

- 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 m s^{-1} and, when it passes the next one, its speed is 20 m s^{-1} .

9702/01/M/J/04

What is the car's acceleration?

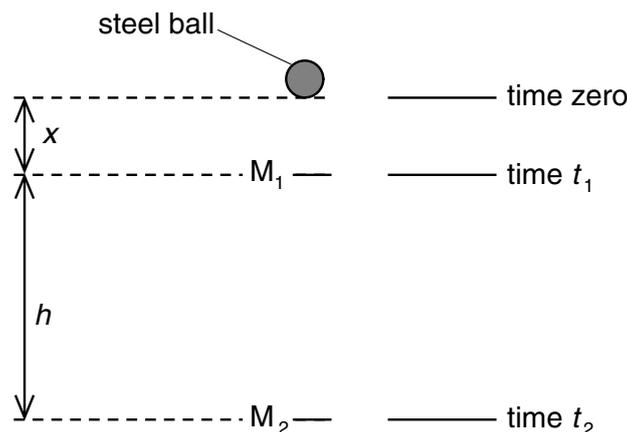
- A 0.67 m s^{-2} B 1.5 m s^{-2} C 2.5 m s^{-2} D 6.0 m s^{-2}

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

- 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

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

9702/01/O/N/04

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.

9702/01/O/N/04

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

9702/01/M/J/06

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

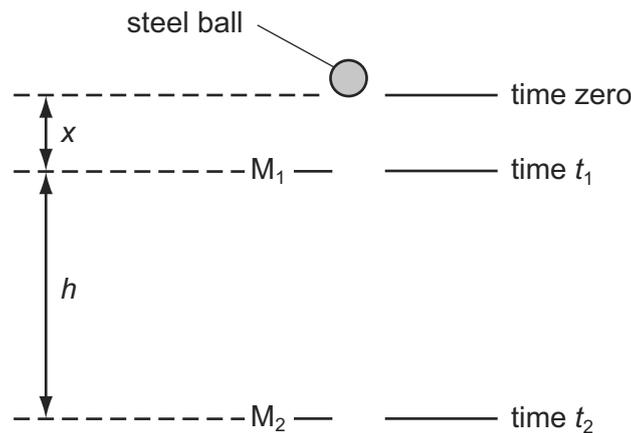
9702/01/O/N/06

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

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

9702/01/O/N/05



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

- 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

- 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.

- 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

- 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 ms^{-2} .

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

- A** 20 ms^{-1} **B** 40 ms^{-1} **C** 200 ms^{-1} **D** 400 ms^{-1}
- 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/ms^{-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 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.

- 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

- 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 ms^{-2} B 0.49 ms^{-2} C 0.56 ms^{-2} D 1.1 ms^{-2}

- 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 $\frac{\text{the horizontal distance travelled in time } t}{\text{the vertical distance travelled in time } t}$?

- A $\frac{vt}{g}$ B $\frac{v}{gt}$ C $\frac{2vt}{g}$ D $\frac{2v}{gt}$

- 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 ms^{-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 ms^{-2}	0	$+9.81 \text{ ms}^{-2}$
B	-9.81 ms^{-2}	-9.81 ms^{-2}	-9.81 ms^{-2}
C	$+9.81 \text{ ms}^{-2}$	$+9.81 \text{ ms}^{-2}$	$+9.81 \text{ ms}^{-2}$
D	$+9.81 \text{ ms}^{-2}$	0	-9.81 ms^{-2}

- 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 ms^{-2} .

9702/13/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

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

9702/11/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
- 7 A stone of mass m is dropped from a tall building. There is significant air resistance. The acceleration of free fall is g .

9702/12/O/N/11

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

- 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

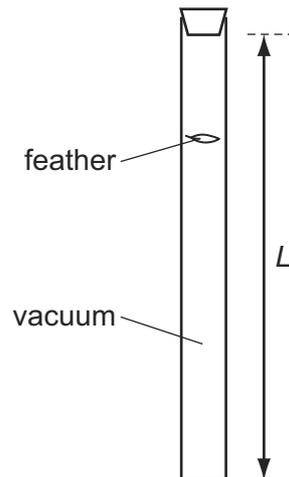
- 6 In an experiment to determine the acceleration of free fall using a falling body, what would lead to a value that is too large?

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 in a long evacuated vertical tube of length L .

9702/11/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 $0.13 L$ B $0.25 L$ C $0.38 L$ D $0.50 L$

- 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 $\pm 0.5\%$ B $\pm 1\%$ C $\pm 2\%$ D $\pm 3\%$

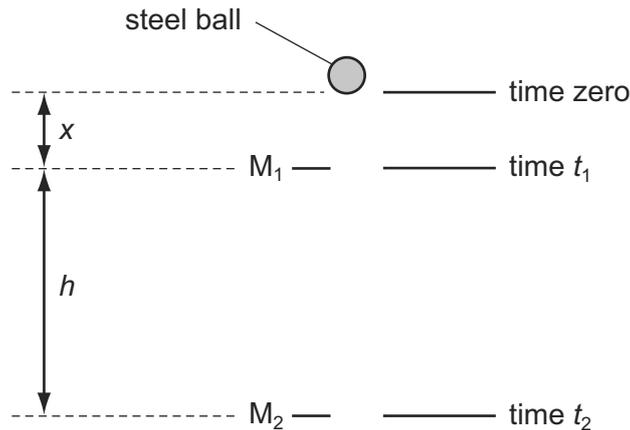
- 9 A ball is thrown vertically in air.

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

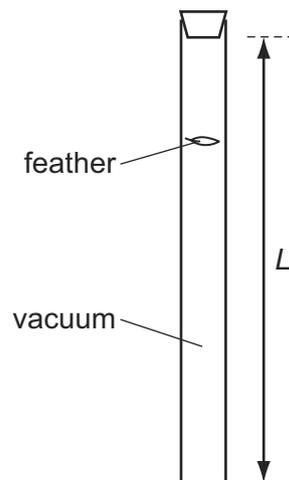
- 8 Two markers M_1 and M_2 are set up a vertical distance h apart.



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 $\frac{2h}{t_2^2}$ B $\frac{2h}{(t_2 + t_1)}$ C $\frac{2h}{(t_2 - t_1)^2}$ D $\frac{2h}{(t_2^2 - t_1^2)}$
- 9 The diagram shows a laboratory experiment in which a feather falls from rest in a long evacuated vertical tube of length L .



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 $0.50T$?

- A $0.13L$ B $0.25L$ C $0.38L$ D $0.50L$
- 8 A bicycle brakes so that it undergoes uniform deceleration from a speed of 8 m s^{-1} to 6 m s^{-1} over a distance of 7 m .

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

- 7 A body is released from rest and falls vertically in air of constant density. 9702/11/M/J/13

Which statement about the motion of the falling body is correct?

- A As it accelerates, its weight decreases so that its acceleration decreases until it travels with constant velocity.
- B It accelerates initially at 9.8 m s^{-2} but the drag force increases so its acceleration decreases.
- C Its velocity increases at a constant rate until its velocity becomes constant.
- D The drag force of the air increases continually and eventually the velocity decreases.
- 8 A goods train passes through a station at a steady speed of 10 m s^{-1} . An express train is at rest at the station. The express train leaves the station with a uniform acceleration of 0.5 m s^{-2} just as the goods train goes past. Both trains move in the same direction on straight, parallel tracks. 9702/11/M/J/13

How much time passes before the express train overtakes the goods train?

- A 6 s B 10 s C 20 s D 40 s

- 7 The diagram shows an arrangement to stop trains that are travelling too fast. 9702/12/M/J/13



Trains coming from the left travel at a speed of 50 m s^{-1} . At marker 1, the driver must apply the brakes so that the train decelerates uniformly in order to pass marker 2 at no more than 10 m s^{-1} .

The train carries a detector that notes the times when the train passes each marker and will apply an emergency brake if the time between passing marker 1 and marker 2 is less than 20 s.

How far from marker 2 should marker 1 be placed?

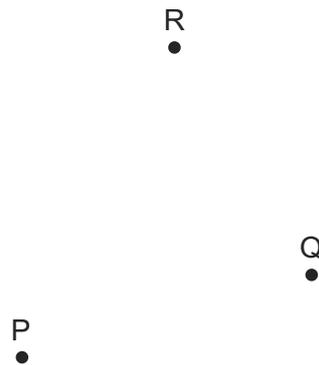
- A 200 m B 400 m C 500 m D 600 m
- 8 An aeroplane travels at an average speed of 600 km h^{-1} on an outward flight and at 400 km h^{-1} on the return flight over the same distance. 9702/11/O/N/13

What is the average speed of the whole flight?

- A 111 m s^{-1} B 167 m s^{-1} C 480 km h^{-1} D 500 km h^{-1}

- 6 One object moves directly from P to R.

9702/11/O/N/13



In a shorter time, a second object moves from P to Q to R.

Which statement about the two objects is correct for the journey from P to R?

- A They have the same average speed.
 - B They have the same average velocity.
 - C They have the same displacement.
 - D They travel the same distance.
- 8 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 the train stops.

9702/13/O/N/13

The maximum deceleration of the train is 0.20 m s^{-2} .

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

- A 14 m s^{-1}
 - B 20 m s^{-1}
 - C 40 m s^{-1}
 - D 400 m s^{-1}
- 9 A person, travelling on a motorway a total distance of 200 km, travels the first 90 km at an average speed of 80 km h^{-1} .

9702/13/O/N/13

Which average speed must be obtained for the rest of the journey if the person is to reach the destination in a total time of 2 hours 0 minutes?

- A 110 km h^{-1}
 - B 120 km h^{-1}
 - C 122 km h^{-1}
 - D 126 km h^{-1}
- 12 A mass accelerates uniformly when the resultant force acting on it

9702/13/O/N/13

- 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.

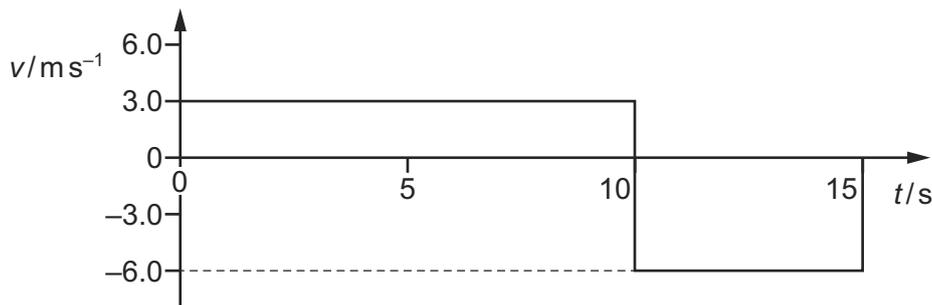
- 7 An object is thrown with velocity 5.2 m s^{-1} vertically upwards on the Moon. The acceleration due to gravity on the Moon is 1.62 m s^{-2} . 9702/11/M/J/14

What is the time taken for the object to return to its starting point?

- A 2.5 s B 3.2 s C 4.5 s D 6.4 s

- 6 A radio-controlled toy car travels along a straight line for a time of 15 s. 9702/12/M/J/14

The variation with time t of the velocity v of the car is shown below.



What is the average velocity of the toy car for the journey shown by the graph?

- A -1.5 m s^{-1} B 0.0 m s^{-1} C 4.0 m s^{-1} D 4.5 m s^{-1}

- 8 In a cathode-ray tube, an electron is accelerated uniformly in a straight line from a speed of $4 \times 10^3 \text{ m s}^{-1}$ to $2 \times 10^7 \text{ m s}^{-1}$ over a distance of 10 mm. 9702/13/M/J/14

What is the acceleration of the electron?

- A $2 \times 10^3 \text{ m s}^{-2}$
B $2 \times 10^6 \text{ m s}^{-2}$
C $2 \times 10^{13} \text{ m s}^{-2}$
D $2 \times 10^{16} \text{ m s}^{-2}$

- 7 An experiment is performed to measure the acceleration of free fall g . A body falls between two fixed points. The four measurements shown below are taken. 9702/13/M/J/14

Which measurement is **not** required for the calculation of g ?

- A the distance fallen by the body
B the initial velocity of the body
C the mass of the body
D the time taken for the body to fall

- 6 In an experiment to determine the acceleration of free fall g , a ball-bearing is held by an electromagnet. When the current to the electromagnet is switched off, a clock starts and the ball-bearing falls. After falling a distance h , the ball-bearing strikes a switch to stop the clock which measures the time t of the fall. 9702/13/O/N/14

Which expression can be used to calculate the value of g ?

- A $\frac{ht^2}{2}$ B $\frac{th^2}{2}$ C $\sqrt{\frac{2t}{h^2}}$ D $\frac{2h}{t^2}$

- 5 The acceleration of free fall on the Moon is one-sixth of that on Earth. 9702/11/O/N/14

On Earth it takes time t for a stone to fall from rest a distance of 2 m.

What is the time taken for a stone to fall from rest a distance of 2 m on the Moon?

- A $6t$ B $\frac{t}{6}$ C $t\sqrt{6}$ D $\frac{t}{\sqrt{6}}$

- 7 In an experiment to determine the acceleration of free fall g , a ball bearing is held by an electromagnet. When the current to the electromagnet is switched off, a clock starts and the ball bearing falls. After falling a distance h , the ball bearing strikes a switch to stop the clock which measures the time t of the fall. 9702/12/M/J/15

If systematic errors cause t and h to be measured incorrectly, which error **must** cause g to appear greater than 9.81 m s^{-2} ?

- A h measured as being **smaller** than it actually is and t is measured correctly
 B h measured as being **smaller** than it actually is and t measured as being **larger** than it actually is
 C h measured as being **larger** than it actually is and t measured as being **larger** than it actually is
 D h is measured correctly and t measured as being **smaller** than it actually is

- 9 A body having uniform acceleration a increases its velocity from u to v in time t . 9702/11/M/J/15

Which expression would **not** give a correct value for the body's displacement during time t ?

- A $ut + \frac{1}{2}at^2$
 B $vt - \frac{1}{2}at^2$
 C $\frac{(v+u)(v-u)}{2a}$
 D $\frac{(v-u)t}{2}$

- 9 A sprinter runs a 100 m race in a straight line. He accelerates from the starting block at a constant acceleration of 2.5 m s^{-2} to reach his maximum speed of 10 m s^{-1} . He maintains this speed until he crosses the finish line.

9702/12/M/J/15

Which time does it take the sprinter to run the race?

- A 4 s B 10 s C 12 s D 20 s

- 8 An insect jumps with an initial vertical velocity of 1.0 m s^{-1} , reaching a maximum height of $3.5 \times 10^{-2} \text{ m}$. Assume the deceleration is uniform.

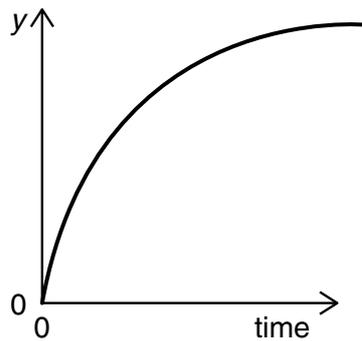
9702/11/M/J/15

What is the magnitude of the deceleration?

- A 3.6 m s^{-2} B 9.8 m s^{-2} C 14 m s^{-2} D 29 m s^{-2}

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

9702/1/M/J/02

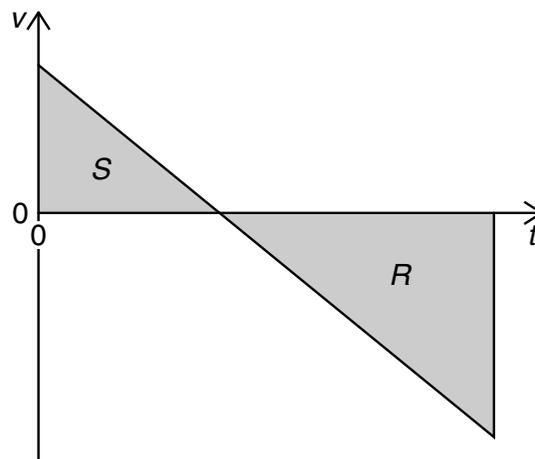


Which is a correct description of the graph?

- 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.

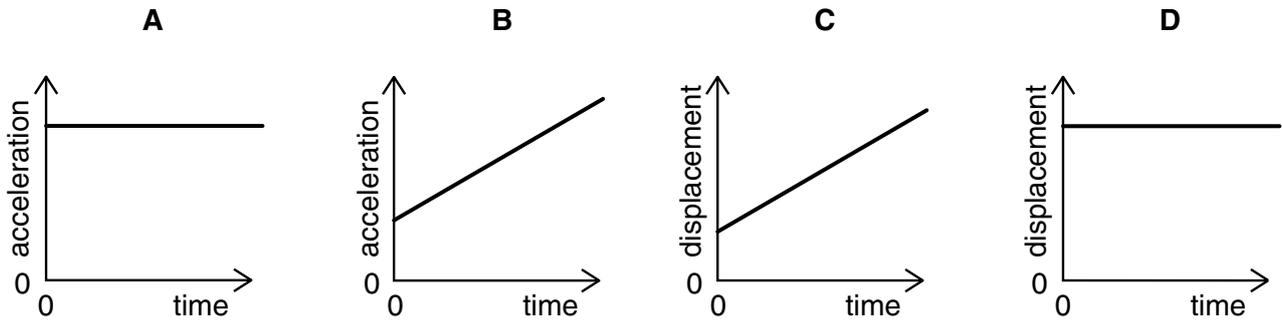


What is the height of the cliff-top above the sea?

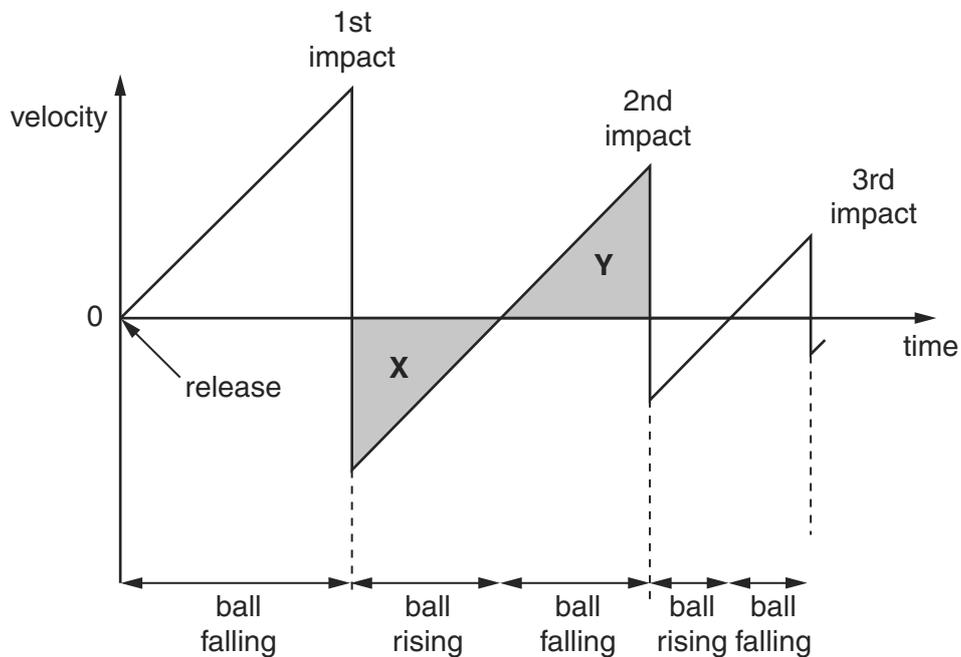
- A R
- B S
- C $R + S$
- D $R - S$

- 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



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

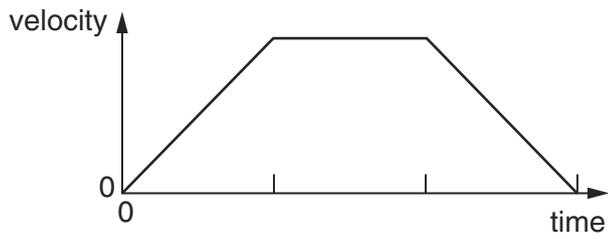


Areas **X** and **Y** are equal.

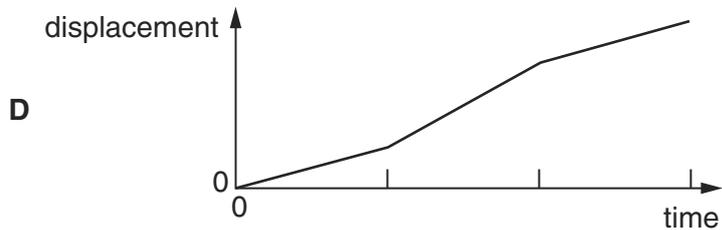
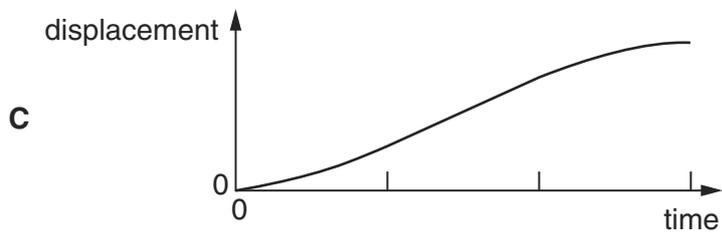
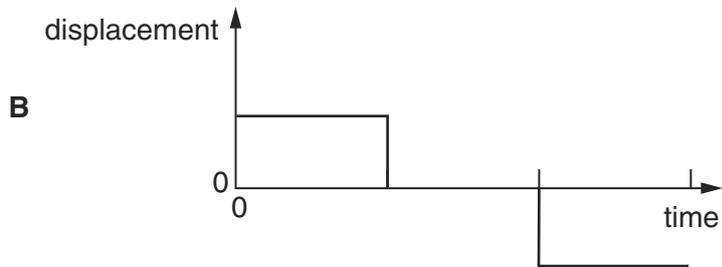
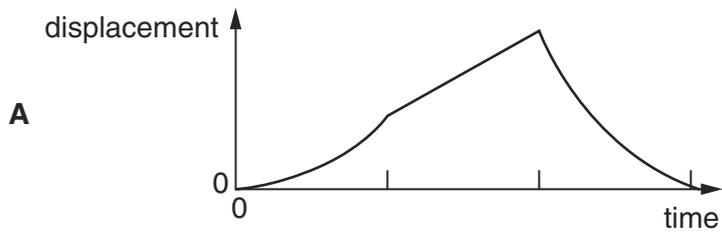
This is because

- 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.



