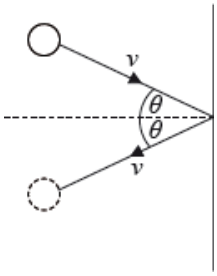
SL Paper 1

Two objects undergo an inelastic collision. Which of the following is correct in respect of both the conservation of momentum and the conservation of total energy of the system?

	Momentum	Total energy
A.	conserved	not conserved
B.	conserved	conserved
C.	not conserved	not conserved
D.	not conserved	conserved

A gas atom strikes a wall with speed v at an angle θ to the normal to the wall. The atom rebounds at the same speed v and angle θ.



Which of the following gives the magnitude of the momentum change of the gas atom?

A. zero

B. $2mv\sin\theta$

C. $2mv$

D. $2mv\cos\theta$

The initial kinetic energy of a block moving on a horizontal floor is 48 J. A constant frictional force acts on the block bringing it to rest over a distance of 2 m. What is the frictional force on the block?

A. 24 N

B. 48 N

C. 96 N

D. 192 N

Objects A and B collide together. They end up joined together and stationary. During the collision, a force $+F$ is exerted on object A by object B.

According to Newton's third law, there will also be a force of

A. $-F$ acting on object B.

B. $-F$ acting on object A.

C. $+F$ acting on object B.

D. $+F$ acting on object A.

An object falls from rest from a height *h* close to the surface of the Moon. The Moon has no atmosphere.

When the object has fallen to height $\frac{h}{4}$ above the surface, what is

$$\frac{\text{kinetic energy of the object at } \frac{h}{4}}{\text{gravitational potential energy of the object at } h}?$$

A. $\frac{3}{4}$

B. $\frac{4}{3}$

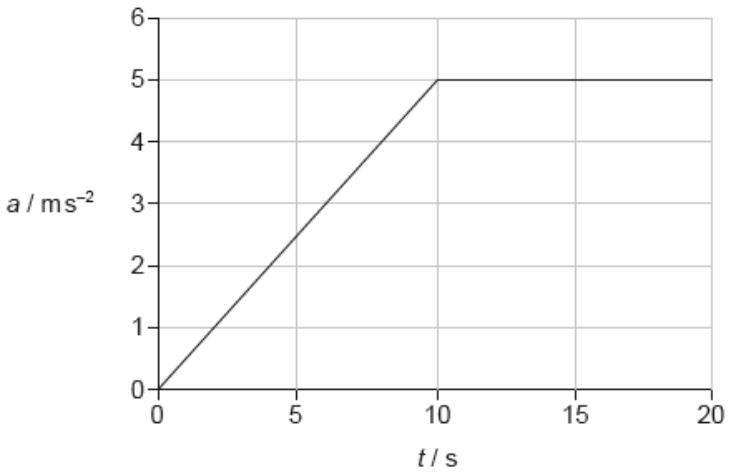
C. $\frac{9}{16}$

D. $\frac{16}{9}$

A car travelling at a constant velocity covers a distance of 100 m in 5.0 s. The thrust of the engine is 1.5 kN. What is the power of the car?

A. 0.75 kW
B. 3.0 kW
C. 7.5 kW
D. 30 kW

An object is at rest at time $t = 0$. The variation with t of the acceleration a of the object is shown from $t = 0$ to $t = 20$ s.



What is the speed of the object when $t = 15$ s?

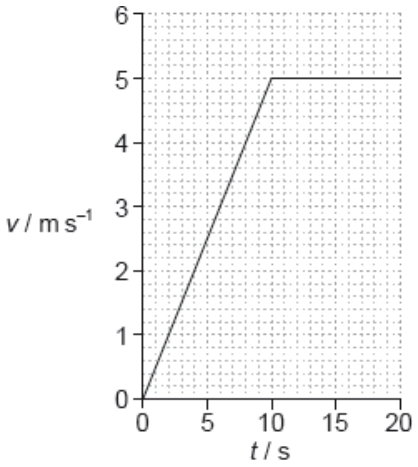
A. $25\ \mathrm{m\,s^{-1}}$

B. $50\ \mathrm{m\,s^{-1}}$

C. $75\ \mathrm{m\,s^{-1}}$

D. $100\ \mathrm{m\,s^{-1}}$

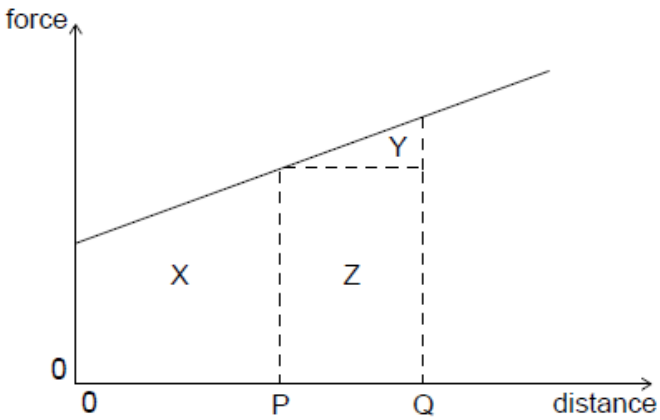
A boy runs along a straight horizontal track. The graph shows how his speed *v* varies with time *t*.



After 15 s the boy has run 50 m. What is his instantaneous speed and his average speed when *t* = 15 s?

	Instantaneous speed / m s^{-1}	Average speed / m s^{-1}
A.	3.3	3.3
B.	3.3	5.0
C.	5.0	3.3
D.	5.0	5.0

A graph shows the variation of force acting on an object moving in a straight line with distance moved by the object. Which area represents the work done on the object during its motion from P to Q?



A. X
B. Y
C. Y + Z
D. X + Y + Z

Two objects m_1 and m_2 approach each other along a straight line with speeds v_1 and v_2 as shown. The objects collide and stick together.

What is the total change of linear momentum of the objects as a result of the collision?

A. $m_1v_1 + m_2v_2$
B. $m_1v_1 - m_2v_2$
C. $m_2v_2 - m_1v_1$
D. zero

Two balls of different mass are dropped from the top of a tall building one after the other. The distance between the balls

A. increases with time.

B. depends on the initial velocity only.

C. remains constant.

D. depends on the mass of the balls.

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 horizontally from the top of a cliff. The projectile hits the ground 4 s later at a distance of 2 km from the base of the cliff. What is the height of the cliff?

A. 40 m

B. 80 m

C. 120 m

D. 160 m

The momentum of a particle stays constant provided that

A. it moves in a circle with constant speed.
B. its acceleration is uniform.
C. the net internal force acting on it is zero.
D. the net external force acting on it is zero.

The diagram shows a girl attempting (but failing) to lift a heavy suitcase of weight W. The magnitude of the vertical upwards pull of the girl on the suitcase is P and the magnitude of the vertical reaction of the floor on the suitcase is R.

Which equation correctly relates W, P and R?

A. $W = P + R$
B. $W > P + R$
C. $W < P + R$
D. $W = P = R$

A net force acts on a body. Which characteristic of the body will definitely change?

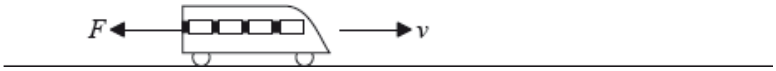
A. Speed
B. Momentum
C. Kinetic energy
D. Direction of motion

A stone is thrown vertically upwards from the surface of Earth. Which of the following quantities will **not** become zero while the stone is in the air?

A. Speed
B. Velocity
C. Momentum

D. Acceleration

A railway engine of mass *m* moves along a horizontal track with uniform speed v. The total resistive force acting on the engine is F.



Which of the following is the power of the engine?

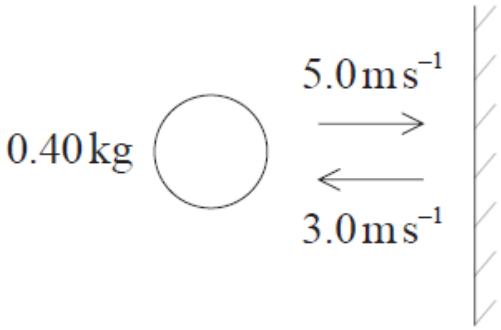
A. $\frac{F}{mv}$

B. Fv

C. $\frac{mv}{F}$

D. $\frac{v}{F}$

A ball of mass 0.40 kg travels horizontally and strikes a vertical wall with a speed of 5.0 ms^{-1}. It rebounds horizontally with a speed of 3.0 ms^{-1}. The ball is in contact with the wall for a time of 0.20 s.



What is the average magnitude of the force exerted by the ball on the wall?

A. 0.16 N
B. 0.64 N
C. 4 N
D. 16 N

An object is projected vertically upwards at time *t* = 0. Air resistance is negligible. The object passes the same point above its starting position at times 2 s and 8 s.

If g = 10 m s^{-2}, what is the initial speed of the object?

A. 50

B. 30

C. 25

D. 4

Which of the following is proportional to the net external force acting on a body?

A. Speed

B. Velocity

C. Rate of change of speed

D. Rate of change of velocity

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 lift (elevator) is operated by an electric motor. It moves between the 10^{th} floor and the 2^{nd} floor at a constant speed. One main energy transformation during this journey is

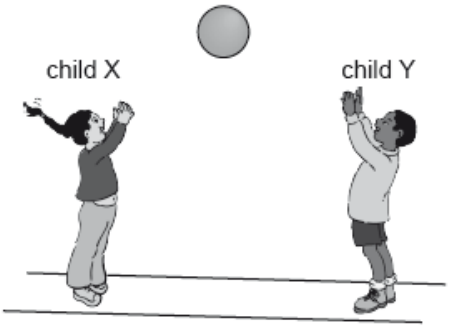
A. gravitational potential energy $\rightarrow$ kinetic energy.

B. electrical energy $\rightarrow$ kinetic energy.

C. kinetic energy $\rightarrow$ thermal energy.

D. electrical energy $\rightarrow$ thermal energy.

Child X throws a ball to child Y. The system consists of the ball, the children and the Earth. What is true for the system when the ball has been caught by Y?



[Source: https://pixabay.com/en/playing-ball-kids-boy-girl-31339/]

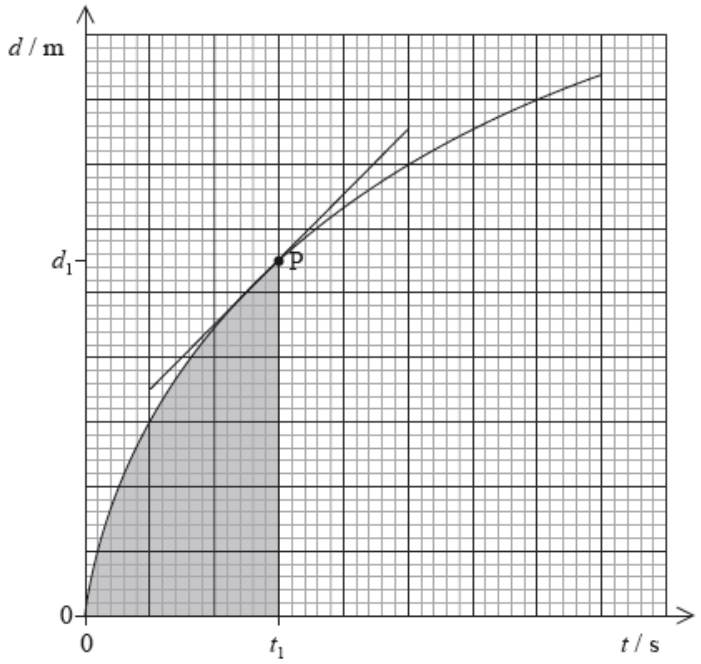
A. The momentum of child Y is equal and opposite to the momentum of child X.

B. The speed of rotation of the Earth will have changed.

C. The ball has no net momentum while it is in the air.

D. The total momentum of the system has not changed.

The graph shows how the displacement d of an object varies with time t. The tangent to the curve at time t_1 is also shown.



Which of the following gives the speed of the object at point P?

A. the gradient at P

B. the shaded area

C. $\frac{1}{\text{gradient at P}}$

D. $\frac{d_1}{t_1}$

An object, initially at rest, travels a distance *d* in a time *t* at a constant acceleration. What is the time taken for the object to travel 16*d* from rest at the same acceleration?

A. 16*t*

B. 8*t*

C. 4*t*

D. 2*t*

Which of the following is an elastic collision?

A. Two railway trucks collide and they link together.

B. Two railway trucks collide and they do not link together.

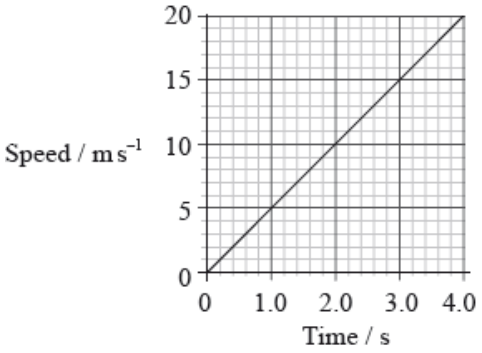
C. Two gas molecules collide and each changes direction.

D. Two gas molecules collide and a bond is formed between them.

An egg dropped on the floor is likely to break. However, when it is wrapped in a cloth it is less likely to break. This is because the cloth

A. increases the time for which the force of the ground acts on the egg.
B. reduces the momentum of the egg.
C. reduces the change of momentum of the egg.
D. reduces the impulse acting on the egg.

The graph is a speed versus time graph for an object that is moving in a straight line.



The distance travelled by the object during the first 4.0 seconds is

A. 80 m.

B. 40 m.

C. 20 m.

D. 5 m.

An object of mass m_1 has a kinetic energy E_1. Another object has a mass m_2 and kinetic energy E_2. The objects have the same momentum. What is the ratio $\frac{E_1}{E_2}$?

A. 1

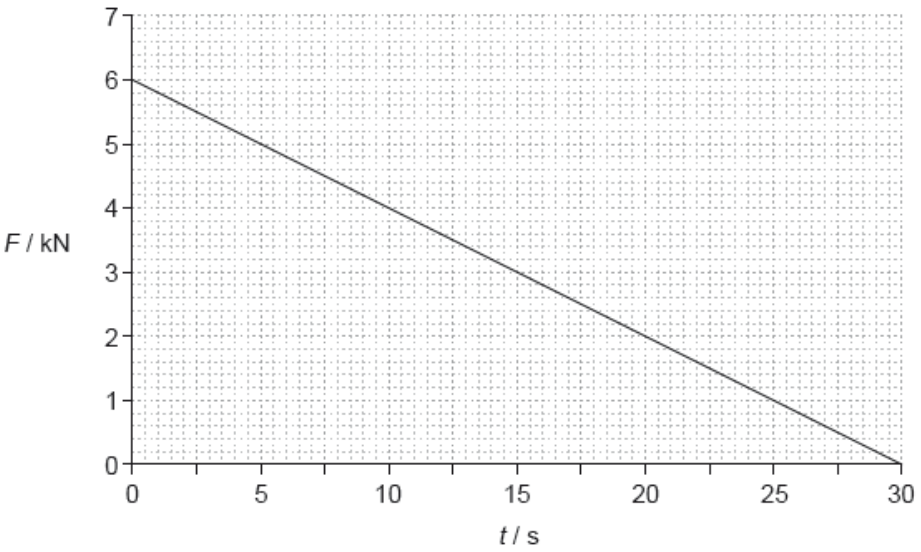
B. $\sqrt{\frac{m_2}{m_1}}$

C. $\frac{m_2}{m_1}$

D. $\left(\frac{m_2}{m_1}\right)^2$

The graph shows the variation with time t of the force F acting on an object of mass 15 000 kg.

The object is at rest at $t = 0$.



What is the speed of the object when $t = 30$ s?

