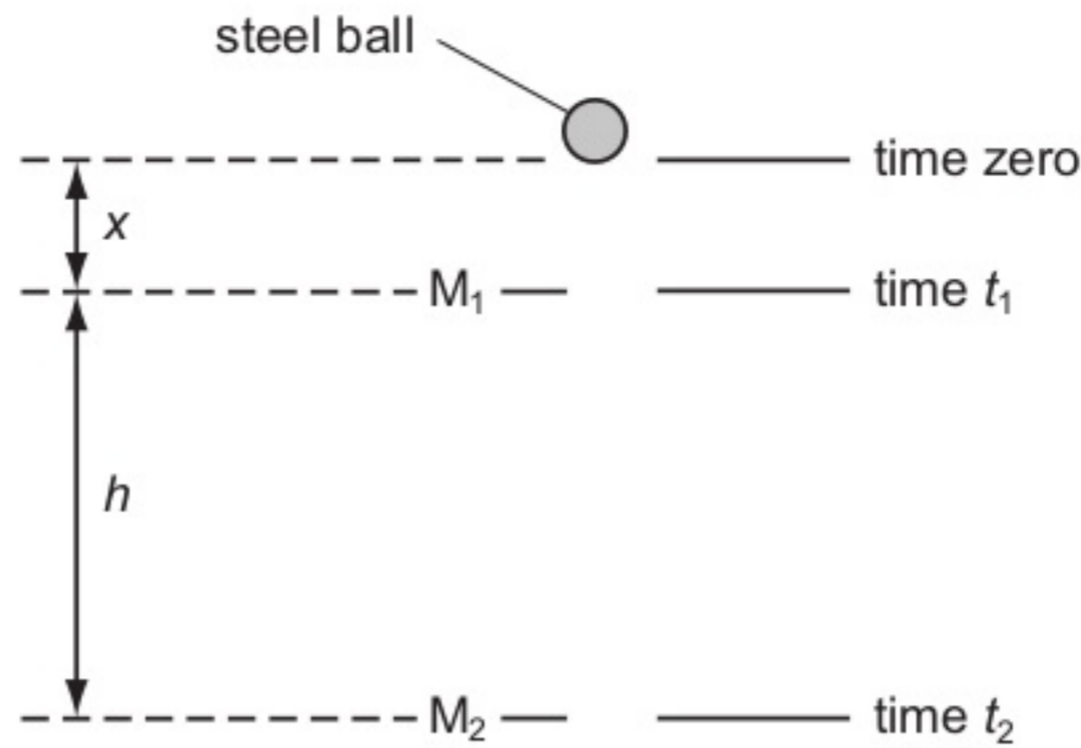**9** The diagram shows a velocity-time graph for a mass moving up and down on the end of a spring.

Which point represents the velocity of the mass when at the lowest point of its motion?

9702/01/O/N/05

velocity vs time graph with points A, B, C, D

7 Two markers M_1 and M_2 are set up a vertical distance h apart.

A steel ball is released at time zero from a point a distance x above M_1. The ball reaches M_1 at time t_1 and reaches M_2 at time t_2. The acceleration of the ball is constant.
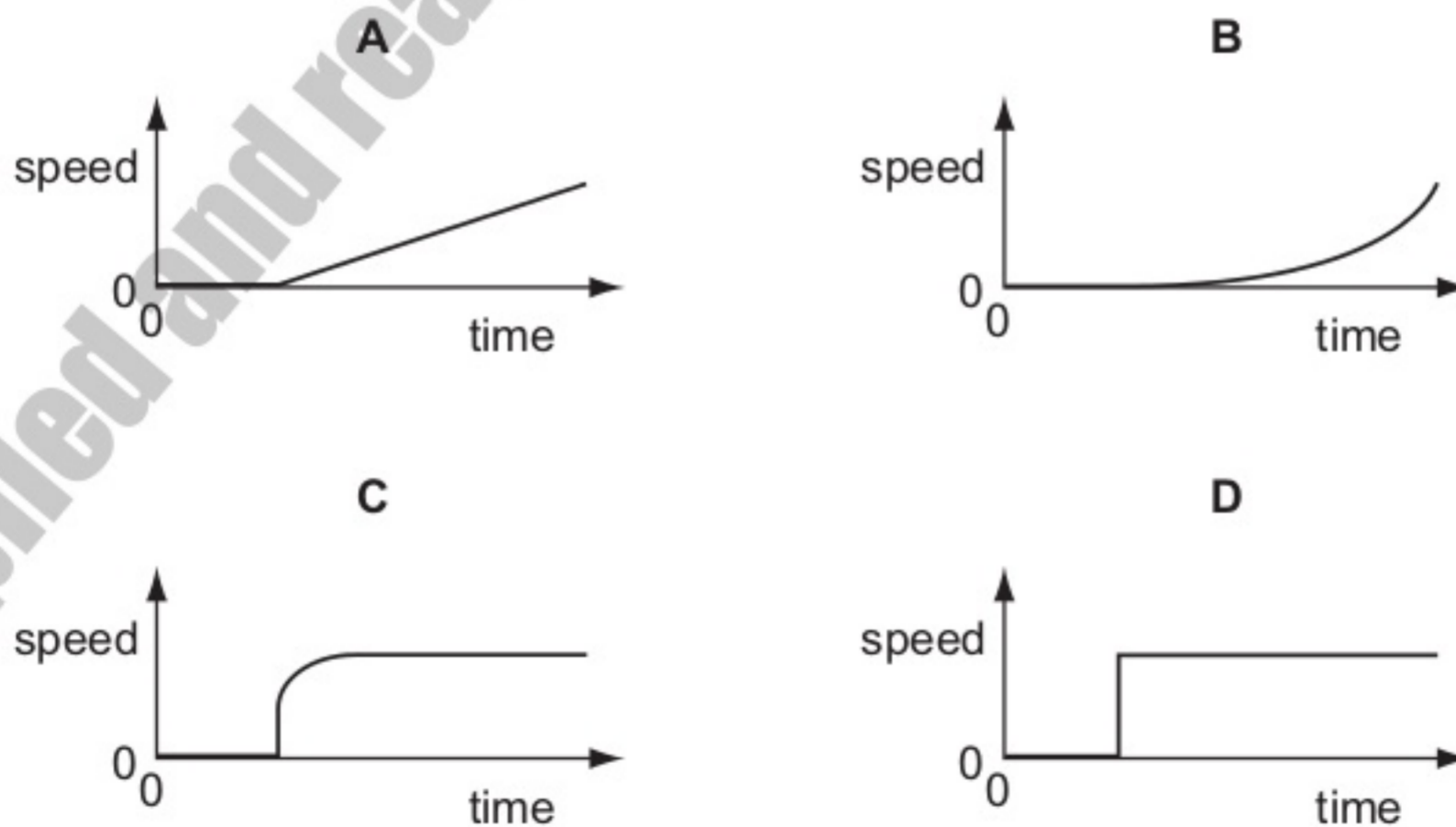
Which expression gives the acceleration of the ball?

A $\dfrac{2h}{t_2^2}$
B $\dfrac{2h}{(t_2+t_1)}$
C $\dfrac{2h}{(t_2-t_1)^2}$
D $\dfrac{2h}{(t_2^2-t_1^2)}$

8 A car driver sharply presses down the accelerator when the traffic lights go green. The resultant horizontal force acting on the car varies with time as shown.
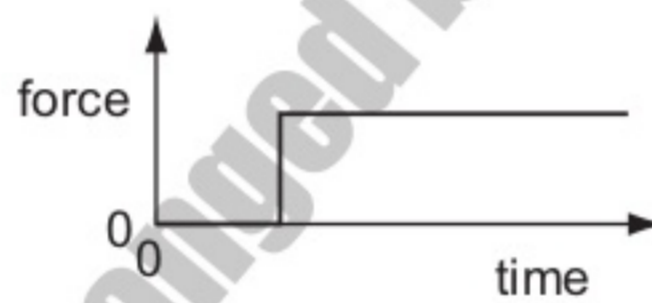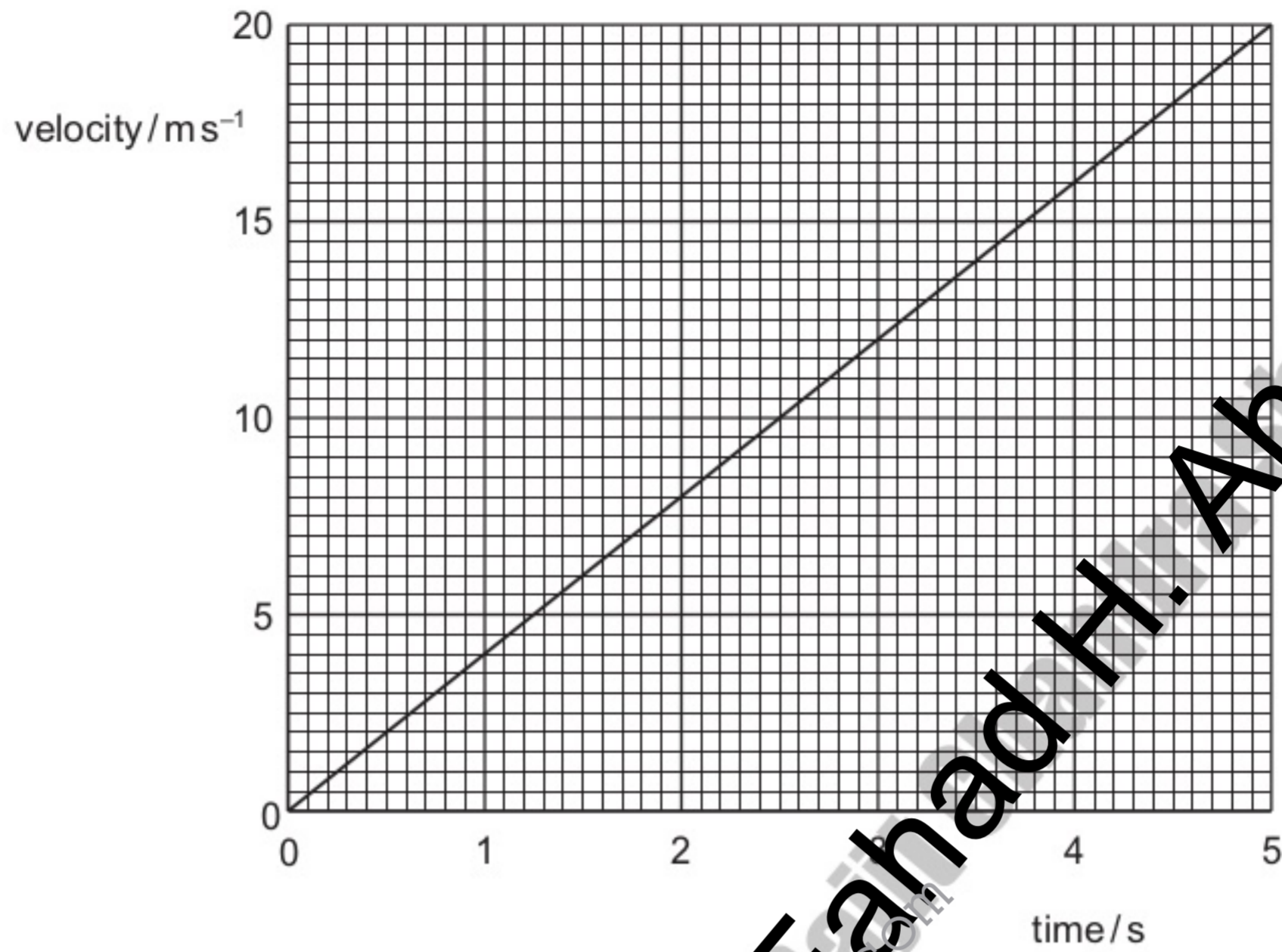
Which graph shows the variation with time of the speed of the car?

8 The velocity of an object during the first five seconds of its motion is shown on the graph.
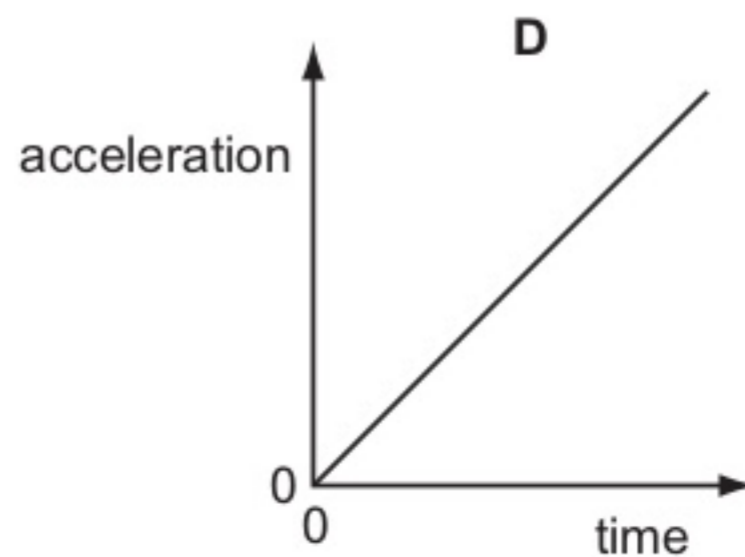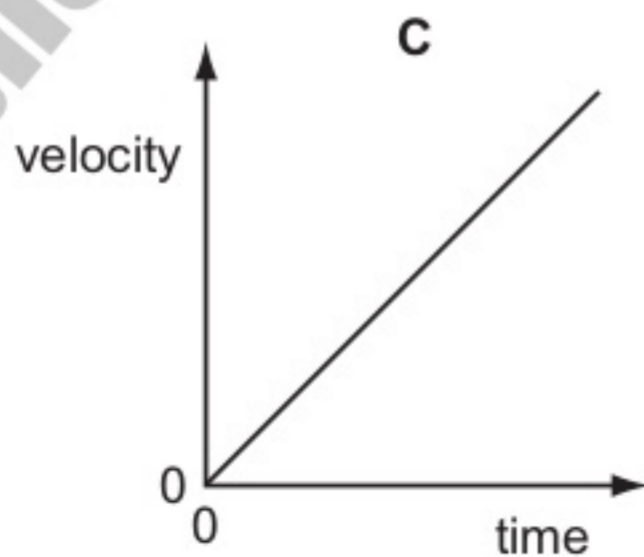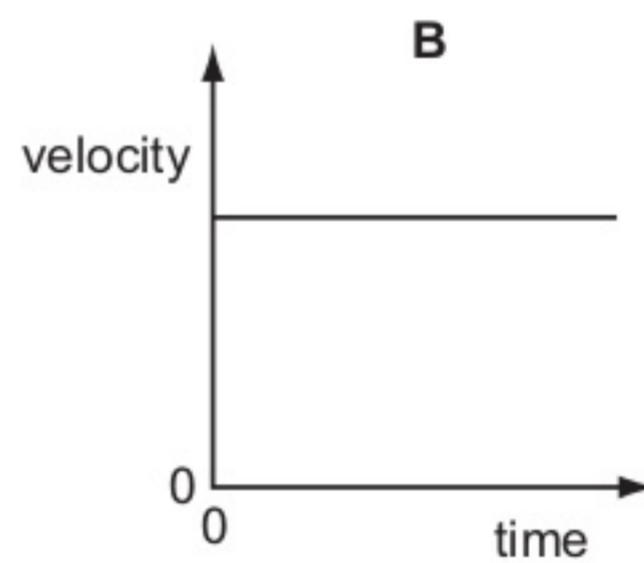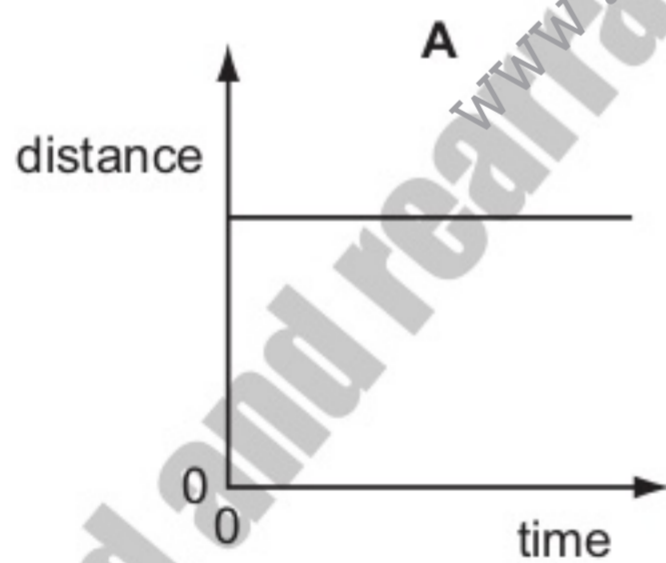
What is the distance travelled by the object in this time?

A 4 m **B** 20 m **C** 50 m **D** 100 m

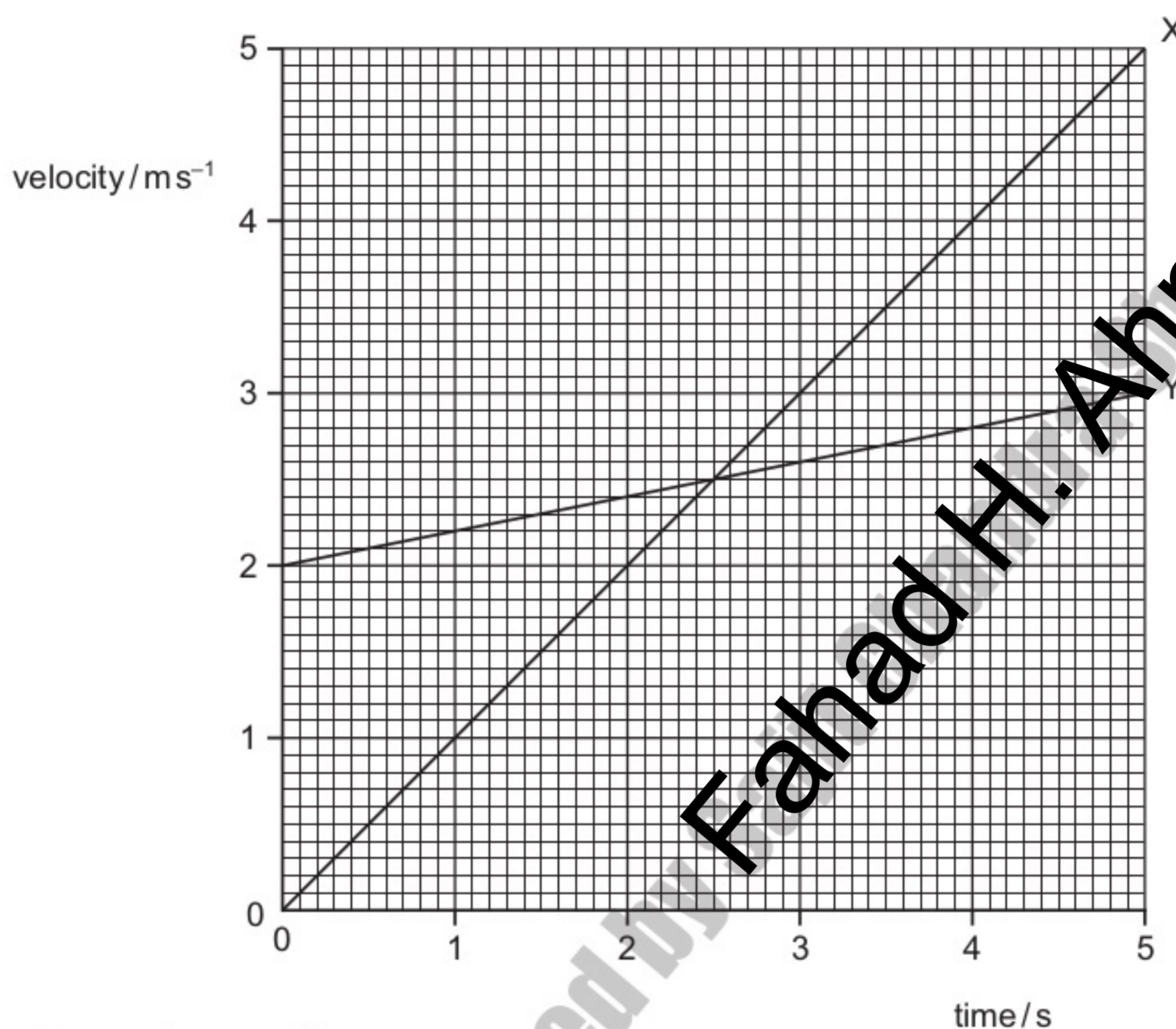**7** A particle is moving in a straight line with uniform acceleration.

Which graph represents the motion of the particle?

8 The graph shows velocity-time plots for two vehicles X and Y. The accelerations and distances travelled by the two vehicles can be estimated from these plots.

9702/01/O/N/06

Which statement is correct?

A   The accelerations of X and Y are the same at 2.5 s.

B   The initial acceleration of Y is greater than that of X.

C   The distance travelled by X is greater than that travelled by Y in the 5 s period.

D   The distances travelled by X and Y in the 5 s period are the same.

8 A stone is dropped from the top of a tower of height 40 m. The stone falls from rest and air resistance is negligible.

9702/01/M/J/07

What time is taken for the stone to fall the last 10 m to the ground?

A   0.38 s   B   1.4 s   C   2.5 s   D   2.9 s

9 What is meant by the weight of an object?

9702/01/M/J/07

A   the gravitational field acting on the object

B   the gravitational force acting on the object

C   the mass of the object multiplied by gravity

D   the object's mass multiplied by its acceleration

9 A projectile is fired at an angle α to the horizontal at a speed u, as shown.

9702/01/O/N/06
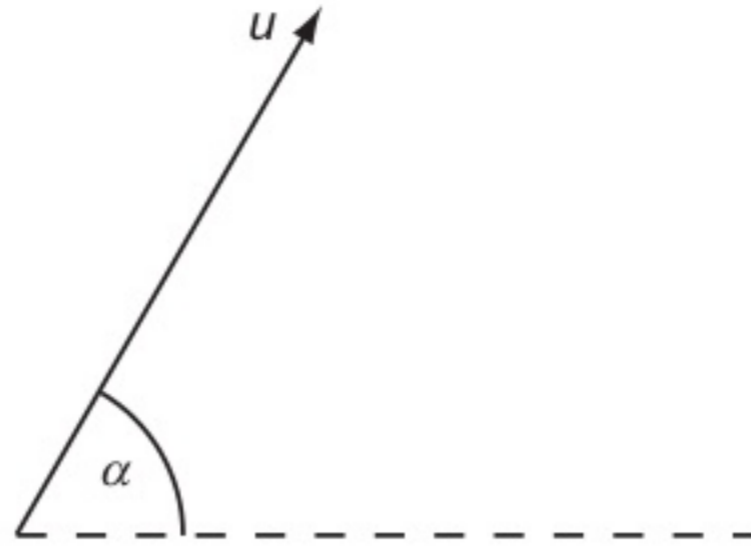
What are the vertical and horizontal components of its velocity after a time t? Assume that air resistance is negligible. The acceleration of free fall is g.

|	vertical component	horizontal component
A	$u \sin \alpha$	$u \cos \alpha$
B	$u \sin \alpha - gt$	$u \cos \alpha - gt$
C	$u \sin \alpha - gt$	$u \cos \alpha$
D	$u \cos \alpha$	$u \sin \alpha - gt$

6 What gives the value of a body's acceleration?

9702/01/M/J/07

A the area under its displacement-time graph

B the area under its velocity-time graph

C the gradient of its displacement-time graph

D the gradient of its velocity-time graph

8 A particle moves along a straight line. A particular property K of the particle's motion is plotted against time.

9702/01/O/N/07
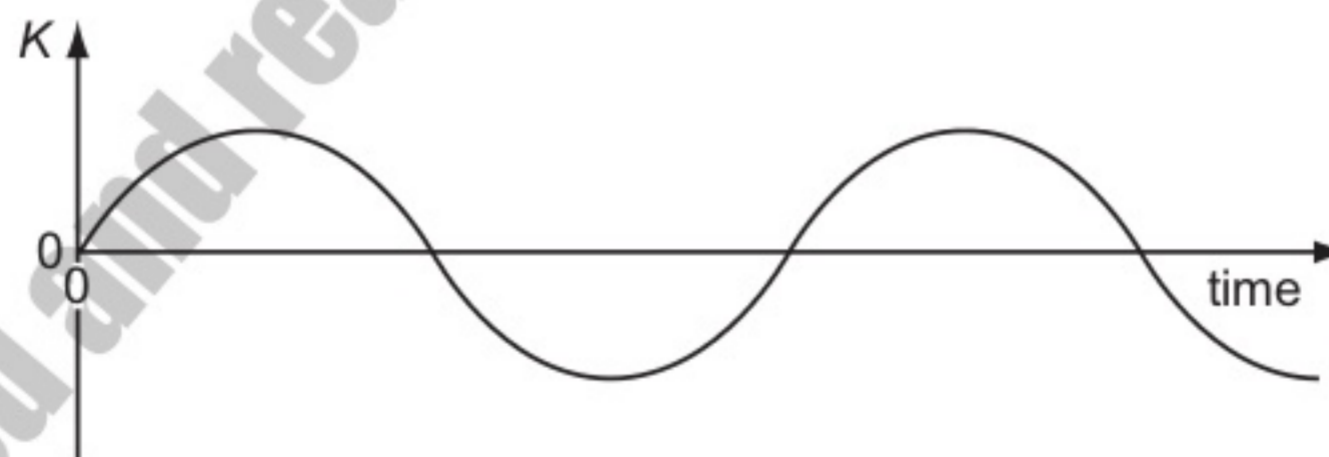
At any time, the slope of the graph is the acceleration of the particle.

What is the property K?

A the displacement of the particle

B the distance travelled by the particle

C the speed of the particle

D the velocity of the particle

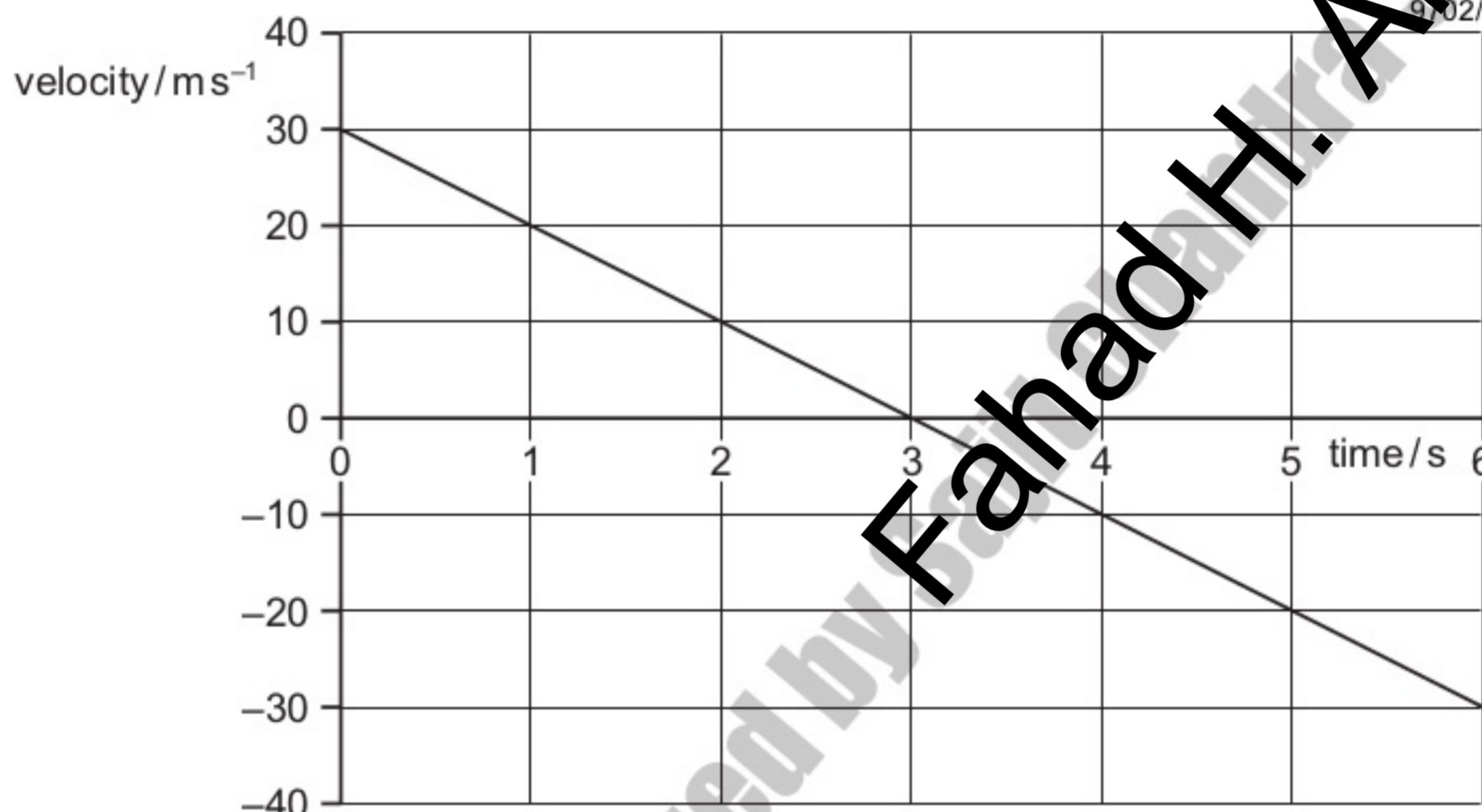**7** The symbol g represents the acceleration of free fall.   9702/01/O/N/07

Which of these statements is correct?