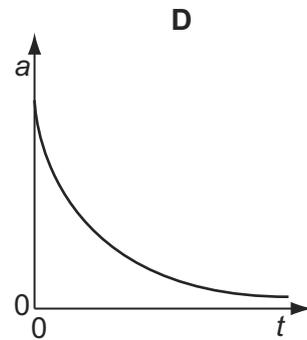
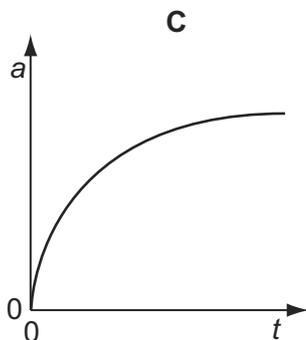
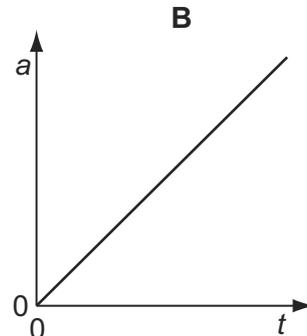
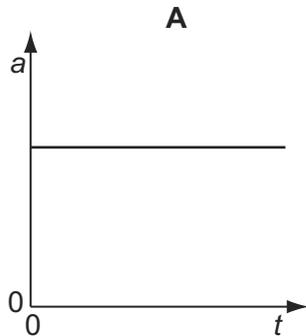
Which of the following is the corresponding graph of displacement against time?



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

9702/01/M/J/04

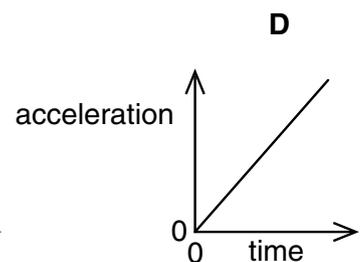
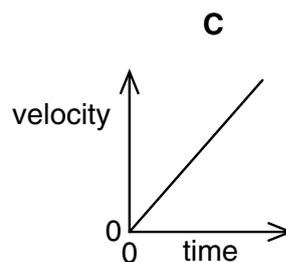
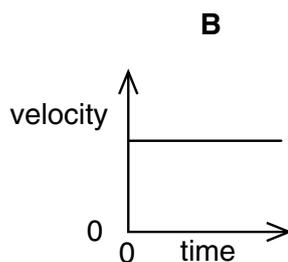
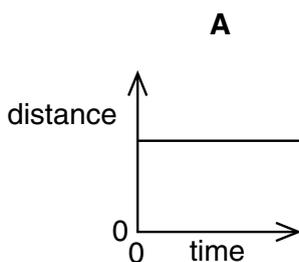
Which graph best represents the variation with time t of the acceleration a of the ball as it falls, assuming that the effects of air resistance are appreciable?



- 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?



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

9702/01/M/J/05

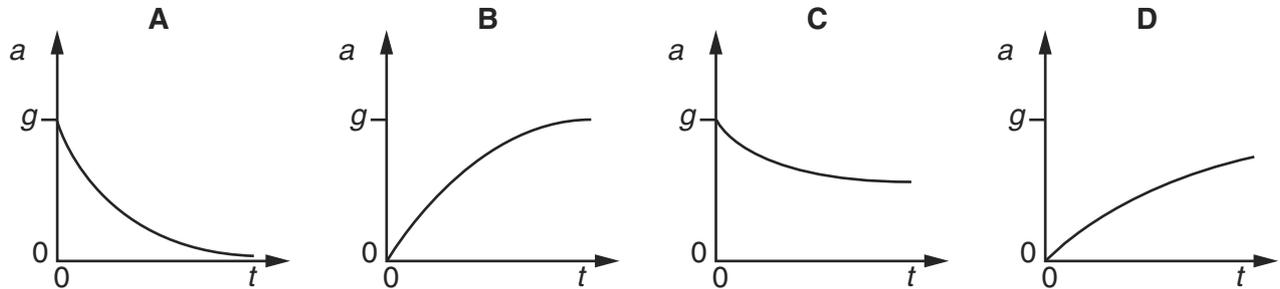
- A** the area under a displacement-time graph
- B** the area under a velocity-time graph
- C** the slope of a displacement-time graph
- D** the slope of a velocity-time graph

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

9702/01/O/N/03

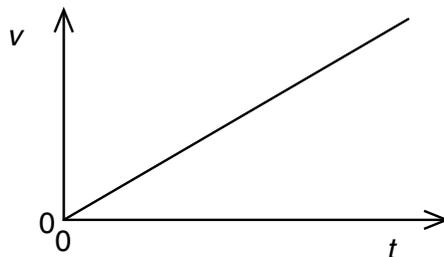
The acceleration of free fall is g .

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

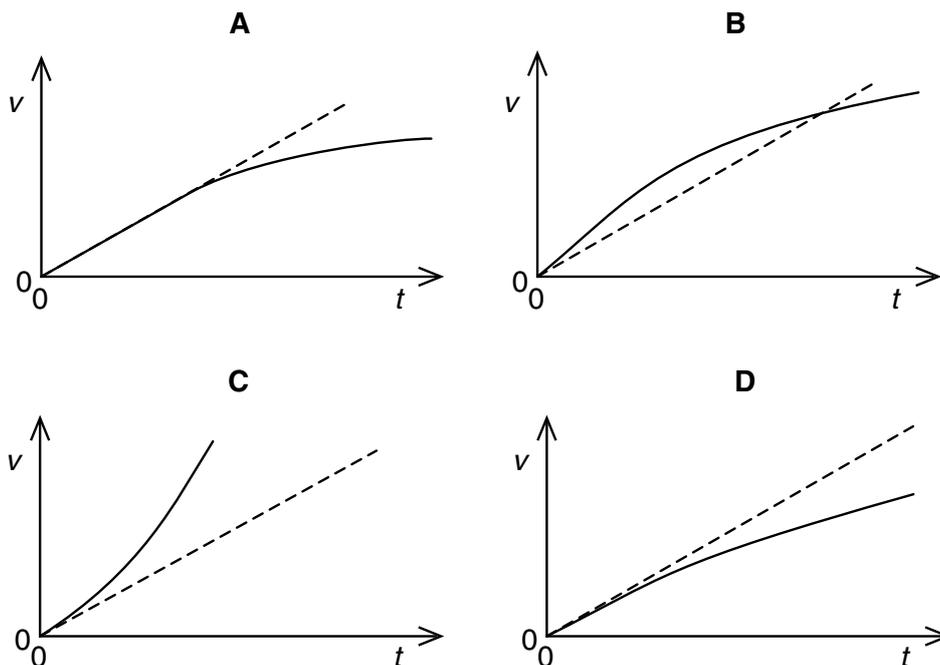


- 10 A body falls from rest in a vacuum near the Earth's surface. The variation with time t of its speed v is shown below.

9702/1/O/N/02

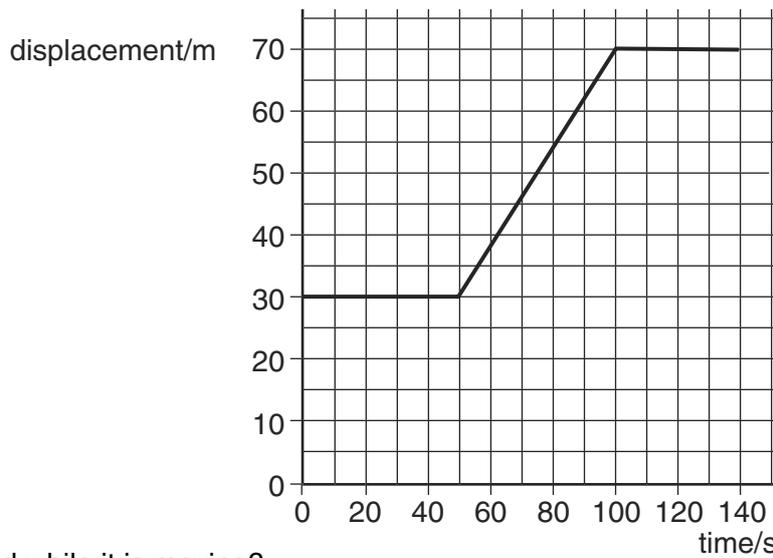


Which graph shows the variation with time t of the speed v of the same ball falling in air at the same place on Earth?



- 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.

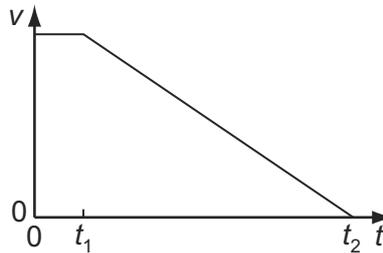
9702/01/O/N/03



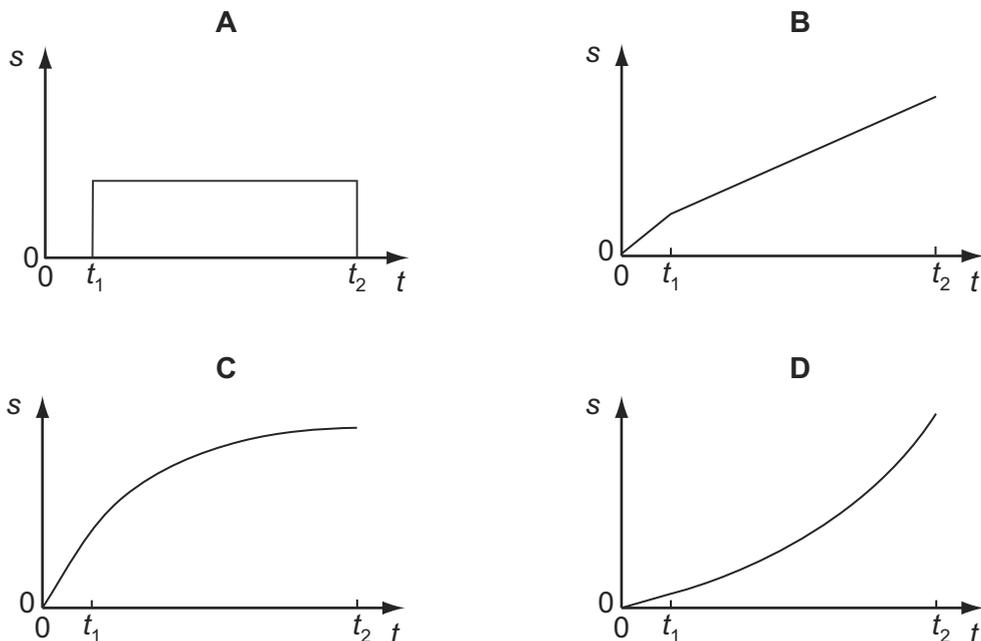
What is its speed while it is moving?

- A 0.70 ms^{-1} B 0.80 ms^{-1} C 1.25 ms^{-1} D 1.40 ms^{-1}
- 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

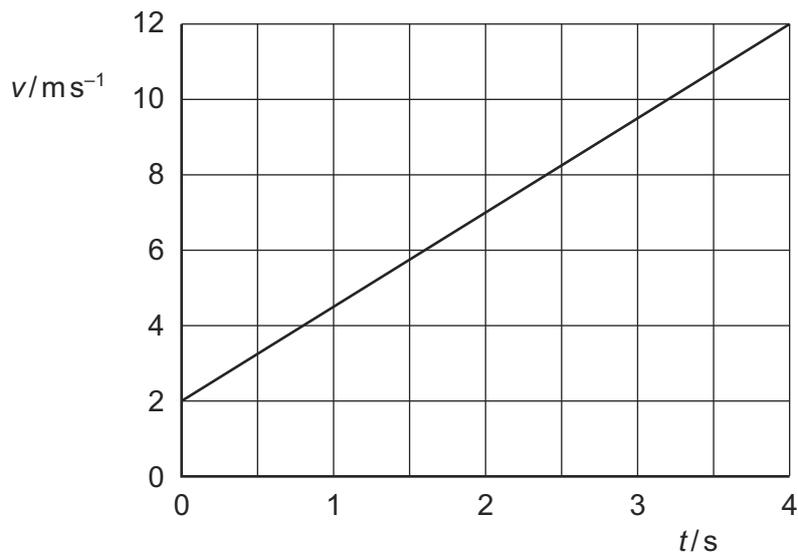


Which graph represents the variation with time t of the distance s travelled by the car after the hazard has been seen?



Kinematics (graphs)

8 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

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 ms^{-2}	0	$+9.81 \text{ ms}^{-2}$
B	-9.81 ms^{-2}	-9.81 ms^{-2}	-9.81 ms^{-2}
C	$+9.81 \text{ ms}^{-2}$	$+9.81 \text{ ms}^{-2}$	$+9.81 \text{ ms}^{-2}$
D	$+9.81 \text{ ms}^{-2}$	0	-9.81 ms^{-2}

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

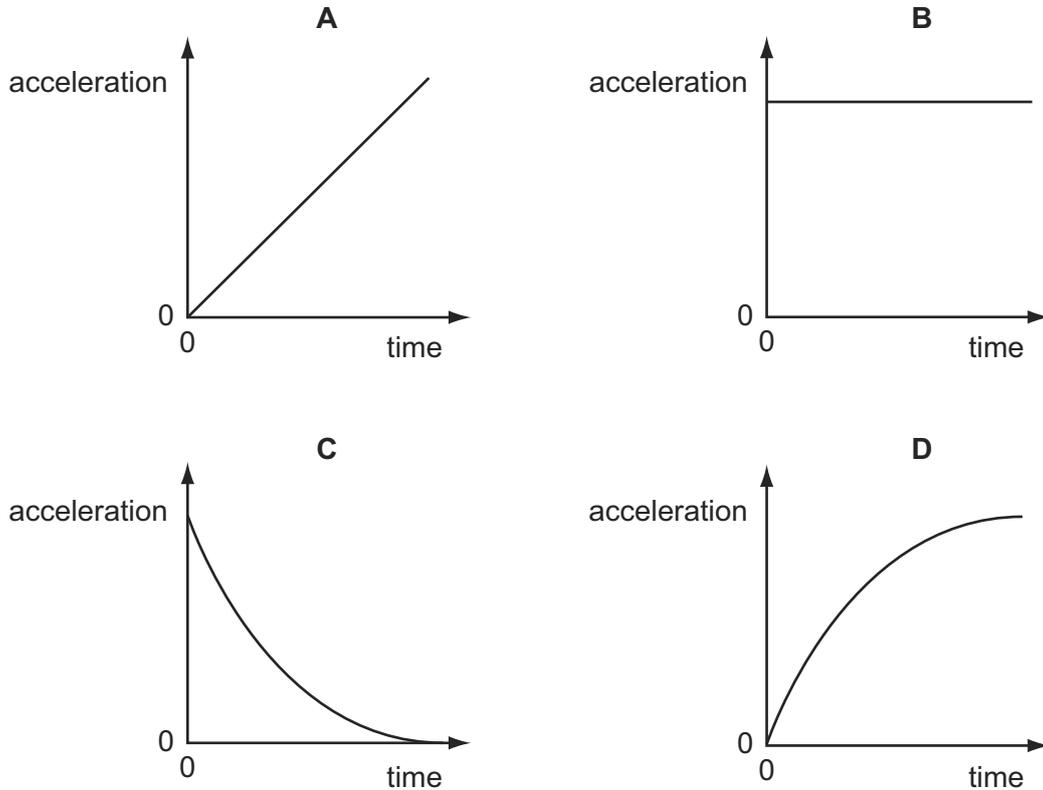
What remains constant throughout the fall?

- A** acceleration of the football
B air resistance on the football
C velocity of the football
D weight of the football

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

9702/01/O/N/05

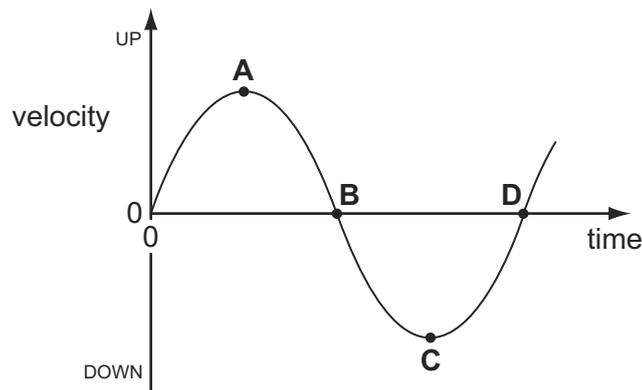
Which acceleration-time graph best represents the motion of the football through the air?



- 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



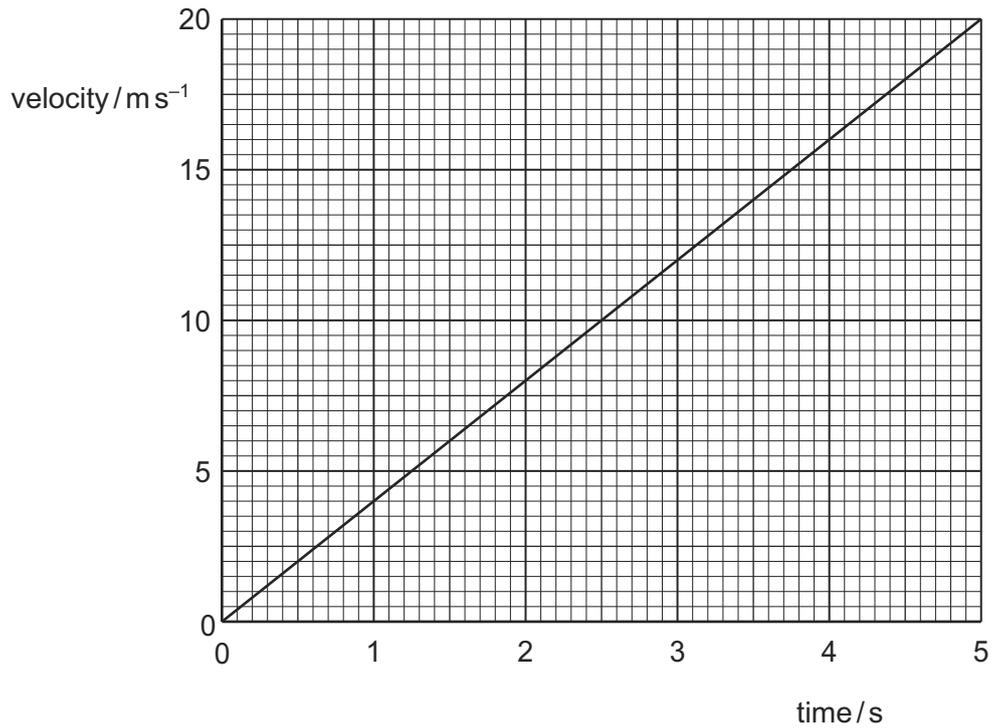
- 6 What gives the value of a body's acceleration?

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

9702/01/M/J/06



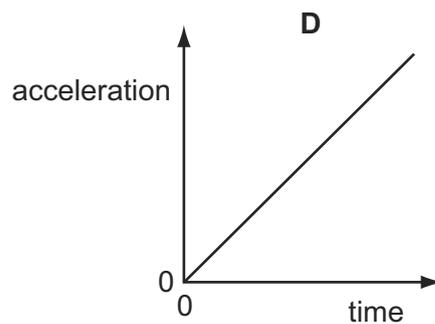
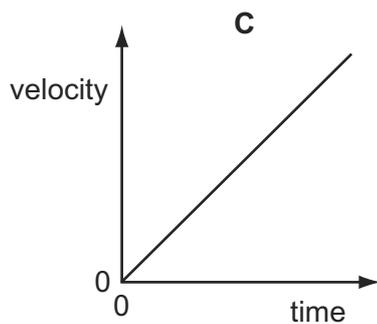
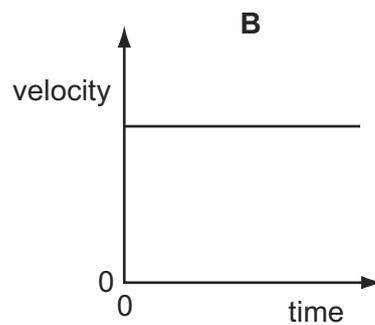
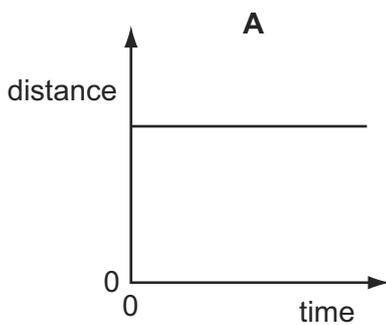
What is the distance travelled by the object in this time?