A. 0.18 m s^{-1}

B. 6 m s^{-1}

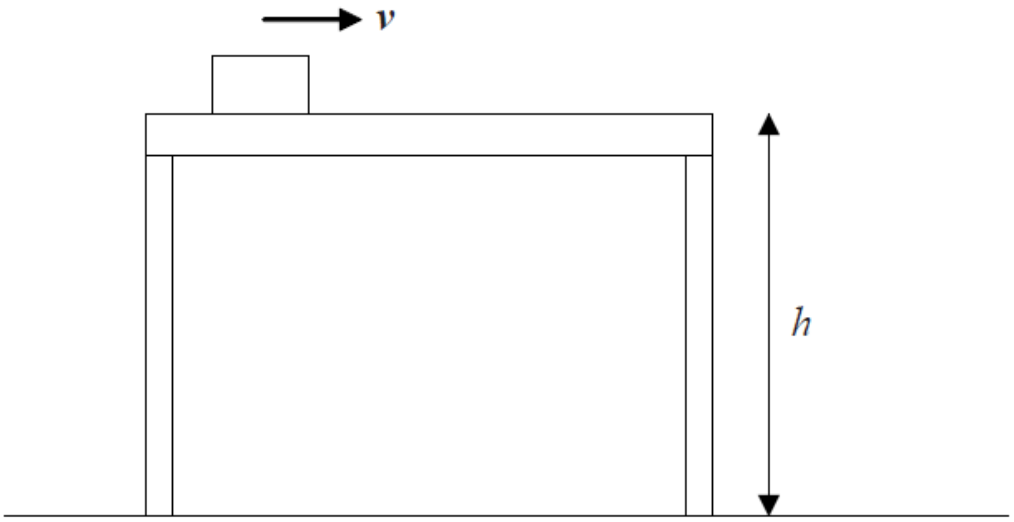
C. 12 m s^{-1}

D. 180 m s^{-1}

A constant force of 12 N is applied for 3.0 s to a body initially at rest. The final velocity of the body is 6.0m s^{-1}. What is the mass of the body?

A. 1.5 kg
B. 6.0 kg
C. 24 kg
D. 36 kg

A block of mass m is moving at constant velocity v along a frictionless surface that is height h above the ground.



Which expression gives the work necessary to maintain the constant velocity?

A. mgh

B. $\frac{1}{2}mv^2$

C. $mgh+\frac{1}{2}mv^2$

D. zero

A vehicle is driven up a hill at constant speed. Which of the following best describes the energy changes involved?

A. Chemical energy is converted into gravitational potential energy.

B. Chemical energy is converted into gravitational potential energy, sound and thermal energy.

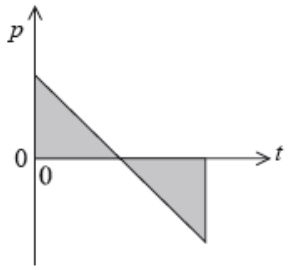
C. Gravitational potential energy is converted into chemical energy.

D. Gravitational potential energy is converted into chemical energy, sound and thermal energy.

Each side of a metal cube is measured to be 2.0 cm ± 0.20 cm. What is the absolute uncertainty in the calculated volume of the cube?

A. ± 0.08 cm^3
B. ± 0.60 cm^3
C. ± 0.80 cm^3
D. ± 2.4 cm^3

A rubber ball, travelling in a horizontal direction, strikes a vertical wall. It rebounds at right angles to the wall. The graph below illustrates the variation of the ball's momentum p with time t when the ball is in contact with the wall.



Which of the following statements is true?

A. The shaded area is equal to the force exerted by the wall on the ball.

B. The shaded area is equal to the force exerted by the ball on the wall.

C. The gradient is equal to the force exerted by the wall on the ball.

D. The gradient is equal to the force exerted by the ball on the wall.

Two balls X and Y with the same diameter are fired horizontally with the same initial momentum from the same height above the ground. The mass of X is greater than the mass of Y. Air resistance is negligible.

What is correct about the horizontal distances travelled by X and Y and the times taken by X and Y to reach the ground?

	Horizontal distances	Time to reach ground
A.	X and Y the same	X and Y times the same
B.	X and Y the same	X takes a shorter time than Y
C.	X less than Y	X and Y times the same
D.	X less than Y	X takes a shorter time than Y

The time taken for a stone dropped from rest to fall vertically through 16 m is 2.0 s. Based on these measurements, what is the best estimate for the acceleration of free fall?

A. $4.0\ \mathrm{m\,s^{-2}}$

B. $8.0\ \mathrm{m\,s^{-2}}$

C. $9.8\ \mathrm{m\,s^{-2}}$

D. $10\ \mathrm{m\,s^{-2}}$

Two identical spheres, each of mass m and speed v, travel towards each other on a frictionless surface in a vacuum.

The spheres undergo a head-on elastic collision.

Which statement correctly describes the spheres after the collision?

A. The total momentum of the spheres is $2mv$.

B. Each sphere has zero momentum.

C. The total kinetic energy of the spheres is mv^2.

D. Each sphere has zero kinetic energy.

A force which increases uniformly from 0 to a maximum value of F is applied to an object. The object does not move until the force exceeds $0.5F$. As the force increases from $0.5F$ to F the object moves a distance x in the direction of the force. What is the work done by this force?

A. $0.25Fx$
B. $0.5Fx$
C. $0.75Fx$
D. Fx

A student makes three statements about situations in which no work is done on an object.

I. The object is moving with uniform circular motion.
II. A force is applied to the object in the direction of its velocity.
III. A force is applied to the object in a direction opposite to its motion.

Which of the above statements is/are correct?

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

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

A. The resultant force on the body in any direction is zero.

B. The velocity of the body in any direction is zero.

C. No external force is acting on the body.

D. No work is done on the body.

An ice-hockey puck is slid along ice in a straight line. The puck travels at a steady speed of 20 ms^{-1} and experiences no frictional force. How far does the puck travel in 2.5 s?

A. 5 m
B. 8 m
C. 25 m
D. 50 m

An object is released from rest in the gravitational field of the Earth. Air resistance is negligible. How far does the object move during the fourth second of its motion?

A. 15 m
B. 25 m
C. 35 m
D. 45 m

A ball of mass *m* travels horizontally with speed *v* before colliding with a vertical wall. The ball rebounds at speed *v* in a direction opposite to its initial direction. What is the magnitude of the change in momentum of the ball?

A. 0

B. $\frac{mv}{2}$

C. *mv*

D. 2 *mv*

An object is released from a stationary hot air balloon at height *h* above the ground.

An identical object is released at height *h* above the ground from another balloon that is rising at constant speed. Air resistance is negligible. What does **not** increase for the object released from the rising balloon?

A. The distance through which it falls

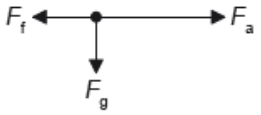
B. The time taken for it to reach the ground

C. The speed with which it reaches the ground

D. Its acceleration

A box is accelerated to the right across rough ground by a horizontal force F_a. The force of friction is F_f. The weight of the box is F_g and the normal reaction is F_n. Which is the free-body diagram for this situation?

A.



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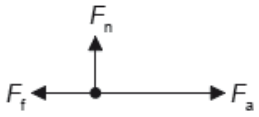
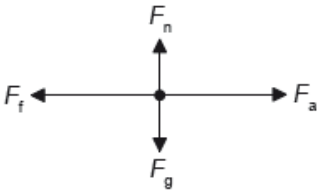
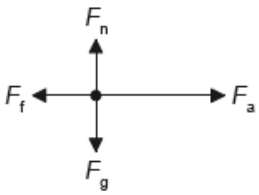


C.



D.



Which of the following is a correct statement of Newton's second law of motion?

A. A force acting on a body is proportional to the mass of the body.

B. The rate of change of momentum of a body is equal to the net external force acting on the body.

C. The momentum of a body is proportional to the net external force acting on the body.

D. A force acting on a body is proportional to the acceleration of the body.

A ball is tossed vertically upwards with a speed of 5.0 m s^{-1}. After how many seconds will the ball return to its initial position?

A. 0.50 s

B. 1.0 s

C. 1.5 s

D. 2.0 s

Three coplanar forces of 5 N, 6 N and 7 N act on an object. Which force could **not** be the resultant of these three forces?

A. 0 N
B. 11 N
C. 13 N
D. 19 N

A motor of input power 160 W raises a mass of 8.0 kg vertically at a constant speed of 0.50 m s^{-1}.

What is the efficiency of the system?

A. 0.63%

B. 25%

C. 50%

D. 100%

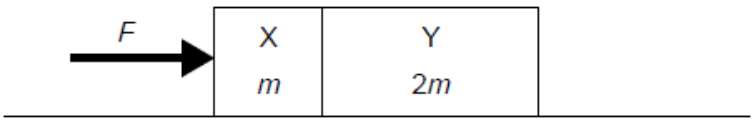
A cart of mass 4.0 kg is being pulled with a force of 24 N. The cart accelerates at 3.0m s^{-2}. What is the net force on the cart?

A. 6.0 N
B. 8.0 N
C. 12 N
D. 24 N

In an inelastic collision

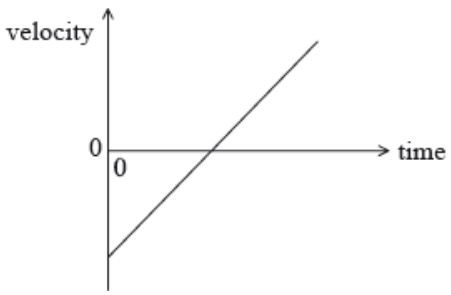
A. momentum and kinetic energy are both conserved.
B. momentum is conserved but kinetic energy is not.
C. kinetic energy is conserved but momentum is not.
D. neither momentum nor kinetic energy are conserved.

Two boxes in contact are pushed along a floor with a force *F*. The boxes move at a constant speed. Box X has a mass *m* and box Y has a mass 2*m*.



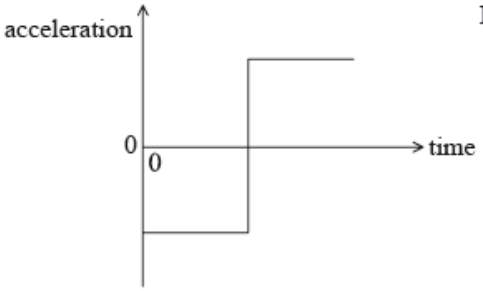
What is the resultant force acting on Y?
A. 0
B. $\frac{F}{2}$
C. *F*
D. 2*F*

The graph shows how the velocity of a particle varies with time.



Which of the following graphs correctly shows how the acceleration of the particle varies with time?

A.



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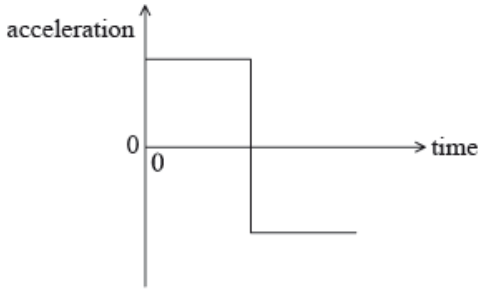
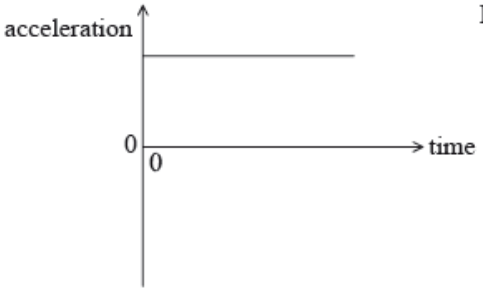
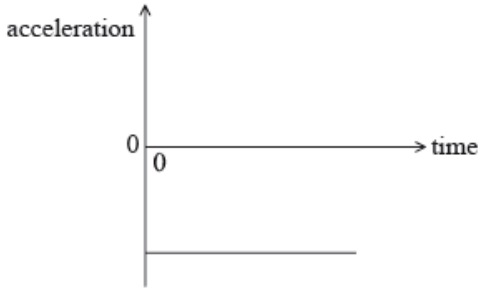


C.



D.



The net force on a body is *F*. The impulse of *F* is equal to the

A. change in momentum of the body.
B. rate of change of momentum of the body.
C. change of kinetic energy of the body.
D. change of total energy of the body.

A skydiver of mass 80 kg falls vertically with a constant speed of 50 m s^{-1}. The upward force acting on the skydiver is approximately

A. 0 N.
B. 80 N.
C. 800 N.
D. 4000 N.

The efficiency of an electric motor is 20 %. When lifting a body 500 J of energy are wasted. What is the useful work done by the motor?

A. 100 J

B. 125 J

C. 250 J

D. 400 J

A spring of negligible mass and length l_0 hangs from a fixed point. When a mass *m* is attached to the free end of the spring, the length of the spring increases to *l*. The tension in the spring is equal to $k\Delta x$, where *k* is a constant and Δx is the extension of the spring. What is *k*?

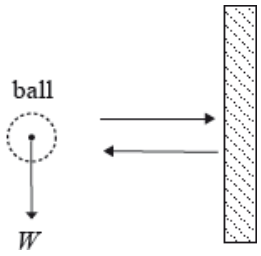
A. $\frac{mg}{l_0}$

B. $\frac{mg}{l}$

C. $\frac{mg}{l-l_0}$

D. $\frac{mg}{l_0-l}$

A ball of weight W is travelling horizontally towards a vertical wall. It strikes the wall and rebounds horizontally. The change in the magnitude of the momentum of the ball is Δp. Which of the following is the magnitude of the impulse that the ball imparts to the wall?



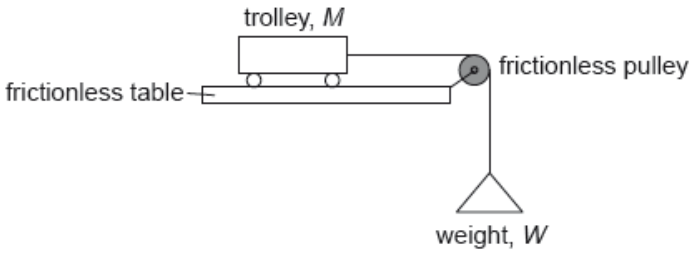
A. $W + \Delta p$

B. $W - \Delta p$

C. W

D. Δp

A weight *W* is tied to a trolley of mass *M* by a light string passing over a frictionless pulley. The trolley has an acceleration *a* on a frictionless table. The acceleration due to gravity is *g*.



What is *W* ?

A. $\frac{Mag}{(g-a)}$

B. $\frac{Mag}{(g+a)}$

C. $\frac{Ma}{(g-a)}$

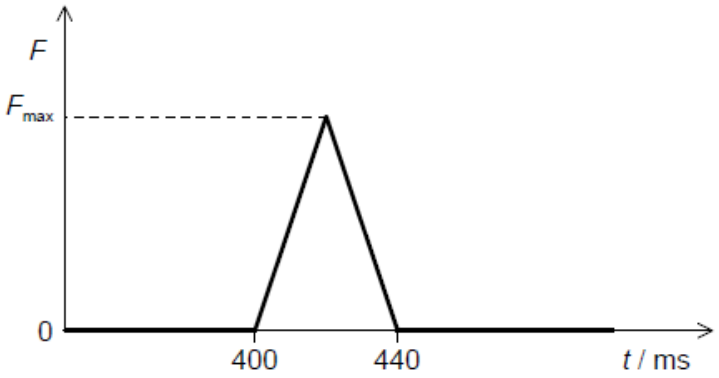
D. $\frac{Ma}{(g+a)}$

An inelastic collision occurs between two bodies in the absence of external forces.

What must be true about the total momentum of the two bodies and the total kinetic energy of the two bodies during this interaction?

A. Only momentum is conserved.
B. Only kinetic energy is conserved.
C. Both momentum and kinetic energy are conserved.
D. Neither momentum nor kinetic energy are conserved.

A ball of mass 0.2 kg strikes a force sensor and sticks to it. Just before impact the ball is travelling horizontally at a speed of 4.0 m s^{-1}. The graph shows the variation with time t of the force F recorded by the sensor.



What is F_{max}?

A. 2 N

B. 4 N

C. 20 N

D. 40 N

An object of weight *W* is falling vertically at a constant speed in a fluid. What is the magnitude of the drag force acting on the object?

