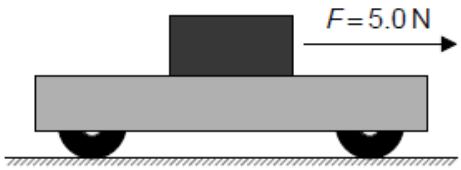
HL Paper 1

A block of mass 1.0 kg rests on a trolley of mass 4.0 kg. The coefficient of dynamic friction between the block and the trolley is 0.30.



A horizontal force F = 5.0 N acts on the block. The block slides over the trolley. What is the acceleration of the trolley?

A. 5.0 m s^{-2}

B. 1.0 m s^{-2}

C. 0.75 m s^{-2}

D. 0.60 m s^{-2}

The momentum of an object changes by Δp in a time Δt. What is the impulse acting on the object during this change?

A. Δp

B. $\Delta p\ \Delta t$

C. $\frac{\Delta p}{\Delta t}$

D. zero

Which of the following is a condition for an object to be in translational equilibrium?

A. The object must be moving at constant speed.

B. The velocity of the object in any direction must be zero.

C. The forces acting horizontally on the object must equal the forces acting vertically on the object.

D. The resultant force acting on the object must be zero.

A projectile is fired from level ground with speed v at an angle θ to the ground. Ignoring air resistance, which of the following is a correct expression for the maximum height reached by the projectile?

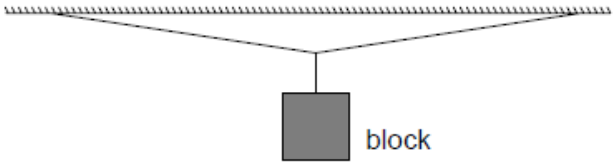
A. $\frac{v^2 \sin^2 \theta}{2g}$

B. $\frac{v^2 \cos^2 \theta}{2g}$

C. $\frac{v \sin \theta}{g}$

D. $\frac{v \cos \theta}{g}$

A block of weight *W* is suspended by two strings of equal length. The strings are almost horizontal.



What is correct about the tension *T* in one string?

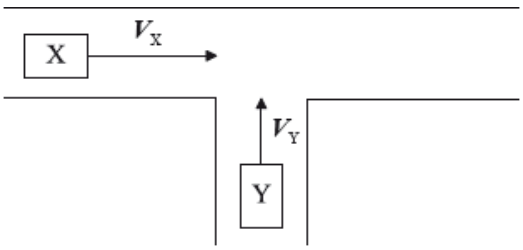
A. $T < \frac{W}{2}$

B. $T = \frac{W}{2}$

C. $\frac{W}{2} < T \leqslant W$

D. $T > W$

Two cars, X and Y, are travelling towards a junction. The velocity of car X is $\boldsymbol{V}_X$ and car Y is $\boldsymbol{V}_Y$.



Which of the following vectors represent the velocity of Y relative to X?

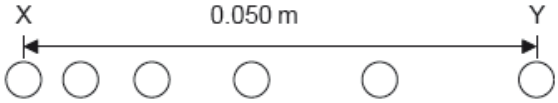
A. 

B. 

C. 

D. 

A ball starts from rest and moves horizontally. Six positions of the ball are shown at time intervals of 1.0 ms. The horizontal distance between X, the initial position, and Y, the final position, is 0.050 m.



What is the average acceleration of the ball between X and Y?

A. $2000\ \text{m s}^{-2}$

B. 4000 m s^{-2}

C. 5000 m s^{-2}

D. 8000 m s^{-2}

A parachutist of total mass 70 kg is falling vertically through the air at a constant speed of 8 m s^{-1}.

What is the total upward force acting on the parachutist?

A. 0 N

B. 70 N

C. 560 N

D. 700 N

A student is sitting on a chair. One force that is acting on the student is the pull of gravity. According to Newton's third law, there must be another force which is

A. the upward push of the chair on the student.

B. the downward force on the student.

C. the downward push of the chair on Earth.

D. the upward force on Earth.

A cyclist accelerates in a straight line. At one instant, when the cyclist is exerting a forward force of 40 N, the air resistance acting on the cyclist is 10 N.

What is the rate of change of momentum of the cyclist at this instant?

A. 10 kg m s^{-2}

B. 30 kg m s^{-2}

C. 40 kg m s^{-2}

D. 50 kg m s^{-2}

A stationary nucleus of polonium-210 undergoes alpha decay to form lead-206. The initial speed of the alpha particle is v. What is the speed of the lead-206 nucleus?

A. $\frac{206}{4}v$

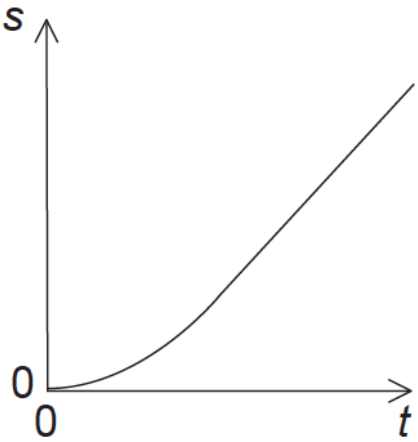
B. v

C. $\frac{206}{210}v$

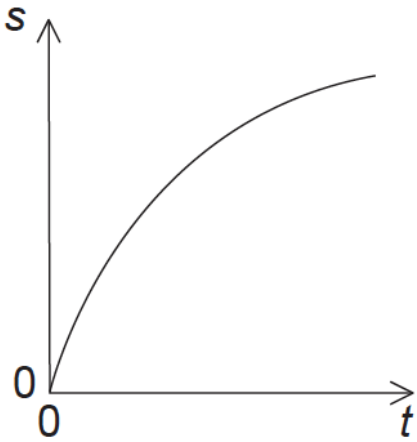
D. $\frac{4}{206}v$

A tennis ball is dropped from the top of a tall building. Air resistance is **not** negligible. Which graph shows the variation with time *t* of the displacement *s* of the ball?

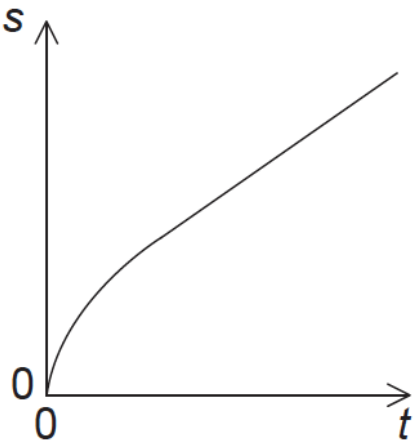
A.



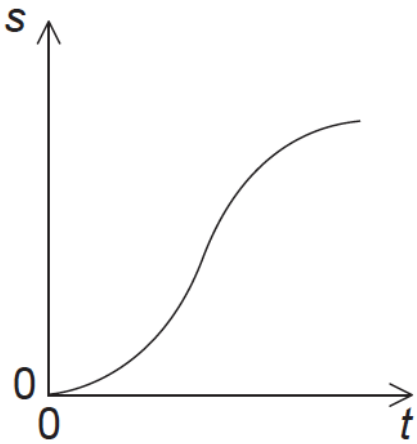
B.



