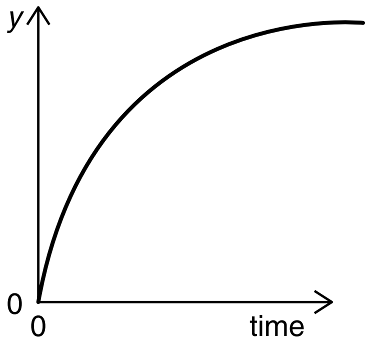
Kinematics

1 The graph relates to the motion of a falling body.



Which is a correct description of the graph?

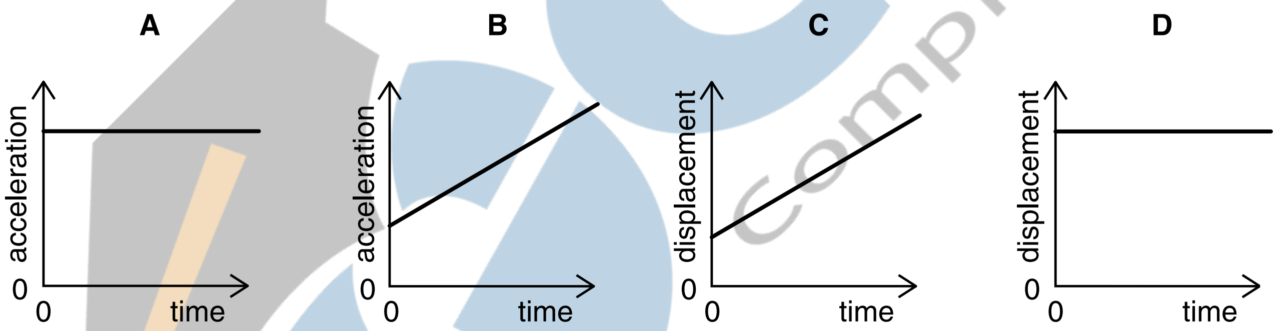
A y is distance and air resistance is negligible

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

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



3 A body, initially at rest, explodes into two masses M_1 and M_2 that move apart with speeds v_1 and v_2 respectively.

What is the ratio $\dfrac{v_1}{v_2}$?

A $\dfrac{M_1}{M_2}$ **B** $\dfrac{M_2}{M_1}$ **C** $\left(\dfrac{M_1}{M_2}\right)^{\frac{1}{2}}$ **D** $\left(\dfrac{M_2}{M_1}\right)^{\frac{1}{2}}$

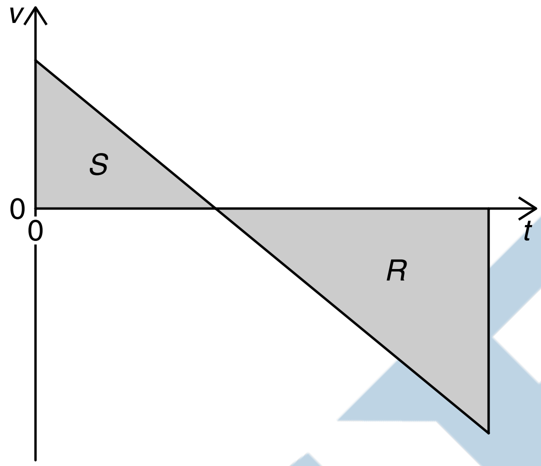
4 A motorist travelling at $10\,\text{m s}^{-1}$ can bring his car to rest in a distance of 10 m.

If he had been travelling at $30\,\text{m s}^{-1}$, in what distance could he bring the car to rest using the same braking force?

A 17 m **B** 30 m **C** 52 m **D** 90 m

5 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.

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** $R - S$

6 Two similar spheres, each of mass m and travelling with speed v, are moving towards each other.

The spheres have a head-on elastic collision.

Which statement is correct?

A The spheres stick together on impact.

B The total kinetic energy after impact is mv^2.

C The total kinetic energy before impact is zero.

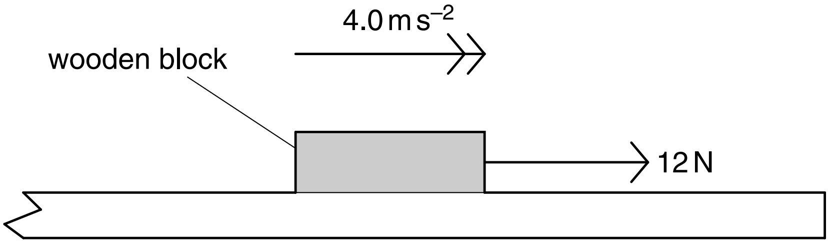
D The total momentum before impact is $2mv$.

7 Two railway trucks of masses m and $3m$ move towards each other in opposite directions with speeds $2v$ and v respectively. These trucks collide and stick together.

What is the speed of the trucks after the collision?

A $\frac{v}{4}$ **B** $\frac{v}{2}$ **C** v **D** $\frac{5v}{4}$

8 A wooden block of mass 0.60 kg is on a rough horizontal surface. A force of 12 N is applied to the block and it accelerates at 4.0 m s^{-2}.



What is the magnitude of the frictional force acting on the block?

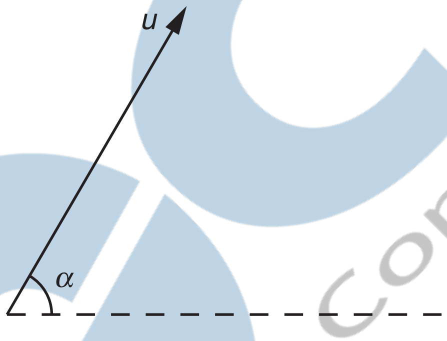
A 2.4 N

B 9.6 N

C 14 N

D 16 N

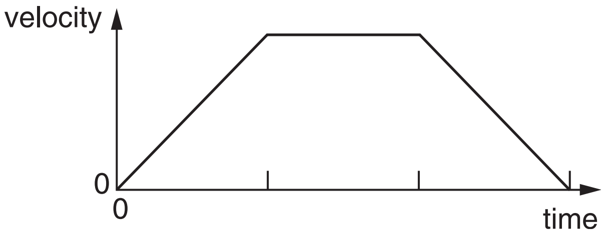
9 A projectile is fired at an angle α to the horizontal at a speed u, as shown.



What will be 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.

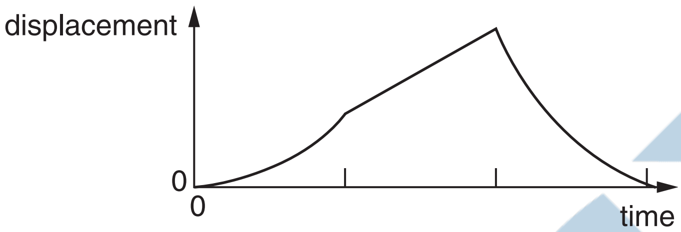
	vertical component	horizontal component
A	$u \sin \alpha$	$u \cos \alpha$
B	$u \sin \alpha - gt$	$u \cos \alpha - gt$
C	$u \sin \alpha - gt$	$u \cos \alpha$
D	$u \cos \alpha$	$u \sin \alpha - gt$

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

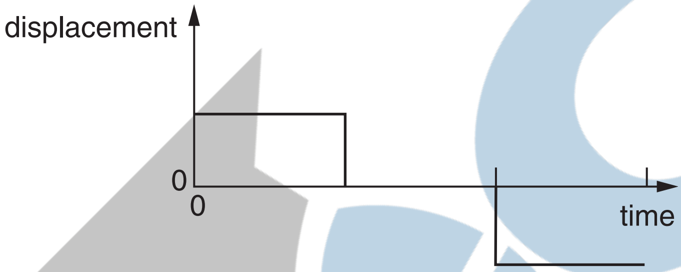


Which of the following is the corresponding graph of displacement against time?