A. 0
B. $\frac{W}{2}$
C. *W*
D. 2*W*

A stone is falling at a constant velocity vertically down a tube filled with oil. Which of the following statements about the energy changes of the stone during its motion are correct?

I. The gain in kinetic energy is less than the loss in gravitational potential energy.
II. The sum of kinetic and gravitational potential energy of the stone is constant.
III. The work done by the force of gravity has the same magnitude as the work done by friction.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

A tennis ball is released from rest at a height *h* above the ground. At each bounce 50 % of its kinetic energy is lost to its surroundings. What is the height reached by the ball after its second bounce?

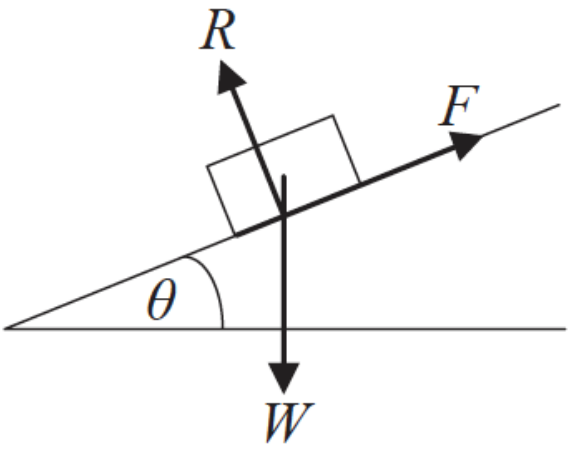
A. $\frac{h}{8}$

B. $\frac{h}{4}$

C. $\frac{h}{2}$

D. zero

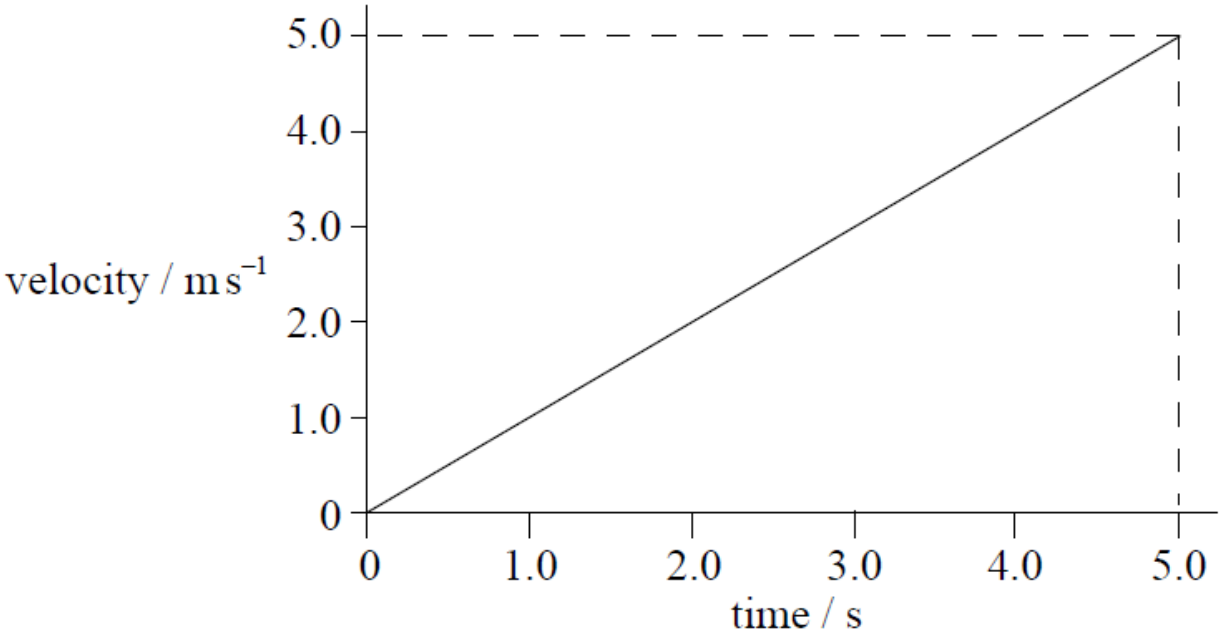
A block of weight *W* slides down an inclined plane at a constant speed.



The normal reaction acting between the block and the plane is *R* and the frictional force between the block and the plane is *F*. The incline is at an angle *θ* to the horizontal. What is the magnitude of *F*?

A. *R* cos *θ*
B. *R* sin *θ*
C. *W* cos *θ*
D. *W* sin *θ*

The velocity–time graph for an accelerating object that is traveling in a straight line is shown below.



Which of the following is the change in displacement of the object in the first 5.0 seconds?

A. 25.0 m
B. 12.5 m
C. 5.0 m
D. 1.0 m

A brother and sister take the same time to run up a set of steps. The sister has a greater mass than her brother. Which of the following is correct?

	Has done the most work	Has developed the greatest power
A.	brother	brother
B.	brother	sister
C.	sister	brother
D.	sister	sister

The variation of the displacement of an object with time is shown on a graph. What does the area under the graph represent?

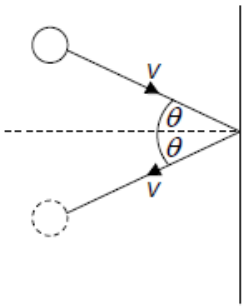
A. No physical quantity

B. Velocity

C. Acceleration

D. Impulse

A ball of mass *m* strikes a vertical wall with a speed *v* at an angle of θ to the wall. The ball rebounds at the same speed and angle. What is the change in the magnitude of the momentum of the ball?



A. 2 *mv* sin θ
B. 2 *mv* cos θ
C. 2 *mv*
D. zero

An object rotates in a horizontal circle when acted on by a centripetal force *F*. What is the centripetal force acting on the object when the radius of the circle doubles and the kinetic energy of the object halves?

A. $\frac{F}{4}$

B. $\frac{F}{2}$

C. *F*

D. 4*F*

A heat engine does 300 J of work during one cycle. In this cycle 900 J of energy is wasted. What is the efficiency of the engine?

A. 0.25

B. 0.33

C. 0.50

D. 0.75

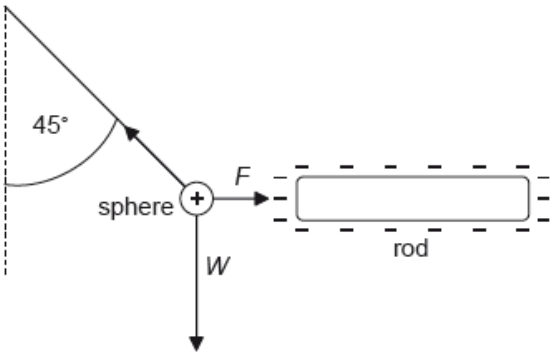
A student of weight 600N climbs a vertical ladder 6.0m tall in a time of 8.0s. What is the power developed by the student against gravity?

A. 22W
B. 45W
C. 220W
D. 450W

In the collision between two bodies, Newton's third law

A. only applies if momentum is conserved in the collision.
B. only applies if energy is conserved in the collision.
C. only applies if both momentum and energy are conserved in the collision.
D. always applies.

A small positively charged sphere is suspended from a thread and placed close to a negatively charged rod. When the thread is at 45° to the vertical the system is in equilibrium. The weight of the sphere is *W* and the magnitude of the electrostatic force between the rod and the sphere is *F*.



(not to scale)

What is the magnitude of *W* compared with the magnitude of *F* ?

A. $W = \sqrt{2}F$
B. $F < W < \sqrt{2}F$
C. $W = F$
D. $W > F$

A body moves in a straight line. In order for the equations for uniformly accelerated motion to be applied, which condition **must** be true?

A. A constant net force acts on the body of fixed mass.
B. A constant net force acts on the body.
C. The body falls towards the surface of a planet.
D. The body has an initial velocity of zero.

A skydiver jumped out of an airplane. On reaching a terminal speed of $60\ \mathrm{m\,s^{-1}}$, she opened her parachute. Which of the following describes her motion after opening her parachute?

A. She went upwards for a short time, before falling to Earth at a speed of $60\ \mathrm{m\,s^{-1}}$.
B. She continued downwards at $60\ \mathrm{m\,s^{-1}}$, but hit the ground with less force.
C. She continued to fall but reached a new terminal speed of less than $60\ \mathrm{m\,s^{-1}}$.
D. She went upwards for a short time, before falling to Earth at a speed of less than $60\ \mathrm{m\,s^{-1}}$.

An insect of mass *m* jumps vertically from rest to a height *h*. The insect releases the energy needed for the jump in time Δ*t*. What is the estimate for the power developed by the insect?

A. *mgh* Δ*t*

B. *mh* Δ*t*

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

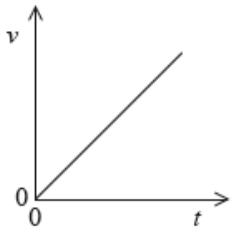
D. $\frac{mh}{\Delta t}$

A nuclear power station produces 10 GW of electrical power. The power generated by the nuclear reactions in the core of the reactor is 25 GW. The efficiency of the power station is

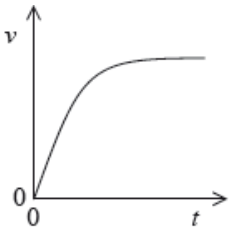
A. 15 %.
B. 35 %.
C. 40 %.
D. 60 %.

A raindrop falling from rest at time $t = 0$ reaches terminal velocity. Which graph best represents how the speed v varies with time t?

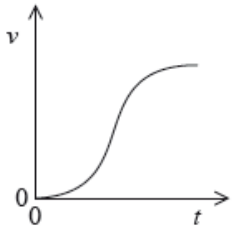
A.



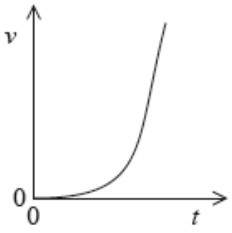
B.



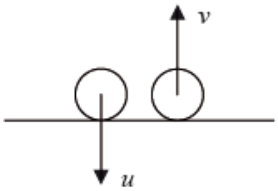
C.



D.



A ball falls vertically and bounces off the ground. Immediately before impact with the ground the speed of the ball is u. Immediately after leaving the ground the speed is v.



Which of the following expressions is the ratio of $\frac{\text{kinetic energy lost on collision}}{\text{kinetic energy immediately before collision}}$?

A. $\frac{v}{u}$

B. $1 - \frac{v}{u}$

C. $\left(\frac{v}{u}\right)^2$

D. $1 - \left(\frac{v}{u}\right)^2$

A wooden block is sliding down an inclined plane at constant speed. The magnitude of the frictional force between the block and the plane is equal to

A. zero.

B. the magnitude of the weight of the block.

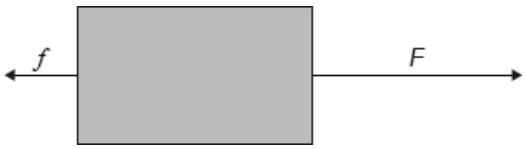
C. the magnitude of the component of weight of the block parallel to the plane.

D. the magnitude of the component of the normal reaction parallel to the plane.

A driving force *F* acts on a car which moves with constant velocity *v*. The quantity *Fv* is equivalent to the

A. useful power developed by the engine of the car.
B. work done by the car against resistive forces.
C. energy of the car.
D. rate of change of momentum of the car.

An object is moving in a straight line. A force *F* and a resistive force *f* act on the object along the straight line.



Both forces act for a time *t*.

What is the rate of change of momentum with time of the object during time *t* ?

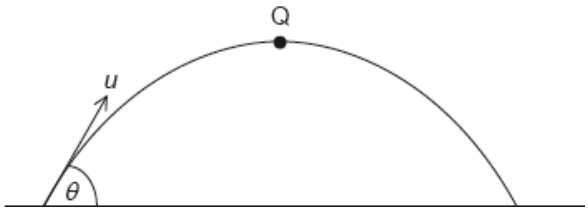
A. $F + f$

B. $F - f$

C. $(F + f)t$

D. $(F - f)t$

A ball of mass m is thrown with an initial speed of u at an angle θ to the horizontal as shown. Q is the highest point of the motion. Air resistance is negligible.



What is the momentum of the ball at Q?

A. zero

B. $mu\cos\theta$

C. mu

D. $mu\sin\theta$

The distances between successive positions of a moving car, measured at equal time intervals, are shown.

The car moves with

A. acceleration that increases linearly with time.

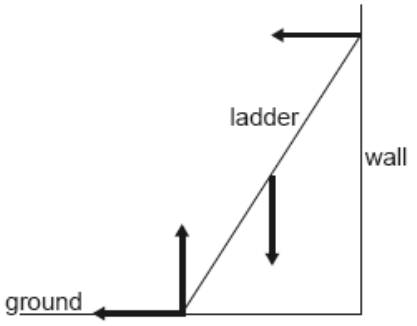
B. acceleration that increases non-linearly with time.

C. constant speed.

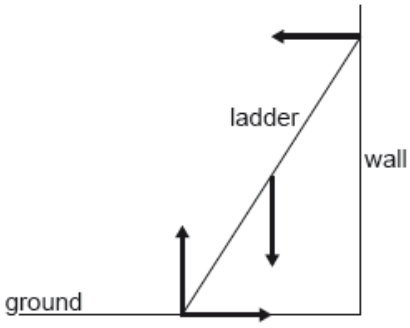
D. constant acceleration.

A uniform ladder resting in equilibrium on rough ground leans against a smooth wall. Which diagram correctly shows the forces acting on the ladder?

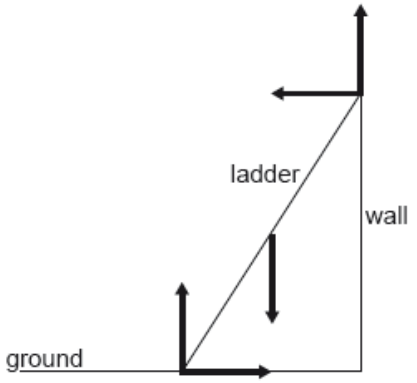
A.



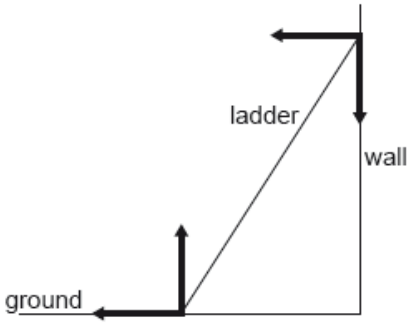
B.



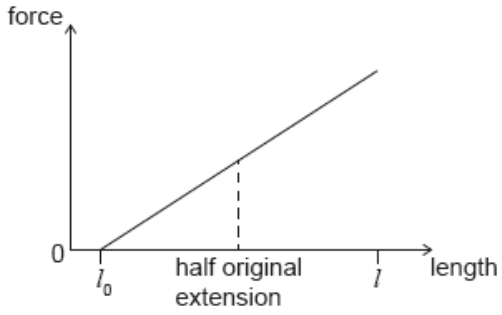
C.



D.



An increasing force acts on a metal wire and the wire extends from an initial length l_0 to a new length l. The graph shows the variation of force with length for the wire. The energy required to extend the wire from l_0 to l is E.



The wire then contracts to half its original extension.

What is the work done by the wire as it contracts?

A. 0.25*E*

B. 0.50*E*

C. 0.75*E*

D. *E*

An object of mass m is initially at rest. When an impulse I acts on the object its final kinetic energy is E_{K}. What is the final kinetic energy when an impulse of $2I$ acts on an object of mass $2m$ initially at rest?