C.



D.



An object of mass 2kg is thrown vertically downwards with an initial kinetic energy of 100J. What is the distance fallen by the object at the instant when its kinetic energy has doubled?

A. 2.5m
B. 5.0m
C. 10m
D. 14m

A stopper of mass 8 g leaves the opening of a container that contains pressurized gas.The stopper accelerates from rest for a time of 18 ms and leaves the container at a speed of 20 m s^{-1}.

What is the order of magnitude of the force acting on the stopper?

A. 10^{-3} N

B. 10^{0} N

C. 10^{1} N

D. 10^{3} N

A body is moving in a straight line. A force *F* acts on the body in the direction of the body's motion. A resistive force *f* acts on the body. Both forces act along the same straight line as the motion of the body. The rate of change of momentum of the body is equal to

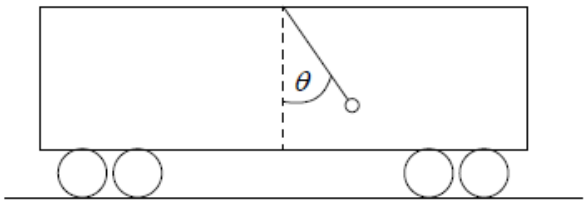
A. *F*–*f*.

B. *F*.

C. *F*+*f*.

D. *f*.

A mass is suspended from the ceiling of a train carriage by a string. The string makes an angle θ with the vertical when the train is accelerating along a straight horizontal track.



What is the acceleration of the train?

A. $g \sin \theta$

B. $g \cos \theta$

C. $g \tan \theta$

D. $\frac{g}{\tan \theta}$

Two identical balls are dropped from a tall building, one a few seconds after the other. Air resistance is **not** negligible. As the balls fall, the distance between the balls will

A. decrease.
B. increase.
C. increase then remain constant.
D. remain constant.

Which of the following quantities can be determined from a speed-time graph of a particle travelling in a straight line?

A. Only the magnitude of the acceleration at a given instant

B. Both the velocity and the acceleration at a given instant

C. Only the distance travelled in a given time

D. Both the distance travelled in a given time and the magnitude of the acceleration at a given instant

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A truck is pulled up an inclined plane at constant speed by an electric motor. The gain in potential energy of the truck is 48 kJ. The efficiency of the electric motor is $\frac{2}{3}$.

How much energy is dissipated in pulling the truck up the plane?

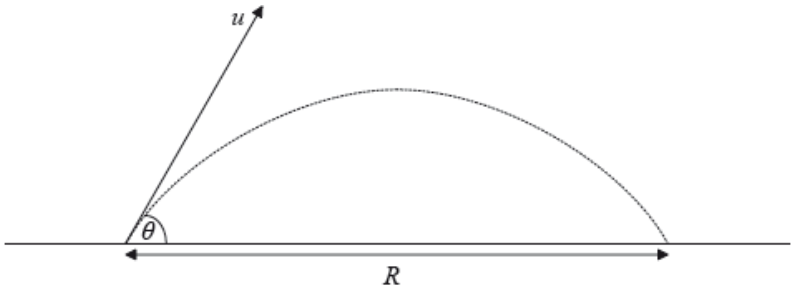
A. 16 kJ

B. 24 kJ

C. 32 kJ

D. 64 kJ

A football is kicked with an initial velocity u at an angle θ to the horizontal and reaches the ground t seconds later.



Ignoring air resistance what is the range R of the football?

A. ut

B. $ut\cos\theta$

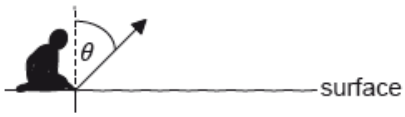
C. $ut\sin\theta$

D. $ut\tan\theta$

Which of the following is always true for an object moving in a straight line at constant speed?

A. No forces act on the object.
B. No resultant force acts on the object.
C. The momentum of the object is zero.
D. No work is being done on the object.

A student throws a stone with velocity v at an angle θ to the vertical from the surface of a lake. Air resistance can be ignored. The acceleration due to gravity is g.



What is the time taken for the stone to hit the surface of the lake?

A. $\frac{v \sin \theta}{g}$

B. $\frac{v \cos \theta}{g}$

C. $\frac{2v \sin \theta}{g}$

D. $\frac{2v \cos \theta}{g}$

Two isolated spherical planets have the same gravitational potential at their surfaces. Which ratio must also be the same for the two planets?

A. $\frac{\text{radius}^3}{\text{mass}}$

B. $\frac{\text{radius}^2}{\text{mass}}$

C. $\frac{\text{radius}}{\text{mass}}$

D. radius

If a moving object is subject to a constant force, which of the following can be correctly deduced from Newton's first law?

A. The object continues to move with a changing velocity.

B. The object continues to move with a constant velocity.

C. The object continues to move with a changing direction.

D. The object continues to move in the same direction.

Which of the following is necessary for an object to be in translational equilibrium?

A. The object must be stationary.
B. The object must move with a constant speed.
C. The resultant force acting on the object must be zero.
D. No forces must act on the object.

A toy car of mass 0.15 kg accelerates from a speed of 10 cm s^{-1} to a speed of 15 cm s^{-1}. What is the impulse acting on the car?

A. 7.5 mN s

B. 37.5 mN s

C. 0.75 N s

D. 3.75 N s

Which statement applies to an object in translational equilibrium?

A. The object must be stationary.

B. The object must be moving with constant acceleration.

C. The resultant force acting on the object must be zero.

D. There must be no external forces acting on the object.

A gun fires a bullet of mass *m* at a horizontal velocity of *v*. Air resistance on the bullet is negligible. A change in which of the following will affect the time for the bullet to hit the ground?

A. *m* only

B. *v* only

C. *m* and *v*

D. neither *m* nor *v*

A net force of magnitude 4.0 N acts on a body of mass 3.0 kg for 6.0 s. The body is initially at rest. Which of the following is the speed of the body after the 6.0 s interval?

A. $0.50\ \mathrm{m\,s^{-1}}$

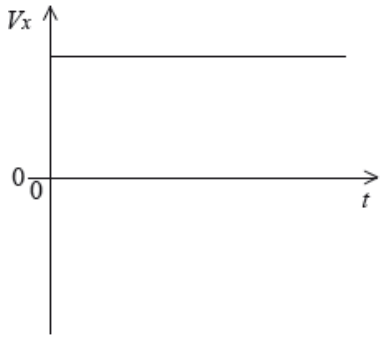
B. $2.0\ \mathrm{m\,s^{-1}}$

C. $4.5\ \mathrm{m\,s^{-1}}$

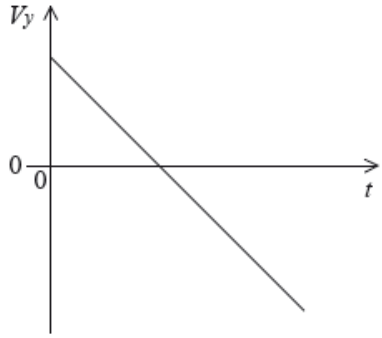
D. $8.0\ \mathrm{m\,s^{-1}}$

An object moves in the x-y plane. The graphs below show how the component of its velocity V_x in the *x*-direction and the component of its velocity V_y in the *y*-direction, vary with time t.

x-direction component



y-direction component



The particle is moving

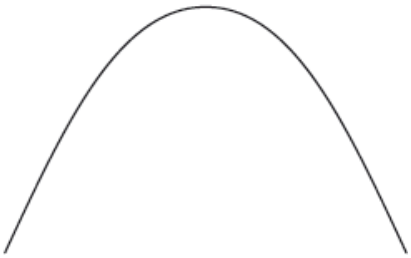
A. in a parabola.