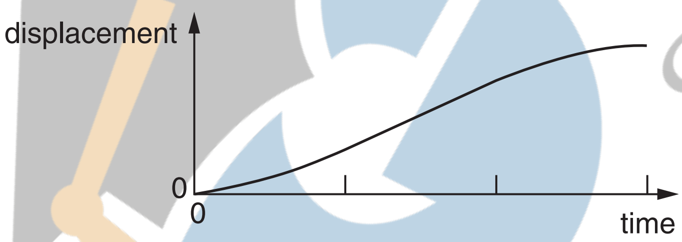
A



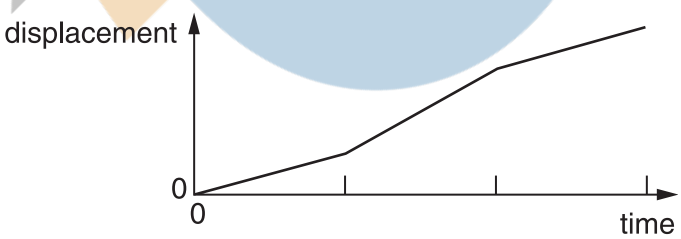
B



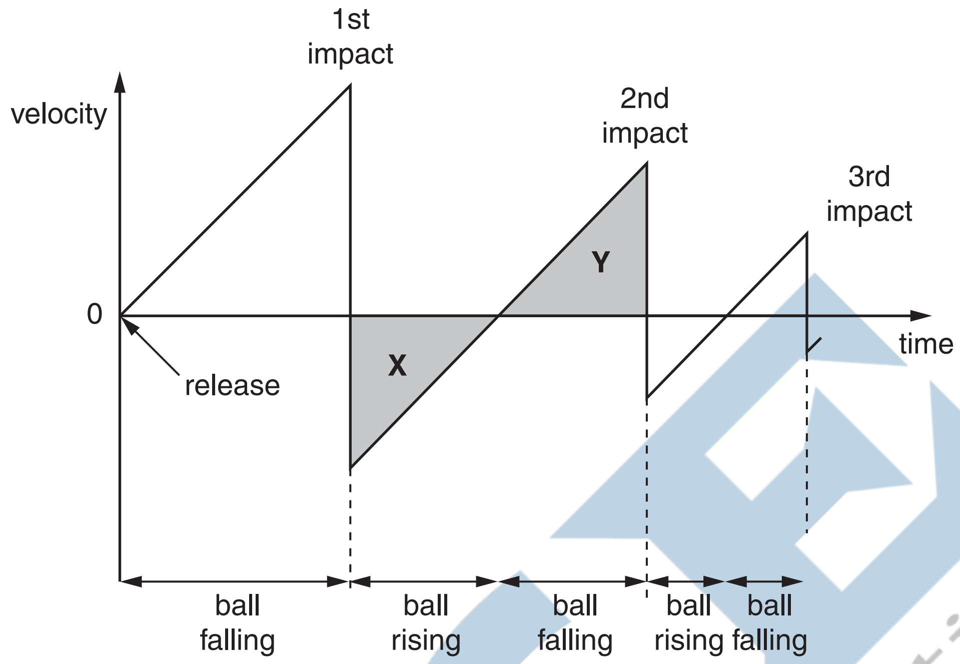
C



D



11 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

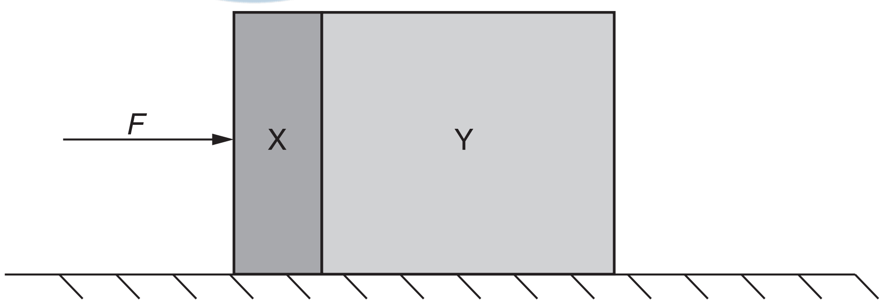
A the ball's acceleration is the same during its upward and downward motion.

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.

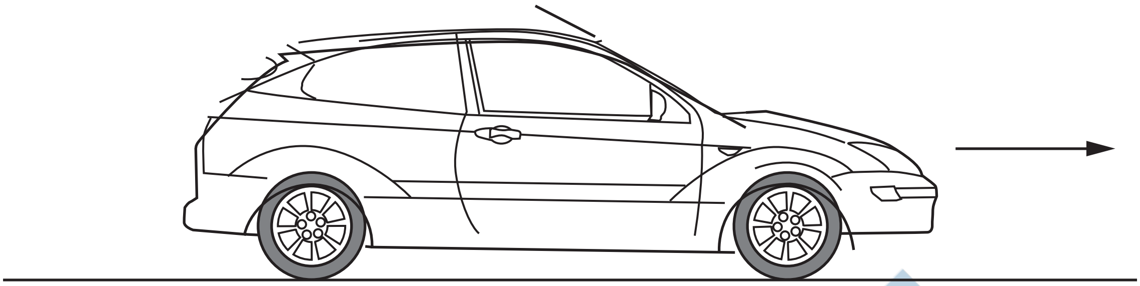
12 Two blocks X and Y, of masses m and $3m$ respectively, are accelerated along a smooth horizontal surface by a force F applied to block X as shown.



What is the magnitude of the force exerted by block X on block Y during this acceleration?

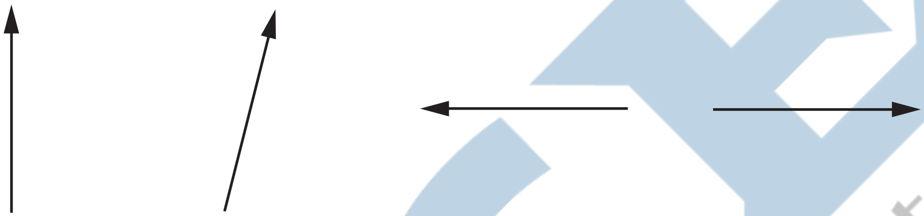
A $\frac{F}{4}$ **B** $\frac{F}{3}$ **C** $\frac{F}{2}$ **D** $\frac{3F}{4}$

13 A car with front-wheel drive accelerates in the direction shown.

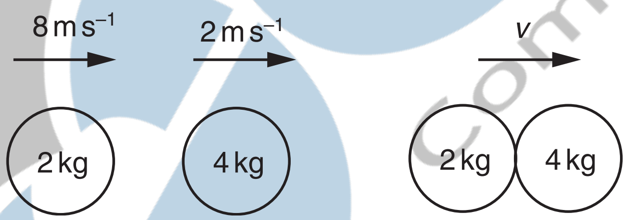


Which diagram best shows the direction of the total force exerted by the road on the front wheels?

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



14 A ball of mass 2 kg travelling at $8\,m\,s^{-1}$ strikes a ball of mass 4 kg travelling at $2\,m\,s^{-1}$. Both balls are moving along the same straight line as shown.



After collision, both balls move at the same velocity v.

What is the magnitude of the velocity v?

A $4\,m\,s^{-1}$ **B** $5\,m\,s^{-1}$ **C** $6\,m\,s^{-1}$ **D** $8\,m\,s^{-1}$

15 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

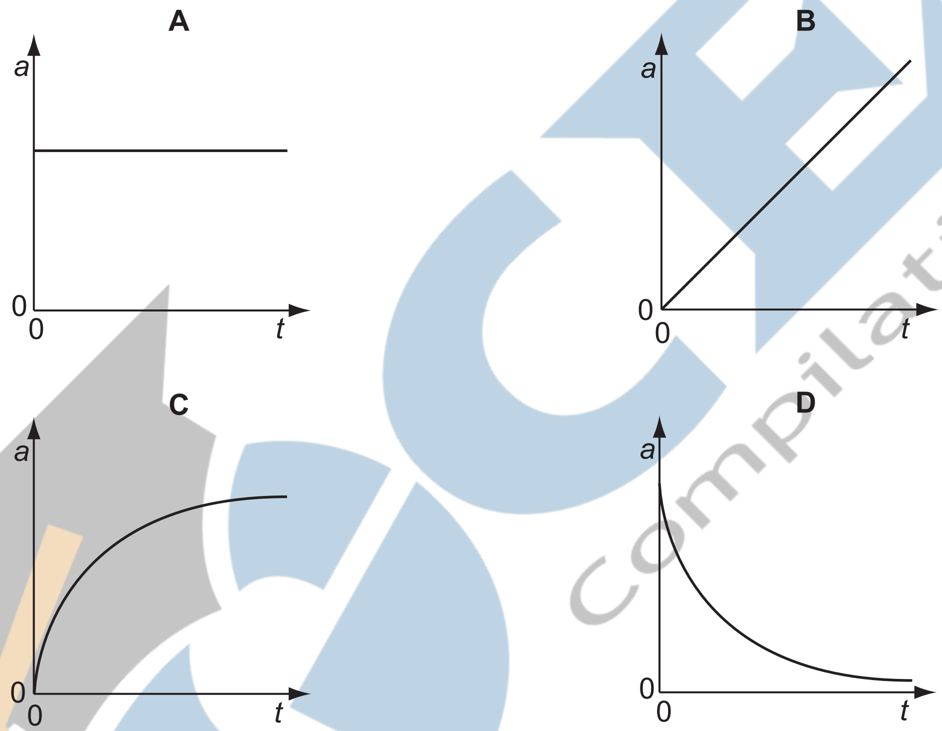
16 A car is travelling with uniform acceleration along a straight road. The road has marker posts every 100 m. When the car passes one post, it has a speed of $10\,m\,s^{-1}$ and, when it passes the next one, its speed is $20\,m\,s^{-1}$.

What is the car's acceleration?

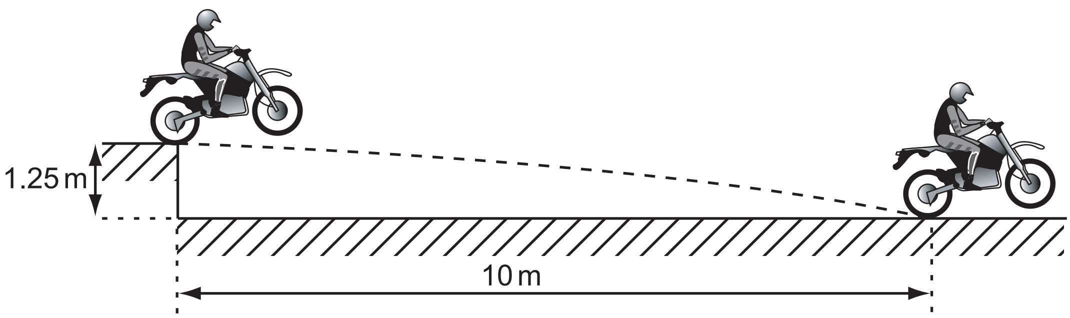
A $0.67\,m\,s^{-2}$ **B** $1.5\,m\,s^{-2}$ **C** $2.5\,m\,s^{-2}$ **D** $6.0\,m\,s^{-2}$

17 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 effects of air resistance are appreciable?



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



What was the speed at take-off?

A $5\,m\,s^{-1}$ **B** $10\,m\,s^{-1}$ **C** $15\,m\,s^{-1}$ **D** $20\,m\,s^{-1}$

19 A ball falls vertically and bounces on the ground.

The following statements are about the forces acting while the ball is in contact with the ground.

Which statement is correct?