A g is gravity.

B g is reduced by air resistance.

C g is the ratio weight/mass.

D g is the weight of an object.

9 A stone is thrown vertically upwards. A student plots the variation with time of its velocity.   9702/01/O/N/07

What is the vertical displacement of the stone from its starting point after 5 seconds?

A 20 m   **B** 25 m   **C** 45 m   **D** 65 m

5 Four students each made a series of measurements of the acceleration of free fall g. The table shows the results obtained.   9702/01/M/J/08

Which set of results could be described as precise but **not** accurate?

	g/m s^{-2}			
A	9.81	9.79	9.84	9.83
B	9.81	10.12	9.89	8.94
C	9.45	9.21	8.99	8.76
D	8.45	8.46	8.50	8.41

7 The acceleration of free fall on a planet P is $\frac{1}{6}$ of the acceleration of free fall on Earth. 9702/01/M/J/08

The mass of a body on planet P is 30 kg.

What is its weight on planet P?

A 4.9 N   **B** 49 N   **C** 180 N   **D** 290 N

6 An object accelerates in a direction that is always perpendicular to its motion.

9702/01/M/J/08

What is the effect, if any, of the acceleration on the object's speed and direction?

	speed	direction
A	changes	changes
B	changes	constant
C	constant	changes
D	constant	constant

8 A football is dropped from the top of a tall building.

9702/01/M/J/08

Which acceleration-time graph best represents the motion of the football through the air?
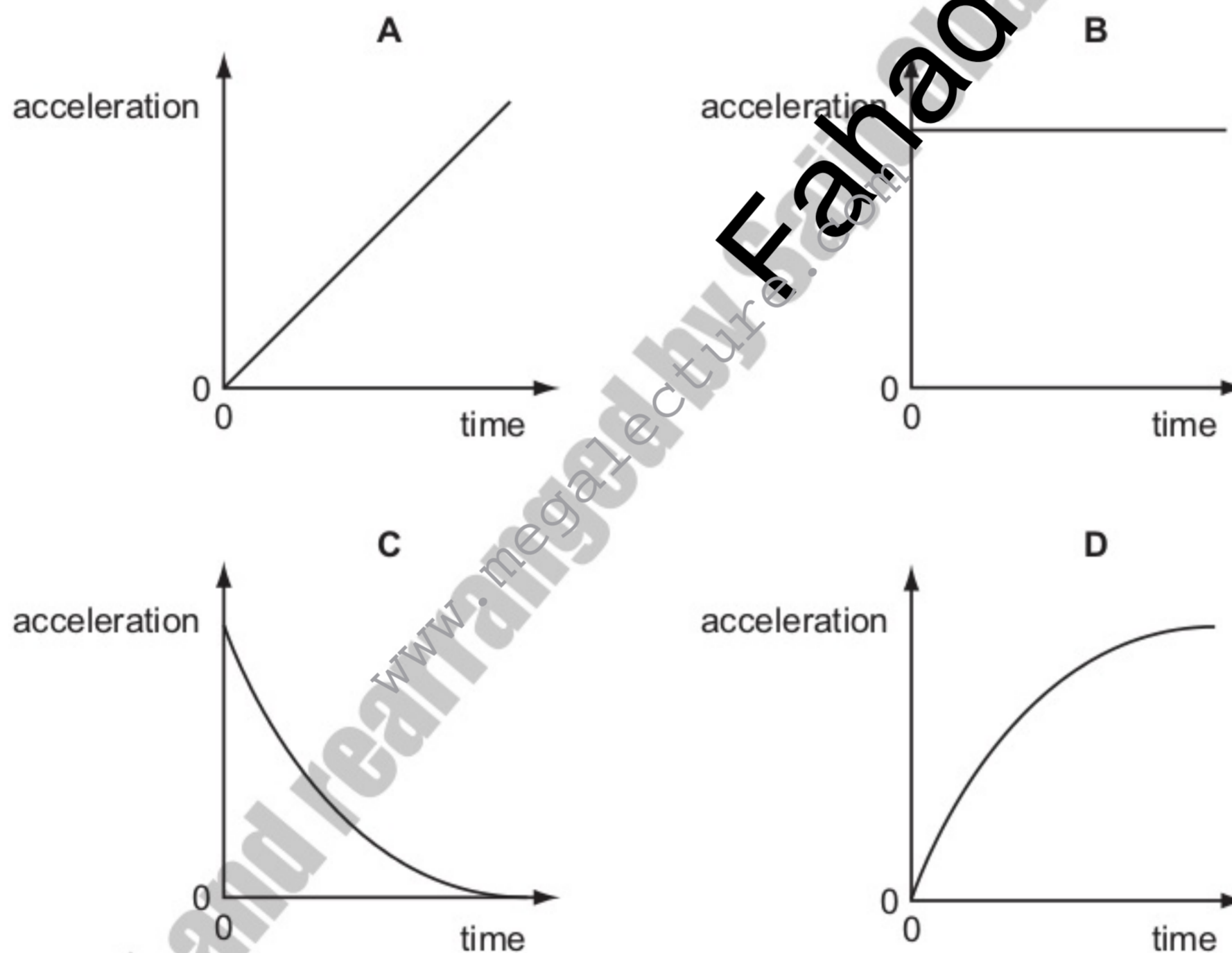
5 On a particular railway, a train driver applies the brake of the train at a yellow signal, a distance of 1.0 km from a red signal, where it stops.
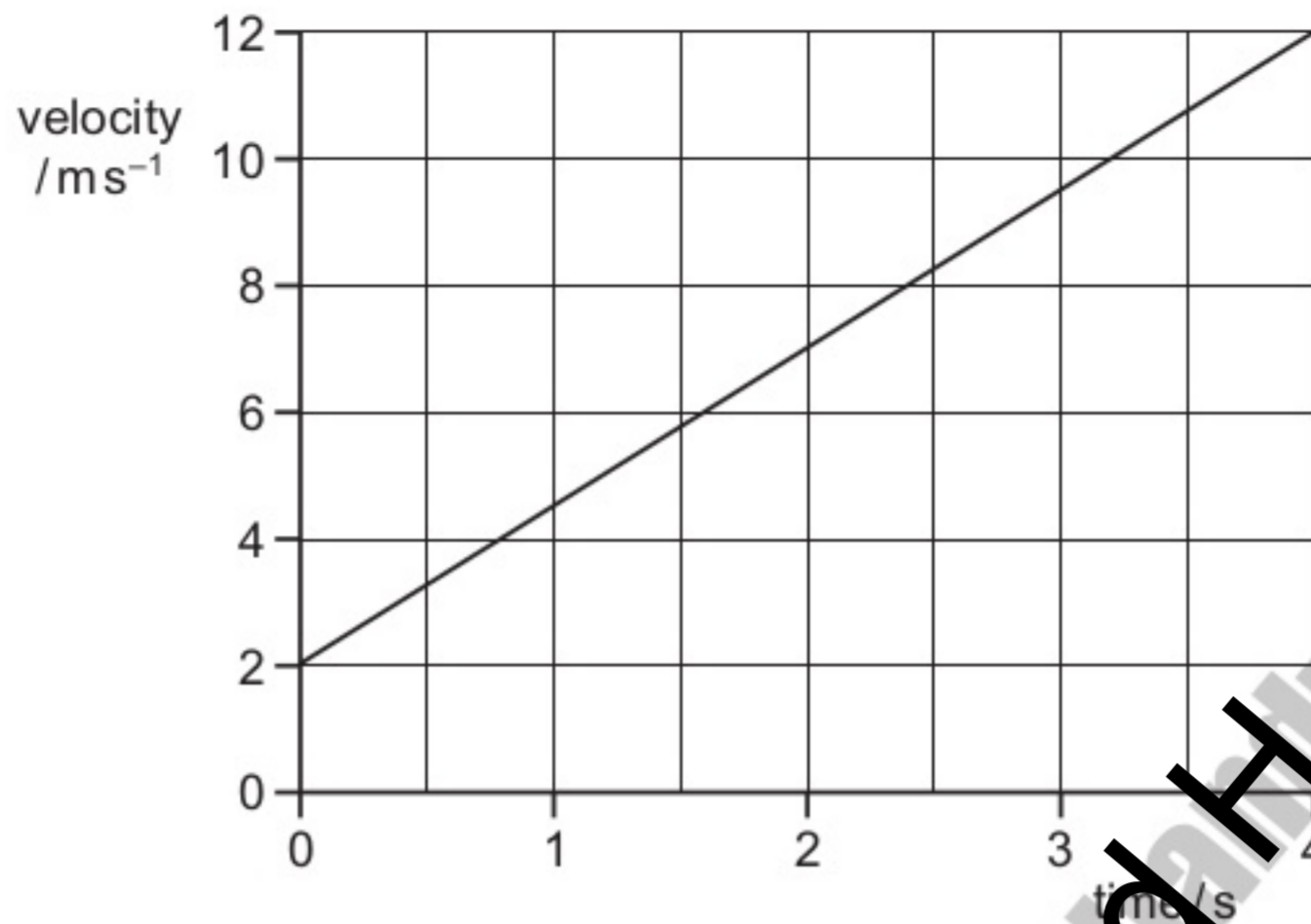
9702/11/O/N/09

The maximum deceleration of the train is $0.2\,m\,s^{-2}$.

Assuming uniform deceleration, what is the maximum safe speed of the train at the yellow signal?

A $20\,m\,s^{-1}$ B $40\,m\,s^{-1}$ C $200\,m\,s^{-1}$ D $400\,m\,s^{-1}$

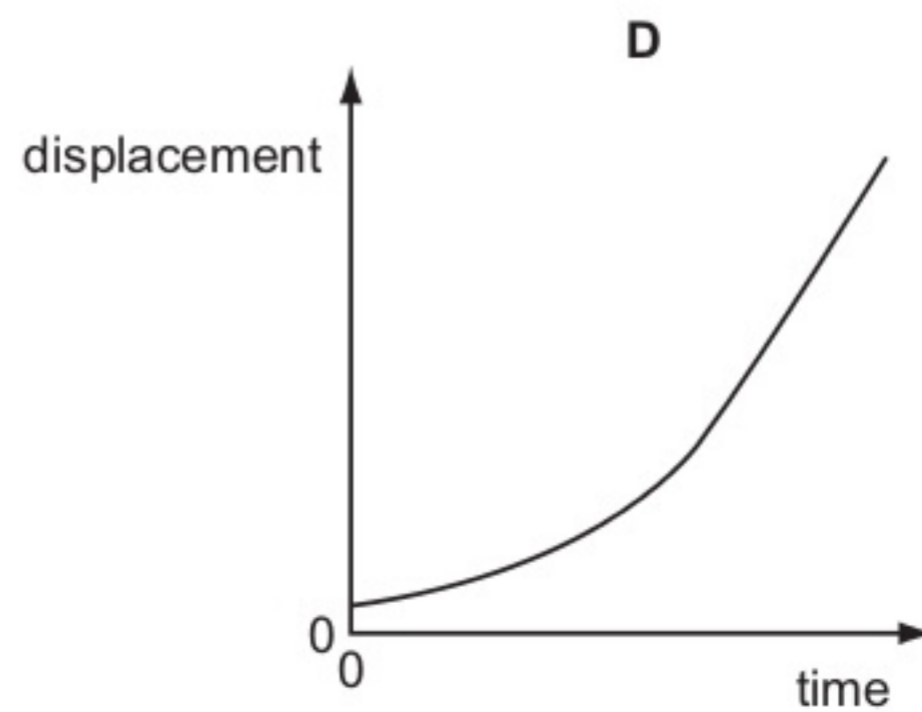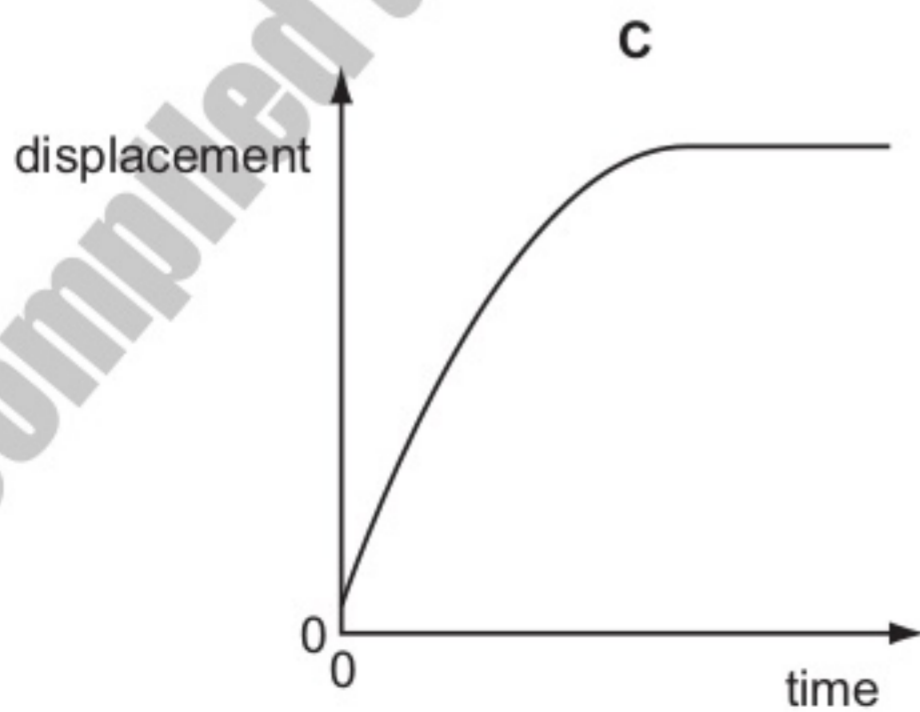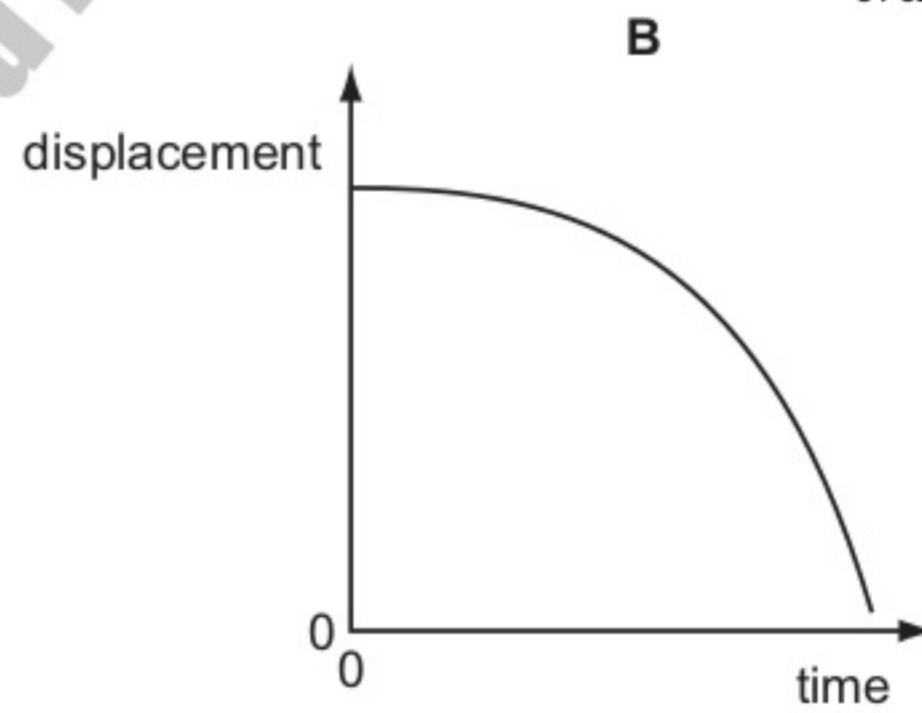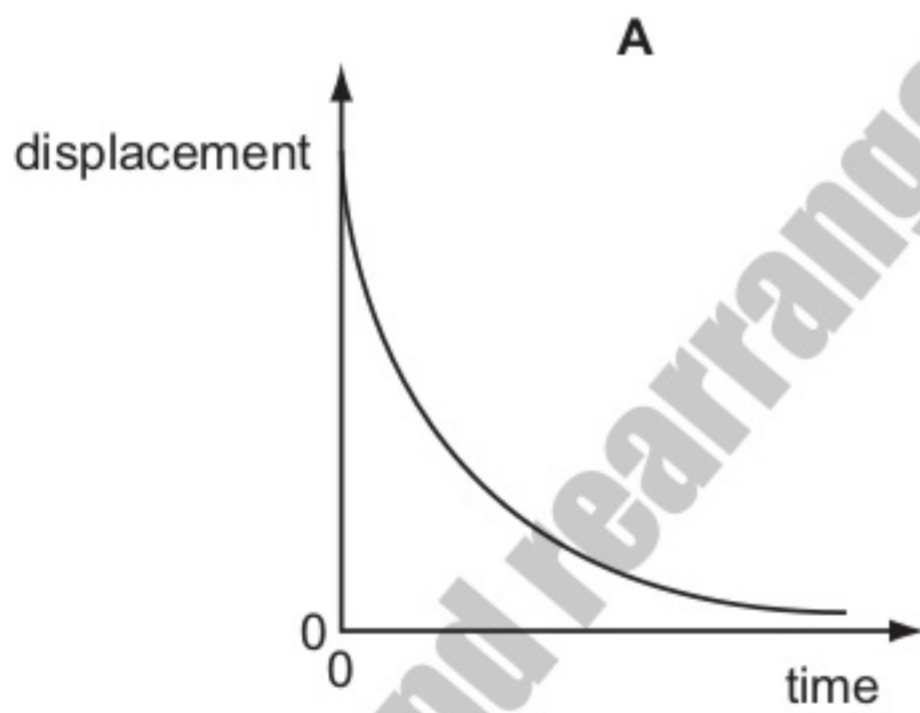**6** The diagram shows a velocity-time graph for a car.

9702/01/O/N/08

What is the distance travelled during the first 4.0s?
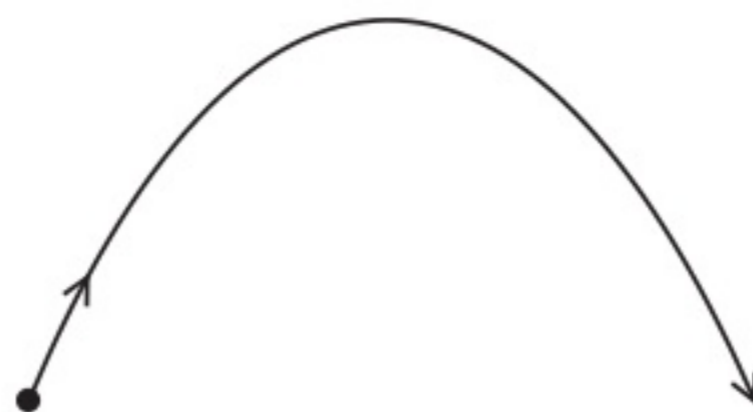
A 2.5m **B** 3.0m **C** 20m **D** 28m

5 Which displacement-time graph best represents the motion of a falling sphere, the initial acceleration of which eventually reduces until it begins to travel at constant terminal velocity?

9702/01/M/J/09

**7** A stone is thrown upwards and follows a curved path.

9702/01/O/N/08

Air resistance is negligible.

Why does the path have this shape?

A The stone has a constant horizontal velocity and constant vertical acceleration.

B The stone has a constant horizontal acceleration and constant vertical velocity.

C The stone has a constant upward acceleration followed by a constant downward acceleration.

D The stone has a constant upward velocity followed by a constant downward velocity.

8 Which graph represents the motion of a car that is travelling along a straight road with a speed that increases uniformly with time?

9702/01/O/N/08
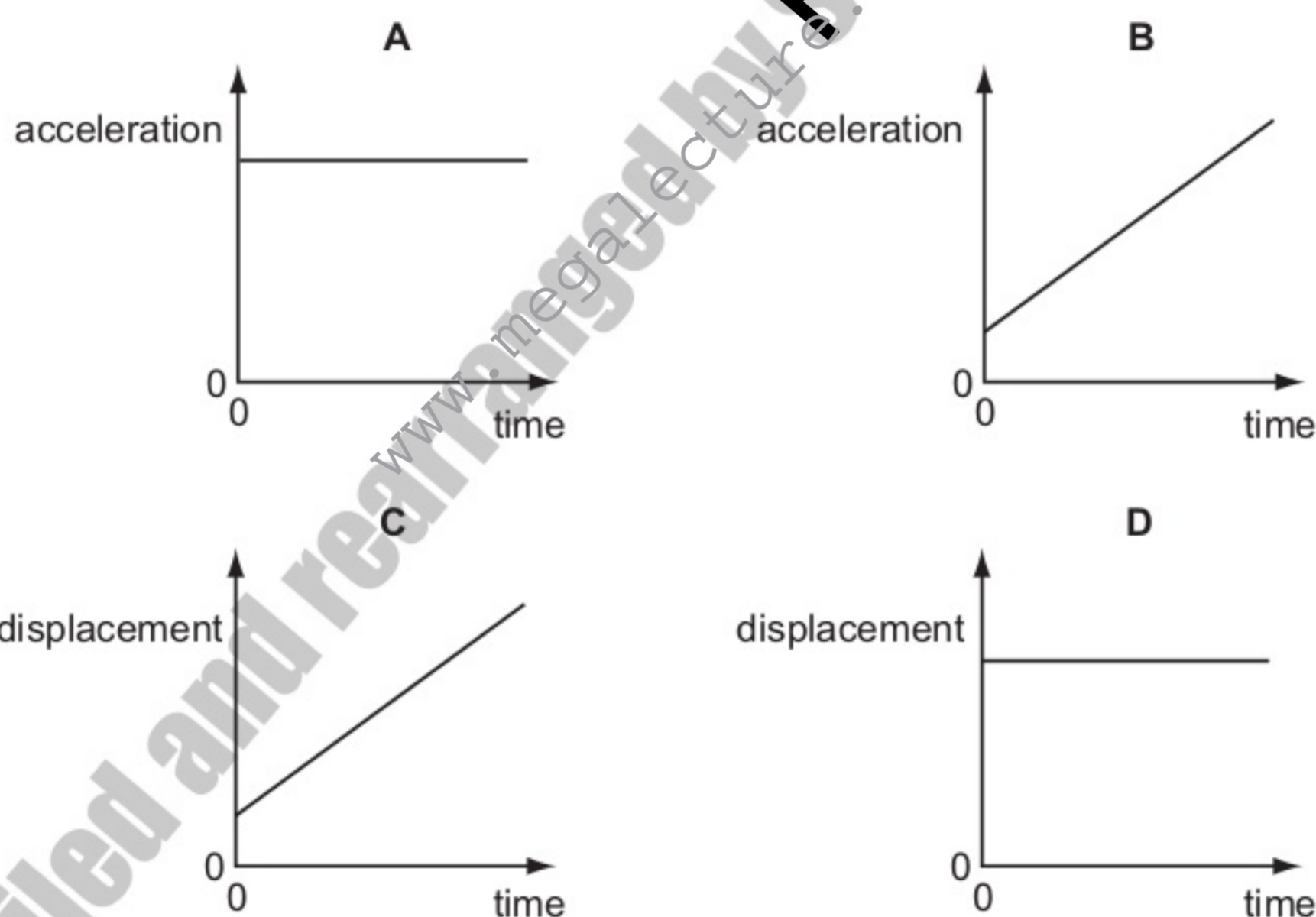
4 On a particular railway, a train driver applies the brake of the train at a yellow signal, a distance of 1.0 km from a red signal, where it stops.

9702/12/O/N/09

The maximum deceleration of the train is $0.2 \, \text{m s}^{-2}$.
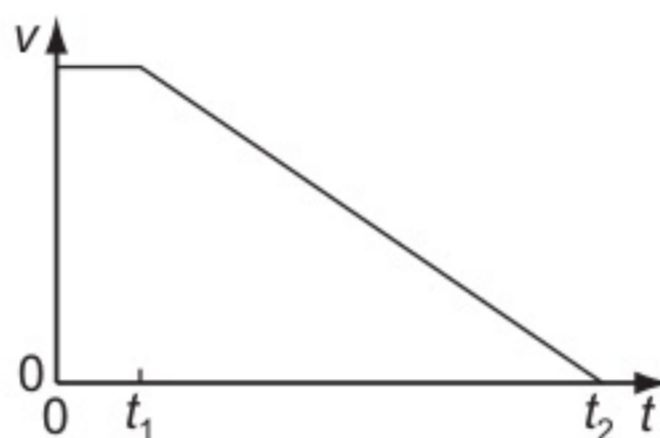
Assuming uniform deceleration, what is the maximum safe speed of the train at the yellow signal?

A $20 \, \text{m s}^{-1}$ **B** $40 \, \text{m s}^{-1}$ **C** $200 \, \text{m s}^{-1}$ **D** $400 \, \text{m s}^{-1}$
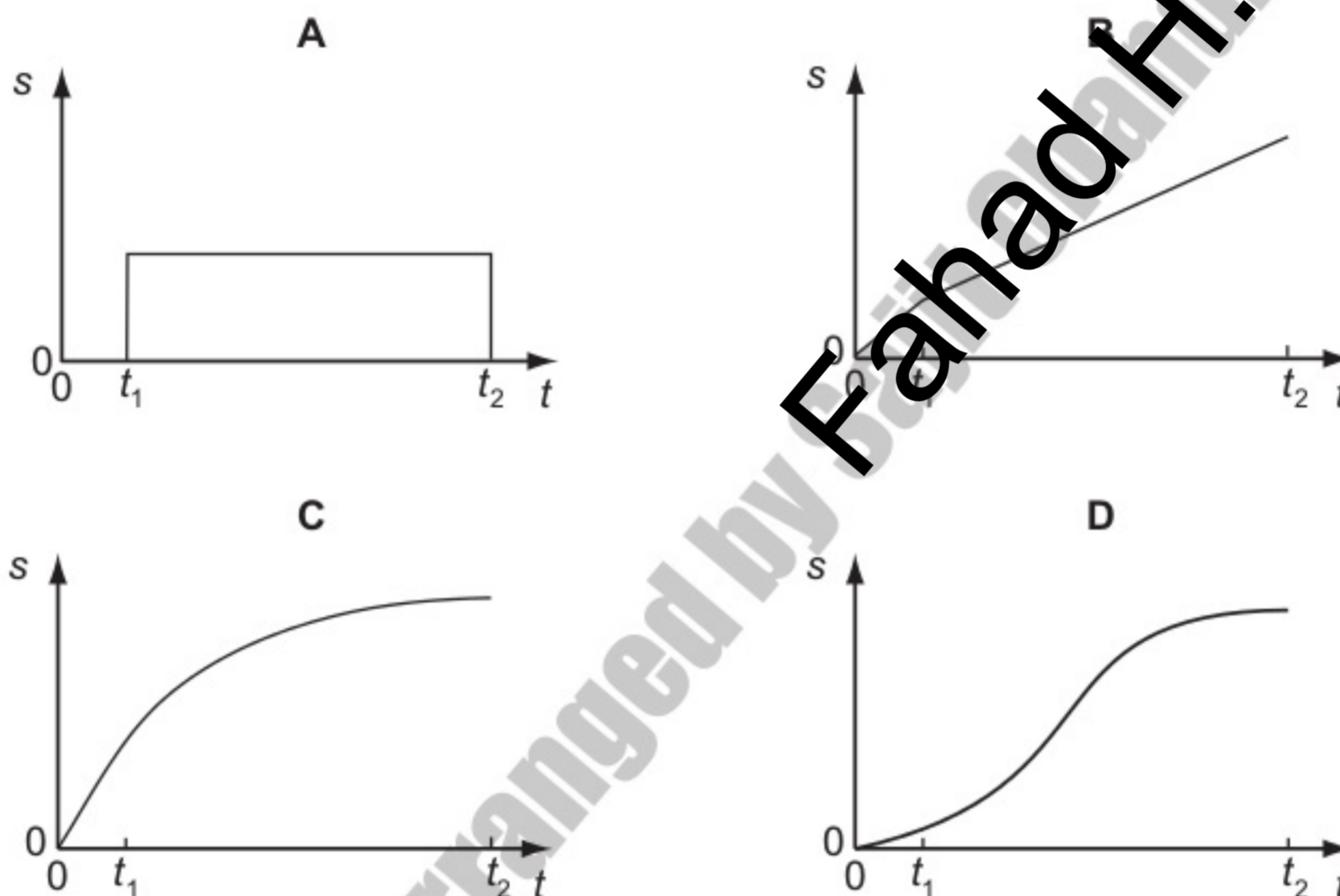
6 When a car driver sees a hazard ahead, she applies the brakes as soon as she can and brings the car to rest.