B. with simple harmonic motion.

C. with constant velocity in a straight line.

D. in a circle.

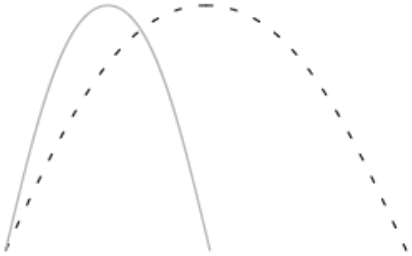
The diagram shows the path of a projectile that is launched with velocity v. Air resistance is negligible.



A second projectile has double the mass of the first projectile and is launched with the same velocity. Air resistance is still negligible. Which of the following paths best represents the path of the projectile? *(The original path is shown as a dotted line)*

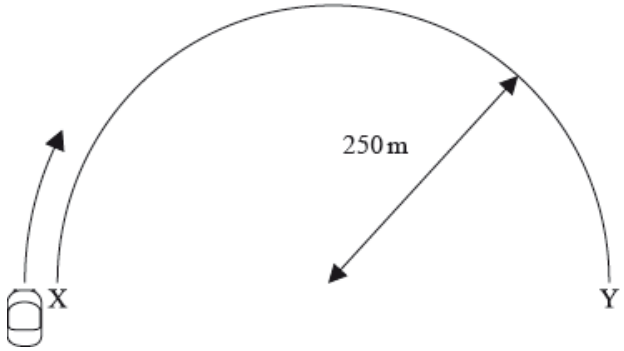
A. 

B. 

C. 

D. 

A car moves from X to Y along a semicircular path. The radius of the path is 250 m and the time taken to complete the trip is 50 s.



Which of the following correctly shows the magnitude of the average velocity and the magnitude of the average speed?

	Average velocity	Average speed
A.	$10\,m\,s^{-1}$	$10\,m\,s^{-1}$
B.	$10\,m\,s^{-1}$	$16\,m\,s^{-1}$
C.	$16\,m\,s^{-1}$	$10\,m\,s^{-1}$
D.	$16\,m\,s^{-1}$	$16\,m\,s^{-1}$

An object is dropped from rest. Air resistance is **not** negligible. What is the acceleration of the object at the start of the motion?

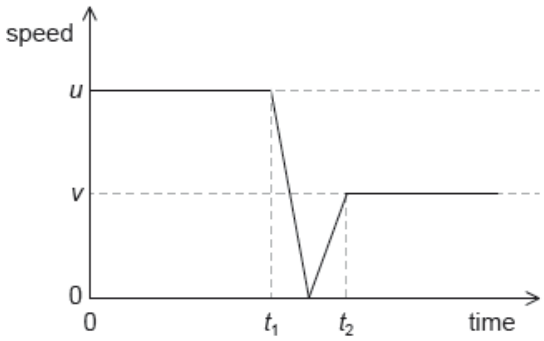
A. Zero

B. Increasing

C. Decreasing

D. Constant

A ball of mass *m* collides with a vertical wall with an initial horizontal speed *u* and rebounds with a horizontal speed *v*. The graph shows the variation of the speed of the ball with time.



What is the magnitude of the mean net force on the ball during the collision?

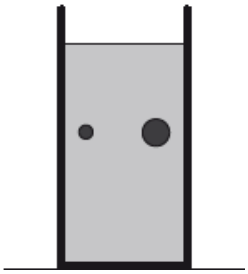
A. $\frac{m(u-v)}{(t_2+t_1)}$

B. $\frac{m(u-v)}{(t_2-t_1)}$

C. $\frac{m(u+v)}{(t_2+t_1)}$

D. $\frac{m(u+v)}{(t_2-t_1)}$

Two steel balls, of mass M and $2M$, fall at constant speeds in a tube filled with oil.



Which of the following correctly compares the magnitudes of the net force and of the drag (resistance) force on the two balls?

	Net force	Drag force
A.	same	same
B.	same	different
C.	different	same
D.	different	different

Which of the following is a correct definition of work?

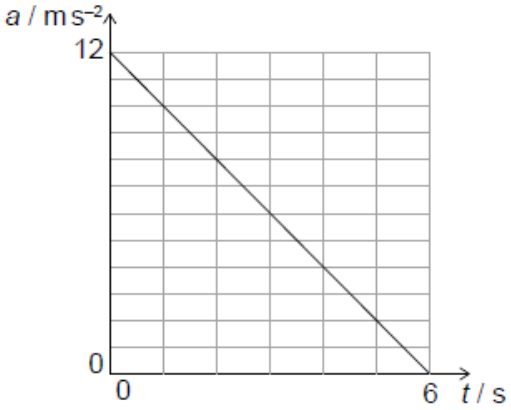
A. Product of force and distance

B. Product of force and distance moved in the direction of the force

C. Product of power and time

D. Product of force and displacement

The graph shows the variation of the acceleration a of an object with time *t*.



What is the change in speed of the object shown by the graph?

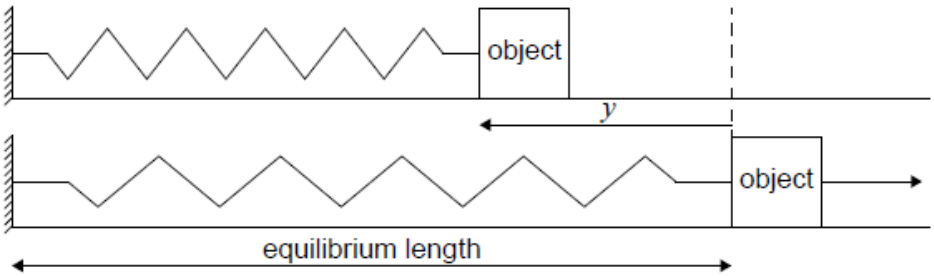
A. 0.5 m s^{-1}

B. 2.0 m s^{-1}

C. 36 m s^{-1}

D. 72 m s^{-1}

A horizontal spring of spring constant k and negligible mass is compressed through a distance y from its equilibrium length. An object of mass m that moves on a frictionless surface is placed at the end of the spring. The spring is released and returns to its equilibrium length.



What is the speed of the object just after it leaves the spring?

