

1. Question | 9702 Feb-March 2016 P1 V2 Q6

- 6 An object has an initial velocity u and an acceleration a . The object moves in a straight line through a displacement s and has final velocity v .

The above quantities are related by the equation shown.

$$v^2 = u^2 + 2as$$

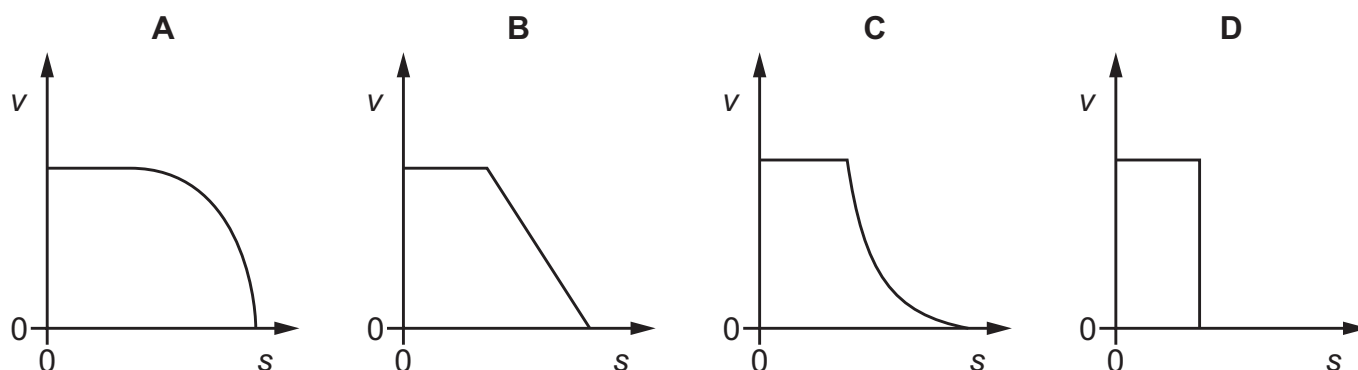
Which condition **must** be satisfied in order for this equation to apply to the motion of the object?

- A The direction of a is constant and the direction of a is the same as the direction of s .
- B The direction of a is constant and the direction of a is the same as the direction of u .
- C The magnitude of a is constant and the direction of a is constant.
- D The magnitude of a is constant and the direction of a is the same as the direction of v .

2. Question | 9702 Feb-March 2016 P1 V2 Q7

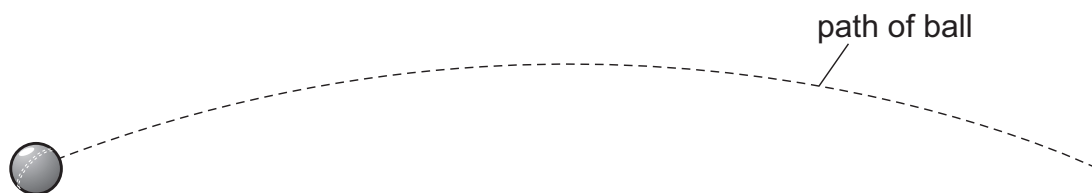
- 7 A car is travelling at constant velocity. Its brakes are then applied, causing uniform deceleration.

Which graph shows the variation with distance s of the velocity v of the car?



3. Question | 9702 Feb-March 2016 P1 V2 Q8

- 8** A ball is thrown across a flat field.

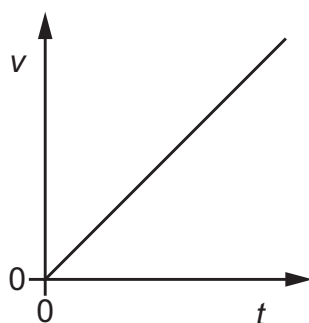


Which statement describes the motion of the ball, when the effects of air resistance are ignored?

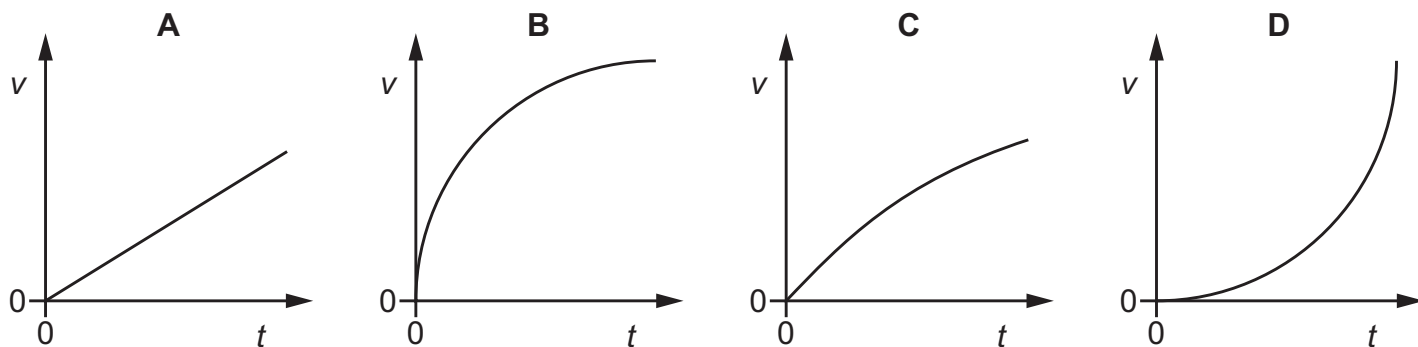
- A** The ball lands with the same velocity at which it is thrown.
- B** The horizontal component of acceleration is constant throughout the motion.
- C** The horizontal and vertical components of acceleration are both zero at the highest point of the motion.
- D** The horizontal and vertical components of velocity are both zero at the highest point of the motion.

4. Question | 9702 Feb-March 2016 P1 V2 Q11

- 11** An object falls freely from rest in a vacuum. The graph shows the variation with time t of the velocity v of the object.

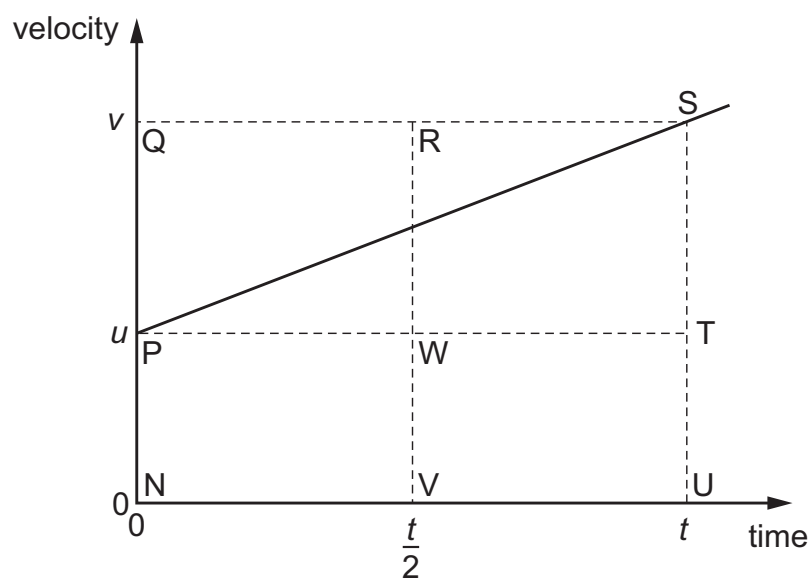


Which graph, using the same scales, represents the object falling in air?



5. Question | 9702 May-June 2016 P1 V1 Q6

- 6** A car accelerates uniformly from velocity u to velocity v in time t .

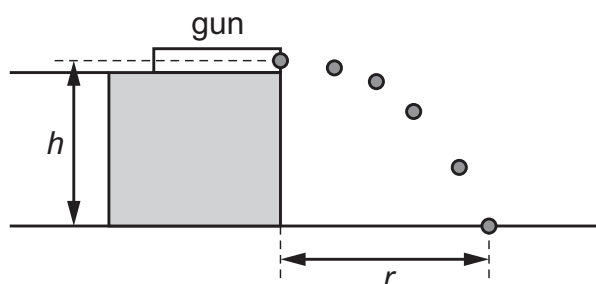


On the graph, which area equals the distance travelled by the car in time t ?

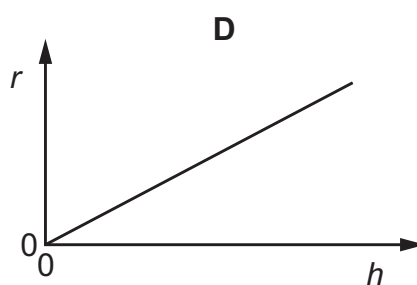
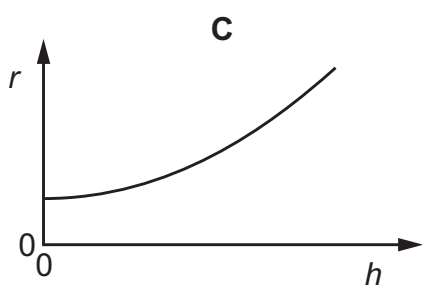
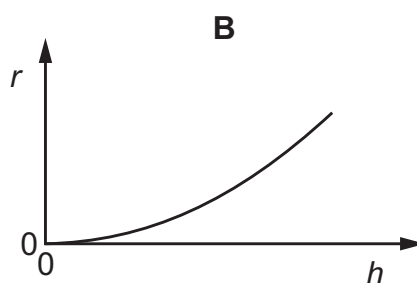
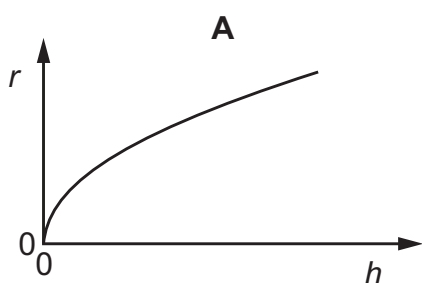
- A** NPTU + PQST
- B** NPWV + VRSU
- C** NPWV + WRST
- D** PST + PQS

6. Question | 9702 May-June 2016 P1 V1 Q7

- 7 A student uses a spring gun to launch a steel ball with a constant horizontal velocity. He varies the height h of the gun and measures the horizontal displacement r of the ball when it hits the ground.



Which graph shows the variation with height h of the horizontal displacement r ?

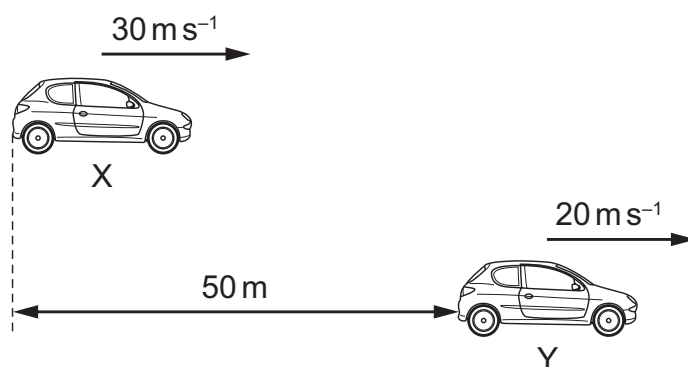


7. Question | 9702 May-June 2016 P1 V1 Q8

8 Two cars X and Y are positioned as shown at time $t = 0$.

They are travelling in the same direction.

X is 50 m behind Y and has a constant velocity of 30 m s^{-1} . Y has a constant velocity of 20 m s^{-1} .



What is the value of t when X is level with Y?

A 1.0 s

B 1.7 s

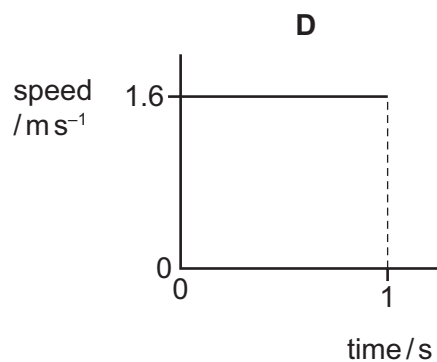
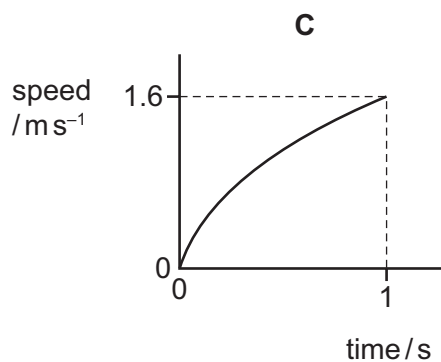
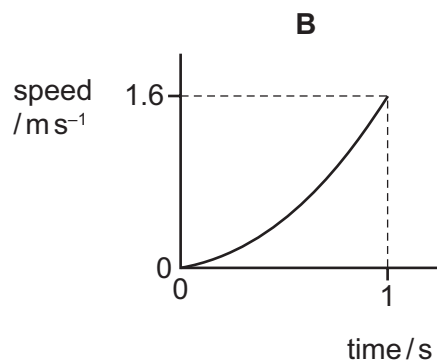
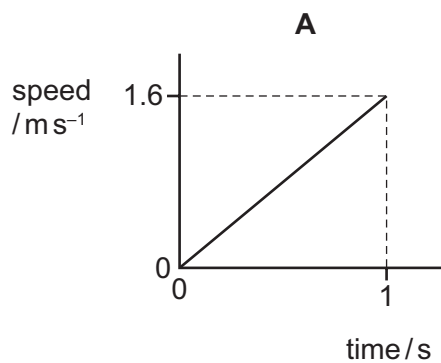
C 2.5 s

D 5.0 s

8. Question | 9702 May-June 2016 P1 V2 Q6

- 6 The acceleration of free fall on the Moon is 1.6 m s^{-2} . The Moon has no atmosphere. An astronaut standing on the surface of the Moon drops a feather.

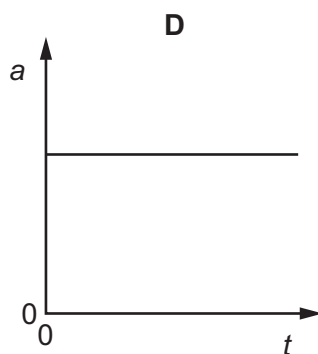
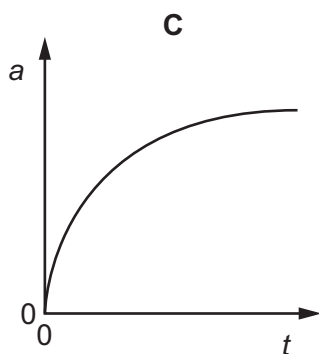
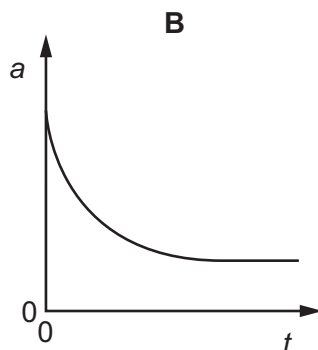
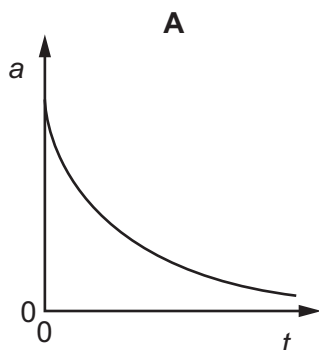
Which graph shows the variation with time of the speed of the feather during the first second of its fall?



9. Question | 9702 May-June 2016 P1 V2 Q7

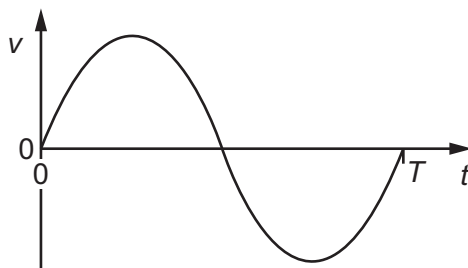
- 7 A tennis ball is released from rest at the top of a tall building.

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

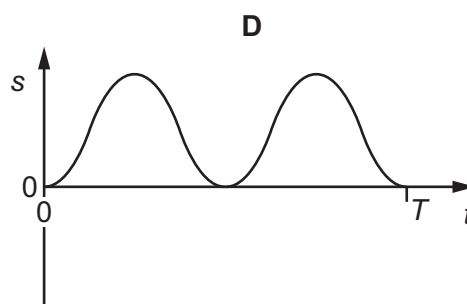
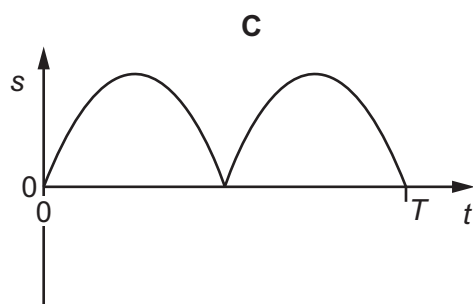
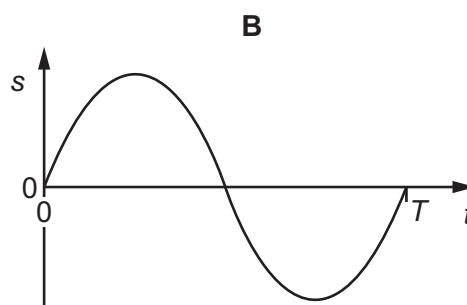
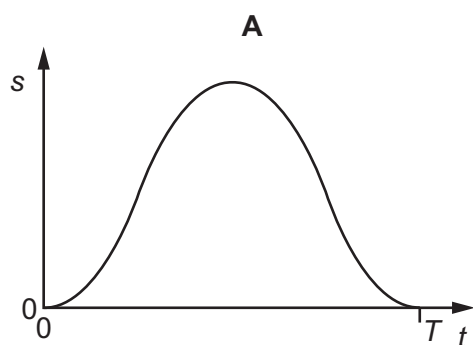


10. Question | 9702 May-June 2016 P1 V2 Q8

- 8 The graph shows how the velocity v of an object moving in a straight line varies with time t from $t = 0$ to $t = T$.



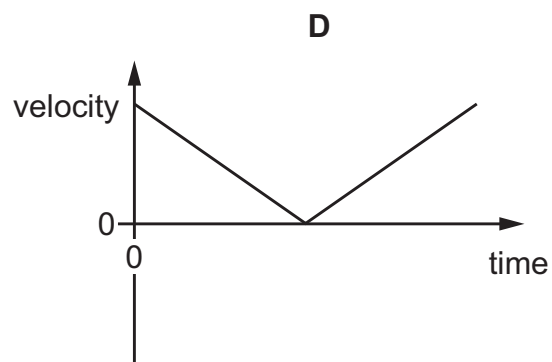
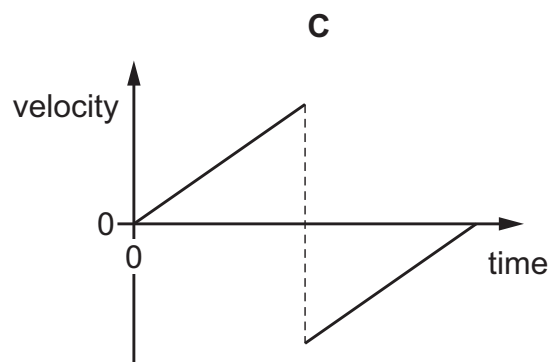
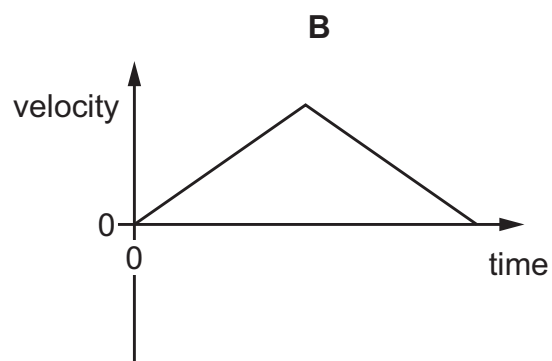
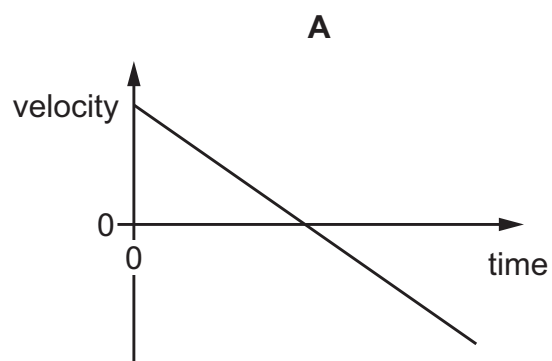
Which graph represents the displacement s of the object in the time $t = 0$ to $t = T$?



11. Question | 9702 May-June 2016 P1 V3 Q6

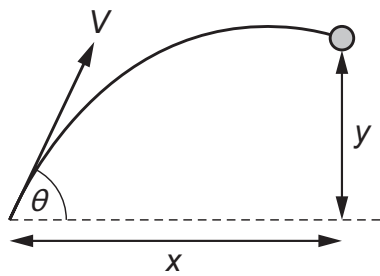
- 6** A ball rolls in a straight line up a ramp and then back down the ramp along its original path.

Which graph shows the variation with time of the ball's velocity?



12. Question | 9702 May-June 2016 P1 V3 Q7

7 A ball is thrown with velocity V at an angle θ to the horizontal.



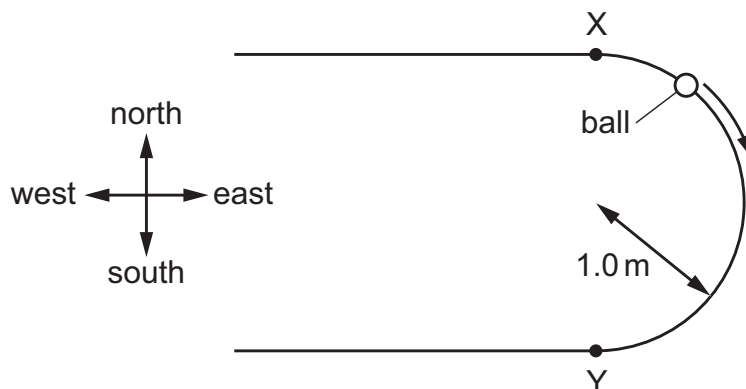
The acceleration of free fall is g . Assume that air resistance is negligible.

What are the horizontal displacement x and the vertical displacement y after time t ?

	x	y
A	$Vt \cos \theta$	$Vt \sin \theta + \frac{1}{2}gt^2$
B	$Vt \cos \theta$	$Vt \sin \theta - \frac{1}{2}gt^2$
C	$Vt \sin \theta$	$Vt \cos \theta + \frac{1}{2}gt^2$
D	$Vt \sin \theta$	$Vt \cos \theta - \frac{1}{2}gt^2$

13. Question | 9702 May-June 2016 P1 V3 Q8

- 8 A ball travels from point X to point Y around a semi-circular track of radius 1.0 m as shown.

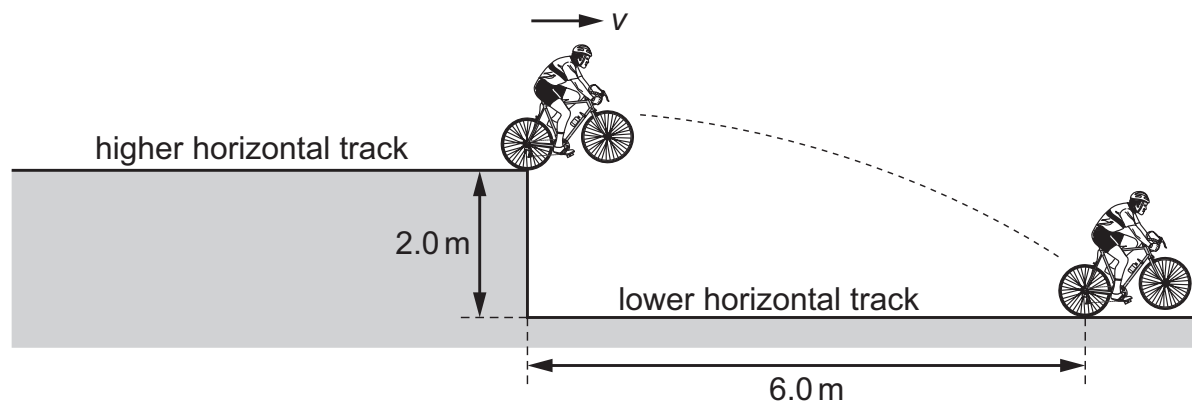


What is the displacement of the ball from X to Y?

- A 2.0 m
- B 2.0 m due south
- C 3.1 m
- D 3.1 m due south

14. Question | 9702 Oct-Nov 2016 P1 V1 Q6

- 6 A cyclist pedals along a raised horizontal track. At the end of the track, he travels horizontally into the air and onto a track that is vertically 2.0 m lower.



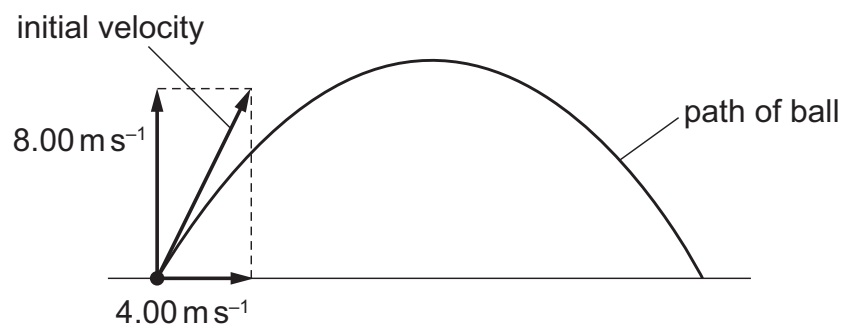
The cyclist travels a horizontal distance of 6.0 m in the air. Air resistance is negligible.

What is the horizontal velocity v of the cyclist at the end of the higher track?

- A 6.3 m s^{-1}
- B 9.4 m s^{-1}
- C 9.9 m s^{-1}
- D 15 m s^{-1}

15. Question | 9702 Oct-Nov 2016 P1 V1 Q7

- 7** An astronaut on the Moon, where there is no air resistance, throws a ball. The ball's initial velocity has a vertical component of 8.00 m s^{-1} and a horizontal component of 4.00 m s^{-1} , as shown.



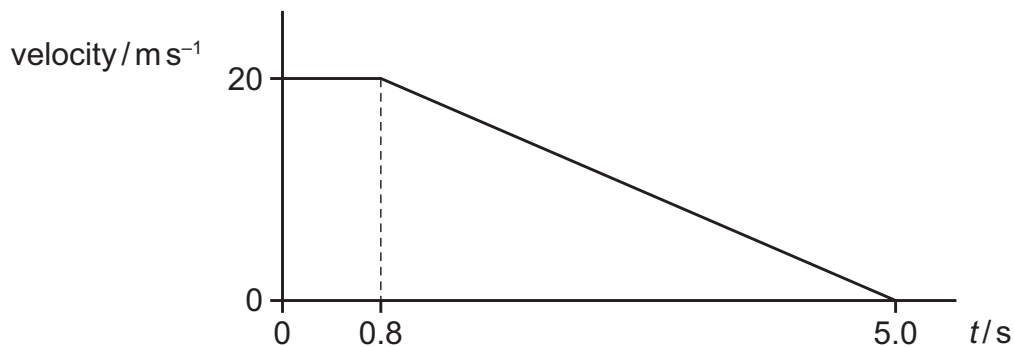
The acceleration of free fall on the Moon is 1.62 m s^{-2} .

What will be the speed of the ball 9.00 s after being thrown?

- A** 6.6 m s^{-1} **B** 7.7 m s^{-1} **C** 10.6 m s^{-1} **D** 14.6 m s^{-1}

16. Question | 9702 Oct-Nov 2016 P1 V1 Q8

- 8** A car is travelling at constant velocity. At time $t = 0$, the driver of the car sees an obstacle in the road and then brakes to a halt. The graph shows the variation with t of the velocity of the car.

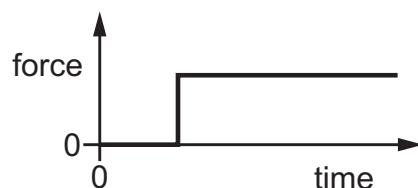


How far does the car travel in the 5.0 s after the driver sees the obstacle?

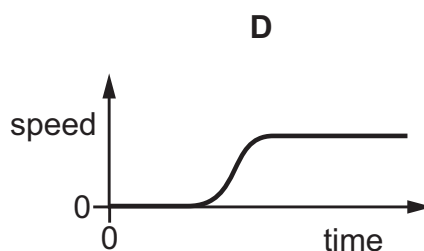
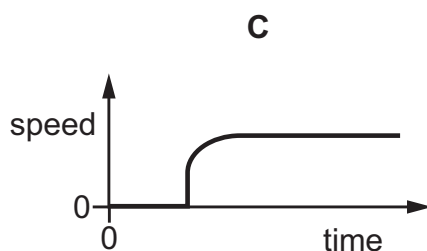
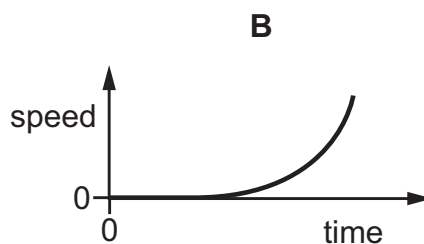
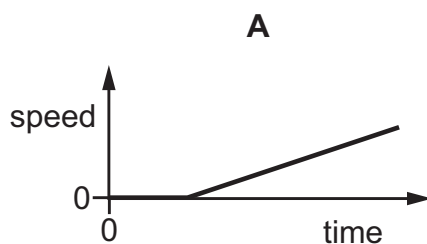
- A** 16 m **B** 42 m **C** 58 m **D** 84 m

17. Question | 9702 Oct-Nov 2016 P1 V1 Q9

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

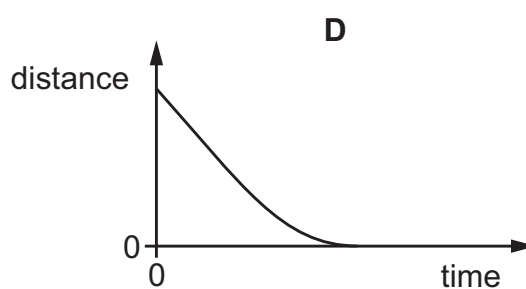
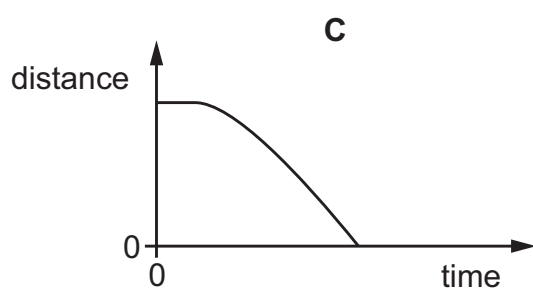
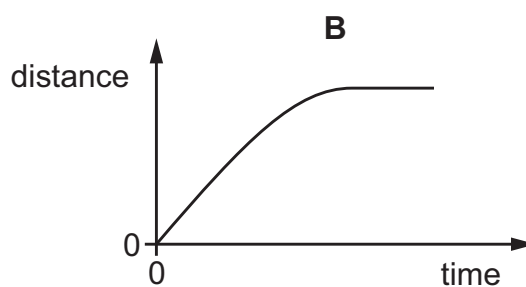
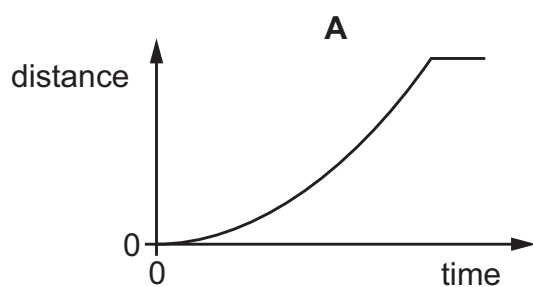


Which graph shows the variation with time of the speed of the car?



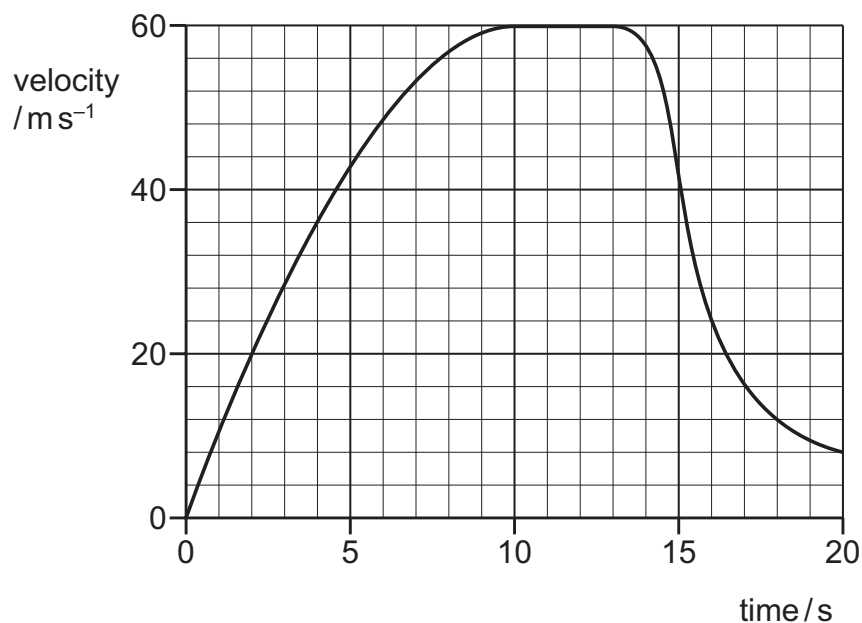
- 7 A lorry travels at a constant speed and then decelerates until it stops.