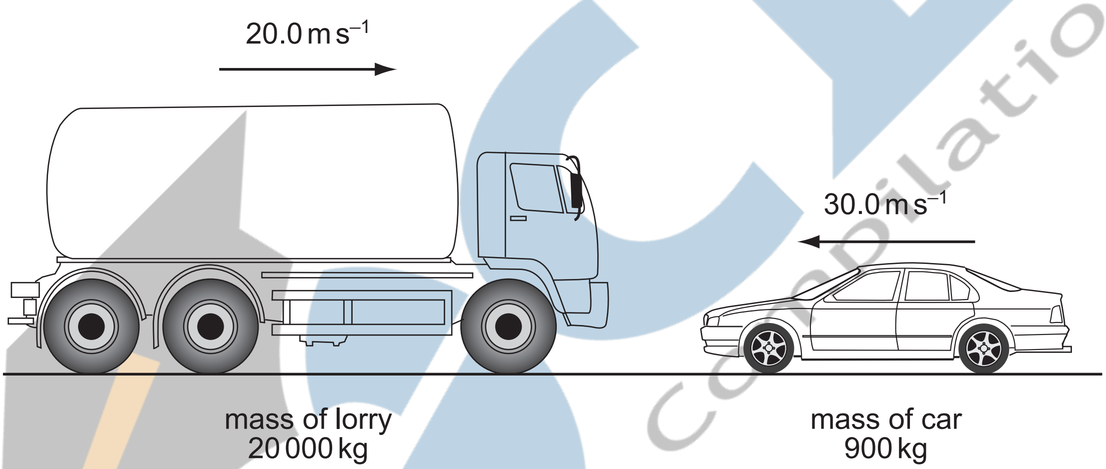
A The force that the ball exerts on the ground is always equal to the weight of the ball.

B The force that the ball exerts on the ground is always equal in magnitude and opposite in direction to the force the ground exerts on the ball.

C The force that the ball exerts on the ground is always less than the weight of the ball.

D The weight of the ball is always equal in magnitude and opposite in direction to the force that the ground exerts on the ball.

20 The diagram shows a situation just before a head-on collision. A lorry of mass 20 000 kg is travelling at $20.0\,\text{m}\,\text{s}^{-1}$ towards a car of mass 900 kg travelling at $30.0\,\text{m}\,\text{s}^{-1}$ towards the lorry.



What is the magnitude of the total momentum?

A 373 kN s **B** 427 kN s **C** 3600 kN s **D** 4410 kN s

21 Which is **not** one of Newton's laws of motion?

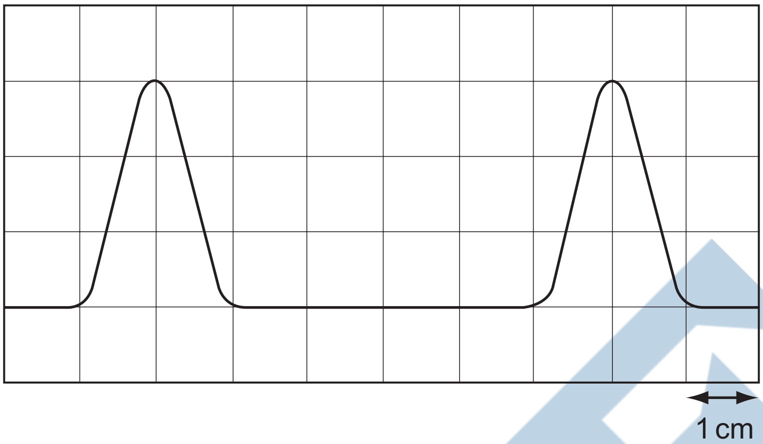
A The total momentum of a system of interacting bodies remains constant, providing no external force acts.

B The rate of change of momentum of a body is directly proportional to the external force acting on the body and takes place in the direction of the force.

C If body A exerts a force on body B, then body B exerts an equal and oppositely-directed force on body A.

D A body continues in a state of rest or of uniform motion in a straight line unless acted upon by some external force.

22 The diagram shows two pulses on the screen of a cathode ray oscilloscope. A grid of 1 cm squares covers the screen. The time base setting is $1\,\mu s\,cm^{-1}$.



How long does each pulse last?

A $2\,\mu s$ **B** $3\,\mu s$ **C** $4\,\mu s$ **D** $6\,\mu s$

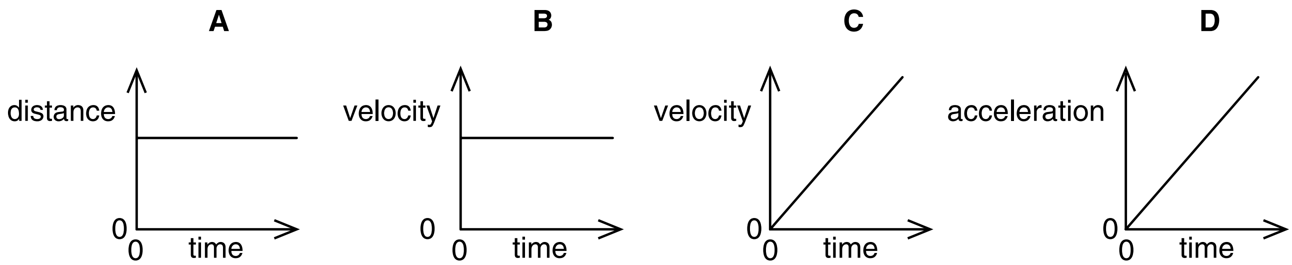
23 A boy throws a ball vertically upwards. It rises to a maximum height, where it is momentarily at rest, and falls back to his hands.

Which of the following gives the acceleration of the ball at various stages in its motion? Take vertically upwards as positive. Neglect air resistance.

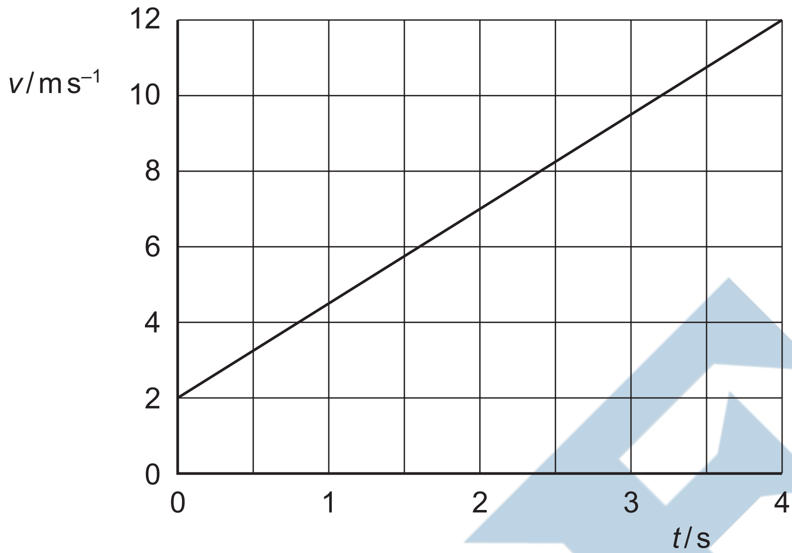
	rising	at maximum height	falling
A	$-9.81\,m\,s^{-2}$	0	$+9.81\,m\,s^{-2}$
B	$-9.81\,m\,s^{-2}$	$-9.81\,m\,s^{-2}$	$-9.81\,m\,s^{-2}$
C	$+9.81\,m\,s^{-2}$	$+9.81\,m\,s^{-2}$	$+9.81\,m\,s^{-2}$
D	$+9.81\,m\,s^{-2}$	0	$-9.81\,m\,s^{-2}$

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

Which graph represents the motion of the particle?



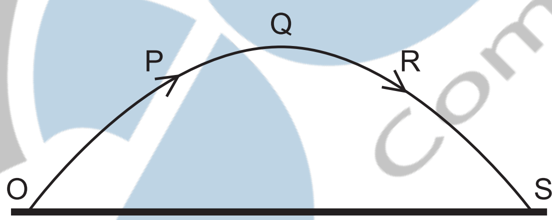
25 The diagram shows a velocity-time graph for a car.



What is the distance travelled between time $t = 0$ and $t = 4$ s?

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

26 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.

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

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

28 A cyclist is riding at a steady speed on a level road.

According to Newton's third law of motion, what is equal and opposite to the backward push of the back wheel on the road?

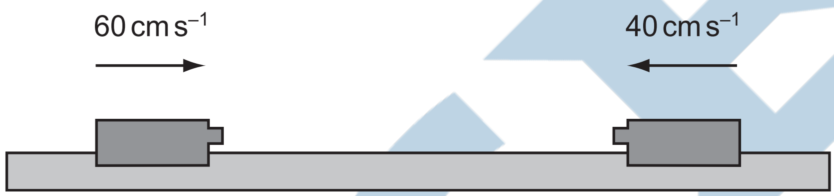
A the force exerted by the cyclist on the pedals

B the forward push of the road on the back wheel

C the tension in the cycle chain

D the total air resistance and friction force

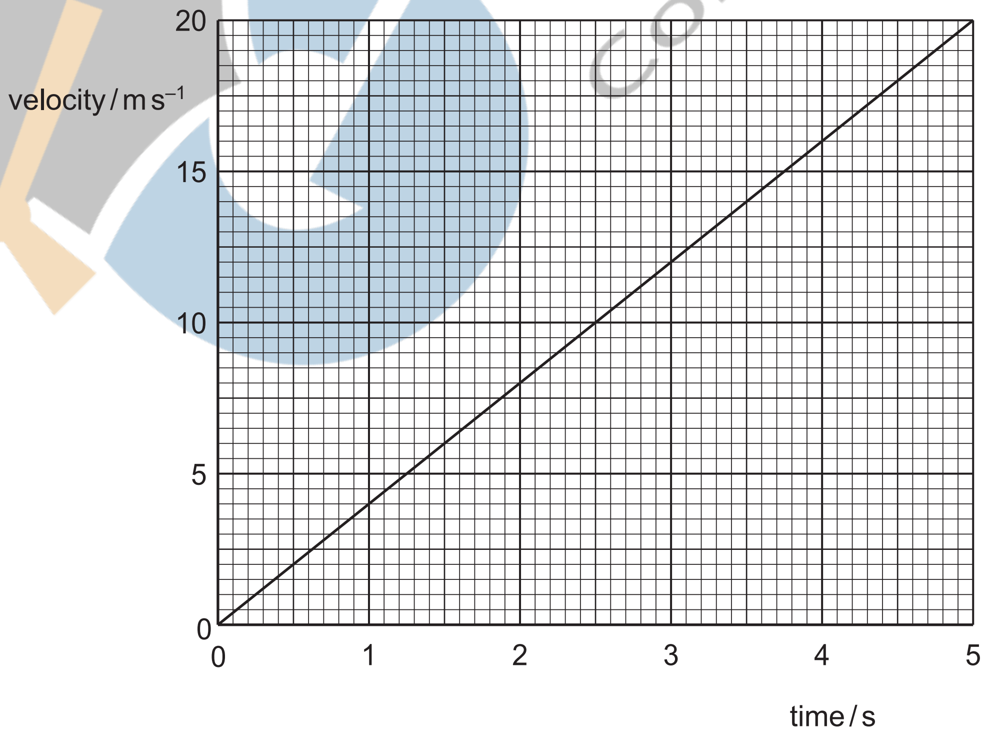
29 Two equal masses travel towards each other on a frictionless air track at speeds of 60 cm s^{-1} and 40 cm s^{-1}. They stick together on impact.