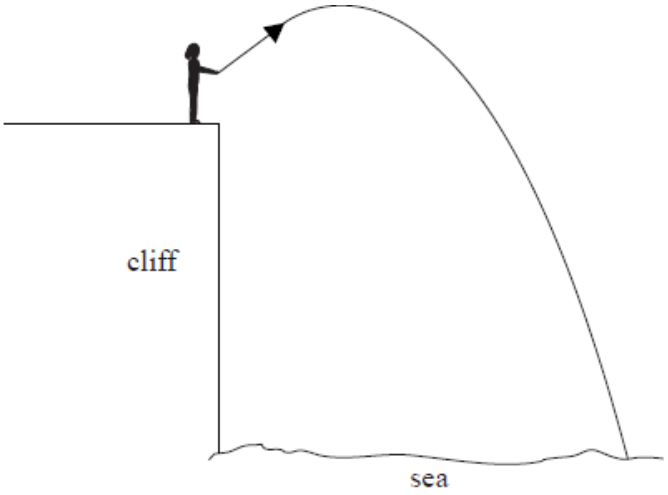
A. $y\sqrt{\frac{k}{m}}$

B. $y\sqrt{\frac{m}{k}}$

C. $y\frac{k}{m}$

D. $y\frac{m}{k}$

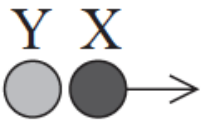
A stone is thrown from a cliff and it lands in the sea as shown below. Air resistance is negligible.



Which of the following statements is correct whilst the stone is in motion?

A. The vertical component of the stone's displacement is constant.
B. The horizontal component of the stone's displacement is constant.
C. The vertical component of the stone's velocity is constant.
D. The horizontal component of the stone's velocity is constant.

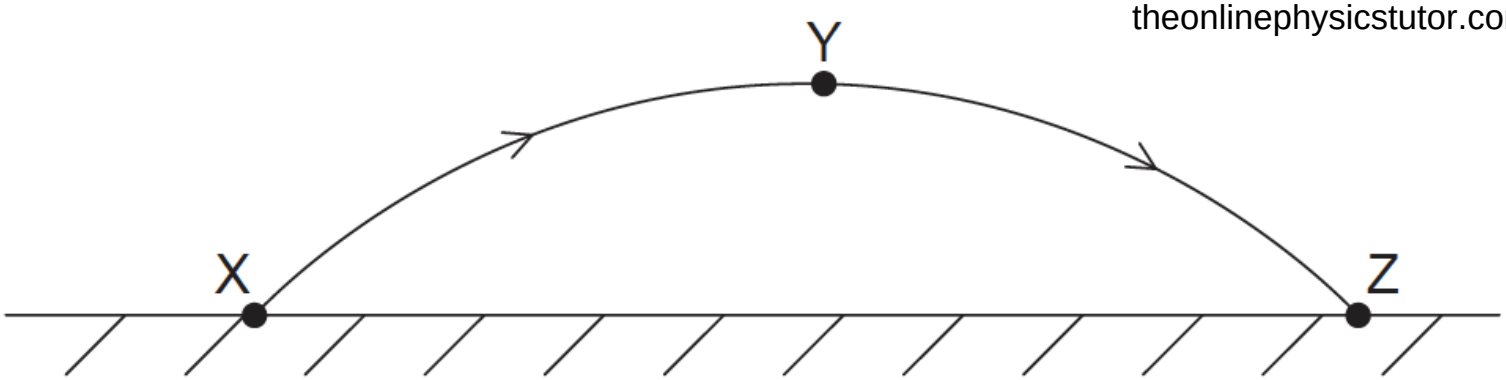
Balls X and Y are at the same height. X is projected horizontally at the same time that Y is dropped. Y is the same size as X but has half its mass.



Ignoring air resistance, which statement is **true**?

A. Y will hit the ground before X.
B. Y will hit the ground after X.
C. Y will hit the ground at the same time as X.
D. The outcome can only be determined if the initial speed of X is known.

A ball is thrown from point X and follows path XYZ. Air resistance is negligible.



Which quantity is zero when the ball is at the highest point Y of the path?

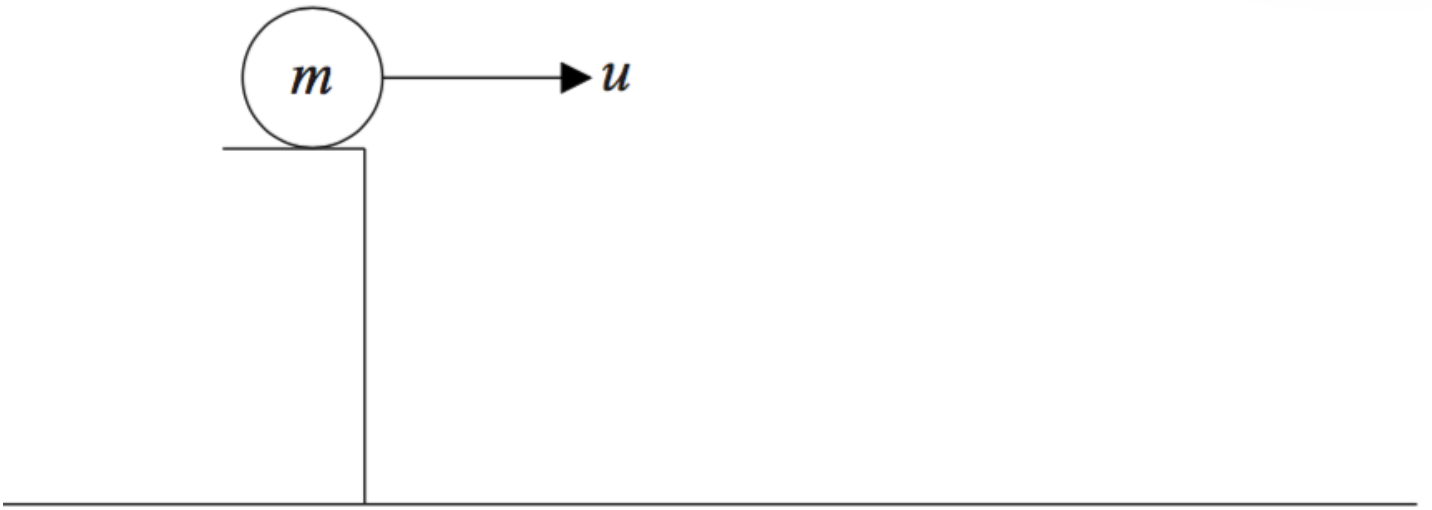
A. The horizontal component of the ball's acceleration

B. The vertical component of the ball's acceleration

C. The horizontal component of the ball's velocity

D. The kinetic energy of the ball

A ball of mass *m* is thrown horizontally from a cliff with initial velocity *u*. Air resistance is negligible.