Which graph shows the variation with time of the distance travelled by the lorry?



19. Question | 9702 Oct-Nov 2016 P1 V2 Q8

- 8 The graph shows the vertical velocity of a parachutist during the first 20 s of her jump.



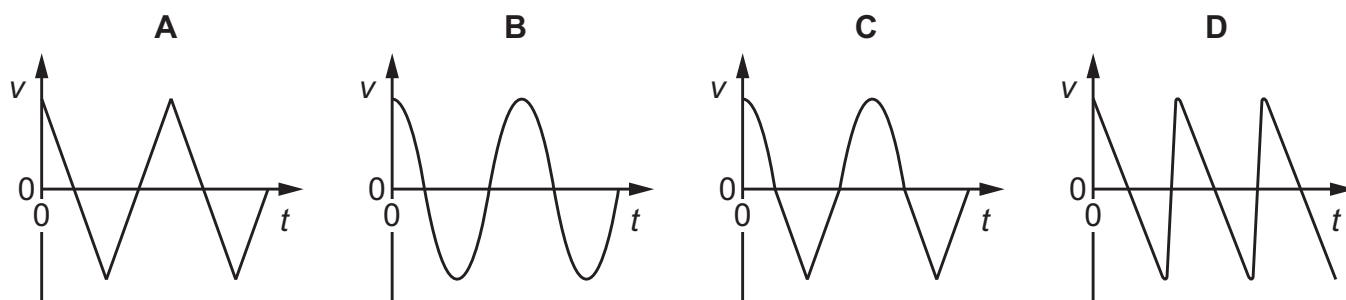
Approximately how far does she fall **before** opening the parachute?

- A** 390 m **B** 570 m **C** 710 m **D** 770 m

20. Question | 9702 Oct-Nov 2016 P1 V2 Q9

- 9 A girl is jumping on a trampoline.

Which graph shows the variation of the girl's velocity v with time t ?



21. Question | 9702 Oct-Nov 2016 P1 V2 Q10

10 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.

The distance between the red and yellow lights is x .

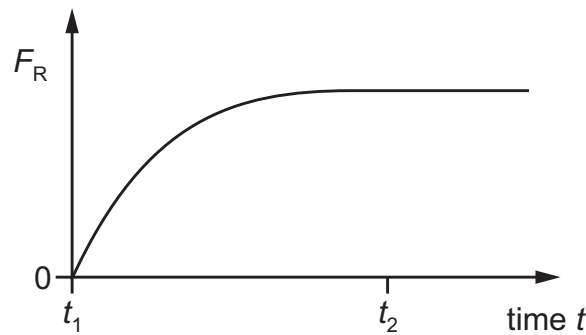
If the speed of the train is increased by 20%, without changing the deceleration of the train, what must be the minimum distance between the lights?

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

22. Question | 9702 Oct-Nov 2016 P1 V2 Q13

13 A light ball is falling vertically through air.

The variation with time t of the resistive force F_R acting on the ball is shown.



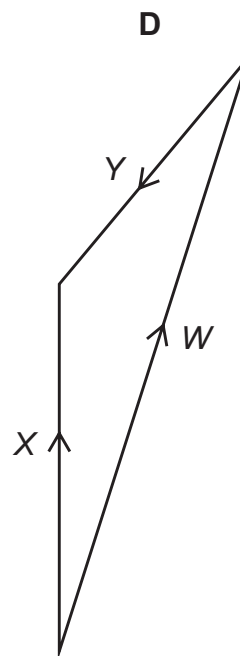
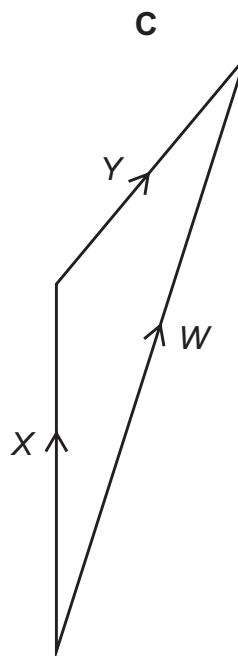
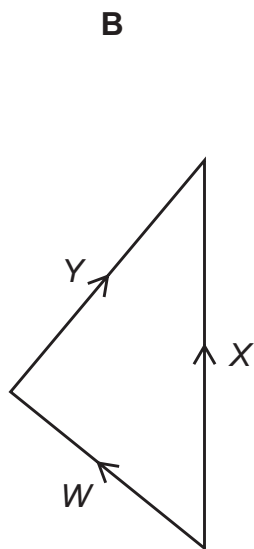
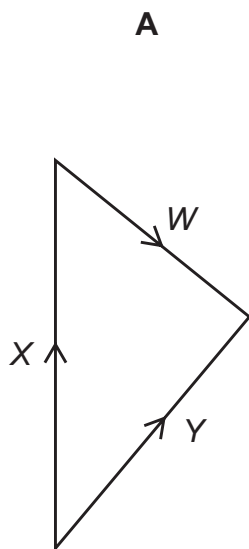
At which times are the speed of the ball zero, the speed at a maximum and the acceleration zero?

	zero speed	maximum speed	zero acceleration
A	t_1	t_2	t_1
B	t_1	t_2	t_2
C	t_2	t_1	t_1
D	t_2	t_1	t_2

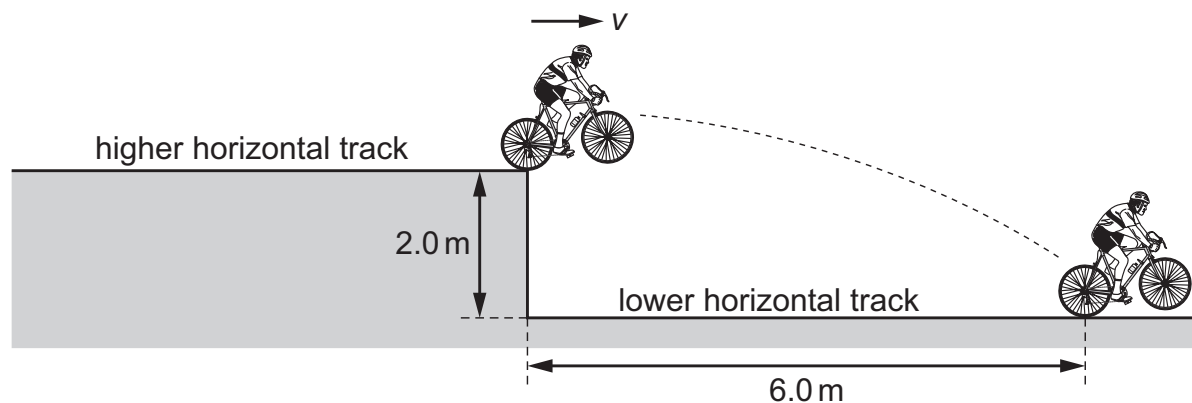
23. Question | 9702 Oct-Nov 2016 P1 V3 Q3

- 3** An aeroplane can fly at a velocity X when moving through still air. When flying in wind the aeroplane's velocity relative to the ground is Y .

Which vector diagram shows the magnitude and direction of the wind velocity W ?



- 6** A cyclist pedals along a raised horizontal track. At the end of the track, he travels horizontally into the air and onto a track that is vertically 2.0 m lower.



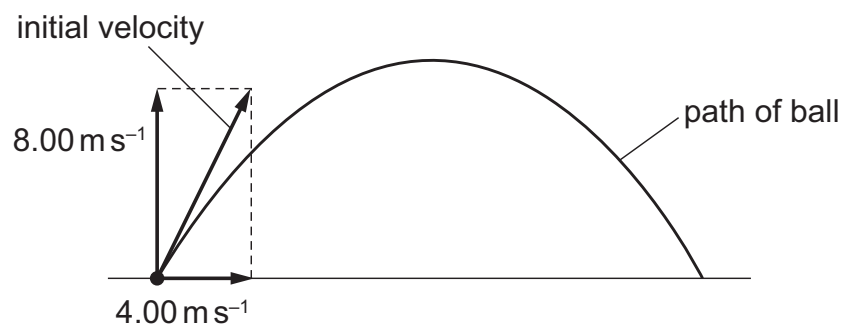
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What is the horizontal velocity v of the cyclist at the end of the higher track?

- A** 6.3 m s^{-1} **B** 9.4 m s^{-1} **C** 9.9 m s^{-1} **D** 15 m s^{-1}

25. Question | 9702 Oct-Nov 2016 P1 V3 Q7

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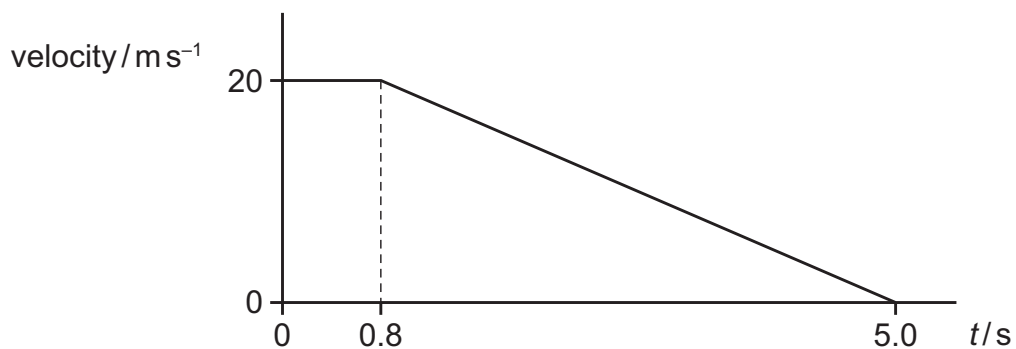
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26. Question | 9702 Oct-Nov 2016 P1 V3 Q8

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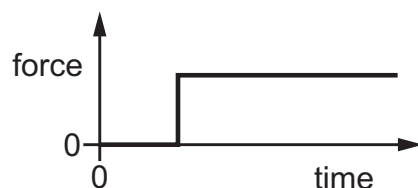


How far does the car travel in the 5.0 s after the driver sees the obstacle?

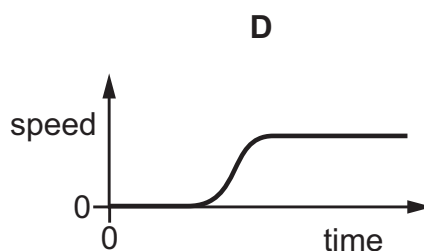
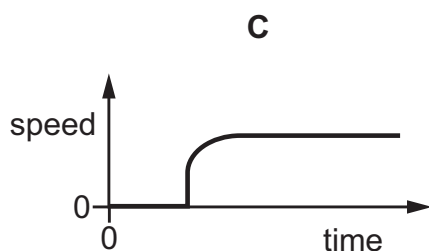
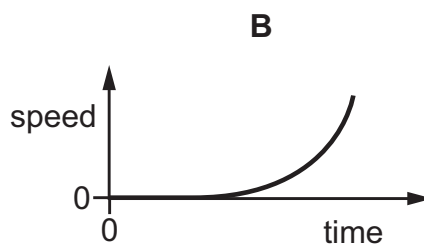
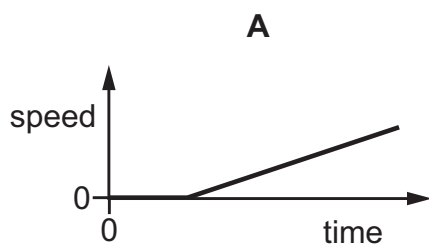
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27. Question | 9702 Oct-Nov 2016 P1 V3 Q9

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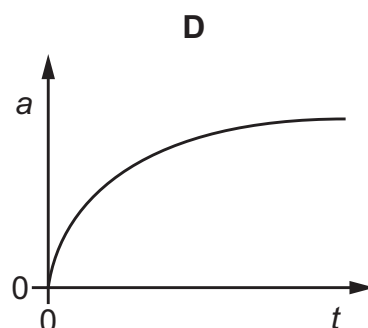
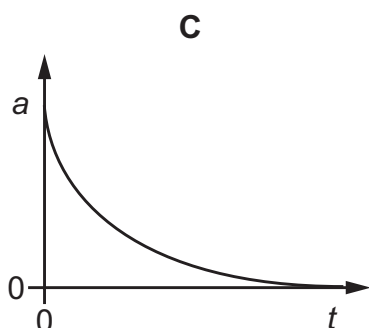
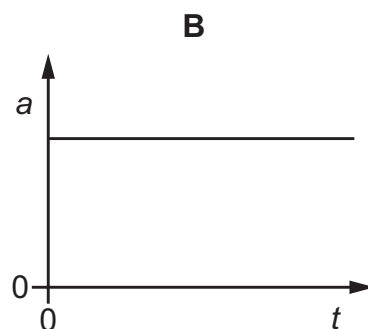
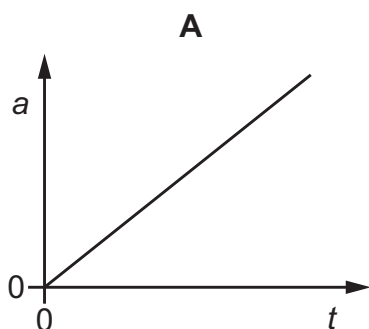
Which graph shows the variation with time of the speed of the car?



28. Question | 9702 Oct-Nov 2016 P1 V3 Q10

- 10** A beach-ball falls vertically from a high hotel window. Air resistance is **not** negligible.

Which graph shows the variation with time t of the acceleration a of the ball?



29. Question | 9702 Feb-March 2017 P1 V2 Q6

- 6** An aircraft, initially stationary on a runway, takes off with a speed of 85 km h^{-1} in a distance of no more than 1.20 km .

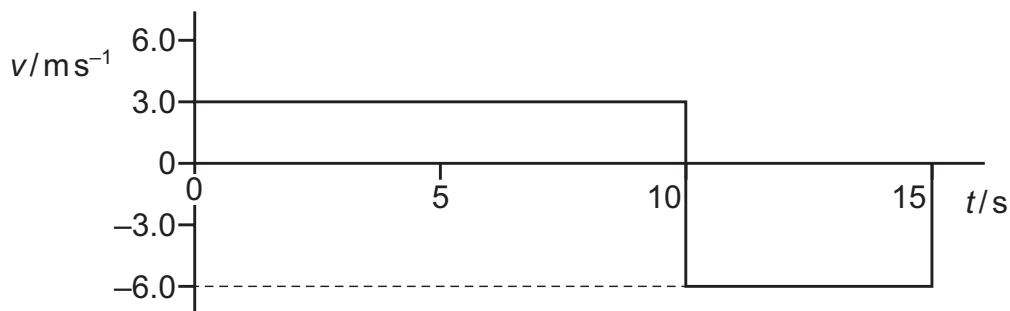
What is the minimum constant acceleration necessary for the aircraft?

- A** 0.23 ms^{-2} **B** 0.46 ms^{-2} **C** 3.0 ms^{-2} **D** 6.0 ms^{-2}

30. Question | 9702 Feb-March 2017 P1 V2 Q7

- 7 A radio-controlled toy car travels along a straight line for a time of 15 s.

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

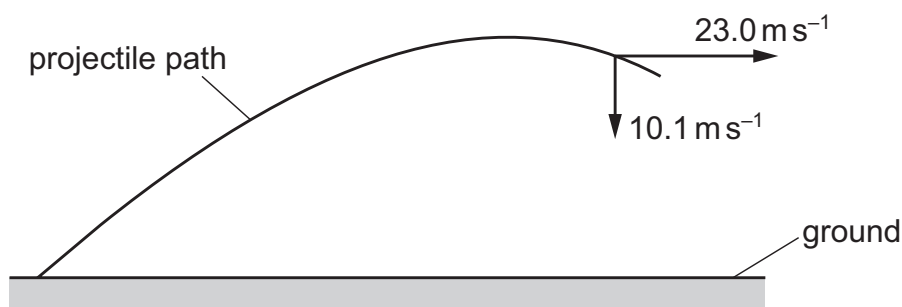


What is the average velocity of the toy car for the journey shown by the graph?

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

31. Question | 9702 Feb-March 2017 P1 V2 Q18

- 18 A projectile is thrown at an angle to the ground.



At a certain time, the projectile has a horizontal velocity of 23.0 m s^{-1} and a vertical velocity of -10.1 m s^{-1} .

What is the speed of the projectile at this time?

- A** 12.9 m s^{-1} **B** 20.7 m s^{-1} **C** 25.1 m s^{-1} **D** 33.1 m s^{-1}

32. Question | 9702 May-June 2017 P1 V1 Q2

- 2 A particle travels in a straight line with speed v .

The particle slows down and changes direction. The new speed of the particle is $\frac{v}{2}$.

The new velocity has a component of $\frac{v}{4}$ in the same direction as the initial path of the particle.

Through which angle has the particle turned?

- A** 27° **B** 30° **C** 45° **D** 60°

33. Question | 9702 May-June 2017 P1 V1 Q4

- 4 The values of displacement, velocity and acceleration of a vehicle can be deduced from graphs representing its motion. Often the areas under these graphs, or the gradients of the graphs, are used.

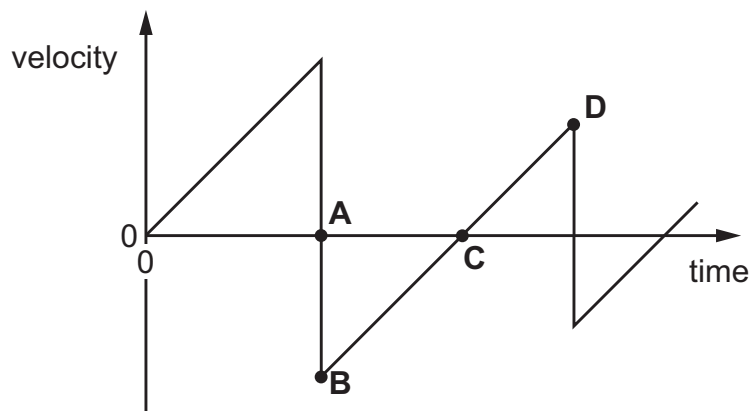
What would **not** give a value for a displacement, a velocity or an acceleration?

- A area under a velocity-time graph
- B gradient of a displacement-time graph
- C gradient of a velocity-time graph
- D gradient of an acceleration-time graph

34. Question | 9702 May-June 2017 P1 V1 Q5

- 5 A ball is released from rest above a hard, horizontal surface. The graph shows how the velocity of the bouncing ball varies with time.

At which point on the graph does the ball reach its maximum height after the first bounce?



35. Question | 9702 May-June 2017 P1 V1 Q6

- 6 A ball is kicked upwards at an angle of 45° to horizontal ground. After a short flight, the ball returns to the ground.

It may be assumed that air resistance is negligible.

What is **never** zero during the flight of the ball?

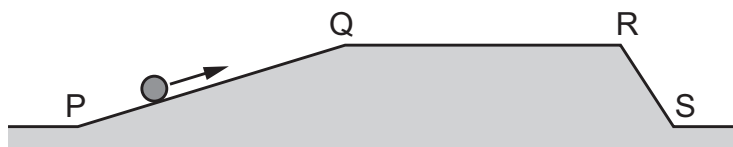
- A the horizontal component of the ball's acceleration
- B the horizontal component of the ball's velocity
- C the vertical component of the ball's momentum
- D the vertical component of the ball's velocity

36. Question | 9702 May-June 2017 P1 V2 Q1

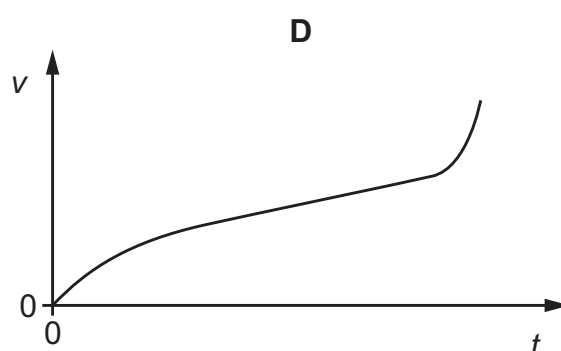
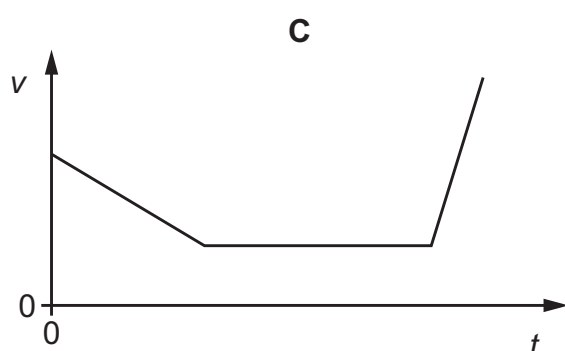
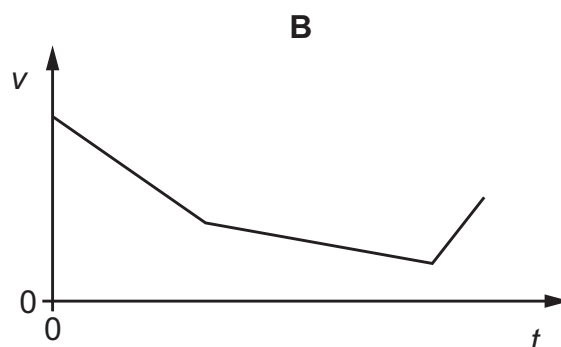
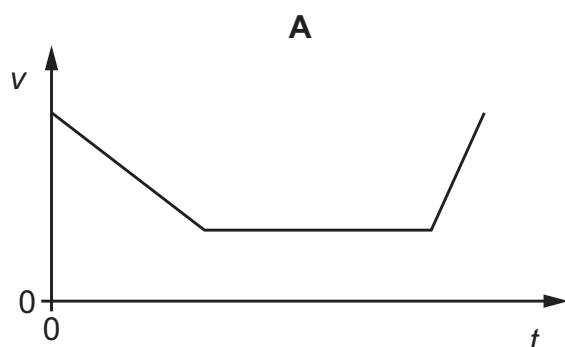
- 1 What is the approximate average speed of a winning female Olympic athlete running a 100m race?
- A** 6 ms^{-1} **B** 9 ms^{-1} **C** 12 ms^{-1} **D** 15 ms^{-1}

37. Question | 9702 May-June 2017 P1 V2 Q6

- 6 A ball is set in motion at P on a frictionless surface. It moves up slope PQ, along the horizontal surface QR and finally descends slope RS.



Which graph could represent the variation with time t of the ball's speed v as the ball moves from P to S?



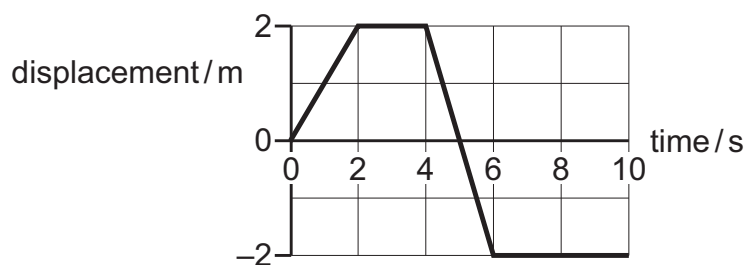
38. Question | 9702 May-June 2017 P1 V3 Q5

- 5 On a planet, a vertically-launched projectile takes 12.5s to return to its starting position. The projectile gains a maximum height of 170m. The planet does not have an atmosphere.

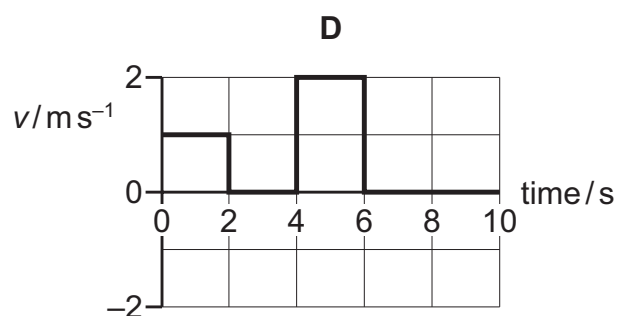
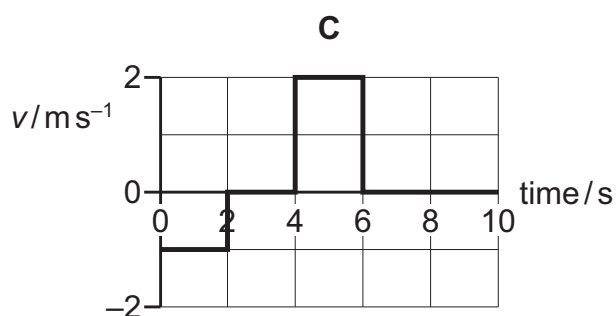
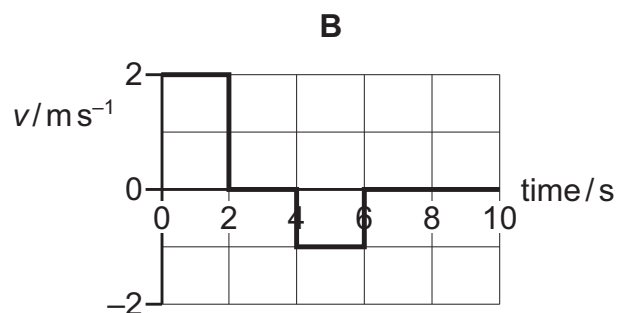
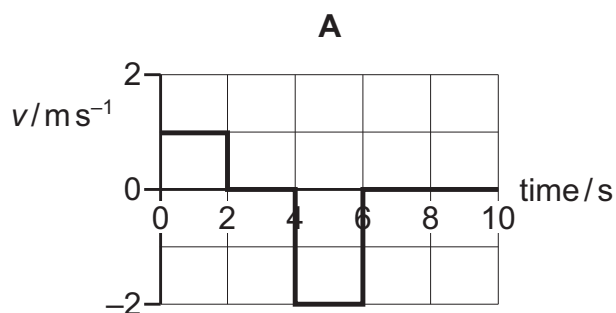
What is the acceleration of free fall on this planet?

- A** 2.2 ms^{-2} **B** 8.7 ms^{-2} **C** 27 ms^{-2} **D** 54 ms^{-2}

6 A displacement-time graph for a toy car is shown.

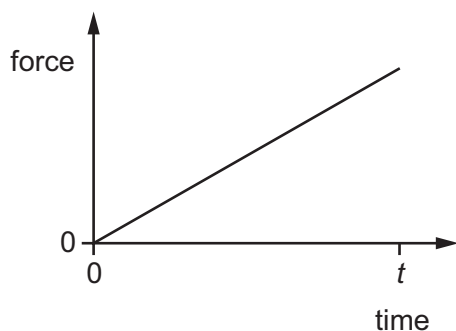


Which graph shows the variation with time of the velocity v of the car?

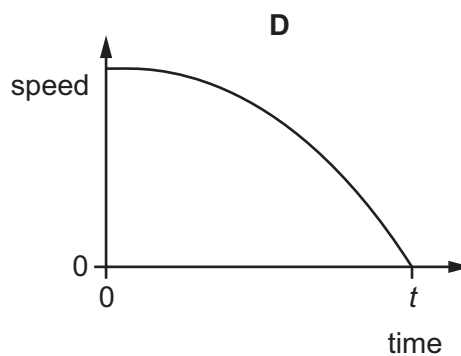
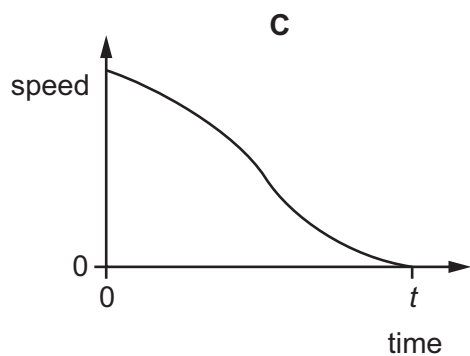
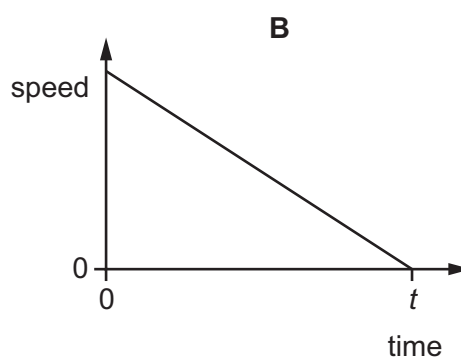
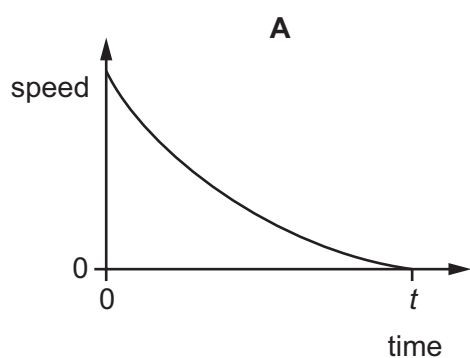


40. Question | 9702 May-June 2017 P1 V3 Q7

- 7 A driver stops his car in time t by gradually increasing the total braking force on the car. The graph shows the resultant force on the car.



Which graph shows how the speed of the car will vary during this time?



41. Question | 9702 Oct-Nov 2017 P1 V1 Q6

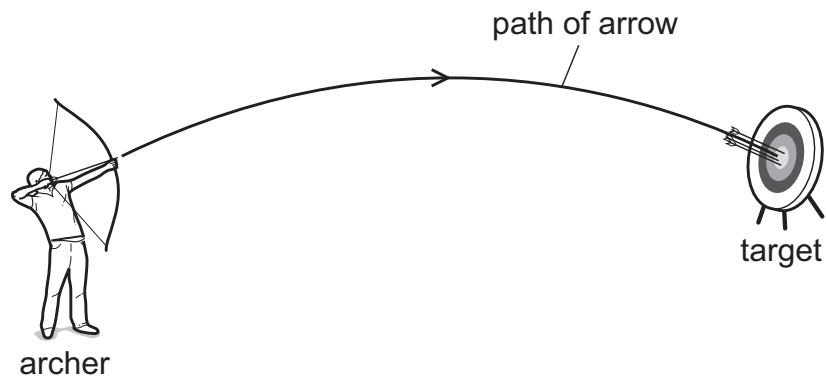
- 6** In still air, a bird can fly at a speed of 10 m s^{-1} . The wind is blowing from the east at 8.0 m s^{-1} .

In which direction must the bird fly in order to travel to a destination that is due north of the bird's current location?

- A** 37° east of north
- B** 37° west of north
- C** 53° east of north
- D** 53° west of north

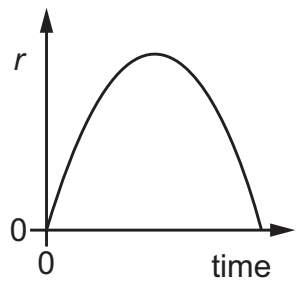
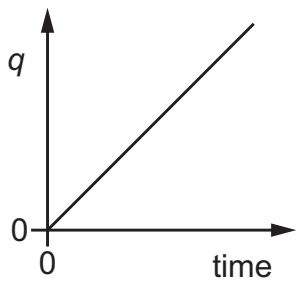
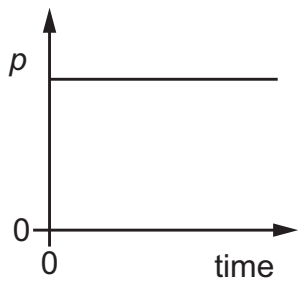
42. Question | 9702 Oct-Nov 2017 P1 V1 Q7

7 An archer shoots an arrow at a target. The diagram shows the path of the arrow.



Air resistance is assumed to be negligible.

The graphs show how three different quantities p , q and r , relating to the motion of the arrow, vary with time.



Which quantity is the horizontal component of displacement and which quantity is the vertical component of displacement of the arrow?

	horizontal component of displacement	vertical component of displacement
A	p	q
B	q	r
C	r	p
D	r	q

43. Question | 9702 Oct-Nov 2017 P1 V1 Q18

18 A stone is projected vertically upwards from the ground at an initial speed of 15 ms^{-1} . Air resistance is negligible.

What is the maximum height reached by the stone?