What is the speed of the masses after impact?

A 10 cm s^{-1} **B** 20 cm s^{-1} **C** 40 cm s^{-1} **D** 50 cm s^{-1}

30 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

31 A motorist travelling at $10\,\text{m}\,\text{s}^{-1}$ can bring his car to rest in a braking distance of 10 m.

In what distance could he bring the car to rest from a speed of $30\,\text{m}\,\text{s}^{-1}$ using the same braking force?

A 17 m **B** 30 m **C** 52 m **D** 90 m

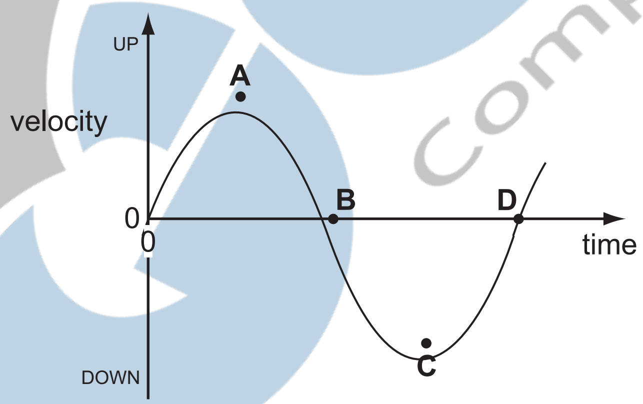
32 An object accelerates in a direction that is always perpendicular to its motion.

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

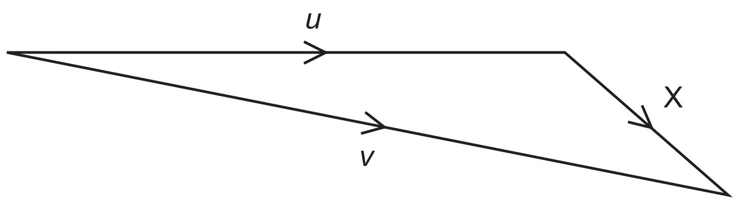
33 The diagram shows a velocity-time graph for a mass moving up and down on the end of a spring.

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



34 An object has an initial velocity u. It is subjected to a constant force F for t seconds, causing a constant acceleration a. The force is **not** in the same direction as the initial velocity.

A vector diagram is drawn to find the final velocity v.



What is the length of side X of the vector diagram?

A F **B** Ft **C** at **D** $u + at$

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

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

36 What is meant by the weight of an object?

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

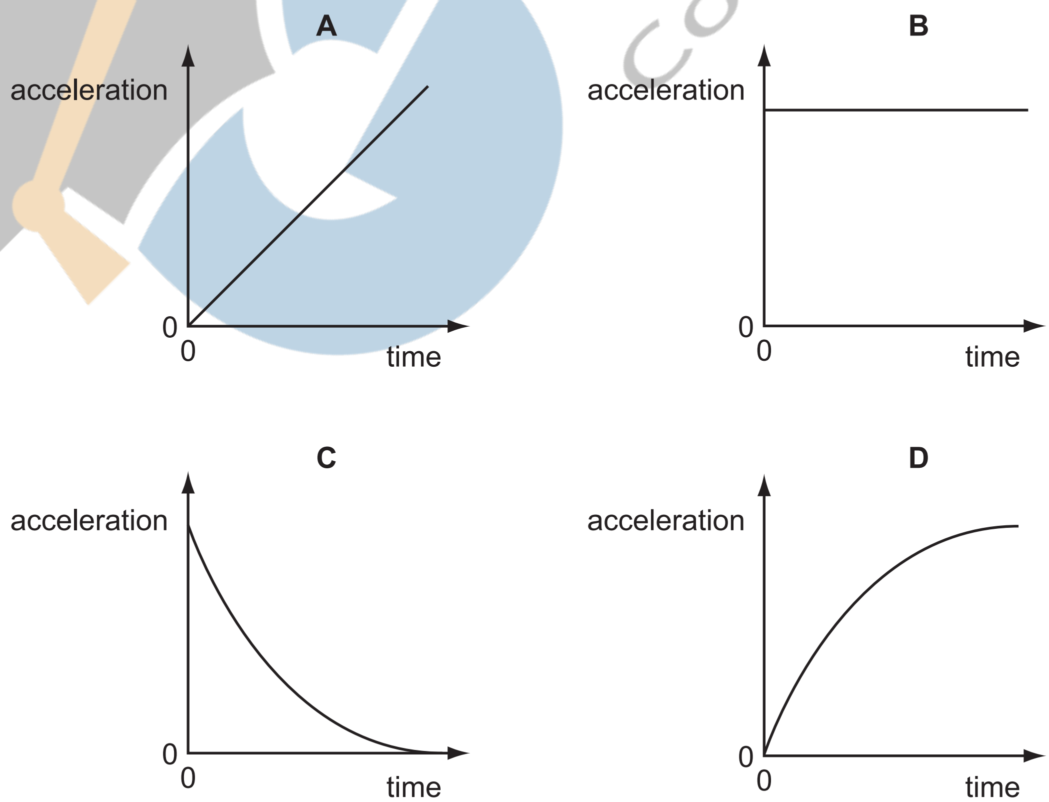
37 A molecule of mass *m* travelling horizontally with velocity *u* hits a vertical wall at right angles to the wall. It then rebounds horizontally with the same speed.

What is its change in momentum?

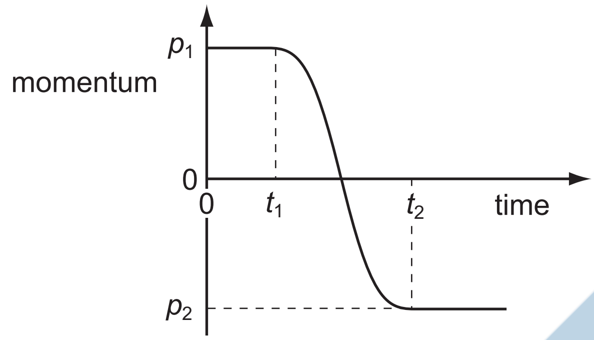
A zero **B** mu **C** $-mu$ **D** $-2mu$

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

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



39 The graph shows the variation with time of the momentum of a ball as it is kicked in a straight line.

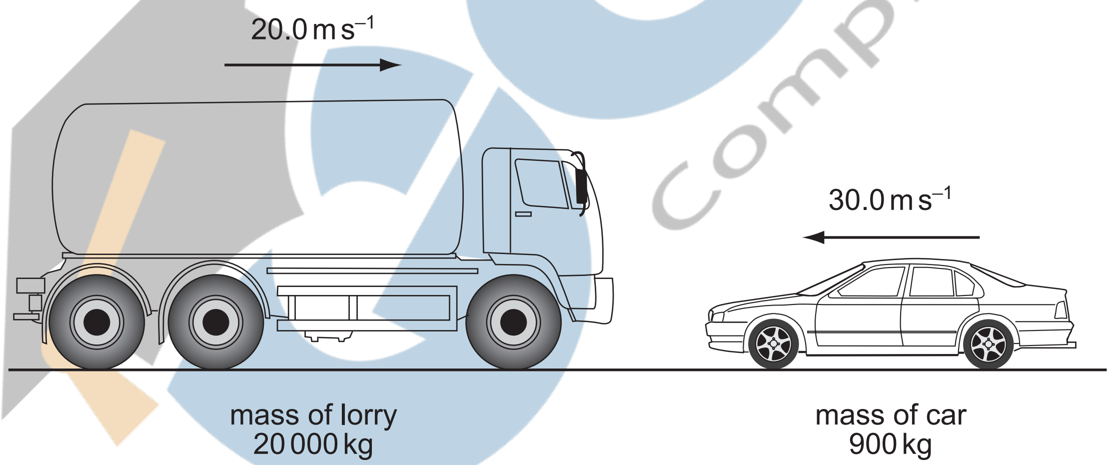


Initially, the momentum is p_1 at time t_1. At time t_2 the momentum is p_2.

What is the magnitude of the average force acting on the ball between times t_1 and t_2?

A $\dfrac{p_1 - p_2}{t_2}$ **B** $\dfrac{p_1 - p_2}{t_2 - t_1}$ **C** $\dfrac{p_1 + p_2}{t_2}$ **D** $\dfrac{p_1 + p_2}{t_2 - t_1}$

40 A lorry of mass 20 000 kg is travelling at $20.0\,\text{m}\,\text{s}^{-1}$. A car of mass 900 kg is travelling at $30.0\,\text{m}\,\text{s}^{-1}$ towards the lorry.



What is the magnitude of the total momentum?

A 209 kN s **B** 373 kN s **C** 427 kN s **D** 1045 kN s

41 A mass accelerates uniformly when the resultant force acting on it

A is zero.