A. $\frac{E_{\mathrm{K}}}{2}$

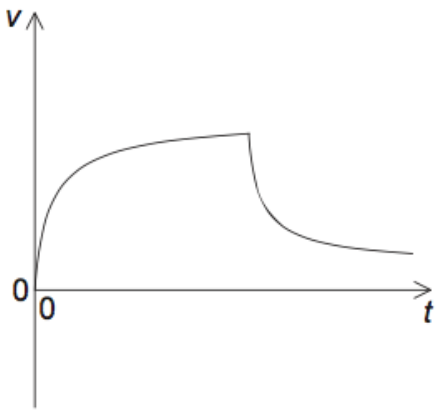
B. E_{K}

C. $2E_K$

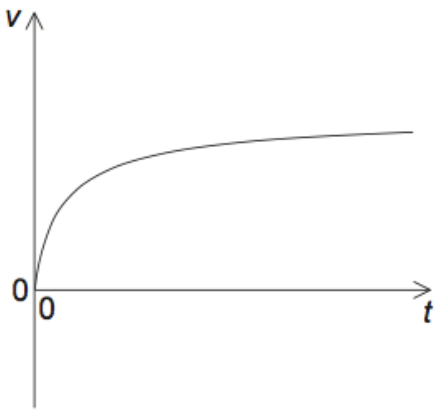
D. $4E_K$

An aircraft is moving horizontally. A parachutist leaves the aircraft and a few seconds later opens her parachute. Which graph shows the variation of the vertical speed *v* with time *t* for the parachutist from the time she leaves the aircraft until just before landing?

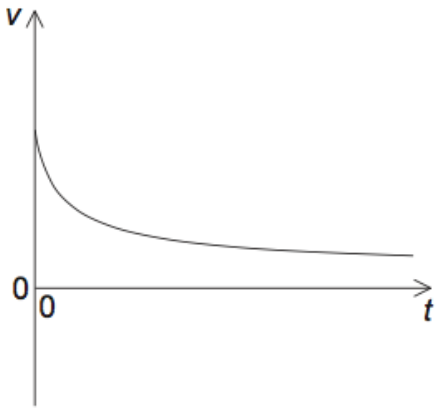
A.



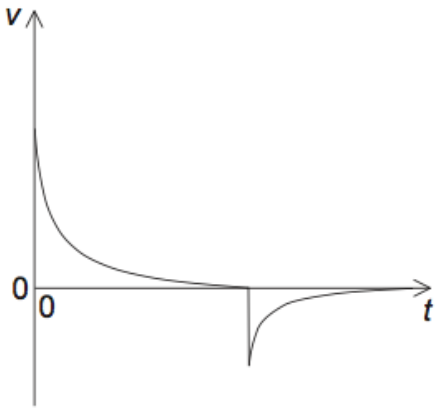
B.



C.



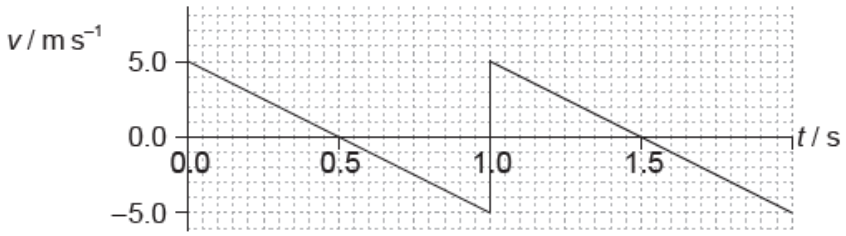
D.



A moving system undergoes an explosion. What is correct for the momentum of the system and the kinetic energy of the system when they are compared immediately before and after the explosion?

	Momentum	Kinetic energy
A.	conserved	increased
B.	conserved	conserved
C.	increased	conserved
D.	increased	increased

An object is thrown upwards. The graph shows the variation with time t of the velocity v of the object.



What is the total displacement at a time of 1.5 s, measured from the point of release?

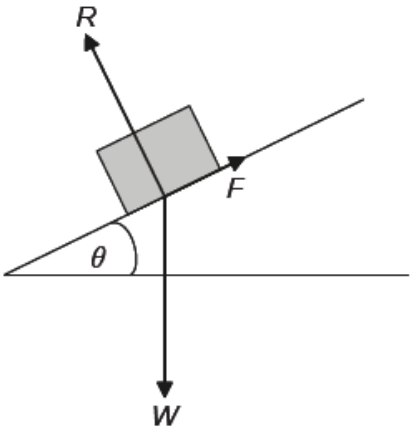
A. 0 m

B. 1.25 m

C. 2.50 m

D. 3.75 m

The diagram shows the forces acting on a block resting on an inclined plane. The angle θ is adjusted until the block is just at the point of sliding. R is the normal reaction, W the weight of the block and F the maximum frictional force.



not to scale

What is the maximum coefficient of static friction between the block and the plane?

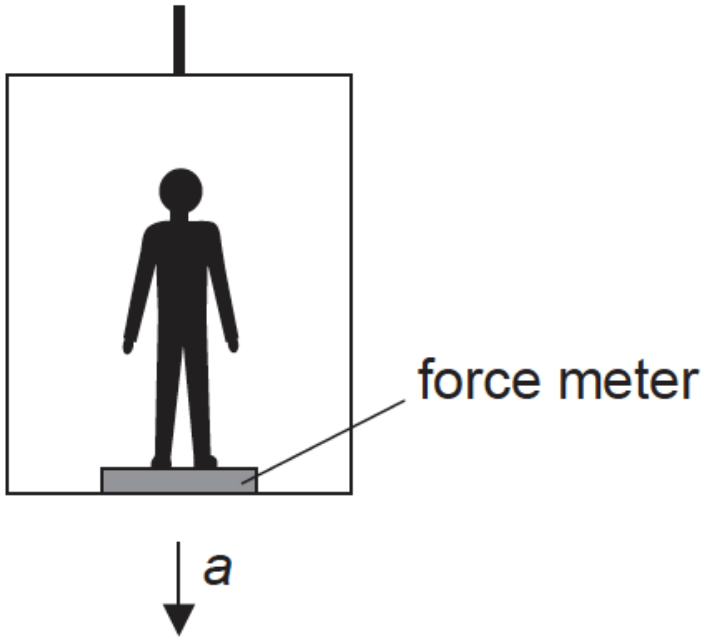
A. sin θ

B. cos θ

C. tan θ

D. $\frac{1}{\tan\theta}$

A student of mass *m* is in an elevator which is accelerating downwards at an acceleration *a*.



What is the reading on the force meter?

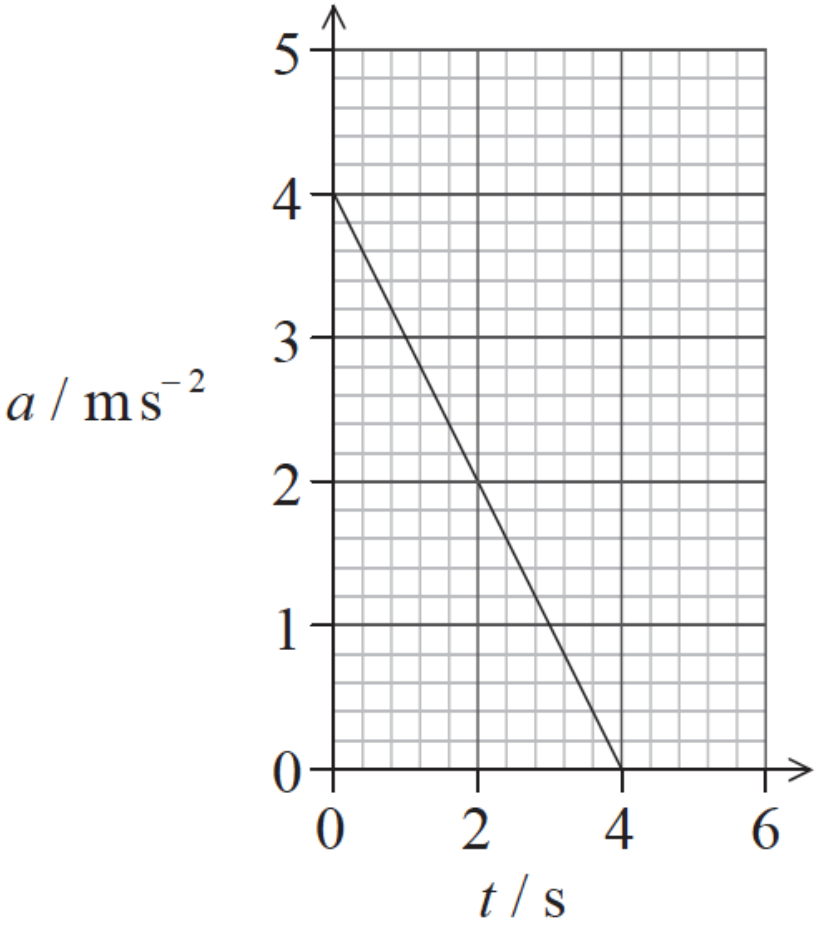
A. *mg*

B. *mg* – *ma*

C. *mg* + *ma*

D. *ma* – *mg*

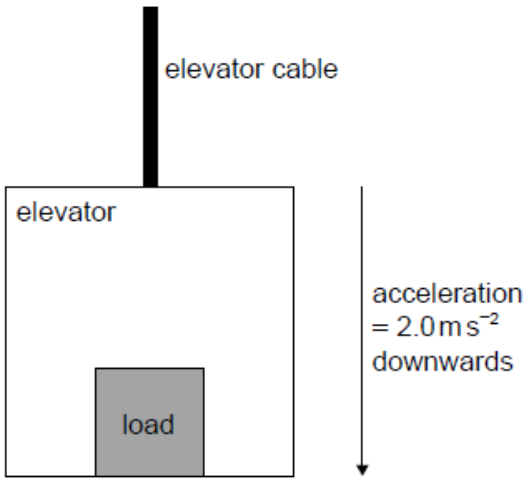
The graph shows the variation with time *t* of the acceleration *a* of an object.



Which of the following is the change in velocity of the object in the time interval 0 to 4s?

A. -8ms^{-1}
B. -4ms^{-1}
C. +4ms^{-1}
D. +8ms^{-1}

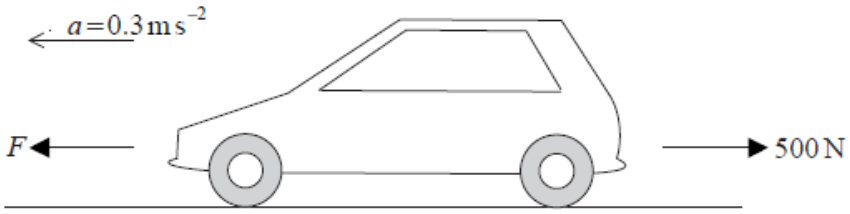
An elevator (lift) and its load have a total mass of 750 kg and accelerate vertically downwards at 2.0 m s^{-2}.



What is the tension in the elevator cable?

A. 1.5 kN
B. 6.0 kN
C. 7.5 kN
D. 9.0 kN

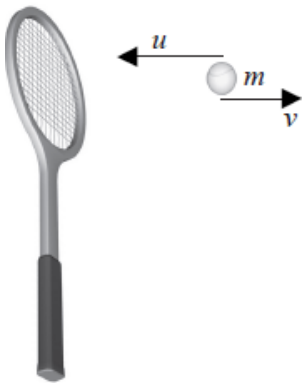
A car of mass 1000 kg accelerates on a straight, flat, horizontal road with an acceleration a = 0.3 m s^{-2}. The driving force F on the car is opposed by a resistive force of 500 N.



The net (resultant) force on the car is

A. 200 N.
B. 300 N.
C. 500 N.
D. 800 N.

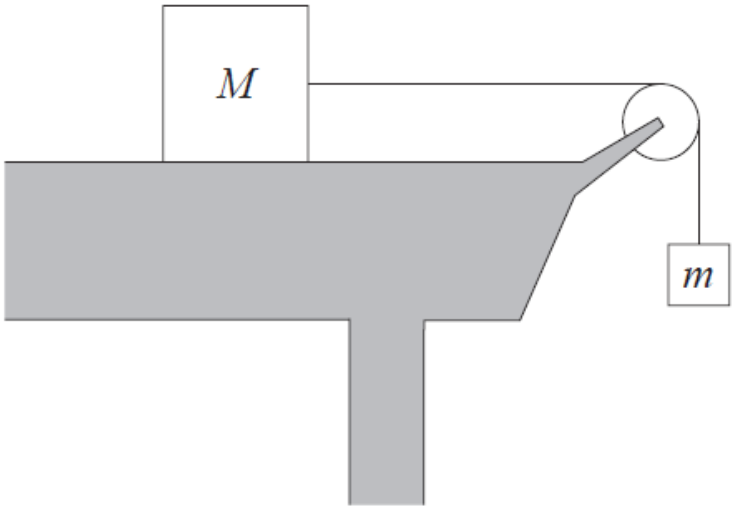
A tennis ball of mass m moving horizontally with speed u strikes a vertical tennis racket. The ball bounces back with a horizontal speed v.



The magnitude of the change in momentum of the ball is

A. m (u + v).
B. m (u – v).
C. m (v – u).
D. zero.

An object of mass m is connected via a frictionless pulley to an object of mass M, where $M > m$. M rests on a horizontal frictionless surface



What is the acceleration of the system?

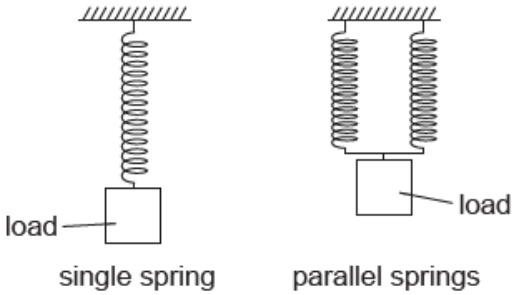
A. $\frac{mg}{(M+m)}$

B. $\frac{(M+m)g}{m}$

C. $\frac{gm}{M}$

D. Zero

A system that consists of a single spring stores a total elastic potential energy E_p when a load is added to the spring. Another identical spring connected in parallel is added to the system. The same load is now applied to the parallel springs.



What is the total elastic potential energy stored in the changed system?

A. E_p

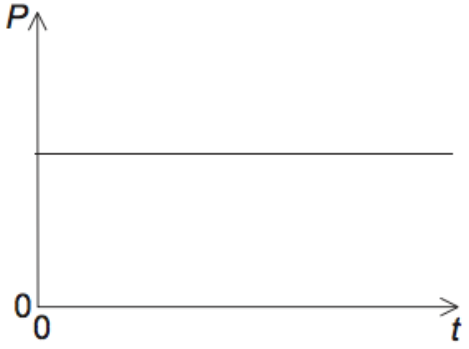
B. $\frac{E_p}{2}$

C. $\frac{E_p}{4}$

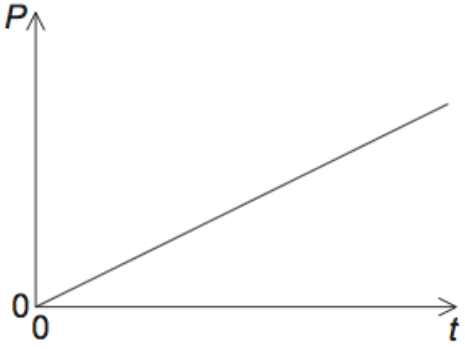
D. $\frac{E_p}{8}$

A train on a straight horizontal track moves from rest at constant acceleration. The horizontal forces on the train are the engine force and a resistive force which increases with speed. Which graph represents the variation with time *t* of the power *P* developed by the engine?

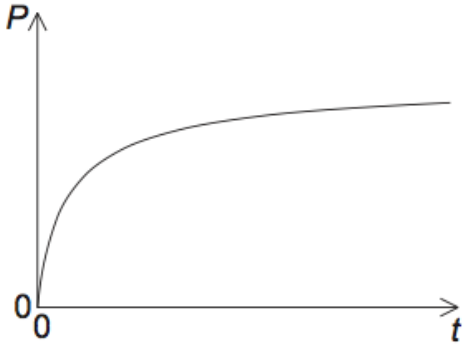
A.



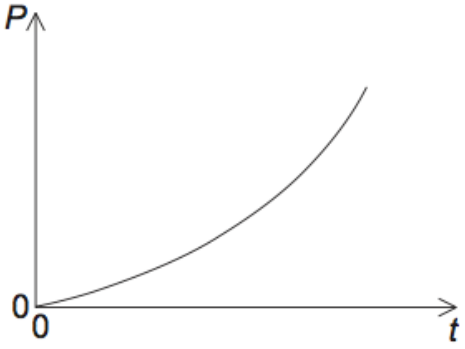
B.