9702/01/M/J/09

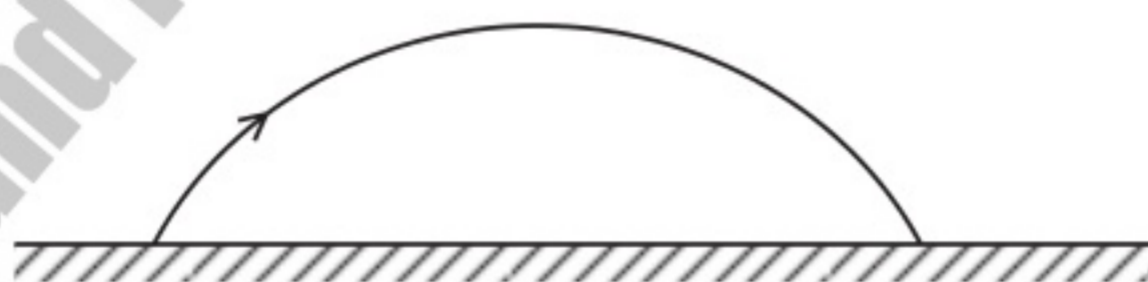The graph shows how the speed v of the car varies with time t after she sees the hazard.

Which graph represents the variation with time t of the distance s travelled by the car after she has seen the hazard?

8 The diagram shows the path of a golf ball.

9702/01/M/J/09

Which row describes changes in the horizontal and vertical components of the golf ball's velocity, when air resistance forces are ignored?

	horizontal	vertical
A	constant deceleration	constant acceleration downwards
B	constant deceleration	acceleration decreases upwards then increases downwards
C	constant velocity	constant acceleration downwards
D	constant velocity	acceleration decreases upwards then increases downwards

6 A ball is released from rest above a horizontal surface and bounces several times. 9702/11/O/N/09

   The graph shows how, for this ball, a quantity y varies with time.
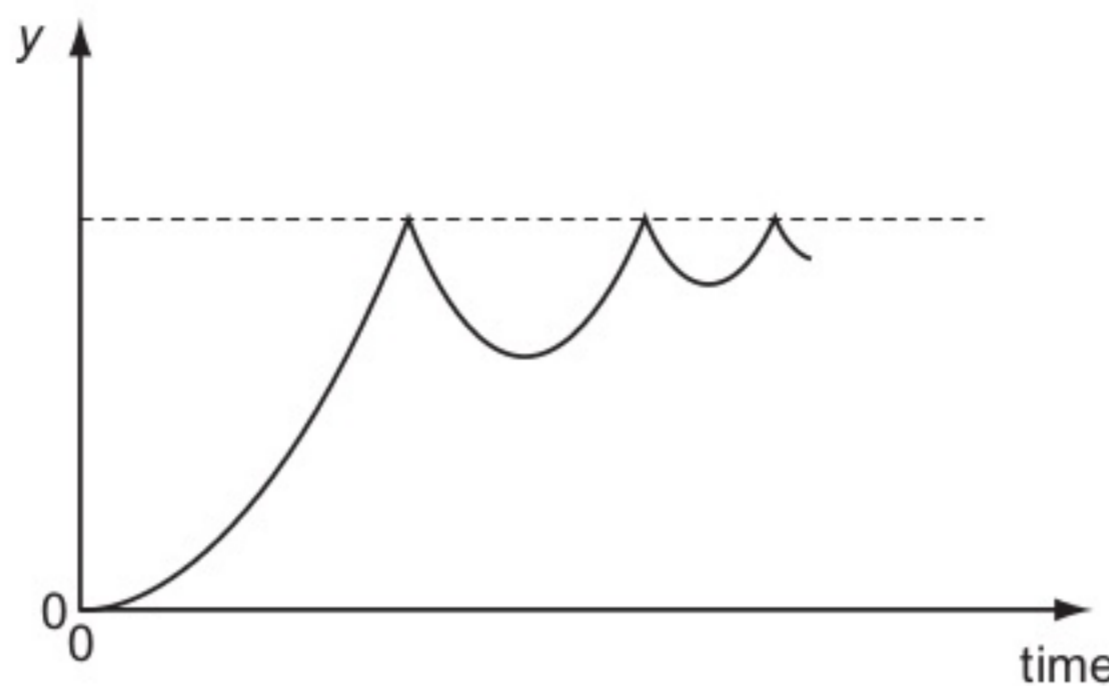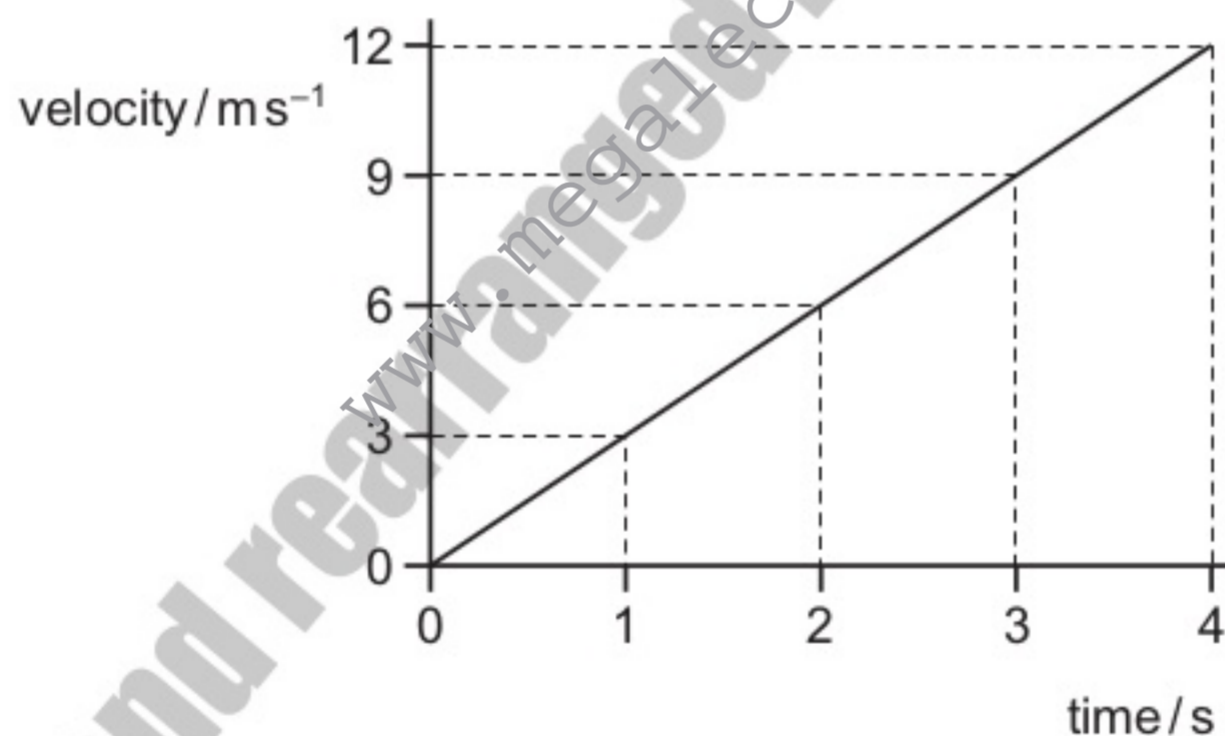

   What is the quantity y?

   A   acceleration

   B   displacement

   C   kinetic energy

   D   velocity

7 The diagram shows a velocity-time graph. 9702/11/O/N/09

   What is the displacement during the last 2 seconds of the motion?

   A   6 m   B   12 m   C   18 m   D   24 m

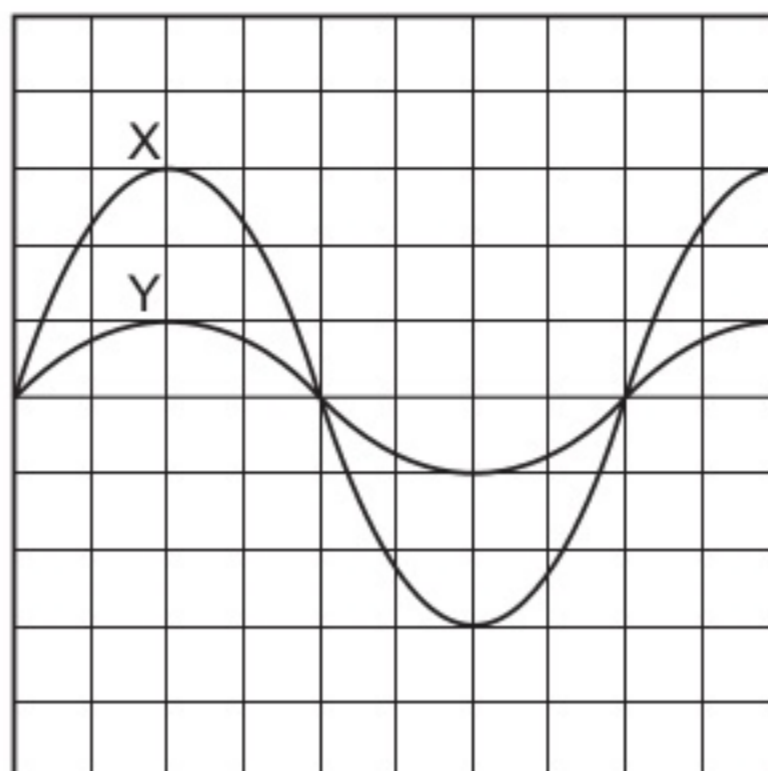7 Which statement about a ball that strikes a tennis racket and rebounds is **always** correct?
                                                                              9702/12/O/N/09

   A   Total kinetic energy of the ball is conserved.

   B   Total kinetic energy of the system is conserved.

   C   Total momentum of the ball is conserved.

   D   Total momentum of the system is conserved.

3   The diagram shows an oscilloscope screen displaying two signals.

Signal X has a frequency of 50 Hz and peak voltage of 12 V.

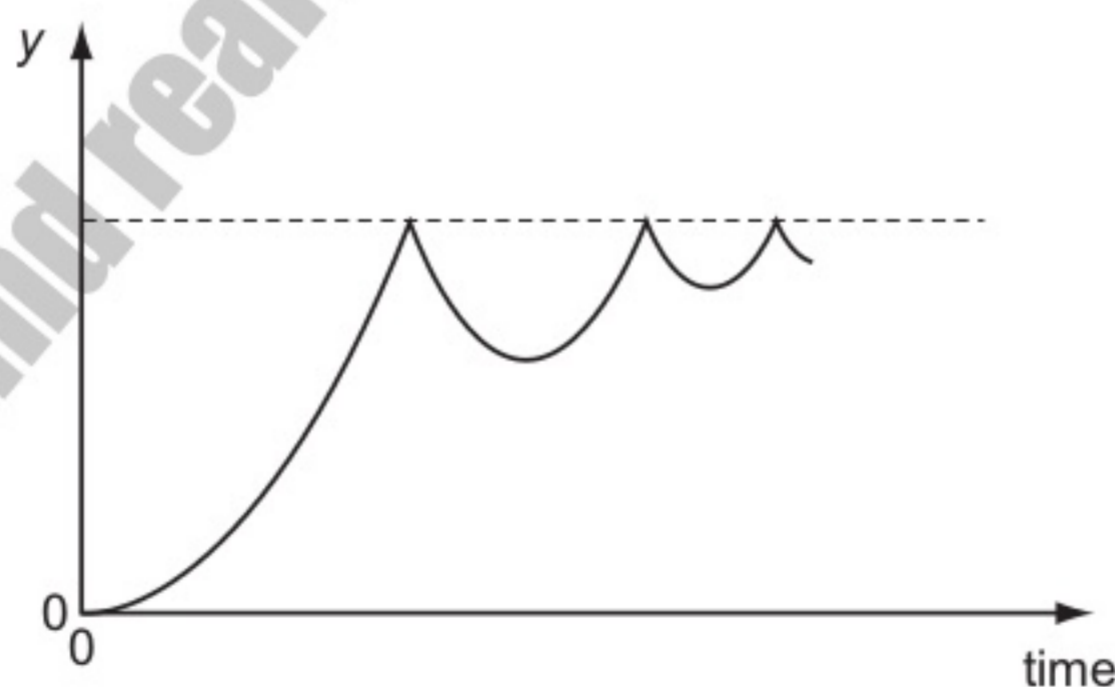What is the period and peak voltage of signal Y?

	period / ms	peak voltage / V
A	20	4
B	20	12
C	50	4
D	50	12

5   A ball is released from rest above a horizontal surface and bounces several times.   9702/12/O/N/09

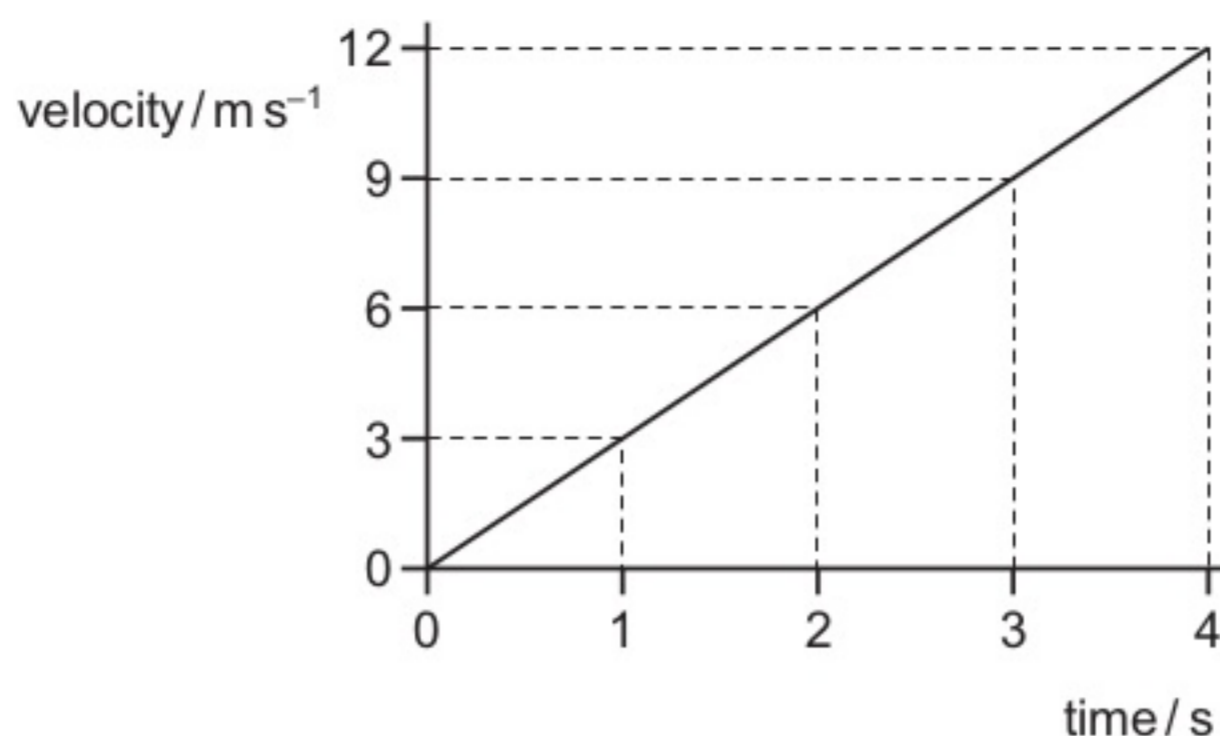The graph shows how, for this ball, a quantity y varies with time.

What is the quantity y?

A   acceleration

B   displacement

C   kinetic energy

D   velocity

6 The diagram shows a velocity-time graph.
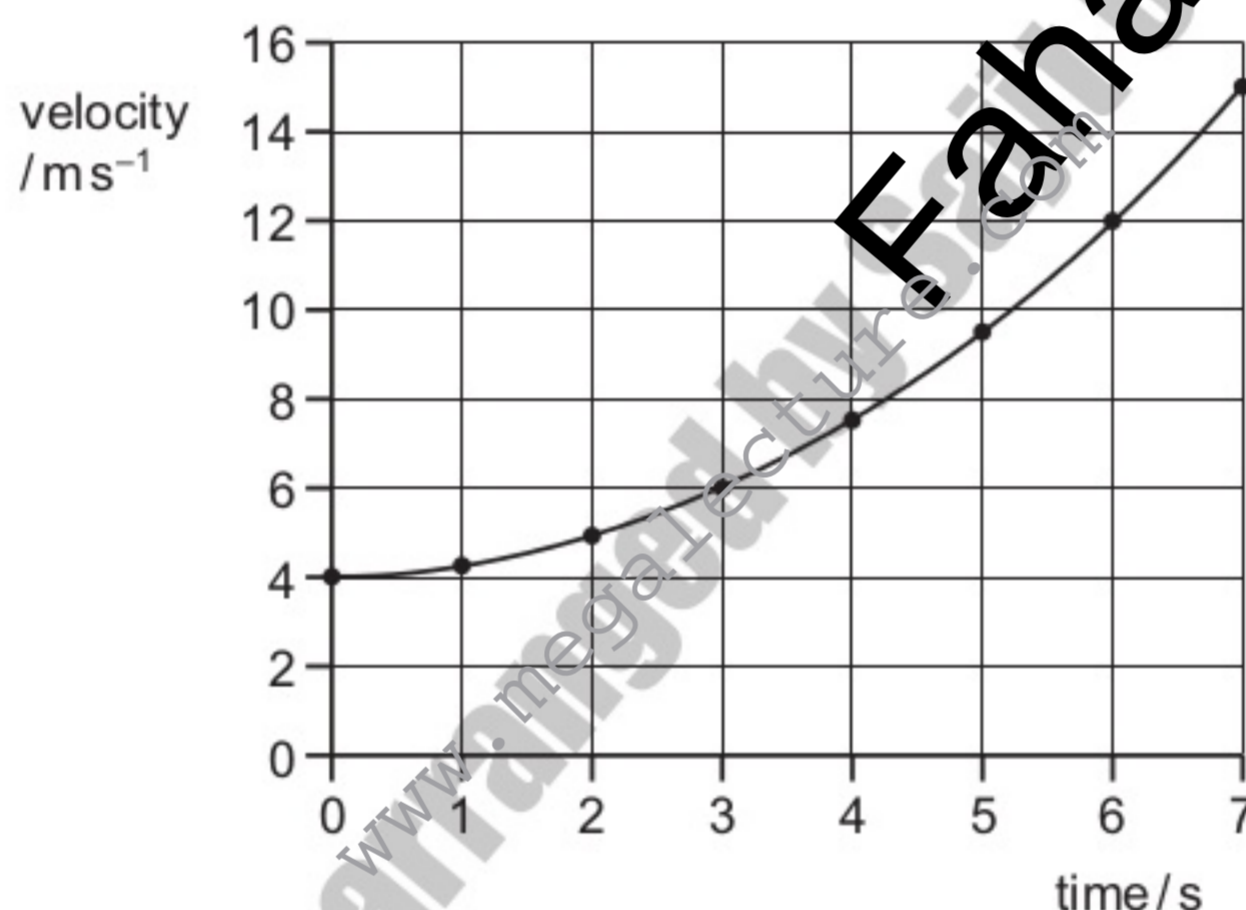
9702/12/O/N/09

What is the displacement during the last 2 seconds of the motion?

A 6 m **B** 12 m **C** 18 m **D** 24 m

8 The diagram shows a velocity-time graph for a vehicle.

9702/11/M/J/10

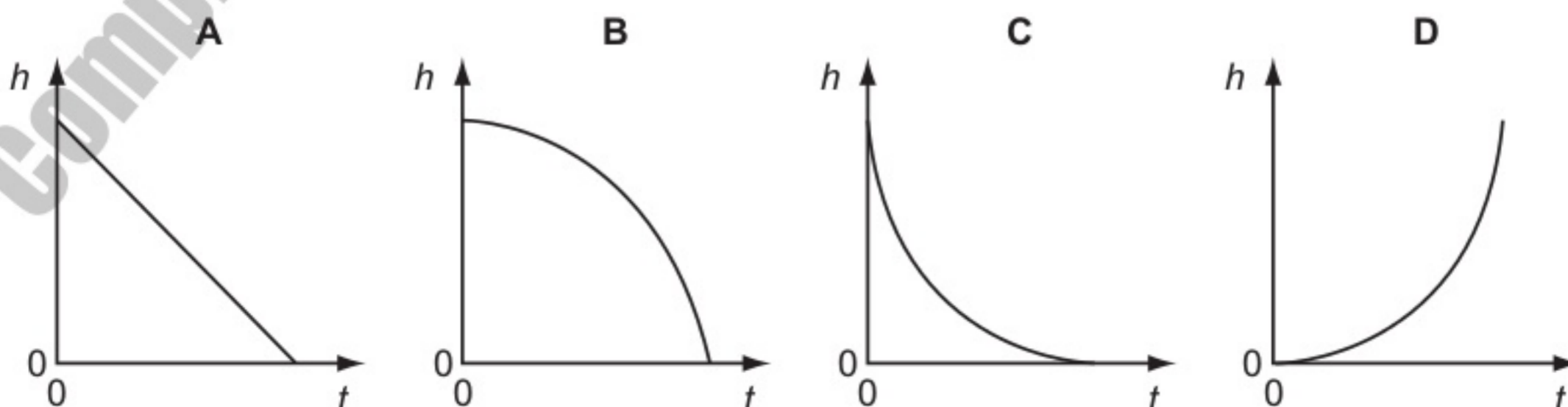The vehicle, moving at $4.0\,\mathrm{m\,s^{-1}}$, begins to accelerate at time = 0.

What is the vehicle's acceleration at time = 3.0 s?

A $0.67\,\mathrm{m\,s^{-2}}$ **B** $1.0\,\mathrm{m\,s^{-2}}$ **C** $1.3\,\mathrm{m\,s^{-2}}$ **D** $2.0\,\mathrm{m\,s^{-2}}$

9 A small steel ball falls freely under gravity after being released from rest.
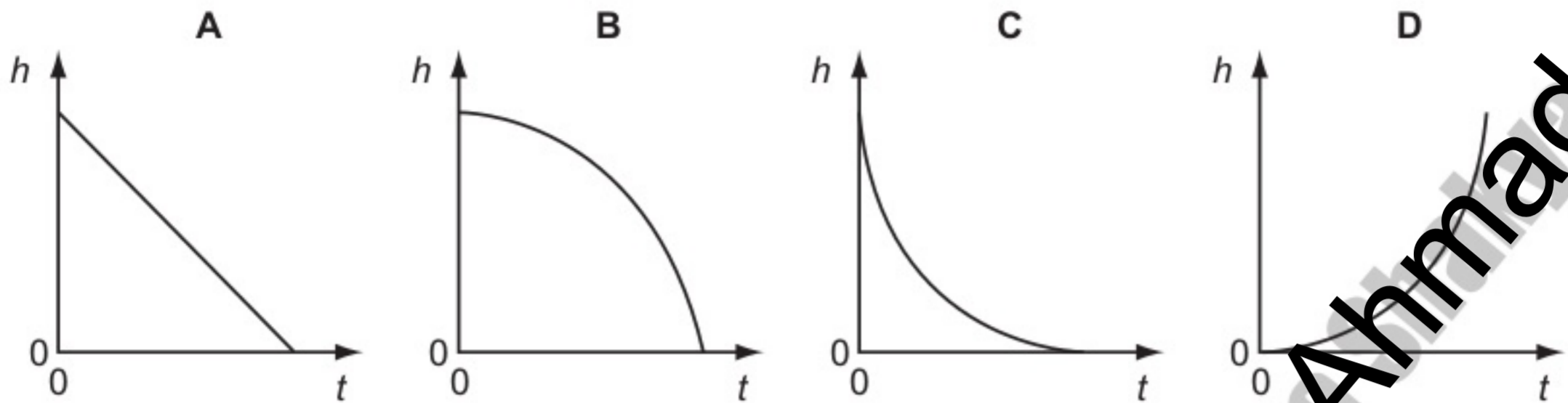
9702/11/M/J/10

Which graph best represents the variation of the height h of the ball with time t?

8 A small steel ball falls freely under gravity after being released from rest.   9702/12/M/J/10
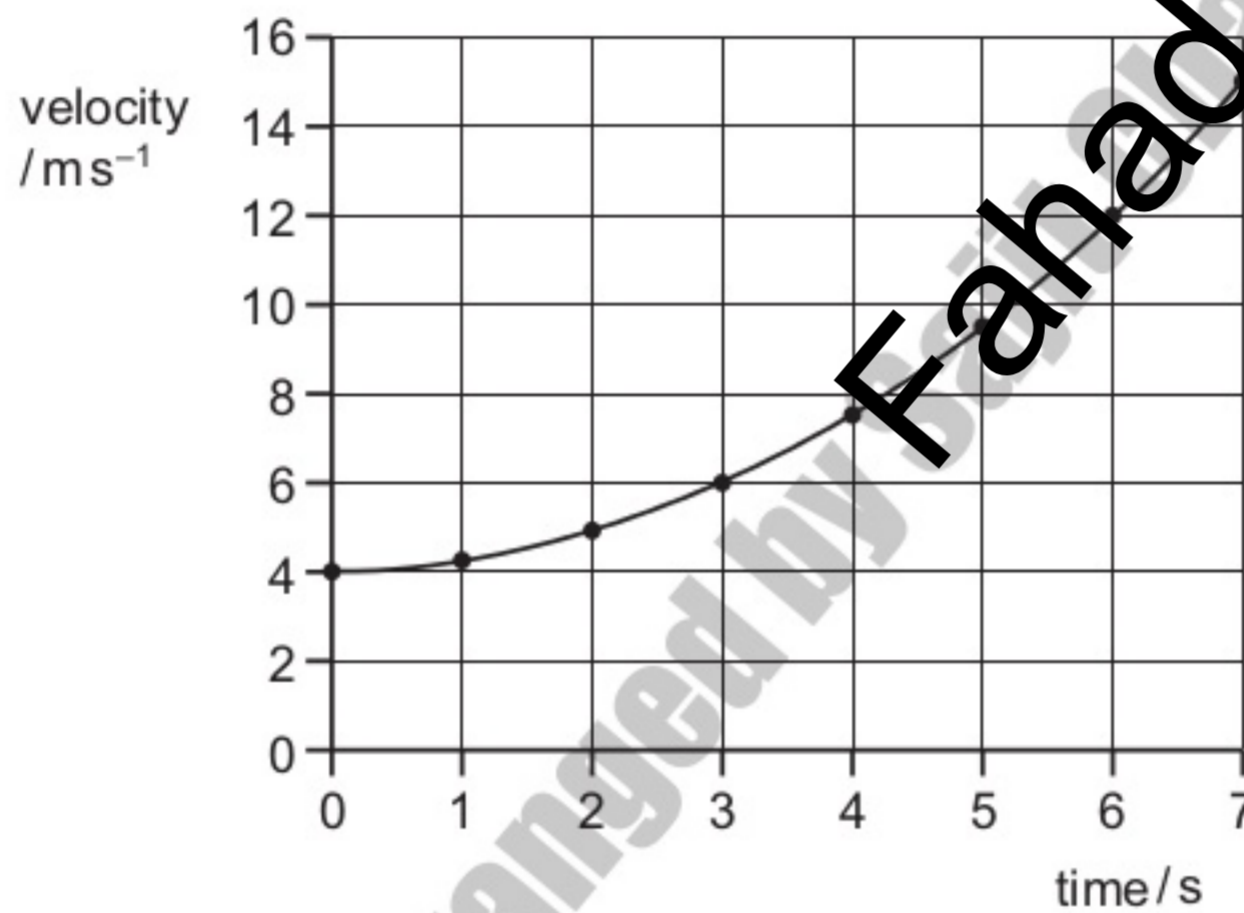
Which graph best represents the variation of the height h of the ball with time t?

9 The diagram shows a velocity-time graph for a vehicle.   9702/12/M/J/10

The vehicle, moving at $4.0\,\mathrm{m\,s^{-1}}$, begins to accelerate at time = 0.
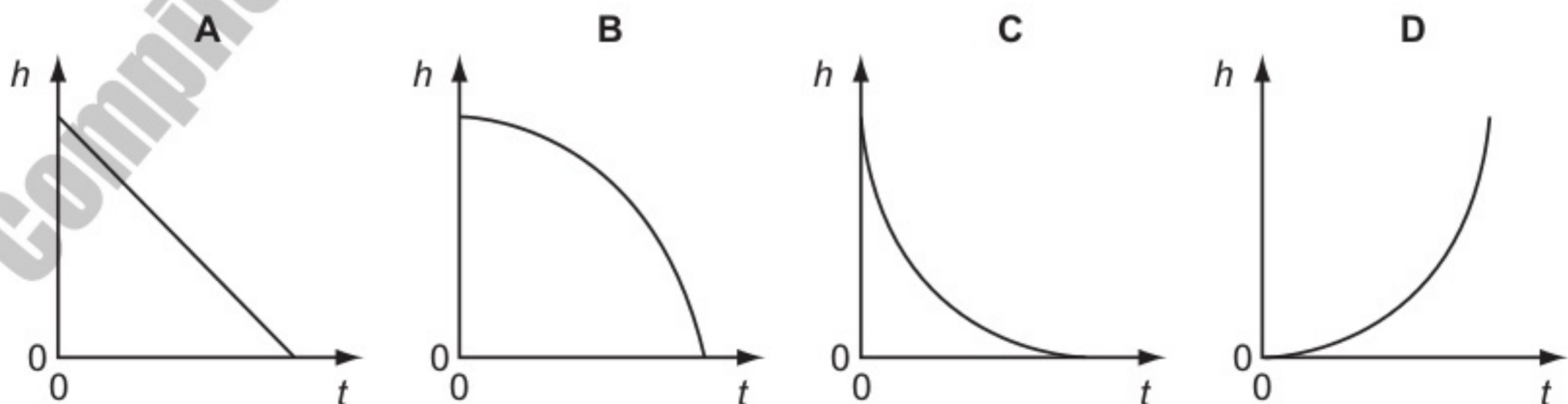
What is the vehicle's acceleration at time = 3.0 s?