B is constant but not zero.

C increases uniformly with respect to time.

D is proportional to the displacement from a fixed point.

42 Which is a statement of the principle of conservation of momentum?

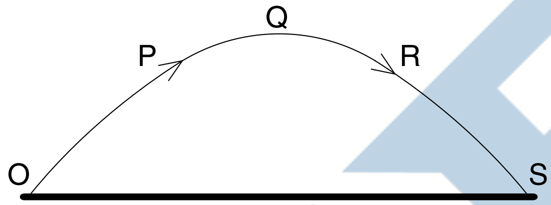
A Momentum is the product of mass and velocity.

B Momentum is conserved only in elastic collisions.

C Momentum is conserved by all bodies in a collision.

D Momentum is conserved providing no external forces act.

43 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?

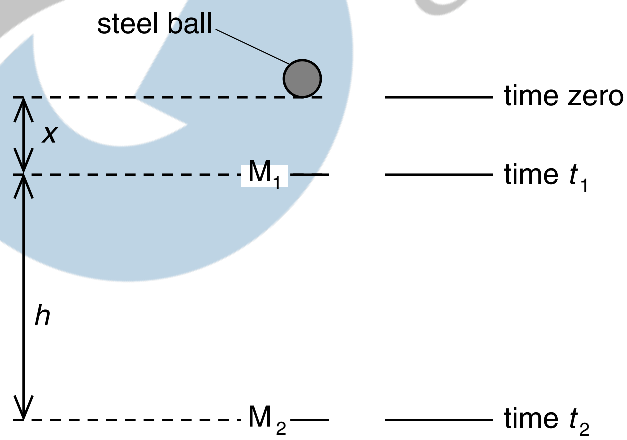
A The horizontal component of the projectile's acceleration is zero.

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.

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

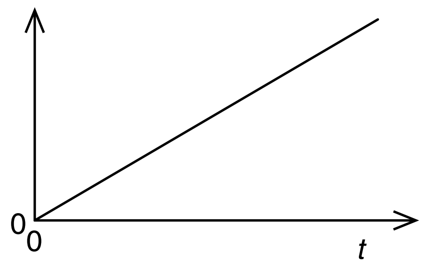


When a steel ball is released from rest from a point a distance x above M_1, it is found that the ball takes time t_1 to reach M_1 and time t_2 to reach M_2.

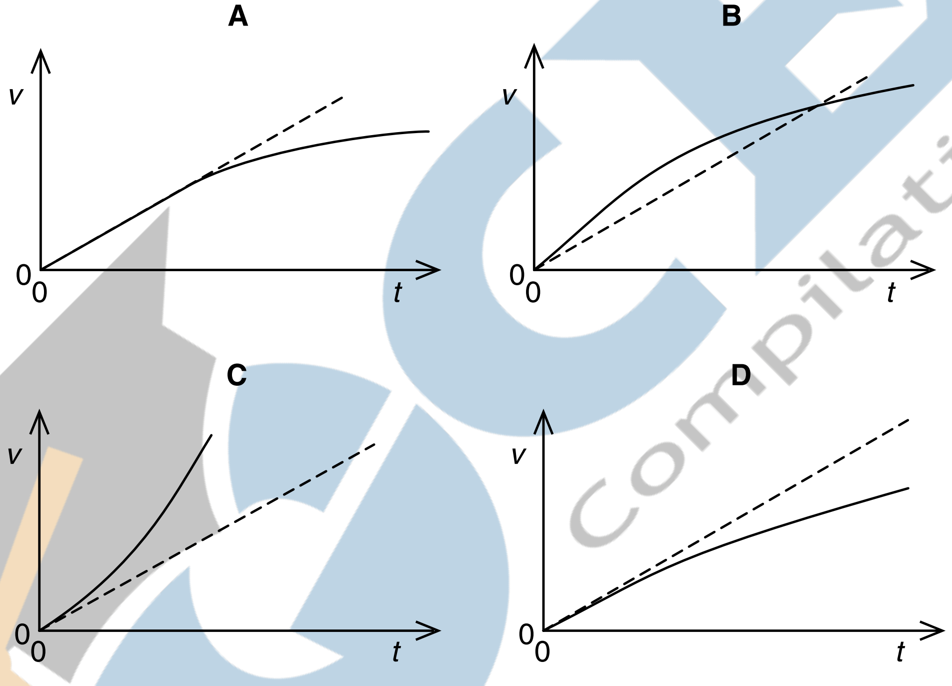
Which expression gives the acceleration of the ball?

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

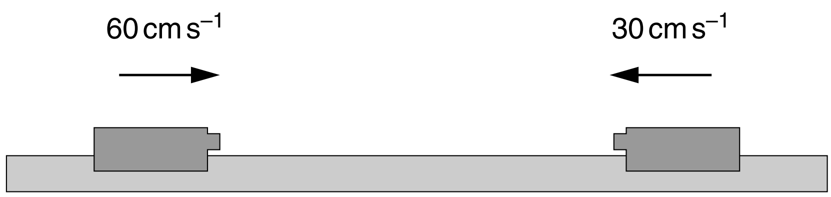
45 A body falls from rest in a vacuum near the Earth's surface. The variation with time t of its speed v is shown below.



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?



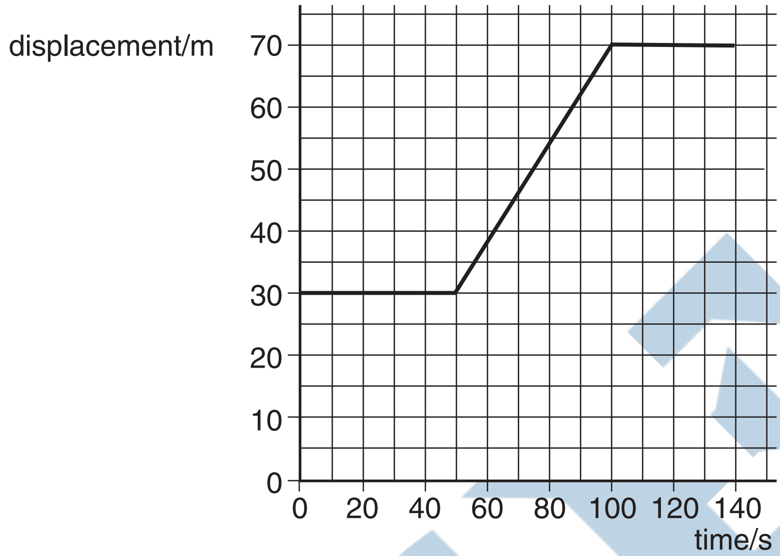
46 Two equal masses travel towards each other on a frictionless air track at speeds of $60\,\text{cm}\,\text{s}^{-1}$ and $30\,\text{cm}\,\text{s}^{-1}$. They stick together on impact.



What is the speed of the masses after impact?

A $15\,\text{cm}\,\text{s}^{-1}$ **B** $20\,\text{cm}\,\text{s}^{-1}$ **C** $30\,\text{cm}\,\text{s}^{-1}$ **D** $45\,\text{cm}\,\text{s}^{-1}$

47 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.



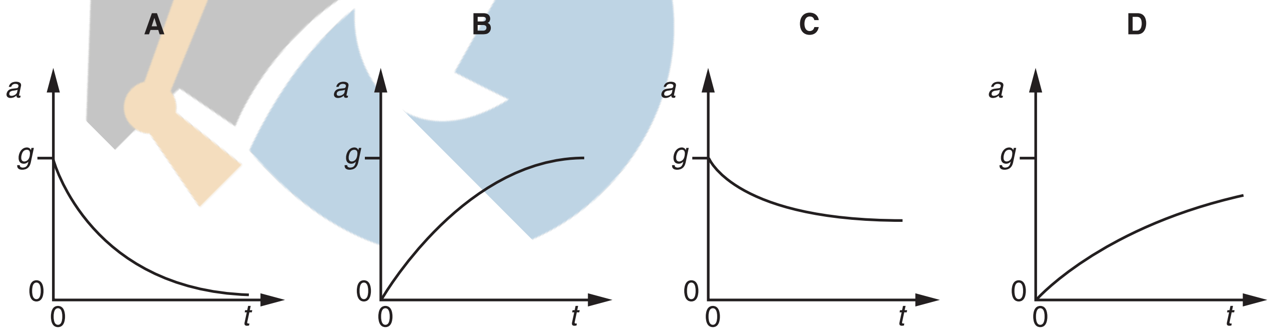
What is its speed while it is moving?

A $0.70\,\mathrm{m\,s^{-1}}$ **B** $0.80\,\mathrm{m\,s^{-1}}$ **C** $1.25\,\mathrm{m\,s^{-1}}$ **D** $1.40\,\mathrm{m\,s^{-1}}$

48 An object is dropped from a great height and falls through air of uniform density.

The acceleration of free fall is g.

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



49 Which of the following is a statement of the principle of conservation of momentum?

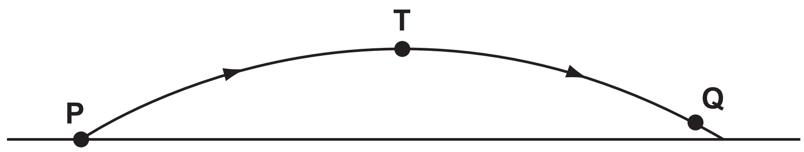
A Momentum is the product of mass and velocity.

B In an elastic collision, momentum is constant.

C The momentum of an isolated system is constant.

D The force acting on a body is proportional to its rate of change of momentum.

50 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

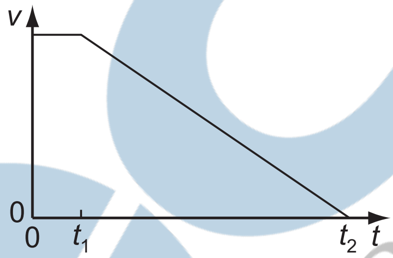
A zero at **T**.