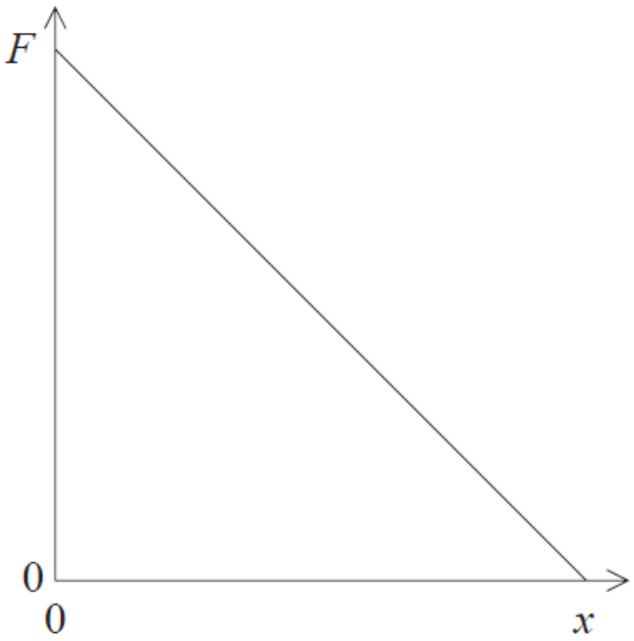
C.



D.



The graph shows the variation with distance *x* of the magnitude of the net force *F* acting on a body initially at rest.

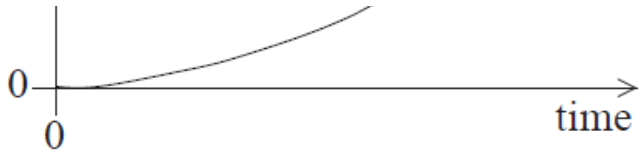


Which of the following describes how the kinetic energy and the acceleration of the body change with distance?

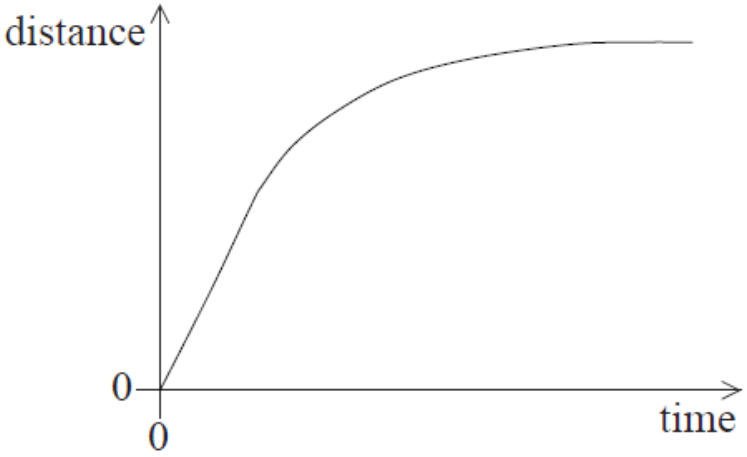
	Kinetic energy	Acceleration
A.	decrease	decrease
B.	decrease	increase
C.	increase	decrease
D.	increase	increase

An object falls vertically from rest. Air resistance acts on the object and it reaches a terminal speed. Which of the following is the distance–time graph for its motion?

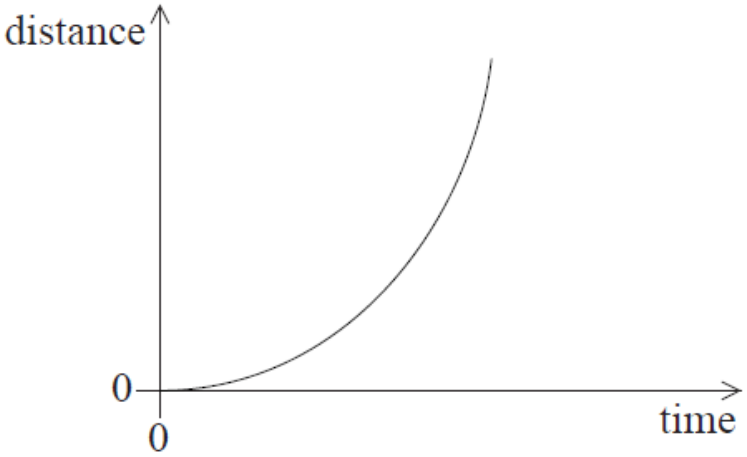
A.



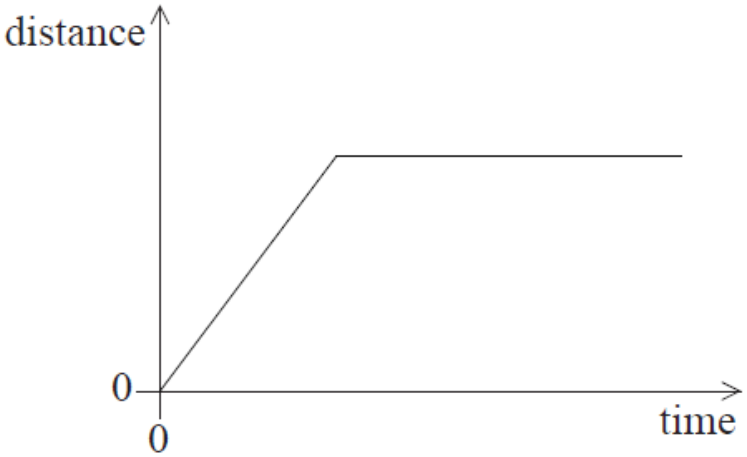
B.



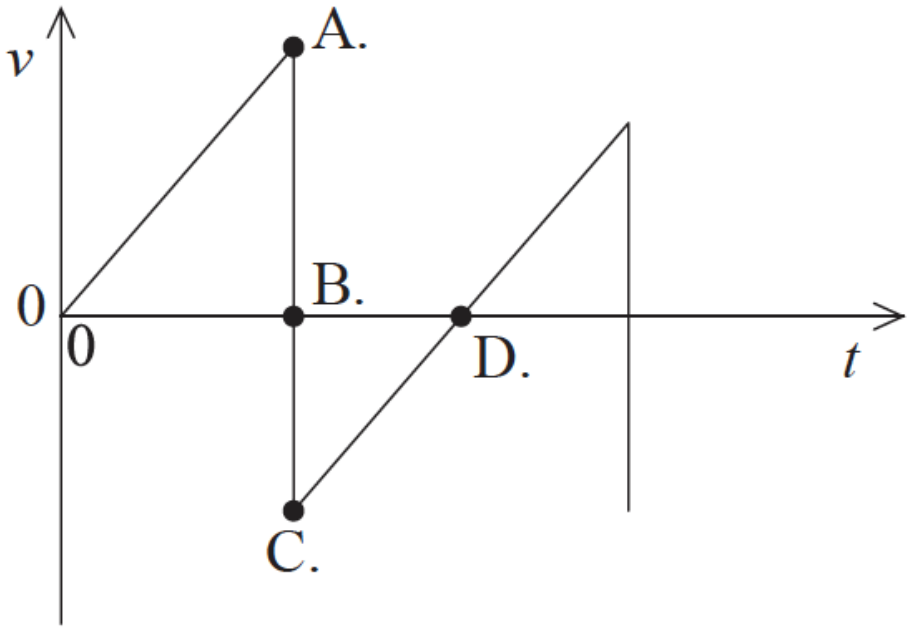
C.



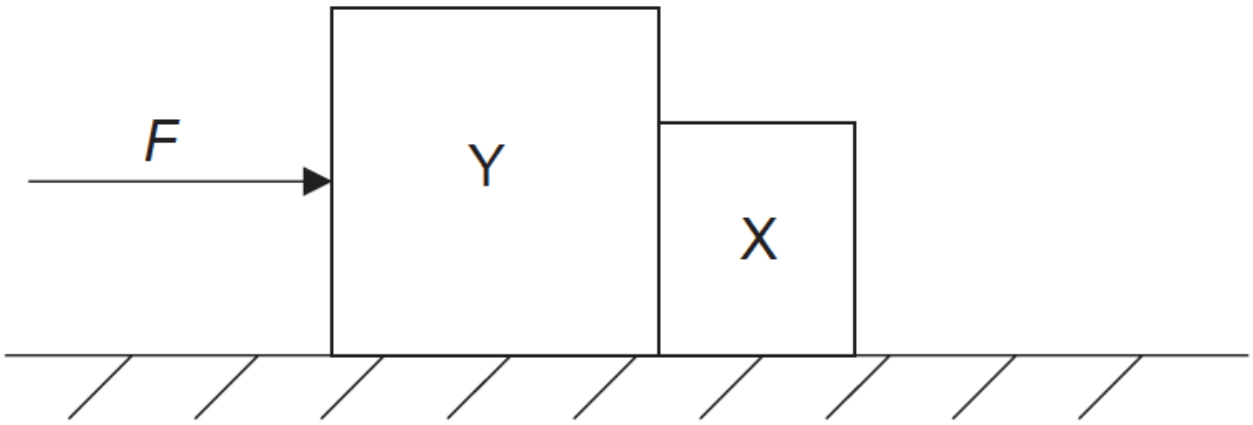
D.



A ball is released at time t=0 above a horizontal surface. The graph shows the variation of velocity v with time. Which of the following shows the highest point of the ball after one bounce?



A constant horizontal force F is applied to a block Y. Block Y is in contact with a separate block X.



The blocks remain in contact as they accelerate along a horizontal frictionless surface. Y has a greater mass than X. Air resistance is negligible. Which statement is correct?

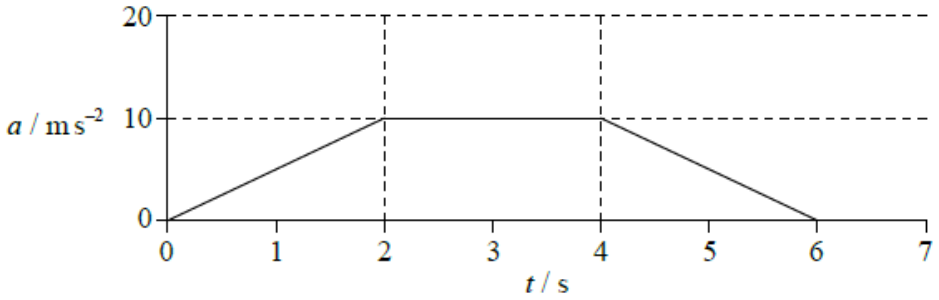
A. The force F is equal to the product of the mass of Y and the acceleration of Y.

B. The force that Y exerts on X is less than F.

C. The force that Y exerts on X is less than the force that X exerts on Y.

D. The force that Y exerts on X is equal to F.

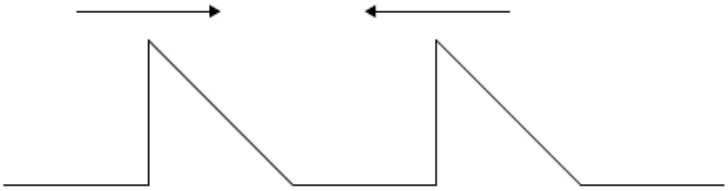
The graph shows the acceleration a of an object as time t varies.



What is the magnitude of the change in the velocity of the object between 0 and 3 seconds?

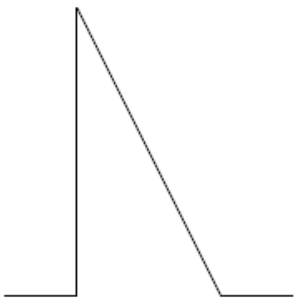
A. 5 ms^{-1}
B. 10 ms^{-1}
C. 20 ms^{-1}
D. 30 ms^{-1}

Two pulses are travelling towards each other.

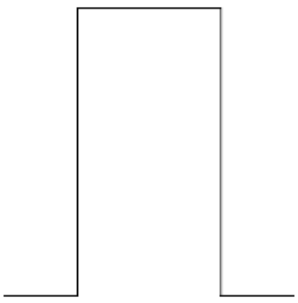


What is a possible pulse shape when the pulses overlap?

A.

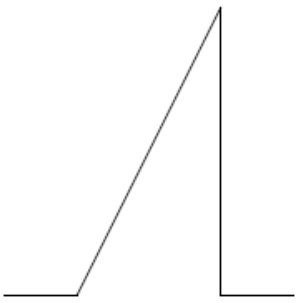


B.



C.

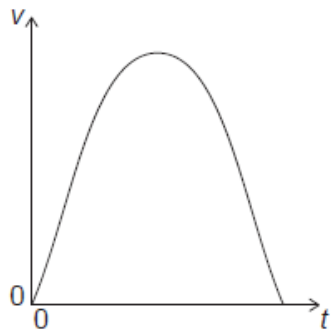
D.



An object is released above the surface of Earth. Which of the following correctly describes the speed and acceleration before it reaches terminal speed?

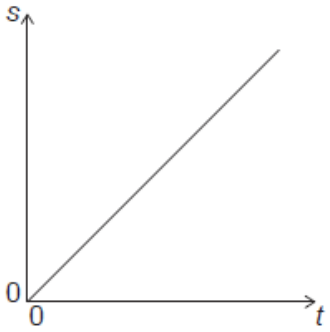
	Speed	Acceleration
A.	increases	remains constant
B.	increases	decreases
C.	remains constant	remains constant
D.	remains constant	decreases

The graph shows the variation of speed *v* of an object with time *t*.

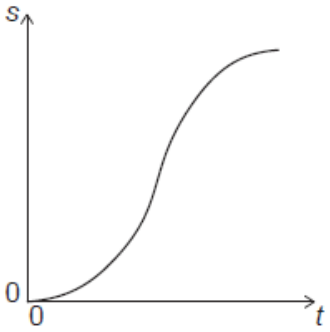


Which graph shows how the distance *s* travelled by the object varies with *t*?

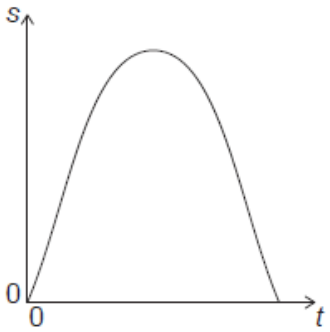
A.



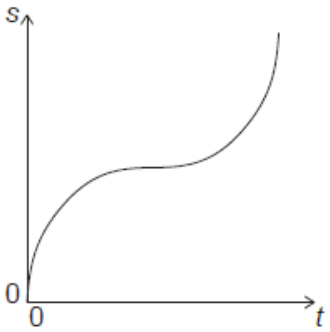
B.



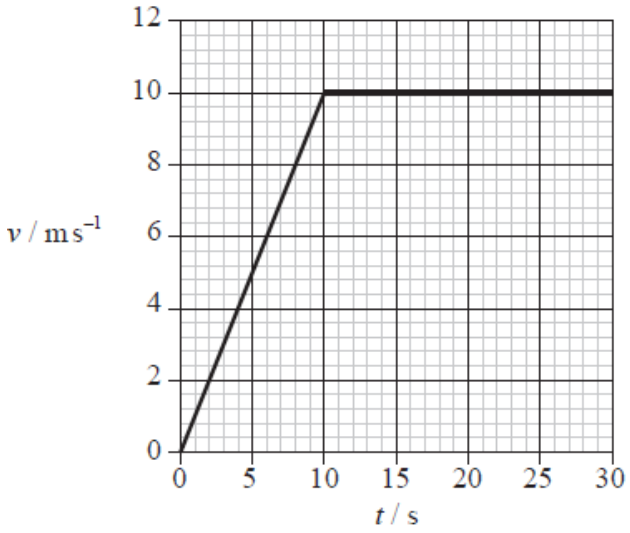
C.



D.