- A** 0.76 m **B** 11 m **C** 23 m **D** 110 m

44. Question | 9702 Oct-Nov 2017 P1 V2 Q6

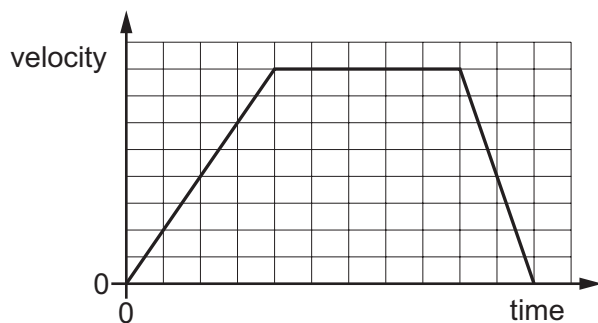
- 6** A hot-air balloon is moving vertically upwards with a constant speed of 3.00 m s^{-1} . A sandbag is dropped from the balloon. It takes 5.00 s for the sandbag to fall to the ground.

What was the height of the balloon when the sandbag was released?

- A** 29 m **B** 108 m **C** 123 m **D** 138 m

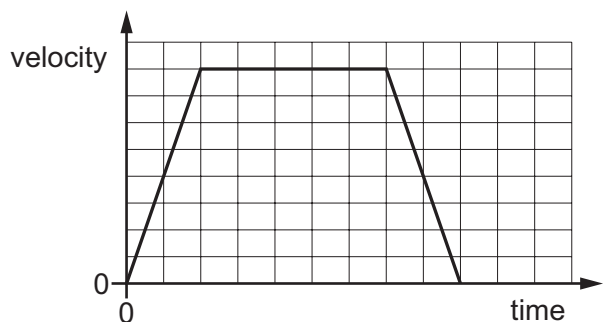
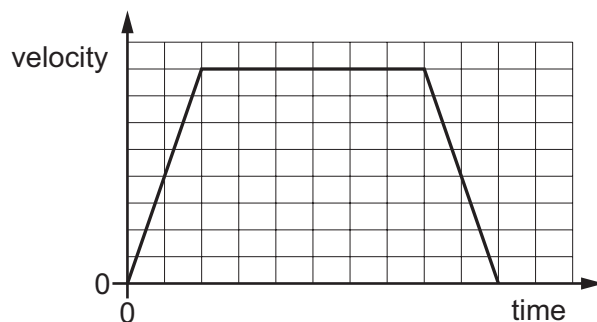
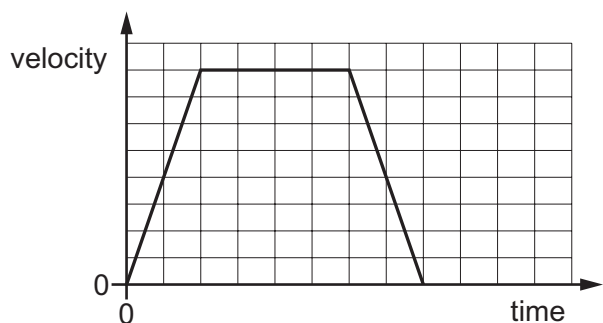
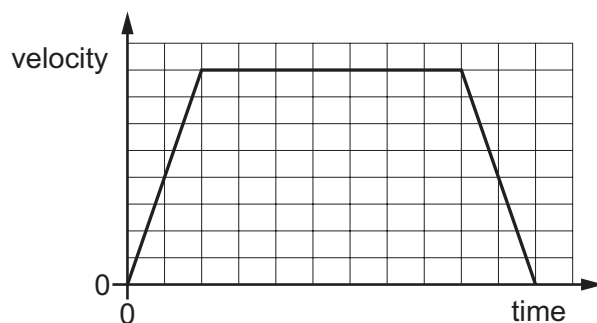
45. Question | 9702 Oct-Nov 2017 P1 V2 Q7

- 7 The velocity-time graph for a train starting at one station and stopping at the next is shown.



Another train has double the acceleration but the same maximum speed and the same deceleration.

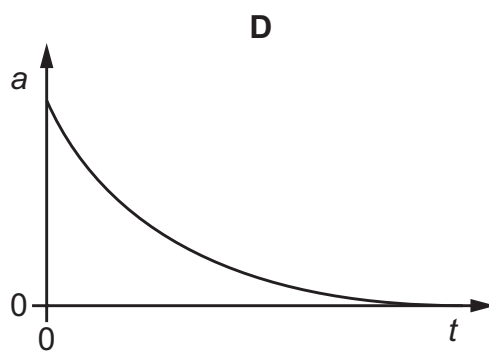
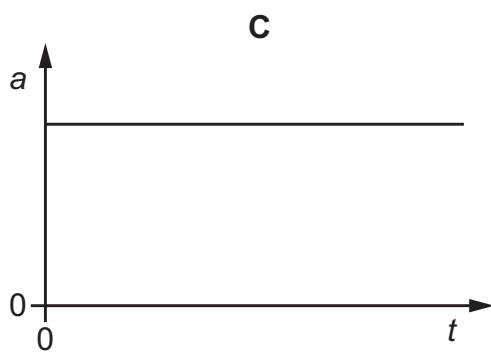
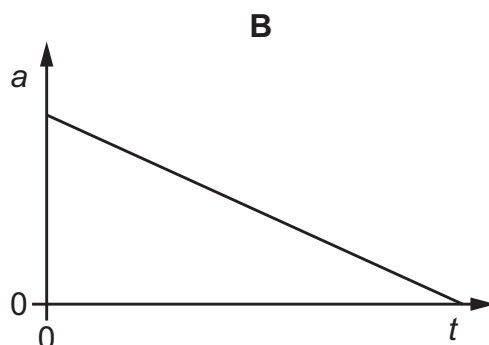
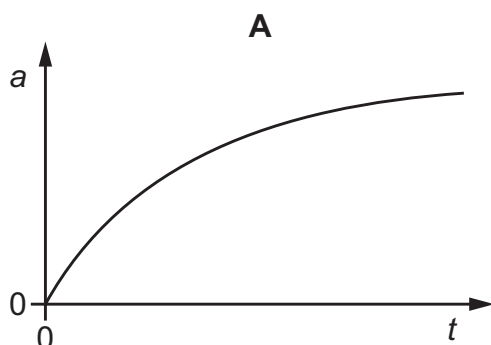
Which velocity-time graph, on the same scale, shows the motion of this train between the same stations?

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

46. Question | 9702 Oct-Nov 2017 P1 V2 Q8

- 8** A stone is released from rest and falls a long distance in air.

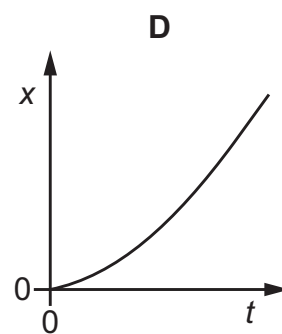
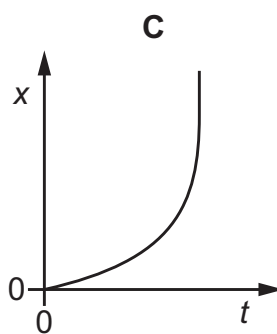
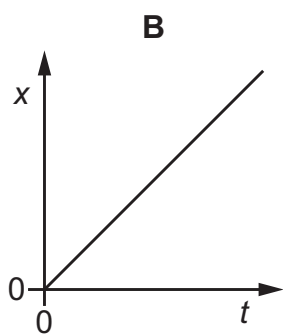
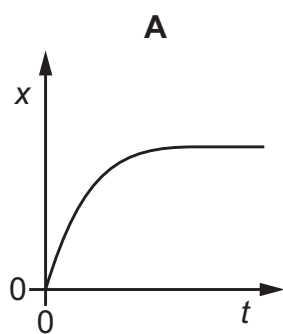
Which graph could show the variation with time t of the acceleration a of the stone?



47. Question | 9702 Oct-Nov 2017 P1 V3 Q6

- 6** A football falls from the top of a tall building.

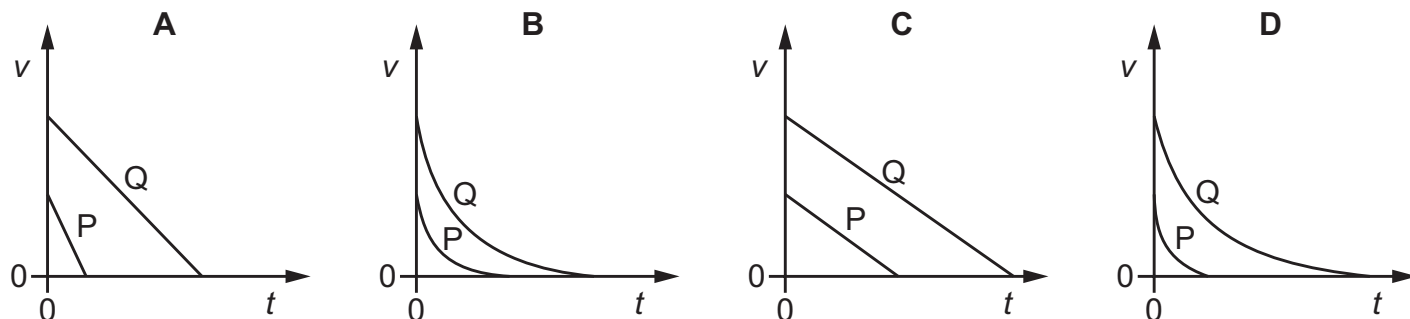
Which graph best represents the way in which the distance x fallen varies with time t ?



48. Question | 9702 Oct-Nov 2017 P1 V3 Q7

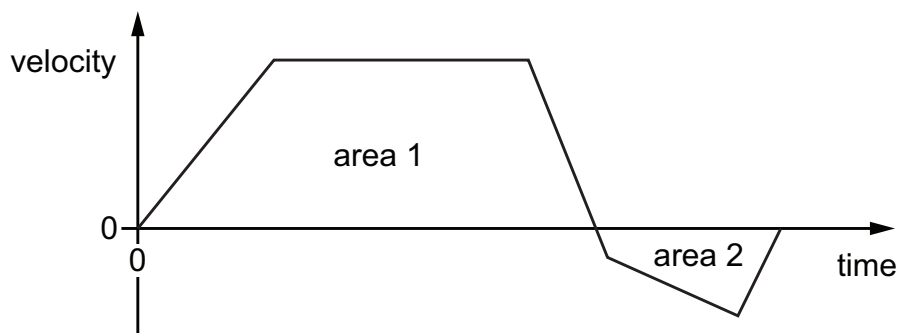
- 7 Two identical cars P and Q are travelling along a straight road. Car Q is travelling at twice the speed of car P. The brakes are applied to both cars, producing the same constant deceleration.

Which graph shows how the velocity v of each car varies with time t ?



49. Question | 9702 Feb-March 2018 P1 V2 Q8

- 8 The velocity-time graph for an object is shown.



How can the total displacement of the object be determined?

- A area 1 – area 2
 B $\frac{(\text{area 1} + \text{area 2})}{2}$
 C area 1 + area 2
 D area 2 – area 1

50. Question | 9702 Feb-March 2018 P1 V2 Q9

- 9** A girl throws a ball vertically upwards. It takes a time of 3.20 s to return to her hand.

Assume air resistance is negligible.

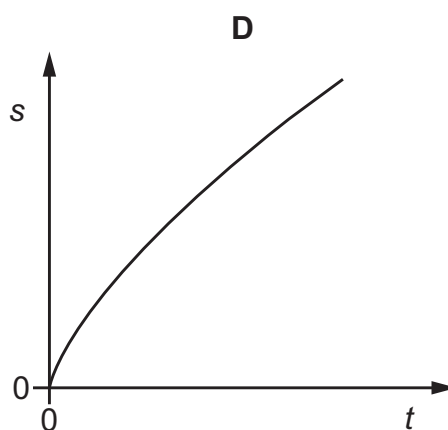
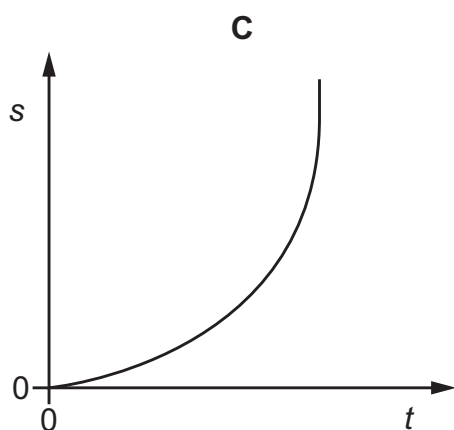
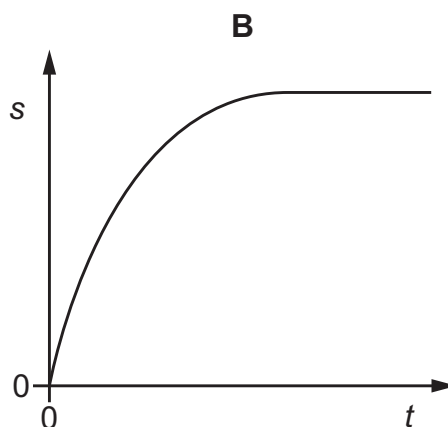
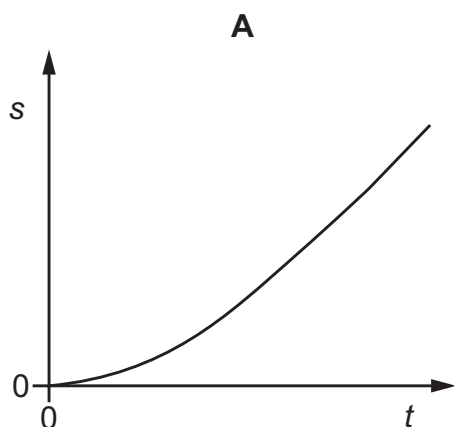
What is the initial speed with which the ball is thrown?

- A** 3.07 ms^{-1} **B** 7.85 ms^{-1} **C** 15.7 ms^{-1} **D** 31.4 ms^{-1}

51. Question | 9702 May-June 2018 P1 V1 Q6

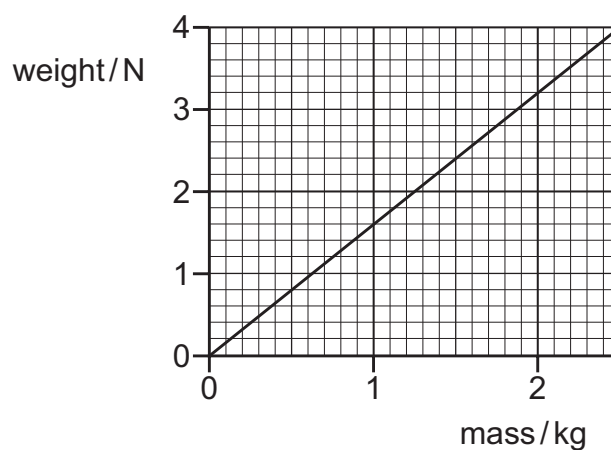
- 6** A tennis ball falls freely, in air, from the top of a tall building.

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



52. Question | 9702 May-June 2018 P1 V1 Q7

- 7 The graph shows the variation with mass of the weight of objects on a particular planet.

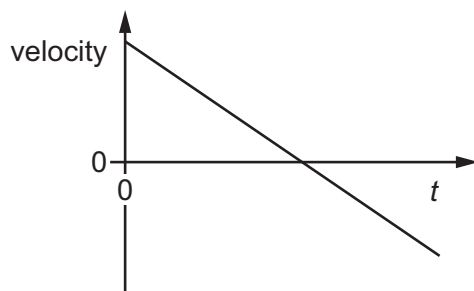


What is the value of the acceleration of free fall on the planet?

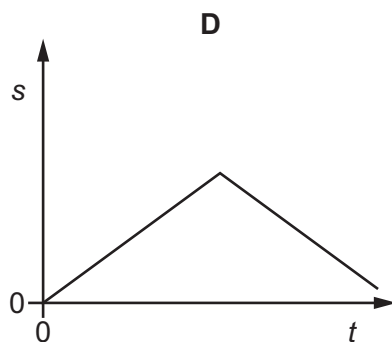
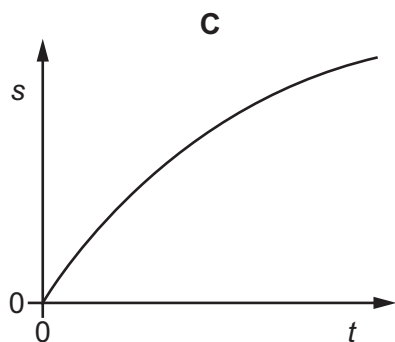
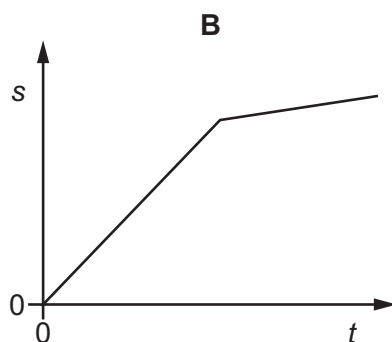
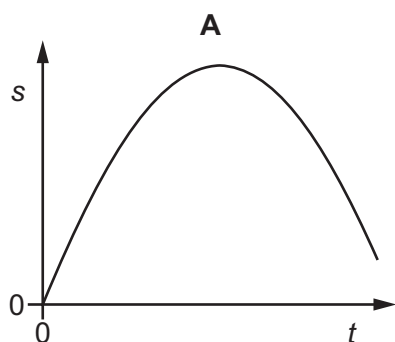
- A** 0.63 ms^{-2} **B** 1.6 ms^{-2} **C** 3.2 ms^{-2} **D** 9.8 ms^{-2}

53. Question | 9702 May-June 2018 P1 V2 Q5

- 5 The velocity of an object changes with time t as shown.

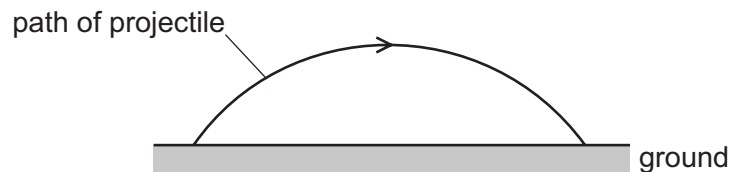


Which graph best shows the variation with time t of the displacement s of the object?



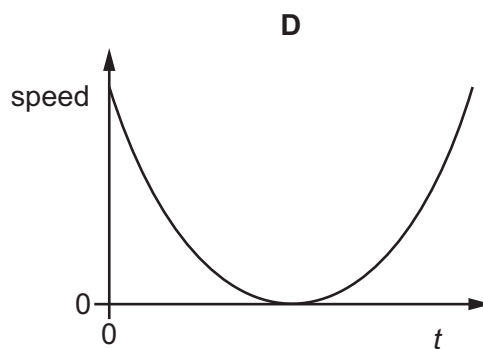
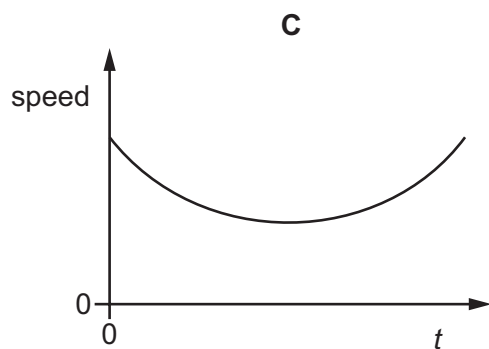
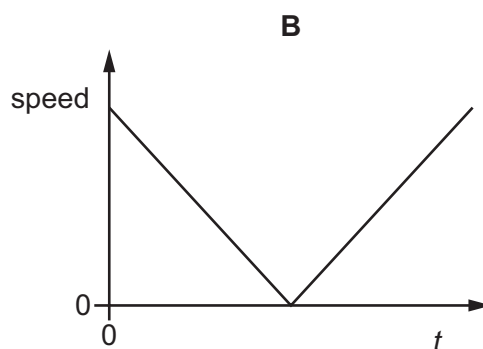
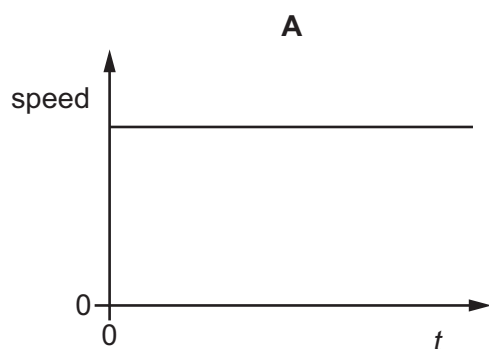
54. Question | 9702 May-June 2018 P1 V2 Q6

- 6 A projectile is launched at an angle to the horizontal at time $t = 0$. It travels over horizontal ground, as shown.



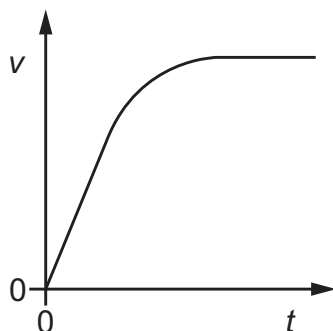
Assume that air resistance is negligible.

Which graph best shows the variation with t of the speed of the projectile from when it is launched to when it lands on the ground?

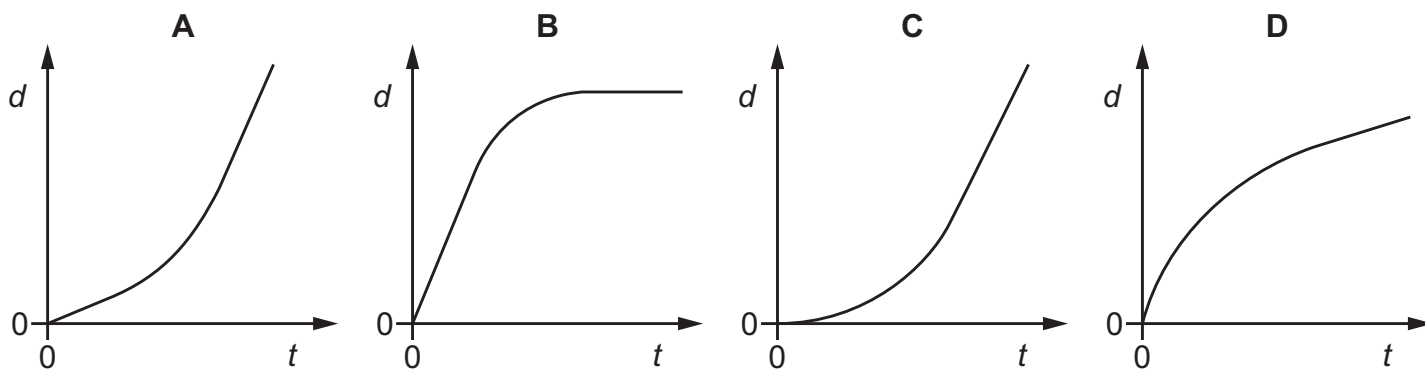


55. Question | 9702 May-June 2018 P1 V2 Q7

- 7 A sky-diver falls vertically from a helicopter and reaches constant (terminal) velocity. The graph shows the variation with time t of the speed v of the sky-diver.



Which graph shows the variation with time t of the distance d fallen by the sky-diver?



56. Question | 9702 May-June 2018 P1 V3 Q6

- 6** A rock on the surface of Mars is projected vertically upwards with an initial speed of 9.4 ms^{-1} . The rock rises to a height of 12 m above the surface.

Assume there is no atmosphere on Mars.

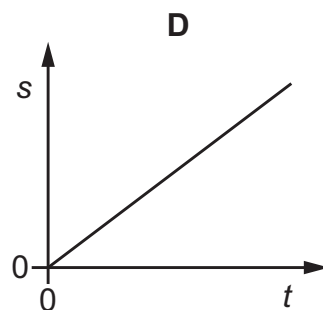
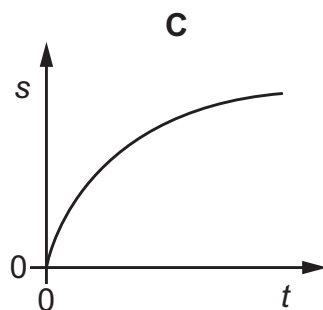
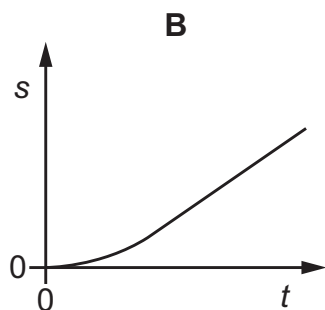
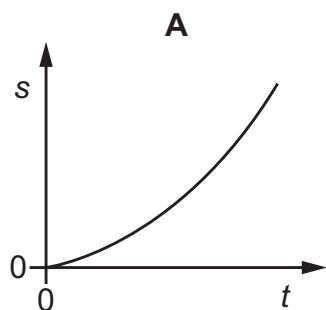
What is the acceleration of free fall near the surface of Mars?

- A** 0.39 ms^{-2} **B** 3.7 ms^{-2} **C** 7.4 ms^{-2} **D** 9.8 ms^{-2}

57. Question | 9702 May-June 2018 P1 V3 Q8

- 8** A sky-diver falls from a stationary balloon at time $t = 0$. As the sky-diver falls, her speed and the air resistance increase until the force of the air resistance is equal to her weight.

Which graph best shows the variation with time t of the displacement s for the motion of the sky-diver?



- 3** A ship is travelling with a velocity of 8.0 km h^{-1} in a direction 30° east of north.

What are the components of the ship's velocity in the east and north directions?

	component of velocity in east direction $/\text{km h}^{-1}$	component of velocity in north direction $/\text{km h}^{-1}$
A	4.0	4.0
B	4.0	6.9
C	4.6	6.9
D	6.9	4.0

59. Question | 9702 Oct-Nov 2018 P1 V1 Q6

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

The effect of air resistance is **not** negligible.

What happens to the horizontal and to the 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

60. Question | 9702 Oct-Nov 2018 P1 V2 Q6

- 6** A sprinter runs a 100 m race. The sprinter has a constant acceleration from rest of 2.5 m s^{-2} until reaching a speed of 10 m s^{-1} . The speed then remains constant until the end of the race.

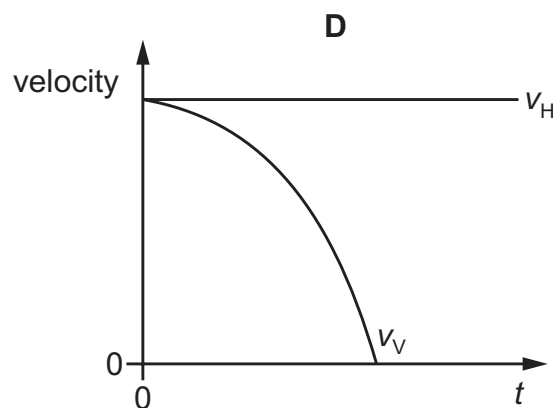
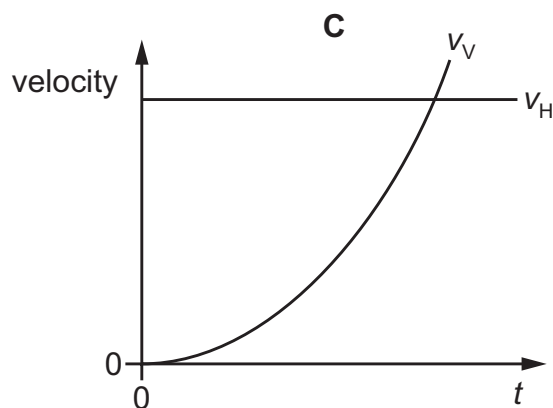
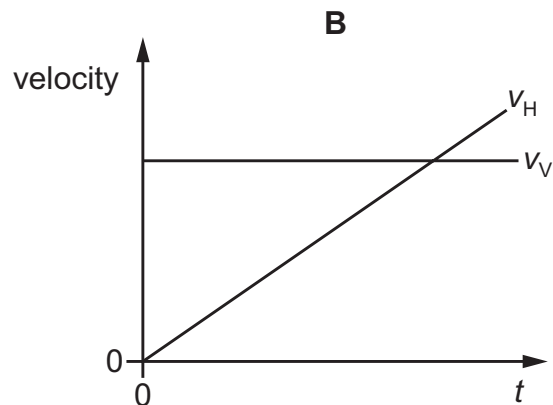
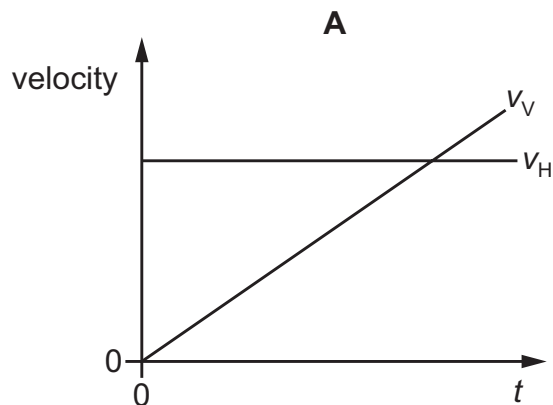
Which time does it take the sprinter to run the race?

- A** 8.9 s **B** 10 s **C** 12 s **D** 14 s

61. Question | 9702 Oct-Nov 2018 P1 V3 Q6

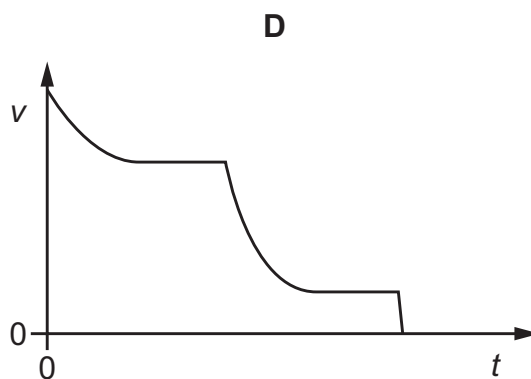
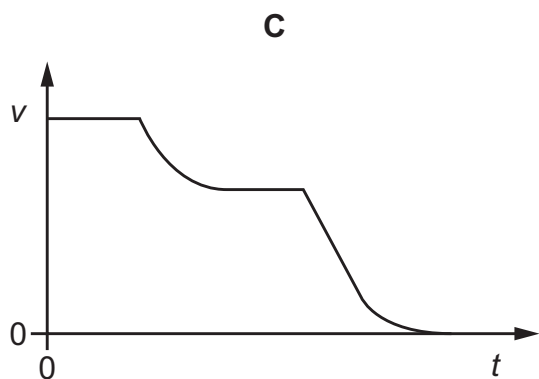
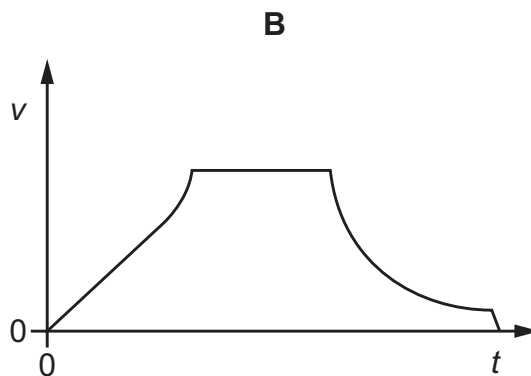
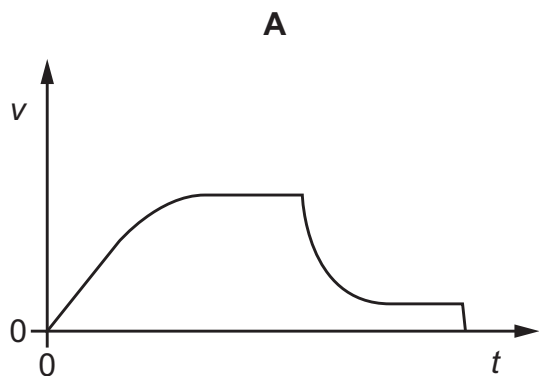
- 6** A stone is projected horizontally at time $t = 0$ and falls. Air resistance is negligible. The stone has a horizontal component of velocity v_H and a vertical component of velocity v_V .

Which graph shows how v_H and v_V vary with time t ?

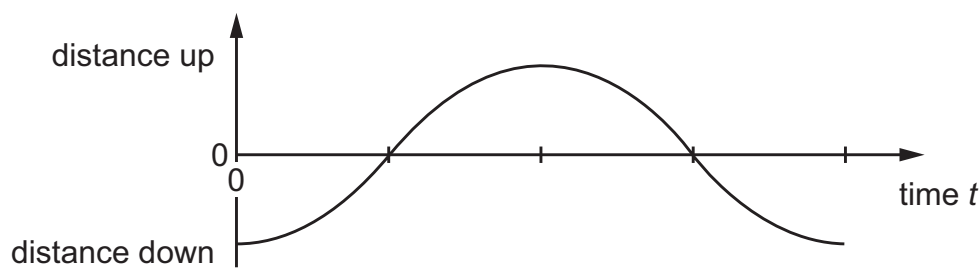


- 9 A parachutist falls vertically from rest at time $t = 0$ from a hot-air balloon. She falls for some distance before opening her parachute.