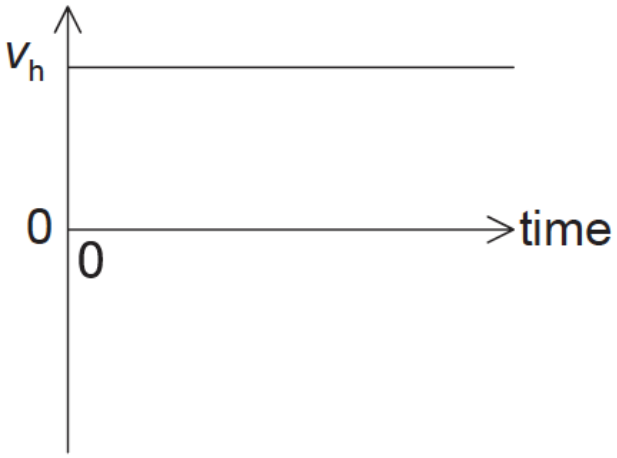
A change in which of the following will affect the horizontal distance travelled?

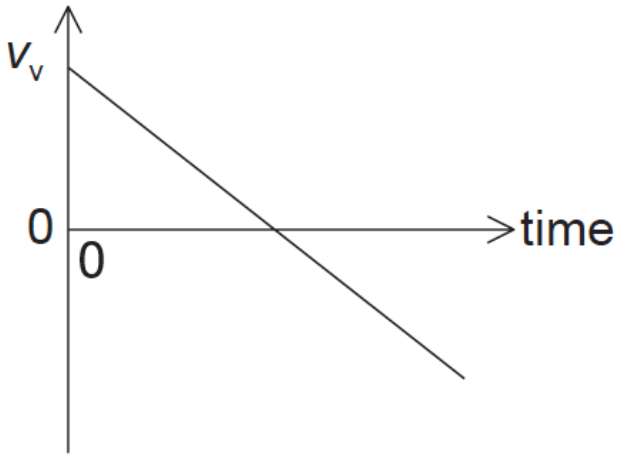
A. *m* only
B. *u* only
C. both *m* and *u*
D. neither *m* nor *u*

An object is thrown horizontally from the edge of a high crater on the Moon. The Moon has no atmosphere. Which of the following describes the changes, if any, to the horizontal and vertical components of the velocity of the object?

	Horizontal velocity	Vertical velocity
A.	stays constant	increases at a constant rate
B.	decreases	increases at a constant rate
C.	stays constant	increases at a non-constant rate
D.	decreases	increases at a non-constant rate

The horizontal component v_h and the vertical component v_v of velocity of an object are shown on the graphs. Air resistance is negligible.





These graphs could represent the motion of an object fired from a cliff

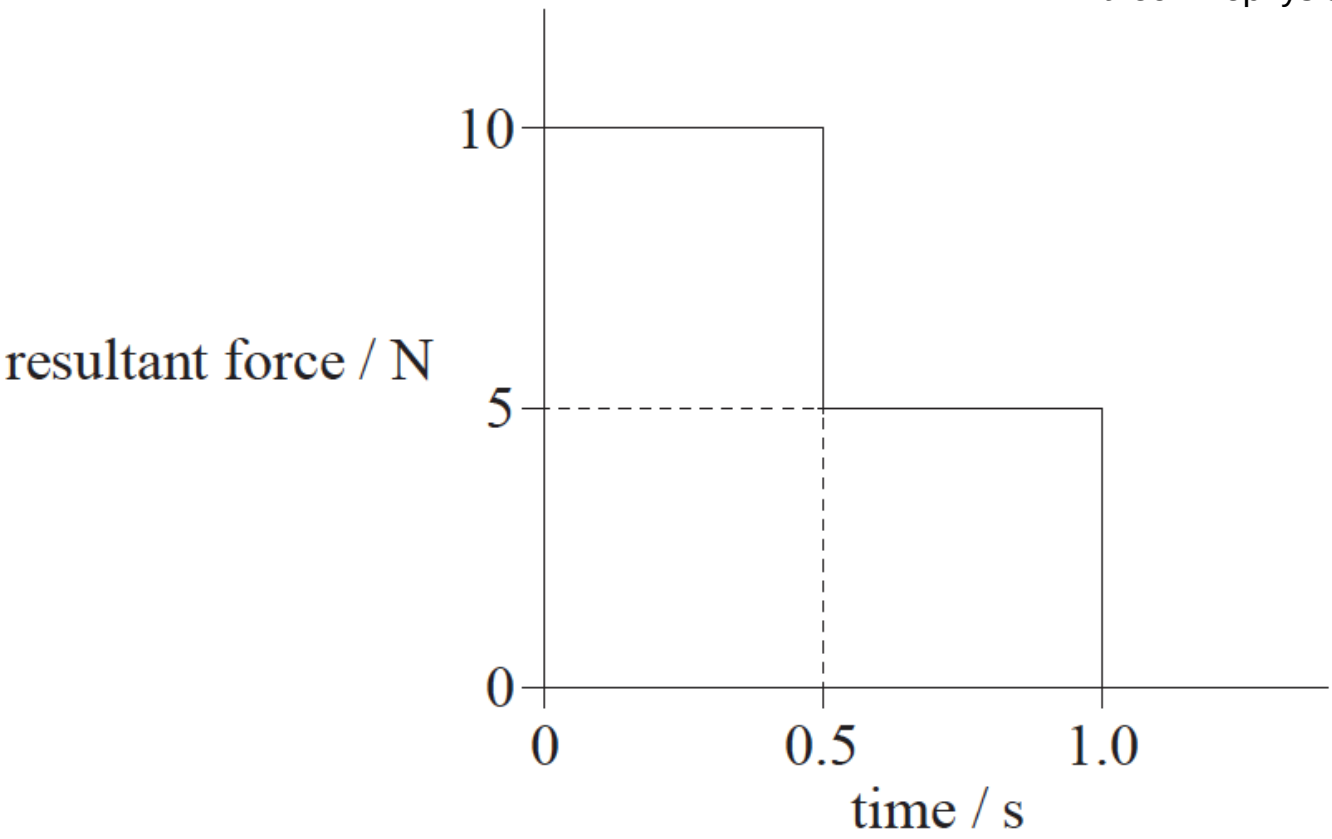
A. vertically upwards.

B. at an angle above the horizontal.

C. horizontally.

D. at an angle below the horizontal.

The resultant force acting on an object of mass 5.0kg varies with time as shown. The object is initially at rest.



What is the speed of the object after 1.0 s?

A. 0.50ms^{-1}

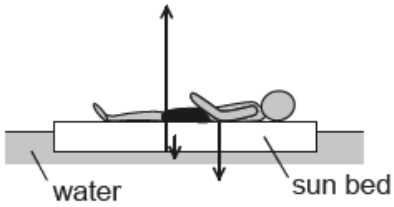
B. 1.0ms^{-1}

C. 1.5ms^{-1}

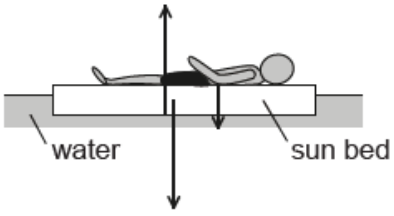
D. 2.0ms^{-1}

A sunbather is supported in water by a floating sun bed. Which diagram represents the magnitudes of the forces acting on the sun bed?