A $0.67\,\mathrm{m\,s^{-2}}$ **B** $1.0\,\mathrm{m\,s^{-2}}$ **C** $1.3\,\mathrm{m\,s^{-2}}$ **D** $2.0\,\mathrm{m\,s^{-2}}$

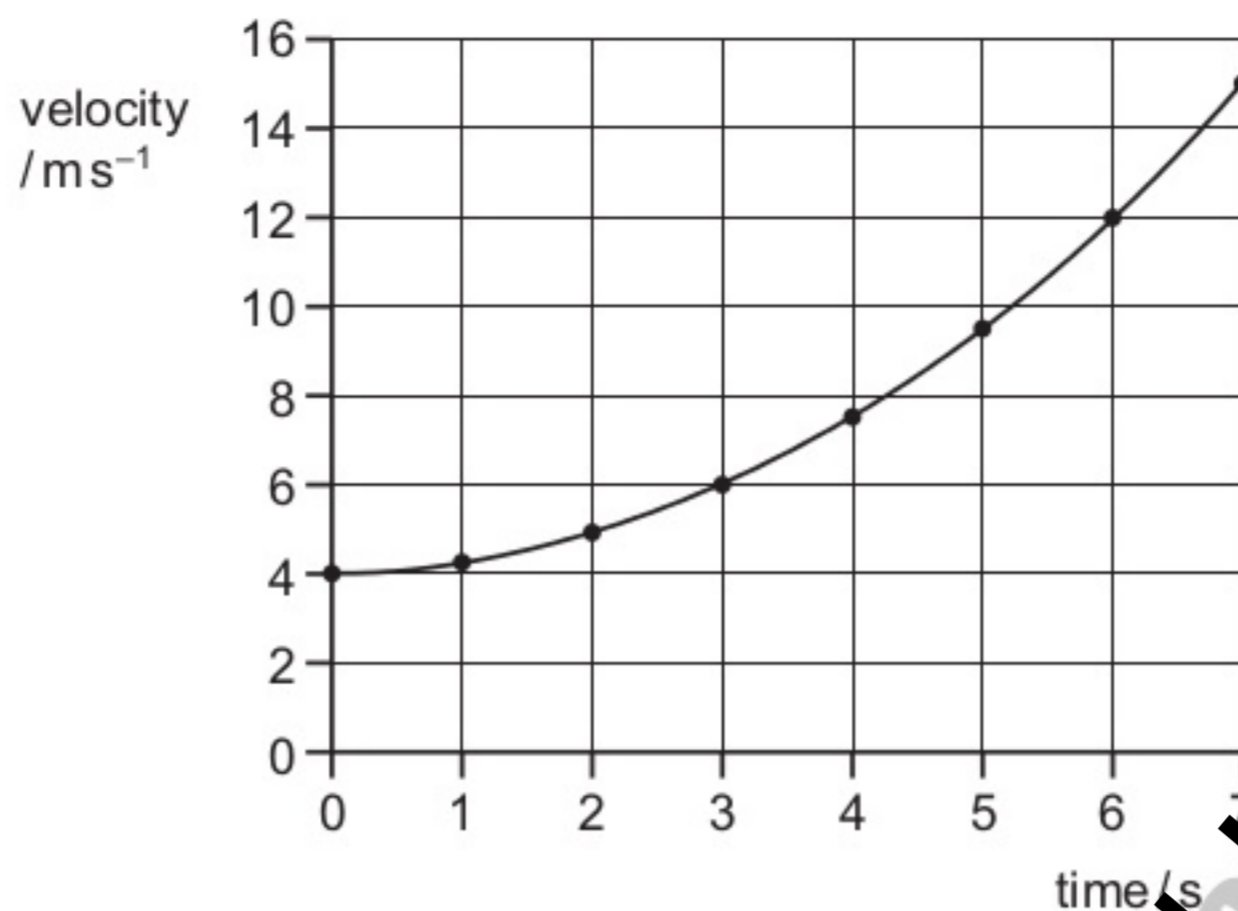**13** A small steel ball falls freely under gravity after being released from rest.   9702/13/M/J/10

Which graph best represents the variation of the height h of the ball with time t?

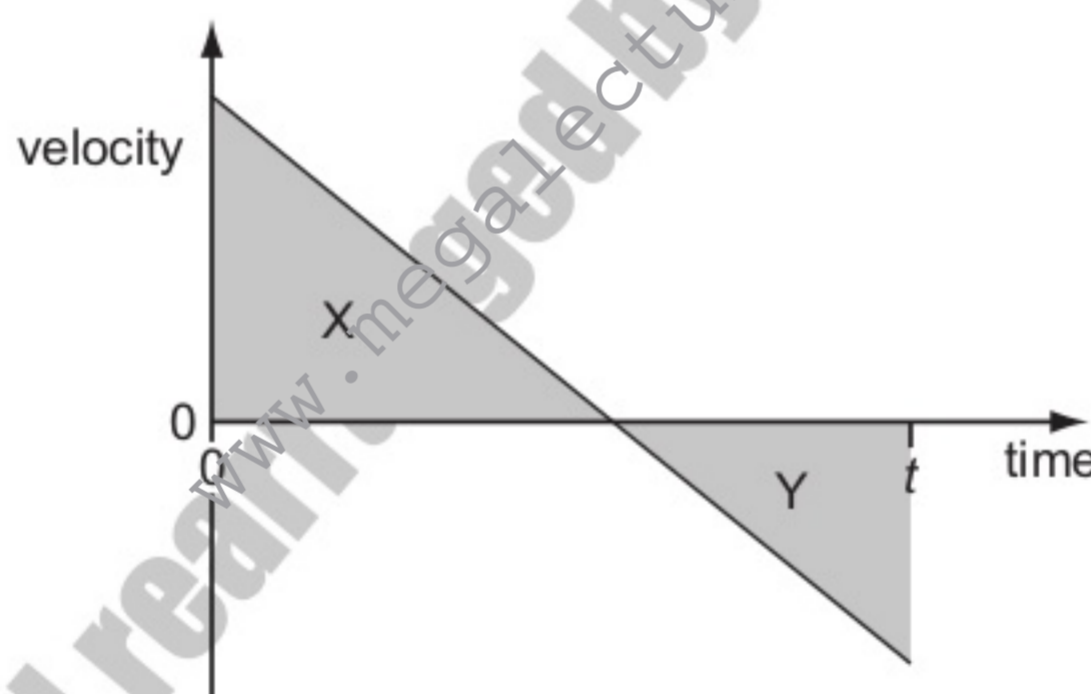**14** The diagram shows a velocity-time graph for a vehicle. 9702/13/M/J/10

The vehicle, moving at $4.0\,\text{m s}^{-1}$, begins to accelerate at time = 0.

What is the vehicle's acceleration at time = 3.0 s?

A $0.67\,\text{m s}^{-2}$ **B** $1.0\,\text{m s}^{-2}$ **C** $1.3\,\text{m s}^{-2}$ **D** $2.0\,\text{m s}^{-2}$

8 The velocity-time graph below is for a stone thrown vertically up into the air. Air resistance is negligible. 9702/13/M/J/10

The stone is thrown up at time zero.

Area X represents a distance of 5 m. Area Y represents a distance of 3 m.

What is the displacement of the stone from its initial position at time t?

A 2 m **B** 3 m **C** 5 m **D** 8 m

10 Which defines the weight of a body? 9702/12/O/N/10

A the amount of matter in the body

B the force of gravity on the body

C the number of particles in the body

D the product of the body's volume and density

7 A ball is thrown horizontally in still air from the top of a very tall building. The ball is affected by air resistance.

9702/11/O/N/10

What happens to the horizontal and to the vertical components of the ball's velocity?

	horizontal component of velocity	vertical component of velocity
A	decreases to zero	increases at a constant rate
B	decreases to zero	increases to a constant value
C	remains constant	increases at a constant rate
D	remains constant	increases to a constant value

9 In order that a train can stop safely, it will always pass a signal showing a yellow light before it reaches a signal showing a red light. Drivers apply the brake at the yellow light and this results in a uniform deceleration to stop exactly at the red light.

9702/11/O/N/10

The distance between the red and yellow lights is x.

What must be the minimum distance between the lights if the train speed is increased by 20 %, without changing the deceleration of the trains?

A $1.20x$ **B** $1.25x$ **C** $1.44x$ **D** $1.56x$

10 The gravitational field strength on the surface of planet P is one tenth of that on the surface of planet Q.

9702/11/O/N/10

On the surface of P, a body has a mass of 1.0 kg and a weight of 1.0 N.

What are the mass and weight of the same body on the surface of planet Q?

	mass on Q/kg	weight on Q/N
A	1.0	0.1
B	1.0	10
C	10	10
D	10	100

6 A football is dropped from the top of a three-storey building. It falls through air until it reaches the ground.

9702/12/O/N/10

What remains constant throughout the fall?

A acceleration of the football

B air resistance on the football

C velocity of the football

D weight of the football

7 A student throws a ball in the positive direction vertically upwards.

The ball makes an elastic collision with the ceiling, rebounds and accelerates back to the student's hand in a time of 1.2 s.
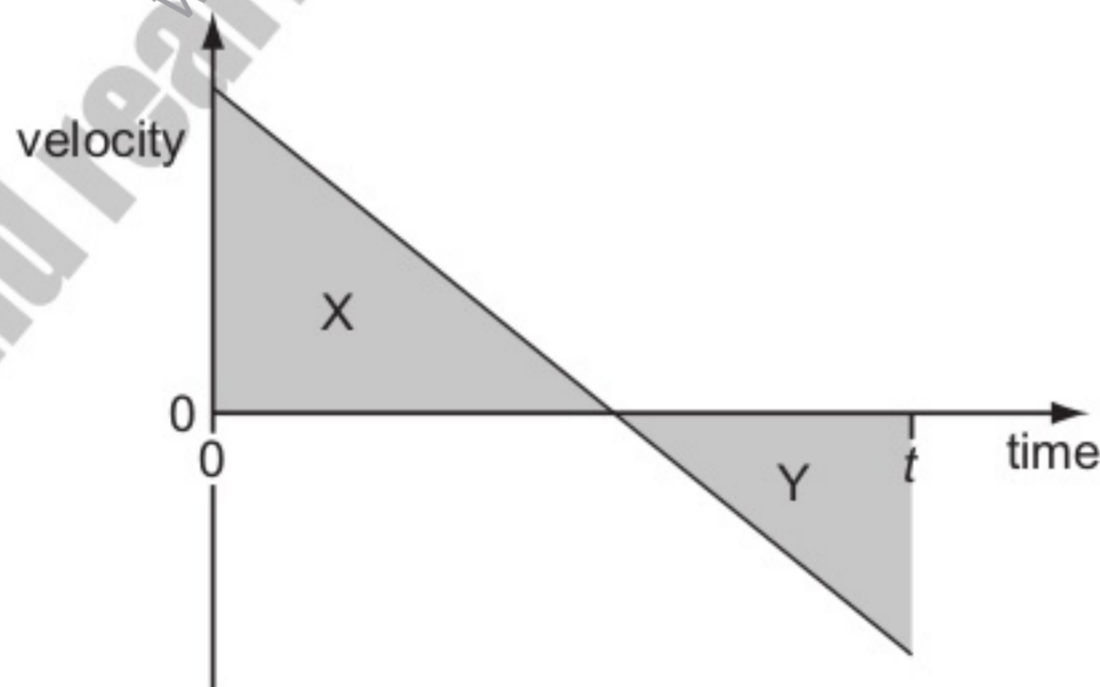
Which graph best represents the acceleration of the ball from the moment it leaves the hand to the instant just before it returns to the hand?
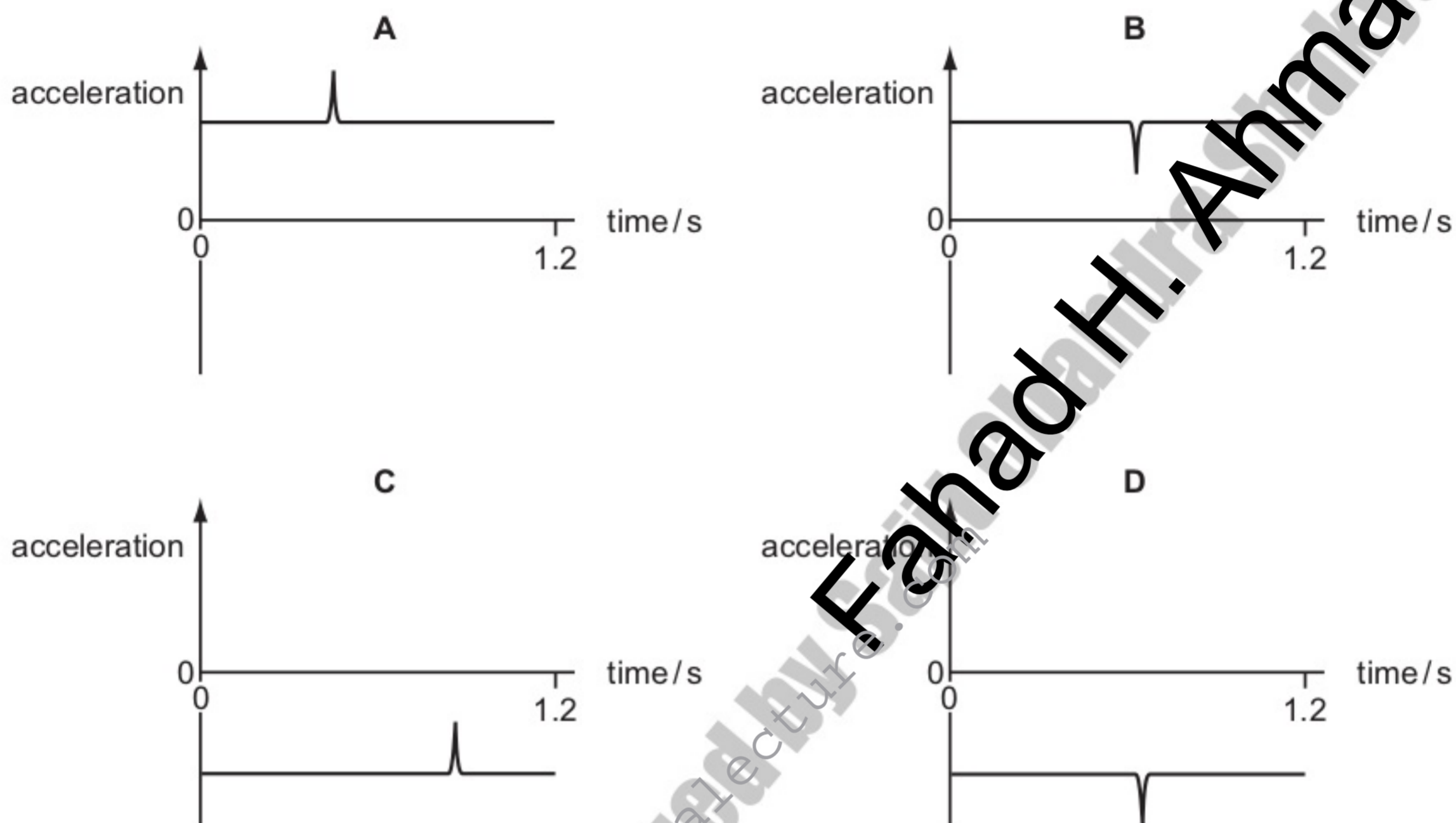
6 The velocity-time graph below is for a stone thrown vertically up into the air. Air resistance is negligible.

The stone is thrown up at time zero.

Area X represents a distance of 5 m. Area Y represents a distance of 3 m.

What is the displacement of the stone from its initial position at time t?

A 2 m **B** 3 m **C** 5 m **D** 8 m

8 A moving body undergoes uniform acceleration while travelling in a straight line between points X, Y and Z. The distances XY and YZ are both 40 m. The time to travel from X to Y is 12 s and from Y to Z is 6.0 s.

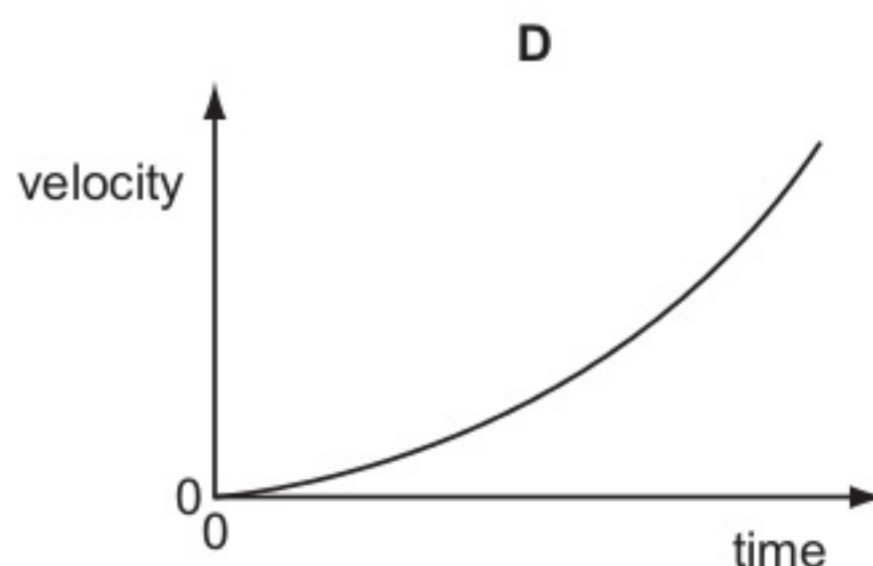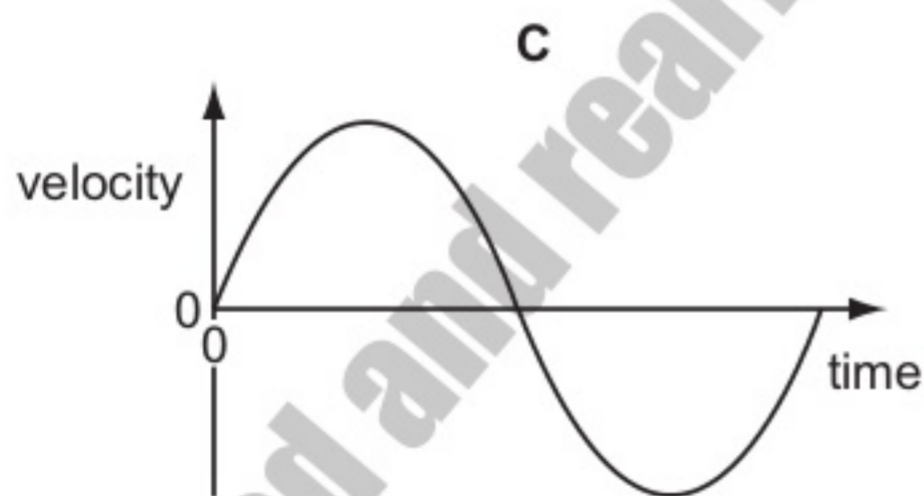9702/12/O/N/10
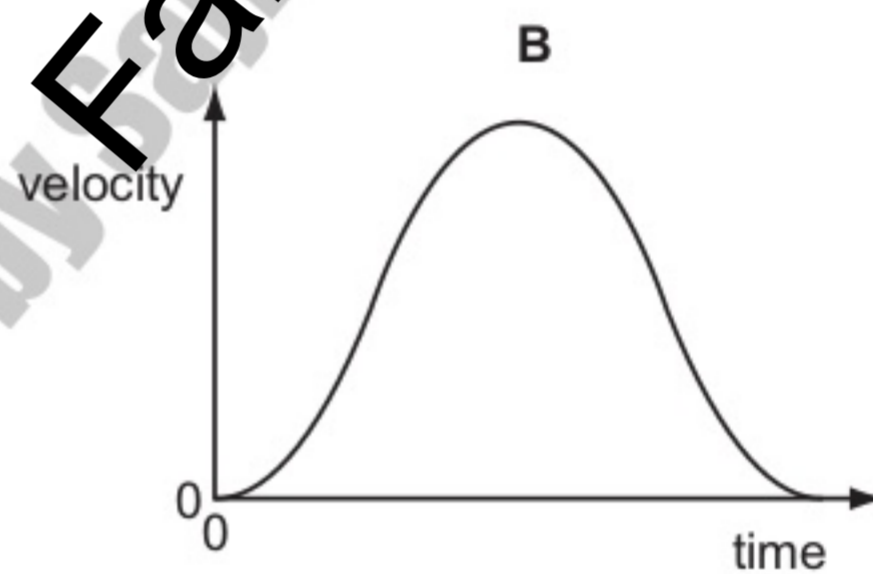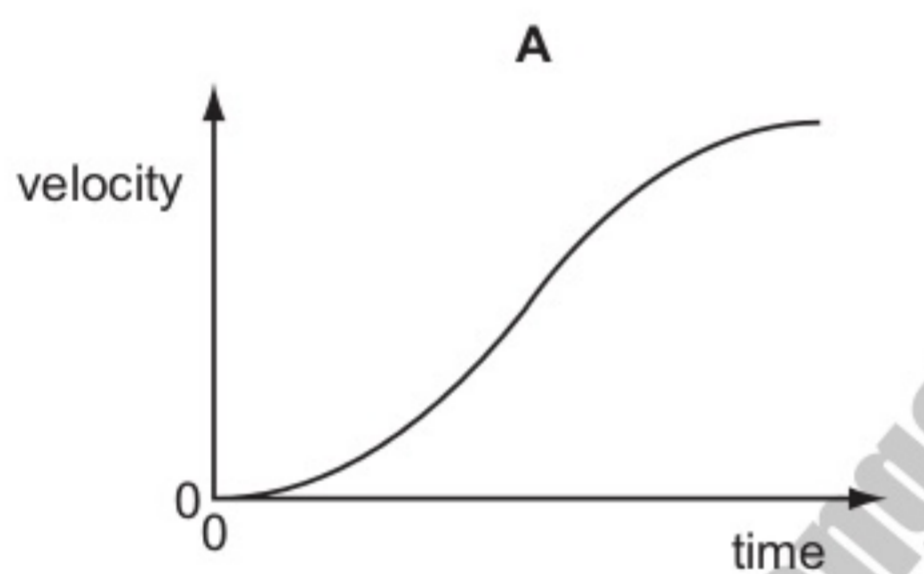
What is the acceleration of the body?

A $0.37\,\mathrm{m\,s^{-2}}$ **B** $0.49\,\mathrm{m\,s^{-2}}$ **C** $0.56\,\mathrm{m\,s^{-2}}$ **D** $1.1\,\mathrm{m\,s^{-2}}$

6 The graph shows how the acceleration of an object moving in a straight line varies with time.

9702/11/M/J/11
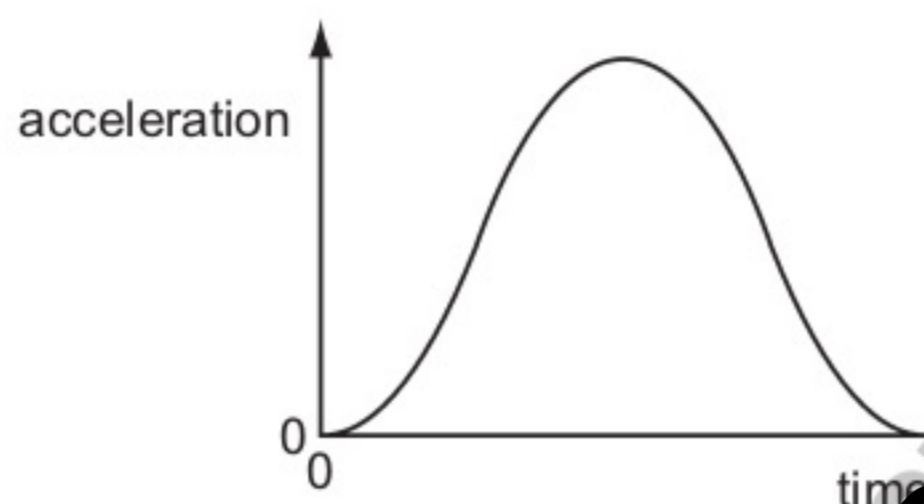
Which graph shows the variation with time of the velocity of the object?

6 A bullet is fired horizontally with speed v from a rifle. For a short time t after leaving the rifle, the only force affecting its motion is gravity. The acceleration of free fall is g.

9702/12/M/J/11

Which expression gives the value of $\dfrac{\text{the horizontal distance travelled in time } t}{\text{the vertical distance travelled in time } t}$?

A $\dfrac{vt}{g}$ **B** $\dfrac{v}{gt}$ **C** $\dfrac{2vt}{g}$ **D** $\dfrac{2v}{gt}$

7 A ball is released from rest at time zero. After 1.0 s it bounces inelastically from a horizontal surface and rebounds, reaching the top of its first bounce after 1.5 s. 9702/11/M/J/11
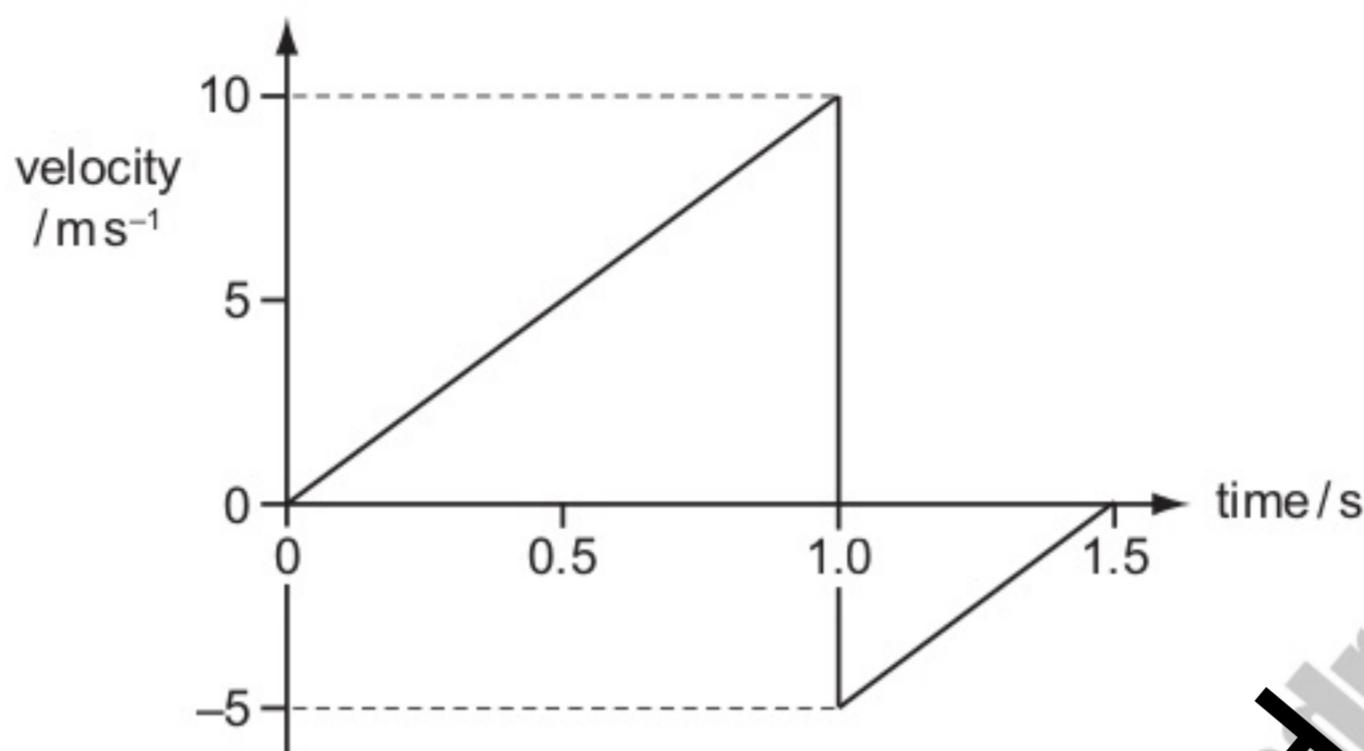
What is the total displacement of the ball from its original position after 1.5 s?