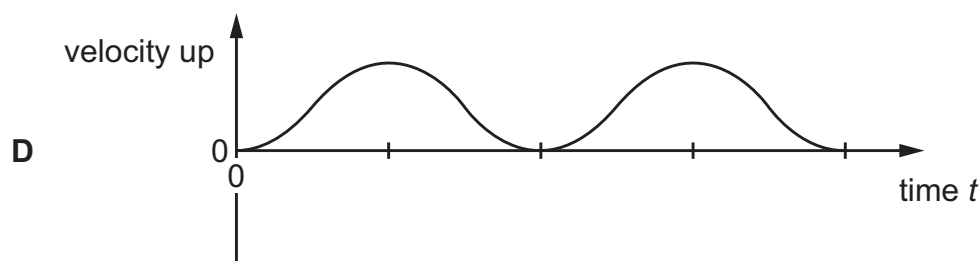
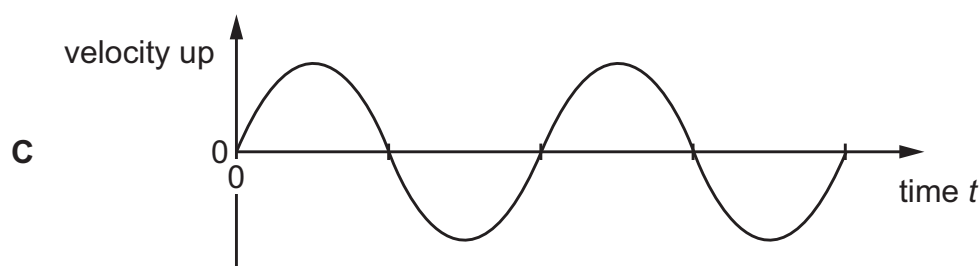
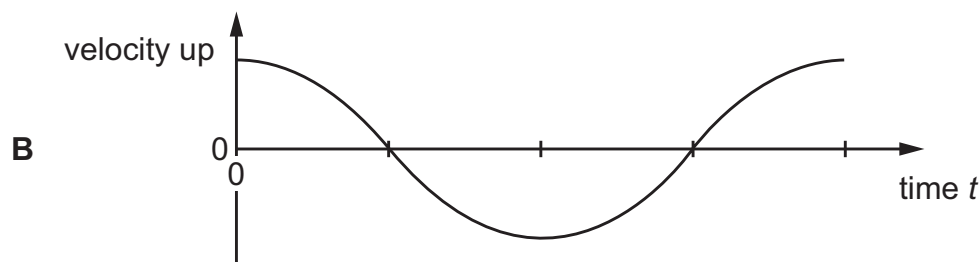
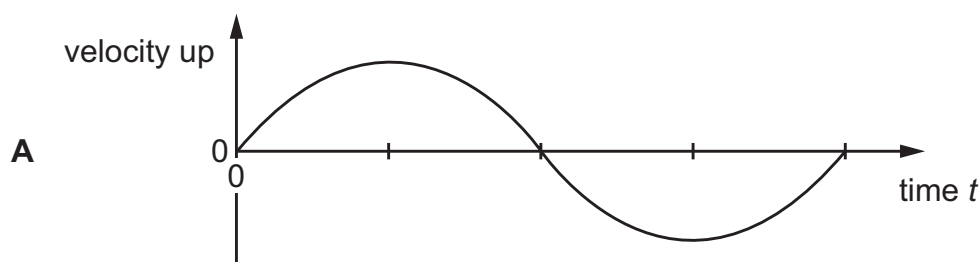
Which graph best shows the variation with time t of the speed v of the parachutist?



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



Which graph shows how the velocity varies with time?



64. Question | 9702 Feb-March 2019 P1 V2 Q7

- 7** A stone is thrown vertically upwards from a point that is 12 m above the sea. It then falls into the sea below after 3.4 s.

Air resistance is negligible.

At which speed was the stone released when it was thrown?

- A** 3.5 m s^{-1} **B** 6.6 m s^{-1} **C** 13 m s^{-1} **D** 20 m s^{-1}

65. Question | 9702 Feb-March 2019 P1 V2 Q9

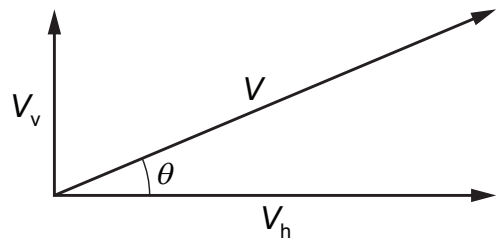
- 9** In the absence of air resistance, a ball thrown horizontally from a tower with velocity v , will land after time T seconds.

If, however, air resistance is taken into account, which statement is correct?

- A** The ball lands with a horizontal velocity less than v after more than T seconds.
B The ball lands with a horizontal velocity less than v after T seconds.
C The ball lands with a horizontal velocity v after more than T seconds.
D The ball lands with a horizontal velocity v after T seconds.

3 A particle has velocity V at an angle θ to the horizontal.

The components of the particle's velocity are V_v upwards in the vertical direction and V_h to the right in the horizontal direction, as shown.

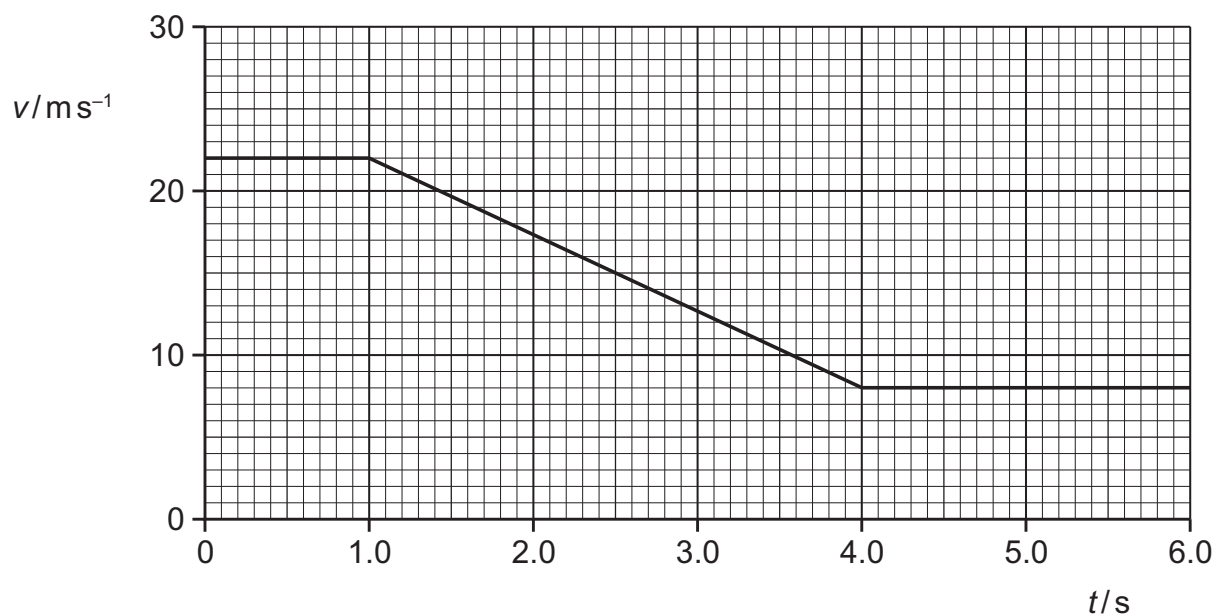


What are expressions for the magnitude of V and for the angle θ ?

	magnitude of V	θ
A	$\sqrt{(V_v^2 + V_h^2)}$	$\tan^{-1} \left(\frac{V_h}{V_v} \right)$
B	$\sqrt{(V_v^2 + V_h^2)}$	$\tan^{-1} \left(\frac{V_v}{V_h} \right)$
C	$\sqrt{(V_v^2 - V_h^2)}$	$\tan^{-1} \left(\frac{V_h}{V_v} \right)$
D	$\sqrt{(V_v^2 - V_h^2)}$	$\tan^{-1} \left(\frac{V_v}{V_h} \right)$

67. Question | 9702 May-June 2019 P1 V1 Q6

- 6** A car travels along a straight horizontal road. The graph shows the variation of the velocity v of the car with time t for 6.0 s of its journey.



The brakes of the car are applied from $t = 1.0$ s to $t = 4.0$ s.

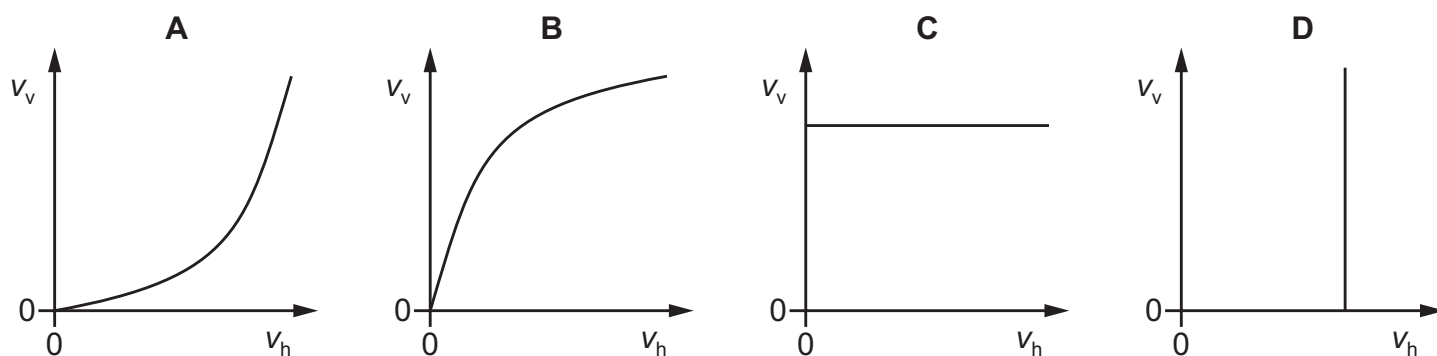
How far does the car travel while the brakes are applied?

- A** 21 m **B** 45 m **C** 67 m **D** 83 m

68. Question | 9702 May-June 2019 P1 V1 Q7

- 7** A stone is thrown horizontally from the top of a cliff and falls into the sea some time later. Air resistance is negligible.

Which graph shows how the vertical component v_v of velocity of this stone varies with its horizontal component v_h of velocity as it moves through the air?

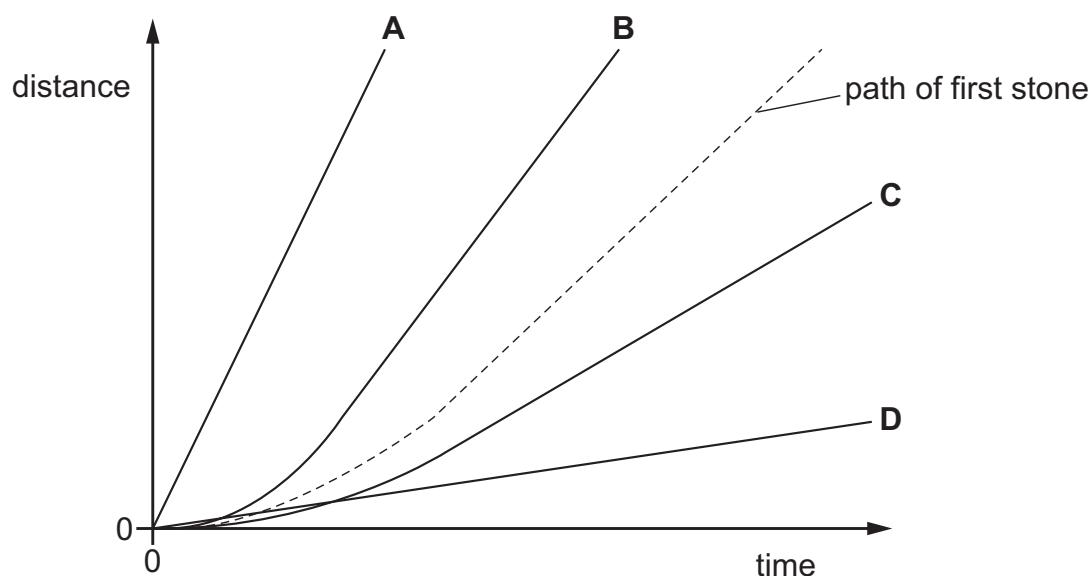


69. Question | 9702 May-June 2019 P1 V1 Q10

- 10** A stone is dropped from a tall building. Air resistance is significant. The variation of distance fallen with time is shown by the dashed line.

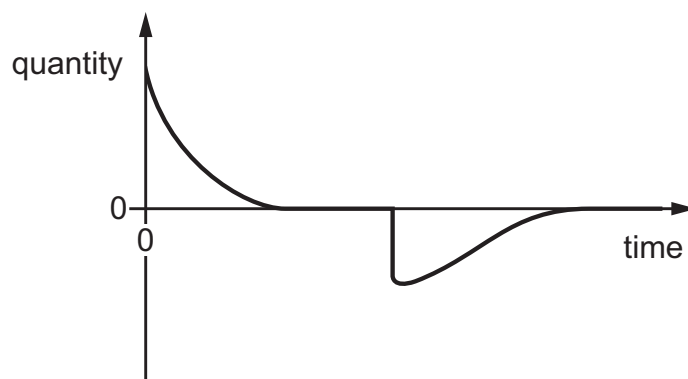
A second stone with the same dimensions but a smaller mass is dropped from the same building.

Which line represents the motion of the second stone?



70. Question | 9702 May-June 2019 P1 V2 Q8

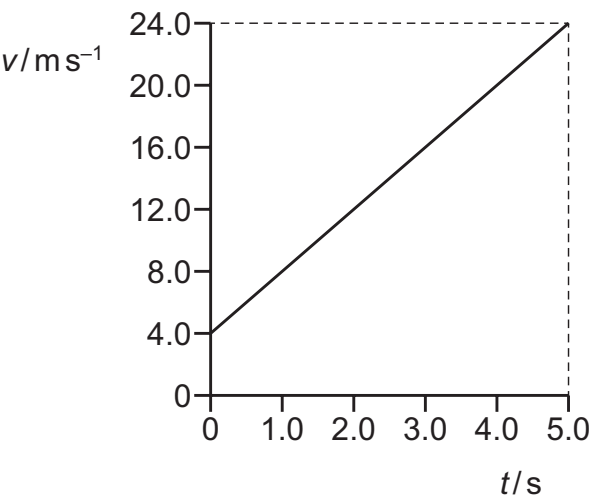
- 8** The graph shows how a physical quantity varies with time.



Which event could best be represented by the graph?

- A** the acceleration of a firework rising to a maximum height and falling to the ground
- B** the acceleration of a skydiver leaving an aircraft, falling, opening a parachute and falling to the ground
- C** the speed of a javelin as it leaves an athlete's hand, falls and sinks into the ground
- D** the speed of a high jump athlete leaving the ground, jumping over a bar and descending to the ground

7 The graph shows the variation of velocity v with time t for an object.



The object passes a fixed point at time $t = 0$.

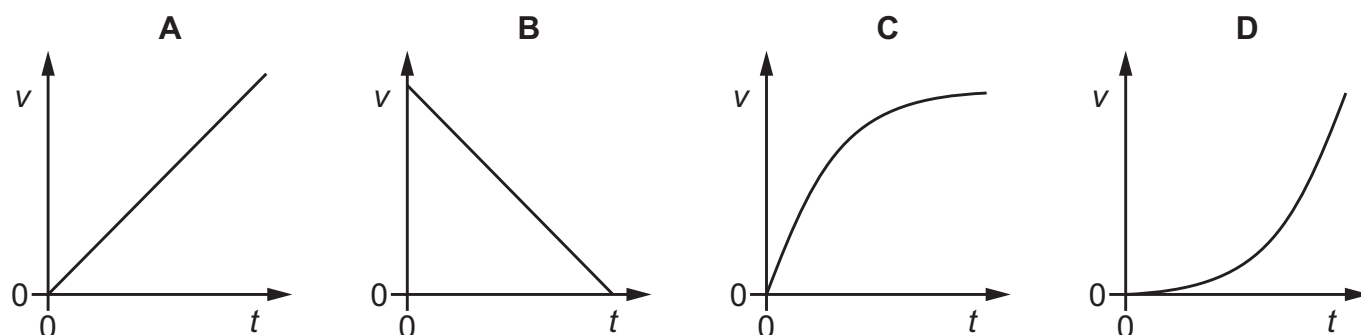
What is the displacement of the object from the fixed point at time $t = 5.0\text{ s}$ and what is the acceleration of the object?

	displacement /m	acceleration /ms ⁻²
A	60	4.0
B	70	4.0
C	60	4.8
D	70	4.8

72. Question | 9702 May-June 2019 P1 V3 Q8

- 8** A skydiver jumps from an aeroplane and falls vertically through the air.

Which graph shows the variation with time t of the skydiver's vertical velocity v ?



73. Question | 9702 Oct-Nov 2019 P1 V2 Q6

- 6** A ball is thrown vertically upwards from ground level and reaches a maximum height of 12.7 m before falling back to ground level.

Assume air resistance is negligible.

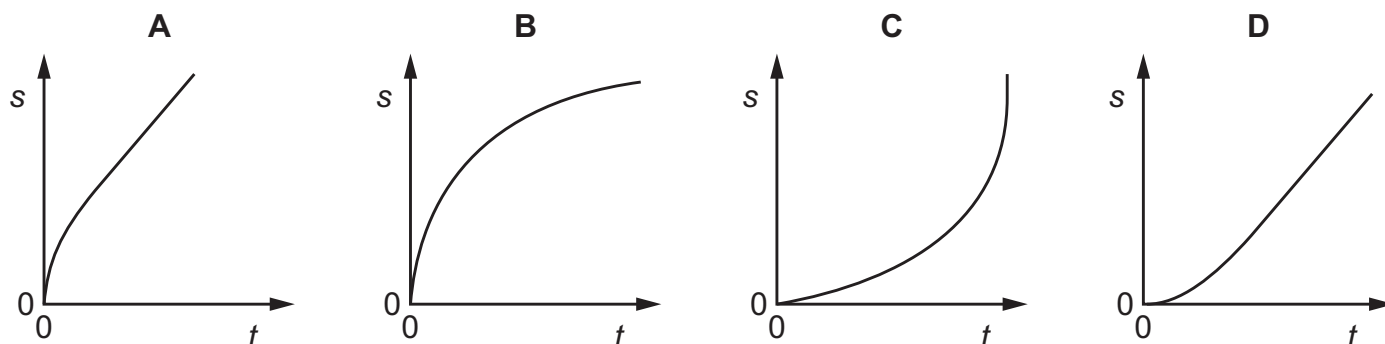
What is the total time for which the ball is in the air?

- A** 1.61 s **B** 3.22 s **C** 3.88 s **D** 5.18 s

74. Question | 9702 Oct-Nov 2019 P1 V2 Q8

- 8 A tennis ball is released from rest at time $t = 0$ and falls through air for a long time.

Which graph of its displacement s against time t best represents the motion of the ball?



75. Question | 9702 Oct-Nov 2019 P1 V3 Q6

- 6 A lead sphere is released from rest at point X, a long way above the surface of a planet. The sphere falls in a vacuum. After a time of 4.0 s, it has fallen through a vertical distance of 3.0 m. Assume the acceleration of free fall is constant.

How far will the sphere have fallen from point X at a time of 20 s after its release?

- A** 15 m **B** 75 m **C** 80 m **D** 2000 m

76. Question | 9702 Feb-March 2020 P1 V2 Q7

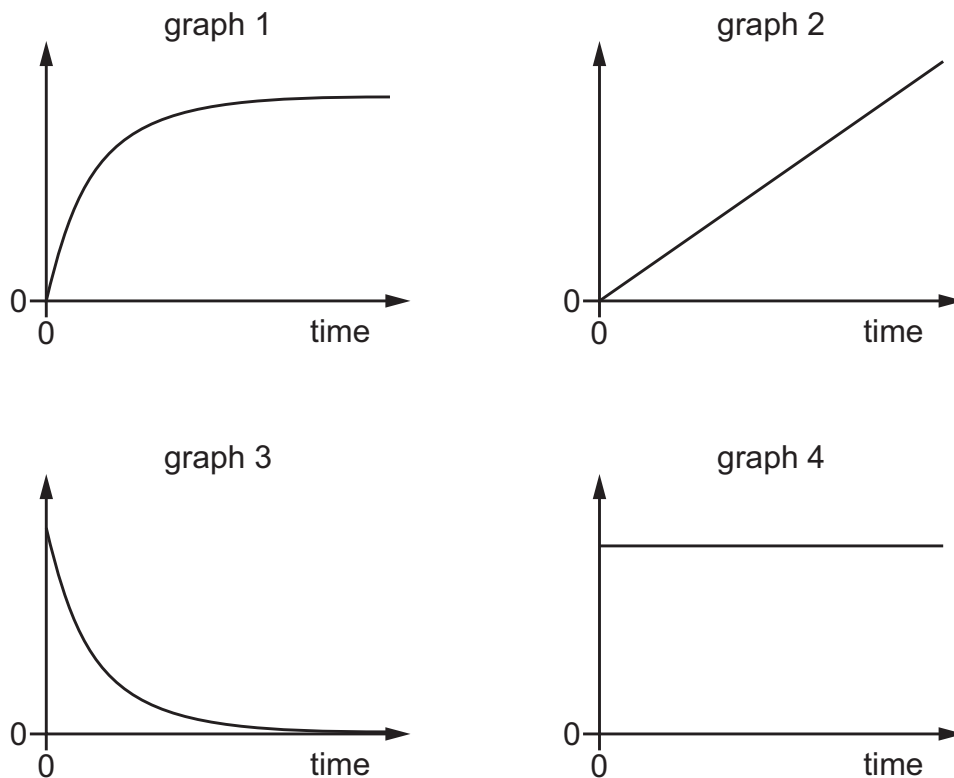
- 7 A car moves with uniform acceleration along a straight road. Oil leaks from the car at the rate of one drop every two seconds. The diagram shows the distances between three successive oil drops on the road.



What is the acceleration of the car?

- A** 0.75 ms^{-2} **B** 1.5 ms^{-2} **C** 3.0 ms^{-2} **D** 6.0 ms^{-2}

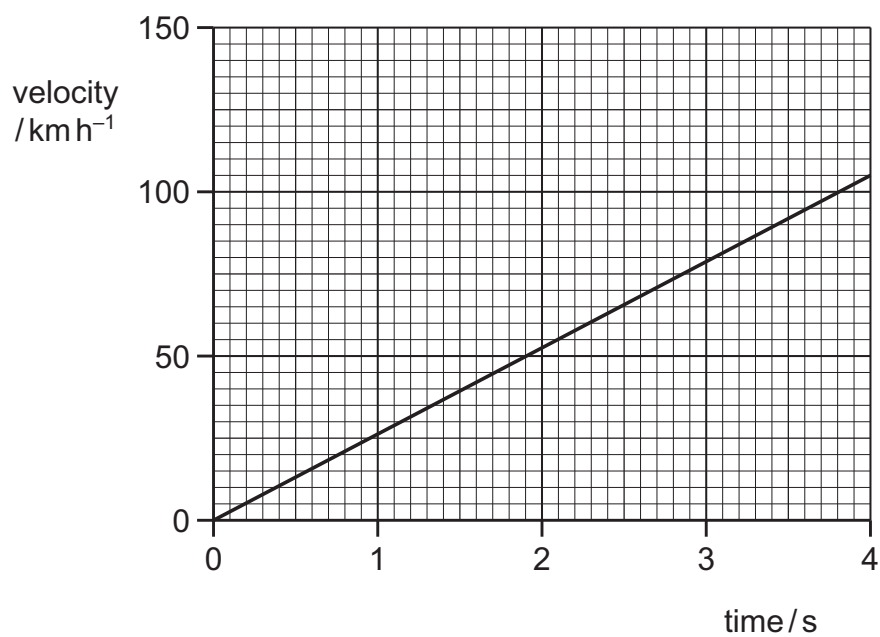
- 9 The diagram shows graphs of various quantities plotted against time for an object dropped from a stationary balloon high in the atmosphere.



Which statement could be correct?

- A** Graph 1 is acceleration against time and graph 3 is resultant force against time.
- B** Graph 1 is acceleration against time and graph 4 is resultant force against time.
- C** Graph 3 is acceleration against time and graph 1 is velocity against time.
- D** Graph 3 is acceleration against time and graph 2 is velocity against time.

6 The velocity of an electric car changes as shown.

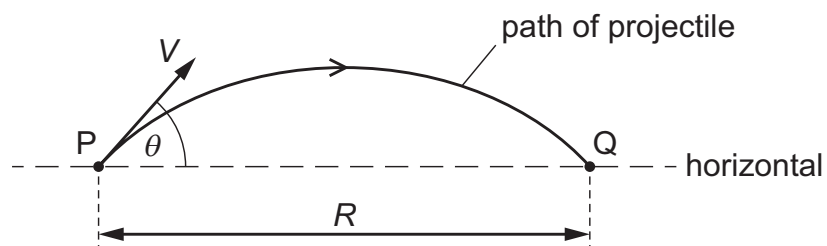


What is the acceleration of the car?

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

79. Question | 9702 May-June 2020 P1 V1 Q7

- 7 A projectile is fired from point P with velocity V at an angle θ to the horizontal. It lands at point Q, a horizontal distance R from P, after time T .

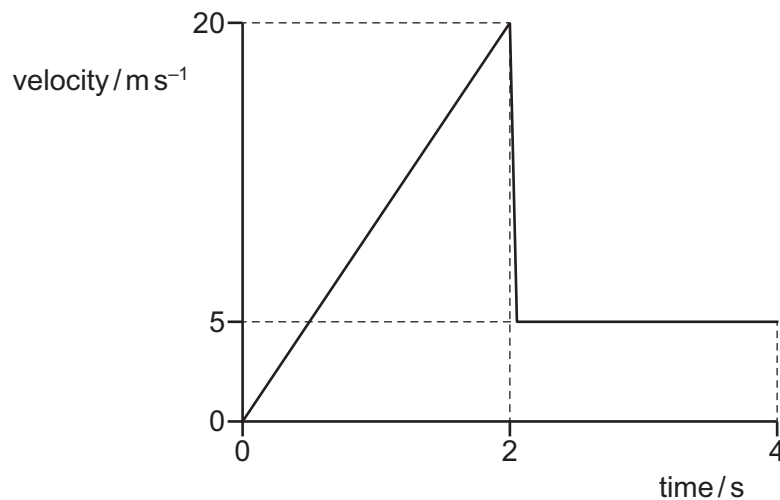


The acceleration of free fall is g . Air resistance is negligible.

Which equation is correct?

- A $R = VT \cos \theta$
- B $R = VT \sin \theta$
- C $R = VT \cos \theta - \frac{1}{2}gT^2$
- D $R = VT \sin \theta - \frac{1}{2}gT^2$

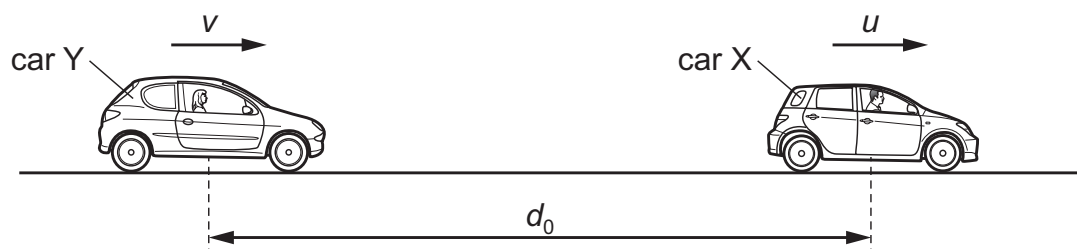
- 5 A stone is dropped from a height of 20 m above water. The graph shows the variation with time of the velocity of the stone.



Which statement describes the approximate position of the stone four seconds after it is dropped?

- A It is at a distance of 10 m above the surface of the water.
- B It is at a distance of 10 m below the surface of the water.
- C It is at a distance of 20 m below the surface of the water.
- D It is at a distance of 30 m below the surface of the water.

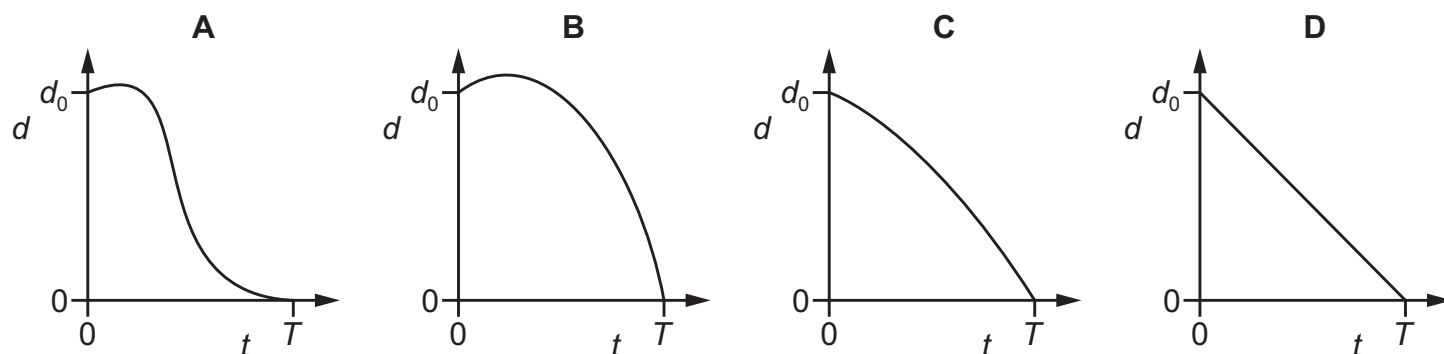
- 6 A car X is travelling at a constant speed u along a straight road. At time $t = 0$ a second car Y is a distance d_0 behind car X and travelling at a speed v in the same direction. Speed v is less than speed u .



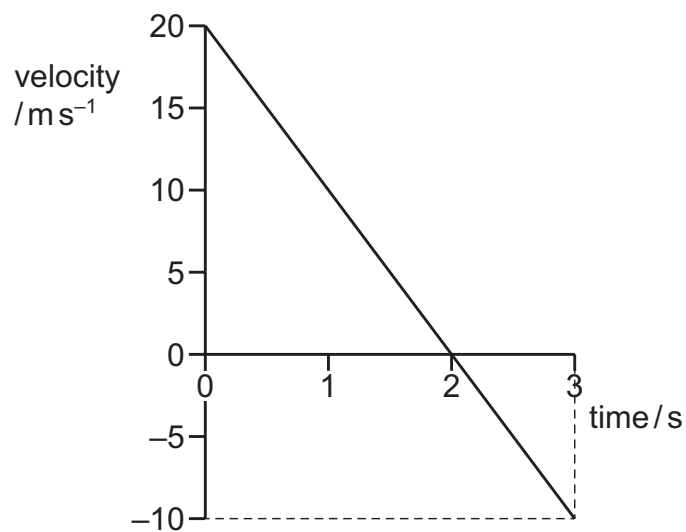
At time $t = 0$ car Y begins to accelerate with a constant acceleration.

Car Y overtakes car X at time $t = T$.

Which graph could best show the variation with time t of the distance d between the cars?



- 6** The graph shows how the velocity of a ball varies with time from the moment it is hit vertically upwards from the ground.



What is the displacement of the ball from the ground after a time of 3.0 s?

- A** 15 m **B** 25 m **C** 30 m **D** 45 m

- 7** Two students each throw a ball horizontally from the top of a tower. The two balls are released at the same time.

The first student throws her ball with a speed of 20 m s^{-1} and the second student throws his ball with a speed of 10 m s^{-1} .