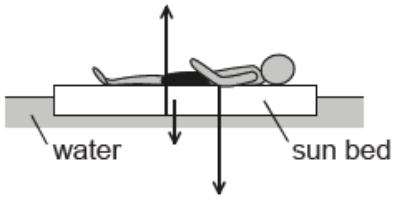
A.



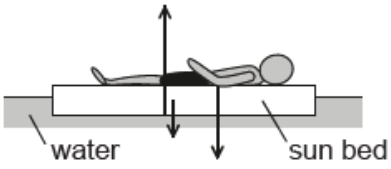
B.



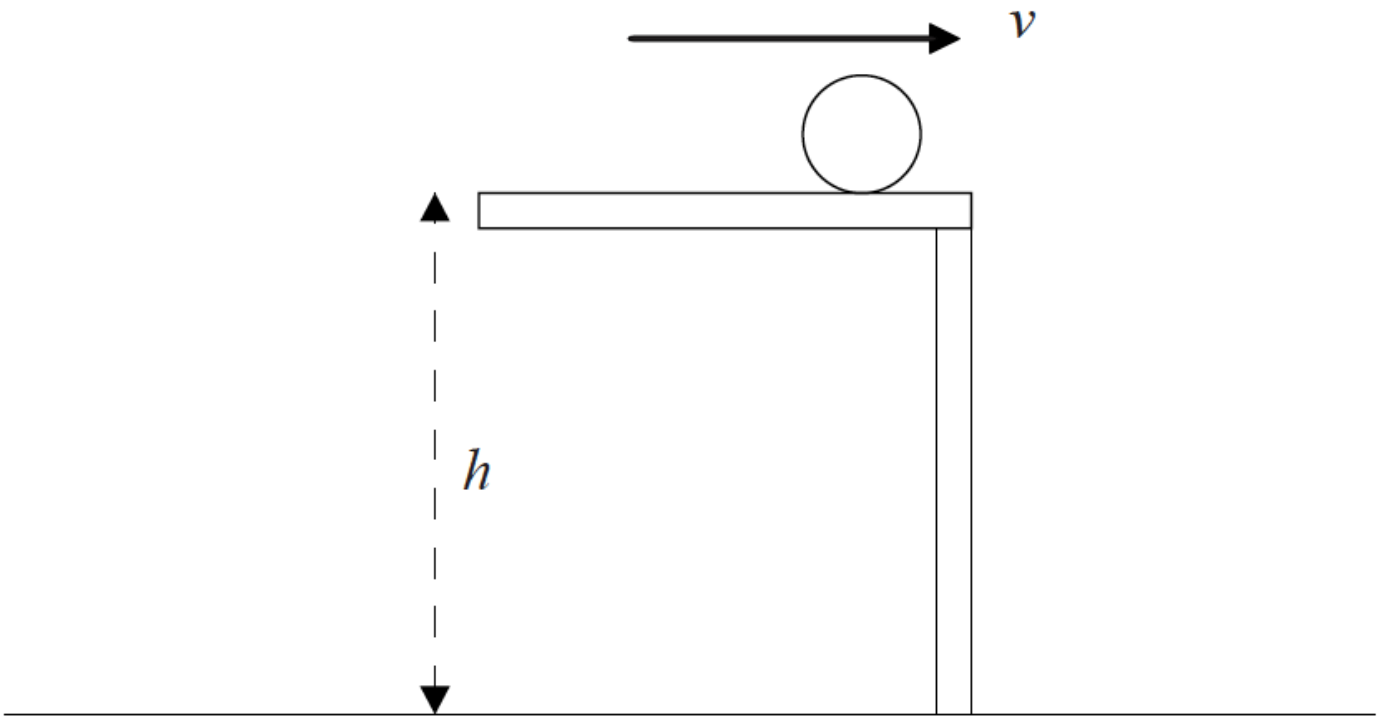
C.



D.



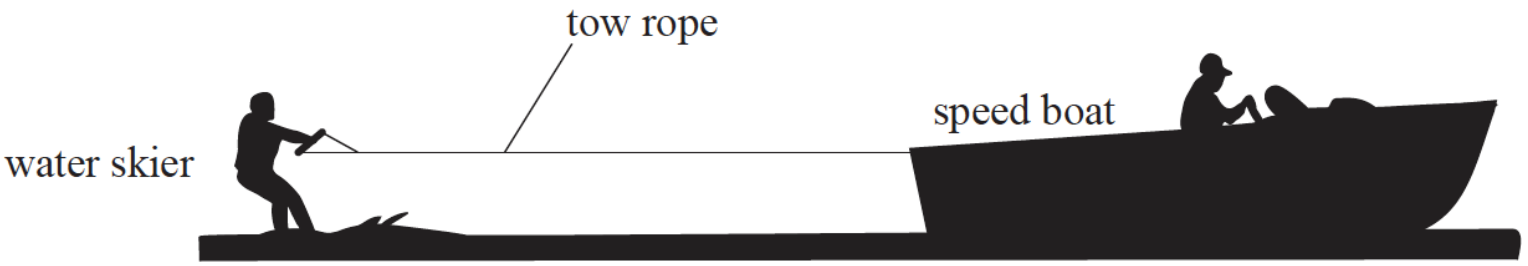
A ball of mass *m* is projected horizontally with speed *v* from a height *h* above the floor. Air resistance is negligible.



The horizontal distance travelled by the ball to the point where it lands on the floor depends on

A. *m* and *h* only.
B. *m* and *v* only.
C. *h* and *v* only.
D. *m*, *h* and *v*.

A speed boat tows a water skier so that the skier accelerates.



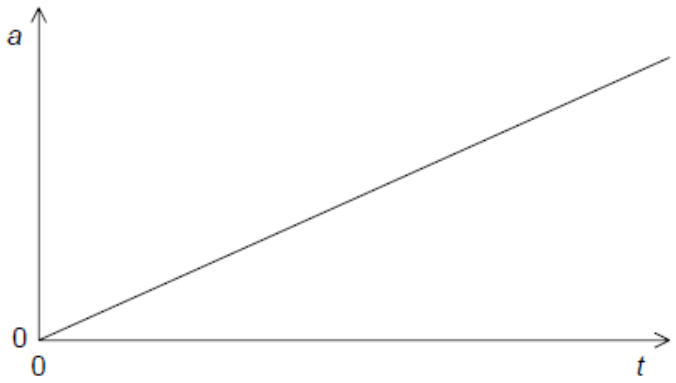
The magnitude of the force exerted on the skier by the tow rope must be

I. greater than the magnitude of the total resistive force acting on the skier
II. equal to the magnitude of the force exerted on the tow rope by the skier
III. equal to the magnitude of the force causing the boat to accelerate.

Which of the above factors is/are correct?

A. I and II only
B. I and III only
C. II only
D. III only

A student draws a graph to show the variation with time *t* of the acceleration *a* of an object.



What can the student deduce from this graph only, and what quantity from the graph is used to make this deduction?