A 1.25 m **B** 3.75 m **C** 5.00 m **D** 6.25 m

8 A body has a weight of 58.9 N when on the Earth. On the Moon, the acceleration of free fall is 1.64 m s^{-2}. 9702/11/M/J/11

What are the weight and the mass of the body when it is on the Moon?

	weight / N	mass / kg
A	9.85	1.00
B	9.85	6.00
C	58.9	1.00
D	58.9	6.00

8 A boy throws a ball vertically upwards. It rises to a maximum height, where it is momentarily at rest, and then falls back to his hands. 9702/11/O/N/11

Which row gives the acceleration of the ball at various stages in its motion? (Take vertically upwards as positive. Ignore air resistance.)

	rising	at maximum height	falling
A	$-9.81\,\text{m s}^{-2}$	0	$+9.81\,\text{m s}^{-2}$
B	$-9.81\,\text{m s}^{-2}$	$-9.81\,\text{m s}^{-2}$	$-9.81\,\text{m s}^{-2}$
C	$+9.81\,\text{m s}^{-2}$	$+9.81\,\text{m s}^{-2}$	$+9.81\,\text{m s}^{-2}$
D	$+9.81\,\text{m s}^{-2}$	0	$-9.81\,\text{m s}^{-2}$

7   A particle moves in the manner shown by the velocity-time graph.

The displacement of the particle has been measured so that it is zero at $t = 0$. Point Q refers to a point in its motion.
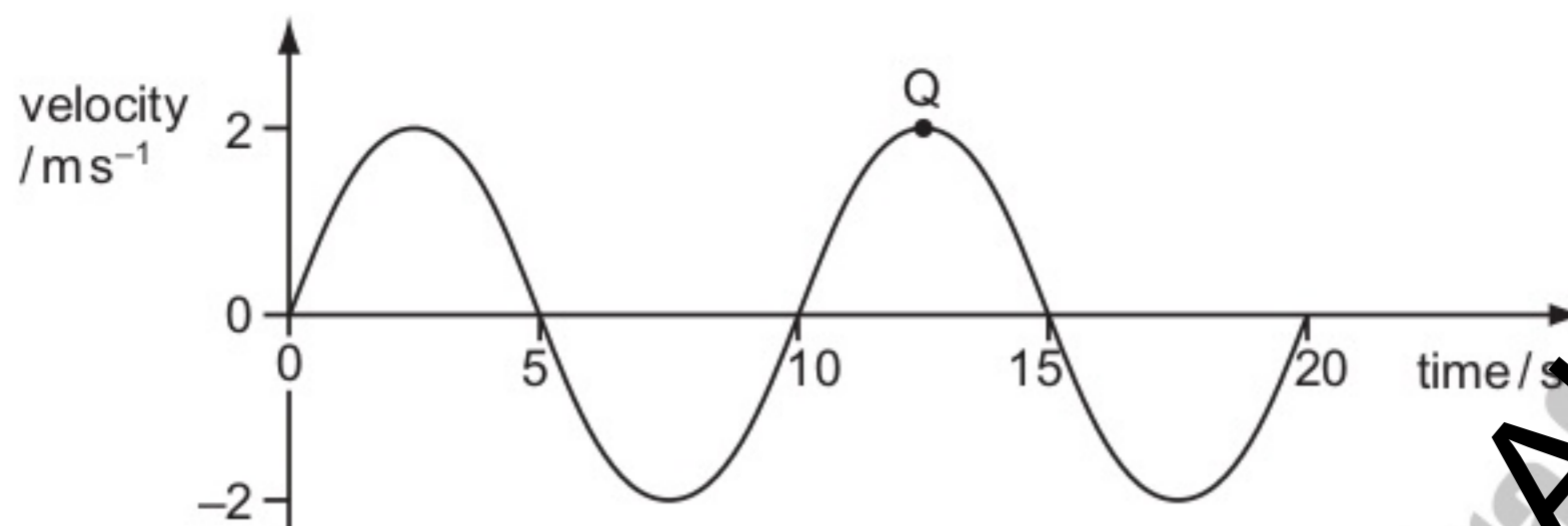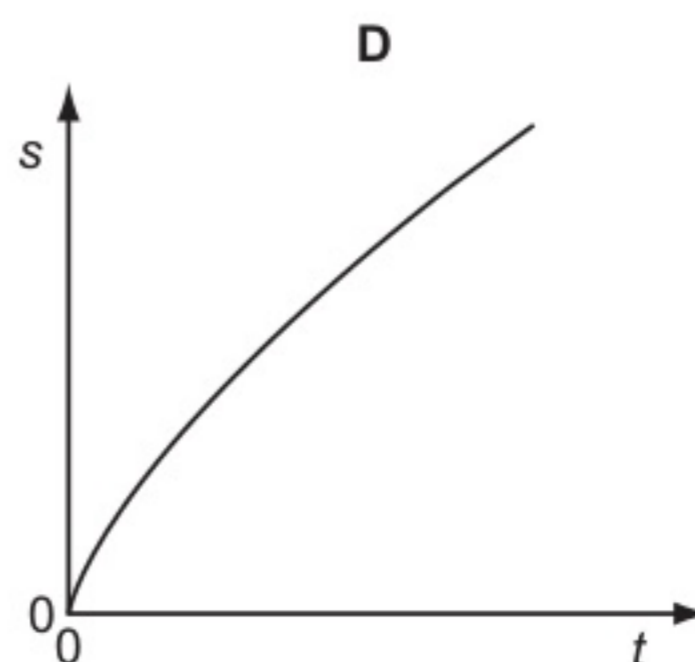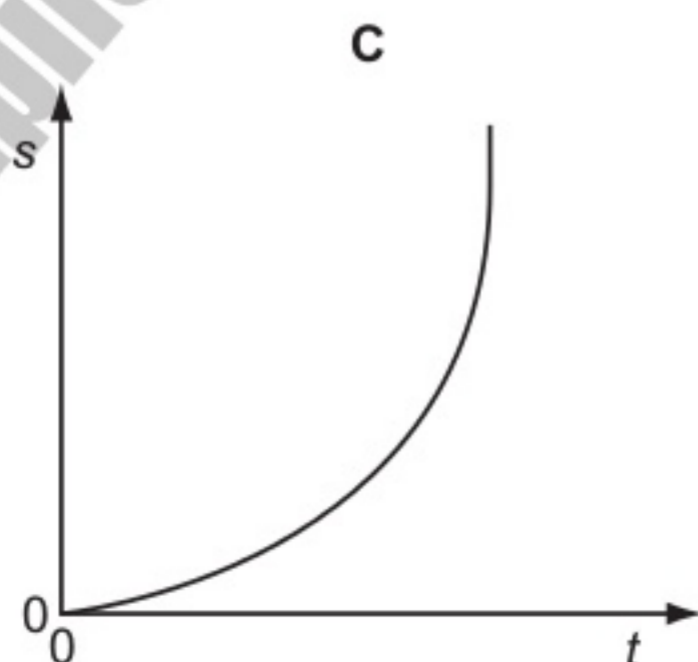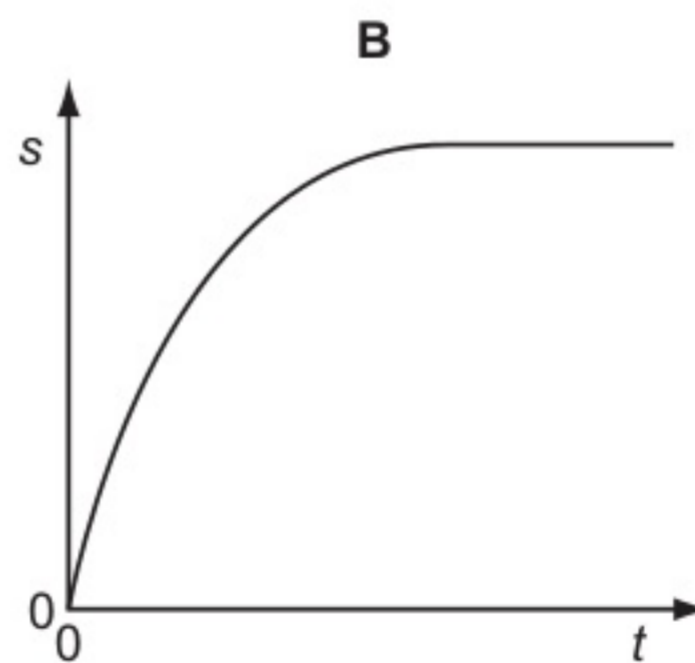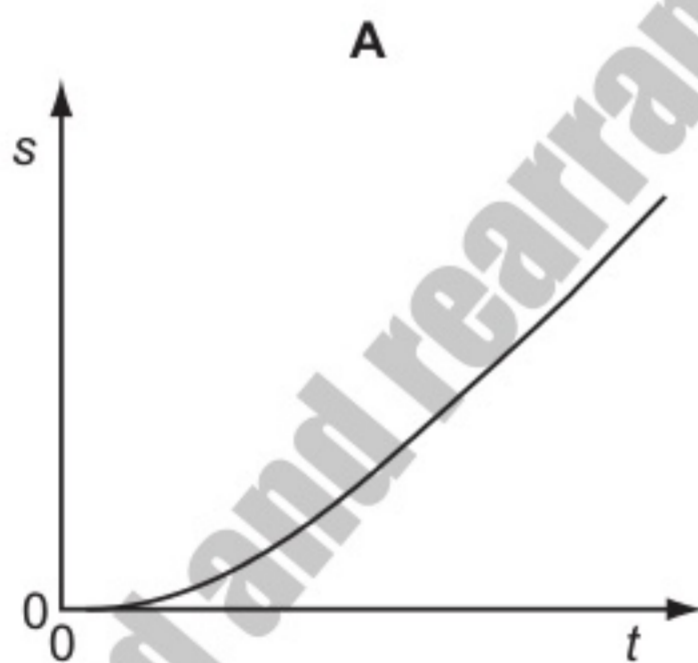

Which row of the table is correct?

	times for maximum displacement/s		acceleration at point Q/m s^{-2}
A	2.5	12.5	2
B	5	15	2
C	2.5	12.5	0
D	5	15	0

8   A tennis ball falls freely, in air, from the top of a tall building.

Which graph best represents the variation of distance s fallen with time t?

9 A small glider moves along a friction-free horizontal air track as shown below.
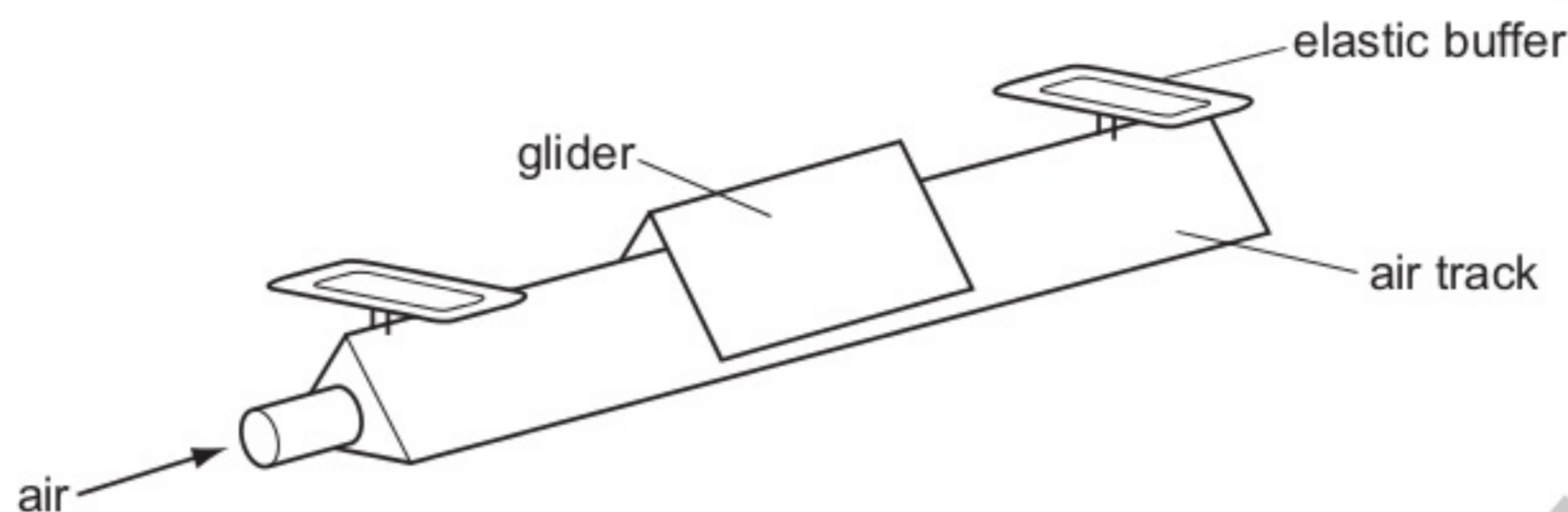
At each end of the air track there is a perfectly elastic buffer.

Which graph represents the variation with time t of the velocity v of the glider as it moves between the two buffers?
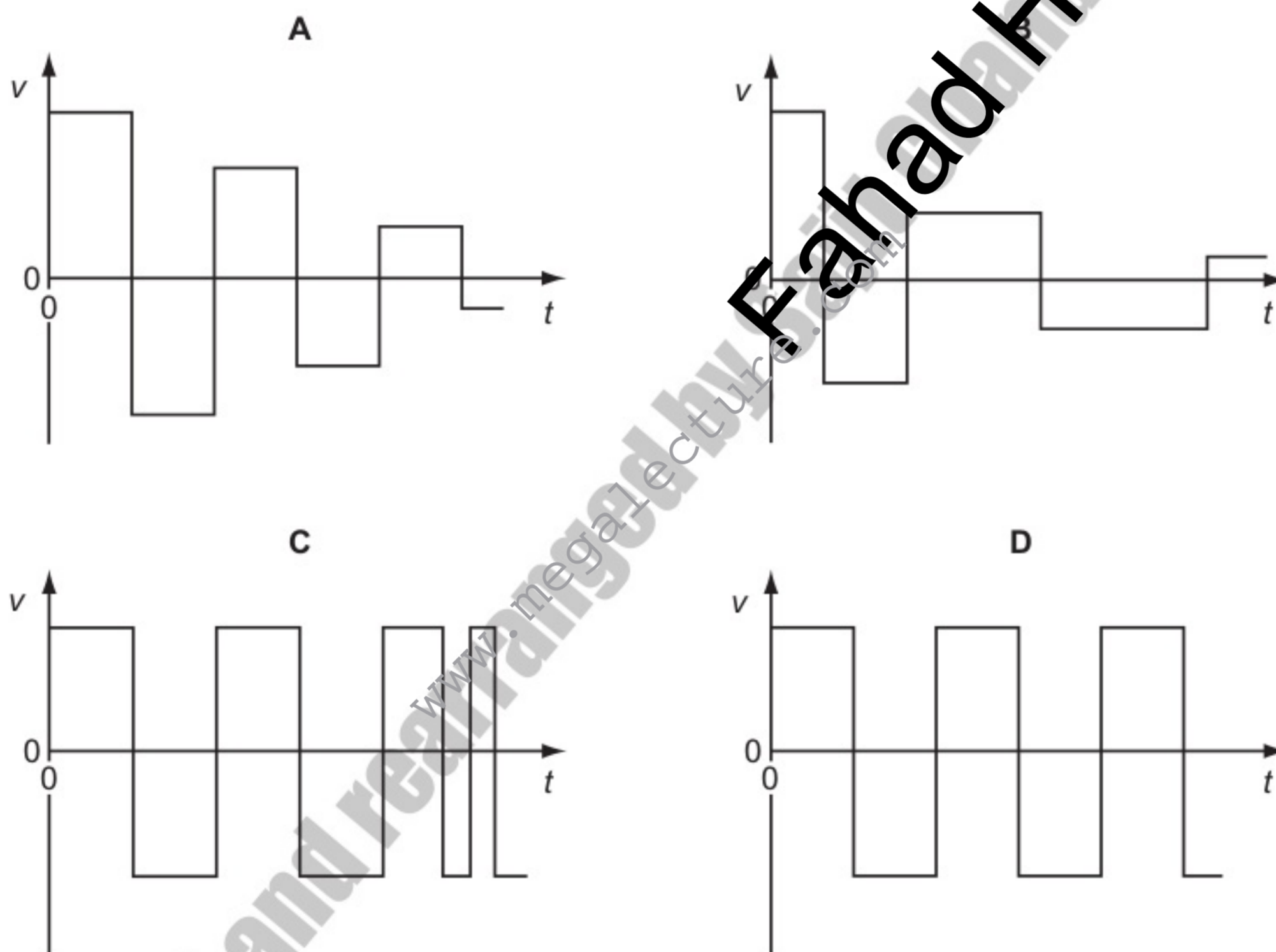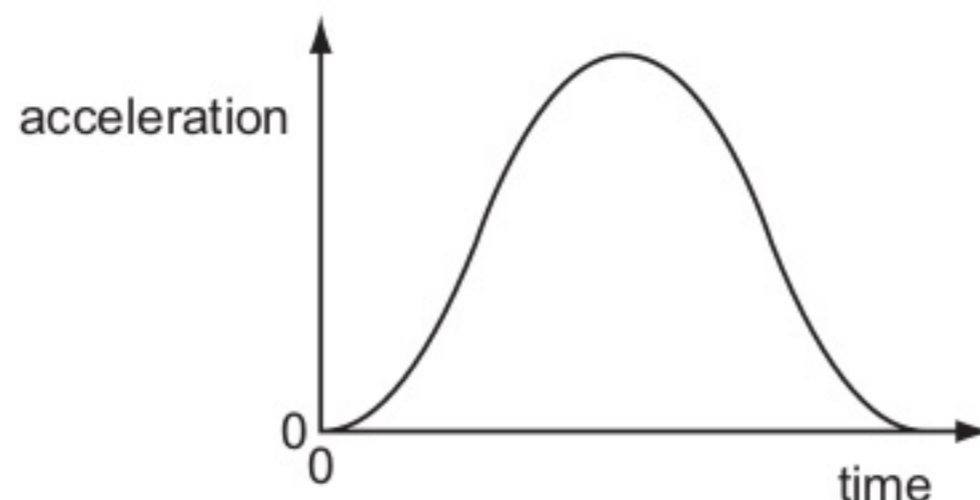

6 A body has a weight of 58.9 N when on the Earth. On the Moon, the acceleration of free fall is $1.64\,\text{m}\,\text{s}^{-2}$.

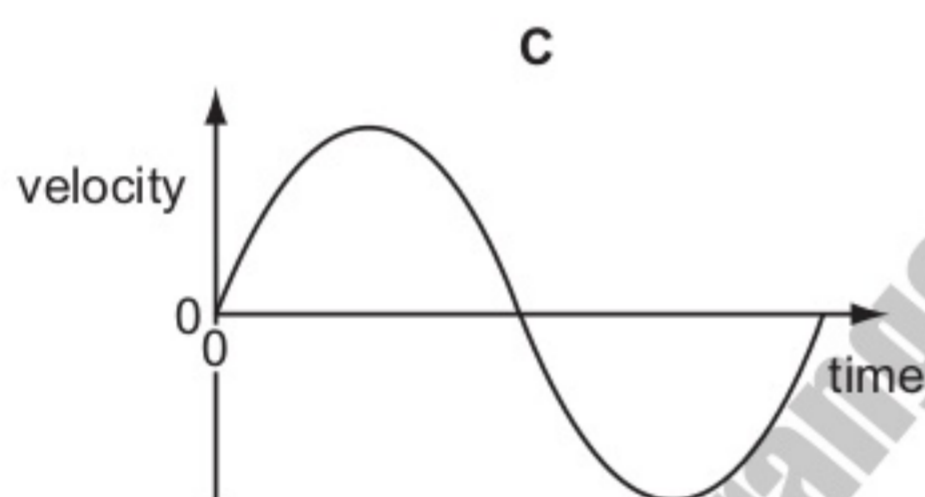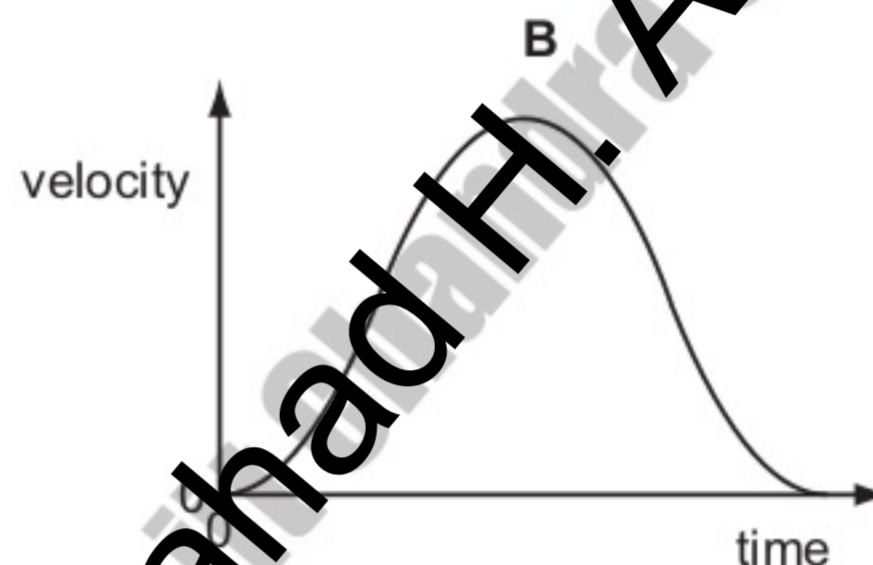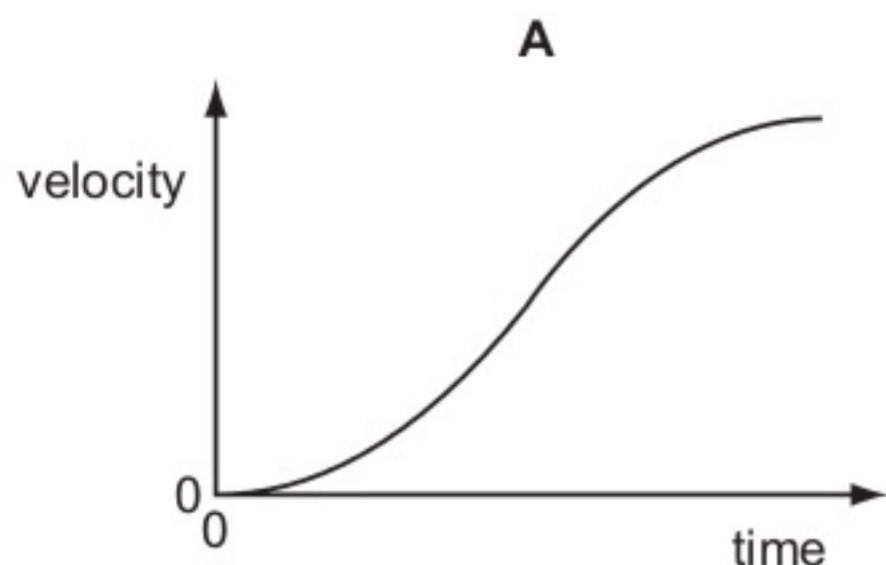What are the weight and the mass of the body when it is on the Moon?

	weight / N	mass / kg
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7 The graph shows how the acceleration of an object moving in a straight line varies with time.
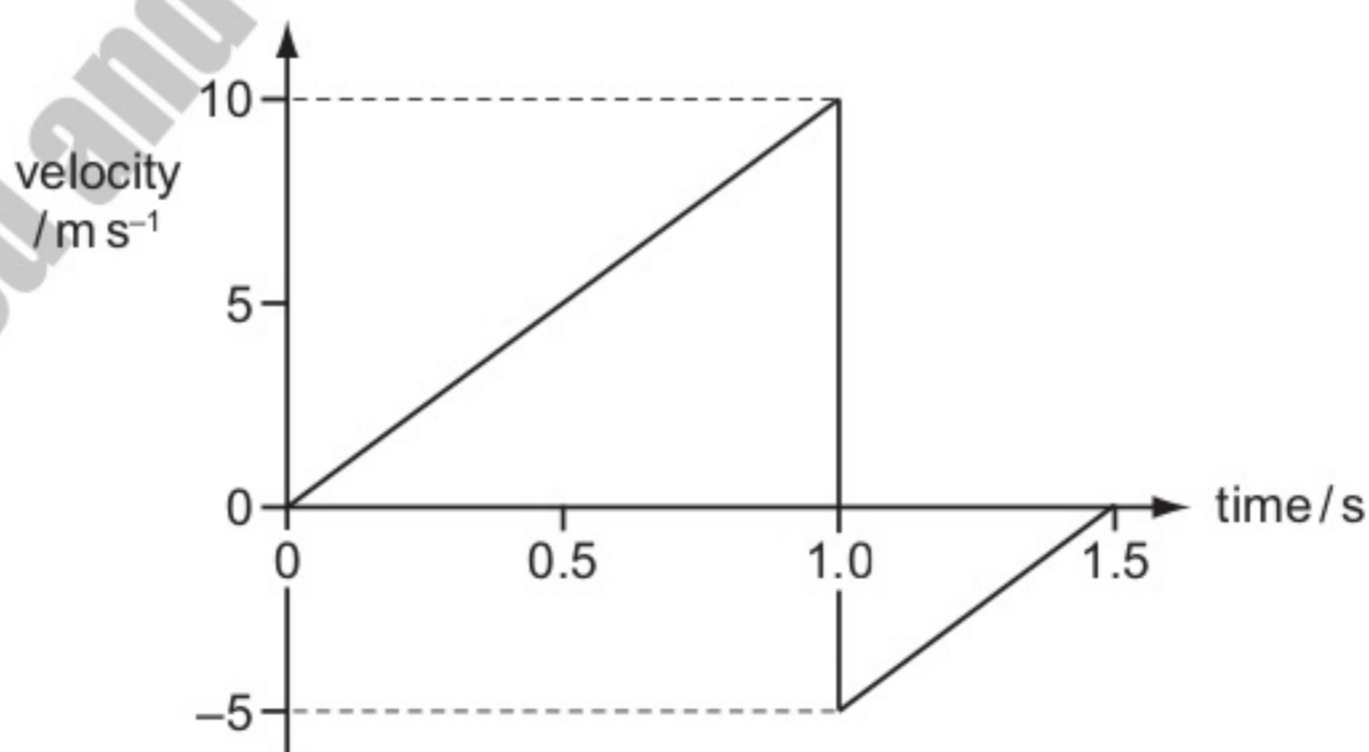
9702/13/M/J/11

Which graph shows the variation with time of the velocity of the object?
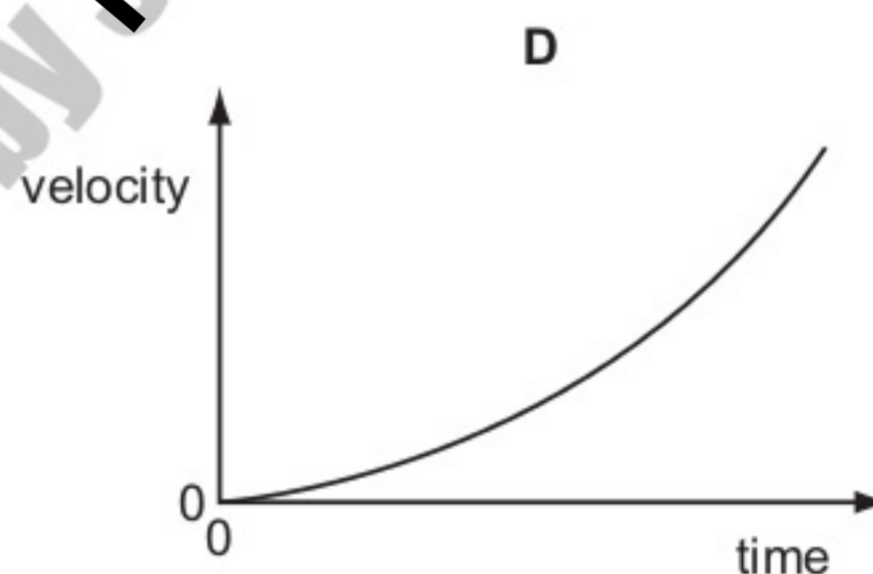
8 A ball is released from rest at time zero. After 1.0 s it bounces inelastically from a horizontal surface and rebounds, reaching the top of its first bounce after 1.5 s.
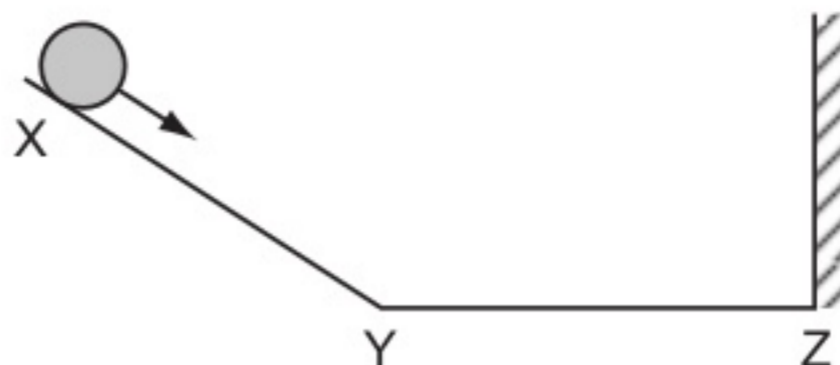
9702/13/M/J/11