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

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

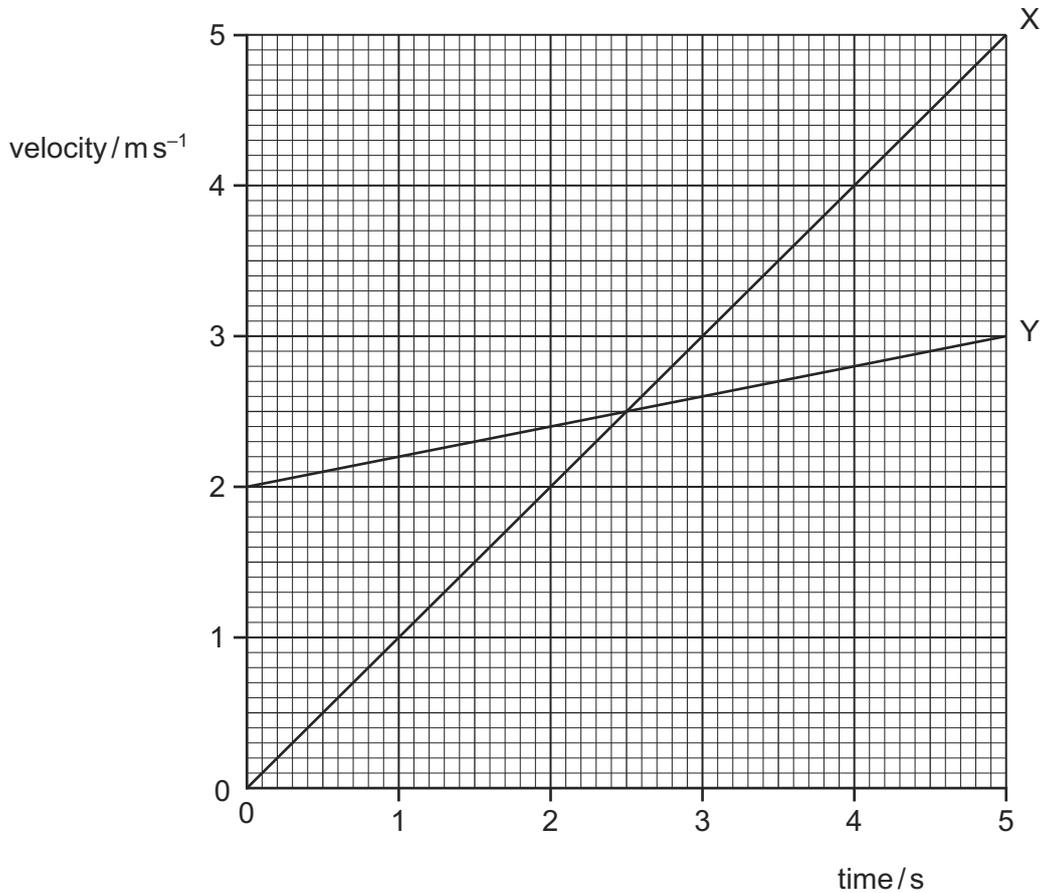
9702/01/O/N/06

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.

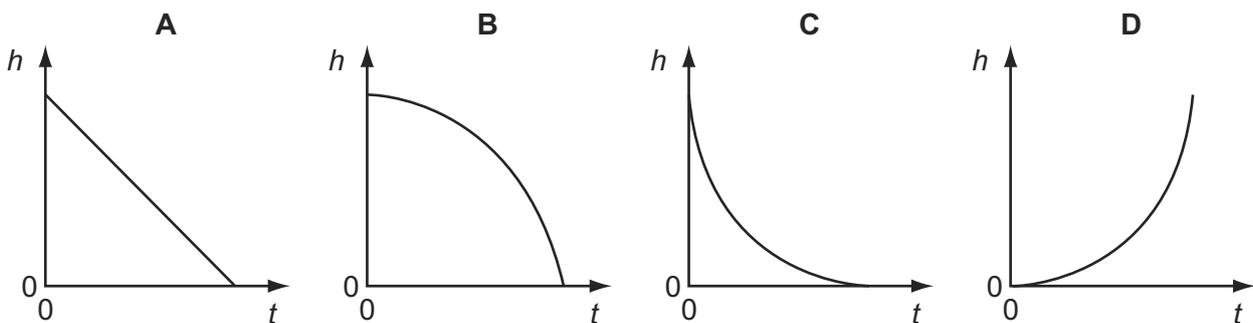
9702/01/O/N/06



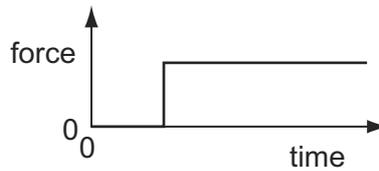
Which statement is correct?

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

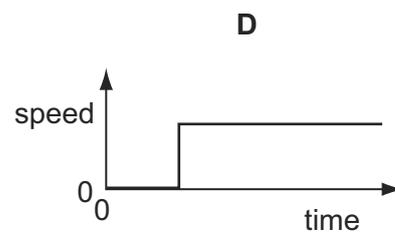
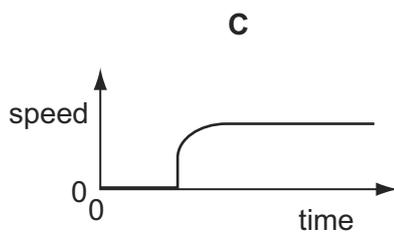
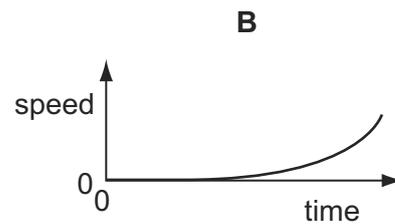
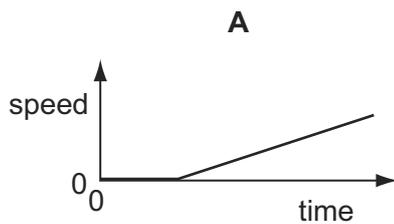
Which graph best represents the variation of the height h of the ball with time t ?



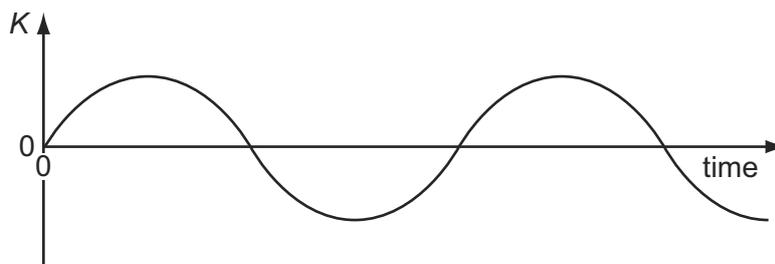
- 8 A car driver sharply presses down the accelerator when the traffic lights go green. The resultant horizontal force acting on the car varies with time as shown. 9702/01/O/N/05



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



- 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



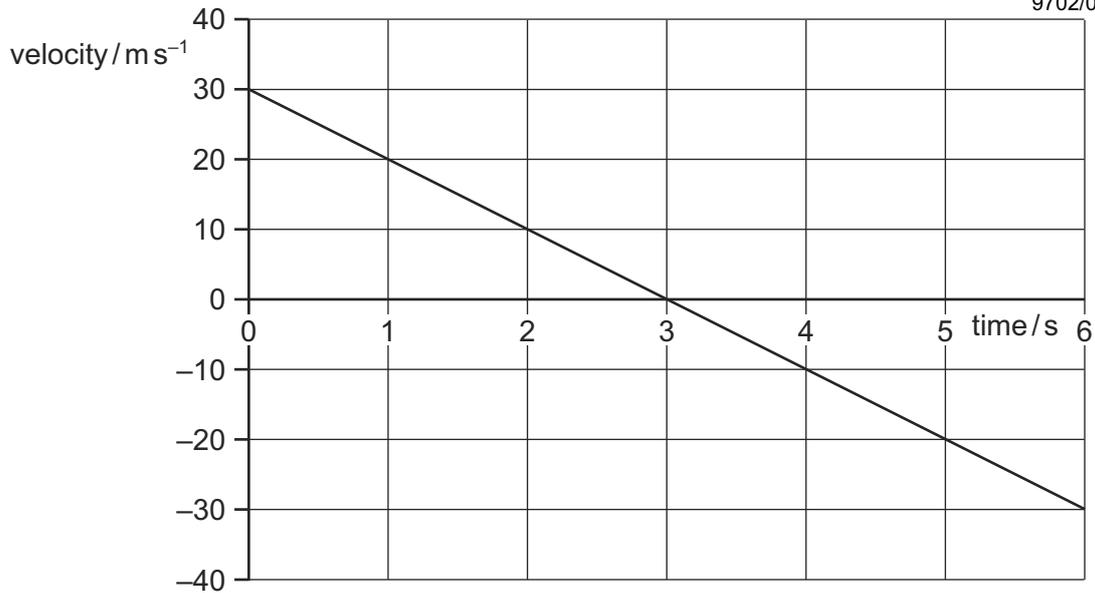
At any time, the slope of the graph is the acceleration of the particle.

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

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

9702/01/O/N/07

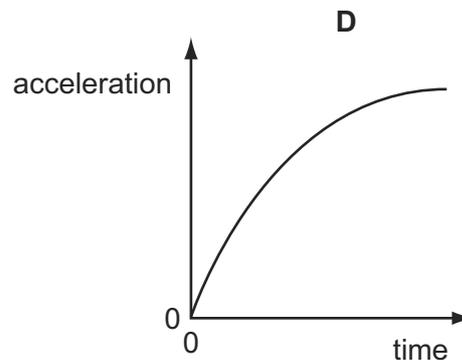
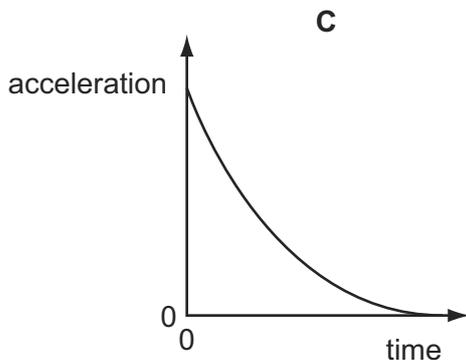
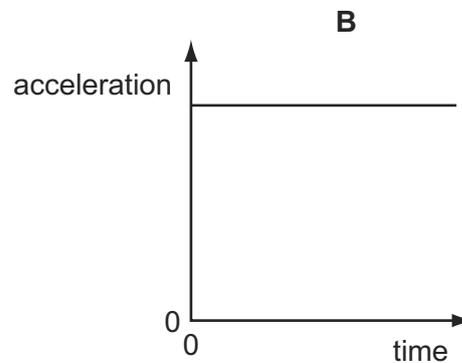
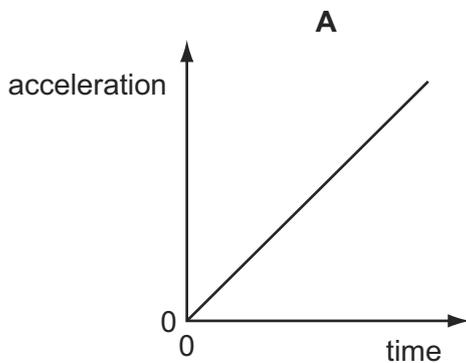


What is the vertical displacement of the stone from its starting point after 5 seconds?

- A** 20 m **B** 25 m **C** 45 m **D** 65 m
- 8 A football is dropped from the top of a tall building.

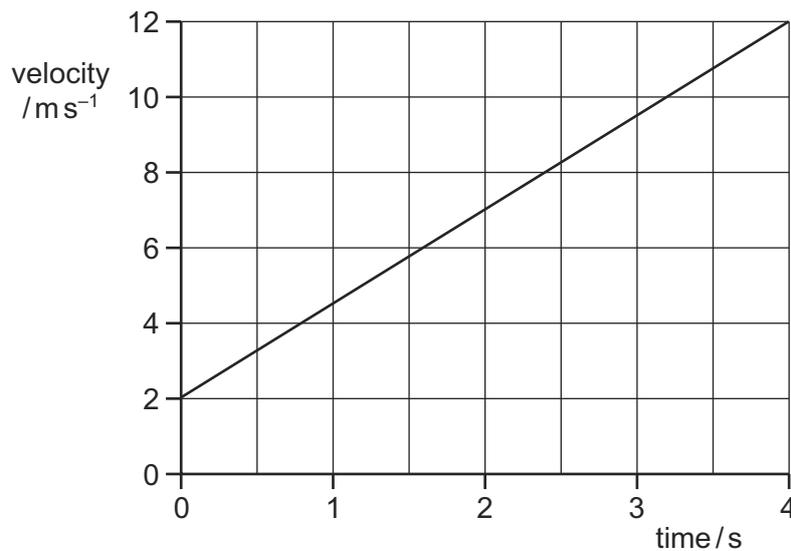
9702/01/M/J/08

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



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

9702/01/O/N/08

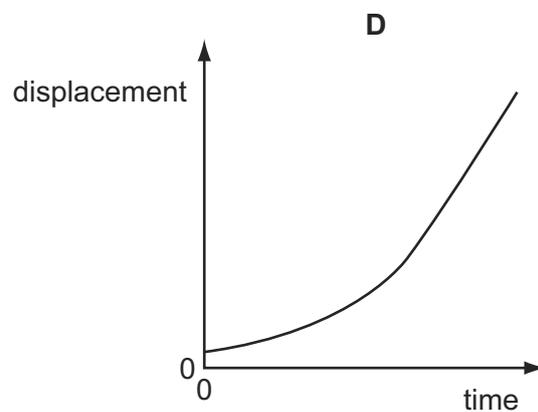
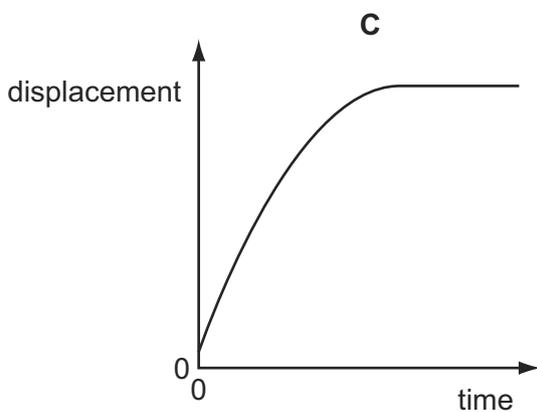
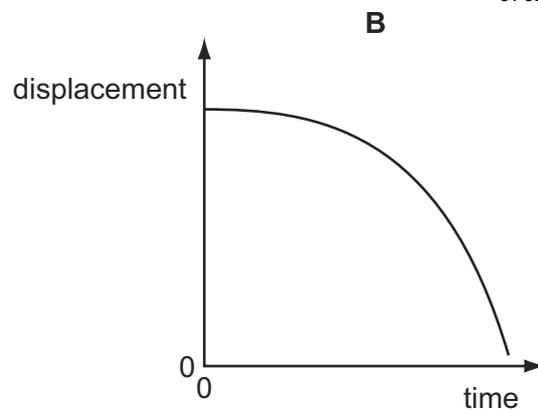
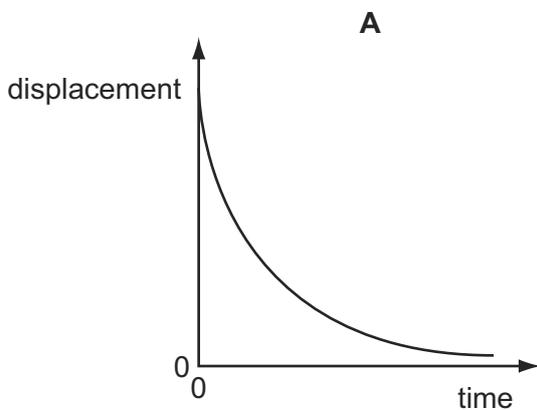


What is the distance travelled during the first 4.0 s?

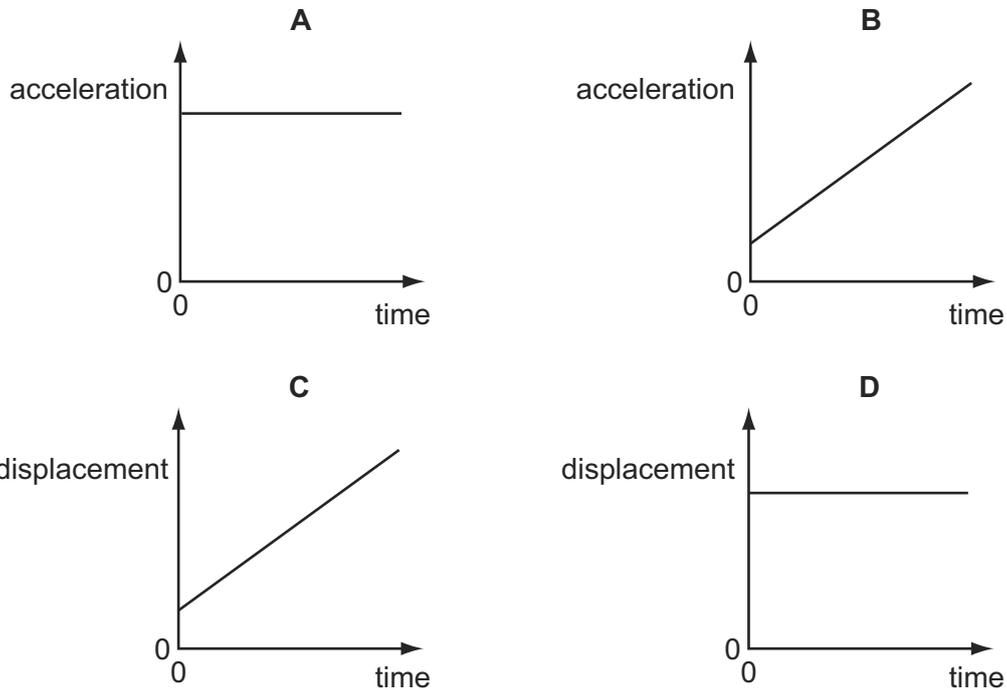
- A** 2.5 m **B** 3.0 m **C** 20 m **D** 28 m

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?

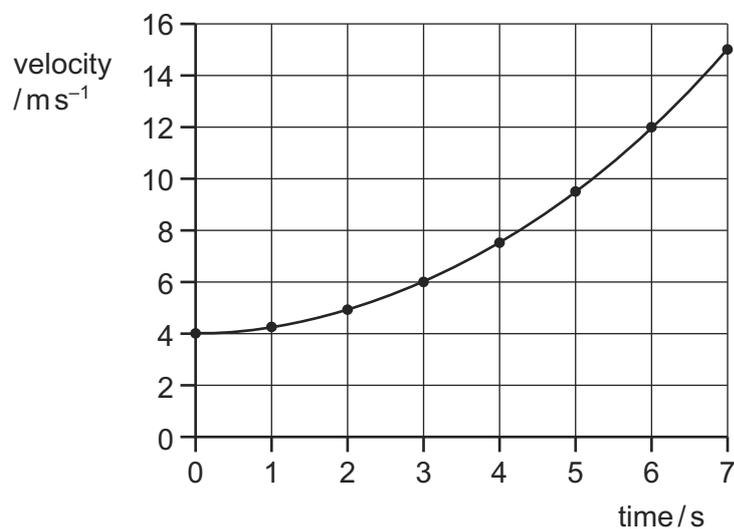
9702/01/M/J/09



- 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



- 8 The diagram shows a velocity-time graph for a vehicle. 9702/11/M/J/10



The vehicle, moving at 4.0 ms^{-1} , begins to accelerate at time = 0.

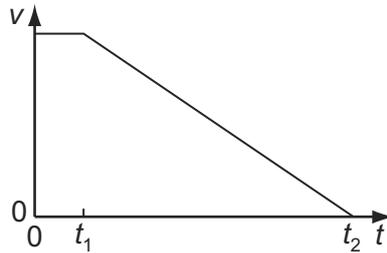
What is the vehicle's acceleration at time = 3.0 s?

- A** 0.67 ms^{-2} **B** 1.0 ms^{-2} **C** 1.3 ms^{-2} **D** 2.0 ms^{-2}

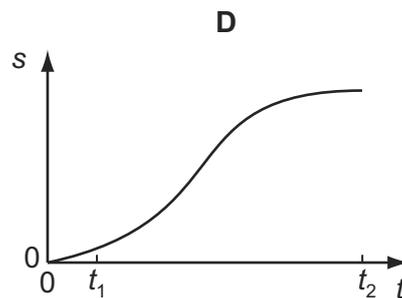
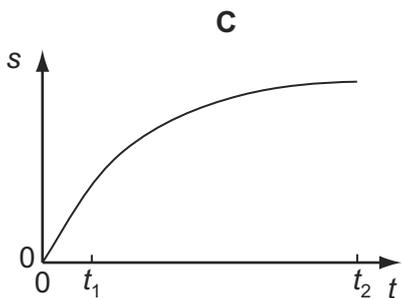
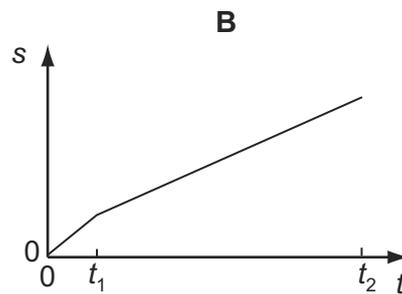
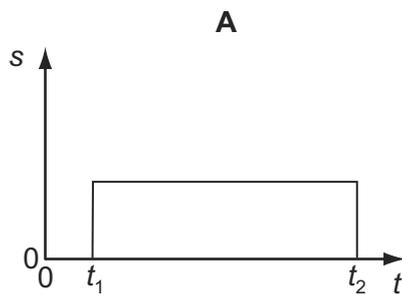
- 6 When a car driver sees a hazard ahead, she applies the brakes as soon as she can and brings the car to rest.