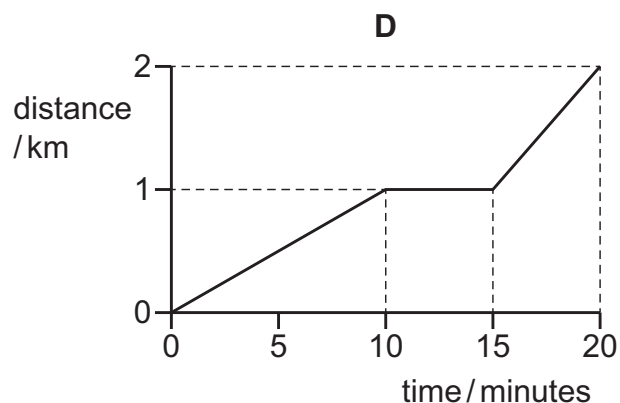
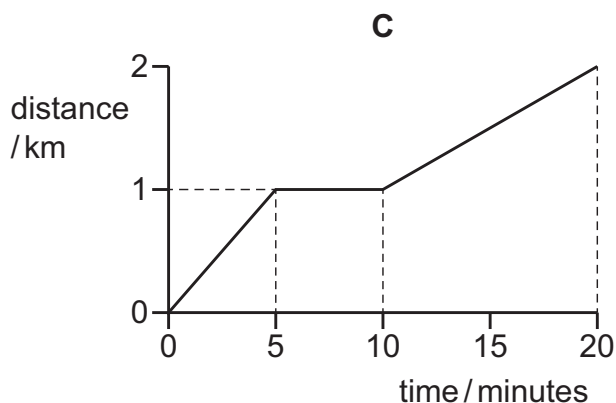
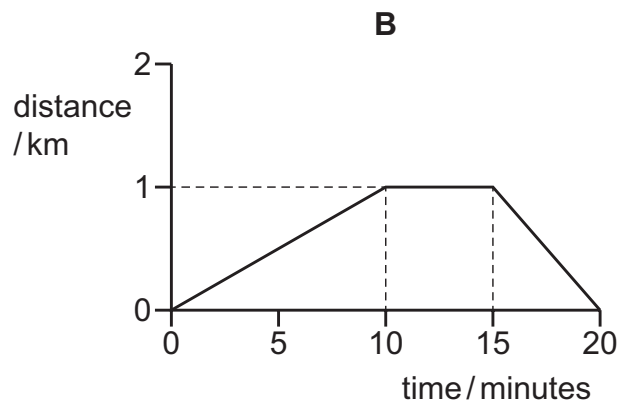
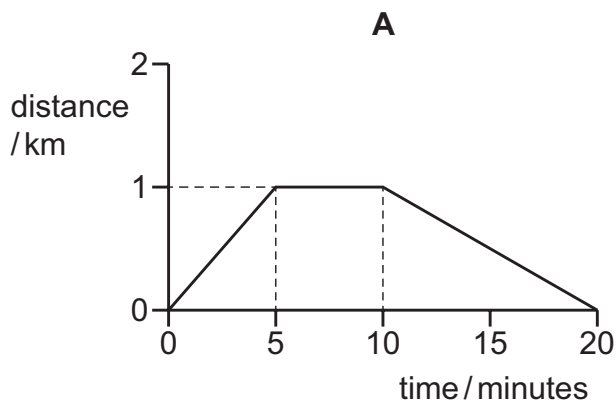
Assume air resistance is negligible and that the balls land on horizontal ground.

Which row describes the horizontal distances travelled and the landing times of the two balls on the ground?

	horizontal distances	landing times
A	same	same
B	same	different
C	different	same
D	different	different

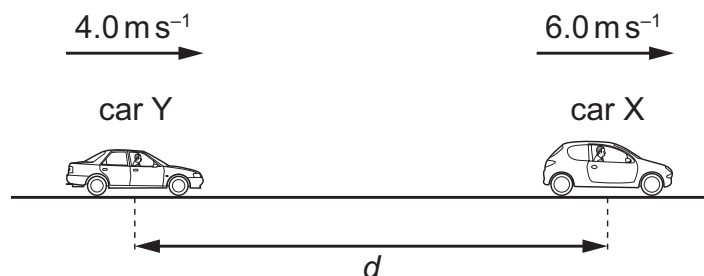
- 6** A student cycles uphill from home to a shop, taking 10 minutes. The student then spends 5 minutes in the shop, before cycling home downhill at twice the initial speed.

Which graph could show the variation with time of the distance travelled by the cyclist?



- 7 Two cars X and Y are travelling along the same straight road. Car X is travelling at a constant speed of 6.0 m s^{-1} . Car Y has a constant acceleration of 0.50 m s^{-2} .

At the instant shown, car X is a distance d ahead of car Y. Car Y is travelling at a speed of 4.0 m s^{-1} .



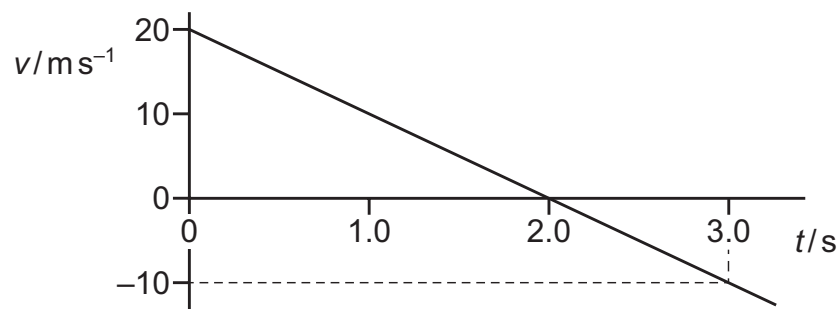
Car Y is level with car X after a time of 20 seconds.

What is the distance d ?

- A** 40 m **B** 60 m **C** 180 m **D** 300 m

- 6** A stone is thrown vertically upwards from a point X at time $t = 0$.

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

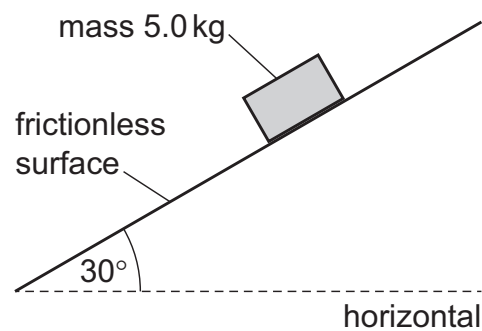


What is the displacement of the stone from point X at time $t = 3.0$ s?

- A** 15 m above X
- B** 15 m below X
- C** 25 m above X
- D** 25 m below X

87. Question | 9702 Oct-Nov 2020 P1 V2 Q7

- 7 A mass of 5.0 kg is released from rest on a frictionless surface inclined at 30° to the horizontal. Air resistance is negligible.



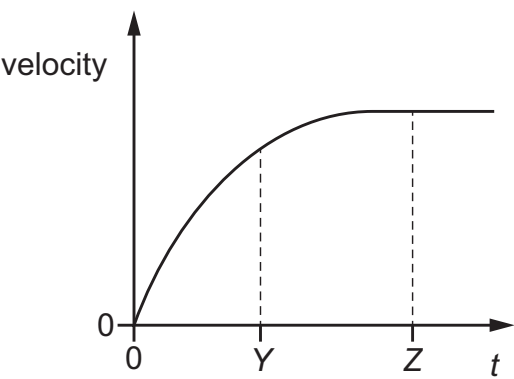
How far does the mass travel in a time of 0.80 s?

- A** 1.6 m **B** 2.0 m **C** 2.7 m **D** 3.1 m

88. Question | 9702 Oct-Nov 2020 P1 V2 Q9

- 9 An object falls from a tall building.

The graph shows how the velocity of the object changes with time t .



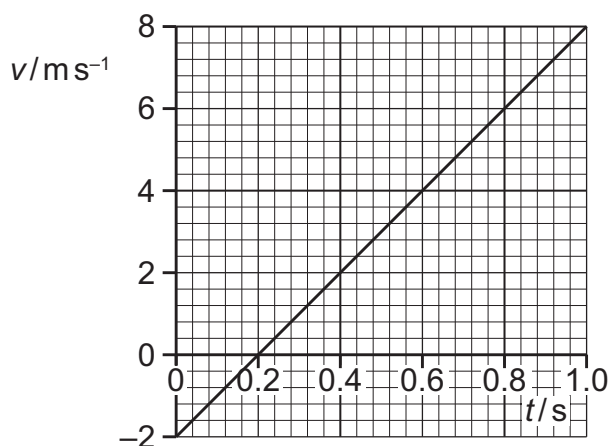
The acceleration of free fall is g .

What describes the acceleration of the object at times $t = Y$ and $t = Z$?

	acceleration at $t = Y$	acceleration at $t = Z$
A	decreasing	g
B	decreasing	0
C	constant	g
D	constant	0

89. Question | 9702 Oct-Nov 2020 P1 V3 Q6

- 6** An object moves in a straight line. The graph shows the variation with time t of the velocity v of the object.



At time $t = 0$ the object is at point X.

What is the displacement of the object from point X at time $t = 0.80 \text{ s}$?

- A** 1.6 m **B** 1.8 m **C** 2.0 m **D** 3.2 m

90. Question | 9702 Oct-Nov 2020 P1 V3 Q7

- 7** An object accelerates uniformly from rest to speed v . It then moves at constant speed v for a time of 8.0 s before decelerating uniformly to rest. The total time taken is 12.0 s, and the total distance travelled is 60 m.

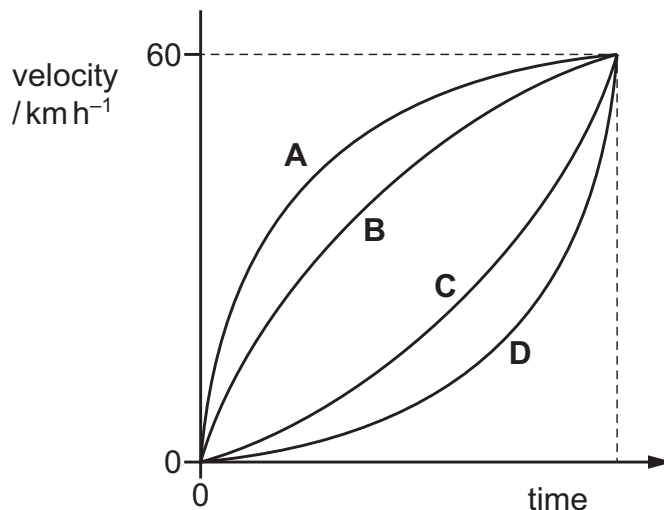
What is the speed v ?

- A** 3.0 ms^{-1} **B** 5.0 ms^{-1} **C** 6.0 ms^{-1} **D** 15 ms^{-1}

91. Question | 9702 Feb-March 2021 P1 V2 Q6

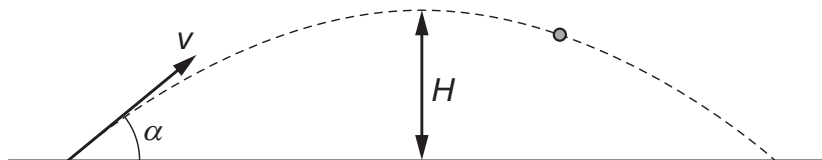
- 6 Four cars, **A**, **B**, **C** and **D**, move from rest in a straight line. The cars take the same time to accelerate to a velocity of 60 km h^{-1} . Their velocity–time graphs are shown.

Which car reaches a velocity of 60 km h^{-1} in the shortest distance?



92. Question | 9702 Feb-March 2021 P1 V2 Q7

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



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** $H = \frac{g^2 \sin \alpha}{2v}$

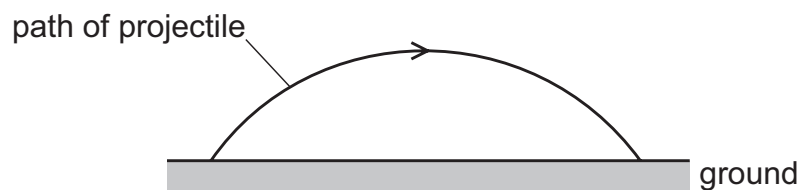
- 9** A skydiver, who is falling vertically through the air, opens his parachute.

Which row describes the velocity of the skydiver immediately after he opens his parachute?

	direction of velocity	magnitude of velocity
A	downwards	decreases
B	downwards	increases
C	upwards	decreases
D	upwards	increases

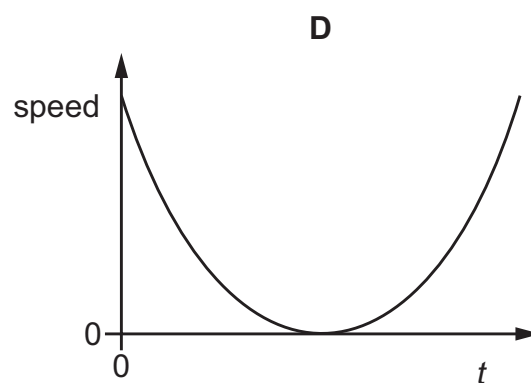
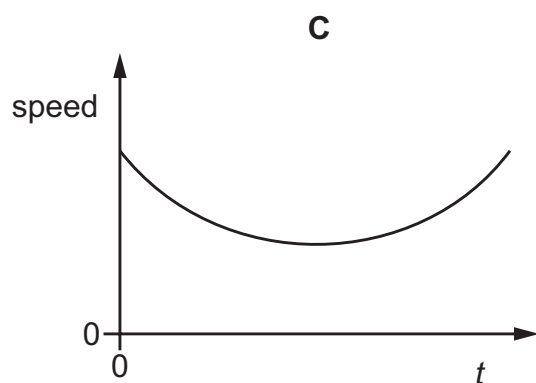
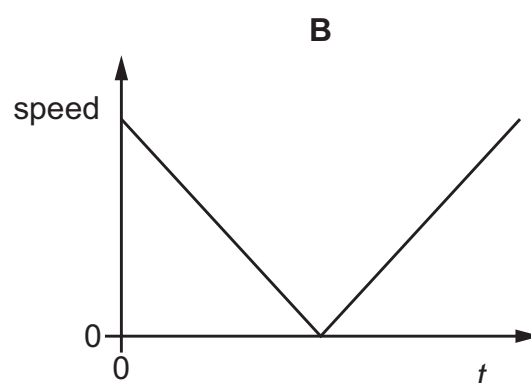
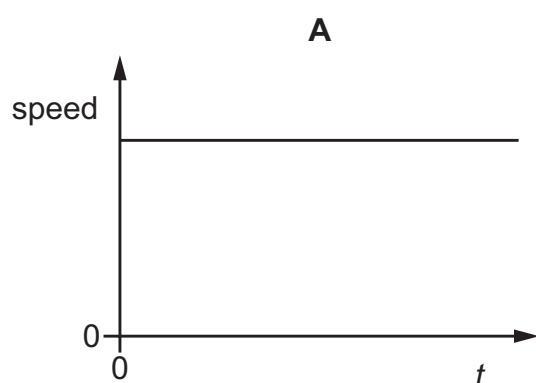
94. Question | 9702 May-June 2021 P1 V1 Q6

- 6** A projectile is launched at an angle to the horizontal at time $t = 0$. It travels over horizontal ground, as shown.



Air resistance is negligible.

Which graph best shows the variation with t of the speed of the projectile from when it is launched to when it lands on the ground?



95. Question | 9702 May-June 2021 P1 V1 Q7

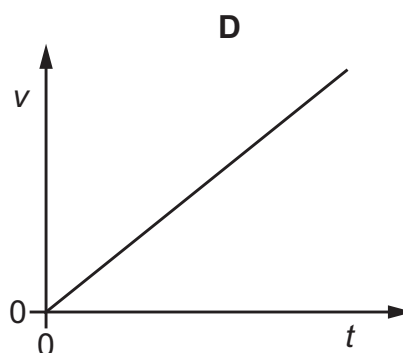
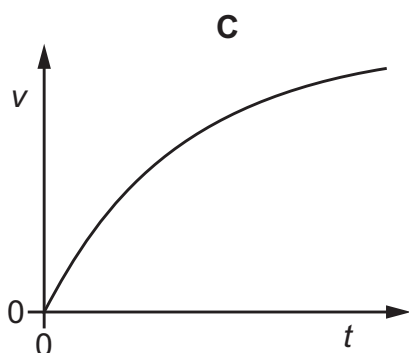
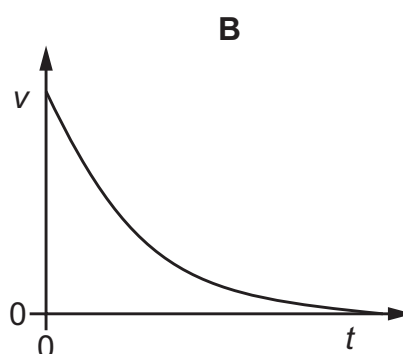
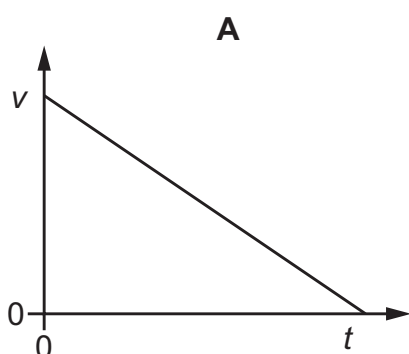
- 7 A train, initially at rest at a station, has a uniform acceleration of 0.20 m s^{-2} until it reaches a speed of 20 m s^{-1} . It travels for a time at this constant speed and then has a uniform deceleration of 0.40 m s^{-2} until it comes to rest at the next station. The distance between the two stations is 3000 m.

What is the time taken by the train to travel between the two stations?

- A** 75 s **B** 150 s **C** 230 s **D** 300 s

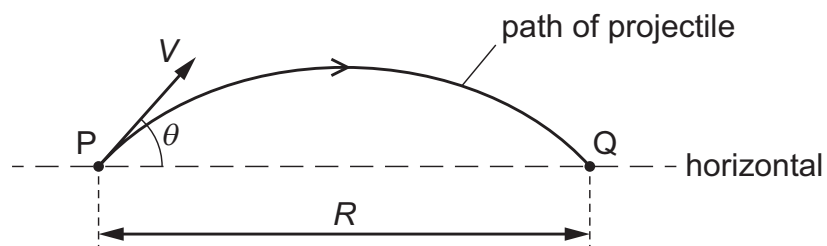
96. Question | 9702 May-June 2021 P1 V2 Q6

- 6 Which graph shows the variation with time t of the velocity v of an object falling vertically downwards in a vacuum?



97. Question | 9702 May-June 2021 P1 V2 Q7

- 7 A projectile is fired from point P with velocity V at an angle θ to the horizontal. It lands at point Q, a horizontal distance R from P. Air resistance is negligible.

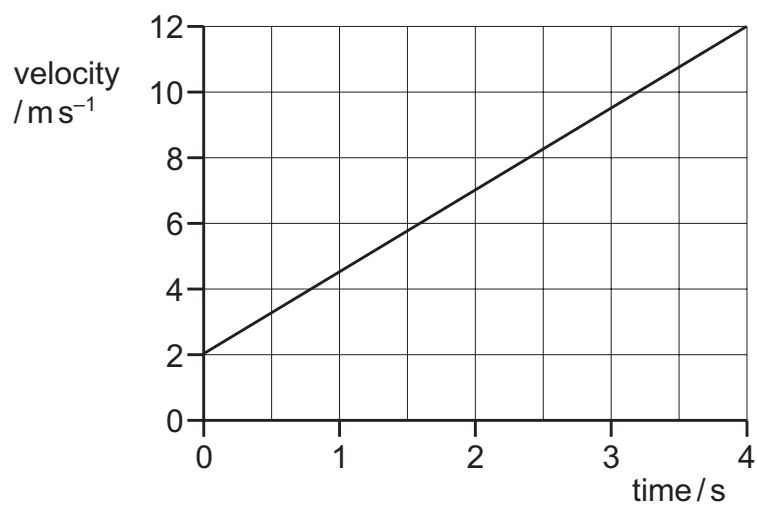


The acceleration of free fall is g .

Which equation for R is correct?

- A** $R = \frac{V^2 \sin \theta \cos \theta}{g}$
- B** $R = \frac{2V^2 \sin \theta \cos \theta}{g}$
- C** $R = \frac{V^2 \sin \theta \cos \theta}{2g}$
- D** $R = \frac{V^2 g \sin \theta \cos \theta}{2}$

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



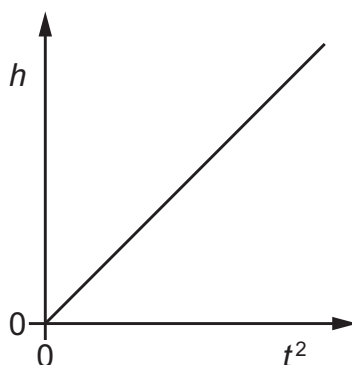
What is the distance travelled during the first 4.0 s?

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

- 7** A steel ball is dropped from rest from a height h above the ground. The ball hits the ground after a time t .

This is repeated for a number of different heights.

The graph shows the variation of h with t^2 for the ball.



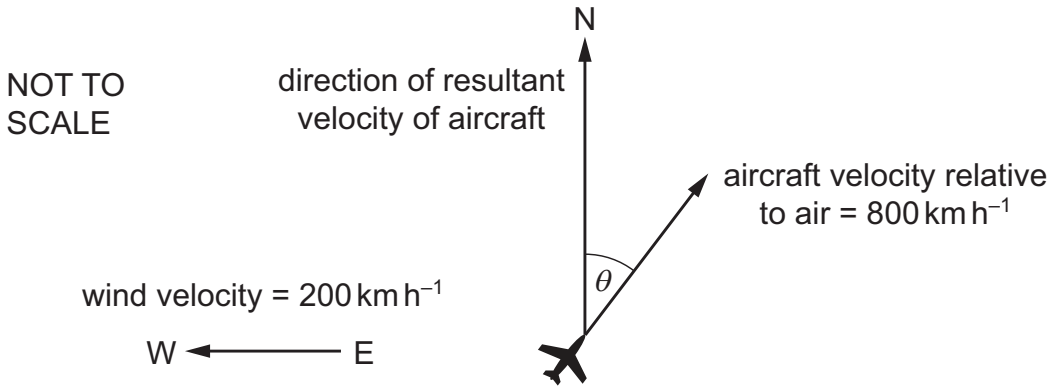
The gradient of the graph is G .

Which expression gives the acceleration of the ball?

- A** $\frac{G}{2}$ **B** G **C** $2G$ **D** G^2

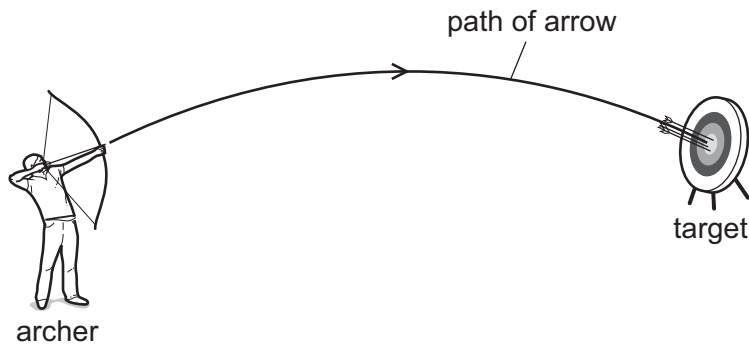
- 3

An aircraft heads in a direction at an angle θ east of north with a horizontal velocity relative to the air of 800 km h^{-1} . The wind blows with a horizontal velocity of 200 km h^{-1} from east to west, as shown.



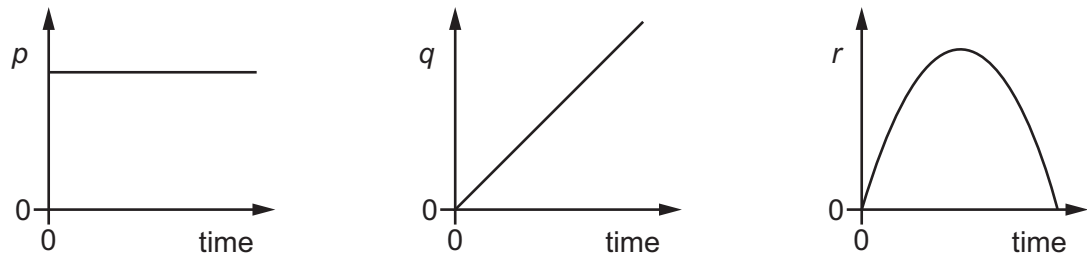
101. Question | 9702 Oct-Nov 2021 P1 V1 Q6

6 An archer shoots an arrow at a target. The diagram shows the path of the arrow.



Air resistance is negligible.

The graphs show how three different quantities p , q and r vary with time.



Which quantity could be the horizontal component of displacement and which quantity could be the vertical component of displacement of the arrow?

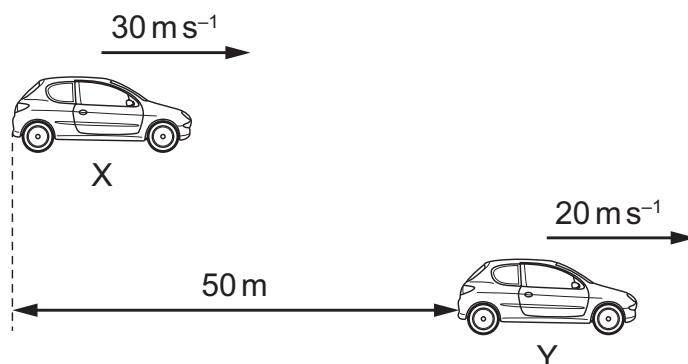
	horizontal component of displacement	vertical component of displacement
A	p	q
B	q	r
C	r	p
D	r	q

102. Question | 9702 Oct-Nov 2021 P1 V1 Q7

7 Two cars X and Y are positioned as shown at time $t = 0$.

They are travelling in the same direction.

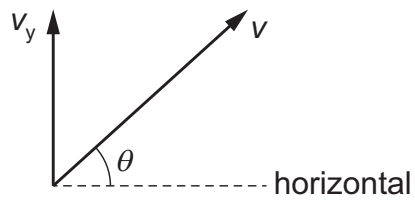
X is 50 m behind Y and has a constant velocity of 30 m s^{-1} . Y has a constant velocity of 20 m s^{-1} .



What is the value of t when X is level with Y?

- A** 1.0 s **B** 1.7 s **C** 2.5 s **D** 5.0 s

- 3** A tennis ball is hit so that it leaves the racket with velocity v at an angle θ to the horizontal.



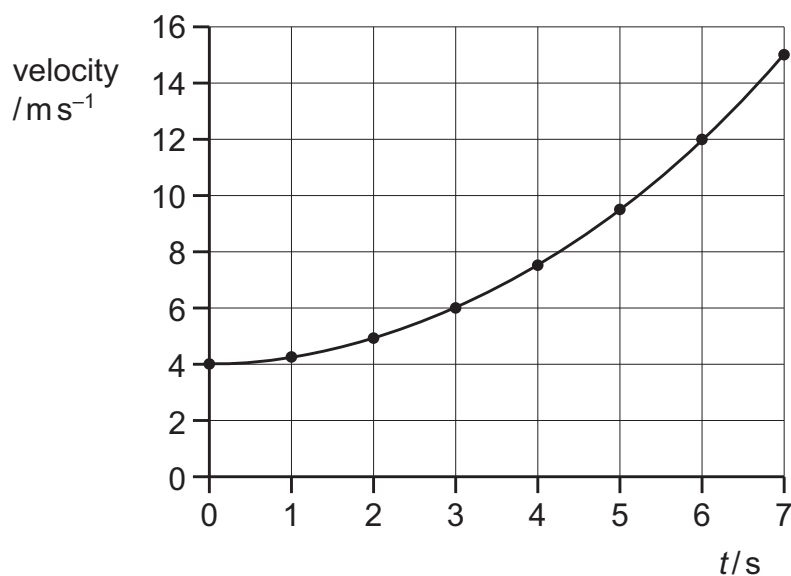
The vertical component of the velocity is v_y .

What is the magnitude of the horizontal component of v ?

- A** $v \sin \theta$ **B** $v_y \cos \theta$ **C** $v_y \sin \theta$ **D** $(v^2 - v_y^2)^{\frac{1}{2}}$

104. Question | 9702 Oct-Nov 2021 P1 V2 Q6

- 6** The graph shows the variation with time t of the velocity of a vehicle moving in a straight line.



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

What is the vehicle's acceleration at time $t = 3.0 \text{ s}$?

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

105. Question | 9702 Oct-Nov 2021 P1 V2 Q7

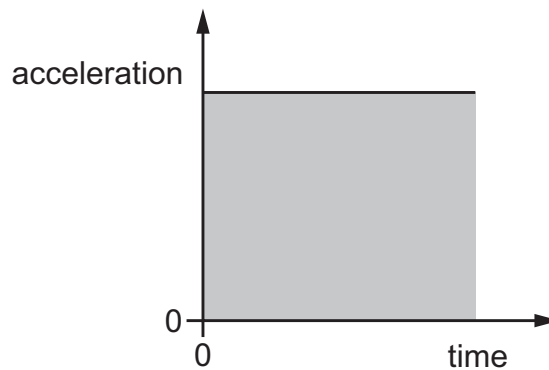
- 7** A stone is projected vertically upwards from the ground at an initial speed of 15 m s^{-1} . Air resistance is negligible.

What is the maximum height reached by the stone?

- A** 0.76 m **B** 11 m **C** 23 m **D** 110 m

106. Question | 9702 Oct-Nov 2021 P1 V3 Q6

- 6 The graph shows the variation with time of the acceleration of a car.



What **must** the shaded area under the graph represent?

- A the average velocity of the car
- B the change in velocity of the car
- C the final velocity of the car
- D the initial velocity of the car

107. Question | 9702 Oct-Nov 2021 P1 V3 Q7

- 7 A stone is thrown horizontally off a cliff and then lands in the sea. Air resistance is negligible.

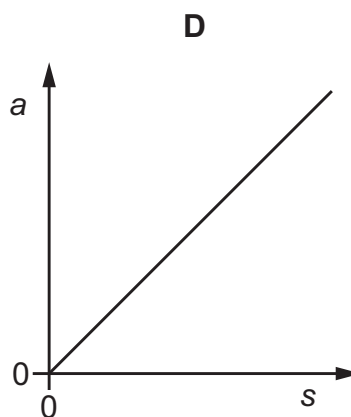
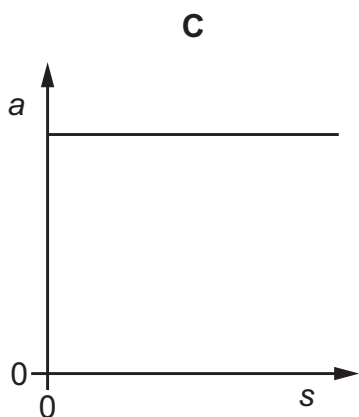
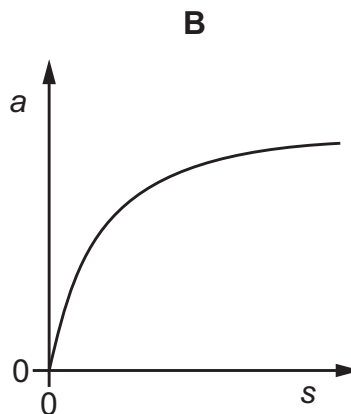
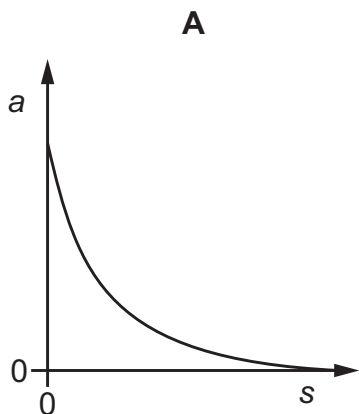
Which statement about the stone's motion is **not** correct?

- A The final displacement of the stone depends upon its initial horizontal velocity.
- B The stone travels with a constant horizontal component of velocity until it hits the water.
- C The stone travels with an increasing vertical component of velocity.
- D The time taken for the stone to hit the surface of the water depends on its initial horizontal velocity.

108. Question | 9702 Oct-Nov 2021 P1 V3 Q9

- 9** A skydiver leaves a stationary balloon and falls vertically through a long distance.

Which graph best represents the variation of the acceleration a of the skydiver with the distance s travelled as she falls through the air?



109. Question | 9702 Feb-March 2022 P1 V2 Q5

- 5** How can the acceleration of an object be determined?

- A** from the area under a displacement–time graph
- B** from the area under a velocity–time graph
- C** from the gradient of a displacement–time graph
- D** from the gradient of a velocity–time graph

110. Question | 9702 Feb-March 2022 P1 V2 Q6

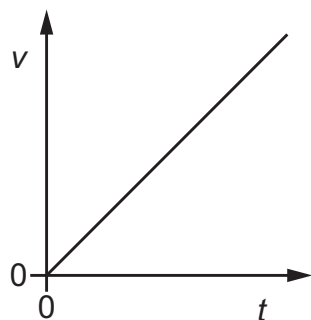
- 6** A sprinter takes a time of 11.0 s to run a 100 m race. She first accelerates uniformly from rest, reaching a speed of 10 m s^{-1} . She then runs at a constant speed of 10 m s^{-1} until the finish line.

What is the uniform acceleration of the sprinter for the first part of the race?

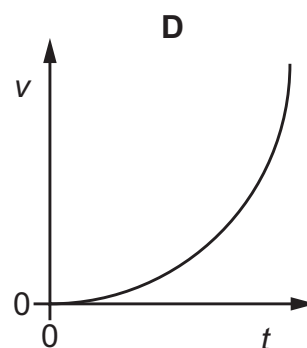
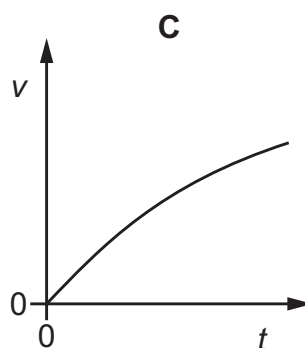
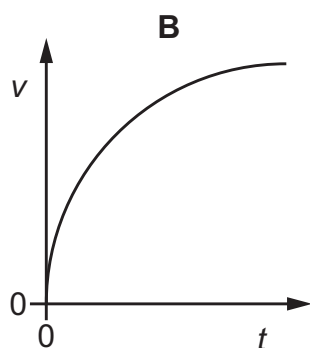
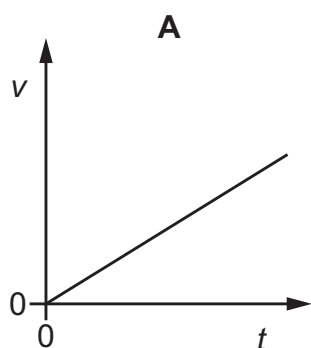
- A** 0.5 m s^{-2}
- B** 0.91 m s^{-2}
- C** 1.7 m s^{-2}
- D** 5.0 m s^{-2}

111. Question | 9702 Feb-March 2022 P1 V2 Q9

- 9 An object falls freely from rest in a vacuum. The graph shows the variation with time t of the velocity v of the object.