What is the total displacement of the ball from its original position after 1.5 s?
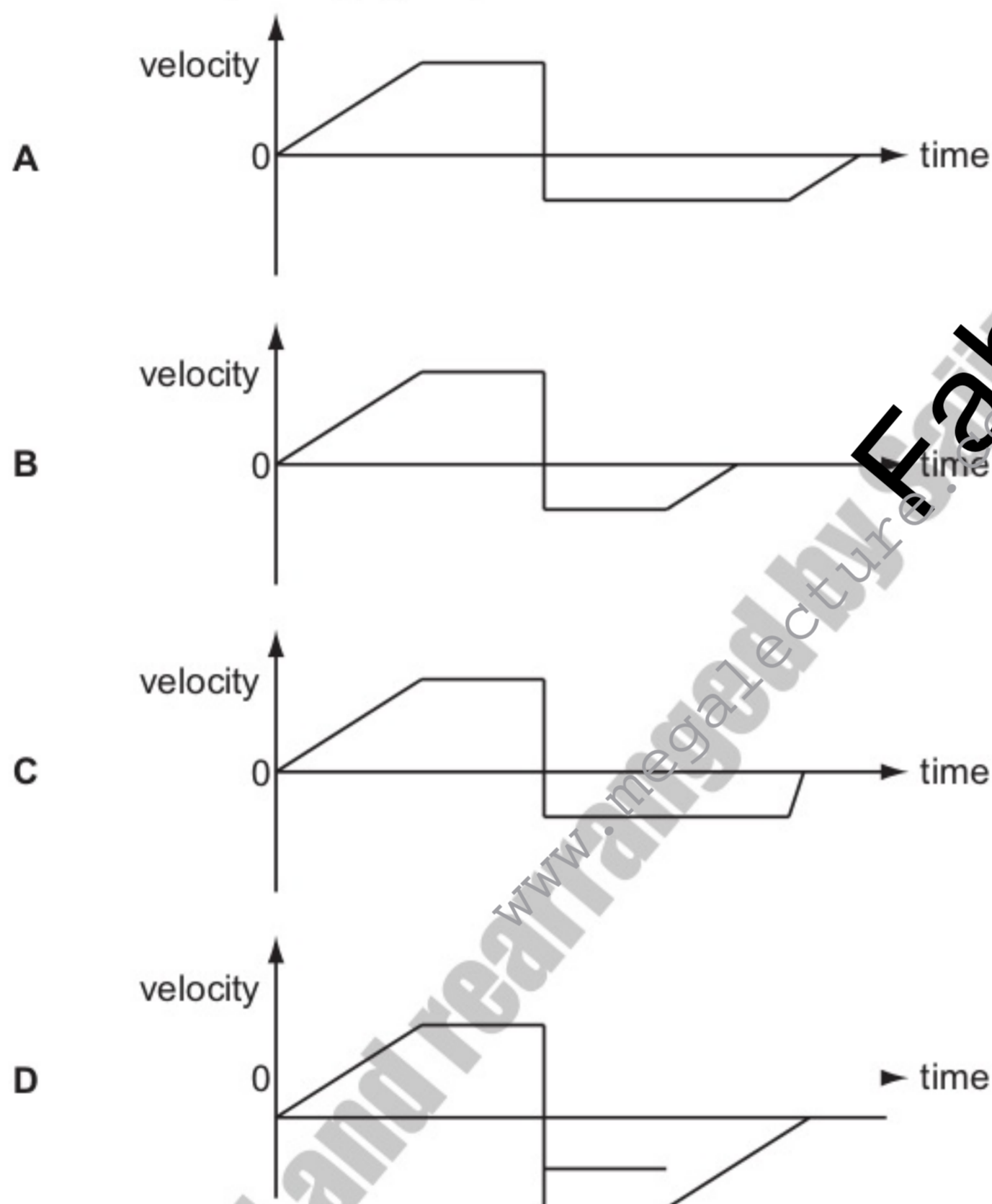
A 1.25 m **B** 3.75 m **C** 5.00 m **D** 6.25 m

6 A ball is released from rest on a smooth slope XY.

It moves down the slope, along a smooth horizontal surface YZ and rebounds inelastically at Z. Then it moves back to Y and comes to rest momentarily somewhere on XY.

Which velocity-time graph represents the motion of the ball?

9 A body falling in a uniform gravitational field encounters air resistance. The air resistance increases until terminal velocity is reached.

Which factor does **not** affect its terminal velocity?

A the density of the air

B the height from which the body falls

C the mass of the body

D the shape of the body

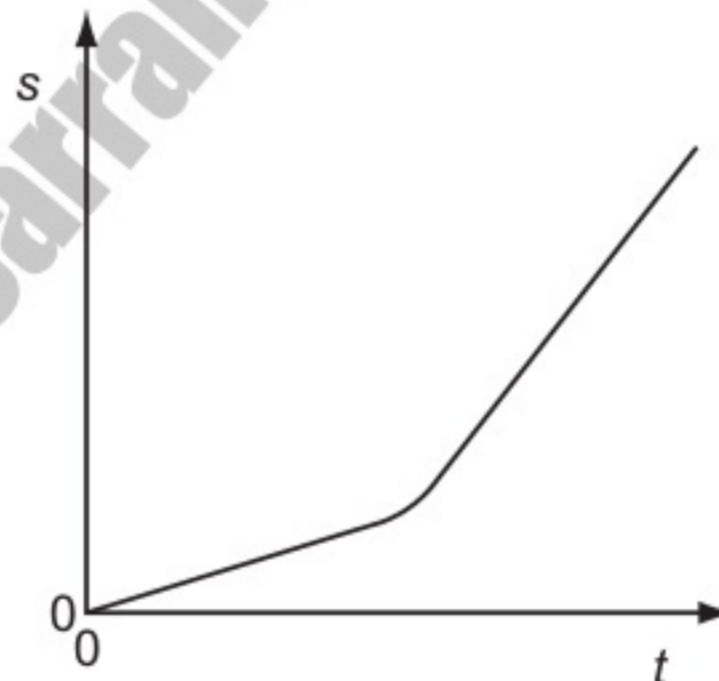**7** A tennis ball is released from rest at the top of a tall building.

9702/11/O/N/11

Which graph best represents the variation with time t of the acceleration a of the ball as it falls, assuming that the effect of air resistance is **not** negligible?
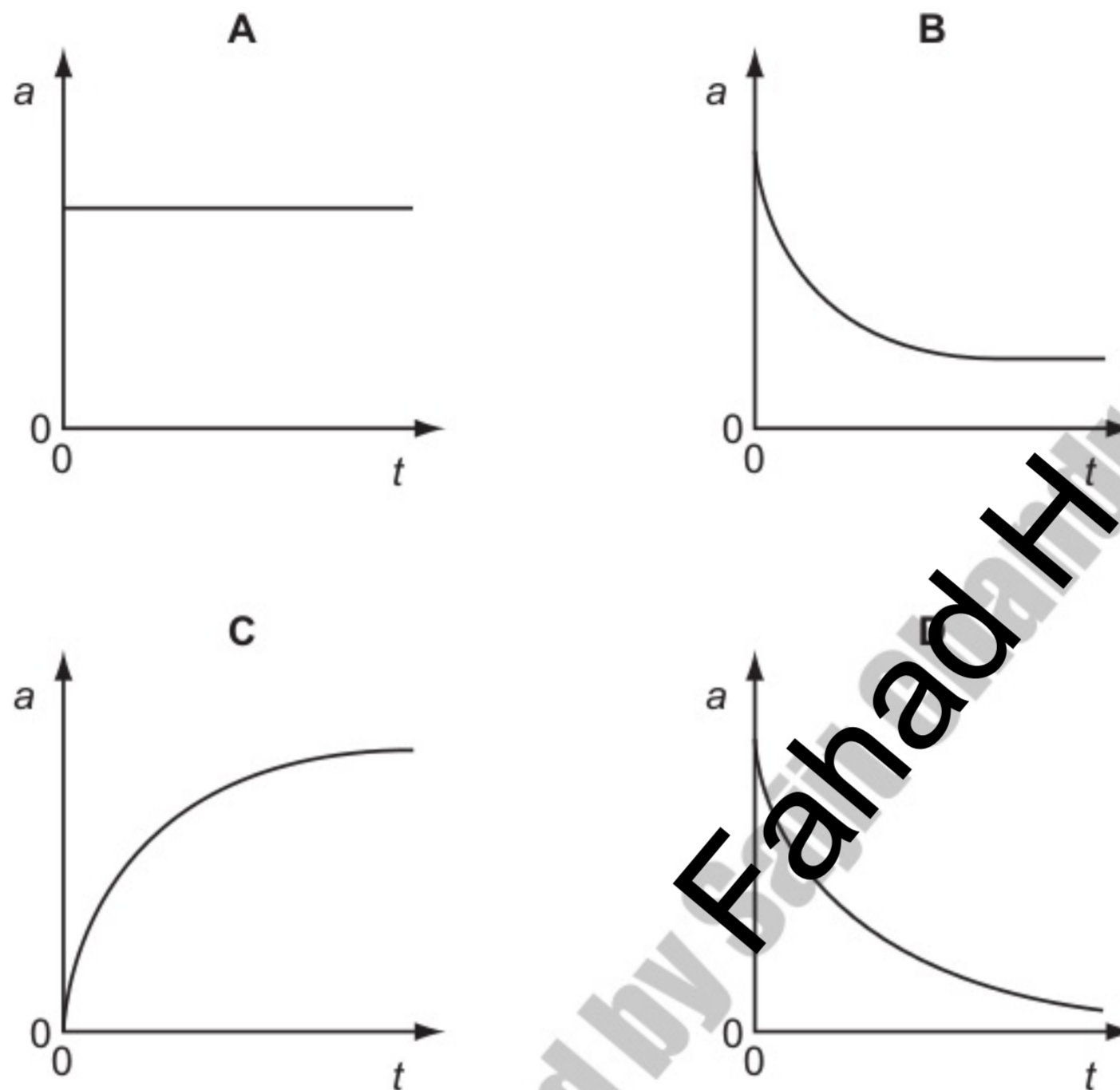
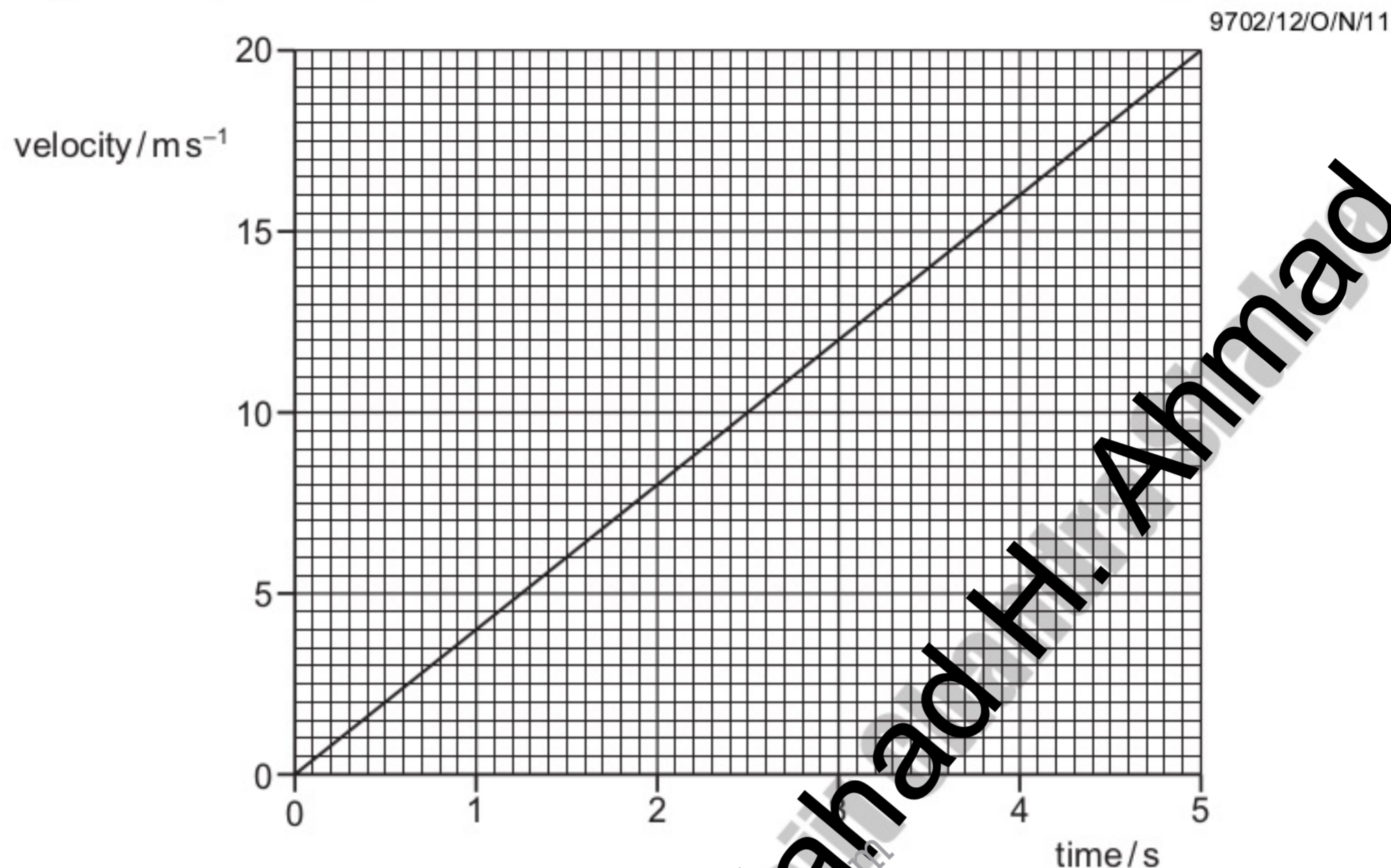**8** The variation with time t of the distance s moved by a body is shown below.

9702/12/O/N/11

What can be deduced from the graph about the motion of the body?

A It accelerates continuously.

B It starts from rest.

C The distance is proportional to time.

D The speed changes.

6 The velocity of an object during the first five seconds of its motion is shown on the graph.

9702/12/O/N/11

What is the distance travelled by the object in this time?

A 4 m **B** 20 m **C** 50 m **D** 100 m

8 A body falling in a uniform gravitational field encounters air resistance. The air resistance increases until terminal velocity is reached.

9702/13/O/N/11

Which factor does **not** affect its terminal velocity?

A the density of the air

B the height from which the body falls

C the mass of the body

D the shape of the body

9 A boy throws a ball vertically upwards. It rises to a maximum height, where it is momentarily at rest, and then falls back to his hands.

9702/13/O/N/11

Which row gives the acceleration of the ball at various stages in its motion? (Take vertically upwards as positive. Ignore air resistance.)

	rising	at maximum height	falling
A	$-9.81\,\mathrm{m\,s^{-2}}$	0	$+9.81\,\mathrm{m\,s^{-2}}$
B	$-9.81\,\mathrm{m\,s^{-2}}$	$-9.81\,\mathrm{m\,s^{-2}}$	$-9.81\,\mathrm{m\,s^{-2}}$
C	$+9.81\,\mathrm{m\,s^{-2}}$	$+9.81\,\mathrm{m\,s^{-2}}$	$+9.81\,\mathrm{m\,s^{-2}}$
D	$+9.81\,\mathrm{m\,s^{-2}}$	0	$-9.81\,\mathrm{m\,s^{-2}}$

6 A tennis ball is released from rest at the top of a tall building.

Which graph best represents the variation with time t of the acceleration a of the ball as it falls, assuming that the effect of air resistance is **not** negligible?
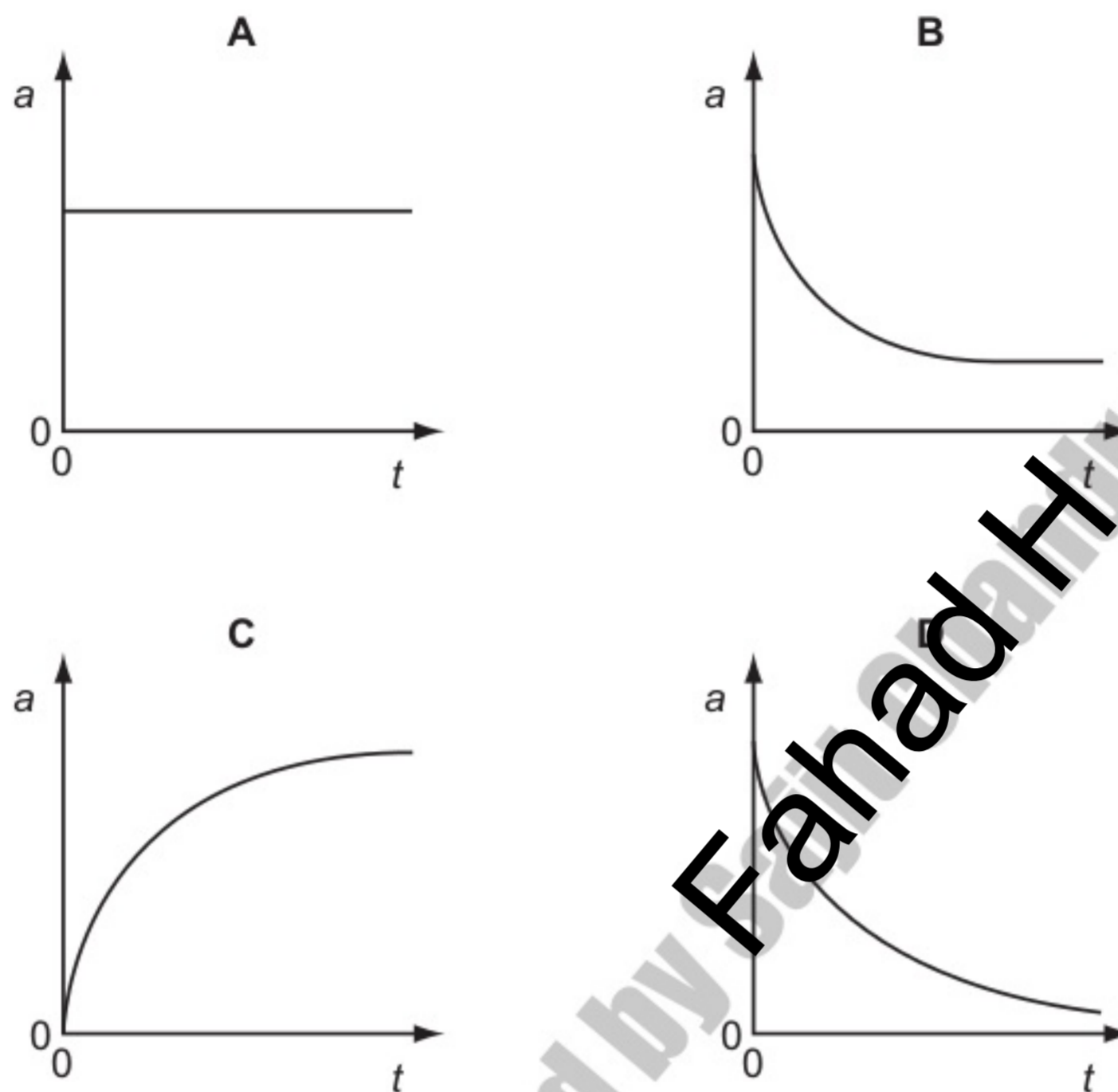
7 A stone of mass m is dropped from a tall building. There is significant air resistance. The acceleration of free fall is g.

When the stone reaches its terminal velocity, which information is correct?

|	magnitude of the acceleration of the stone	magnitude of the force of gravity on the stone	magnitude of the force of air resistance on the stone
A	g	mg	mg
B	zero	mg	mg
C	zero	zero	mg
D	zero	zero	zero

7 A ball is released from rest on a smooth slope XY.

9702/13/O/N/11

It moves down the slope, along a smooth horizontal surface YZ and rebounds inelastically at Z. Then it moves back to Y and comes to rest momentarily somewhere on XY.
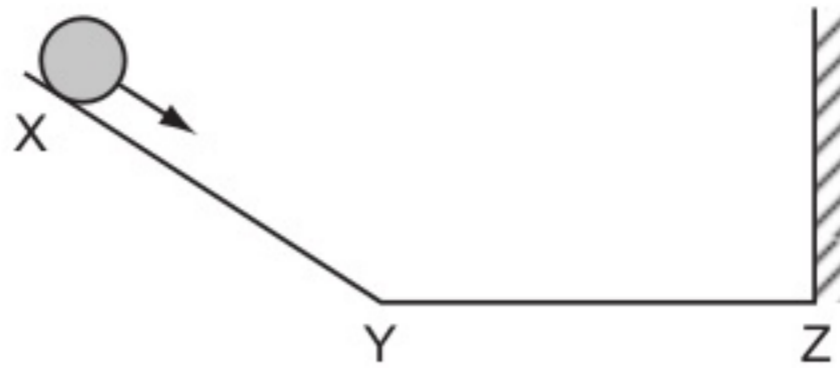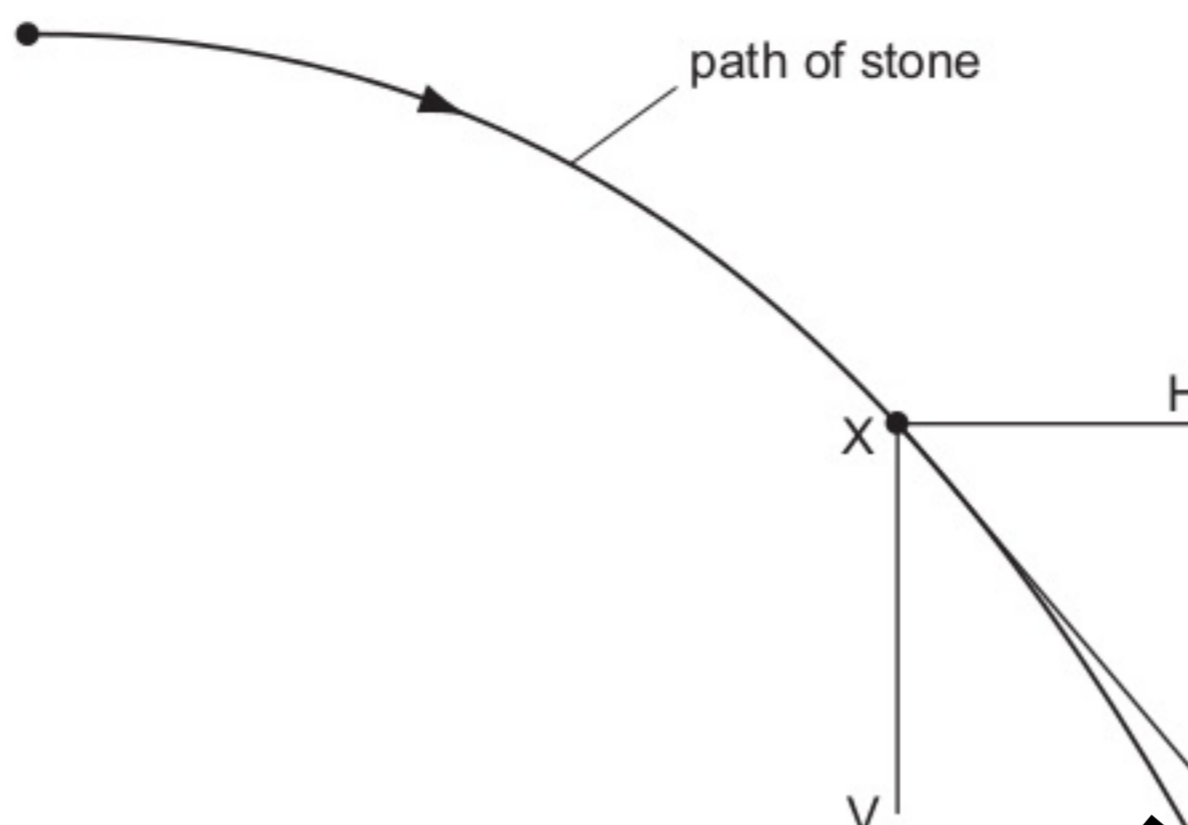

Which velocity-time graph represents the motion of the ball?
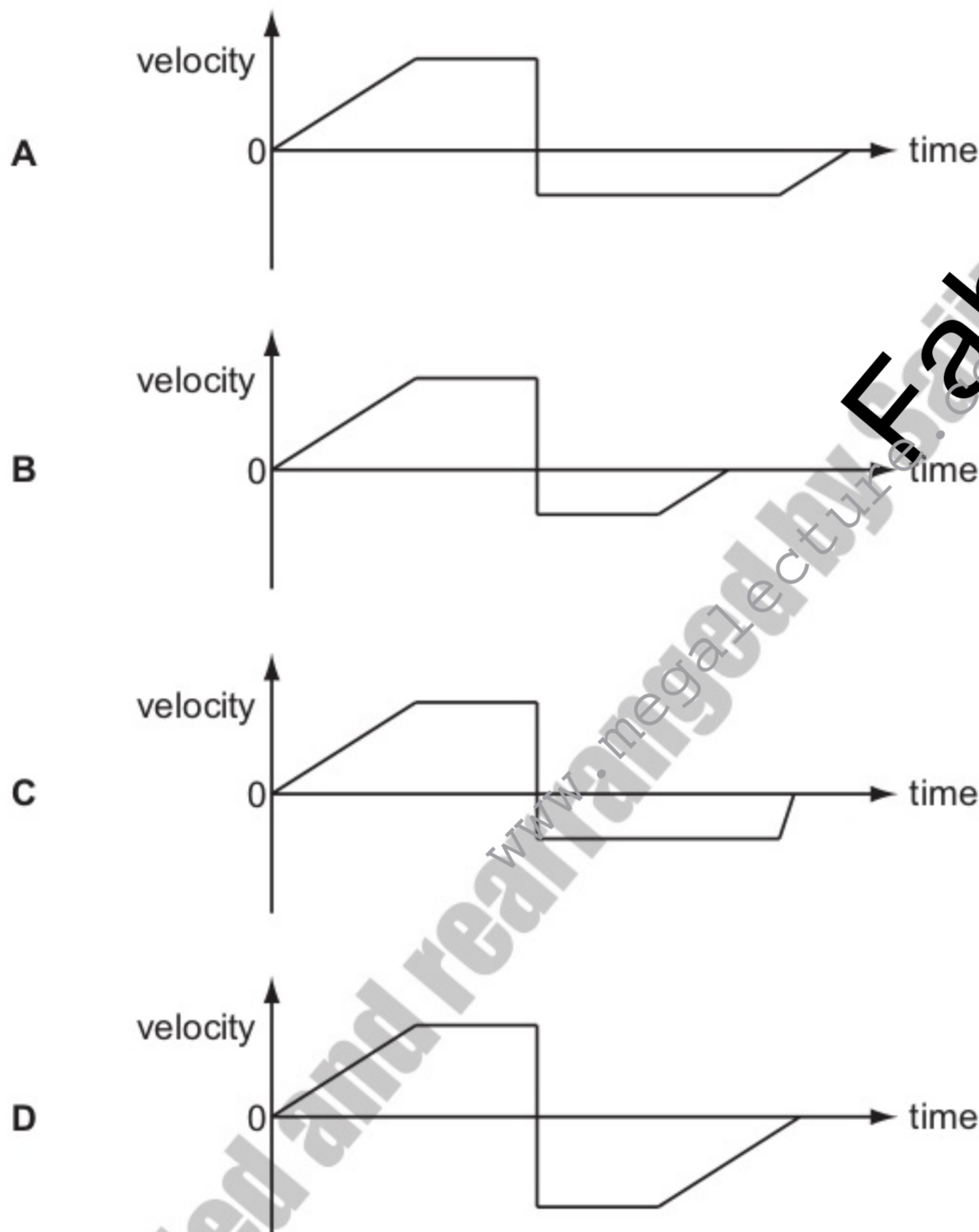
14 A stone is projected horizontally in a vacuum and moves along the path shown.

path of stone

H

X

V

X is a point on this path. XV and XH are vertical and horizontal lines respectively through X. XT is the tangent to the path at X.

Along which directions do forces act on the stone at X?

**A** XV only　　　**B** XH only　　　**C** XV and XH　　**D** XT only

11 A ball is thrown horizontally in still air from the top of a very tall building. The ball is affected by air resistance.