9702/01/M/J/09

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

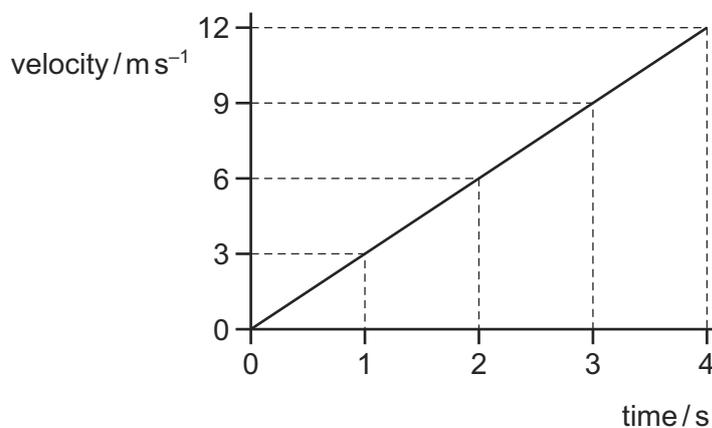


Which graph represents the variation with time t of the distance s travelled by the car after she has seen the hazard?



- 6 The diagram shows a velocity-time graph.

9702/12/O/N/09

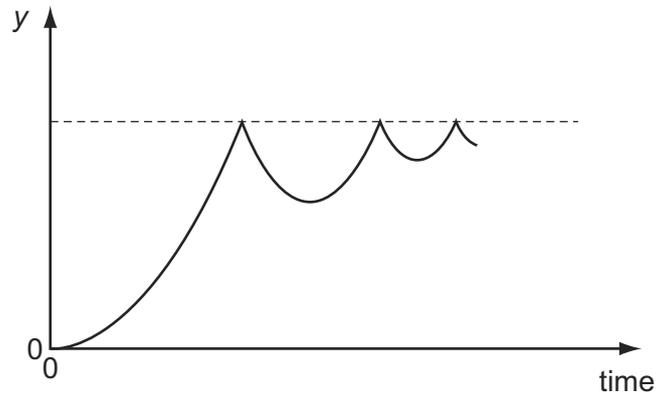


What is the displacement during the last 2 seconds of the motion?

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

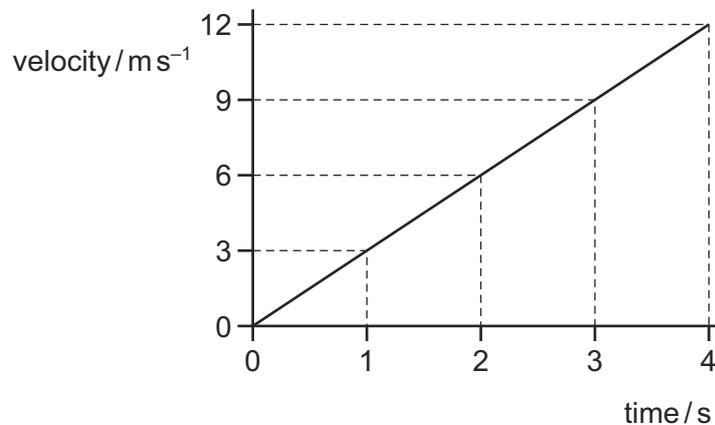
- 6 A ball is released from rest above a horizontal surface and bounces several times. 9702/11/O/N/09

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

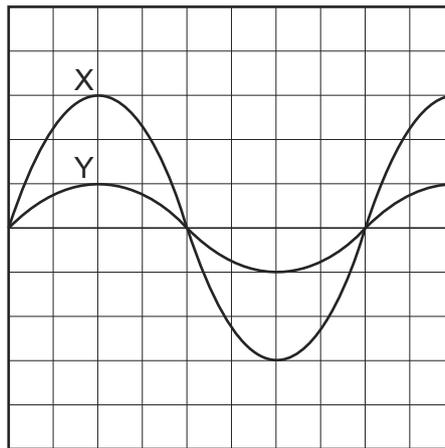


What is the displacement during the last 2 seconds of the motion?

- 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.



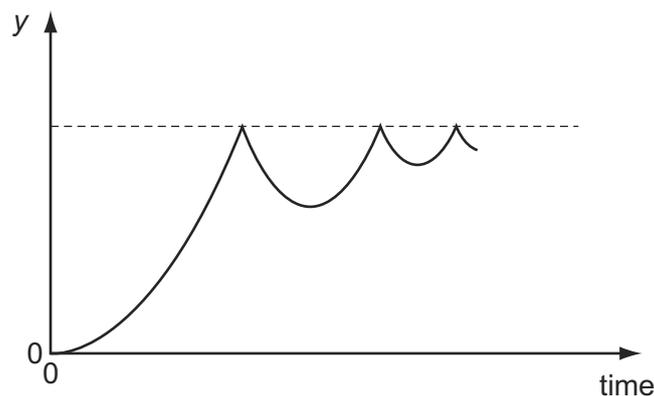
Signal X has a frequency of 50 Hz and peak voltage of 12 V.

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.



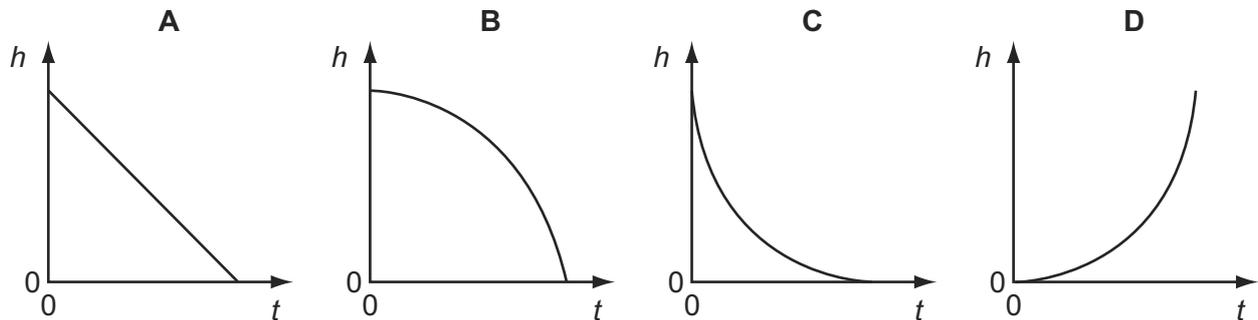
What is the quantity y ?

- A** acceleration
- B** displacement
- C** kinetic energy
- D** velocity

- 8 A small steel ball falls freely under gravity after being released from rest.

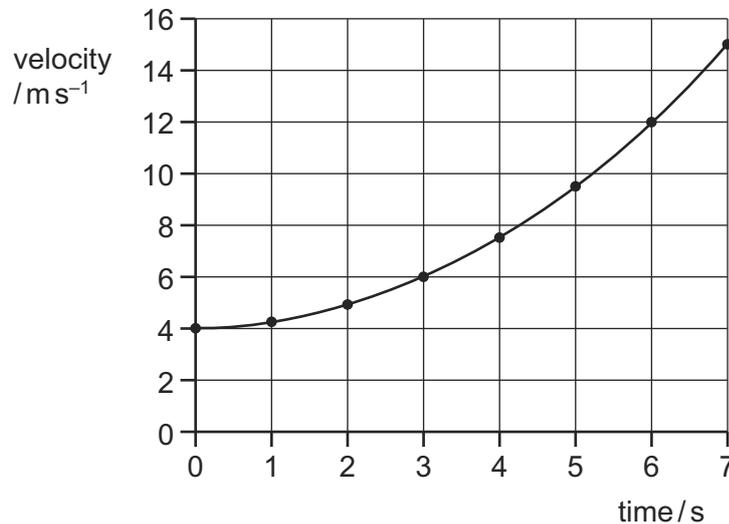
9702/12/M/J/10

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 ms^{-1} , begins to accelerate at time = 0.

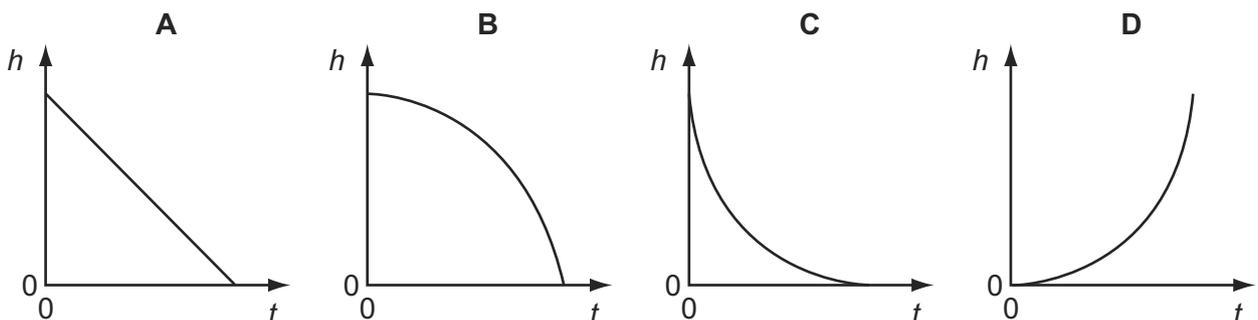
What is the vehicle's acceleration at time = 3.0 s?

- A** 0.67 ms^{-2} **B** 1.0 ms^{-2} **C** 1.3 ms^{-2} **D** 2.0 ms^{-2}

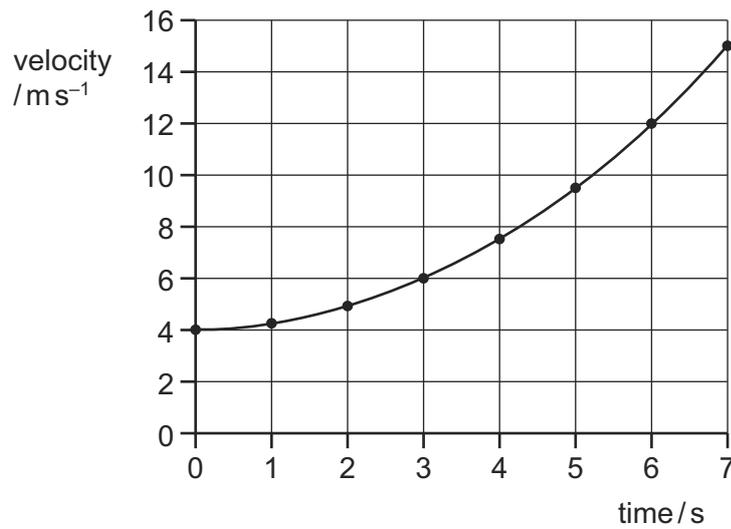
- 9 A small steel ball falls freely under gravity after being released from rest.

9702/11/M/J/10

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



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

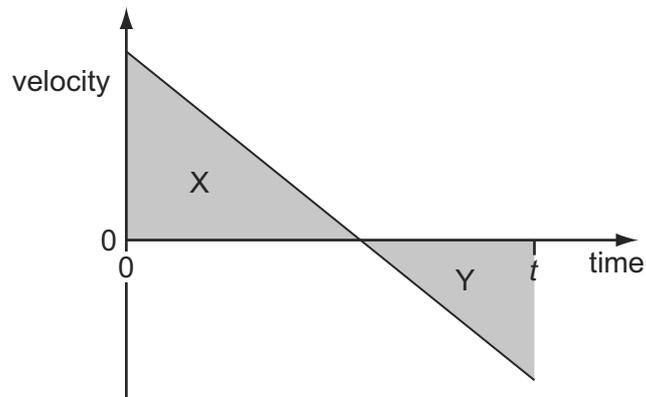


The vehicle, moving at 4.0 ms^{-1} , begins to accelerate at time = 0.

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

- A** 0.67 ms^{-2} **B** 1.0 ms^{-2} **C** 1.3 ms^{-2} **D** 2.0 ms^{-2}

8 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 ?

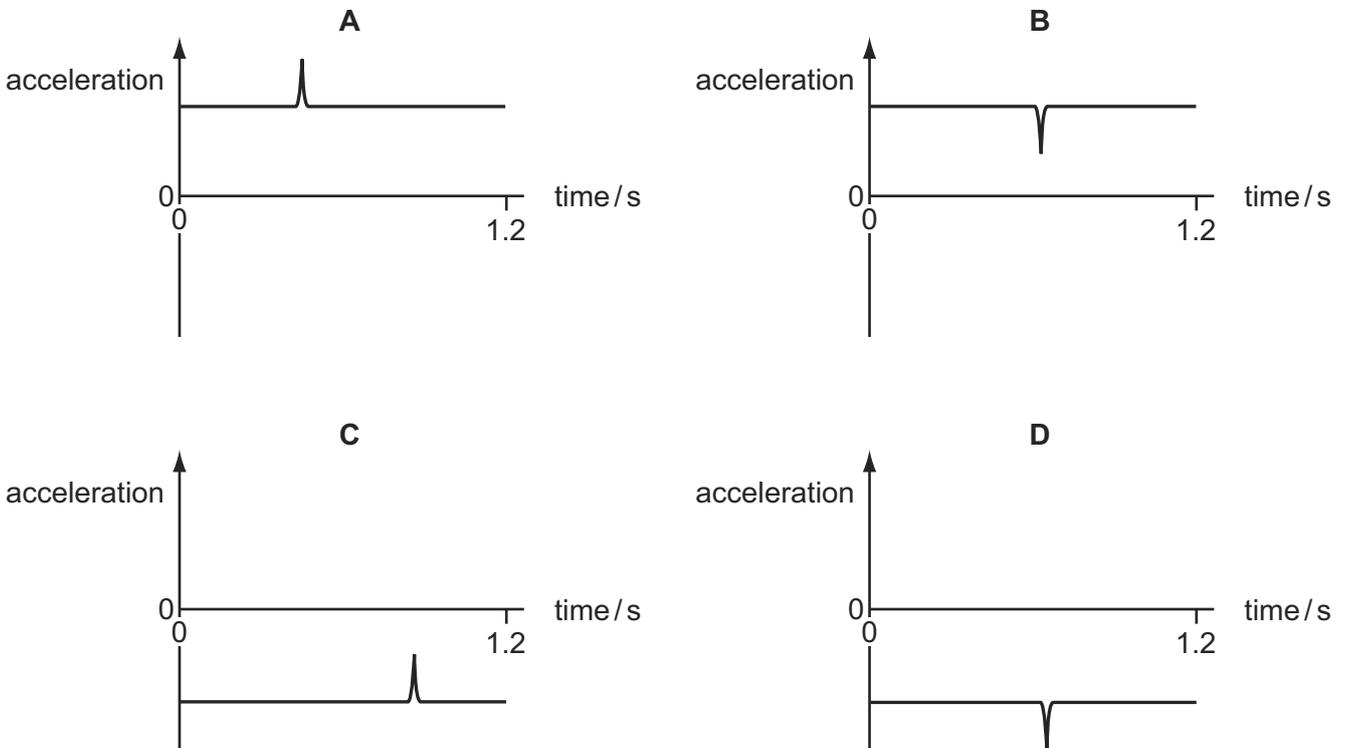
- A** 2 m **B** 3 m **C** 5 m **D** 8 m

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.

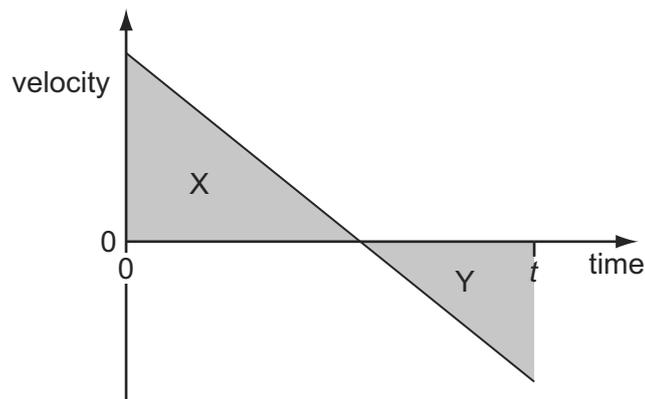
9702/12/O/N/10

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.

9702/13/O/N/10



The stone is thrown up at time zero.

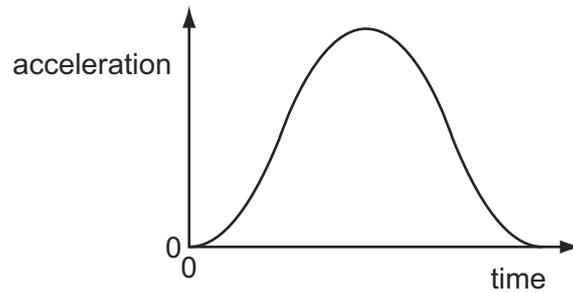
Area X represents a distance of 5 m. Area Y represents a distance of 3 m.

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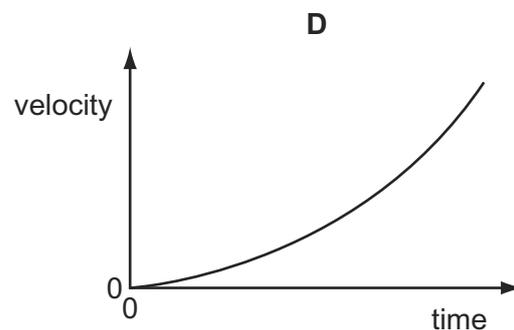
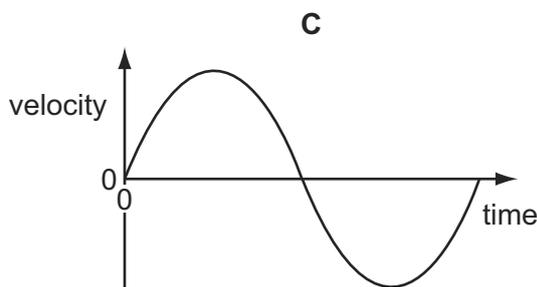
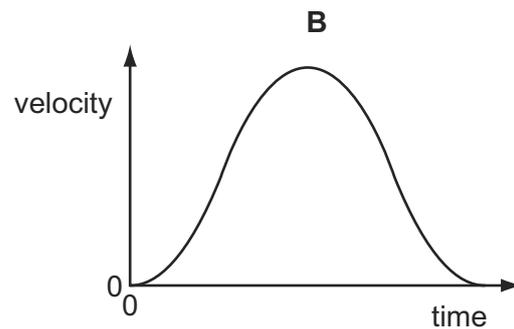
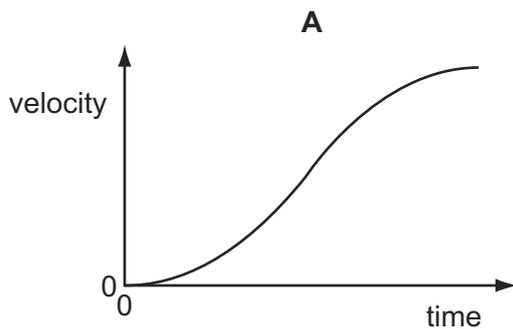
- A** 2 m **B** 3 m **C** 5 m **D** 8 m

- 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?



- 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.

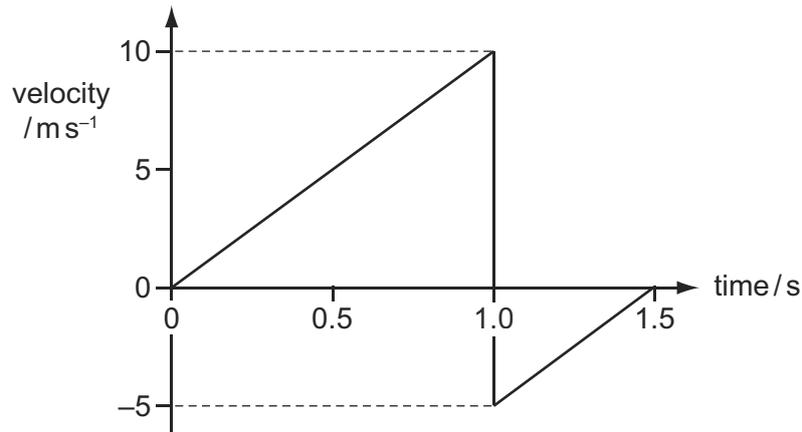
9702/11/O/N/11

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 m s^{-2}	0	$+9.81 \text{ m s}^{-2}$
B	-9.81 m s^{-2}	-9.81 m s^{-2}	-9.81 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 m s^{-2}

- 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

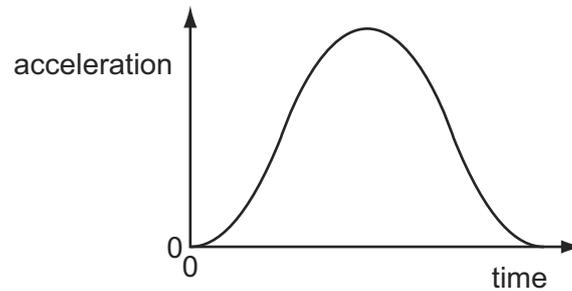


What is the total displacement of the ball from its original position after 1.5 s?