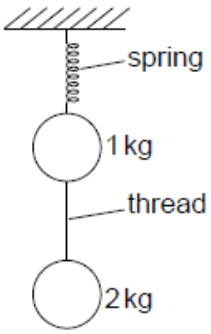
Joseph runs along a long straight track. The variation of his speed v with time t is shown below.



After 25 seconds Joseph has run 200 m. Which of the following is correct at 25 seconds?

	Instantaneous speed / $m\,s^{-1}$	Average speed / $m\,s^{-1}$
A.	$8\,m\,s^{-1}$	$8\,m\,s^{-1}$
B.	$8\,m\,s^{-1}$	$10\,m\,s^{-1}$
C.	$10\,m\,s^{-1}$	$8\,m\,s^{-1}$
D.	$10\,m\,s^{-1}$	$10\,m\,s^{-1}$

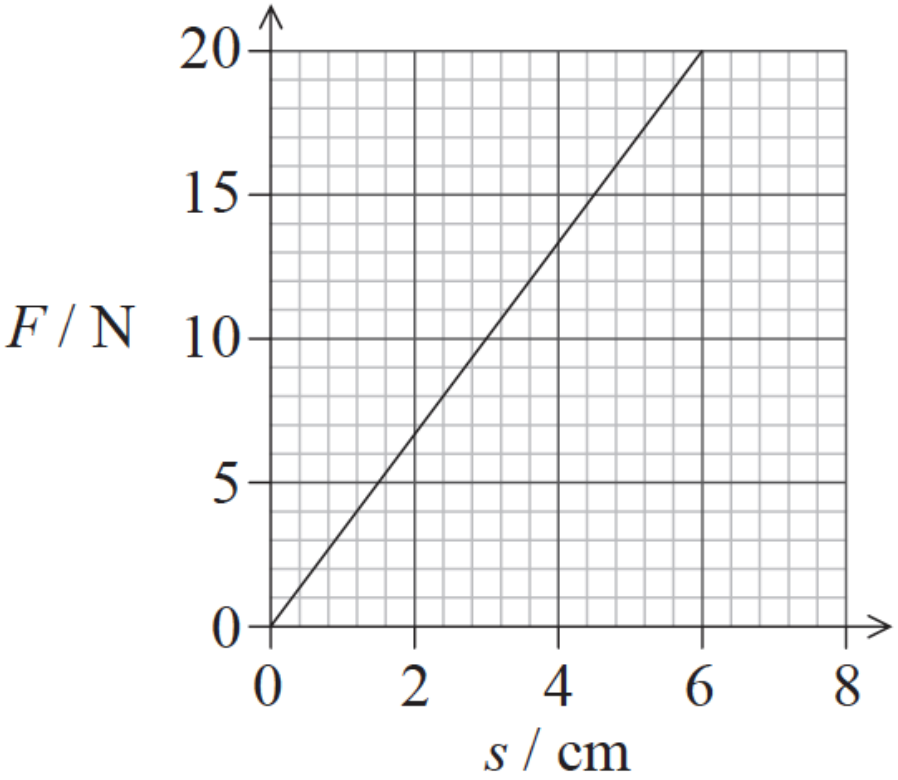
Two stationary objects of mass 1kg and 2kg are connected by a thread and suspended from a spring.



The thread is cut. Immediately after the cut, what are the magnitudes of the accelerations of the objects in terms of the acceleration due to gravity g?

	Acceleration of 1 kg object	Acceleration of 2 kg object
A.	$3g$	$2g$
B.	$2g$	$2g$
C.	$3g$	$1g$
D.	$2g$	$1g$

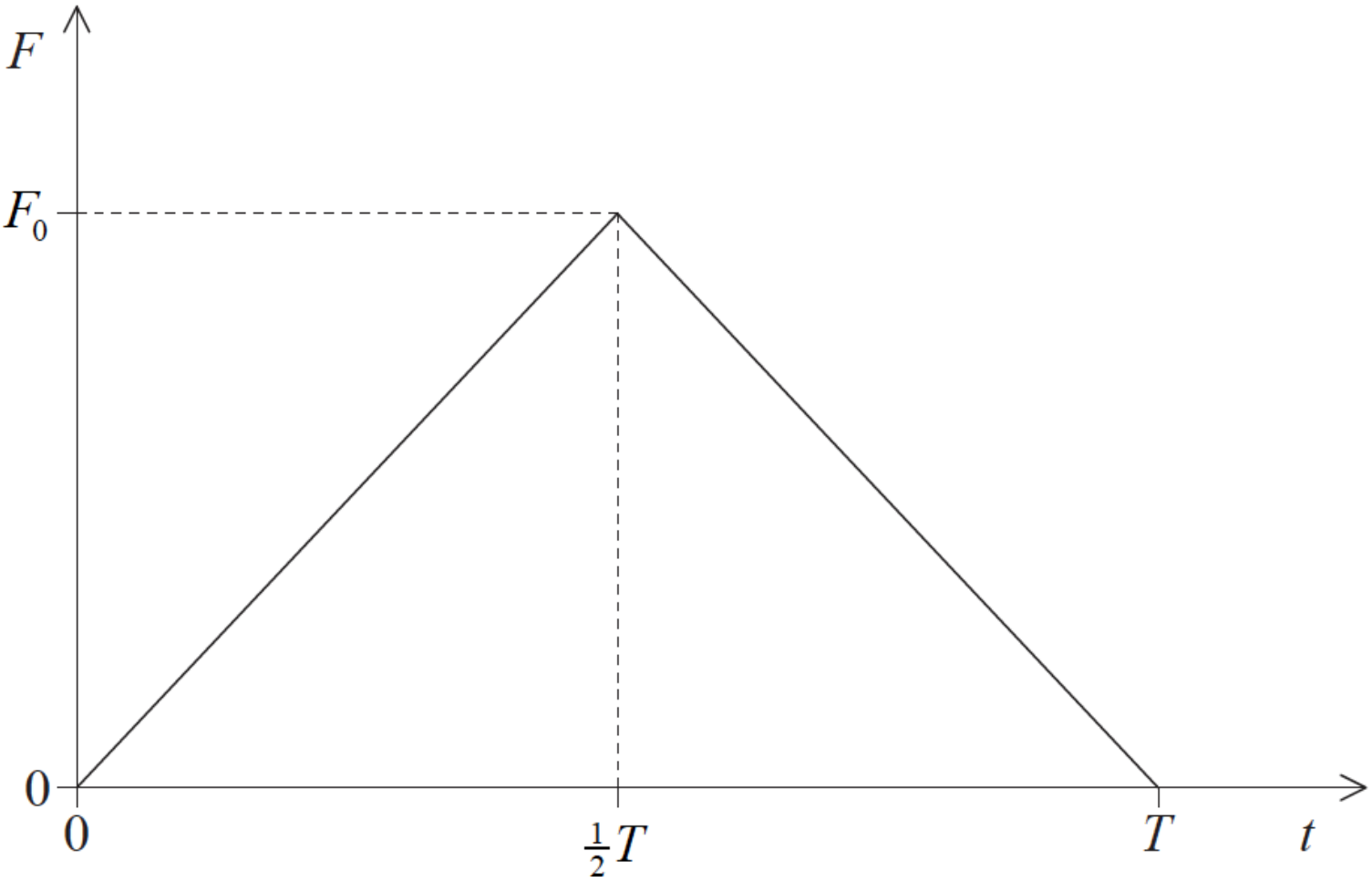
The graph shows the variation with force F of the extension s of a spring.



The work done in changing the extension of the spring from 3.0 cm to 6.0 cm is

A. 15 N cm.
B. 30 N cm.
C. 45 N cm.
D. 60 N cm.

A ball is moving horizontally and strikes a vertical wall from which it rebounds horizontally. The sketch graph shows how the contact force F between ball and wall varies with time of contact t.



The maximum value of F is F_0 and the total time of contact between ball and wall is T.

What is the change in momentum of the ball?

A. $\frac{F_0 T}{2}$

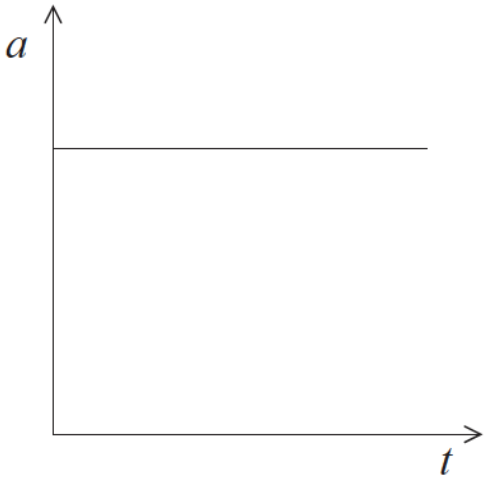
B. $F_0 T$

C. $\frac{F_0}{2T}$

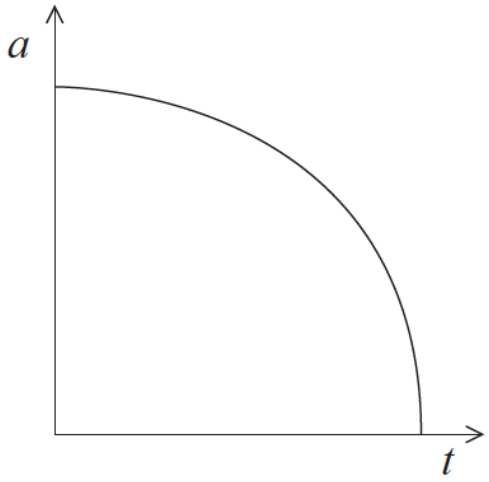
D. $\frac{F_0}{T}$

An object is dropped from rest above the Earth's surface. Air resistance acts on the object. What is the variation of acceleration a with time t for the object?

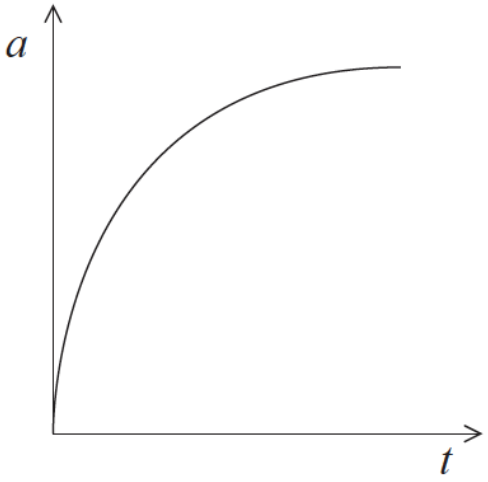
A.



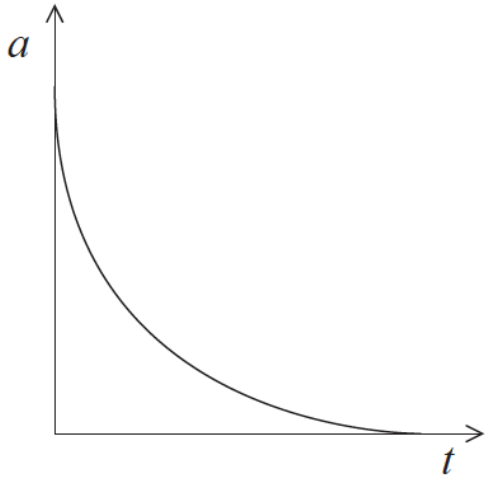
B.



C.

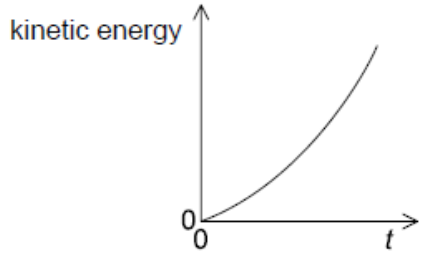


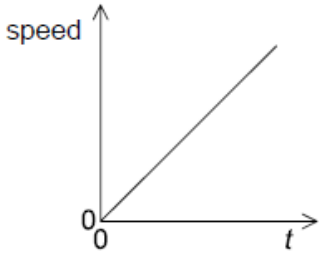
D.



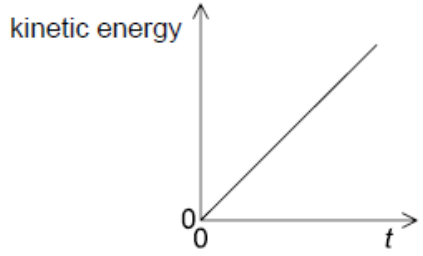
An object, initially at rest, is accelerated by a constant force. Which graphs show the variation with time *t* of the kinetic energy and the variation with time *t* of the speed of the object?

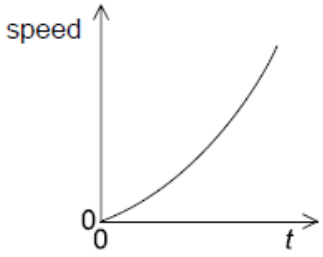
A.



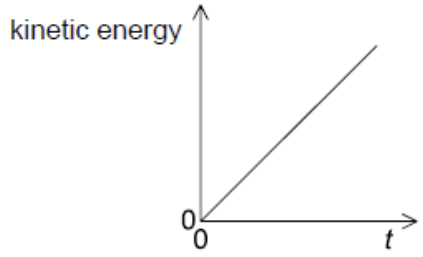


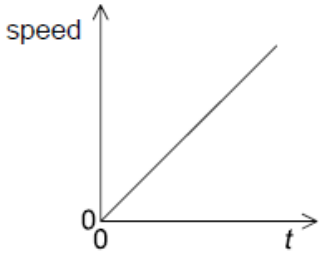
B.



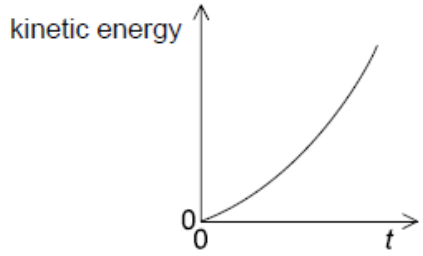


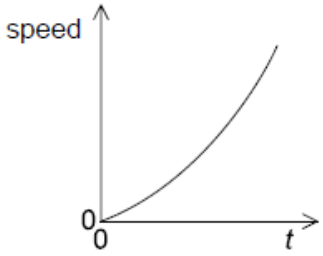
C.





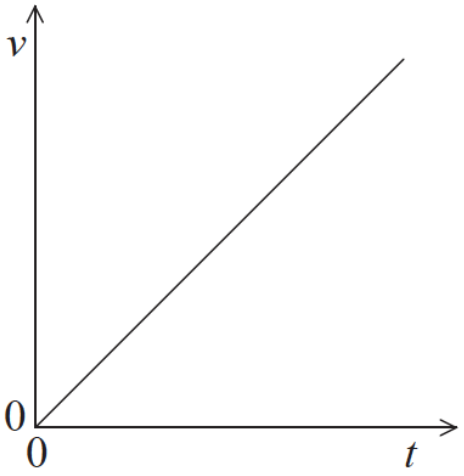
D.



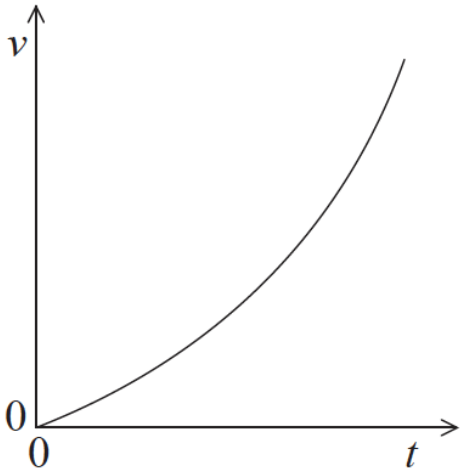


A car accelerates from rest. The acceleration increases with time. Which graph shows the variation with time *t* of the speed *v* of the car?