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What happens to the horizontal and to the vertical components of the ball's velocity?

|	horizontal component of velocity	vertical component of velocity
A	decreases to zero	increases at a constant rate
B	decreases to zero	increases to a constant value
C	remains constant	increases at a constant rate
D	remains constant	increases to a constant value

9 A brick is dislodged from a building and falls vertically under gravity.

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Which graph best represents the variation of its height h above the ground with time t if air resistance is negligible?
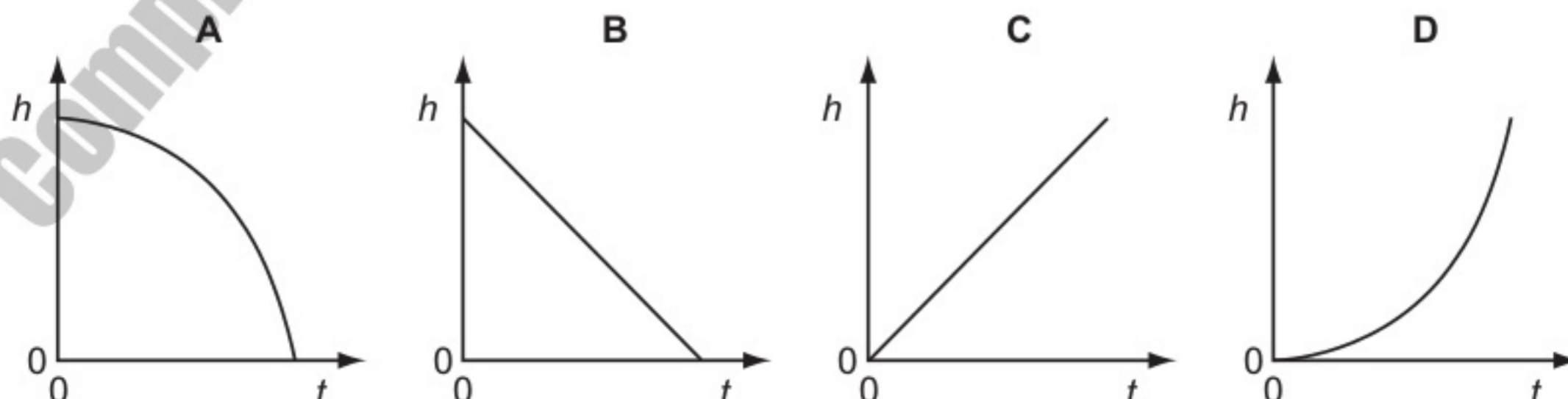
6 In an experiment to determine the acceleration of free fall using a falling body, what would lead to a value that is too large?

9702/11/M/J/12

A air resistance

B dimensions of the body are too large

C measured distance longer than true distance

D measured time longer than true time

8 The diagram shows a laboratory experiment in which a feather falls from rest along evacuated vertical tube of length L.

9702/11/M/J/12
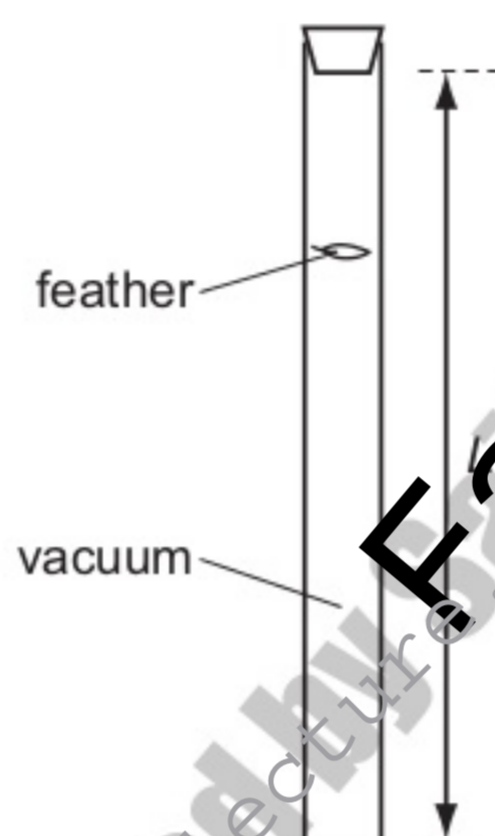
feather

vacuum

The feather takes time T to fall from the top to the bottom of the tube.

How far will the feather have fallen from the top of the tube in time $0.50\,T$?

A $0.13\,L$ **B** $0.25\,L$ **C** $0.38\,L$ **D** $0.50\,L$

10 A projectile is launched at point O and follows the path OPQRS, as shown. Air resistance may be neglected.

9702/12/M/J/12
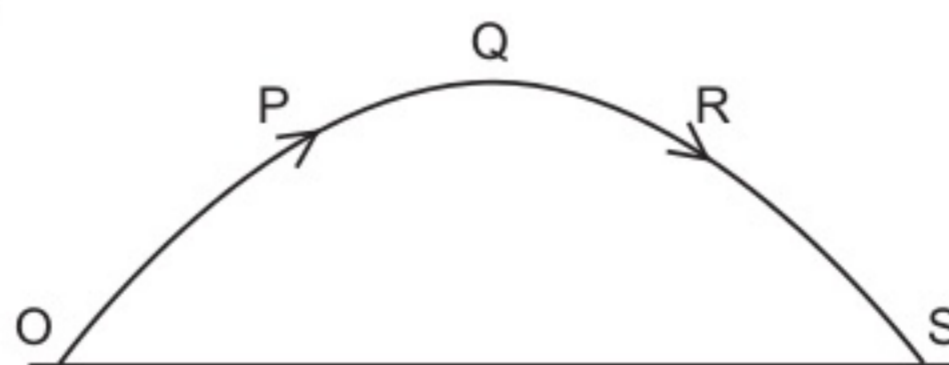
Which statement is true for the projectile when it is at the highest point Q of its path?

A The horizontal component of the projectile's acceleration is zero.

B The horizontal component of the projectile's velocity is zero.

C The kinetic energy of the projectile is zero.

D The momentum of the projectile is zero.

9 In the absence of air resistance, a stone is thrown from P and follows a parabolic path in which the highest point reached is T. The stone reaches point Q just before landing. 9702/11/M/J/12
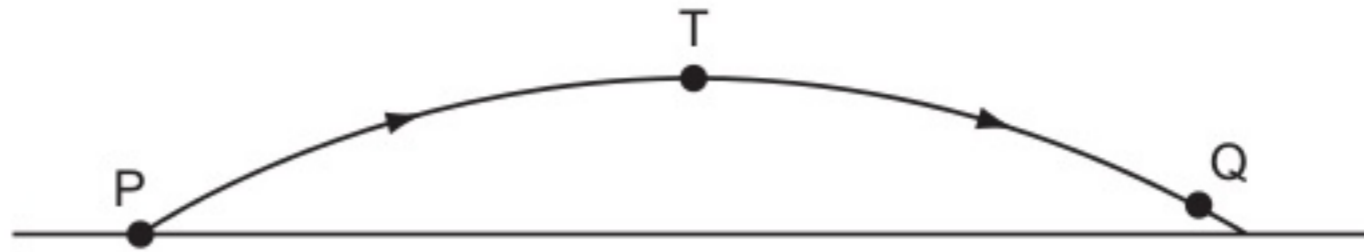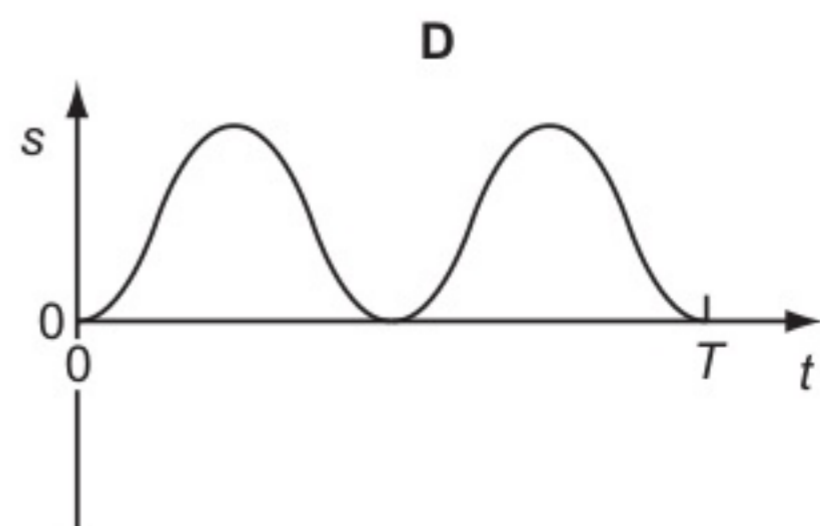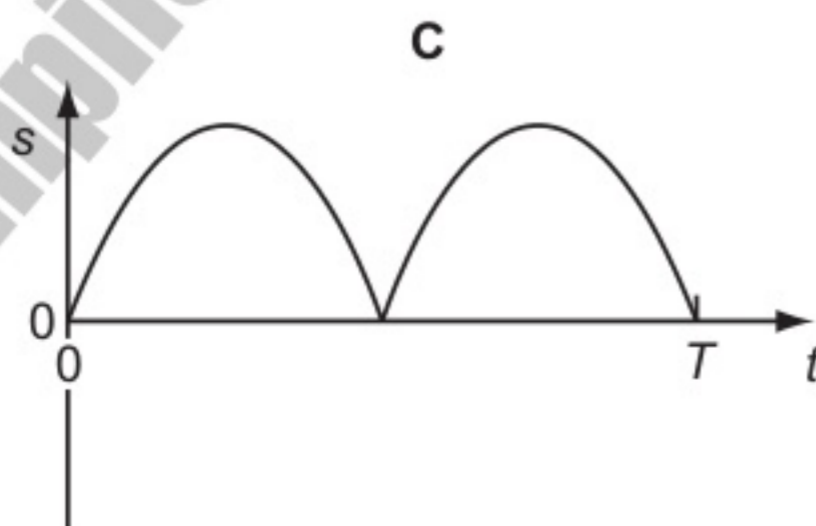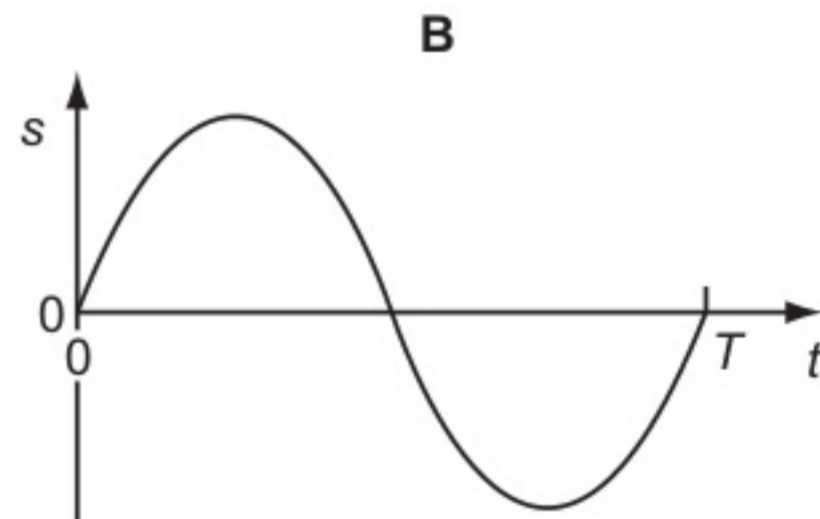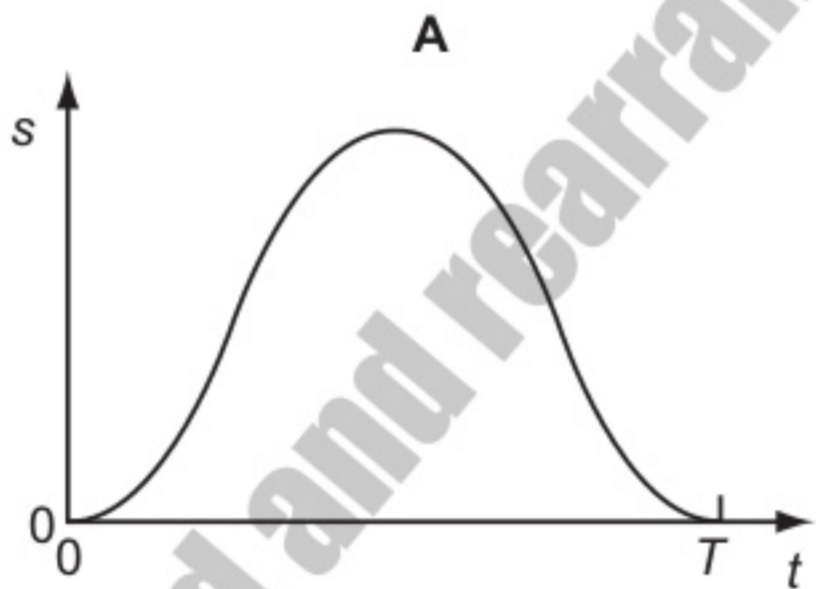

The vertical component of acceleration of the stone is

A zero at T.

B larger at T than at Q.

C larger at Q than at T.

D the same at Q as at T.

7 The graph shows how the velocity v of an object moving in a straight line varies over time $t = 0$ to $t = T$. 9702/12/M/J/12
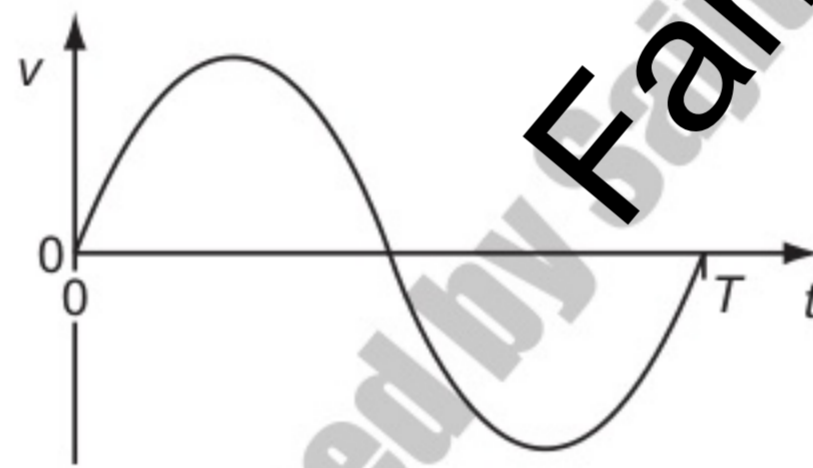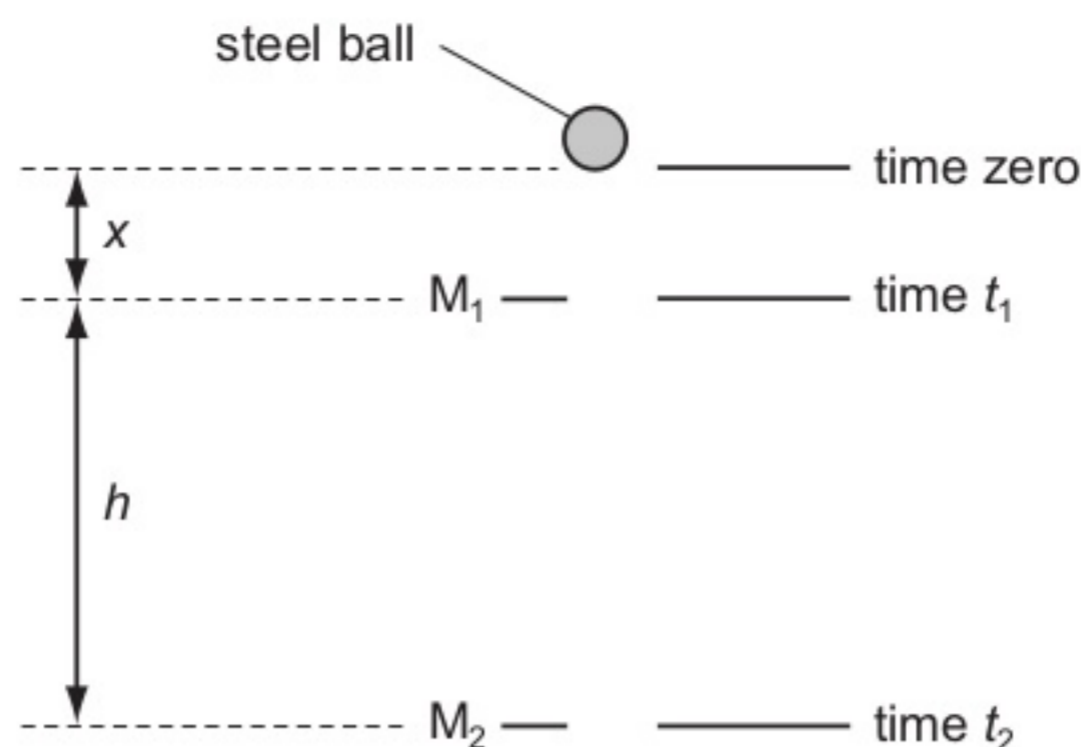

Which graph represents the displacement s of the object in the time $t = 0$ to $t = T$?

8 Two markers M_1 and M_2 are set up a vertical distance h apart.

A steel ball is released at time zero from a point a distance x above M_1. The ball reaches M_1 at time t_1 and reaches M_2 at time t_2. The acceleration of the ball is constant.

Which expression gives the acceleration of the ball?

A $\dfrac{2h}{t_2^{\,2}}$ **B** $\dfrac{2h}{(t_2+t_1)}$ **C** $\dfrac{2h}{(t_2-t_1)^2}$ **D** $\dfrac{2h}{(t_2^{\,2}-t_1^{\,2})}$

8 In the absence of air resistance, a stone is thrown from P and follows a parabolic path in which the highest point reached is T. The stone reaches point Q just before landing.

The vertical component of acceleration of the stone is

A zero at T.

B larger at T than at Q.

C larger at Q than at T.

D the same at Q as at T.

6 Which feature of a graph allows acceleration to be determined?

A the area under a displacement-time graph

B the area under a velocity-time graph

C the slope of a displacement-time graph

D the slope of a velocity-time graph

7 In an experiment to determine the acceleration of free fall using a falling body, what would lead to a value that is too large? 9702/13/M/J/12

A air resistance

B dimensions of the body are too large

C measured distance longer than true distance

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7 Which feature of a graph allows acceleration to be determined? 9702/11/M/J/12

A the area under a displacement-time graph

B the area under a velocity-time graph

C the slope of a displacement-time graph

D the slope of a velocity-time graph

9 The diagram shows a laboratory experiment in which a feather falls from rest in a long evacuated vertical tube of length L. 9702/13/M/J/12
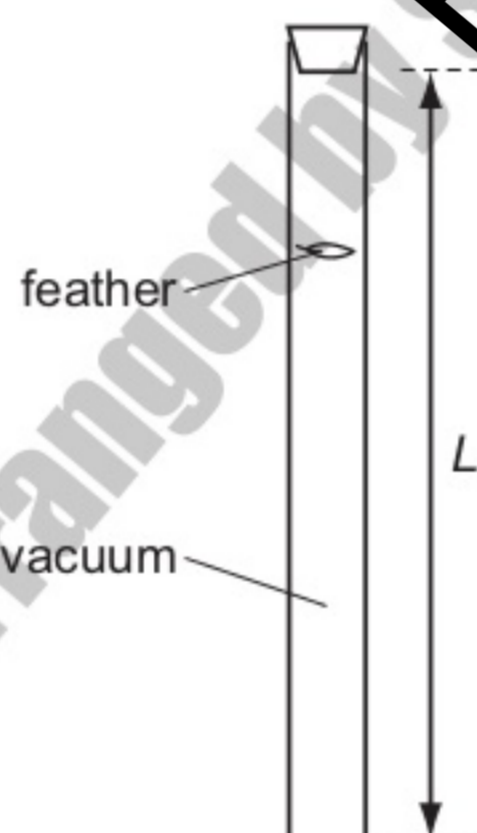
The feather takes time T to fall from the top to the bottom of the tube.

How far will the feather have fallen from the top of the tube in time $0.50\,T$?

A 0.13L **B** 0.25L **C** 0.38L **D** 0.50L

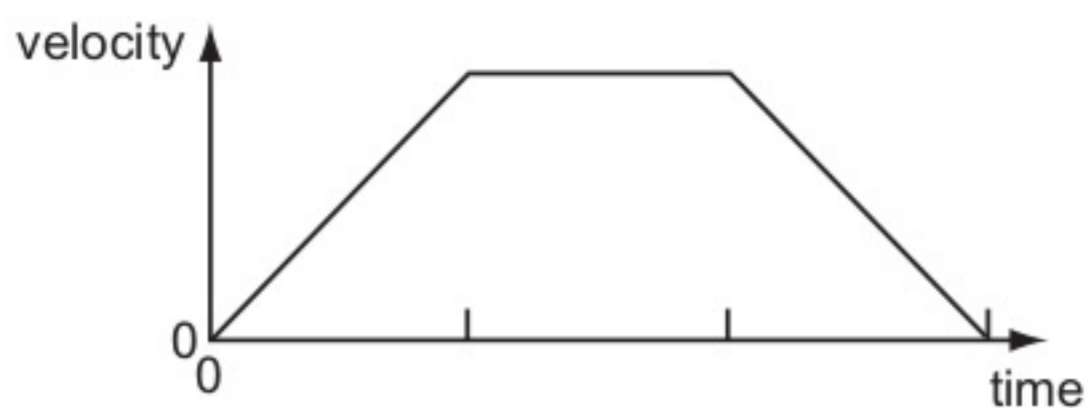**8** A science museum designs an experiment to show the fall of a feather in a vertical glass vacuum tube. 9702/12/O/N/12

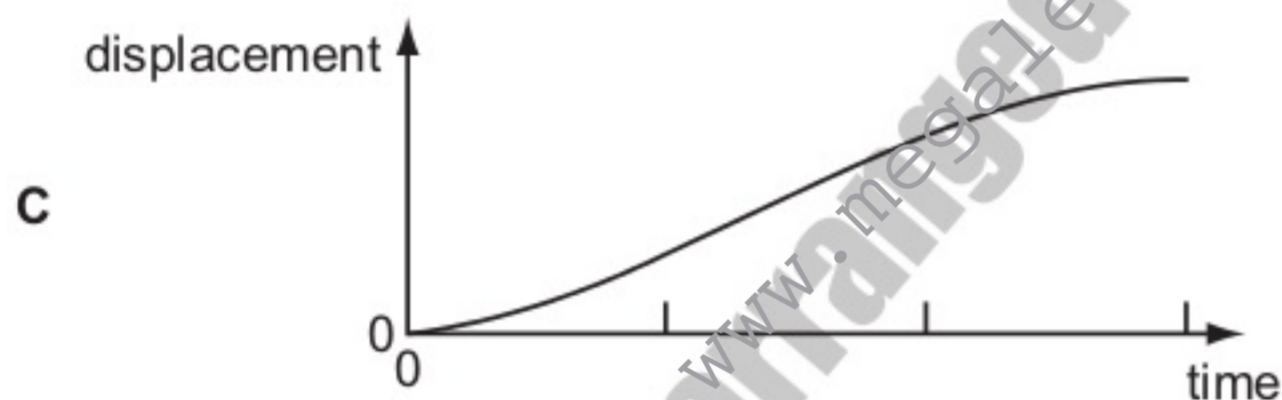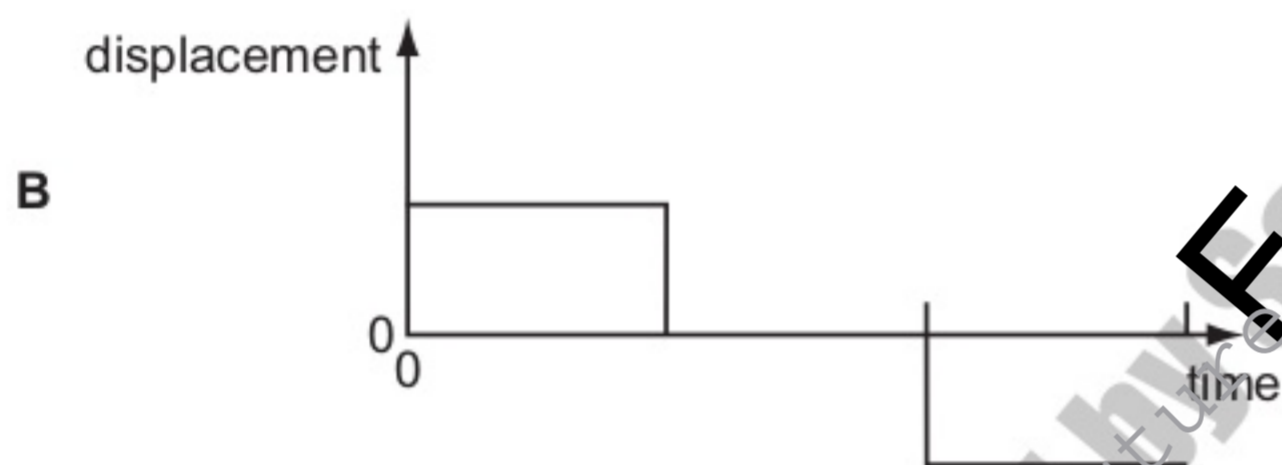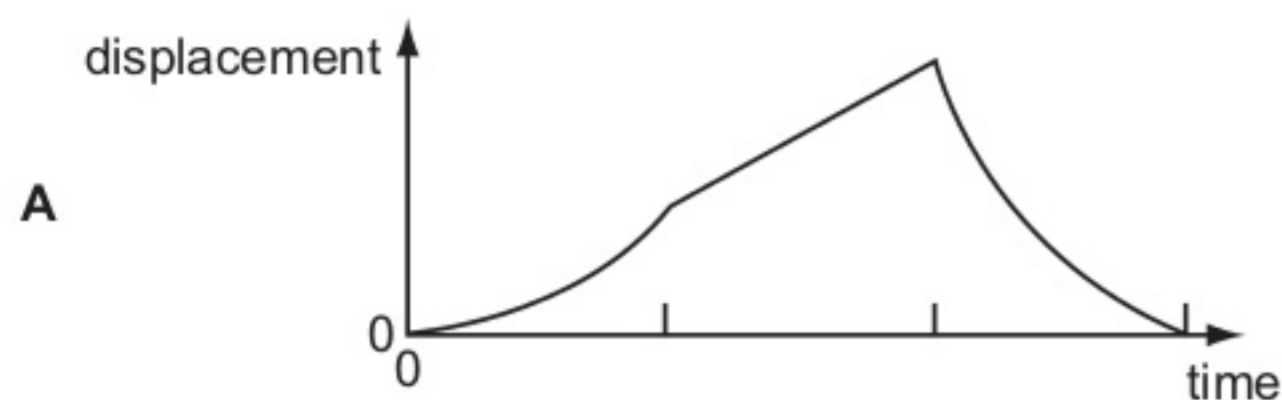The time of fall from rest is to be close to 0.5 s.

What length of tube is required?

A 1.3 m **B** 2.5 m **C** 5.0 m **D** 10.0 m

9 The graph of velocity against time for an object moving in a straight line is shown.   9702/12/O/N/12

What is the corresponding graph of displacement against time?

A

B

C

D

7 The speed of a car is calculated from measurements of the distance travelled and the time taken.

9702/12/O/N/12

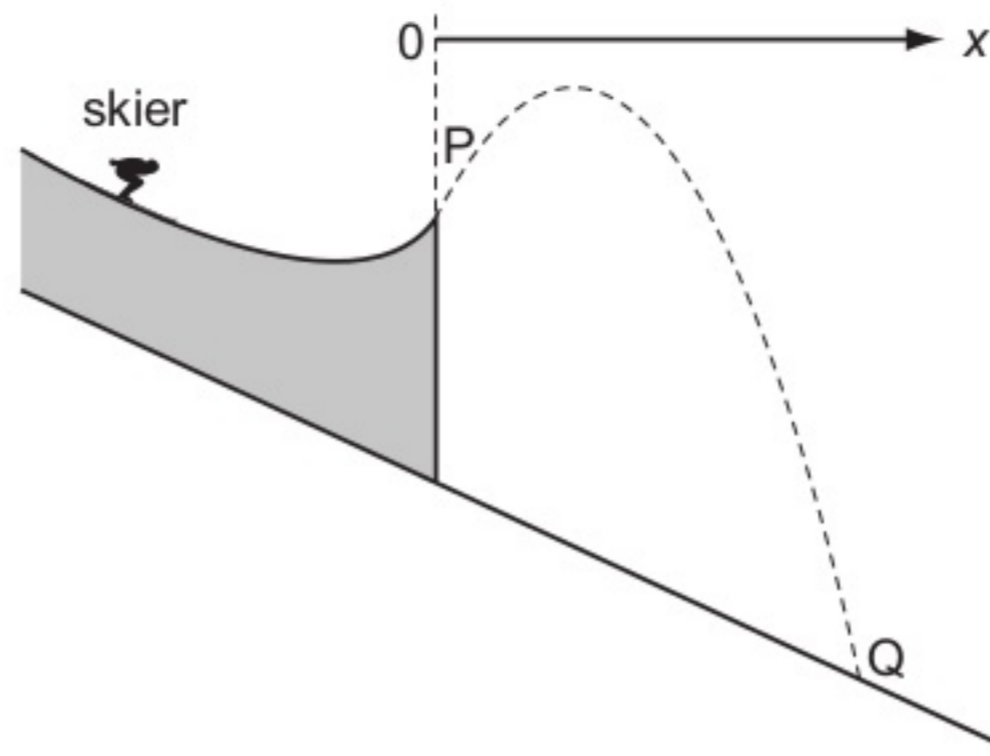The distance is measured as 200 m, with an uncertainty of ±2 m.