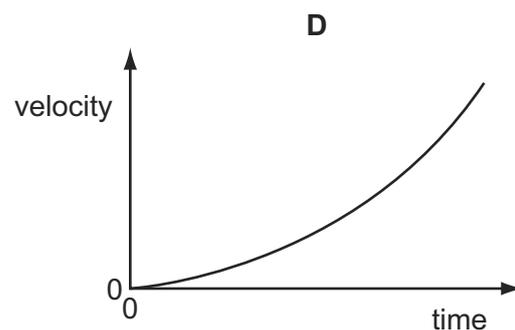
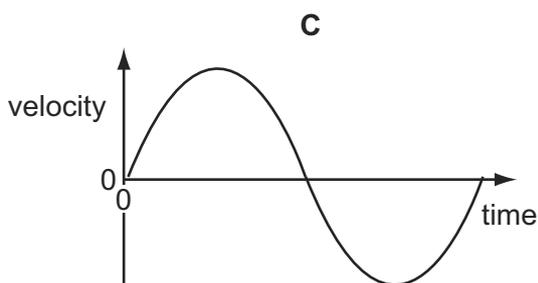
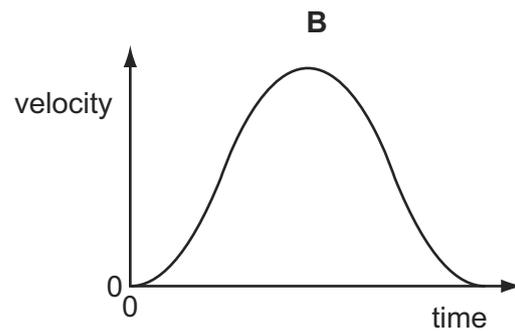
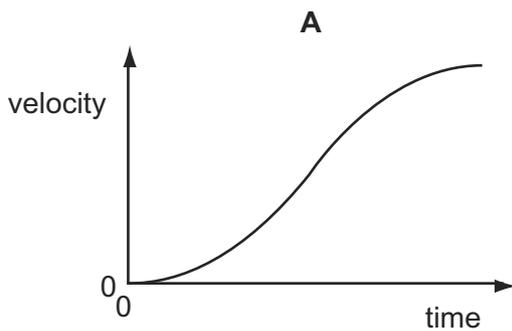
- A 1.25 m B 3.75 m C 5.00 m D 6.25 m

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

9702/13/M/J/11



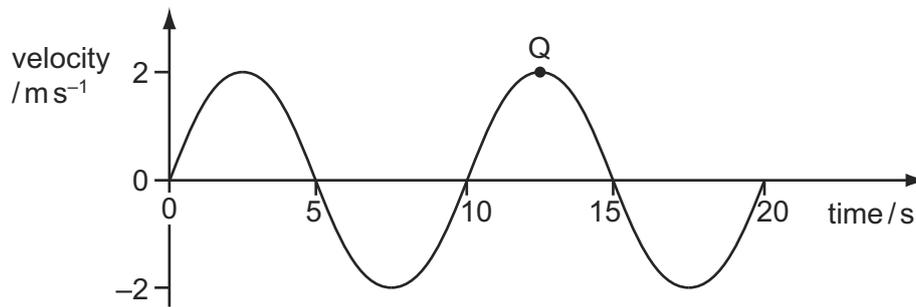
Which graph shows the variation with time of the velocity of the object?



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

9702/12/M/J/11

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.



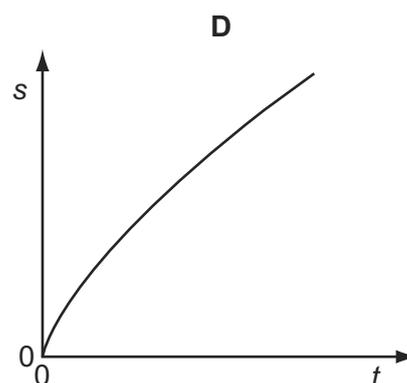
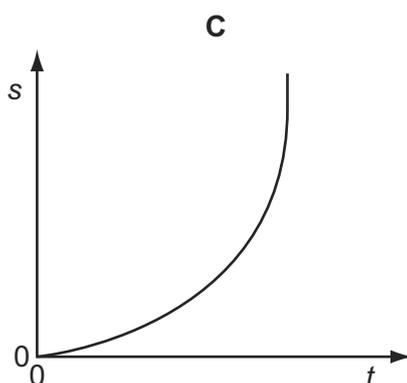
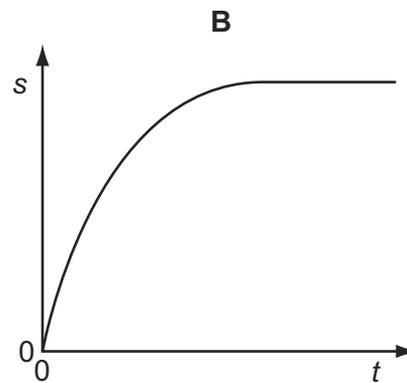
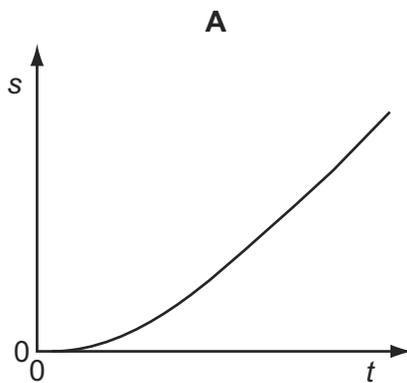
Which row of the table is correct?

	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

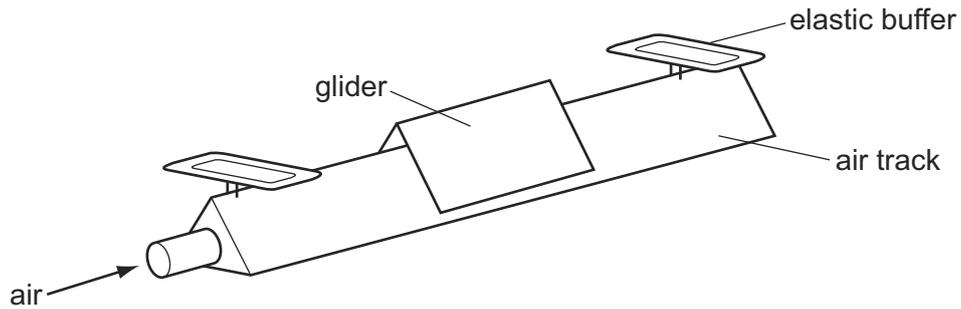
8 A tennis ball falls freely, in air, from the top of a tall building.

9702/12/M/J/11

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

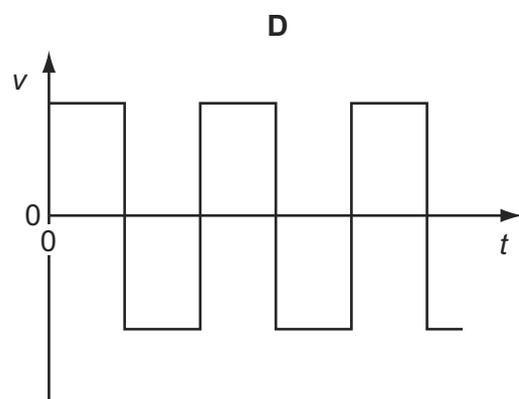
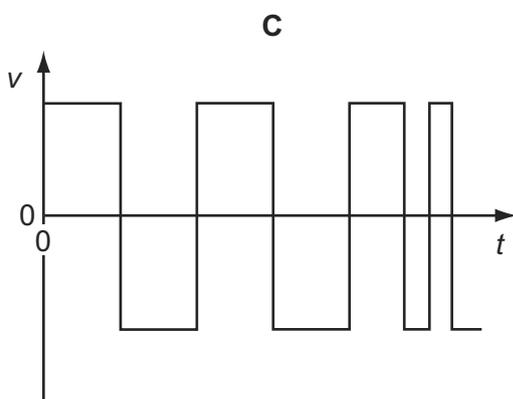
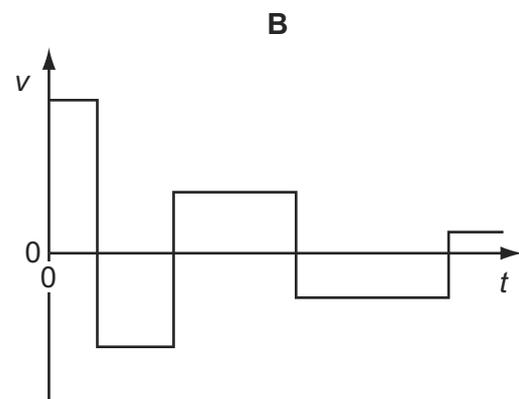
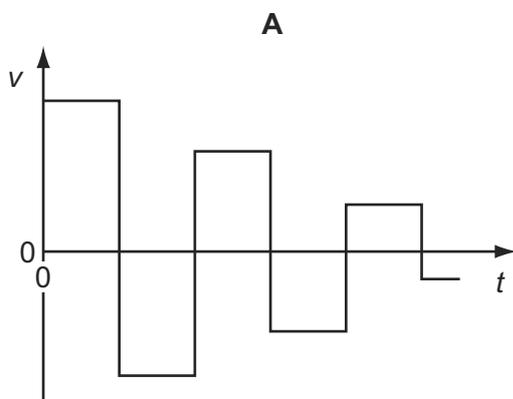


- 9 A small glider moves along a friction-free horizontal air track as shown below. 9702/12/M/J/11



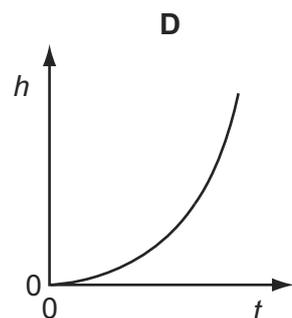
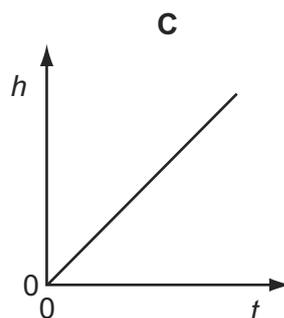
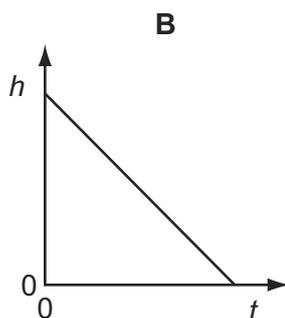
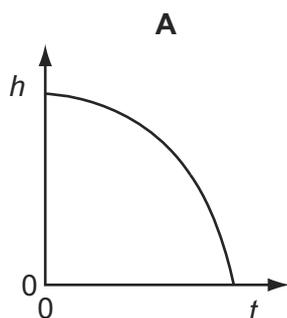
At each end of the air track there is a perfectly elastic buffer.

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



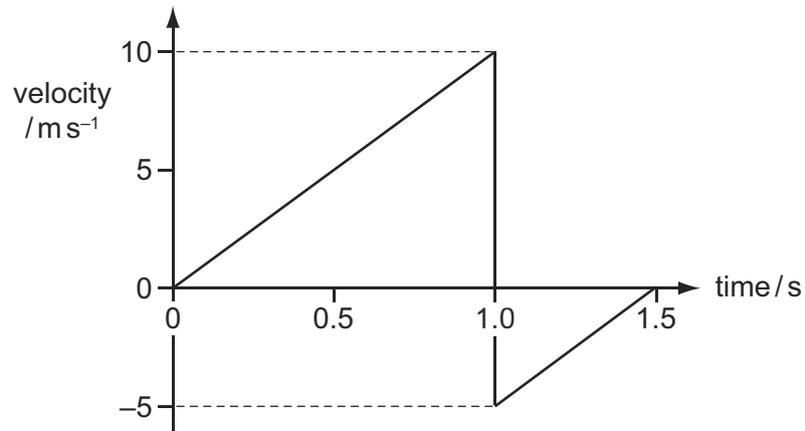
- 9 A brick is dislodged from a building and falls vertically under gravity. 9702/12/M/J/12

Which graph best represents the variation of its height h above the ground with time t if air resistance is negligible?



- 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



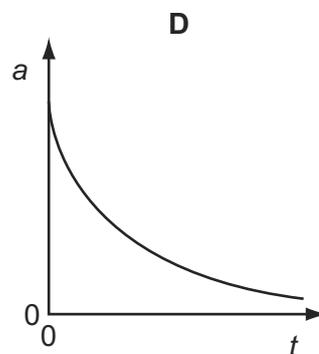
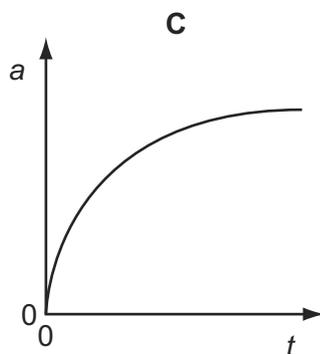
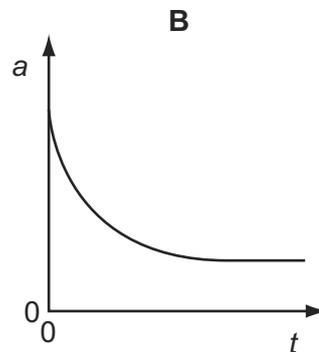
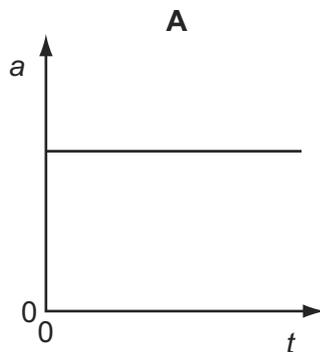
What is the total displacement of the ball from its original position after 1.5 s?

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

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

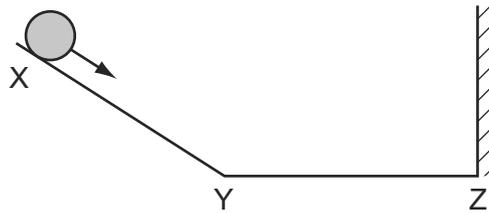
9702/11/O/N/11

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?

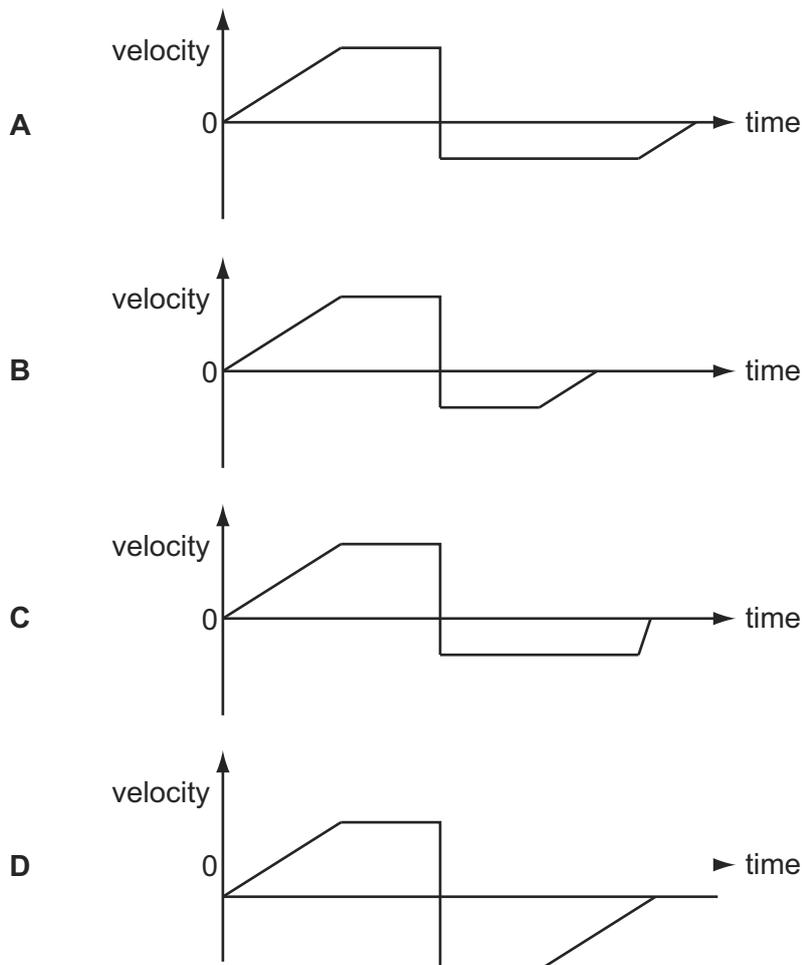


6 A ball is released from rest on a smooth slope XY.

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.



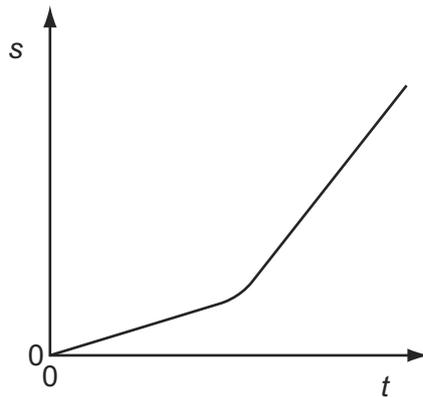
Which velocity-time graph represents the motion of the ball?



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

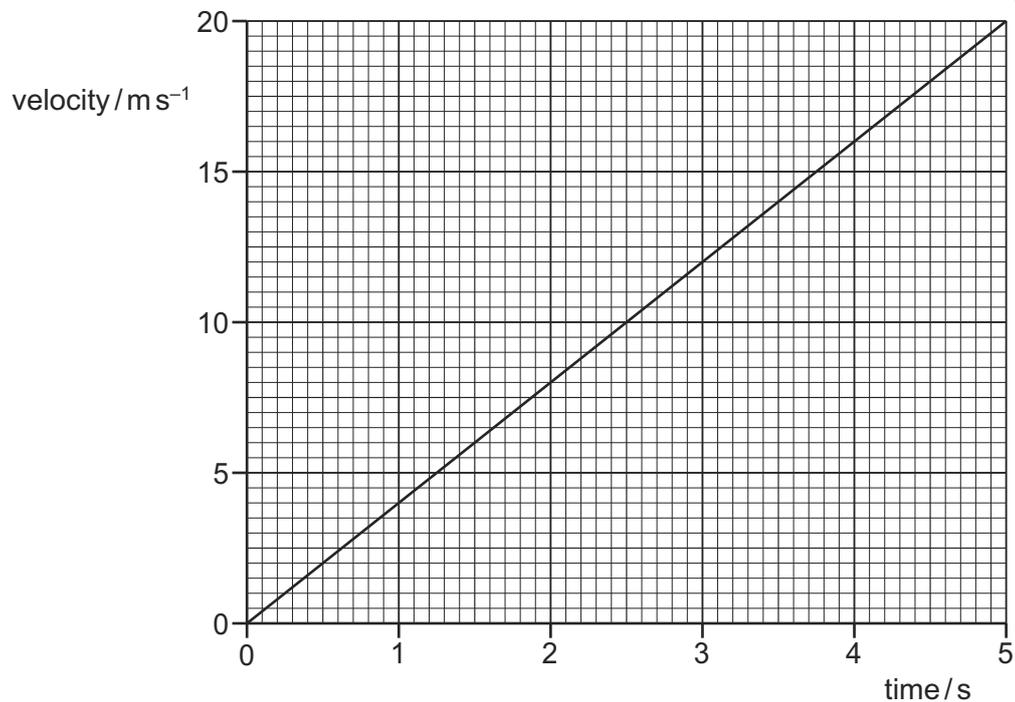
8 The variation with time t of the distance s moved by a body is shown below.



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.



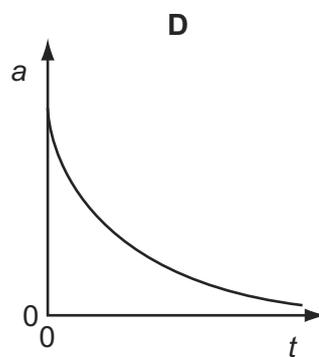
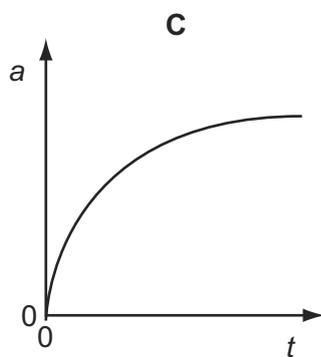
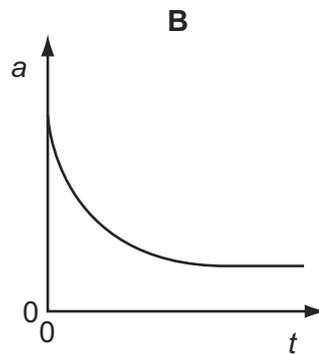
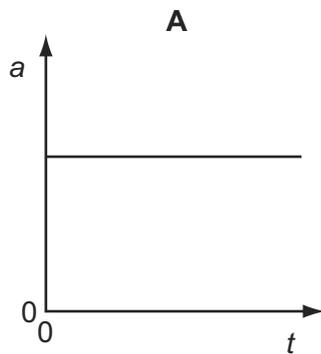
What is the distance travelled by the object in this time?

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

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

9702/13/O/N/11

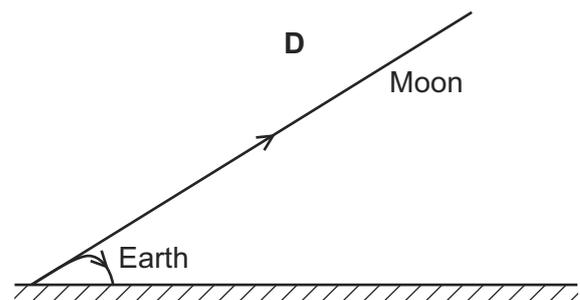
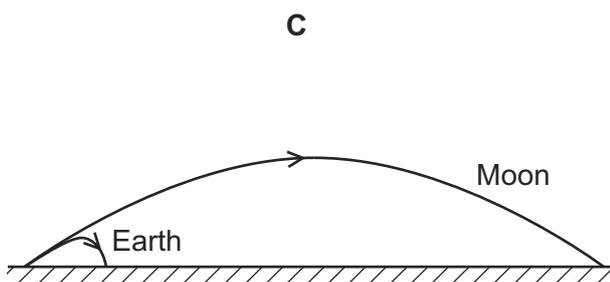
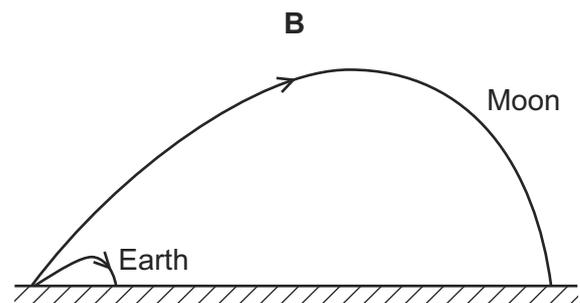
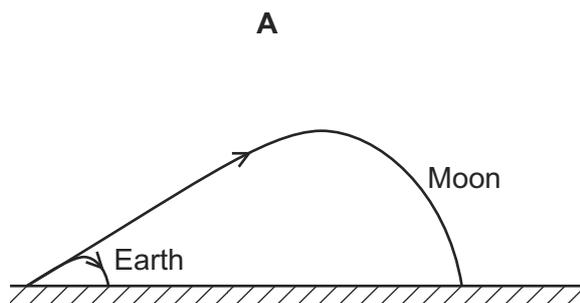
Which graph best represents the variation with time t of the acceleration a of the ball as it falls, assuming that the effect of air resistance is **not** negligible?