B greatest at **T**.

C greatest at **Q**.

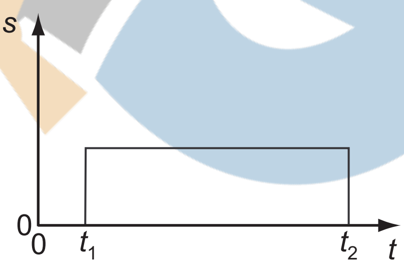
D the same at **Q** as at **T**.

51 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.

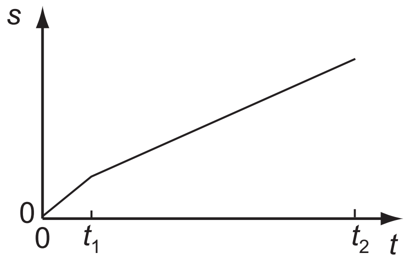


Which graph represents the variation with time t of the distance s travelled by the car after the hazard has been seen?

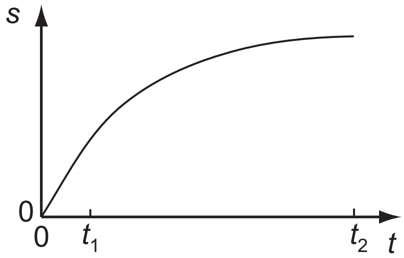
A



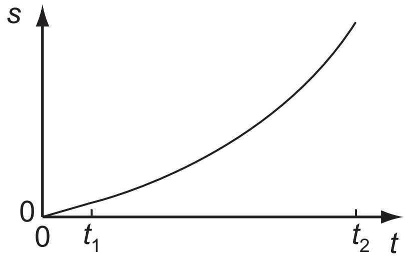
B



C



D

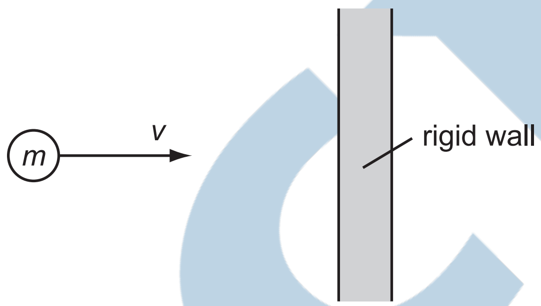


52 An object falls 10.0 m from rest before entering some water.

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

53 A particle of mass *m* strikes a vertical rigid wall perpendicularly from the left with velocity *v*.



If the collision is perfectly elastic, the total change in momentum of the particle that occurs as a result of the collision is

A 2*mv* to the right.

B 2*mv* to the left.

C *mv* to the right.

D *mv* to the left.

54 A ball falls vertically and bounces on the ground.

The following statements are about the forces acting while the ball is in contact with the ground.

Which statement is correct?

A The force that the ball exerts on the ground is always equal to the weight of the ball.

B The force that the ball exerts on the ground is always equal in magnitude and opposite in direction to the force the ground exerts on the ball.

C The force that the ball exerts on the ground is always less than the weight of the ball.

D The weight of the ball is always equal in magnitude and opposite in direction to the force that the ground exerts on the ball.

55 A force F is applied to a freely moving object. At one instant of time, the object has velocity v and acceleration a.

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

A a and v only

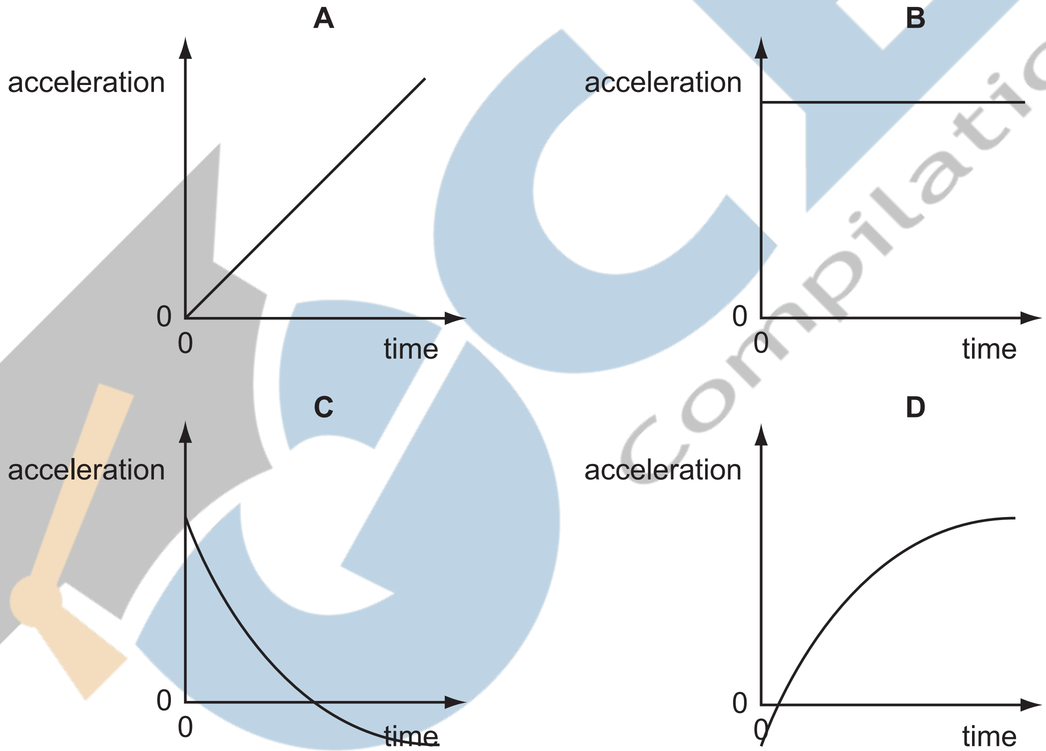
B a and F only

C v and F only

D v, F and a

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

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



57 A constant mass undergoes uniform acceleration.

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

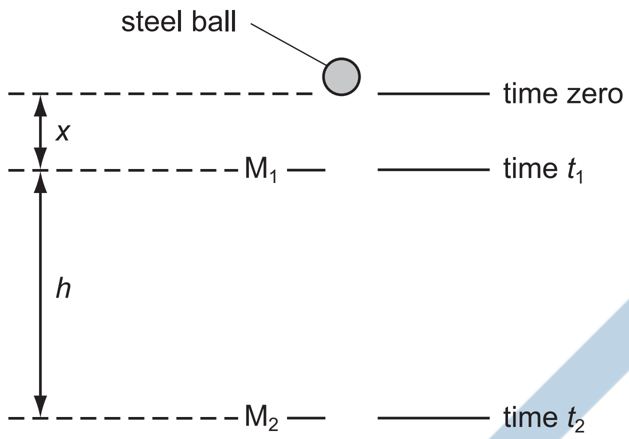
A It increases uniformly with respect to time.

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.

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

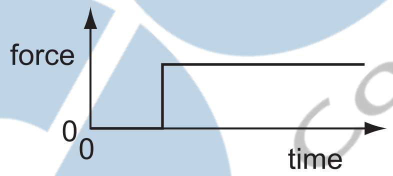


A steel ball is released at time zero from a point a distance x above M_1. The ball reaches M_1 at time t_1 and reaches M_2 at time t_2. The acceleration of the ball is constant.

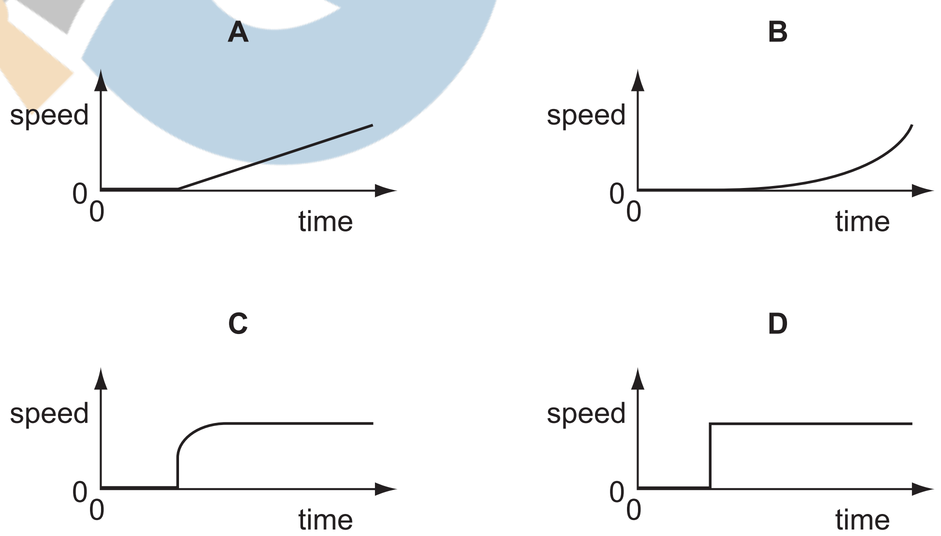
Which expression gives the acceleration of the ball?

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

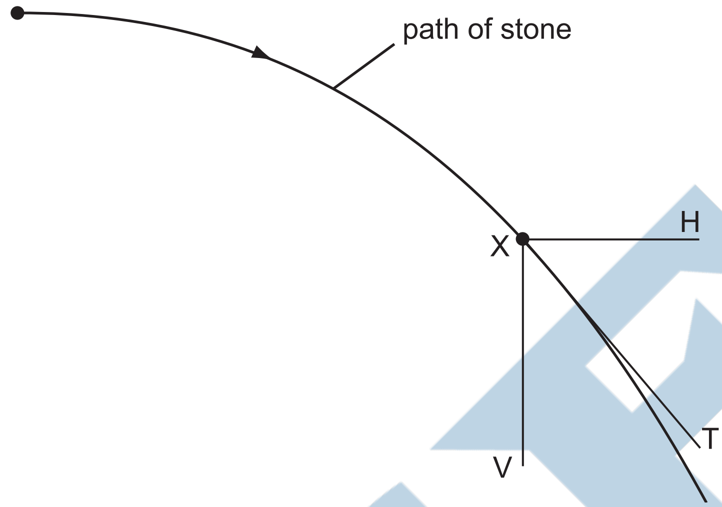
59 A car driver sharply presses down the accelerator when the traffic lights go green. The resultant horizontal force acting on the car varies with time as shown.