The time is measured as 10.0 s, with an uncertainty of ±0.2 s.

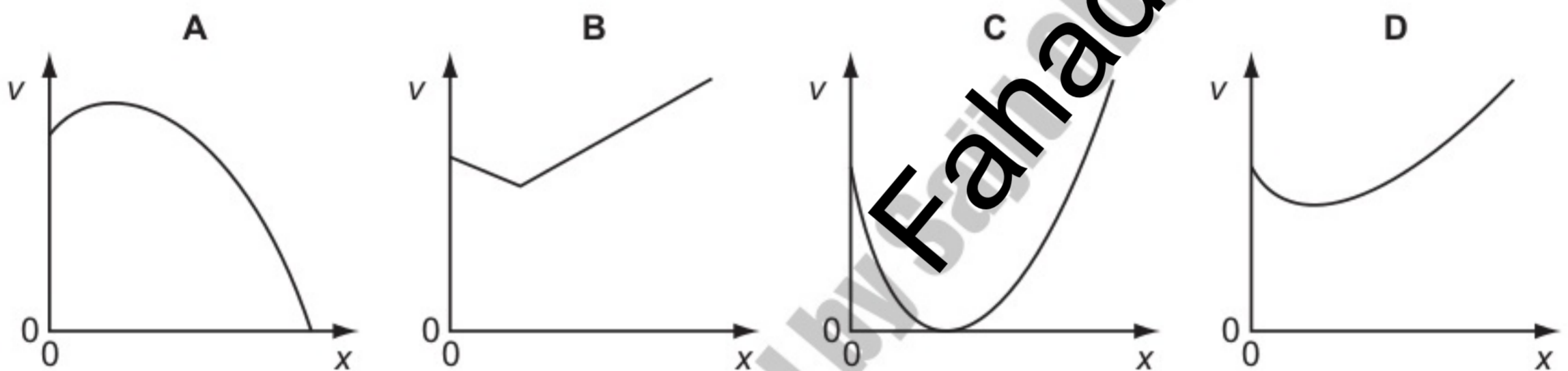What is the percentage uncertainty in the calculated speed?

A   ±0.5 %   **B**   ±1 %   **C**   ±2 %   **D**   ±3 %

10 The dotted line shows the path of a competitor in a ski-jumping competition.
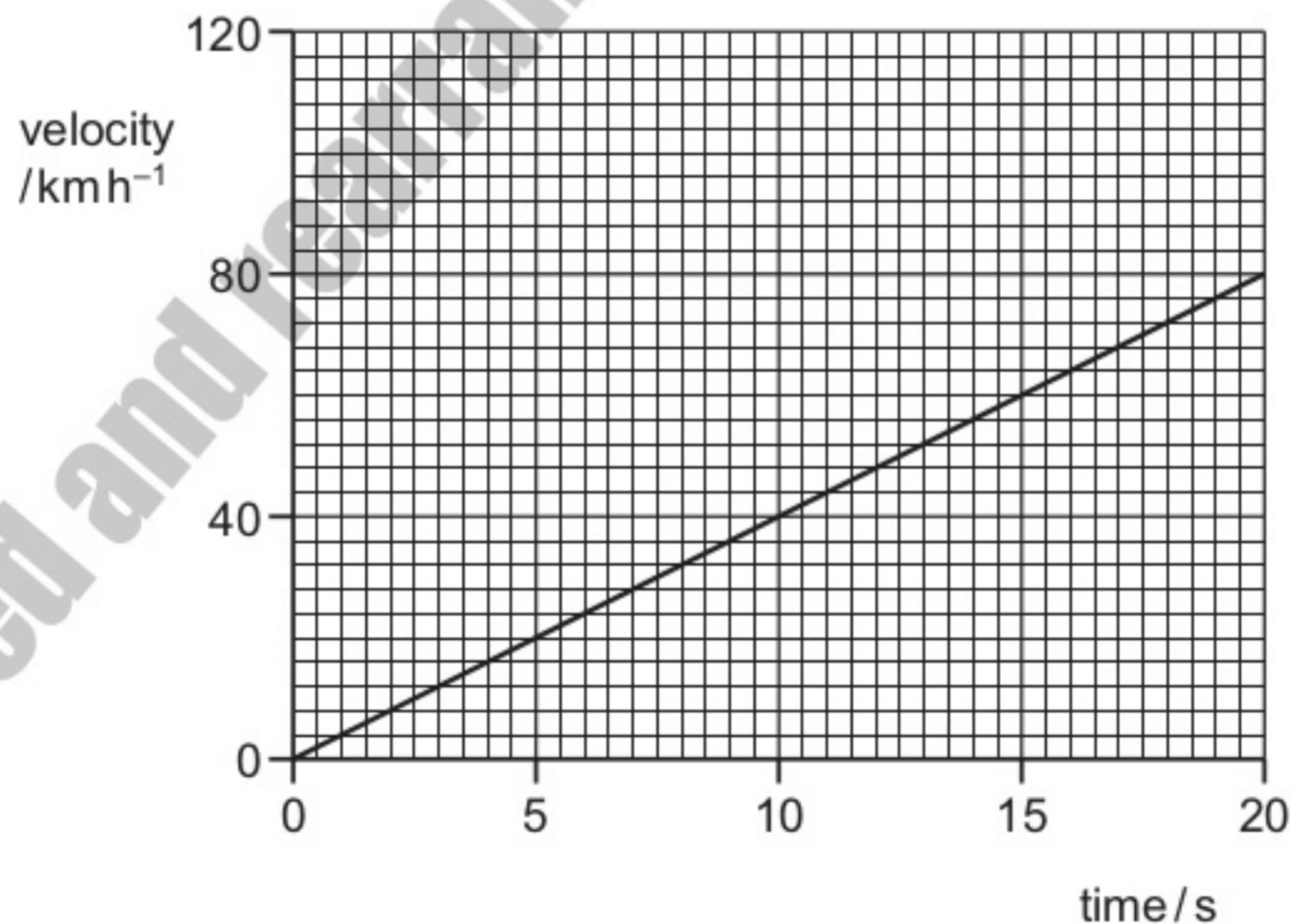

Ignoring air resistance, which graph best represents the variation of his speed v with the horizontal distance x covered from the start of his jump at P before landing at Q?

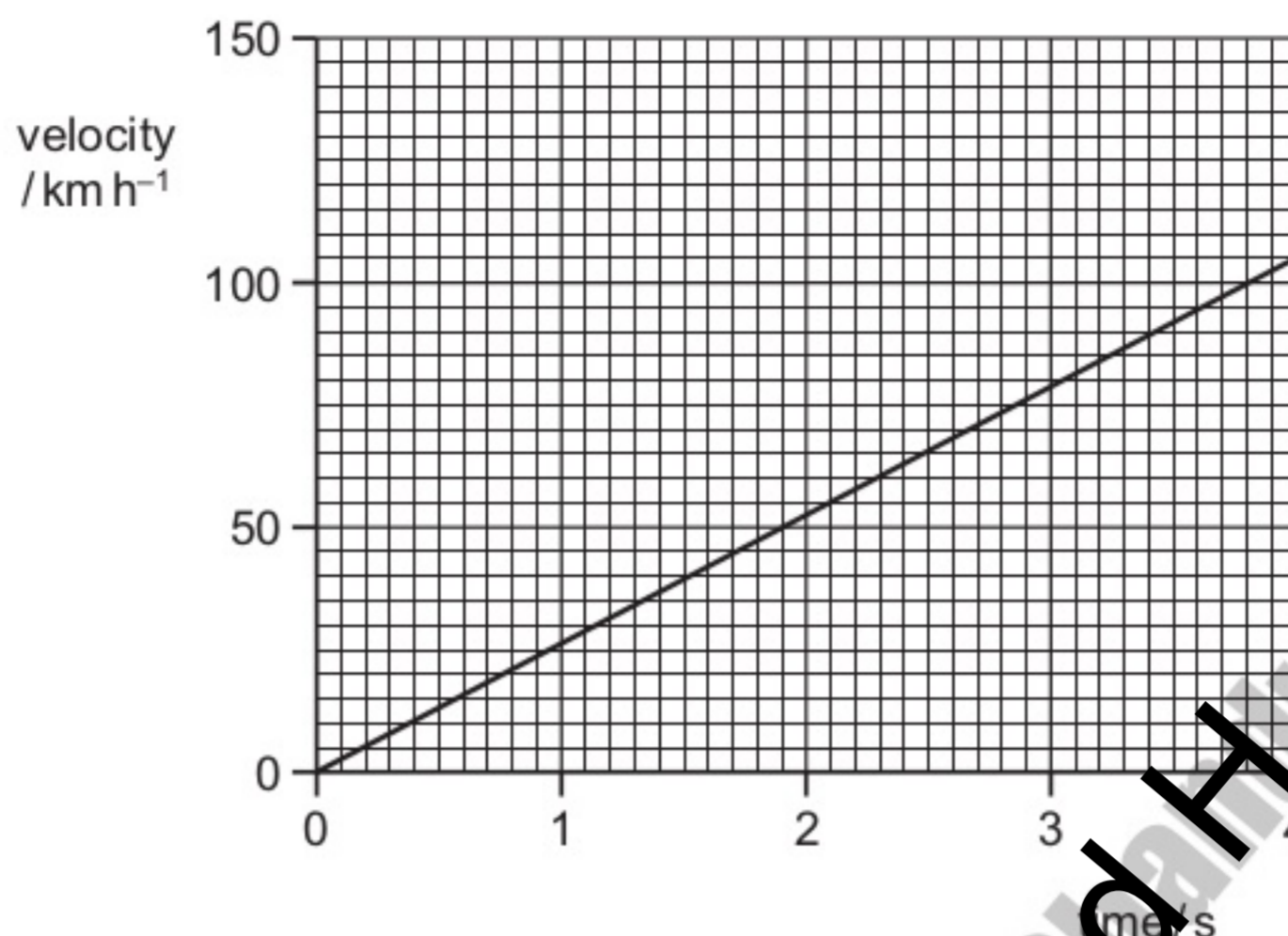**11** The velocity of a car changes as shown.

9702/12/O/N/12

What is the acceleration of the car?

A $1.1\,\text{m s}^{-2}$ **B** $4.0\,\text{m s}^{-2}$ **C** $224\,\text{m s}^{-2}$ **D** $800\,\text{m s}^{-2}$

8 The velocity of an electric car changes as shown. 9702/11/O/N/12

What is the acceleration of the car?

A $190\,\text{m}\,\text{s}^{-2}$ **B** $53\,\text{m}\,\text{s}^{-2}$ **C** $26\,\text{m}\,\text{s}^{-2}$ **D** $7.3\,\text{m}\,\text{s}^{-2}$
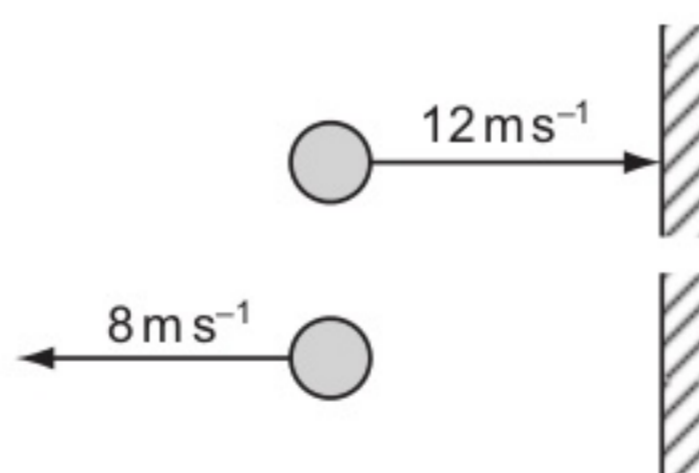
9 A ball is thrown vertically in air. 9702/11/O/N/12

Neglecting air resistance, which property of the ball can **never** be zero at any time during the flight?

A acceleration

B kinetic energy

C speed

D velocity

12 A ball of mass 0.5 kg is thrown against a wall at a speed of $12\,\text{m}\,\text{s}^{-1}$. It bounces back with a speed of $8\,\text{m}\,\text{s}^{-1}$. The collision lasts for 0.10 s. 9702/12/O/N/12
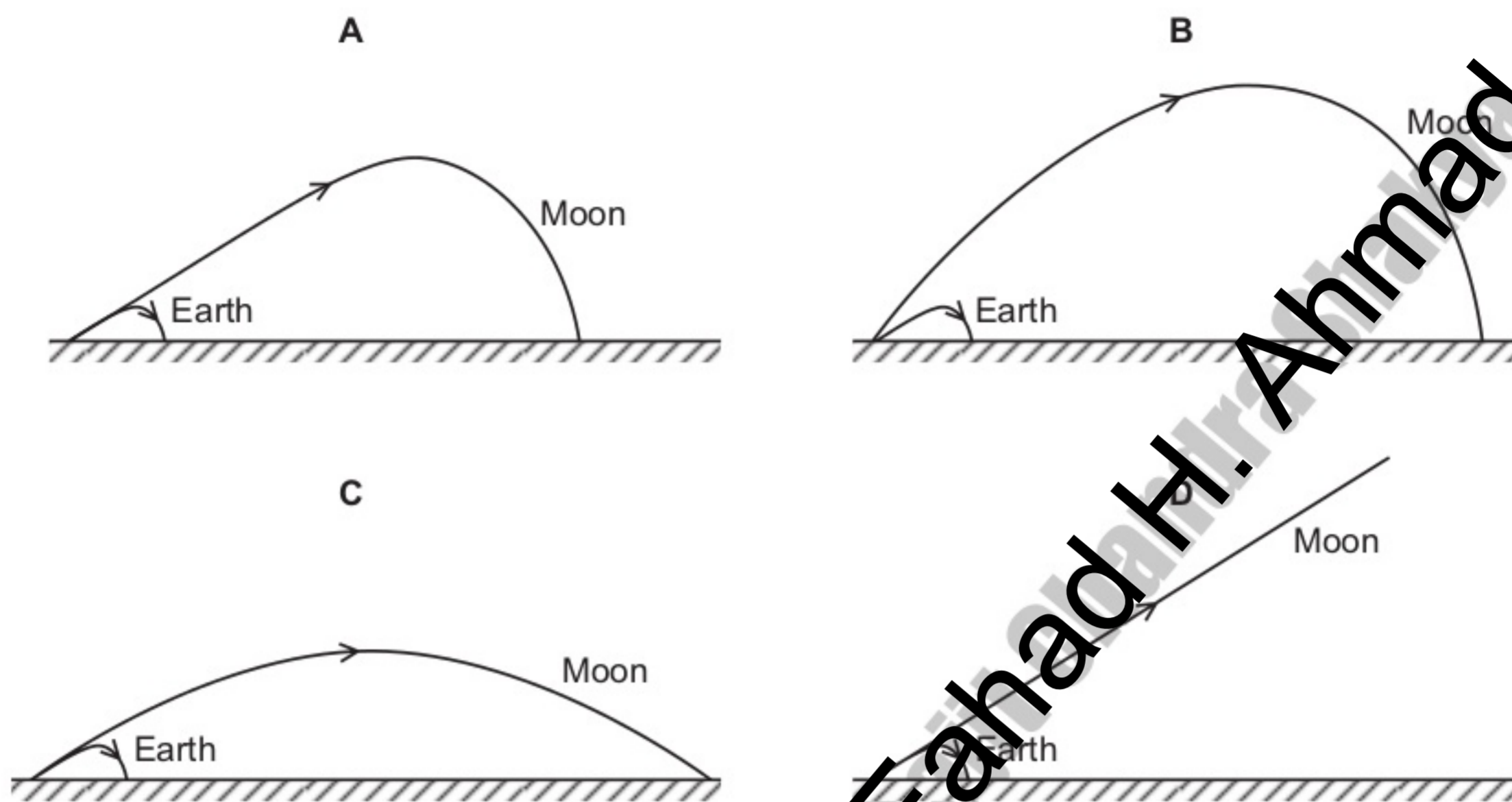

What is the average force on the ball due to the collision?

A 0.2 N **B** 1 N **C** 20 N **D** 100 N

10 A golf ball is hit with the same force and direction on the Earth and on the Moon. 9702/12/O/N/12

Which diagram best represents the shapes of the paths taken by the golf ball?

8 A bicycle brakes so that it undergoes uniform deceleration from a speed of $8\,\text{m s}^{-1}$ to $6\,\text{m s}^{-1}$ over a distance of $7\,\text{m}$. 9702/13/O/N/12

If the deceleration of the bicycle remains constant, what further distance will it travel before coming to rest?

A 7 m **B** 9 m **C** 16 m **D** 21 m

9 A ball is released from rest above a horizontal surface. It bounces once and is caught. 9702/1/O/N/12
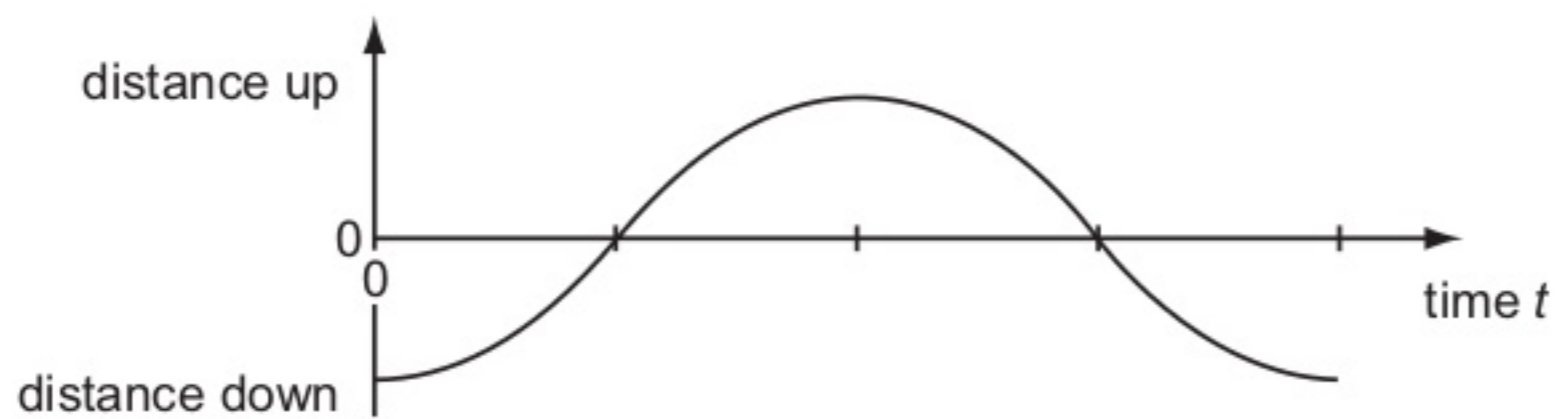
9702/13/O/N/12

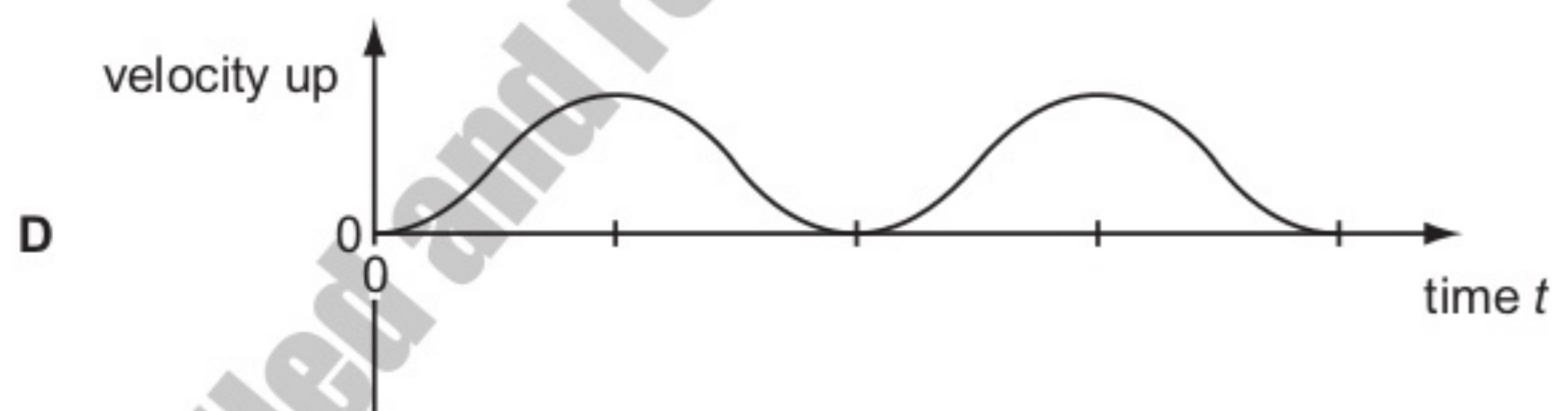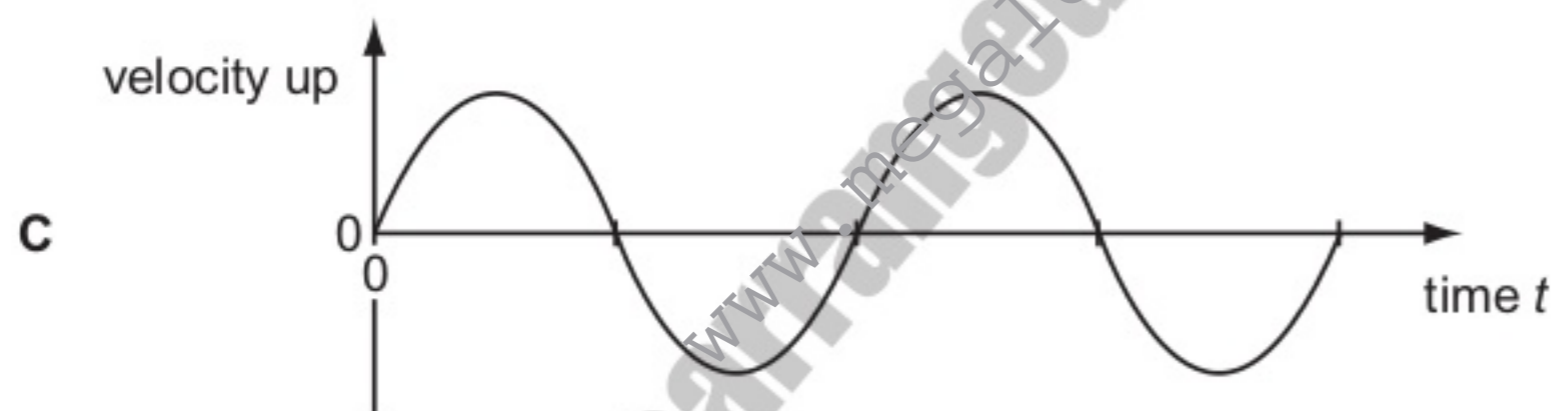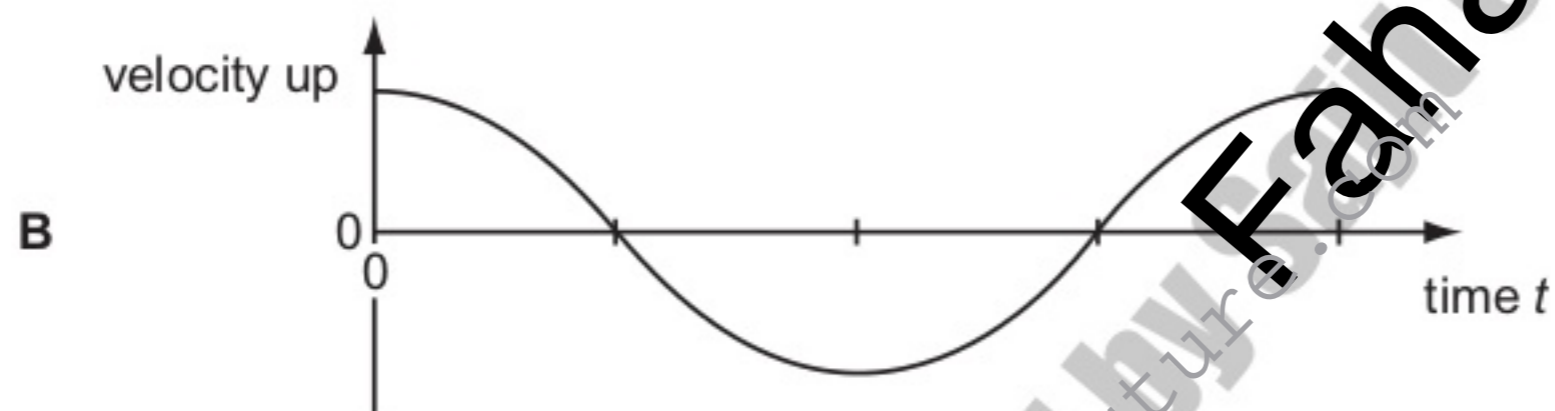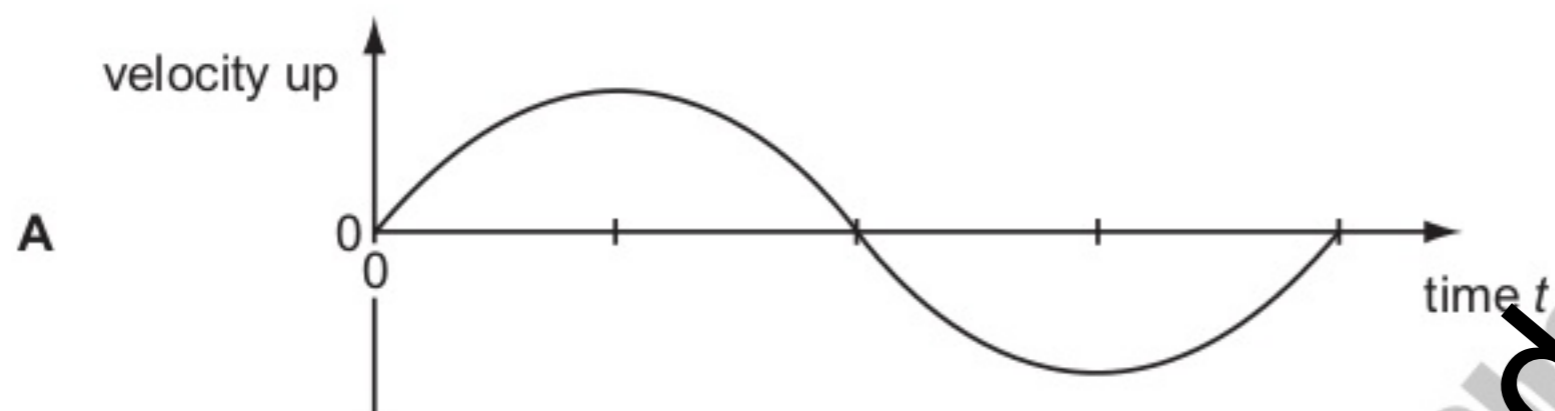Which graph represents the variation with time t of the velocity v of the ball?

MEGA LECTURE
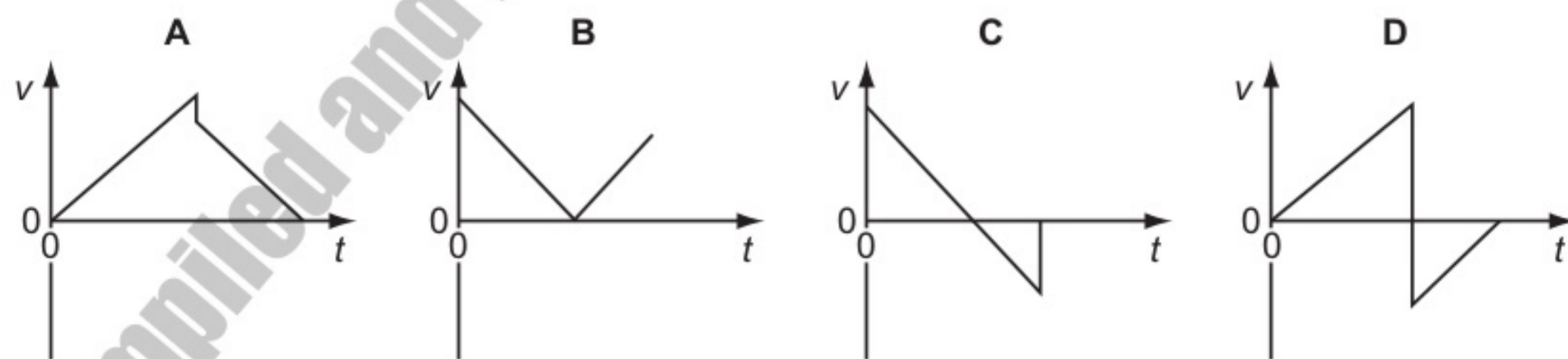
10 A mass on the end of a spring bounces up and down as shown, after being released at time $t = 0$.

Which graph shows how the velocity varies with time?