10 A golf ball is hit with the same force and direction on the Earth and on the Moon.

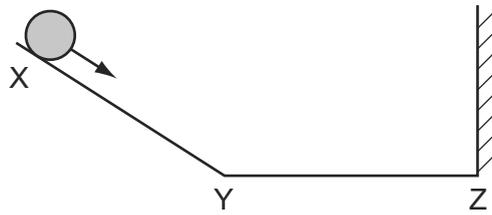
9702/12/O/N/12

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

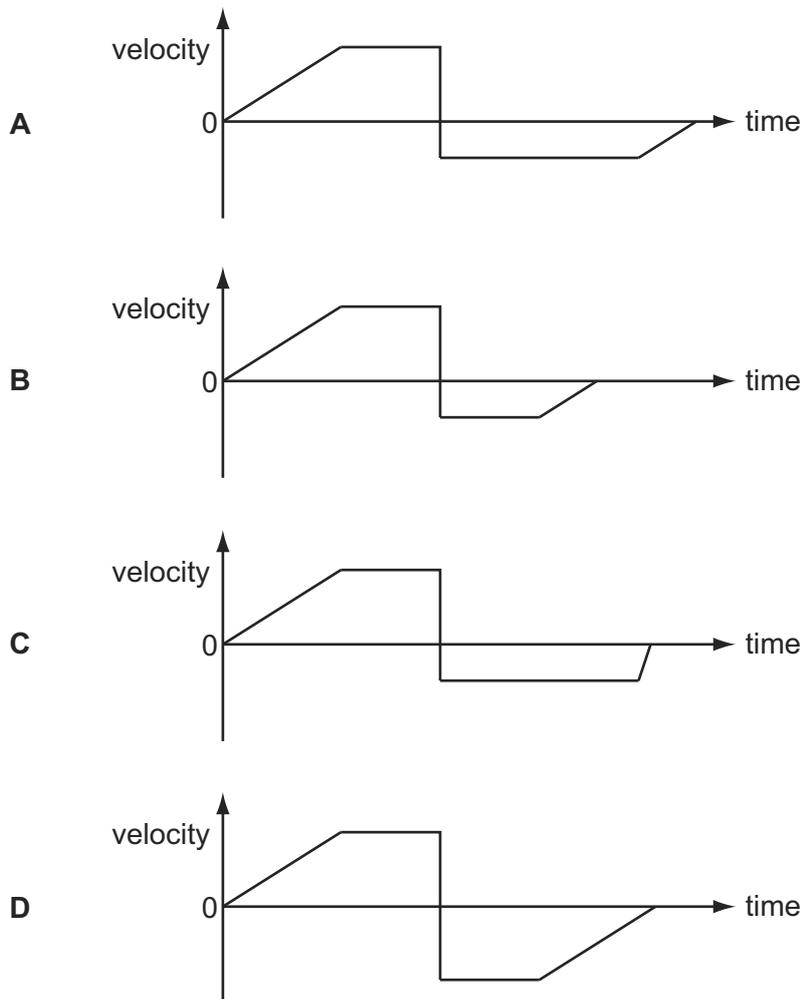


7 A ball is released from rest on a smooth slope XY.

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?

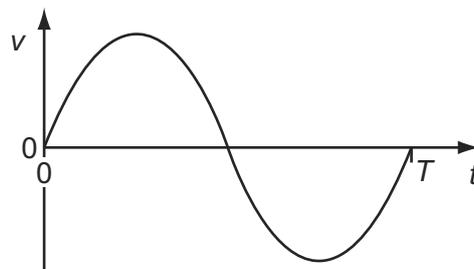


- 9 A boy throws a ball vertically upwards. It rises to a maximum height, where it is momentarily at rest, and then falls back to his hands. 9702/13/O/N/11

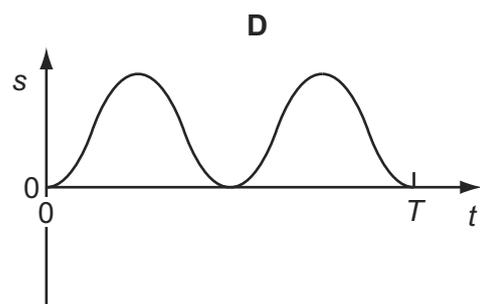
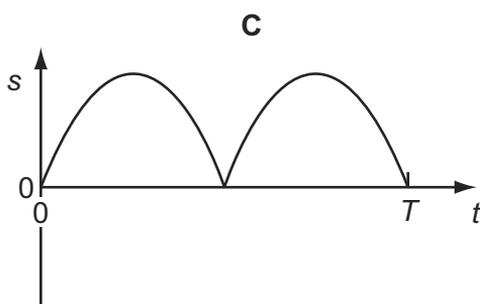
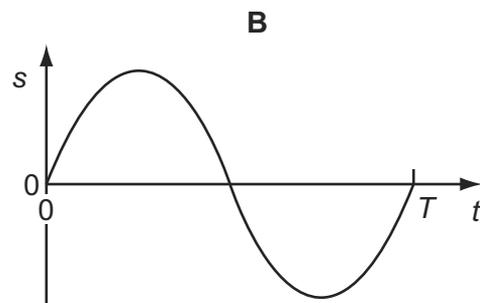
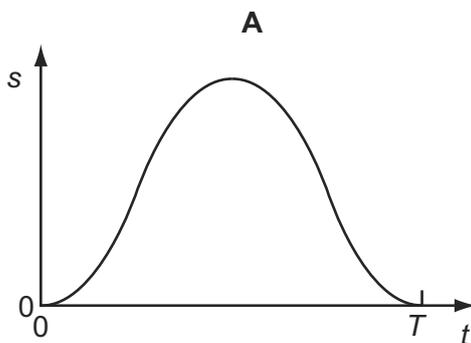
Which row gives the acceleration of the ball at various stages in its motion? (Take vertically upwards as positive. Ignore air resistance.)

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

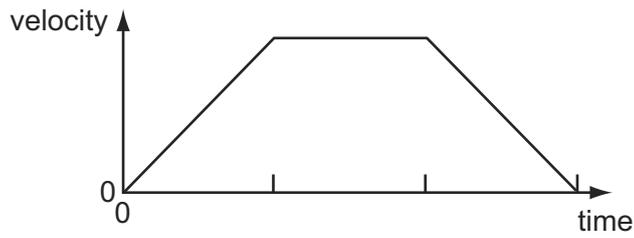
- 7 The graph shows how the velocity v of an object moving in a straight line varies over time $t = 0$ to $t = T$. 9702/12/M/J/12



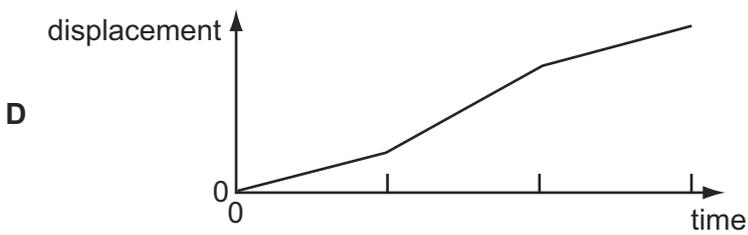
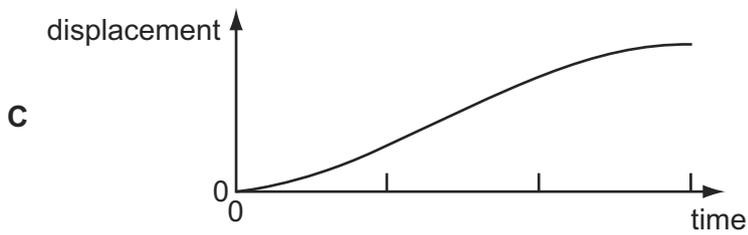
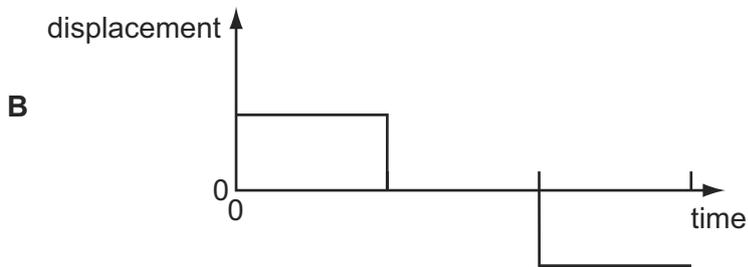
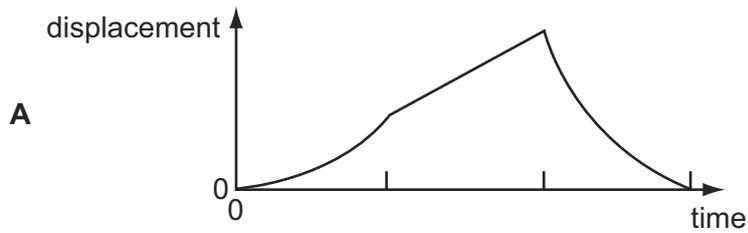
Which graph represents the displacement s of the object in the time $t = 0$ to $t = T$?



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

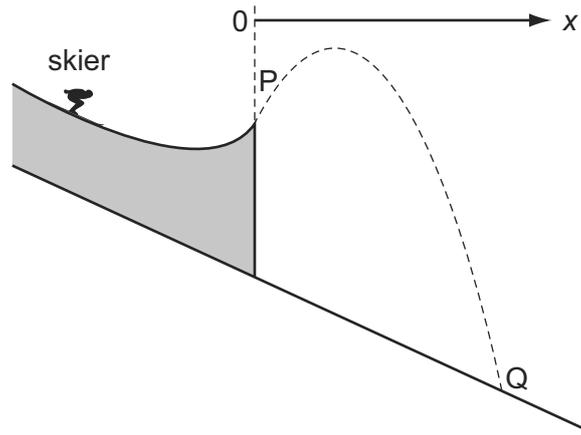


What is the corresponding graph of displacement against time?

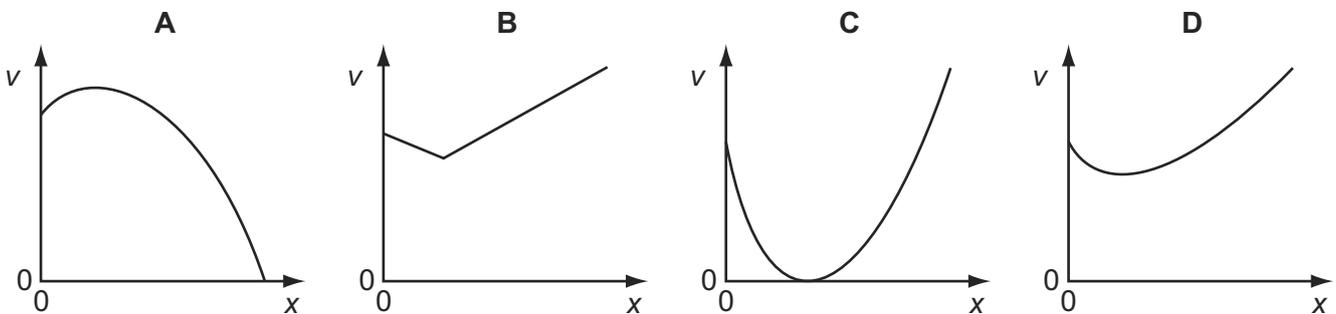


10 The dotted line shows the path of a competitor in a ski-jumping competition.

9702/12/O/N/12

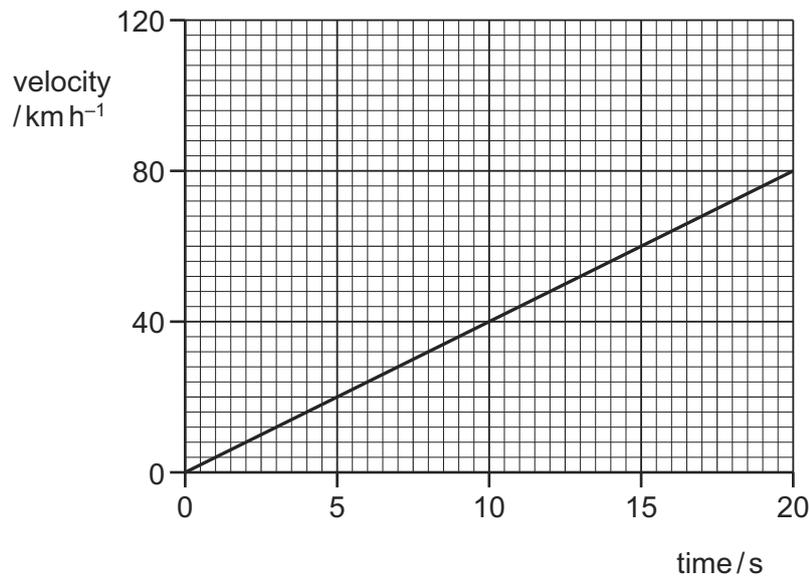


Ignoring air resistance, which graph best represents the variation of his speed v with the horizontal distance x covered from the start of his jump at P before landing at Q?



11 The velocity of a car changes as shown.

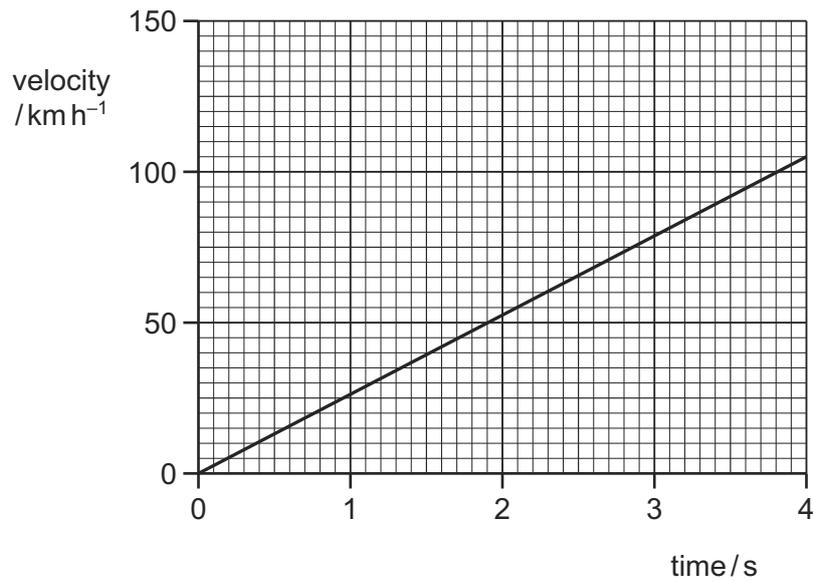
9702/12/O/N/12



What is the acceleration of the car?

- A 1.1 ms^{-2} B 4.0 ms^{-2} C 224 ms^{-2} D 800 ms^{-2}

8 The velocity of an electric car changes as shown.



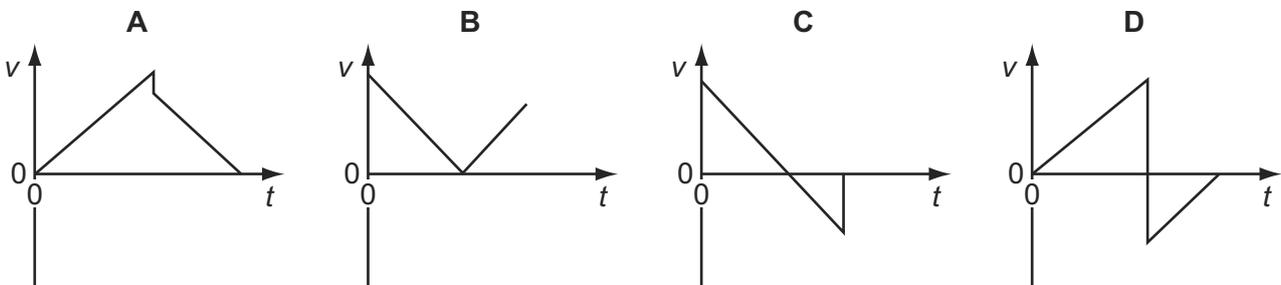
What is the acceleration of the car?

- A** 190 ms^{-2} **B** 53 ms^{-2} **C** 26 ms^{-2} **D** 7.3 ms^{-2}

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

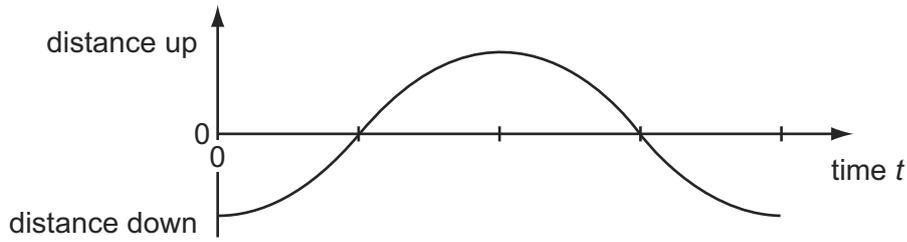
9702/13/O/N/12

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

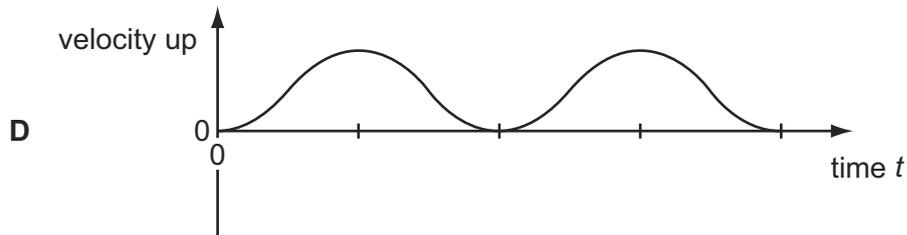
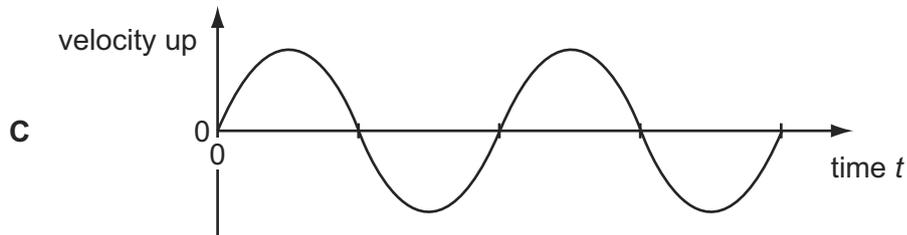
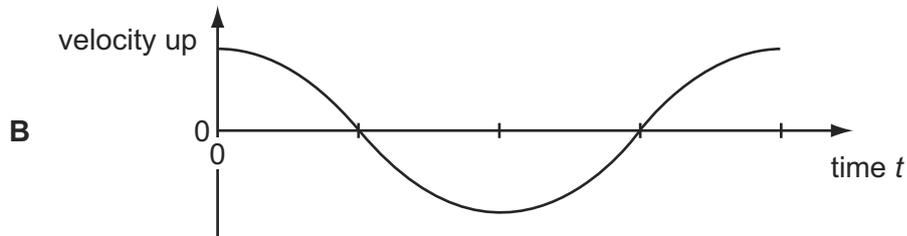
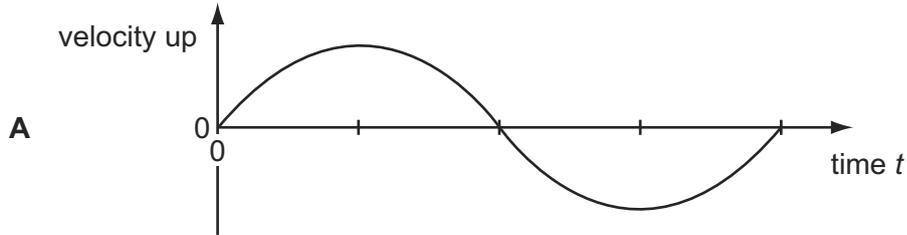


10 A mass on the end of a spring bounces up and down as shown, after being released at time $t = 0$.

9702/13/O/N/12

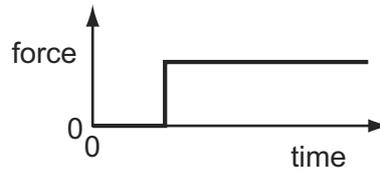


Which graph shows how the velocity varies with time?