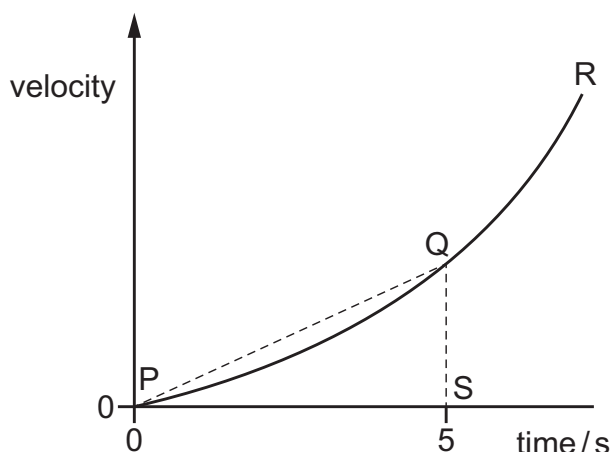


Which graph, **using the same scales**, represents the object falling in air?



112. Question | 9702 May-June 2022 P1 V1 Q5

- 5** The curved line PQR is the velocity–time graph for a car starting from rest.



What is the average acceleration of the car over the first 5 s?

- A** the area below the curve PQ
- B** the area of the triangle PQS
- C** the gradient of the straight line PQ
- D** the gradient of the tangent at Q

113. Question | 9702 May-June 2022 P1 V1 Q6

- 6** A ball is thrown horizontally with a speed of 10.0 m s^{-1} above horizontal ground. The ball hits the ground after a time of 3.0 s.

Air resistance is negligible.

What is the speed of the ball just before it hits the ground?

- A** 10 m s^{-1} **B** 29 m s^{-1} **C** 31 m s^{-1} **D** 39 m s^{-1}

114. Question | 9702 May-June 2022 P1 V2 Q4

- 4 An object is moving with an initial velocity of 4.0 m s^{-1} to the right. The velocity of the object changes so that its final velocity is 3.0 m s^{-1} downwards, as shown.

initial velocity
 4.0 m s^{-1}

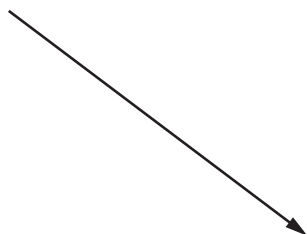


final velocity
 3.0 m s^{-1}

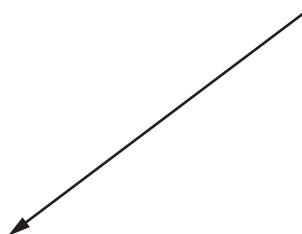


Which arrow represents the change in velocity of the object?

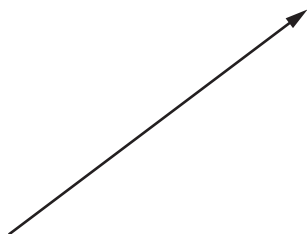
A



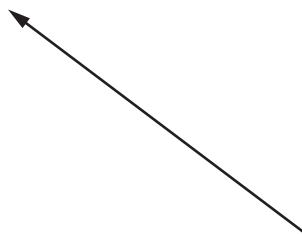
B



C



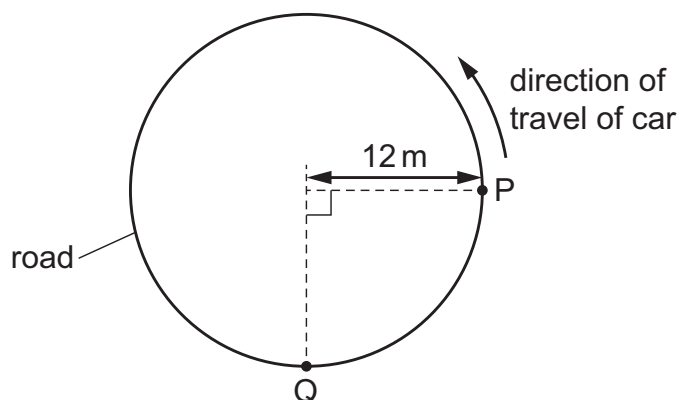
D



115. Question | 9702 May-June 2022 P1 V2 Q5

- 5** A car travels anticlockwise along a horizontal circular road of radius 12 m, as shown.

The car takes a time of 4.0 s to move from position P to position Q.



What is the magnitude of the average velocity of the car for the journey from P to Q?

- A** 4.2 m s^{-1} **B** 4.7 m s^{-1} **C** 6.0 m s^{-1} **D** 14 m s^{-1}

116. Question | 9702 May-June 2022 P1 V2 Q6

- 6** The water surface in a deep well is 78.0 m below the top of the well. A person at the top of the well drops a heavy stone down the well.

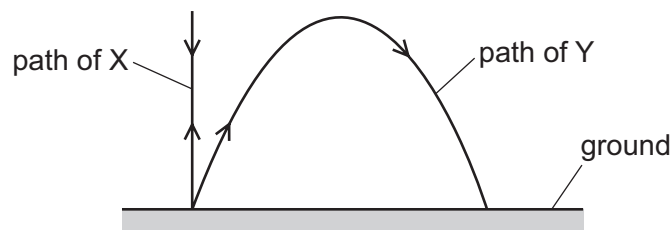
Air resistance is negligible. The speed of sound in the air is 330 m s^{-1} .

What is the time interval between the person dropping the stone and hearing it hitting the water?

- A** 3.75 s **B** 3.99 s **C** 4.19 s **D** 4.22 s

117. Question | 9702 May-June 2022 P1 V3 Q6

- 6** Two projectiles, X and Y, are fired into the air from the same place on level ground and reach the same maximum height, as shown.



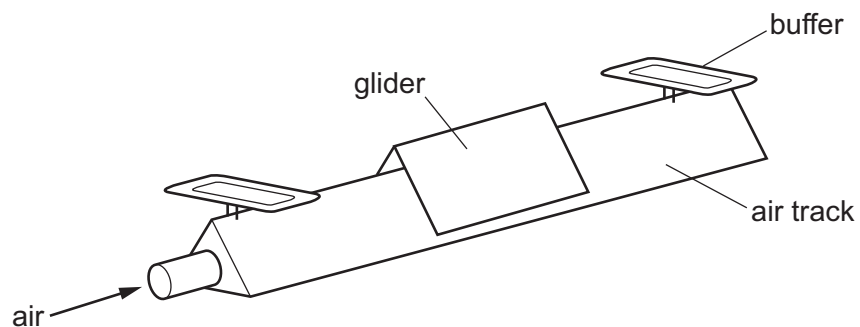
Projectile X is fired vertically upwards and projectile Y is fired at an angle to the horizontal.

Air resistance is negligible.

Which statement is correct?

- A** X and Y are at rest at their maximum heights.
- B** X and Y are fired with the same speed.
- C** X and Y take the same time to return to the ground.
- D** X and Y travel the same distance.

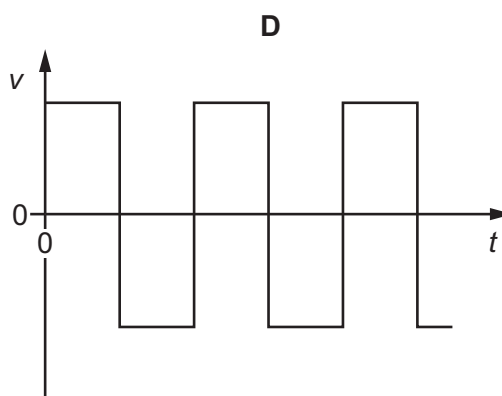
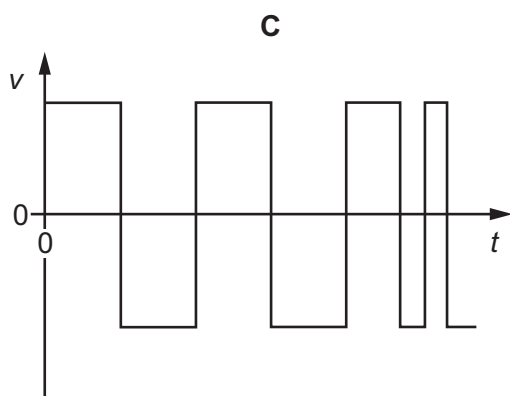
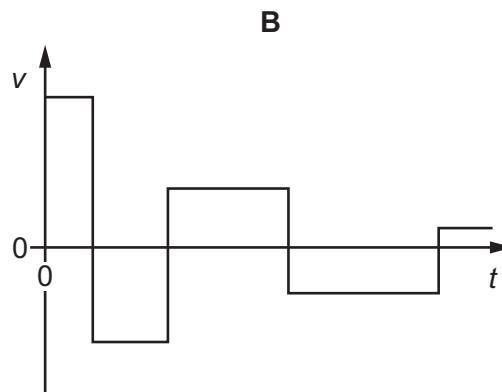
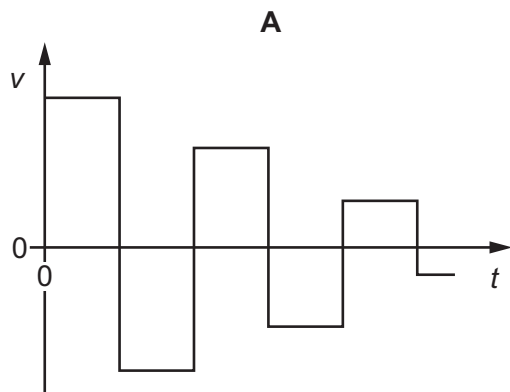
- 7 A small glider moves along a horizontal air track as shown.



At each end of the air track, the glider has a perfectly elastic collision with a fixed buffer.

The glider moves at a constant speed between collisions.

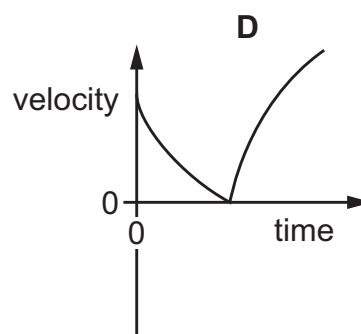
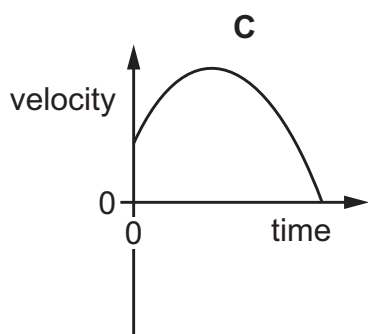
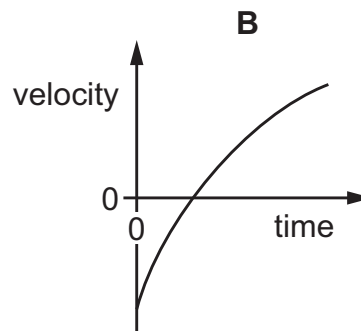
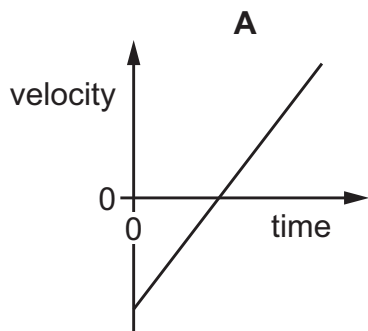
Which graph represents the variation with time t of the velocity v of the glider as it moves between the two buffers?



- 10** A person stands on the edge of a high cliff that is next to the sea. The person throws a stone vertically upwards. Air resistance acts on the stone.

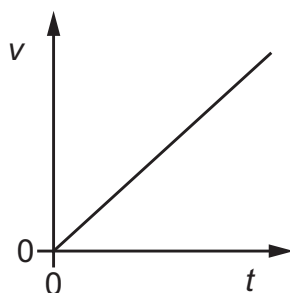
The stone eventually hits the sea.

Which velocity–time graph best shows the motion of the stone from when it is released until it hits the sea?

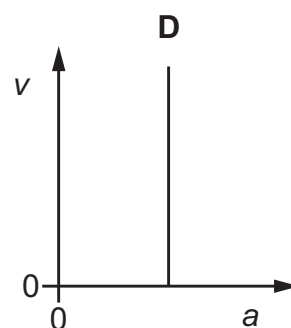
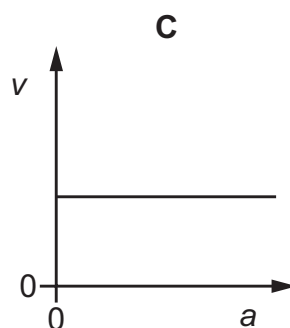
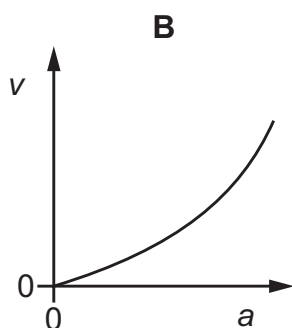
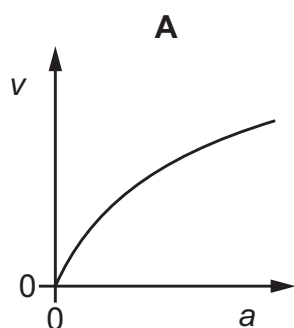


5 A particle accelerates from rest.

The graph shows the variation of the velocity v of the particle with time t .

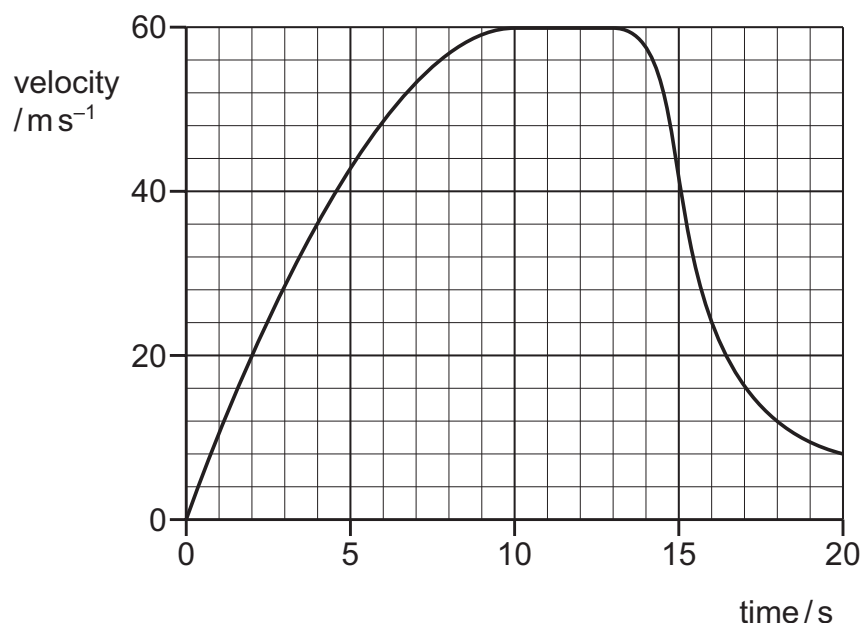


Which graph shows the variation of the velocity v with the acceleration a of the particle?



121. Question | 9702 Oct-Nov 2022 P1 V1 Q6

- 6 The graph shows the vertical velocity of a parachutist during the first 20 s of her jump.



Approximately how far does she fall **before** opening the parachute?

- A** 390 m **B** 570 m **C** 710 m **D** 770 m

122. Question | 9702 Oct-Nov 2022 P1 V2 Q5

- 5 A toy car travels on a circular track at a constant speed of 0.50 m s^{-1} . It passes a point on the track at time $t = 0$ and takes a time of 40 s to travel once around the track.

The magnitude of the average velocity of the car between $t = 0$ and $t = 20 \text{ s}$ is v_{20} .

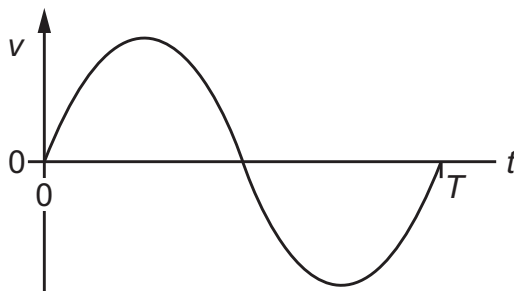
The magnitude of the average velocity of the car between $t = 0$ and $t = 40 \text{ s}$ is v_{40} .

What are v_{20} and v_{40} ?

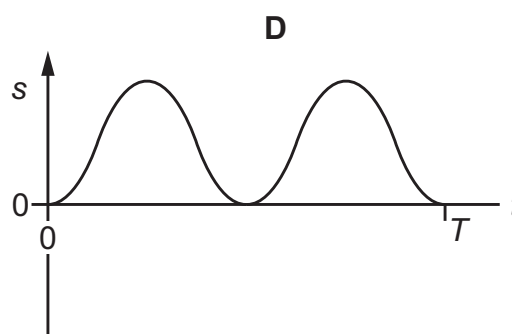
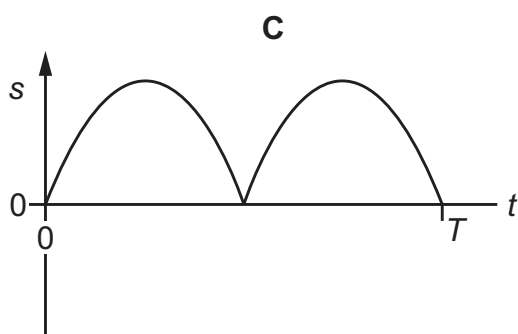
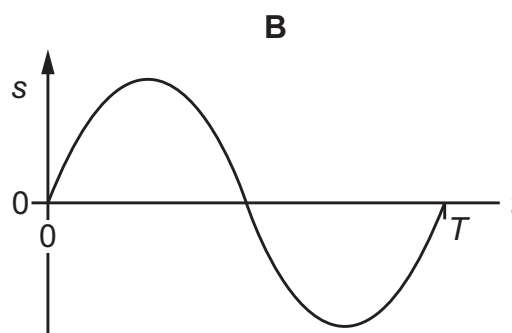
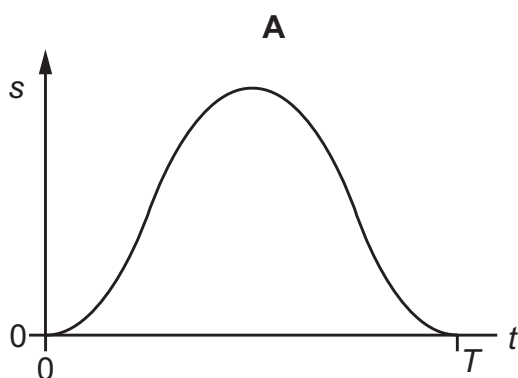
	$v_{20} / \text{m s}^{-1}$	$v_{40} / \text{m s}^{-1}$
A	0.32	0
B	0.32	0.32
C	0.50	0
D	0.50	0.50

123. Question | 9702 Oct-Nov 2022 P1 V2 Q6

- 6** The graph shows how the velocity v of an object moving in a straight line varies with time t from $t = 0$ to $t = T$.



Which graph could represent the displacement s of the object from time $t = 0$ to $t = T$?



124. Question | 9702 Oct-Nov 2022 P1 V2 Q7

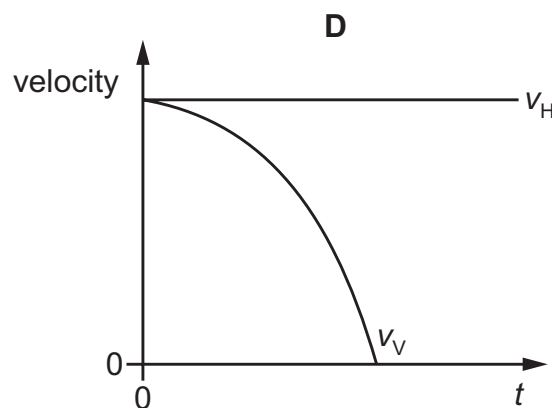
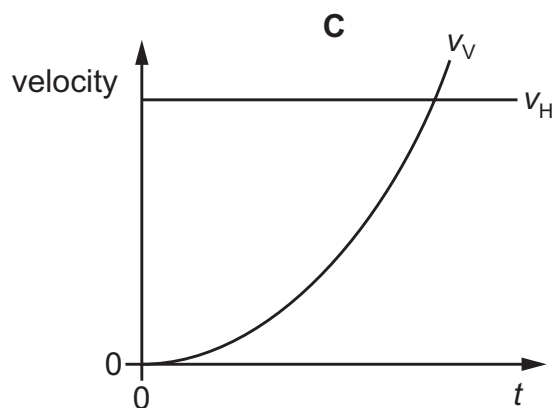
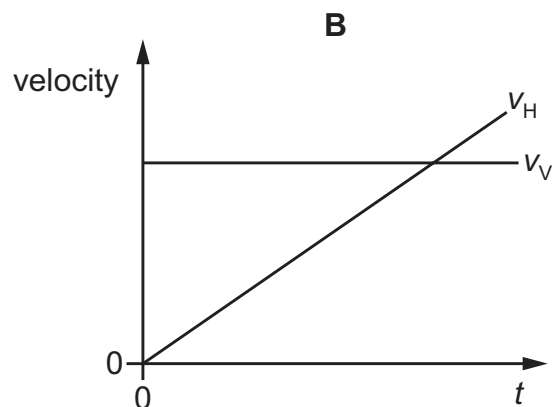
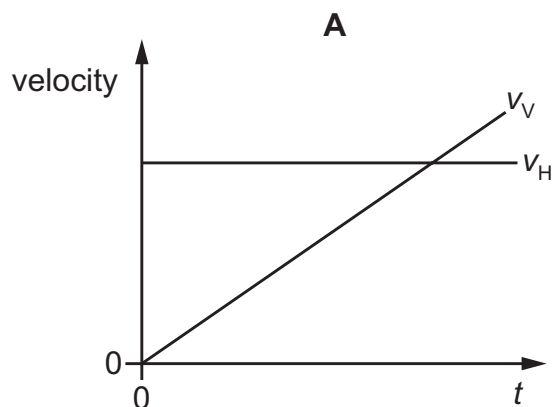
- 7** A goods train passes through a station at a steady speed of 10 ms^{-1} at time $t = 0$. An express train is at rest at the station. The express train leaves the station with a uniform acceleration of 0.5 ms^{-2} just as the goods train goes past. Both trains move in the same direction on straight, parallel tracks.

At which time t does the express train overtake the goods train?

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

- 5** A stone is projected horizontally at time $t = 0$ and falls. Air resistance is negligible. The stone has a horizontal component of velocity v_H and a vertical component of velocity v_V .

Which graph shows how v_H and v_V vary with time t ?



126. Question | 9702 Oct-Nov 2022 P1 V3 Q6

6 On the Earth, an object takes time T_E to fall from rest through a vertical distance h .

On the Moon, the same object takes time T_M to fall from rest through the same vertical distance h .

The ratio $\frac{\text{acceleration of free fall on the Earth}}{\text{acceleration of free fall on the Moon}}$ is equal to 6.

Air resistance is negligible for the object on the Earth and on the Moon.

What is the ratio $\frac{T_E}{T_M}$?

A $\frac{1}{6}$

B $\frac{1}{\sqrt{6}}$

C $\sqrt{6}$

D 6

127. Question | 9702 Specimen 2022 P1 Q5

5 A girl throws a ball vertically upwards. It takes a time of 3.20 s to return to her hand.

Assume air resistance is negligible.

What is the initial speed with which the ball is thrown?

A 3.07 ms^{-1}

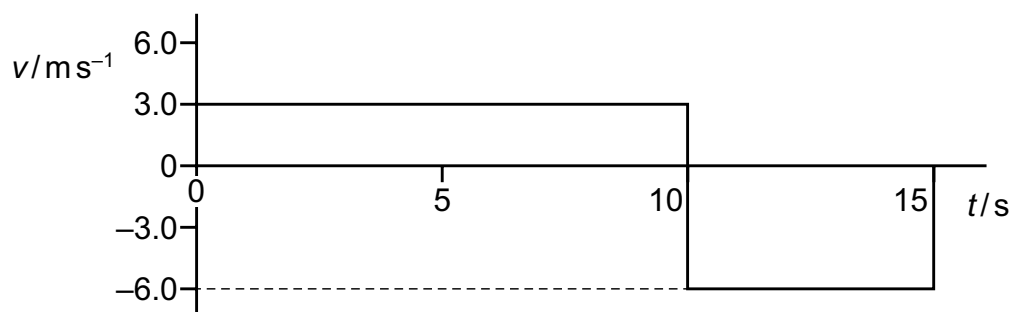
B 7.85 ms^{-1}

C 15.7 ms^{-1}

D 31.4 ms^{-1}

- 6** A radio-controlled toy car travels along a straight line for a time of 15 s.

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



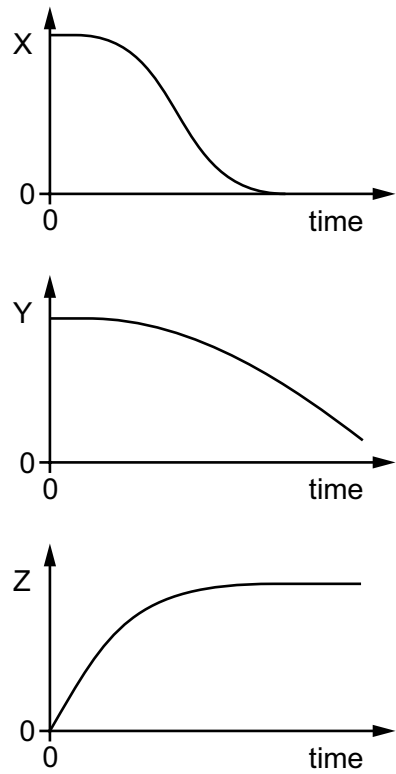
What is the average velocity of the toy car for the journey shown by the graph?

- A** -1.5 ms^{-1} **B** 0.0 ms^{-1} **C** 4.0 ms^{-1} **D** 4.5 ms^{-1}

9 An object is dropped at time $t = 0$ from a high building. Air resistance is significant.

Three graphs are plotted against time:

- the height of the object above the ground
- the speed of the object
- the magnitude of the resultant force on the object.



What are the quantities X, Y and Z?

	height of the object above the ground	speed of the object	magnitude of the resultant force on the object
A	X	Y	Z
B	X	Z	Y
C	Y	Z	X
D	Z	Y	X

130. Question | 9702 Feb-March 2023 P1 V2 Q5

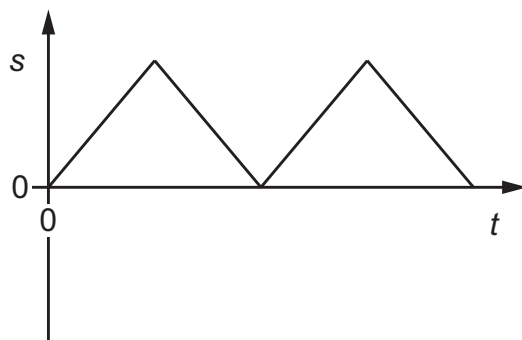
- 5** A ball is kicked upwards at an angle of 45° to horizontal ground. After a short flight, the ball returns to the ground.

It may be assumed that air resistance is negligible.

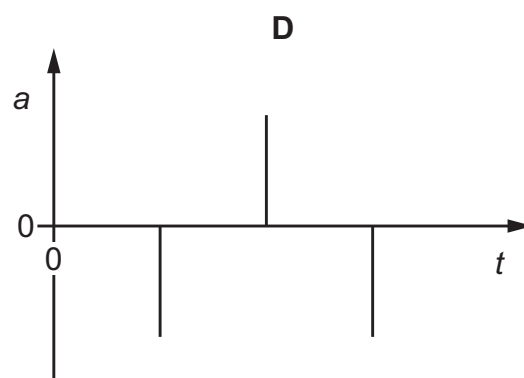
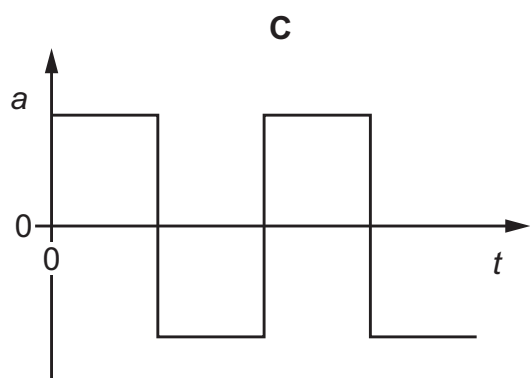
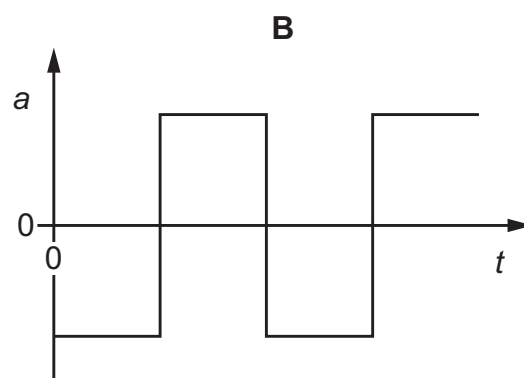
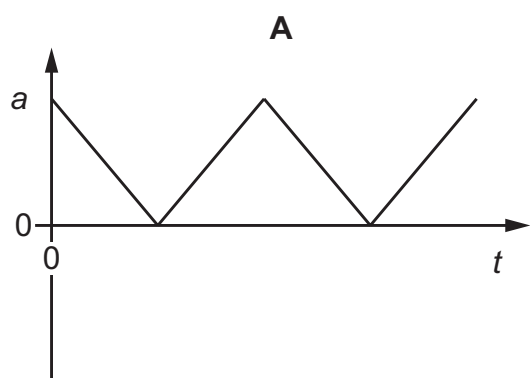
What is **never** zero during the flight of the ball?

- A** the horizontal component of the ball's acceleration
- B** the horizontal component of the ball's velocity
- C** the vertical component of the ball's momentum
- D** the vertical component of the ball's velocity

- 6 The graph shows the variation with time t of the displacement s of an object.



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



- 5** One object moves directly from P to R.



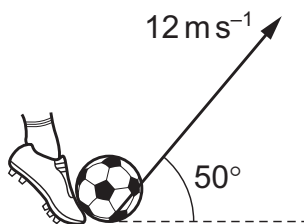
In a shorter time, a second object moves from P to Q to R.

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.

133. Question | 9702 May-June 2023 P1 V1 Q6

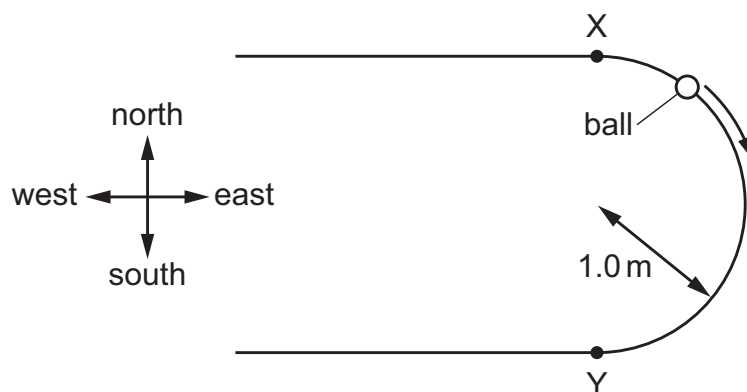
- 6** A ball is kicked so that it has an initial velocity of 12 m s^{-1} at an angle of 50° to horizontal ground. Assume that air resistance is negligible.



What is the maximum height above the ground that is reached by the ball?

- A** 0.47 m **B** 3.0 m **C** 4.3 m **D** 7.3 m

- 5** A ball travels from point X to point Y around a semicircular track of radius 1.0 m, as shown.