Which graph shows the variation with time of the speed of the car?



60 A stone is projected horizontally in a vacuum and moves along a path as shown. 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.

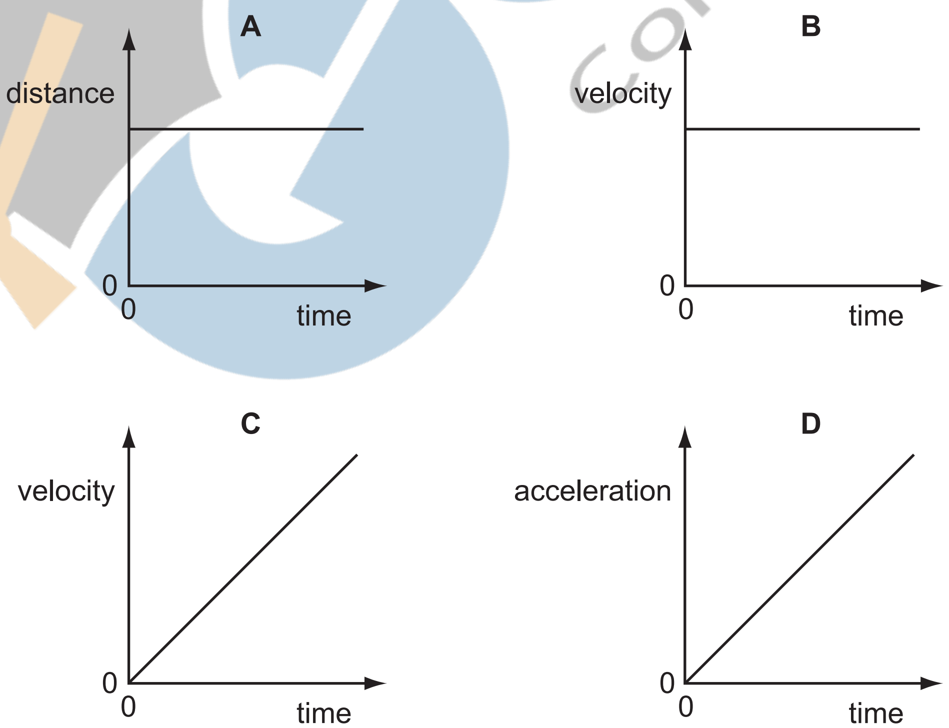


Along which direction or directions do forces act on the stone at X?

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

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

Which graph represents the motion of the particle?



62 Which is a statement of the principle of conservation of momentum?

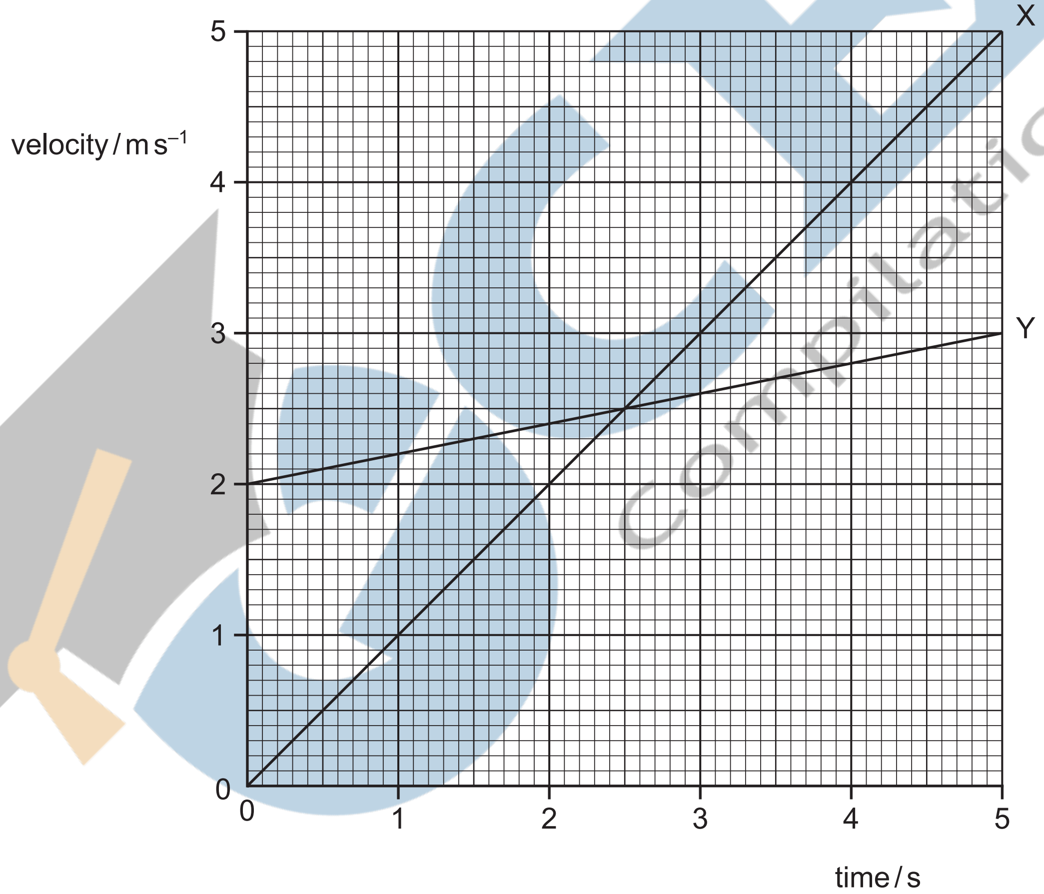
A A force is equal to the rate of change of momentum of the body upon which it acts.

B In a perfectly elastic collision, the relative momentum of the bodies before impact is equal to their relative momentum after impact.

C The momentum of a body is the product of the mass of the body and its velocity.

D The total momentum of a system of interacting bodies remains constant, providing no external force acts.

63 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.



Which statement is correct?

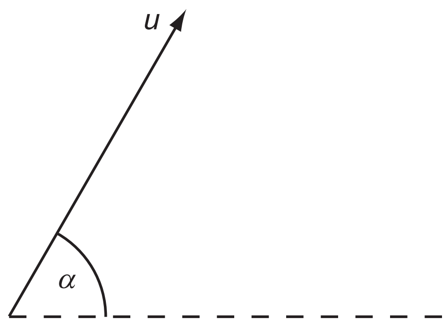
A The accelerations of X and Y are the same at 2.5 s.

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.

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



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	$u \cos \alpha$	$u \sin \alpha - gt$

65 A force F is applied to a freely moving object. At one instant of time, the object has velocity v and acceleration a.

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

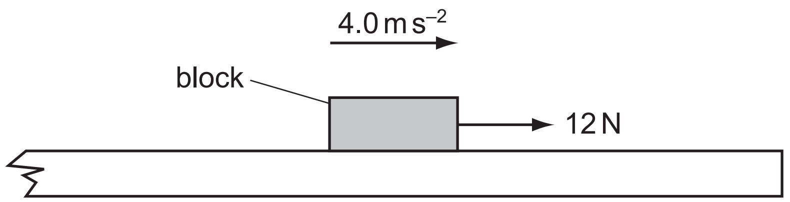
A a and v only

B a and F only

C v and F only

D v, F and a

66 A block of mass 0.60 kg is on a rough horizontal surface. A force of 12 N is applied to the block and it accelerates at $4.0\,\text{m}\,\text{s}^{-2}$.



What is the magnitude of the frictional force acting on the block?

A 2.4 N **B** 5.3 N **C** 6.7 N **D** 9.6 N

67 The symbol g represents the acceleration of free fall.

Which of these statements is correct?

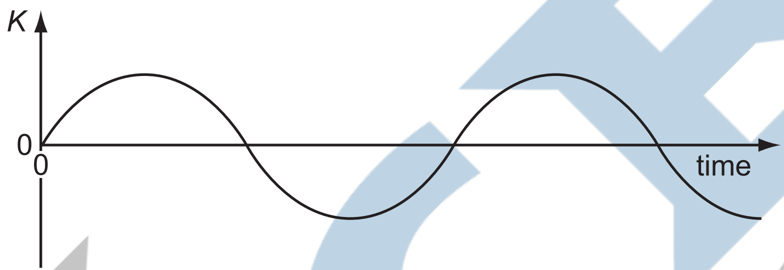
A g is gravity.

B g is reduced by air resistance.

C g is the ratio weight / mass.

D g is the weight of an object.

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



At any time, the slope of the graph is the acceleration of the particle.

What is the property K?