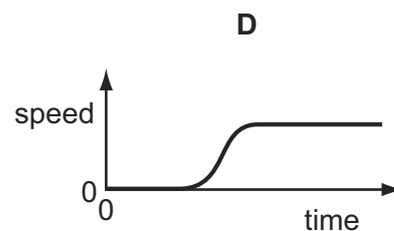
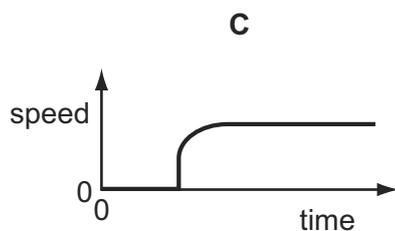
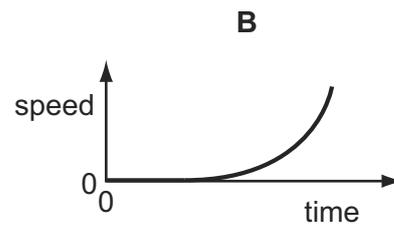
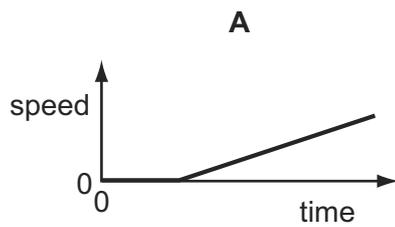


- 9 A car is stationary at traffic lights. When the traffic lights go green, the driver presses down sharply on the accelerator. The resultant horizontal force acting on the car varies with time as shown.

9702/11/M/J/13



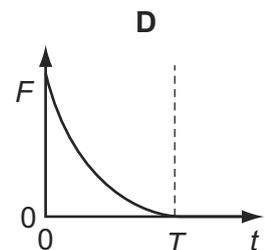
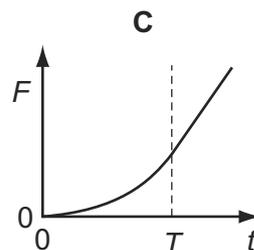
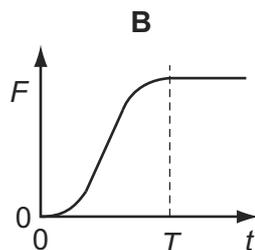
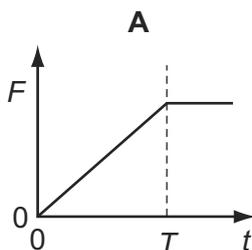
Which graph shows the variation with time of the speed of the car?



- 6 A sky diver falls vertically from a stationary balloon. She leaves the balloon at time $t = 0$. At time $t = T$, she reaches terminal velocity. Beyond the time shown in the graphs, she opens her parachute.

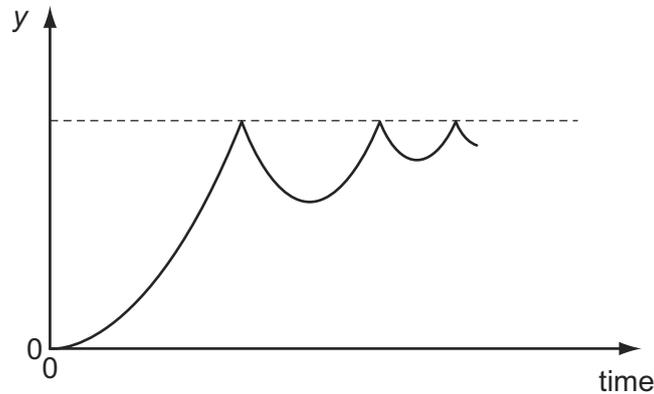
9702/12/M/J/13

Which graph shows the variation with time t of the force F due to air resistance?



- 8 A ball is released from rest above a horizontal surface and bounces several times. 9702/12/M/J/13

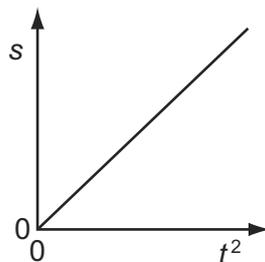
The graph shows how, for this ball, a quantity y varies with time.



What is the quantity y ?

- A acceleration
 - B displacement
 - C kinetic energy
 - D velocity
- 8 At time $t = 0$, a body moves from rest with constant acceleration in a straight line. At time t , the body is distance s from its rest position. 9702/13/M/J/13

A graph is drawn of s against t^2 , as shown.

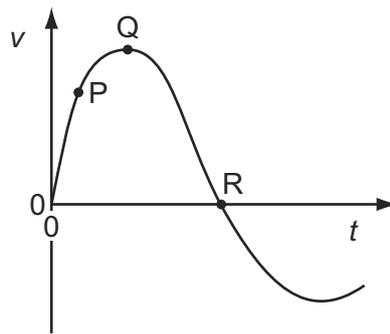


Which statement describes the acceleration of the body?

- A It is equal to half the value of the gradient of the graph.
- B It is equal to the value of the gradient of the graph.
- C It is equal to twice the value of the gradient of the graph.
- D It is equal to the reciprocal of the gradient of the graph.

7 The graph shows how velocity v varies with time t for a bungee jumper.

9702/11/O/N/13



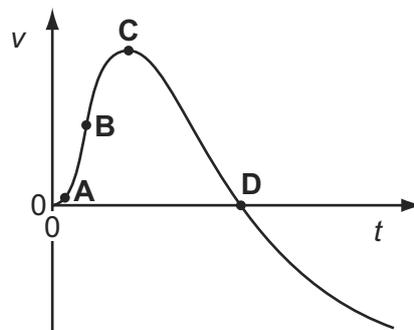
At which point is the bungee jumper momentarily at rest and at which point does she have zero acceleration?

	jumper at rest	jumper with zero acceleration
A	Q	P
B	Q	R
C	R	Q
D	R	R

7 The graph shows how the velocity v of a firework rocket changes with time t .

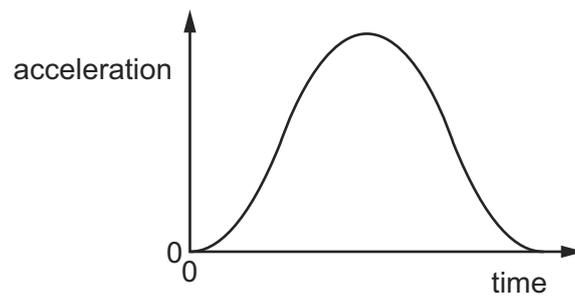
9702/13/O/N/13

At which point on the graph does the rocket have the greatest acceleration?



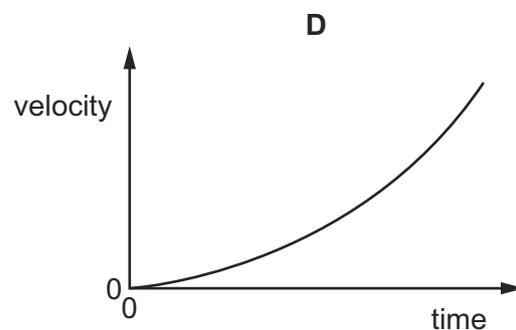
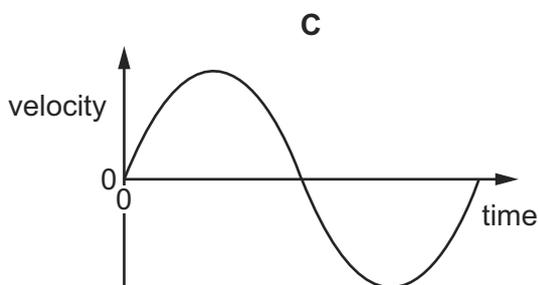
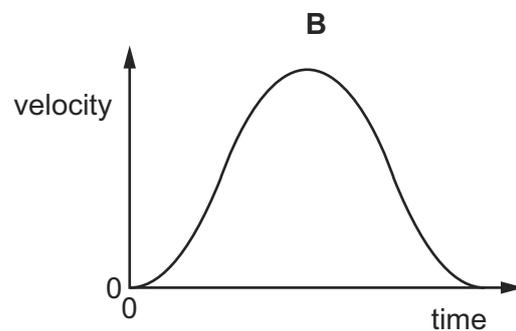
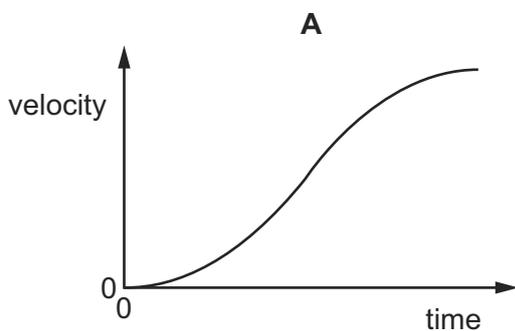
- 8 The graph shows how the acceleration of an object moving in a straight line varies with time.

9702/11/M/J/14



The object starts from rest.

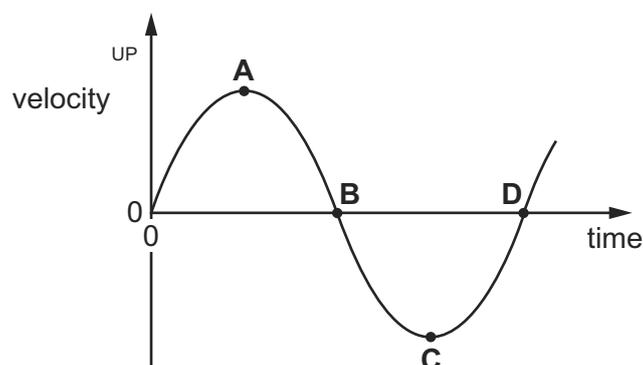
Which graph shows the variation with time of the velocity of the object over the same time interval?



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

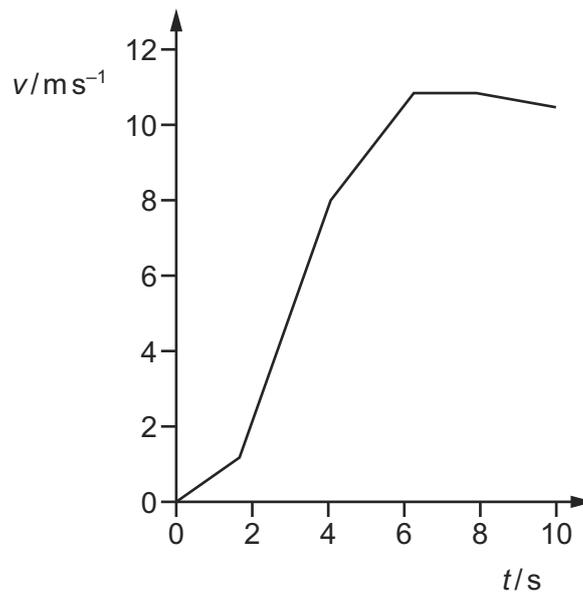
Which point represents the velocity of the mass when at the lowest point of its motion?

9702/13/O/N/14



- 9 The graph shows how the speed v of a sprinter changes with time t during a 100 m race.

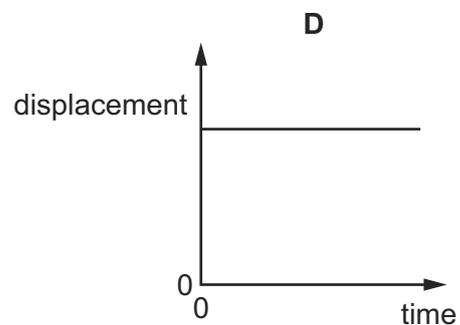
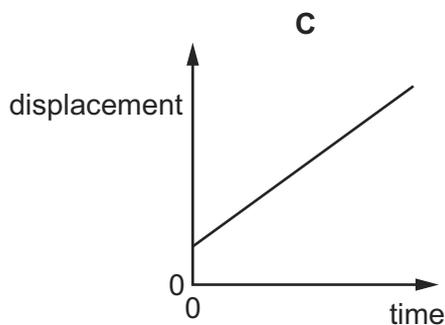
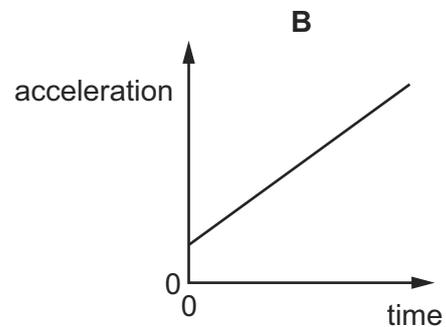
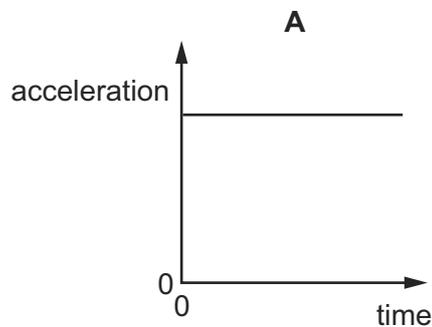
9702/13/M/J/14



What is the best estimate of the maximum acceleration of the sprinter?

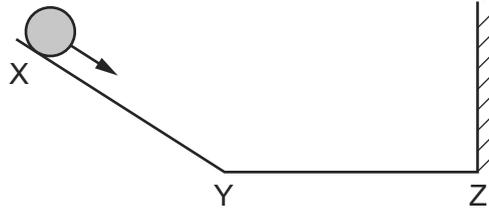
- A 0.5 ms^{-2} B 1 ms^{-2} C 3 ms^{-2} D 10 ms^{-2}
- 6 Which graph represents the motion of a car that is travelling along a straight road with a speed that increases uniformly with time?

9702/11/O/N/14

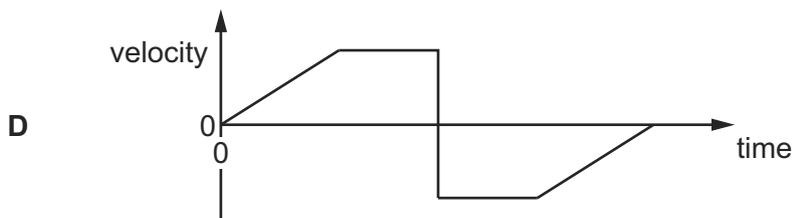
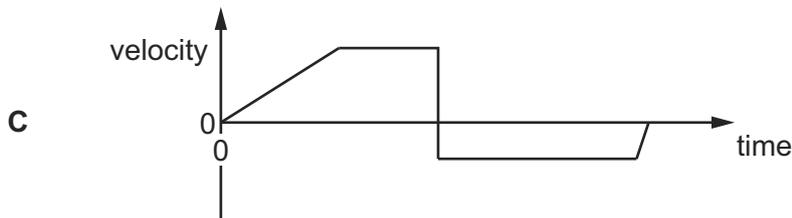
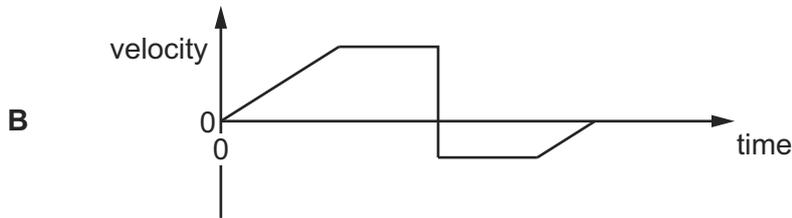
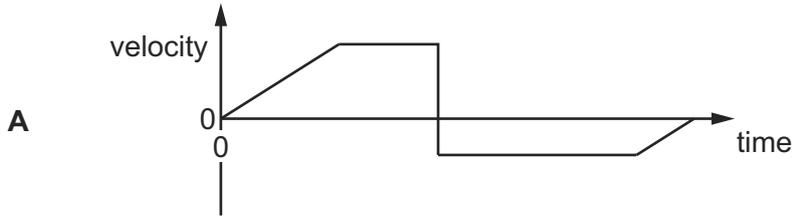


8 A ball is released from rest on a smooth slope XY.

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.

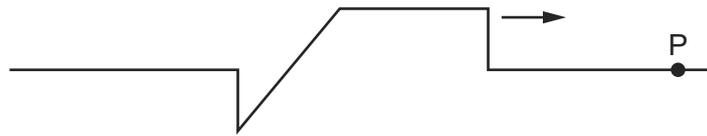


Which velocity-time graph represents the motion of the ball?

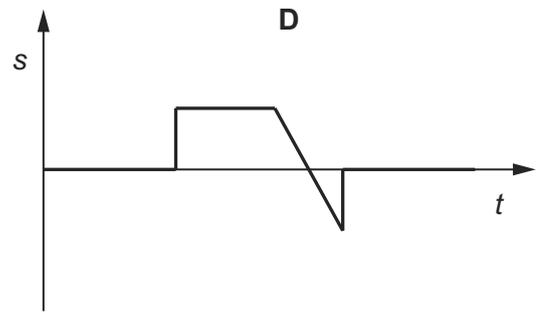
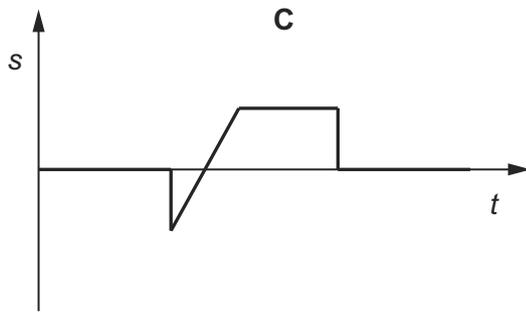
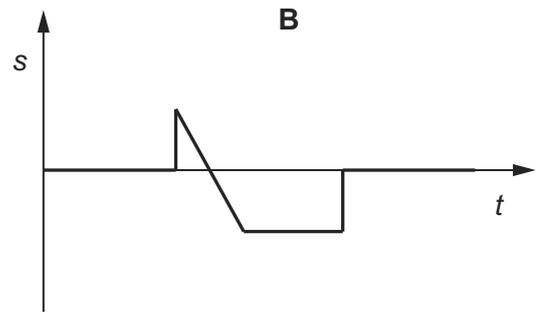
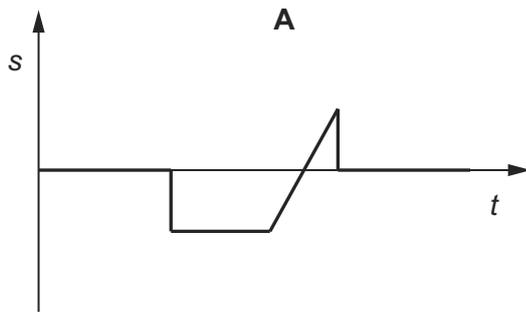


26 A wave pulse moves along a stretched rope in the direction shown.

9702/13/M/J/15

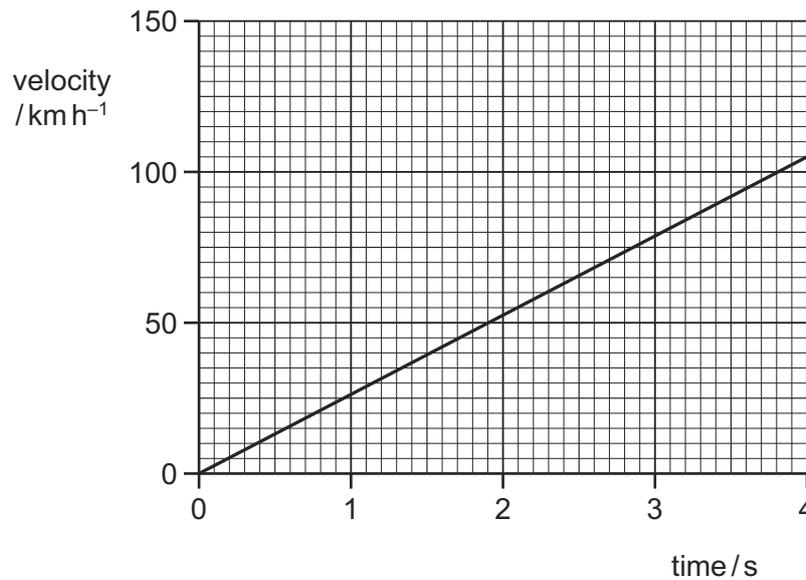


Which diagram correctly shows the variation with time t of the displacement s of the particle P in the rope?



8 The velocity of an electric car changes as shown.

9702/13/M/J/15

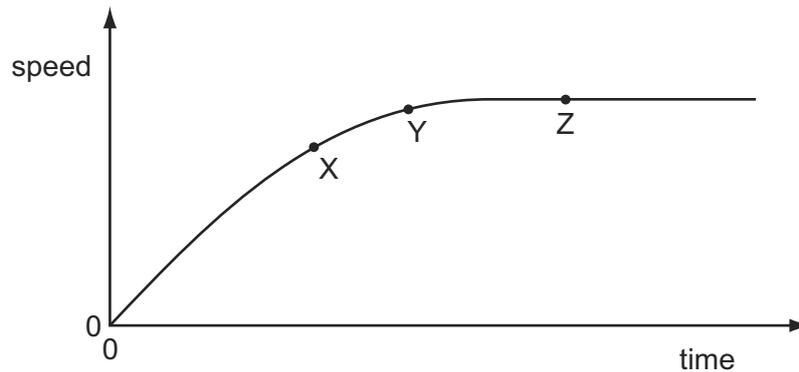


What is the acceleration of the car?

- A** 210ms^{-2} **B** 58ms^{-2} **C** 26ms^{-2} **D** 7.3ms^{-2}

- 7 A raindrop falls vertically from rest in air. The variation with time of the speed of the raindrop is shown in the graph.