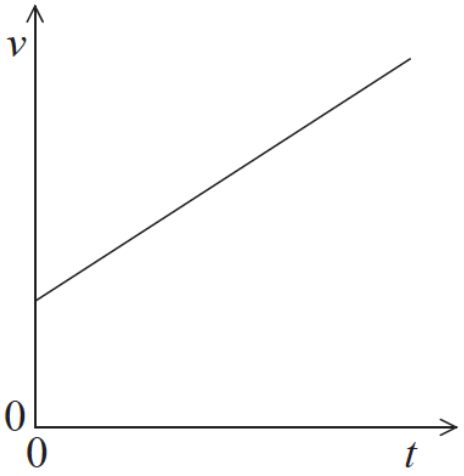
A.



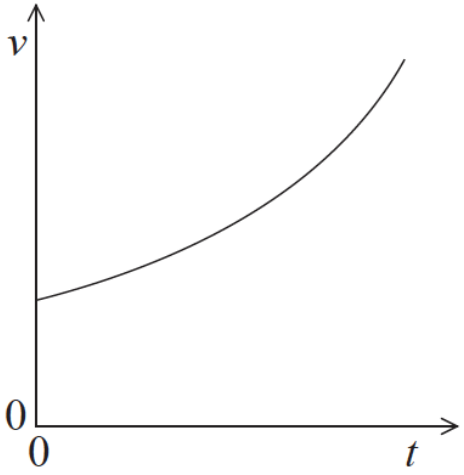
B.



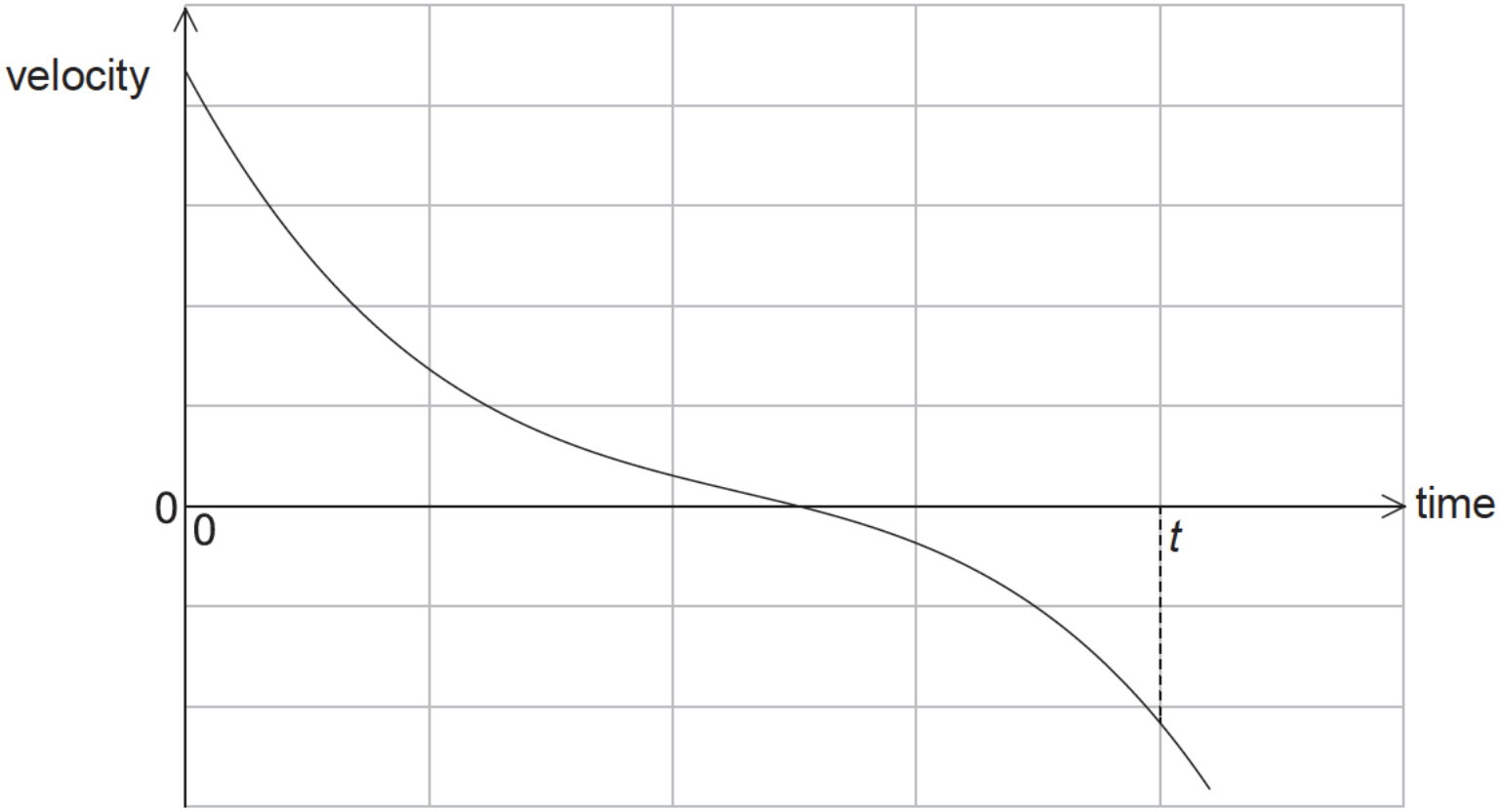
C.



D.



The graph shows the variation with time of the velocity of a truck of fixed mass.



What can be deduced from the graph?

A. The truck is always accelerating.

B. The truck is always moving.

C. The truck is always moving in one direction.

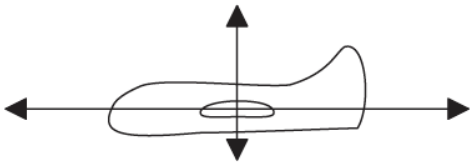
D. The displacement of the truck after time *t* is zero.

A tennis ball is released from rest and falls vertically through a small distance in air. What is the change in the speed of the ball and the change in the acceleration of the ball as it falls?

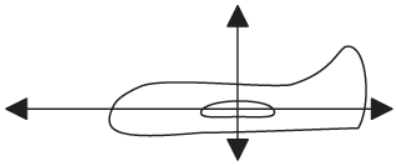
	Speed of the ball	Acceleration of the ball
A.	increases	decreases
B.	decreases	increases
C.	increases	increases
D.	decreases	decreases

A model plane flies with constant velocity at constant height. Which diagram represents the forces acting on the plane?

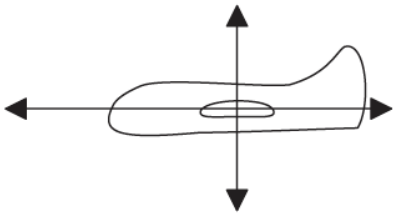
A.



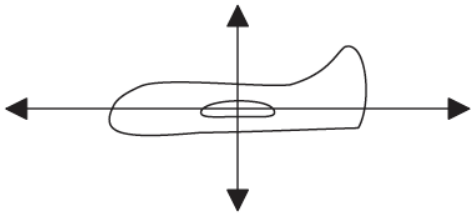
B.



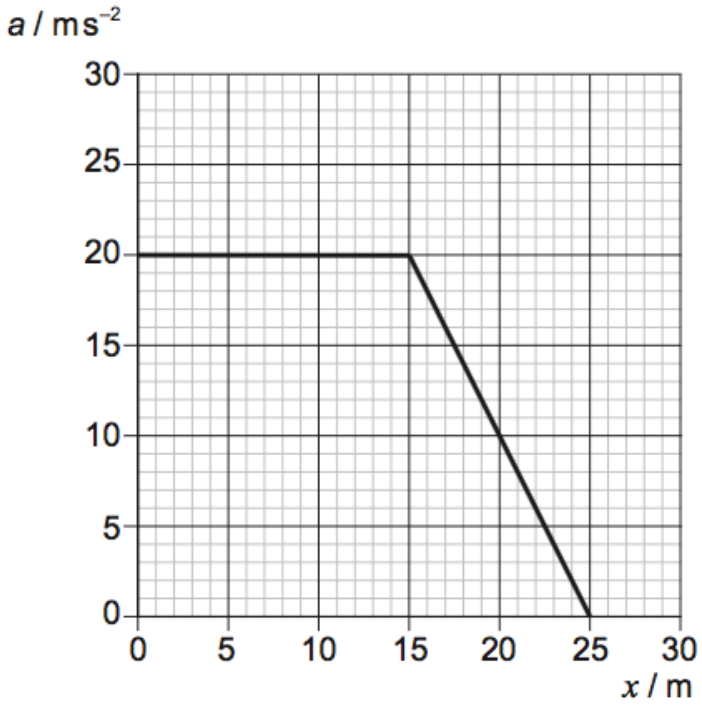
C.



D.



The graph shows how the acceleration *a* of an object varies with distance travelled *x*.



The mass of the object is 3.0 kg. What is the total work done on the object?

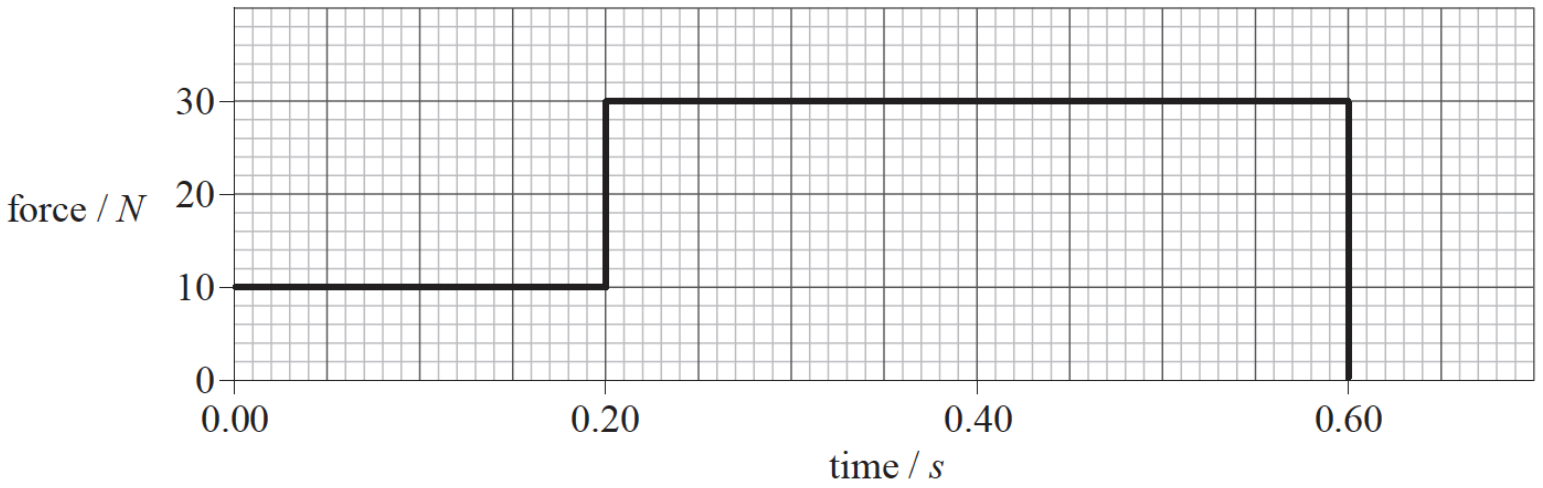
A. 300 J

B. 400 J

C. 1200 J

D. 1500 J

The graph shows how an external force applied to an object of mass 2.0 kg varies with time. The object is initially at rest.



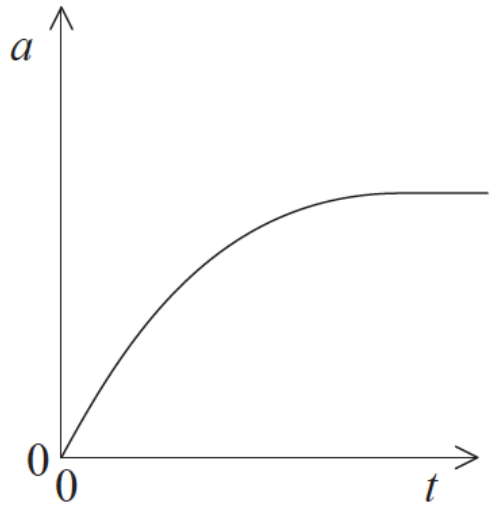
What is the speed of the object after 0.60 s?

A. 7.0 ms^{-1}
B. 14 ms^{-1}
C. 18 ms^{-1}

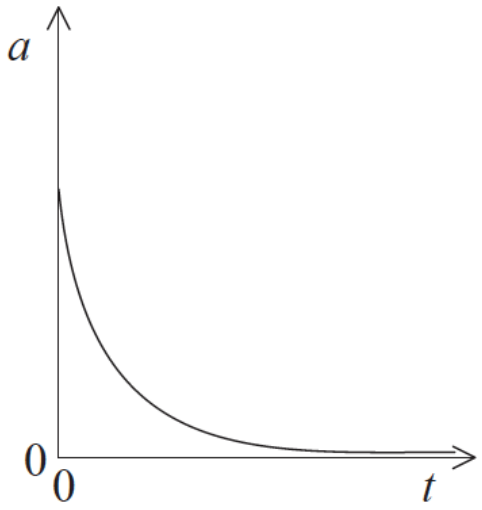
D. 28 ms^{-1}

A tennis ball is dropped from the top of a high building. Air resistance **cannot** be neglected. Which graph represents the variation with time *t* of the magnitude of the acceleration *a* of the ball before it hits the ground?

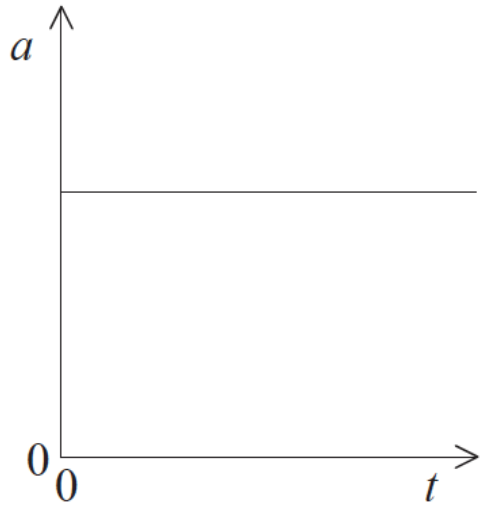
A.



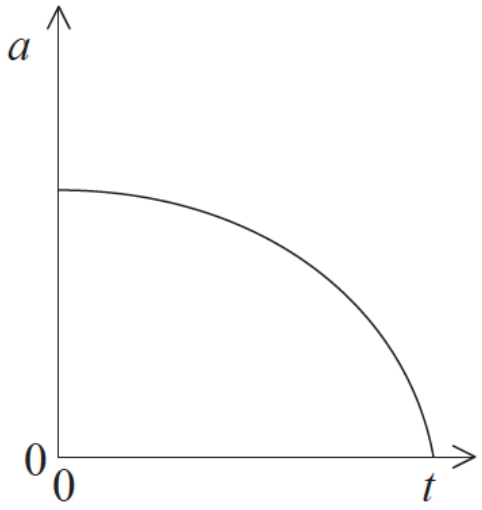
B.



C.



D.



A ball with mass m moves horizontally with speed *u*. The ball hits a vertical wall and rebounds in the opposite direction with speed $v<u$. The duration of the collision is *T*. What are the magnitude of the average force exerted by the wall on the ball and the loss of kinetic energy of the ball?