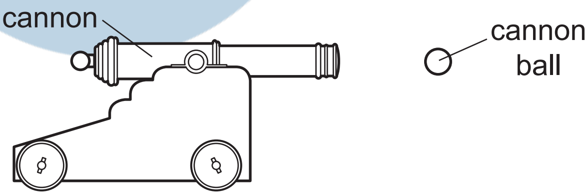
A the displacement of the particle

B the distance travelled by the particle

C the speed of the particle

D the velocity of the particle

69 The diagram shows a cannon ball fired from a cannon.



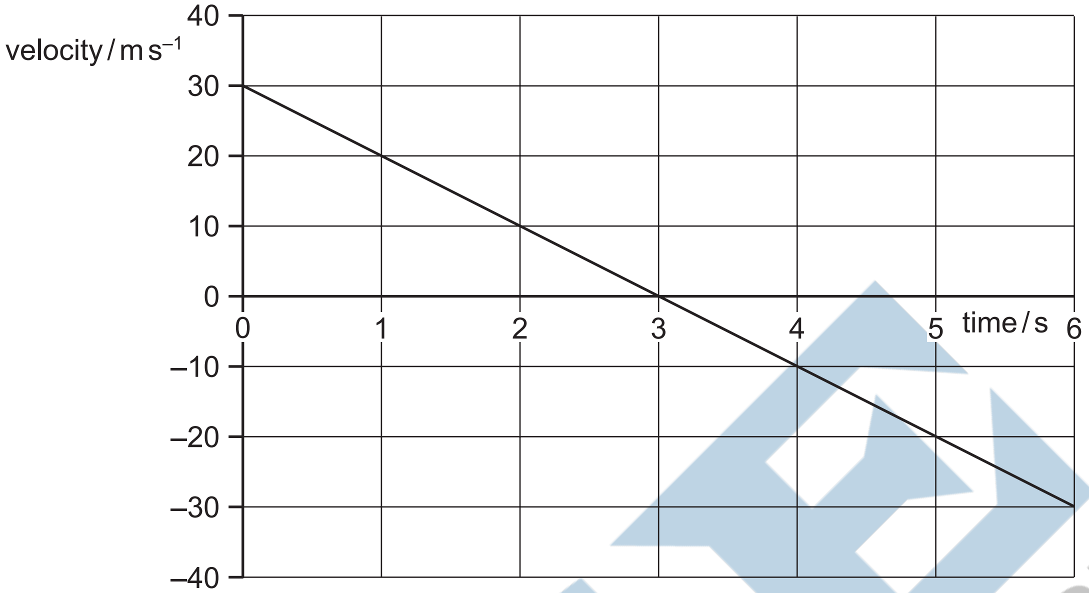
The mass of the cannon is 1000 kg and the mass of the cannon ball is 10 kg.

The recoil velocity of the cannon is $5\,\mathrm{m\,s^{-1}}$ horizontally.

What is the horizontal velocity of the cannon ball?

A $200\,\mathrm{m\,s^{-1}}$ **B** $500\,\mathrm{m\,s^{-1}}$ **C** $2000\,\mathrm{m\,s^{-1}}$ **D** $5000\,\mathrm{m\,s^{-1}}$

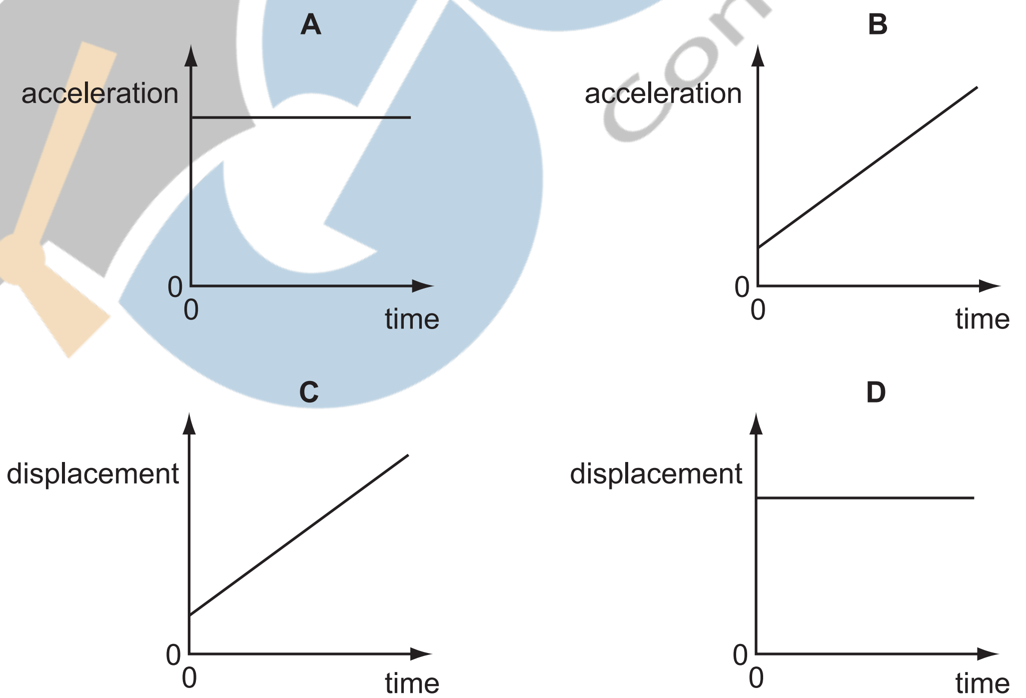
70 A stone is thrown vertically upwards. A student plots the variation with time of its velocity.



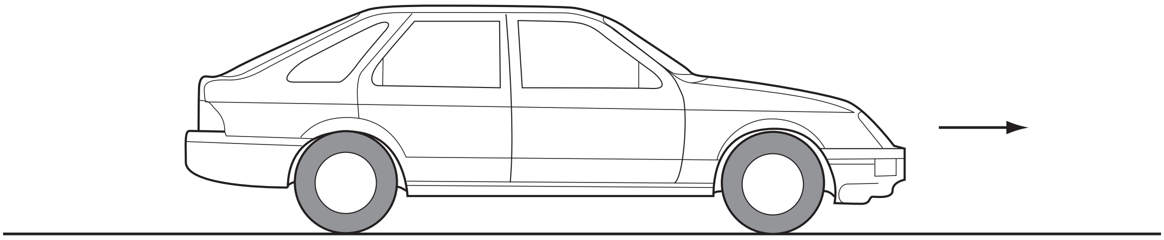
What is the vertical displacement of the stone from its starting point after 5 seconds?

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

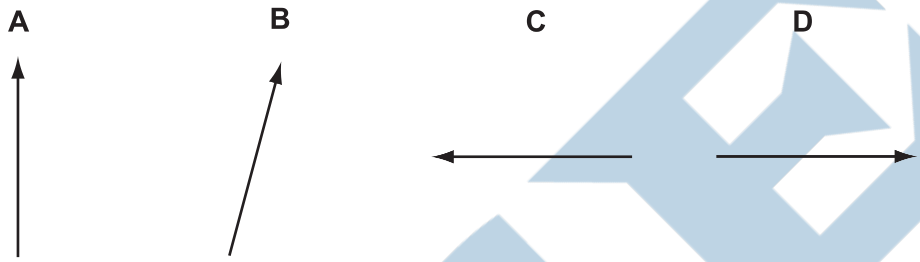
71 Which graph represents the motion of a car that is travelling along a straight road with a speed that increases uniformly with time?



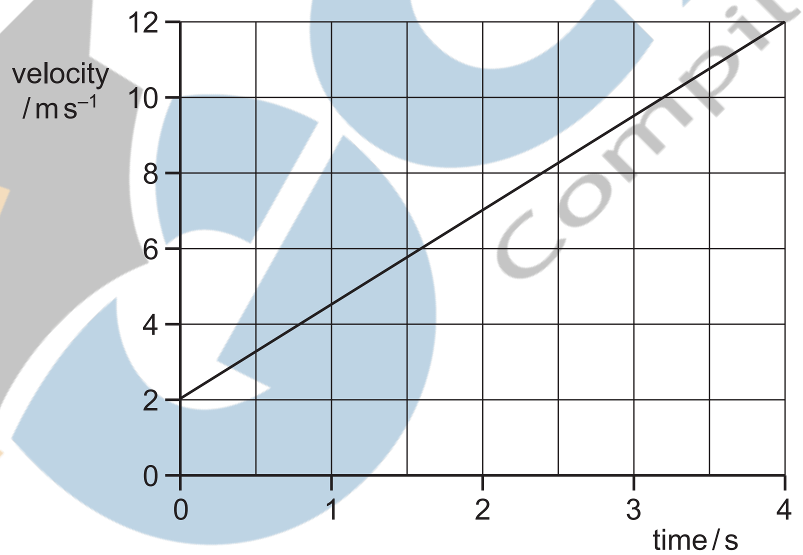
72 A car with front-wheel drive accelerates in the direction shown.



Which diagram best shows the direction of the total force exerted by the road on the front wheels?



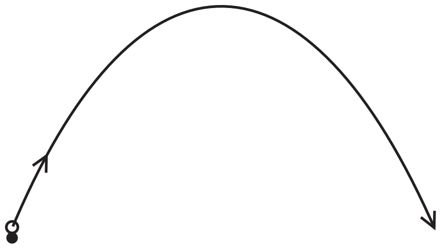
73 The diagram shows a velocity-time graph for a car.



What is the distance travelled during the first 4.0 s?

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

74 A stone is thrown upwards and follows a curved path.



Air resistance is negligible.

Why does the path have this shape?

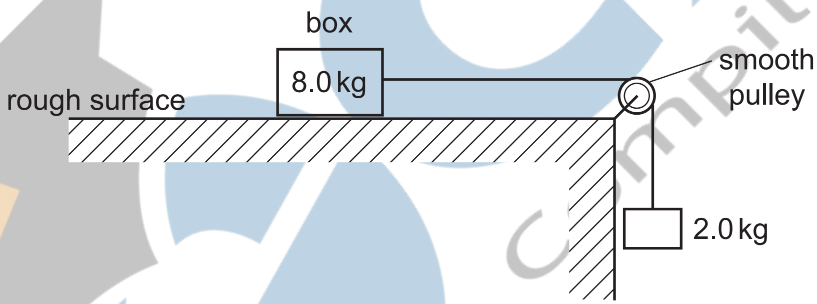
A The stone has a constant horizontal velocity and constant vertical acceleration.

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.

75 A box of mass 8.0 kg rests on a horizontal, rough surface. A string attached to the box passes over a smooth pulley and supports a 2.0 kg mass at its other end.



When the box is released, a friction force of 6.0 N acts on it.

What is the acceleration of the box?

A $1.4\,\text{m s}^{-2}$ **B** $1.7\,\text{m s}^{-2}$ **C** $2.0\,\text{m s}^{-2}$ **D** $2.5\,\text{m s}^{-2}$