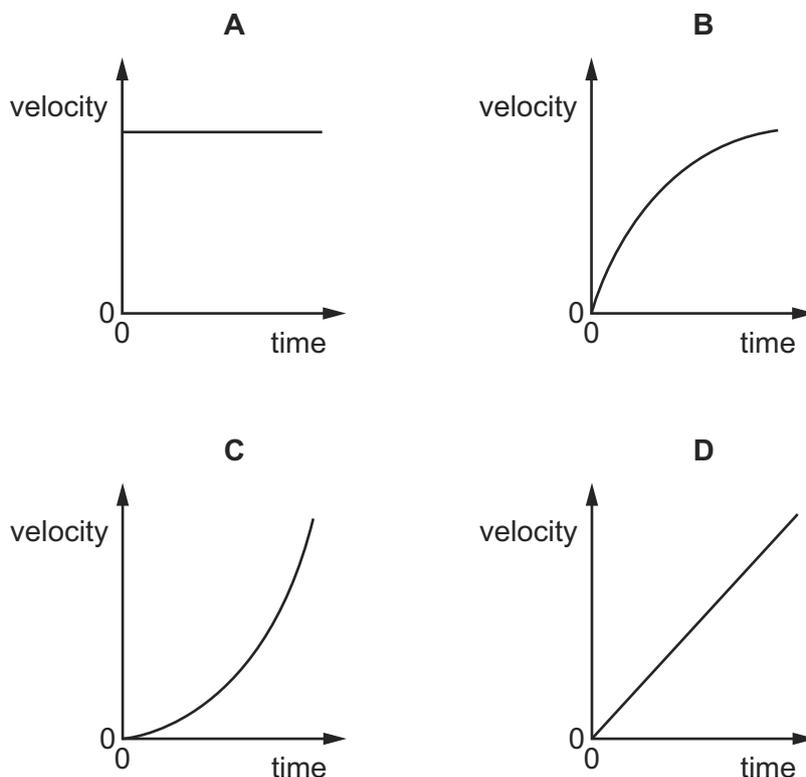
9702/13/M/J/15



Which statement about the raindrop is correct?

- A At point X, the raindrop has an acceleration of 9.81 m s^{-2} .
 - B At point Z, the force on the raindrop due to air resistance has reached its maximum value and so the acceleration of the raindrop has also reached its maximum value.
 - C At point Z, the force due to air resistance is equal and opposite to the weight of the raindrop and so the speed of the raindrop is zero.
 - D The resultant force on the raindrop at point Y is less than the resultant force on the raindrop at point X.
- 8 A stone is thrown horizontally from the top of a cliff. Air resistance is negligible. 9702/12/M/J/15

Which graph shows the variation with time of the vertical component of the stone's velocity?



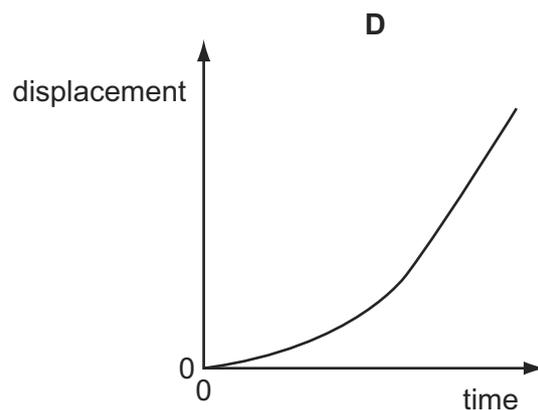
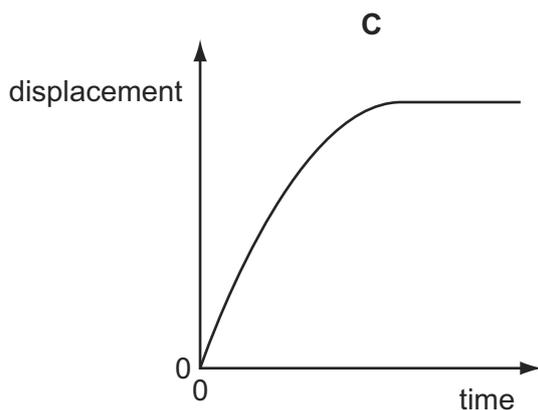
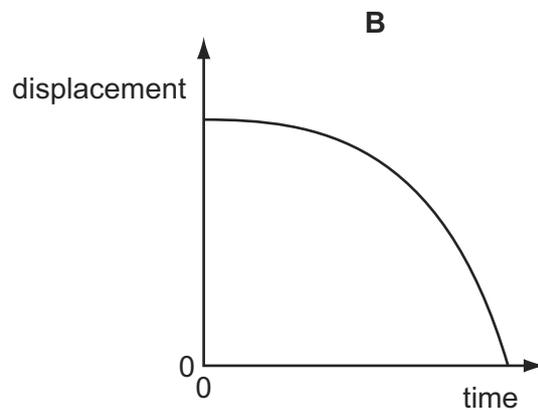
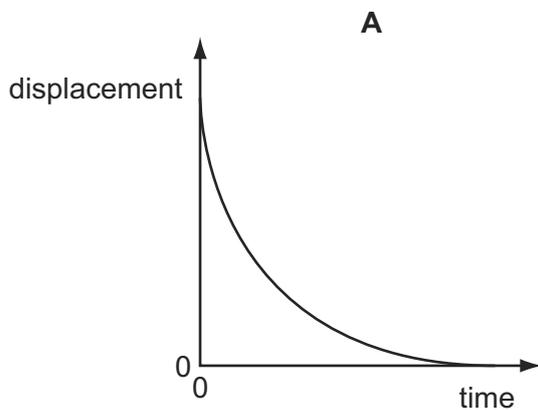
12 An astronaut throws a stone with a horizontal velocity near to the Moon's surface. 9702/12/M/J/15

Which row describes the horizontal and vertical forces acting on the stone after release?

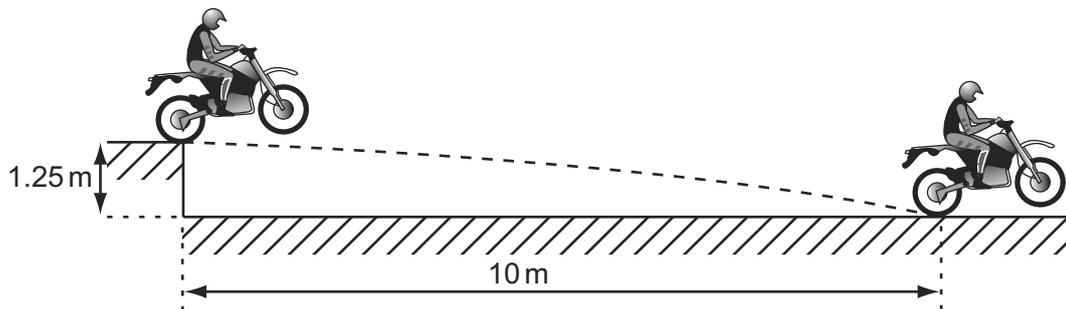
	horizontal force	vertical force
A	constant	constant
B	constant	decreasing
C	zero	constant
D	zero	decreasing

7 A sphere is released and falls. Its initial acceleration reduces until it eventually begins to travel at constant terminal velocity. Which displacement-time graph best represents the motion of the sphere?

9702/11/M/J/15

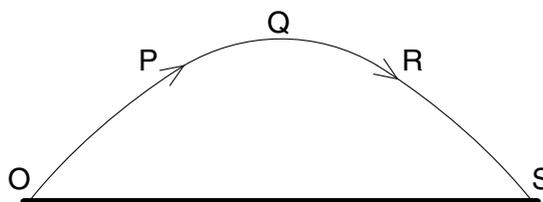


- 9 A motorcycle stunt-rider moving horizontally takes off from a point 1.25 m above the ground, landing 10 m away as shown. 9702/01/M/J/04



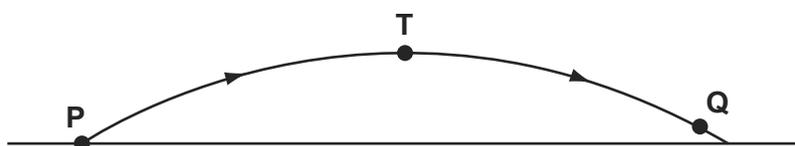
What was the speed at take-off?

- A 5 ms^{-1} B 10 ms^{-1} C 15 ms^{-1} D 20 ms^{-1}
- 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.
- 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



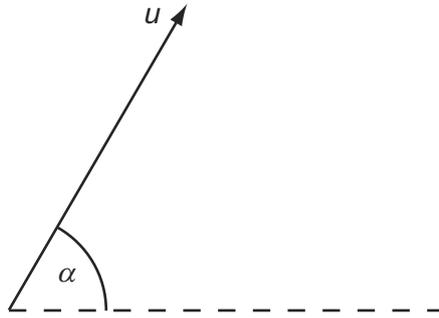
The vertical component of acceleration of the stone is

- A zero at T.
 B greatest at T.
 C greatest at Q.
 D the same at Q as at T.

Projectiles

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

9702/01/O/N/06

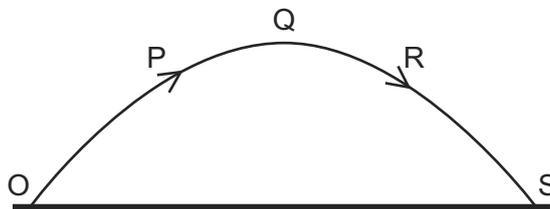


What are the vertical and horizontal components of its velocity after a time t ? Assume that air resistance is negligible. The acceleration of free fall is g .

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

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

9702/01/M/J/05

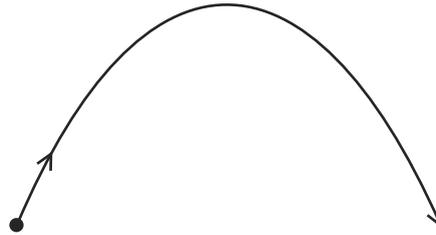


Which statement is true for the projectile when it is at the highest point Q of its path?

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

9702/01/O/N/08



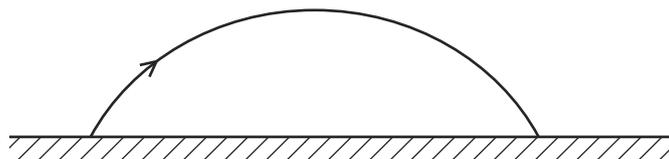
Air resistance is negligible.

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 The diagram shows the path of a golf ball.

9702/01/M/J/09

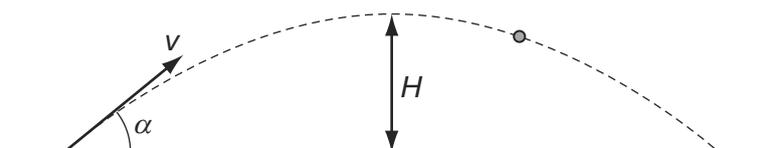


Which row describes changes in the horizontal and vertical components of the golf ball's velocity, when air resistance forces are ignored?

	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

3 A cannon fires a cannonball with an initial speed v at an angle α to the horizontal.

9702/11/M/J/13



Which equation is correct for the maximum height H reached?

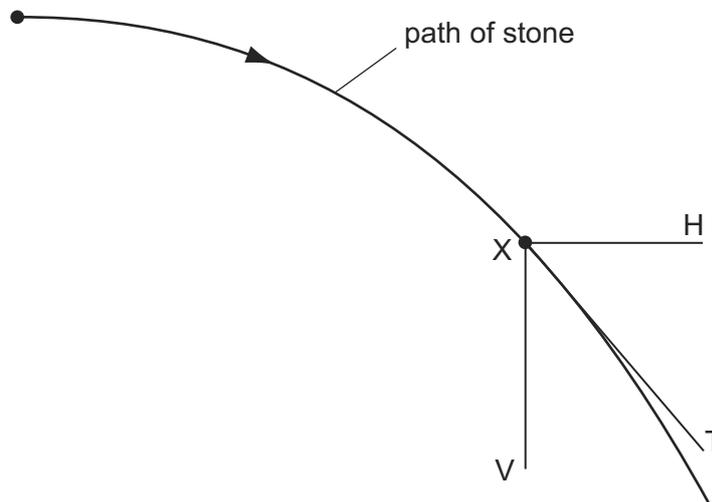
- A $H = \frac{v \sin \alpha}{2g}$
- B $H = \frac{g \sin \alpha}{2v}$
- C $H = \frac{(v \sin \alpha)^2}{2g}$
- D $H = \frac{g^2 \sin \alpha}{2v}$

- 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

- 14 A stone is projected horizontally in a vacuum and moves along the path 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.

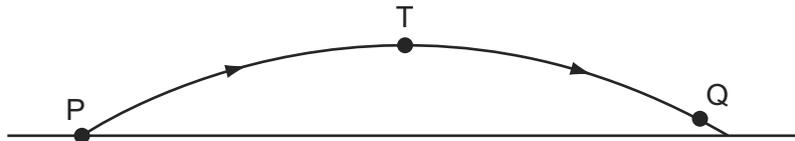
Along which directions do forces act on the stone at X?

- A** XV only **B** XH only **C** XV and XH **D** XT only
- 16 A projectile is launched at 45° to the horizontal with initial kinetic energy E . 9702/11/O/N/14

Assuming air resistance to be negligible, what will be the kinetic energy of the projectile when it reaches its highest point?

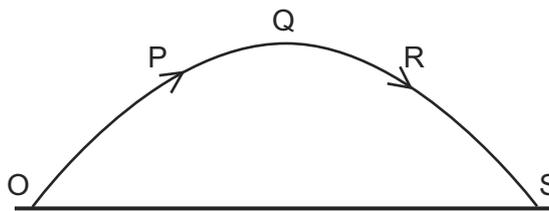
- A** $0.50E$ **B** $0.71E$ **C** $0.87E$ **D** E

- 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



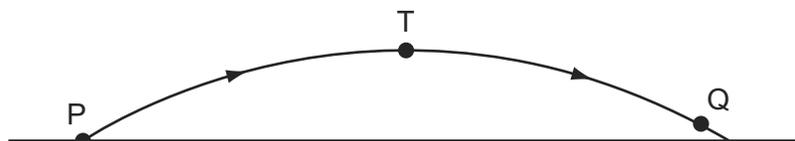
The vertical component of acceleration of the stone is

- 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.
- 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.
- 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. 9702/13/M/J/12

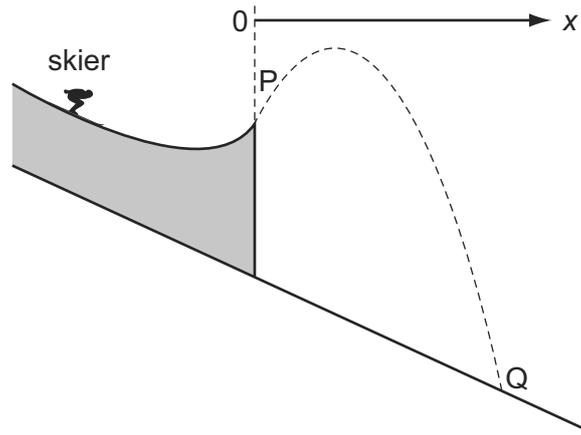


The vertical component of acceleration of the stone is

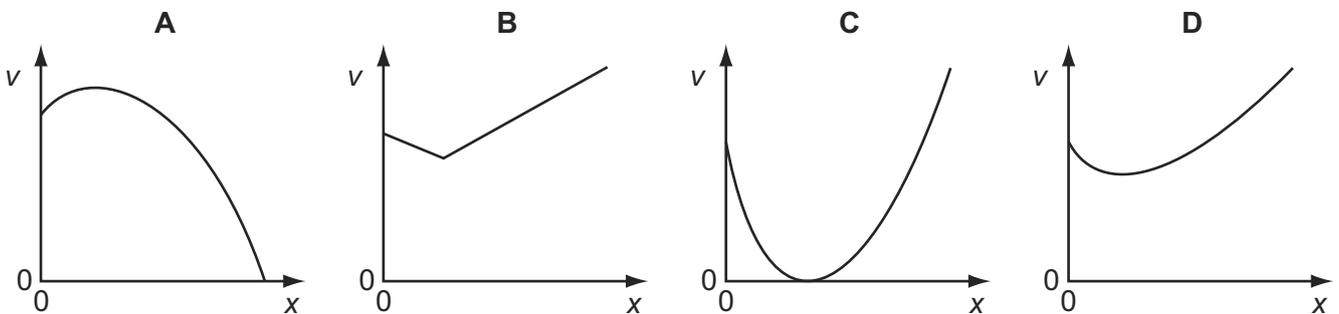
- A zero at T.
 B larger at T than at Q.
 C larger at Q than at T.
 D the same at Q as at T.

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

9702/12/O/N/12



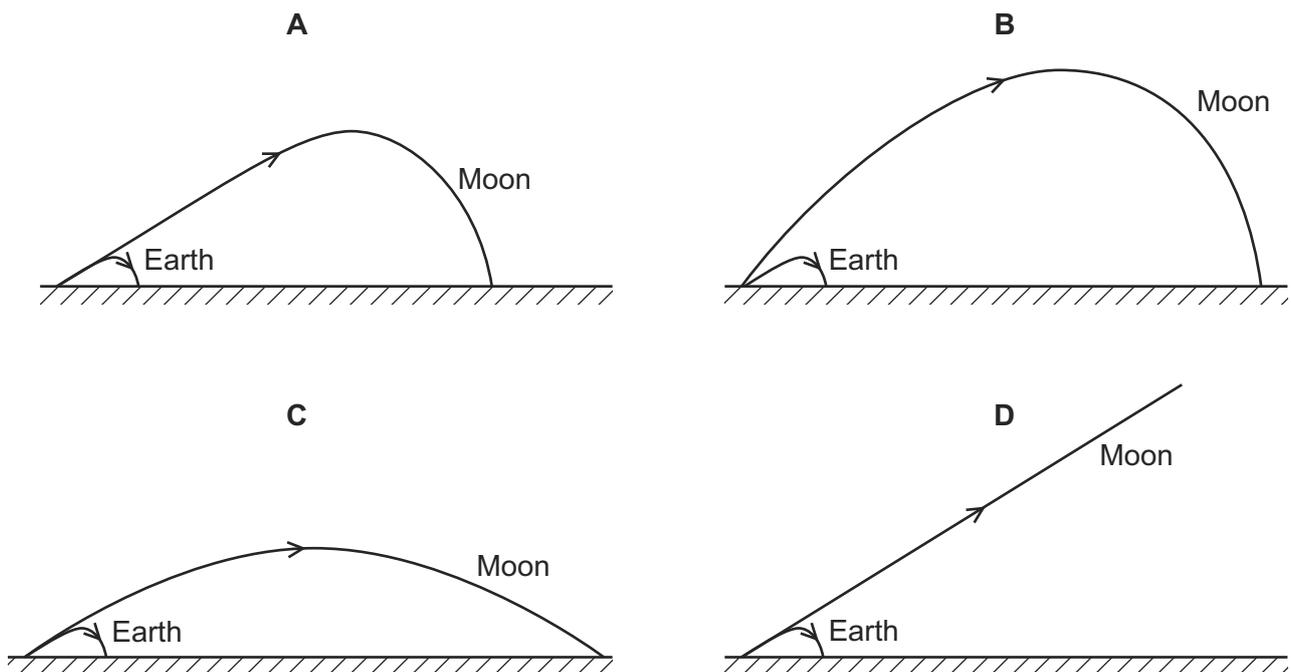
Ignoring air resistance, which graph best represents the variation of his speed v with the horizontal distance x covered from the start of his jump at P before landing at Q?



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?



Projectiles

6 A tennis ball is thrown horizontally in air from the top of a tall building.

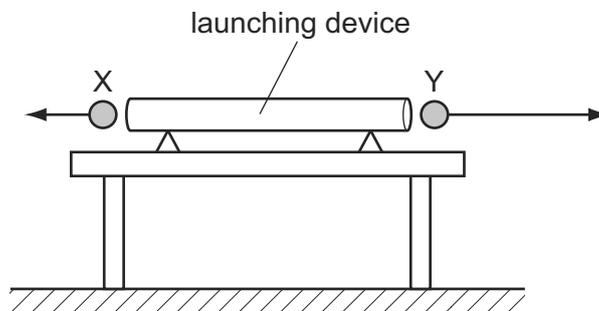
9702/11/M/J/14

If the effect of air resistance is **not** negligible, what happens to the horizontal and vertical components of the ball's velocity?

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

7 A double-ended launching device fires two identical steel balls X and Y at exactly the same time. The diagram shows the initial velocities of the balls. They are both launched horizontally, but Y has greater speed.

9702/13/M/J/13



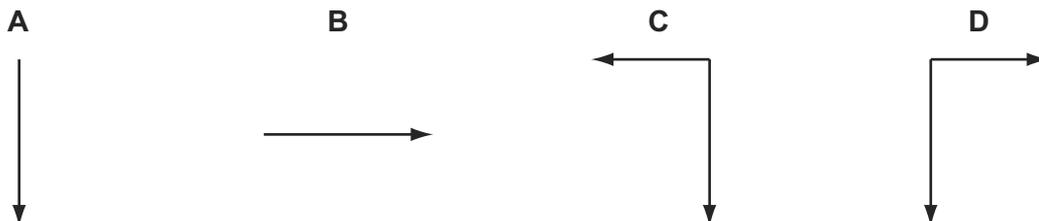
Which statement explains what an observer would see?

- A** Both X and Y reach the ground simultaneously, because air resistance will cause both to have the same final speed.
- B** Both X and Y reach the ground simultaneously, because gravitational acceleration is the same for both.
- C** X reaches the ground before Y, because X lands nearer to the launcher.
- D** Y reaches the ground before X, because Y has greater initial speed.

12 An object in air is thrown upwards and towards the left.

9702/11/O/N/13

Which diagram shows the force(s) acting on the body when it is at its highest point?



- 12 An astronaut throws a stone with a horizontal velocity near to the Moon's surface. 9702/12/M/J/15

Which row describes the horizontal and vertical forces acting on the stone after release?

	horizontal force	vertical force
A	constant	constant
B	constant	decreasing
C	zero	constant
D	zero	decreasing

- 8 A stone is thrown horizontally from the top of a cliff. Air resistance is negligible. 9702/12/M/J/15

Which graph shows the variation with time of the vertical component of the stone's velocity?