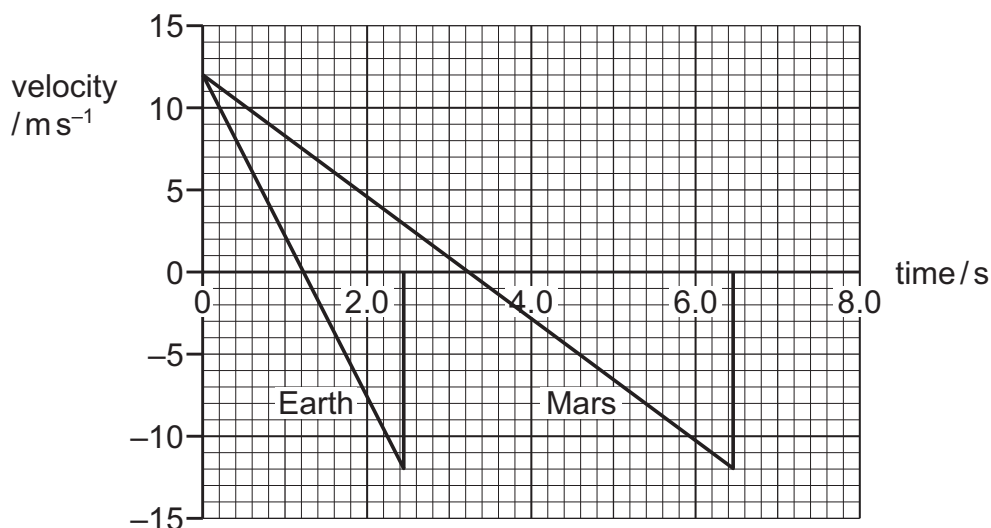
What is the displacement of the ball from X to Y?

- A** 2.0 m
- B** 2.0 m due south
- C** 3.1 m
- D** 3.1 m due south

135. Question | 9702 May-June 2023 P1 V2 Q6

- 6 A rock is launched vertically upwards from the surface of the Earth and an identical rock is launched vertically upwards from the surface of Mars. Each rock is launched with an initial velocity of 12 m s^{-1} .

Each rock then reaches its maximum height above the surface before returning back down to the surface. The velocity–time graph for each rock is shown. In both cases, air resistance is negligible.



What is the difference in the maximum heights of the two rocks?

- A** 12 m **B** 15 m **C** 19 m **D** 24 m

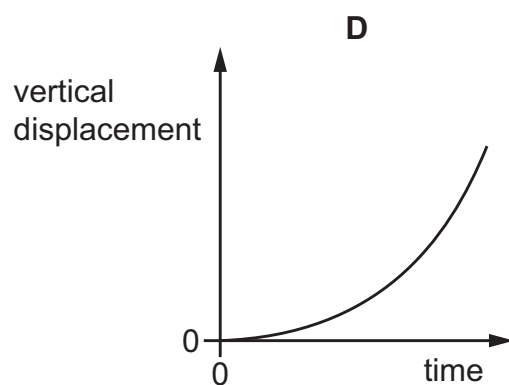
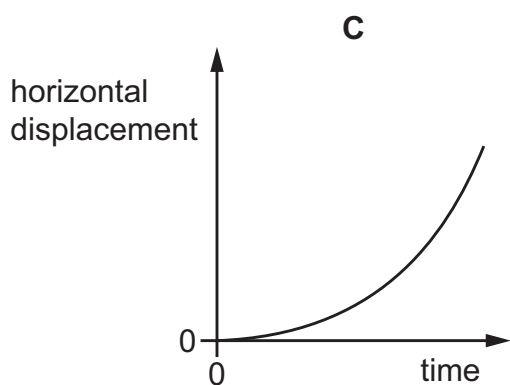
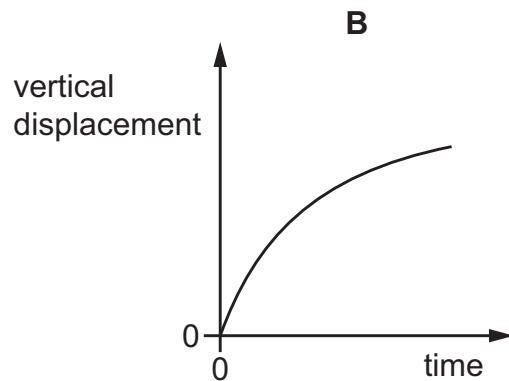
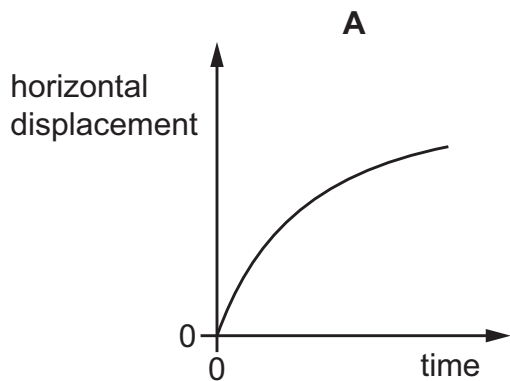
136. Question | 9702 May-June 2023 P1 V3 Q5

- 5 Which equation, representing uniformly accelerated motion in a straight line, can be determined using **only** the definition of acceleration?

- A** $s = ut + \frac{1}{2}at^2$
B $s = \frac{1}{2}(u+v)t$
C $v = u + at$
D $v^2 = u^2 + 2as$

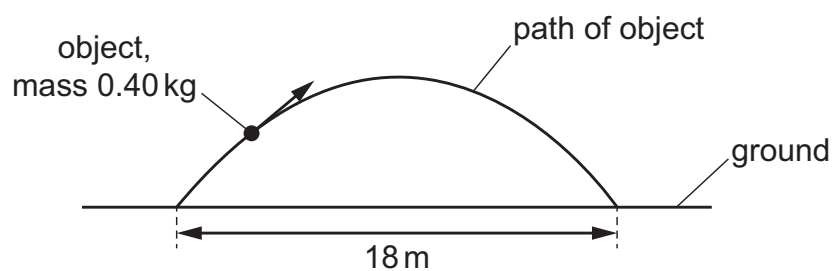
- 6** An object moves from rest with uniform velocity horizontally and uniform acceleration vertically.

Which graph showing the variation with time of the displacement of the object from its initial position is correct?



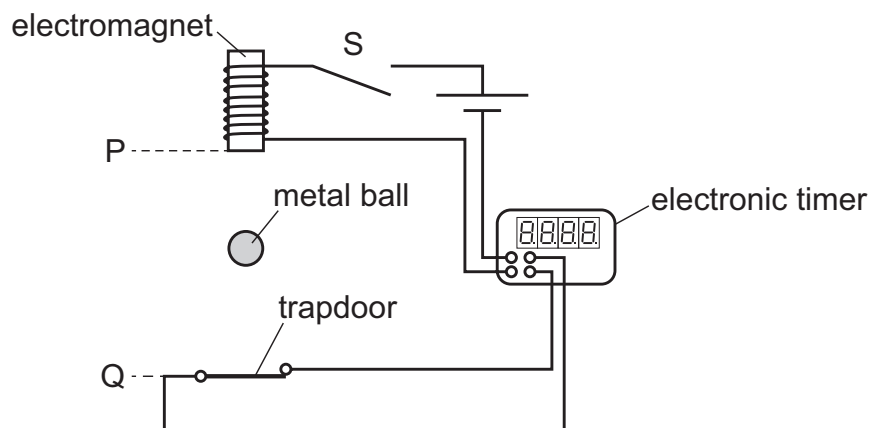
138. Question | 9702 May-June 2023 P1 V3 Q17

- 17** An object of mass 0.40 kg is projected into the air and follows a curved path above horizontal ground.



The object takes a time of 4.5 s to move along its path. The object lands a horizontal distance of

- 3** A student determines the acceleration of free fall by using a small metal ball, as shown.



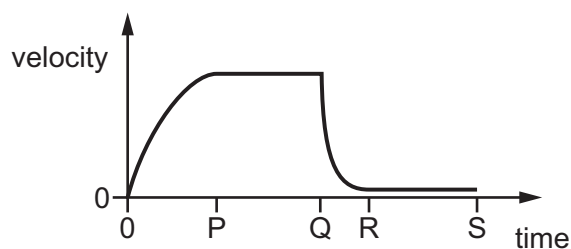
When switch S is opened, the ball is released from an electromagnet and an electronic timer is started. The ball then falls vertically downwards. The timer stops when the ball hits a trapdoor. The student measures the distance PQ between the electromagnet and the trapdoor. This distance and the reading on the timer are then used to calculate the acceleration of free fall.

Which statement about errors in the experiment is correct?

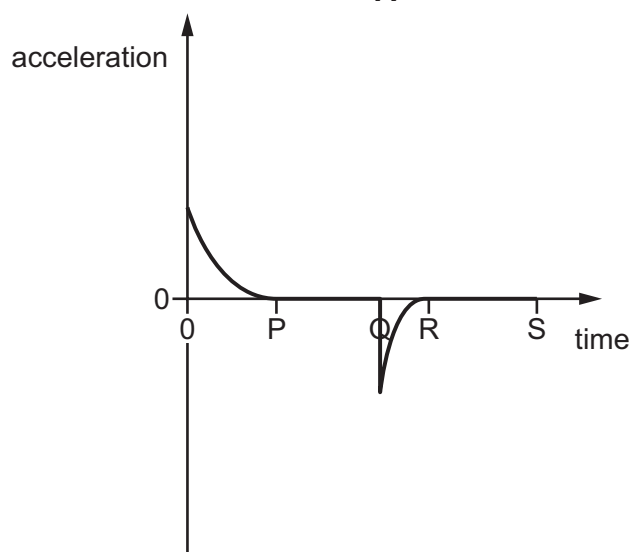
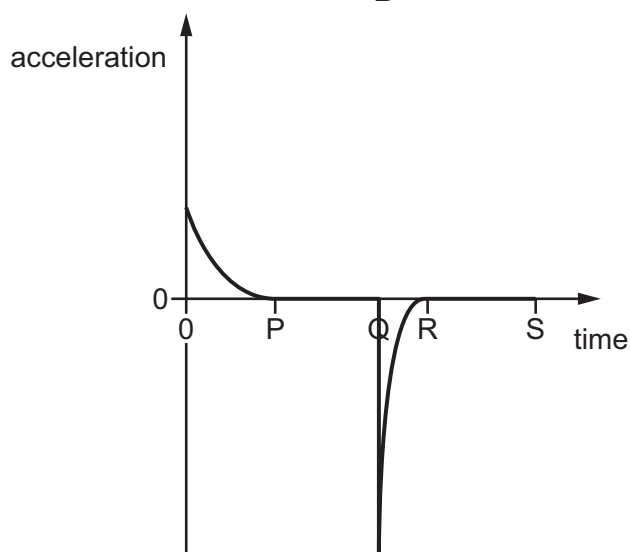
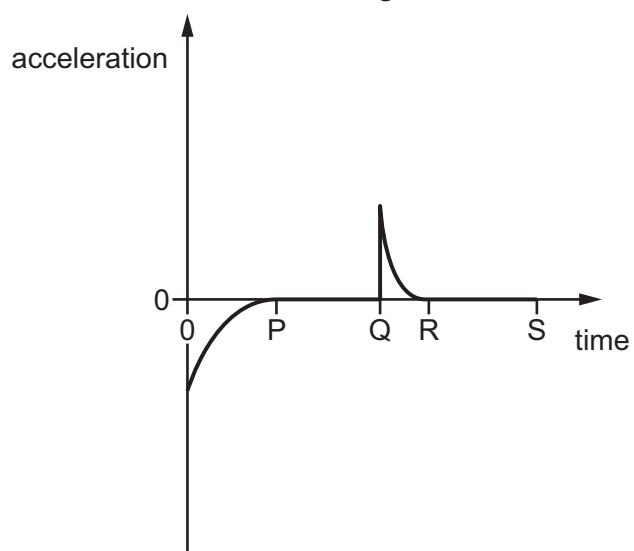
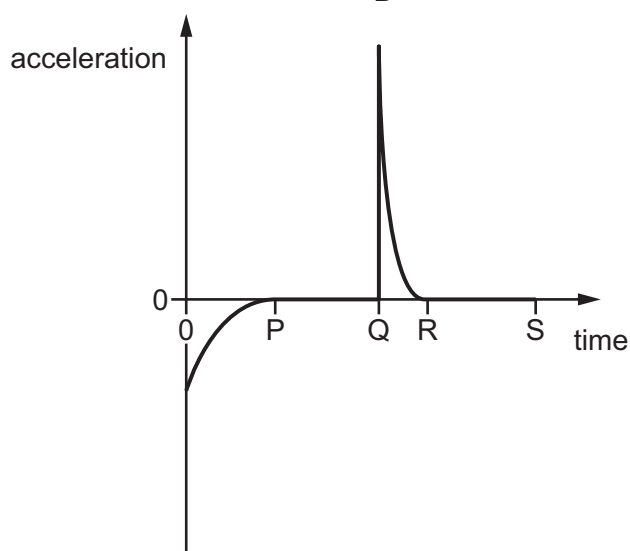
- A** The random error can be reduced by adding the diameter of the ball to the distance PQ.
- B** The random error can be reduced by subtracting the diameter of the ball from the distance PQ.
- C** The systematic error can be reduced by adding the diameter of the ball to the distance PQ.
- D** The systematic error can be reduced by subtracting the diameter of the ball from the distance PQ.

140. Question | 9702 Oct-Nov 2023 P1 V1 Q5

- 5 A parachutist falls from a stationary balloon at time $t = 0$. The velocity–time graph for the parachutist from time $t = 0$ until the time when he is just above the ground is shown.

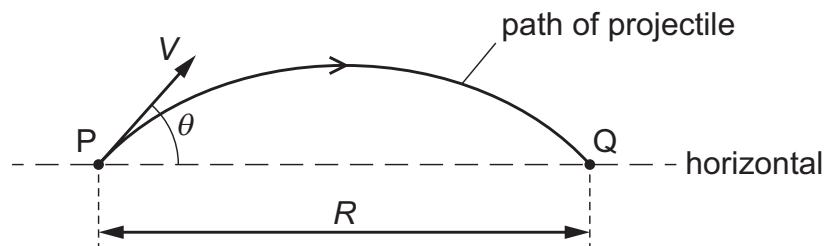


Which graph best shows the variation with time of the acceleration of the parachutist?

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

141. Question | 9702 Oct-Nov 2023 P1 V1 Q6

- 6** A projectile is fired from point P with velocity V at an angle θ to the horizontal. It lands at point Q, a horizontal distance R from P, after time T .



The acceleration of free fall is g . Air resistance is negligible.

Which equation is correct?

- A** $R = VT \cos \theta$
- B** $R = VT \sin \theta$
- C** $R = VT \cos \theta - \frac{1}{2}gT^2$
- D** $R = VT \sin \theta - \frac{1}{2}gT^2$

142. Question | 9702 Oct-Nov 2023 P1 V2 Q3

- 3** A student takes measurements to determine the constant acceleration of a model car moving from rest in a straight line. The measured values with their absolute uncertainties are shown.

quantity	measured value	uncertainty
displacement	16.5 m	± 0.1 m
time	15.0 s	± 1.0 s

The student uses the equation $s = \frac{1}{2}at^2$ to calculate the acceleration of the car.

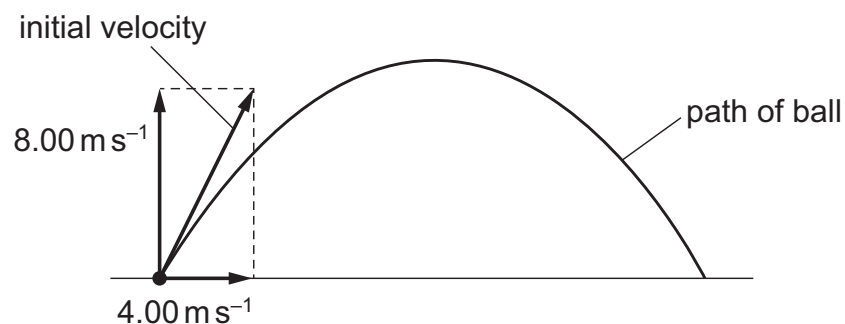
What is the acceleration and its absolute uncertainty?

- A** $(0.11 \pm 0.01) \text{ m s}^{-2}$
B $(0.11 \pm 0.02) \text{ m s}^{-2}$
C $(0.15 \pm 0.01) \text{ m s}^{-2}$
D $(0.15 \pm 0.02) \text{ m s}^{-2}$

143. Question | 9702 Oct-Nov 2023 P1 V2 Q5

- 5** What is the definition of acceleration?
- A** the rate of change of displacement
B the rate of change of kinetic energy
C the rate of change of momentum
D the rate of change of velocity

- 6** An astronaut on the Moon, where there is no air resistance, throws a ball. The ball's initial velocity has a vertical component of 8.00 m s^{-1} and a horizontal component of 4.00 m s^{-1} , as shown.

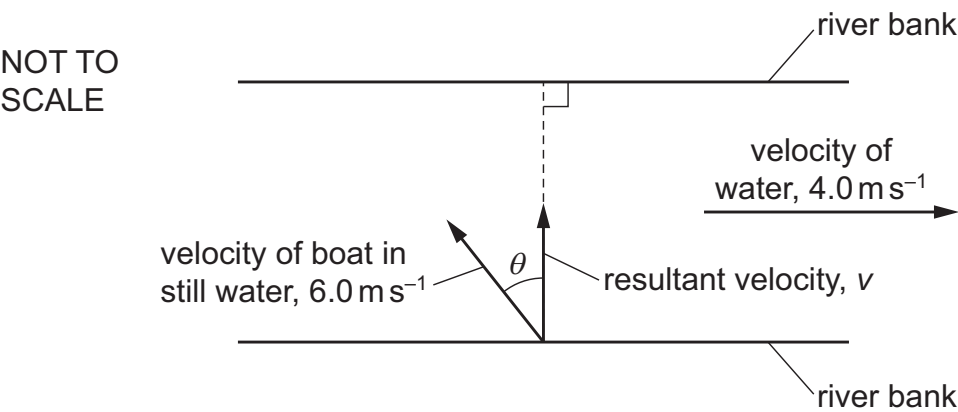


The acceleration of free fall on the Moon is 1.62 m s^{-2} .

What is the speed of the ball 9.00 s after being thrown?

- A** 6.58 m s^{-1} **B** 7.70 m s^{-1} **C** 10.6 m s^{-1} **D** 14.6 m s^{-1}

4 A boat is crossing a river in which the water is moving at a speed of 4.0 m s^{-1} from left to right.



In still water, the speed of the boat is 6.0 m s^{-1} . The boat is directed at an angle θ to a line perpendicular to the river banks. The resultant velocity v of the boat is in a direction perpendicular to the river banks.

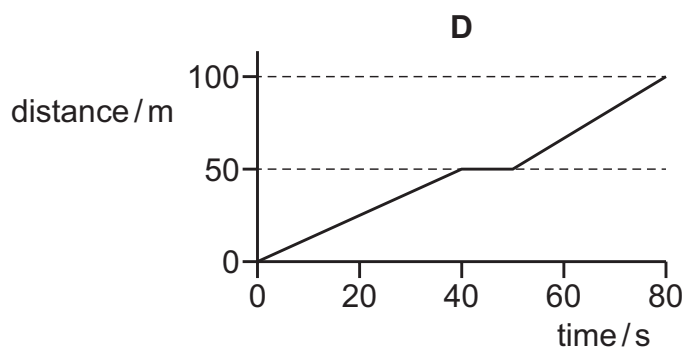
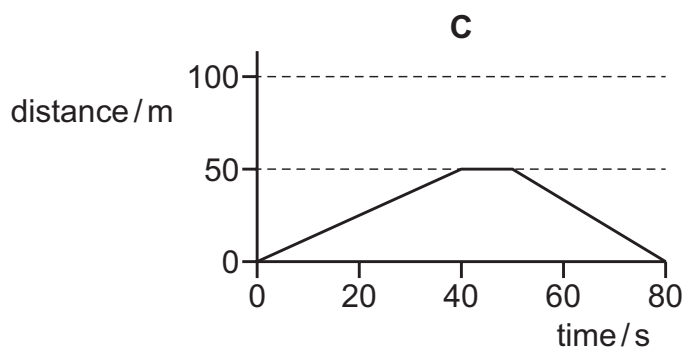
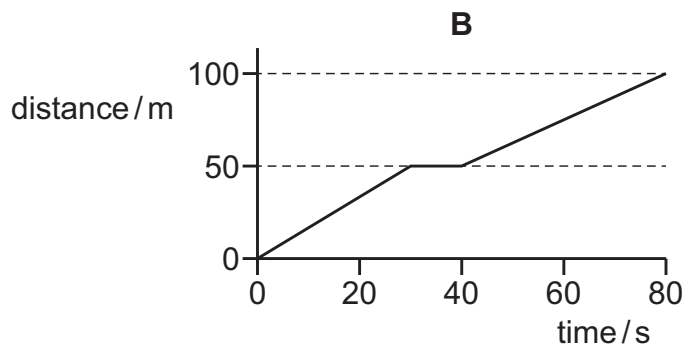
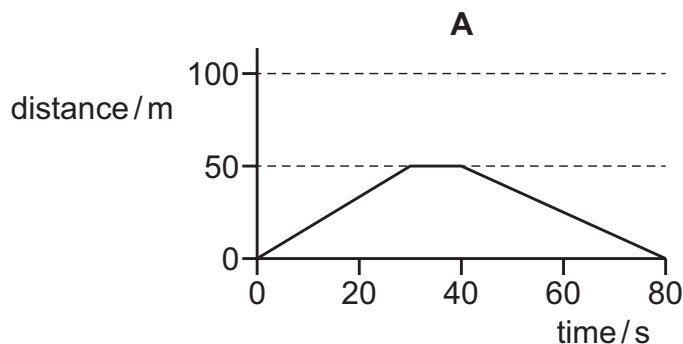
What are the values of θ and v ?

	$\theta / ^\circ$	$v / \text{m s}^{-1}$
A	42	4.5
B	42	7.2
C	48	4.5
D	48	7.2

146. Question | 9702 Oct-Nov 2023 P1 V3 Q5

- 5** A student walks at a constant speed for a distance of 50 m in a time of 40 s. The student rests for a time of 10 s and then walks back to the starting point at a constant speed in a time of 30 s.

What is the distance–time graph for the motion of the student?



147. Question | 9702 Oct-Nov 2023 P1 V3 Q6

- 6** The time taken for an object to fall from rest through a certain distance on Mars is T_M . The time taken for the same object to fall from rest through the same distance on Earth is T_E . The acceleration of free fall on Mars is 3.71 m s^{-2} .

Assume that air resistance is negligible on both Earth and Mars.

What is the ratio $\frac{T_M}{T_E}$?

- A** 0.378 **B** 0.615 **C** 1.63 **D** 2.64

148. Question | 9702 Feb-March 2024 P1 V2 Q5

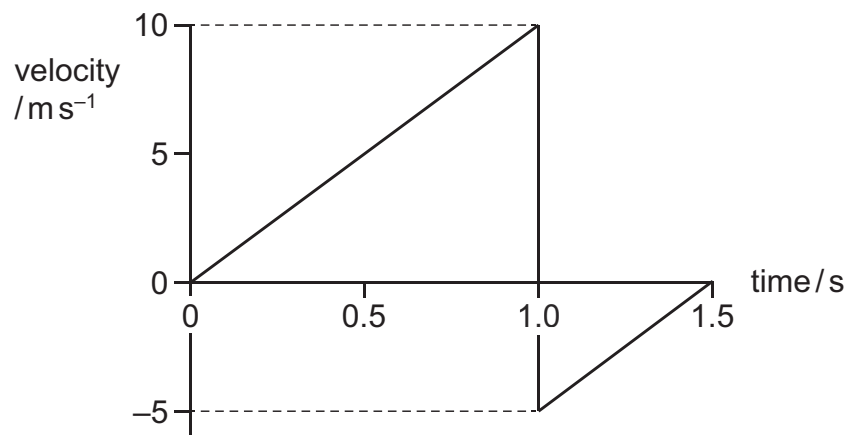
- 5** A projectile is launched at an angle of 25° to the horizontal with a horizontal component of velocity of 13 m s^{-1} .

What is the vertical component of the velocity of the projectile when it is launched?

- A** 5.5 m s^{-1} **B** 6.1 m s^{-1} **C** 12 m s^{-1} **D** 14 m s^{-1}

149. Question | 9702 Feb-March 2024 P1 V2 Q6

- 6** A ball is released from rest at position X at time zero. At 1.0 s, it bounces inelastically from a horizontal surface and rebounds, reaching the top of its first bounce at 1.5 s.



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

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

150. Question | 9702 Feb-March 2024 P1 V2 Q7

- 7** What is the definition of acceleration?
- A** change in velocity per unit time
- B** rate of change of speed per unit time
- C** rate of change of velocity per unit time
- D** resultant force per unit mass

151. Question | 9702 Feb-March 2024 P1 V2 Q9

- 9** A basketball player hits a ball vertically downwards with a speed of 2.4 ms^{-1} from a height of 0.90 m .

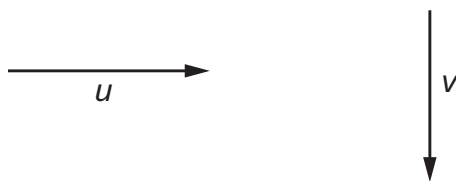
Air resistance is negligible.

What is the speed of the ball as it hits the ground?

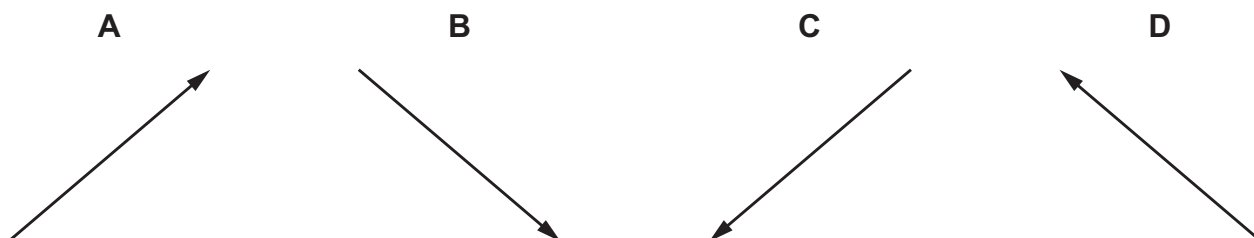
- A** 4.2 ms^{-1} **B** 4.8 ms^{-1} **C** 18 ms^{-1} **D** 23 ms^{-1}

152. Question | 9702 May-June 2024 P1 V1 Q3

- 3** The velocity of an object changes from an initial velocity u to a final velocity v . The vectors represent these velocities.



Which single vector represents the change in velocity of the object?



153. Question | 9702 May-June 2024 P1 V1 Q4

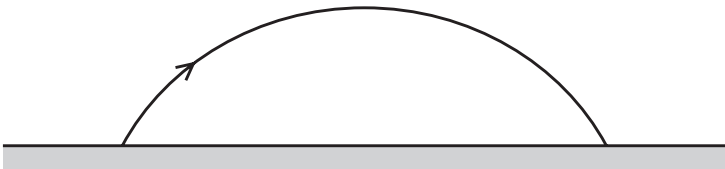
- 4 An object is moving with initial velocity u . The object then moves with uniform acceleration a for time t until it reaches final velocity v .

Which equation describes the motion of the object?

- A $u = v - 2at$ B $u = v - at$ C $v = u + at^2$ D $v = u + 2at^2$

154. Question | 9702 May-June 2024 P1 V1 Q7

- 7 The diagram shows the path of a golf ball.



Which row describes changes in the horizontal and vertical components of the golf ball’s velocity when air resistance is 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

155. Question | 9702 May-June 2024 P1 V2 Q3

- 3** A football is kicked so that it moves vertically upwards through the air.

What is the variation in the air resistance and the resultant force acting on the ball as it moves vertically upwards?

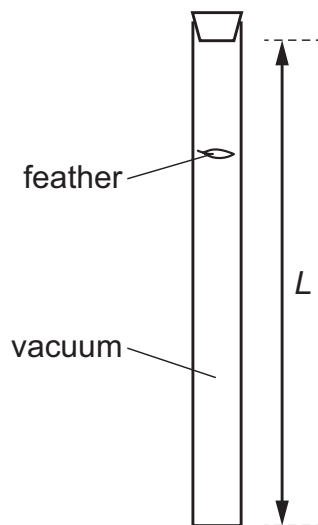
	air resistance	resultant force
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

156. Question | 9702 May-June 2024 P1 V2 Q4

- 4** Which statement is **not** correct?

- A** Acceleration can be determined from the gradient of a velocity–time graph.
- B** Acceleration is the rate of change of velocity.
- C** Displacement can be determined from the area under a velocity–time graph.
- D** Velocity is the rate of change of distance.

- 5** The diagram shows a laboratory experiment in which a feather falls from rest in a long evacuated vertical tube of length L .

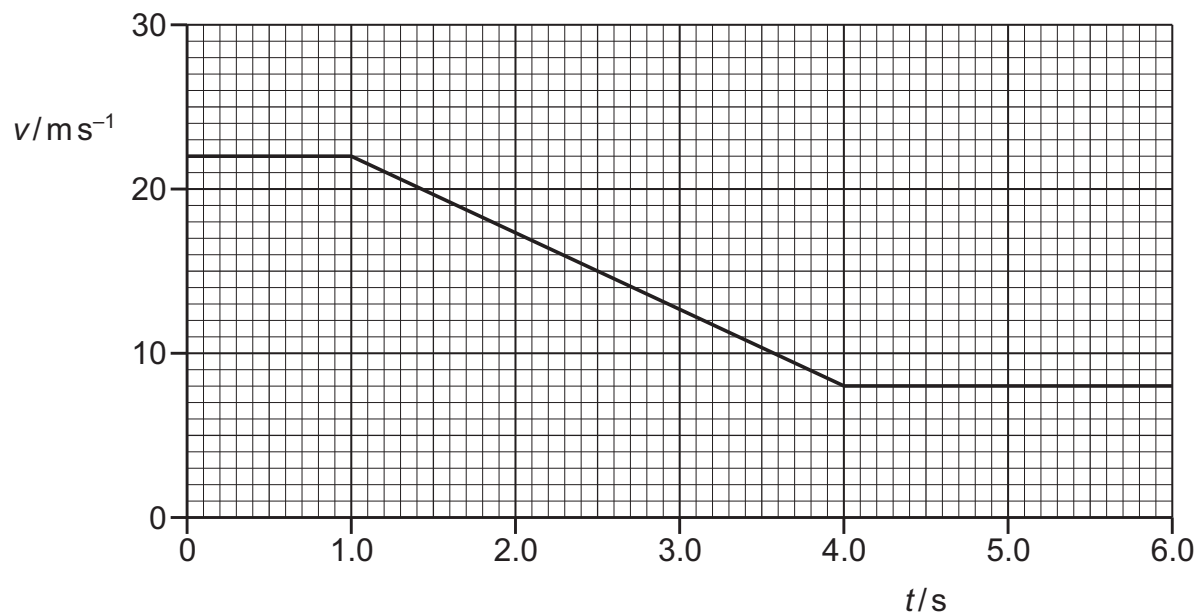


The feather takes time T to fall from the top to the bottom of the tube.

How far does the feather fall from the top of the tube in time $0.50T$?

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

- 6** A car travels along a straight horizontal road. The graph shows the variation of the velocity v of the car with time t for 6.0 s of its journey.



The brakes of the car are applied from $t = 1.0$ s to $t = 4.0$ s.

How far does the car travel while the brakes are applied?

- A** 21 m **B** 45 m **C** 67 m **D** 83 m

159. Question | 9702 May-June 2024 P1 V2 Q9

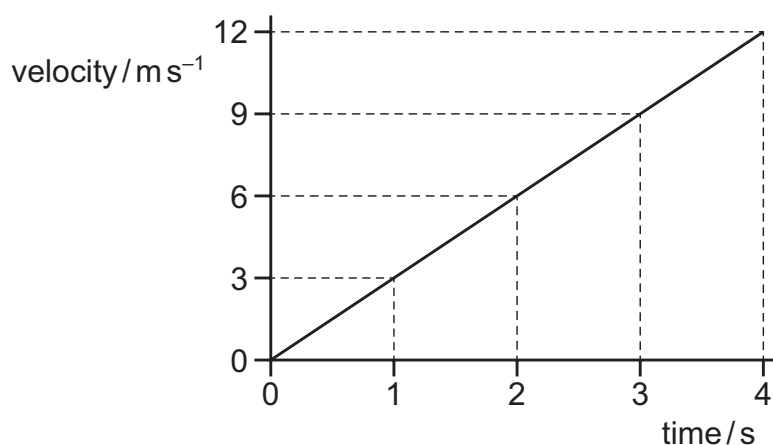
- 9** A ball collides with a wall. Before the collision, the ball moves with velocity 8 m s^{-1} to the right. After the collision, it moves with velocity 3 m s^{-1} to the left.

What is the change in velocity of the ball during the collision?

- A** 5 m s^{-1} to the left
- B** 5 m s^{-1} to the right
- C** 11 m s^{-1} to the left
- D** 11 m s^{-1} to the right

160. Question | 9702 May-June 2024 P1 V3 Q5

- 5** The diagram shows a velocity–time graph for an object moving in a straight line.