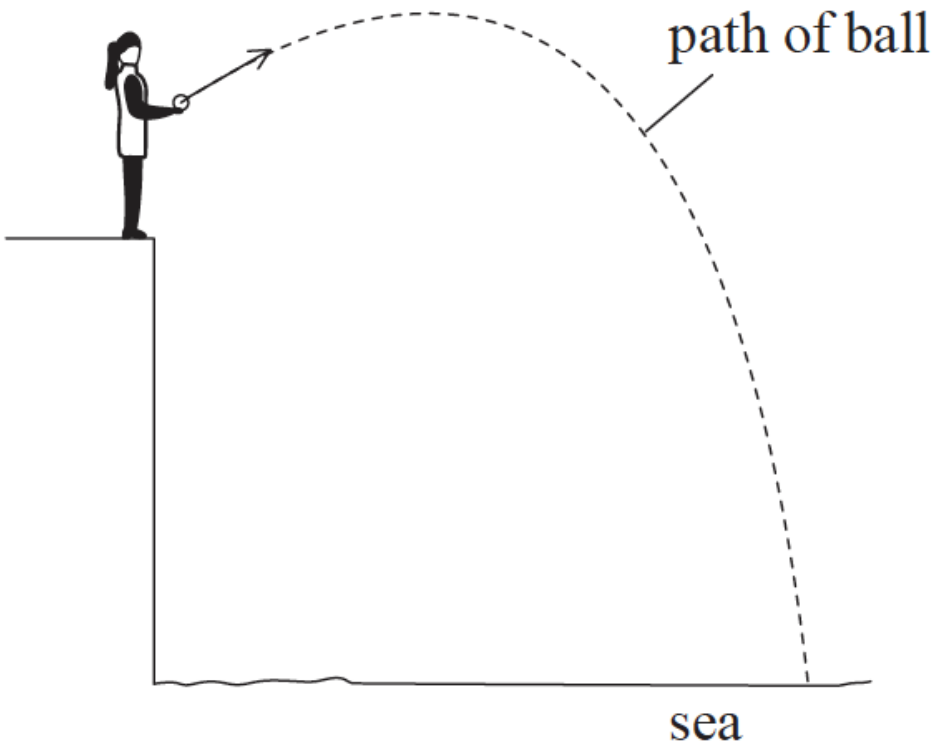
	Deduction	Quantity used
A.	change in velocity	gradient of graph
B.	change in velocity	area under line
C.	change in displacement	gradient of graph
D.	change in displacement	area under line

A ball is thrown horizontally from the top of a high cliff. Air resistance is negligible.

Which of the following correctly describes the changes, if any, to the ball's vertical speed and horizontal speed?

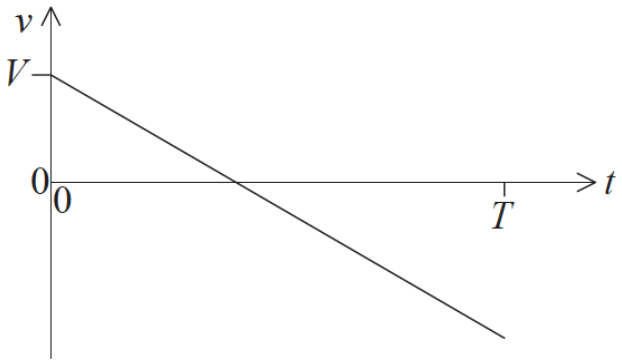
	Vertical speed	Horizontal speed
A.	no change	increases
B.	increases	no change
C.	no change	decreases
D.	decreases	no change

A ball is thrown from the top of a cliff. The initial magnitude of the velocity of the ball at time t=0 is V. The ball hits the sea at time t=T. Air resistance is negligible.

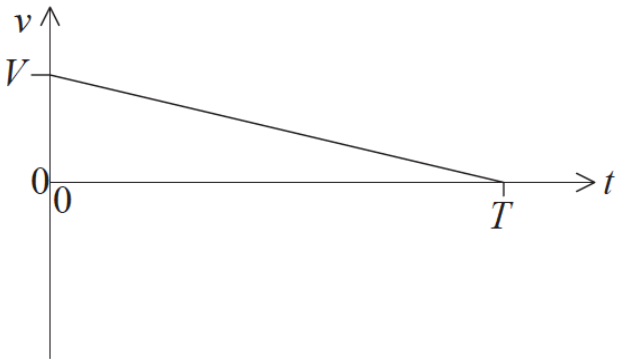


Which graph shows how the **vertical** component of the velocity v of the ball varies with t as it falls to the sea?

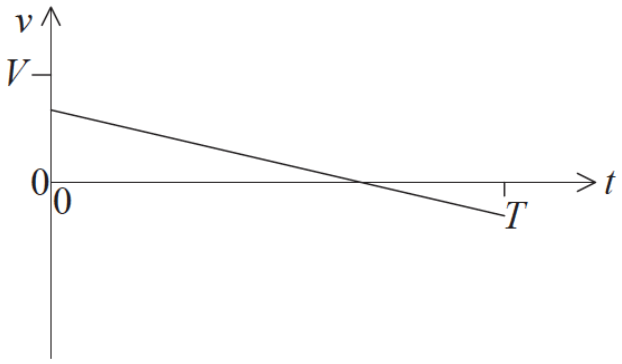
A.



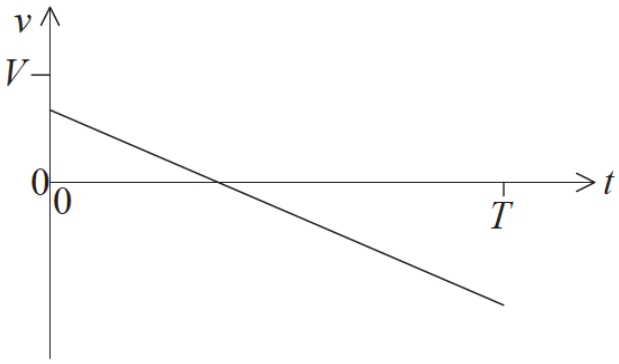
B.