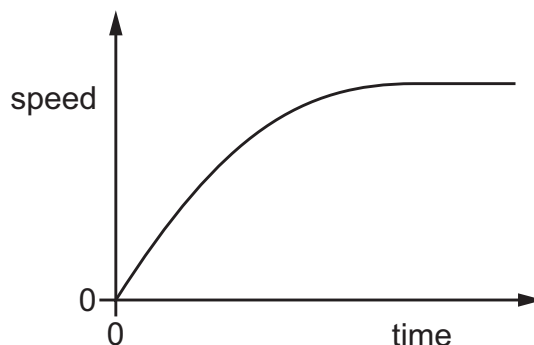


What is the displacement during the last 2 seconds of the motion?

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

161. Question | 9702 May-June 2024 P1 V3 Q8

- 8 The graph shows the variation with time of the speed of a raindrop falling vertically through air.



Which statement is correct?

- A The acceleration decreases to produce a steady speed.
- B The acceleration increases as the speed increases.
- C The air resistance decreases as the speed increases.
- D The resultant force increases as the speed increases.

162. Question | 9702 Oct-Nov 2024 P1 V1 Q5

- 5 An object is projected from horizontal ground at a velocity of magnitude u and angle θ to the horizontal. It hits the ground at a time t after it is projected. Assume air resistance is negligible.



Which statement does **not** describe the motion of this object?

- A The horizontal component of the object's velocity is constant and has the value $u \cos \theta$.
- B The horizontal distance travelled by the object is $t u \cos \theta$.
- C The time taken for the object to reach maximum height is $\frac{t}{2}$.
- D The vertical component of the object's velocity is constant and has the value $u \sin \theta$.

163. Question | 9702 Oct-Nov 2024 P1 V1 Q6

- 6** 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} .

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}

164. Question | 9702 Oct-Nov 2024 P1 V1 Q13

- 13** An object is dropped from rest on the Earth from a height of 2.0 m.

The same object is dropped from rest on the Moon from twice the height.

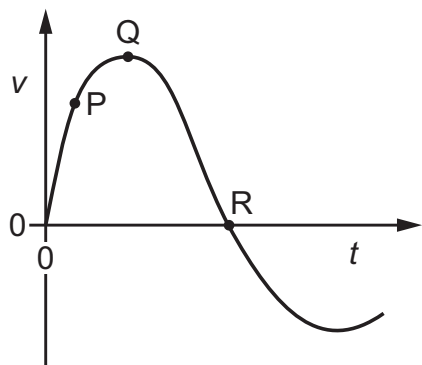
The acceleration of free fall on the Moon is approximately 16% of the value on the Earth.

Assume that there are no resistive forces acting on the object.

What is the ratio $\frac{\text{speed of the object just before hitting the surface on the Earth}}{\text{speed of the object just before hitting the surface on the Moon}}$?

- A** 1.8 **B** 2.5 **C** 3.1 **D** 3.5

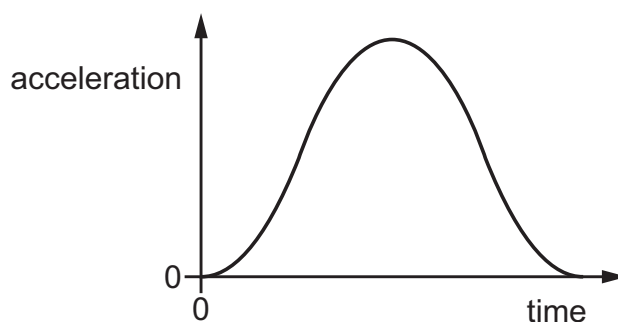
14 The graph shows how velocity v varies with time t for a bungee jumper.



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

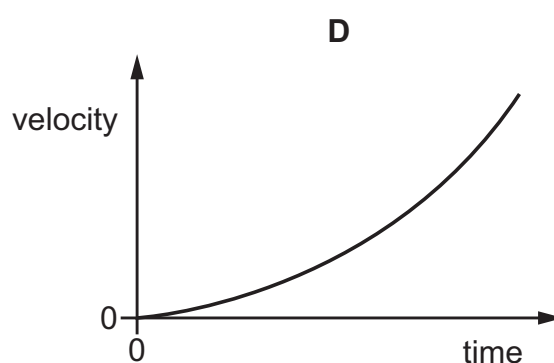
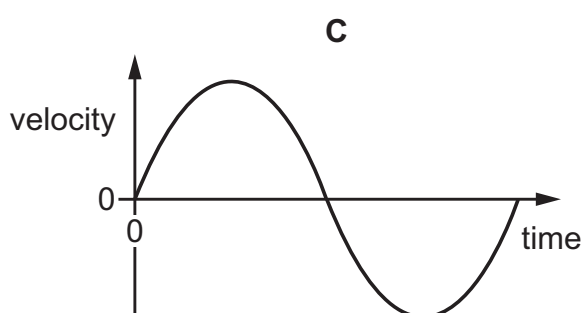
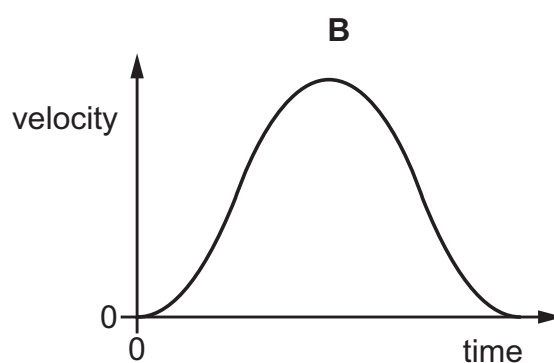
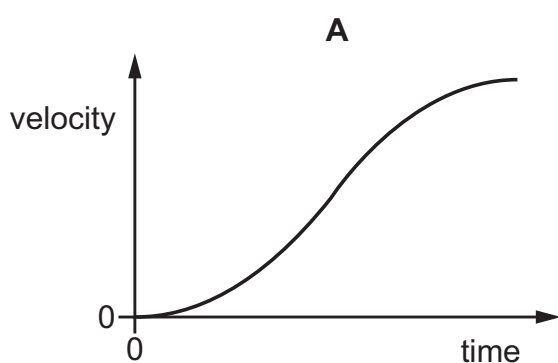
	jumper at rest	jumper with zero acceleration
A	Q	P
B	Q	R
C	R	Q
D	R	R

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



The object starts from rest.

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



167. Question | 9702 Oct-Nov 2024 P1 V2 Q5

- 5** A stone falls vertically from rest. Air resistance is negligible.

What is the speed of the stone when it has fallen through a distance of 0.40 m?

- A** 2.0 ms^{-1} **B** 2.8 ms^{-1} **C** 3.9 ms^{-1} **D** 7.8 ms^{-1}

168. Question | 9702 Oct-Nov 2024 P1 V2 Q6

- 6** A ball is thrown horizontally off a tall building. The ground is horizontal. Air resistance is negligible.

Which statement about the motion of the ball is correct?

- A** The acceleration of the ball is always at right angles to the path of the ball.
B The ball follows a circular path until it hits the ground.
C The ball has constant acceleration.
D The ball's time in the air is proportional to the velocity at which the ball is thrown.

-

	X	Y
A	time	acceleration
B	time	height above surface
C	distance moved	kinetic energy
D	distance moved	velocity

-
- A diagram showing a projectile launched from the top of a building. The building is represented by a grey rectangle on the left. A horizontal dashed line extends from the top of the building to the right, with an arrow pointing right labeled 10 m s^{-1} . A curved arrow shows the parabolic path of the projectile, starting from the top of the building and ending at the ground. A vertical double-headed arrow on the right indicates the height of the building is 8.0 m . The ground is represented by a horizontal line at the bottom, labeled "ground".

A 0.61s **B** 0.80s **C** 1.3s **D** 1.6s

171. Question | 9702 Oct-Nov 2024 P1 V3 Q7

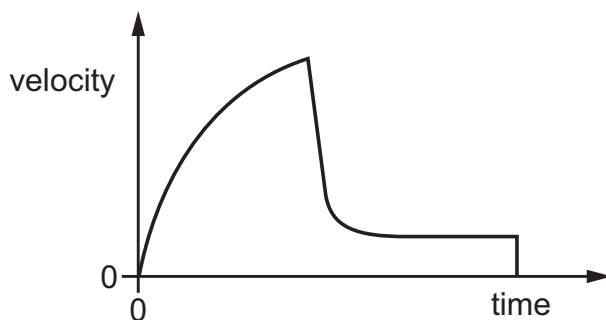
- 7 Two identical balls are projected vertically upwards from ground level with the same initial velocity. Ball X is in a vacuum and ball Y is in air.

Which statement about the motion of the balls is correct?

- A Ball X reaches a greater maximum height and in a longer time than ball Y.
- B Ball X reaches a greater maximum height and in a shorter time than ball Y.
- C Ball Y reaches a greater maximum height and in a longer time than ball X.
- D Ball Y reaches a greater maximum height and in a shorter time than ball X.

172. Question | 9702 Oct-Nov 2024 P1 V3 Q8

- 8 The graph shows the variation of velocity with time for a stone that falls from a bridge into a lake and sinks to the bottom of the lake.



What can be deduced about the motion of the stone?

- A Terminal velocity was reached in air.
- B The acceleration in air was decreasing with increasing time.
- C The distance travelled in water was greater than the distance travelled in air.
- D The rate of change of velocity in air was constant.

173. Question | 9702 Feb-March 2025 P1 V2 Q4

- 4** An aircraft, initially stationary on a runway, takes off with a speed of 85 km h^{-1} in a distance of no more than 1.20 km.

What is the minimum constant acceleration necessary for the aircraft?

- A** 0.23 m s^{-2} **B** 0.46 m s^{-2} **C** 3.0 m s^{-2} **D** 6.0 m s^{-2}

174. Question | 9702 Feb-March 2025 P1 V2 Q5

- 5** An object is fired upwards from horizontal ground. The object has an initial velocity of 20 m s^{-1} at an angle of 45° to the horizontal. Air resistance is negligible.

Which statement describes the speed of the object after it is fired until immediately before it reaches the ground again?

- A** Its speed decreases to a value greater than zero, then increases to 20 m s^{-1} .
B Its speed decreases to a value greater than zero, then increases to a value greater than 20 m s^{-1} .
C Its speed decreases to zero, then increases to 20 m s^{-1} .
D Its speed decreases to zero, then increases to a value less than 20 m s^{-1} .

175. Question | 9702 May-June 2025 P1 V1 Q5

- 5** A ball is projected vertically downwards with an initial velocity of 20 m s^{-1} . Air resistance is negligible.

What is the displacement from its initial position of the ball after a time of 1.5 s?

- A** 11 m **B** 19 m **C** 37 m **D** 41 m

176. Question | 9702 May-June 2025 P1 V1 Q6

- 6** A surveyor's device emits a pulse of light. The light is reflected from a wall 150 m away.

What is the total time taken for the pulse to travel from the device to the wall and then back to the device?

- A** 0.05 ns **B** 0.10 ns **C** 0.50 μs **D** 1.0 μs

177. Question | 9702 May-June 2025 P1 V1 Q7

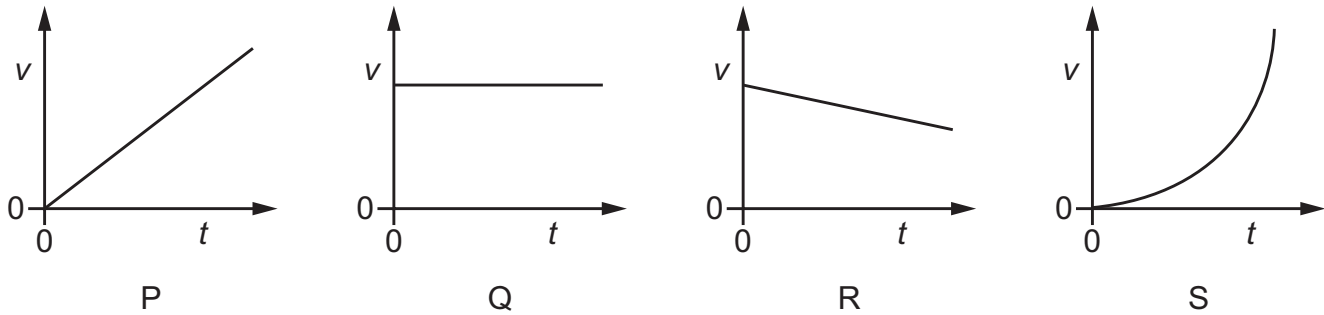
- 7** Which equation of uniformly accelerated motion can be derived using only the gradient of a velocity–time graph?

- A** $s = \frac{1}{2}(u + v)t$
B $s = ut + \frac{1}{2}at^2$
C $v = u + at$
D $v^2 = u^2 + 2as$

178. Question | 9702 May-June 2025 P1 V1 Q8

8 An object is projected horizontally from a table at time $t = 0$. The object falls in a uniform gravitational field. Air resistance is negligible.

Graphs P, Q, R and S are velocity–time graphs.

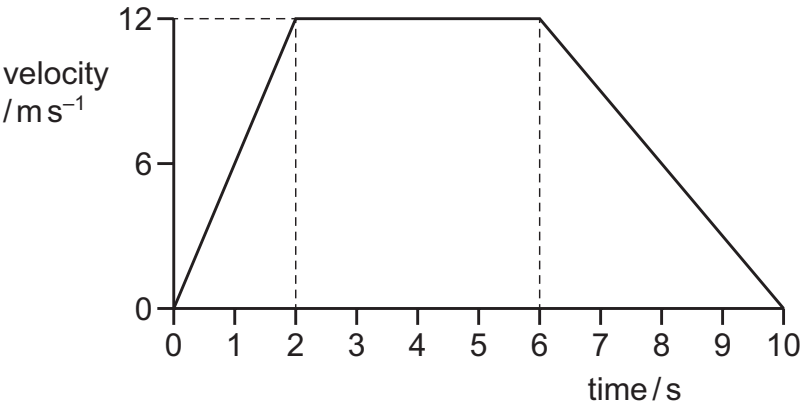


Which graphs represent the horizontal and vertical components of the velocity of the object?

	horizontal	vertical
A	Q	P
B	Q	S
C	R	P
D	R	S

179. Question | 9702 May-June 2025 P1 V2 Q6

6 The graph shows the variation with time of the velocity of a car.

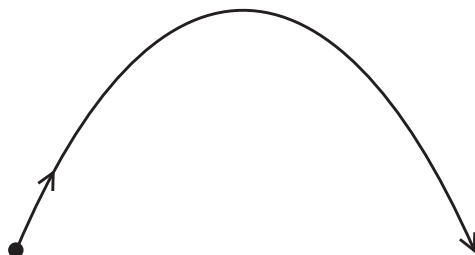


Which statement is correct?

- A The car accelerates for 2 s, then stops for 4 s and then reverses.
- B The car accelerates at 12 m s^{-2} for 2 s.
- C The car travels a distance of 36 m in the first 4 s.
- D The car travels a distance of 48 m in the last 4 s.

180. Question | 9702 May-June 2025 P1 V2 Q8

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



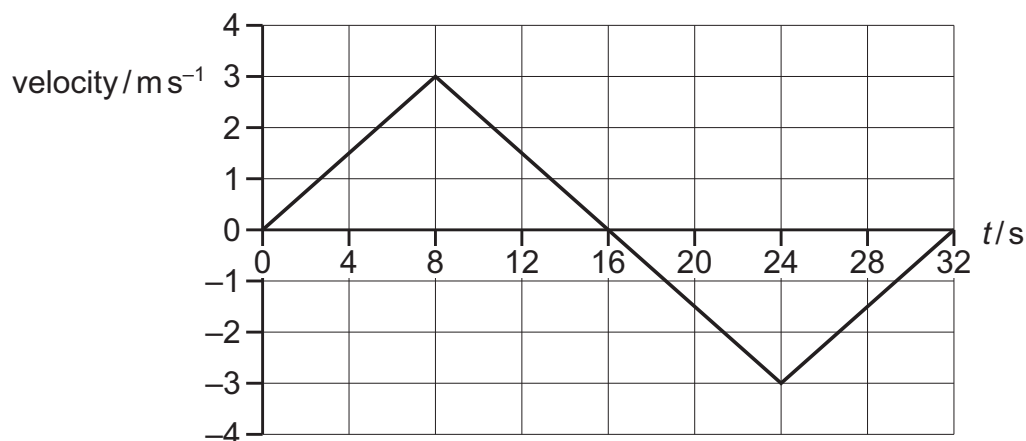
Air resistance is negligible.

Why does the path have this shape?

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

181. Question | 9702 May-June 2025 P1 V3 Q5

- 5 The graph shows the variation of velocity with time t of an object moving in a straight line.



At $t = 0$, the displacement of the object is zero.

What is the displacement of the object at $t = 20$ s?

- A -3 m B 21 m C 24 m D 27 m

182. Question | 9702 May-June 2025 P1 V3 Q6

- 6** A science museum designs an experiment to show the fall of a feather in a vertical glass vacuum tube.

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

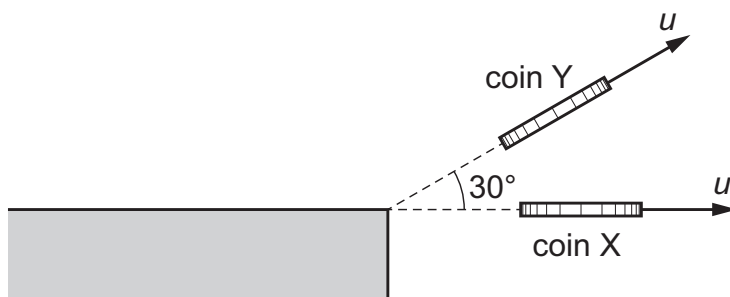
Which length of tube is required?

- A** 1.2m **B** 2.5m **C** 4.9m **D** 9.8m

7 Two coins are projected from a horizontal table at the same initial speed u .

Coin X is projected horizontally.

Coin Y is projected upwards at an angle of 30° to the horizontal.



Both coins hit the horizontal ground without bouncing.

Assume the air resistance on each coin is negligible.

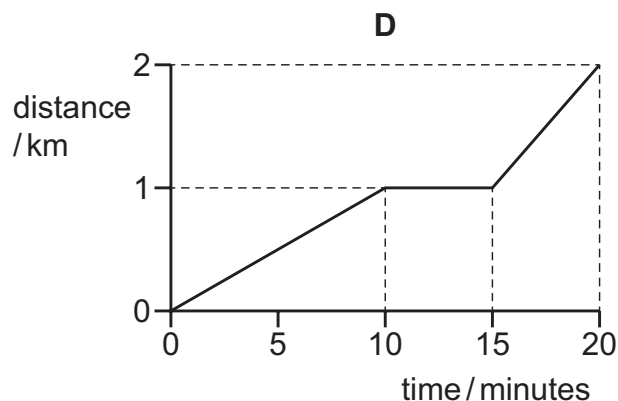
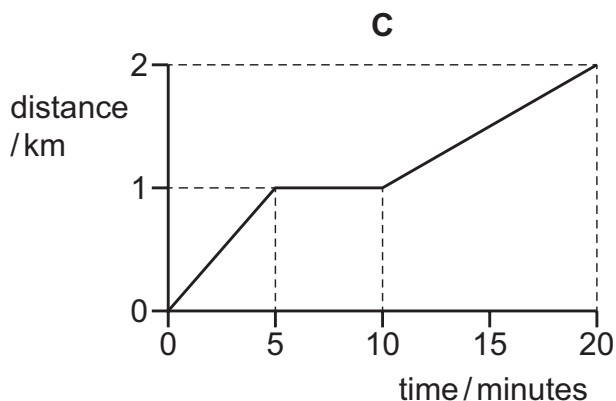
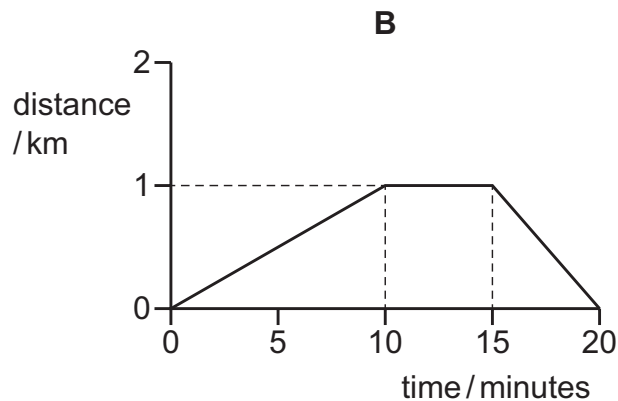
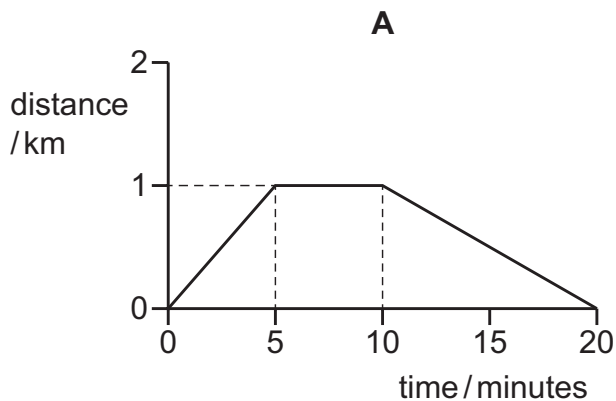
Which statement about the motion of the coins is correct?

- A** Both coins hit the ground with the same speed.
- B** Both coins travel the same vertical distance.
- C** Coin Y hits the ground before coin X.
- D** Coin Y has a smaller vertical acceleration.

184. Question | 9702 May-June 2025 P1 V4 Q5

- 5** A student cycles uphill from home to a shop, taking 10 minutes. The student then spends 5 minutes in the shop before cycling home downhill at twice the initial speed.

Which graph could show the variation with time of the distance travelled by the student?



185. Question | 9702 May-June 2025 P1 V4 Q6

- 6** A ball is released from rest from a window at a height of 12 m above the ground. Air resistance is negligible.

What is the time taken after release for the ball to reach the ground?

- A** 1.1 s **B** 1.2 s **C** 1.6 s **D** 2.4 s

186. Question | 9702 Oct-Nov 2025 P1 V1 Q5

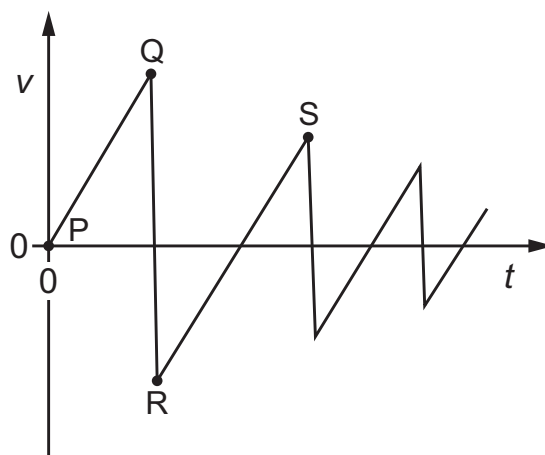
- 5** A goods train passes through a station at a constant speed of 10 m s^{-1} at time $t = 0$. An express train is at rest at the station. The express train leaves the station with a uniform acceleration of 0.5 m s^{-2} just as the goods train goes past. Both trains move in the same direction on straight, parallel tracks.

At which time t does the express train overtake the goods train?

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

- 6** A ball is held above the ground and released. It falls to the ground and bounces several times.

The graph shows the variation with time t of the velocity v of the ball.



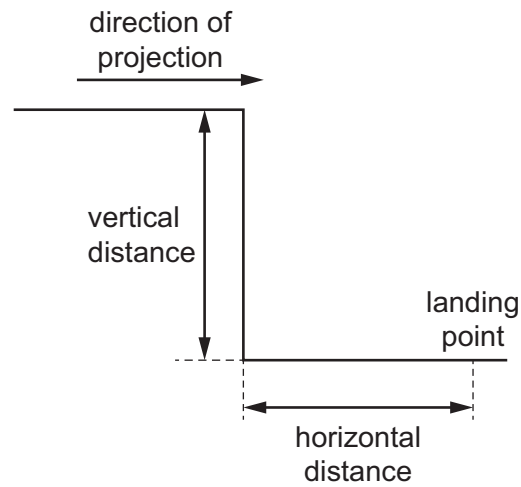
Four points on the graph are labelled P, Q, R and S.

Which statement is **not** correct?

- A** The area under line PQ represents the initial height of the ball.
- B** The collisions of the ball with the ground are inelastic.
- C** The gradient of the line RS represents the acceleration due to free fall.
- D** The maximum upwards velocity of the ball is reached at point P.

188. Question | 9702 Oct-Nov 2025 P1 V1 Q7

- 7 An object is projected horizontally. The object falls a vertical distance y and travels a horizontal distance x before landing on the ground.



A second object is projected horizontally with the same initial velocity and falls a vertical distance $4y$ before landing on the ground.

Assume that air resistance is negligible.

Which horizontal distance does the second object travel?

- A** x **B** $2x$ **C** $4x$ **D** $16x$

189. Question | 9702 Oct-Nov 2025 P1 V2 Q5

- 5** A car has an initial velocity u . The car then moves with constant acceleration a in a straight line through a displacement d . The car reaches a final velocity v .

Which expression gives the initial velocity u of the car?

- A** $v - ad$ **B** $\sqrt{v^2 - 2ad}$ **C** $v + ad$ **D** $v - \frac{1}{2}ad^2$

190. Question | 9702 Oct-Nov 2025 P1 V2 Q6

- 6** 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.

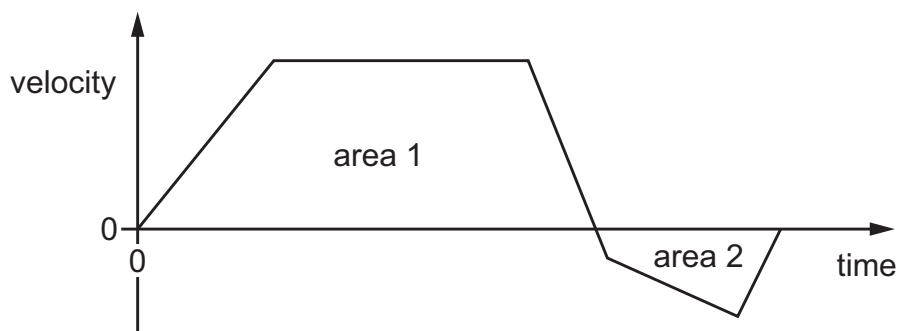
The deceleration of the bicycle remains constant.

Which further distance will the bicycle travel before coming to rest?

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

191. Question | 9702 Oct-Nov 2025 P1 V2 Q7

- 7** The velocity–time graph for an object is shown.



Which expression gives the total displacement of the object?

- A** area 1 – area 2
B $\frac{(\text{area 1} + \text{area 2})}{2}$
C area 1 + area 2
D area 2 – area 1

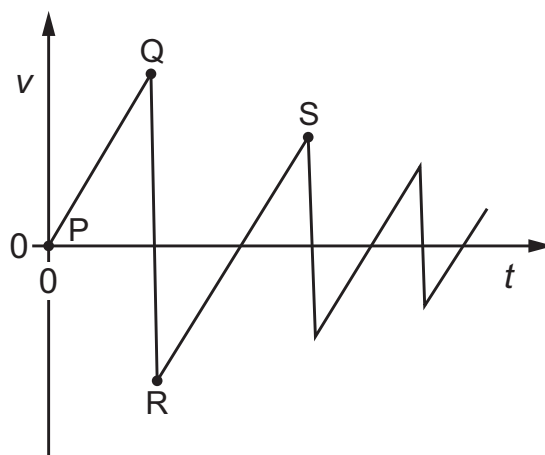
- 5** A goods train passes through a station at a constant speed of 10 m s^{-1} at time $t = 0$. An express train is at rest at the station. The express train leaves the station with a uniform acceleration of 0.5 m s^{-2} just as the goods train goes past. Both trains move in the same direction on straight, parallel tracks.

At which time t does the express train overtake the goods train?

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The graph shows the variation with time t of the velocity v of the ball.



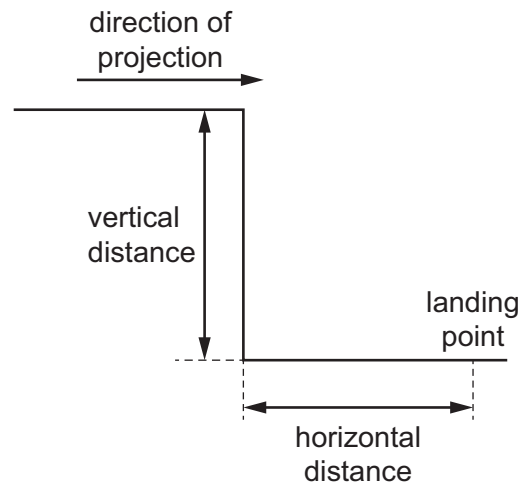
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- B** The collisions of the ball with the ground are inelastic.
- C** The gradient of the line RS represents the acceleration due to free fall.
- D** The maximum upwards velocity of the ball is reached at point P.

194. Question | 9702 Oct-Nov 2025 P1 V3 Q7

- 7 An object is projected horizontally. The object falls a vertical distance y and travels a horizontal distance x before landing on the ground.



A second object is projected horizontally with the same initial velocity and falls a vertical distance $4y$ before landing on the ground.

Assume that air resistance is negligible.

Which horizontal distance does the second object travel?

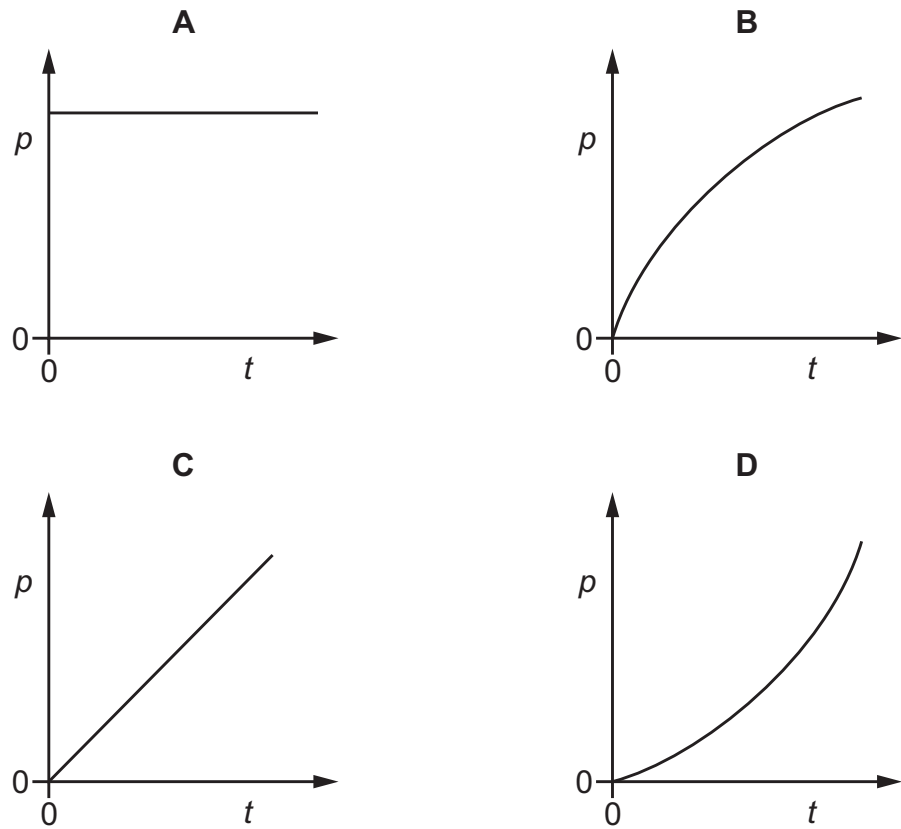
- A** x **B** $2x$ **C** $4x$ **D** $16x$

195. Question | 9702 Oct-Nov 2025 P1 V4 Q4

4 An object falls from rest towards the ground.

Air resistance is negligible.

Which graph shows the variation of the momentum p of the object with time t until it hits the ground?



196. Question | 9702 Oct-Nov 2025 P1 V4 Q5

5 A projectile is fired at an angle of 45° upwards from horizontal ground. Air resistance is negligible.

Which row describes the horizontal motion and the vertical motion of the projectile after it is fired until immediately before it reaches the ground again?

	horizontal motion	vertical motion
A	constant velocity	constant acceleration
B	constant velocity	varying acceleration
C	varying velocity	constant acceleration
D	varying velocity	varying acceleration

197. Question | 9702 Oct-Nov 2025 P1 V4 Q6

- 6** An aircraft on a runway accelerates uniformly from rest to its take-off speed of 58 m s^{-1} .

The acceleration of the aircraft is 4.2 m s^{-2} , and the aircraft uses 74% of the length of the runway to reach its take-off speed.

What is the length of the runway?

- A** 300 m **B** 540 m **C** 590 m **D** 800 m

198. Question | 9702 Oct-Nov 2025 P1 V4 Q7

- 7** How can the acceleration of an object be determined?

- A** from the area under a displacement–time graph
B from the area under a velocity–time graph
C from the gradient of a displacement–time graph
D from the gradient of a velocity–time graph