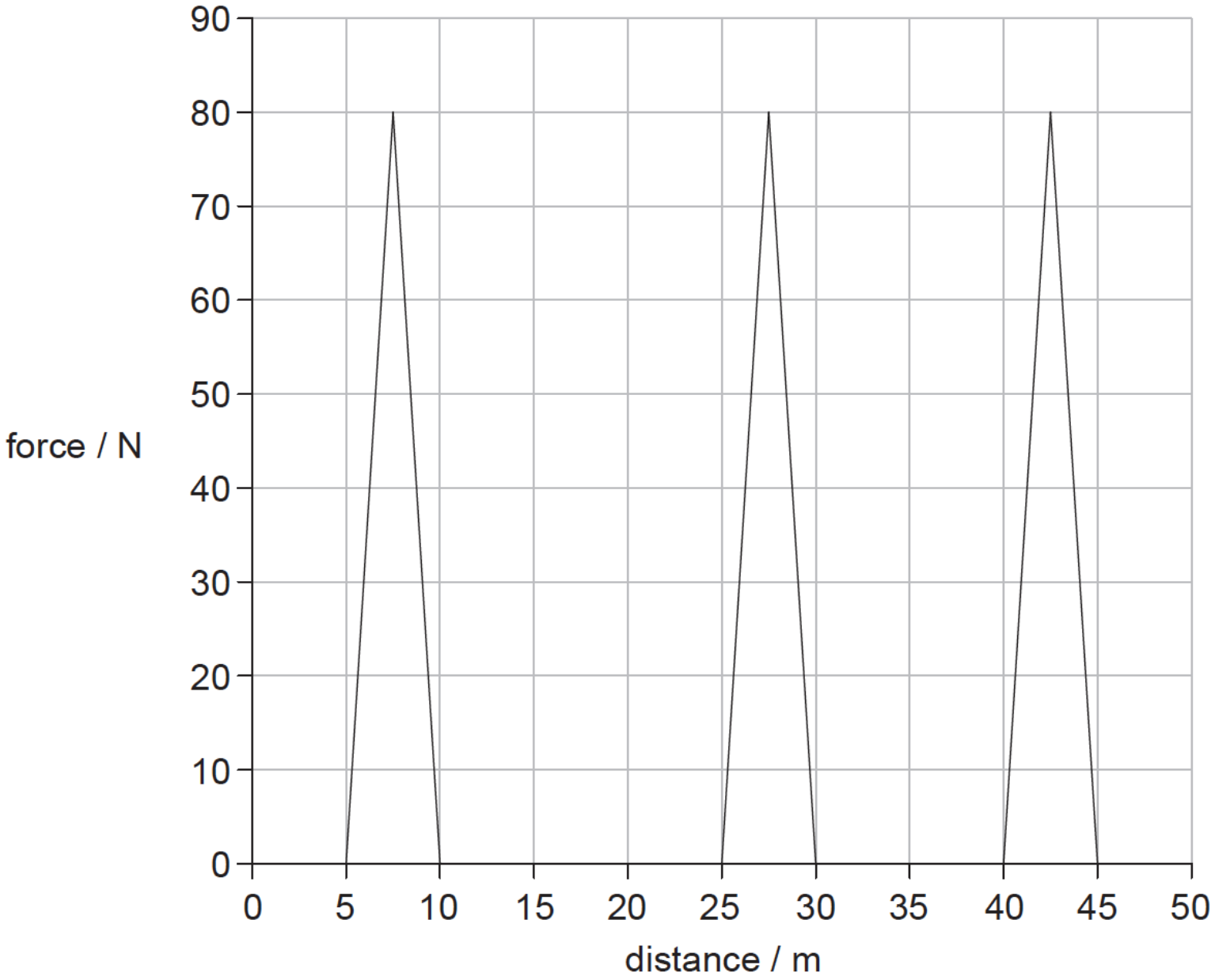
C.



D.



A girl is standing on a moving skateboard. She pushes backwards on the ground at intervals as shown on the graph.



How much kinetic energy is gained by the girl during the period represented on the graph? Frictional forces are negligible.

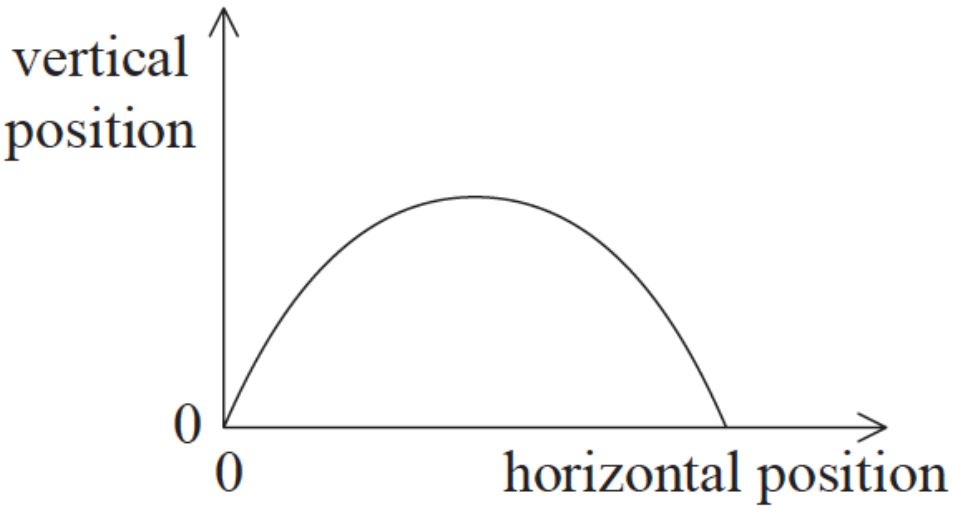
A. 200 J

B. 400 J

C. 600 J

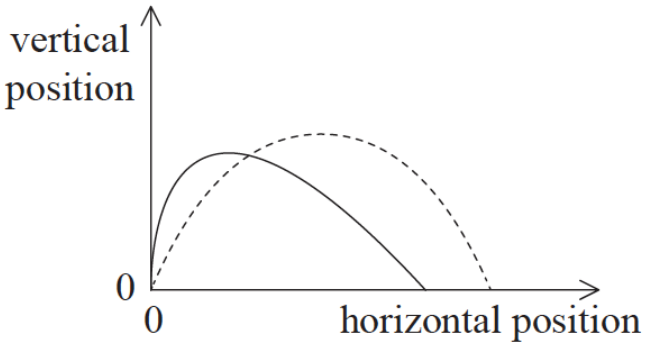
D. 1200 J

The diagram shows the trajectory of an object projected in the absence of air resistance.

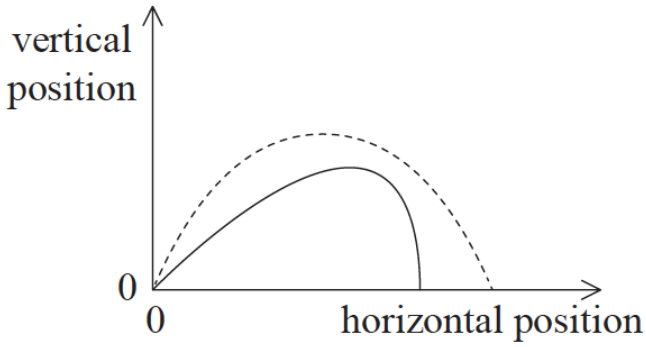


The object is then projected with the same initial conditions but air resistance is taken into account. Which of the following is the trajectory when air resistance is taken into account? The original trajectory is shown as a dotted line.

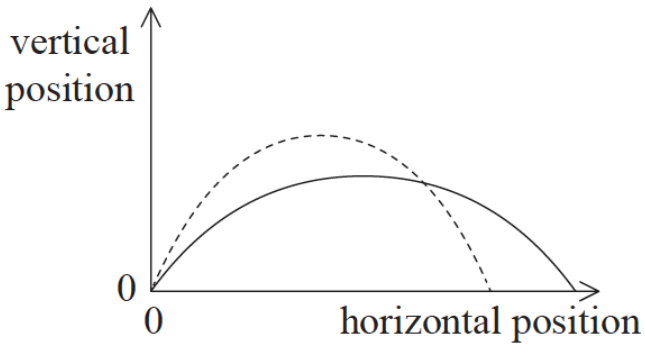
A.



B.



C.



D.