	Average force	Loss of kinetic energy
A.	$\frac{m(u+v)}{T}$	$\frac{m(u^2-v^2)}{2}$
B.	$\frac{m(u+v)}{T}$	$\frac{m(u-v)^2}{2}$
C.	$\frac{m(u-v)}{T}$	$\frac{m(u^2-v^2)}{2}$
D.	$\frac{m(u-v)}{T}$	$\frac{m(u-v)^2}{2}$

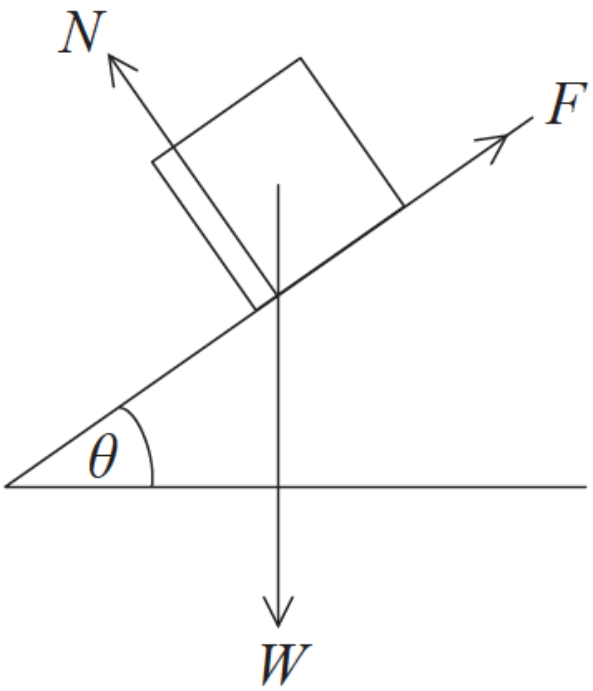
No external forces act on a given system during an inelastic collision. For this system, which is correct about the conservation of kinetic energy and the conservation of linear momentum?

	Kinetic energy	Linear momentum
A.	must be conserved	may be conserved
B.	must be conserved	must be conserved
C.	is not conserved	may be conserved
D.	is not conserved	must be conserved

An object of mass m rests on a horizontal plane. The angle θ that the plane makes with the horizontal is slowly increased from zero. When $\theta=\theta_0$, the object begins to slide. What are the coefficient of static friction μ_s and the normal reaction force N of the plane at $\theta=\theta_0$?

	μ_s	N
A.	$\sin\theta_0$	$mg\cos\theta_0$
B.	$\tan\theta_0$	$mg\sin\theta_0$
C.	$\sin\theta_0$	$mg\sin\theta_0$
D.	$\tan\theta_0$	$mg\cos\theta_0$

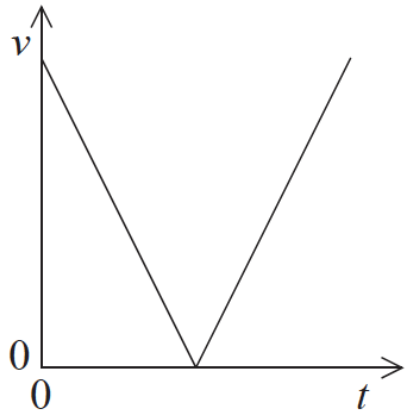
A block rests on a plane inclined at an angle θ to the horizontal. Which of the following gives the relationships for the normal reaction N and the frictional force F with the weight W?



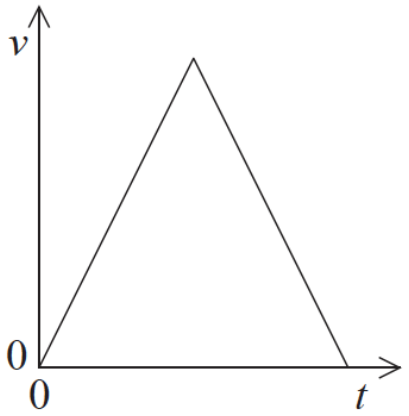
	N	F
A.	$W\sin\theta$	$W\sin\theta$
B.	$W\sin\theta$	$W\cos\theta$
C.	$W\cos\theta$	$W\sin\theta$
D.	$W\cos\theta$	$W\cos\theta$

An object is thrown upwards leaving the thrower's hand at time t=0. Which graph shows how speed v varies with t as the object rises and falls?

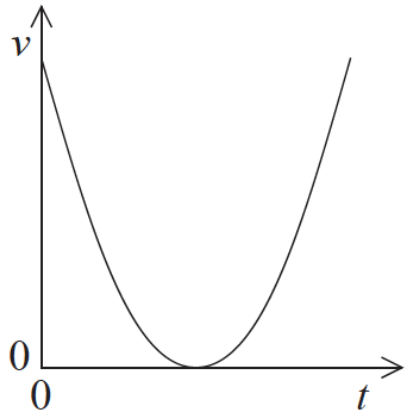
A.



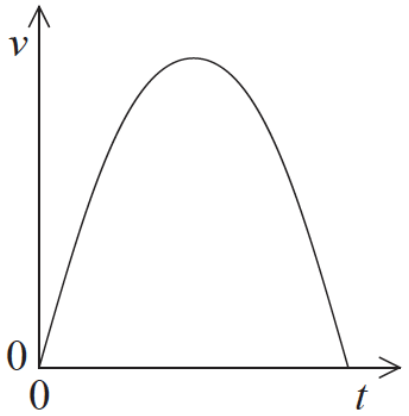
B.



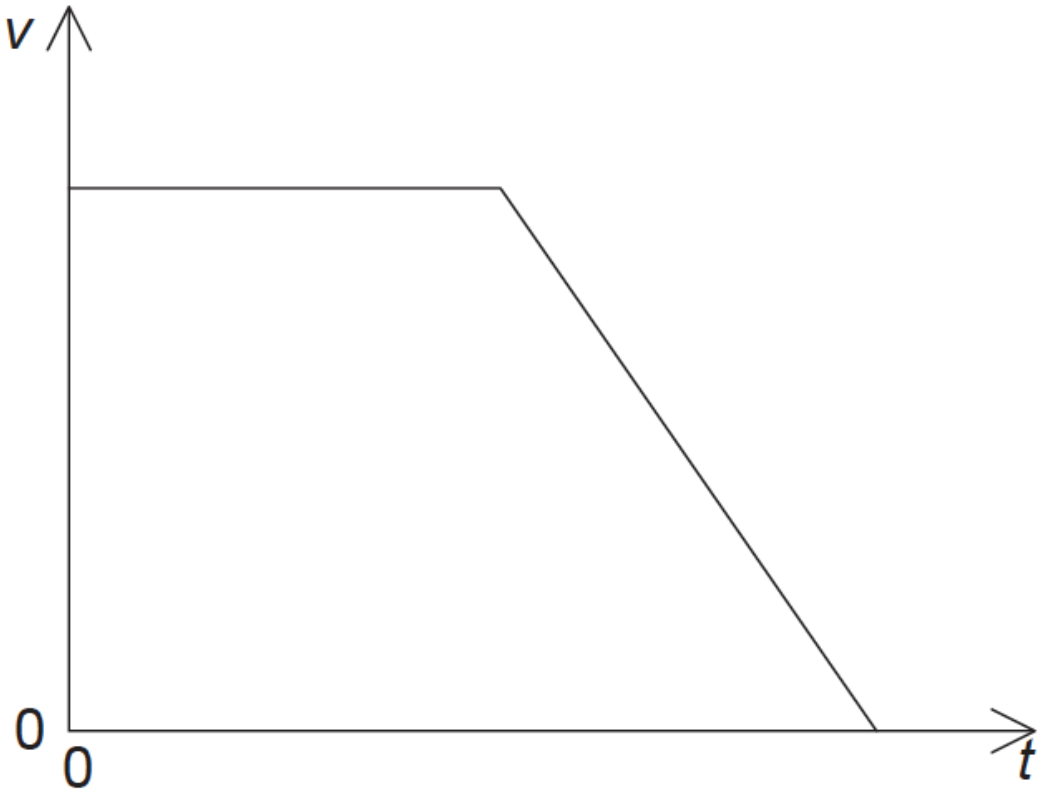
C.



D.

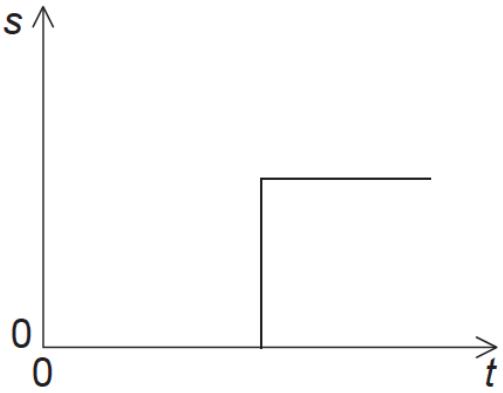


The graph below shows the variation with time *t* of the velocity *v* of a car travelling in a straight line.

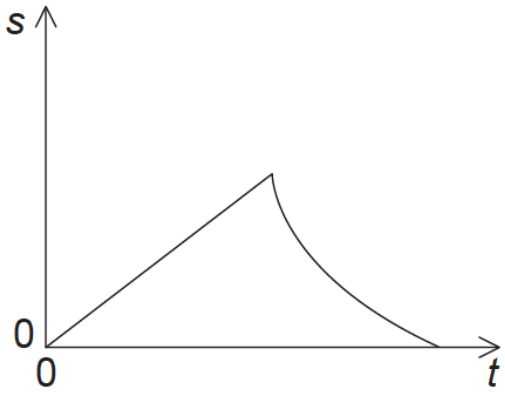


Which graph shows the variation with *t* of the displacement *s* of the car?

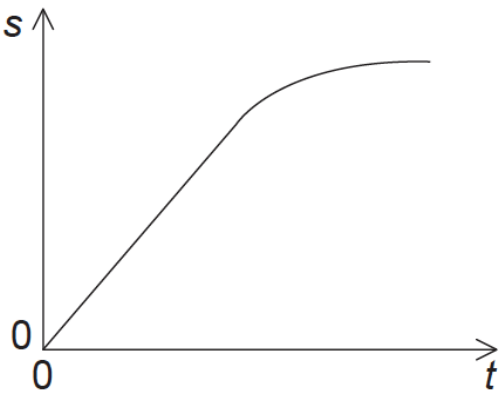
A.



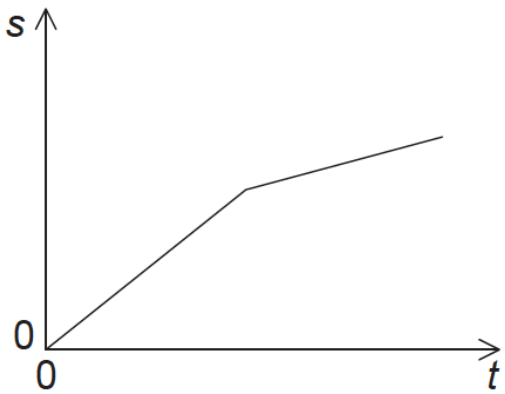
B.



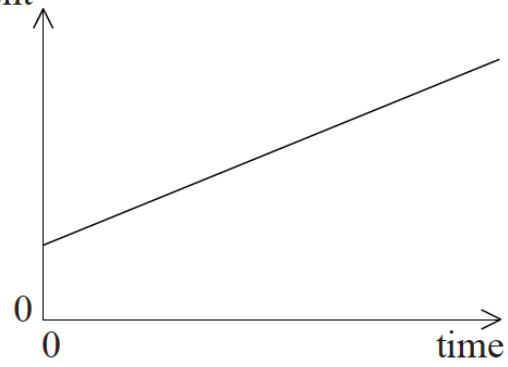
C.

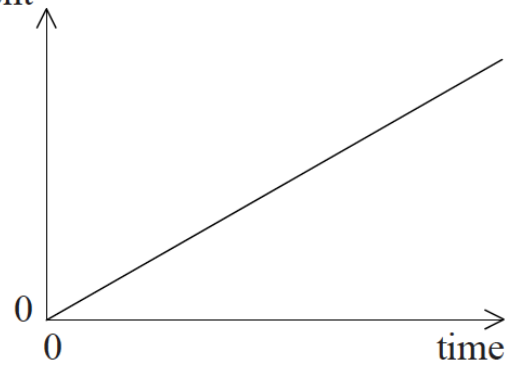


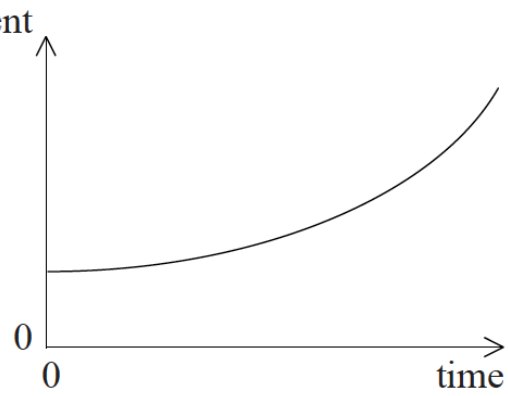
D.

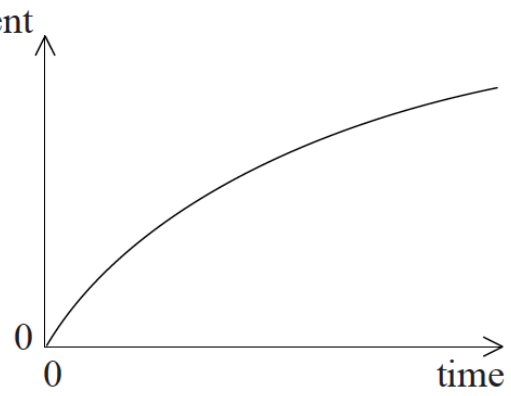


A body moves on a straight line. The graphs show the variation of displacement with time. Which graph shows motion with negative acceleration?

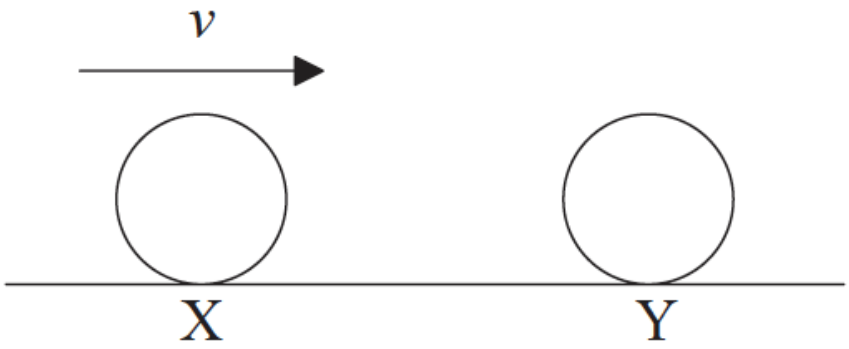
A. 

B. 

C. 

D. 

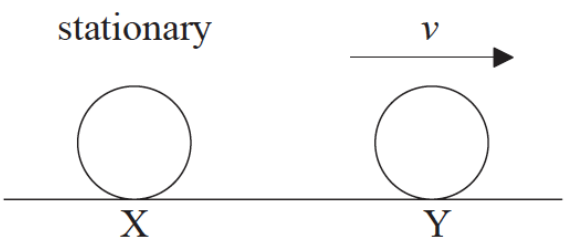
A ball X moving horizontally collides with an identical ball Y that is at rest.



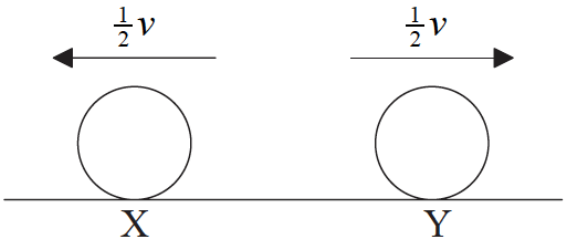
X strikes Y with speed *v*.

What is a possible outcome of the collision?

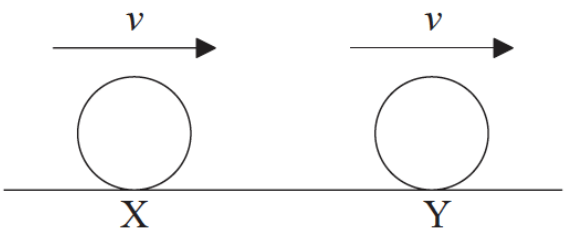
A.



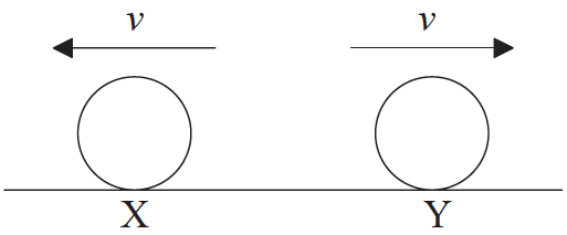
B.



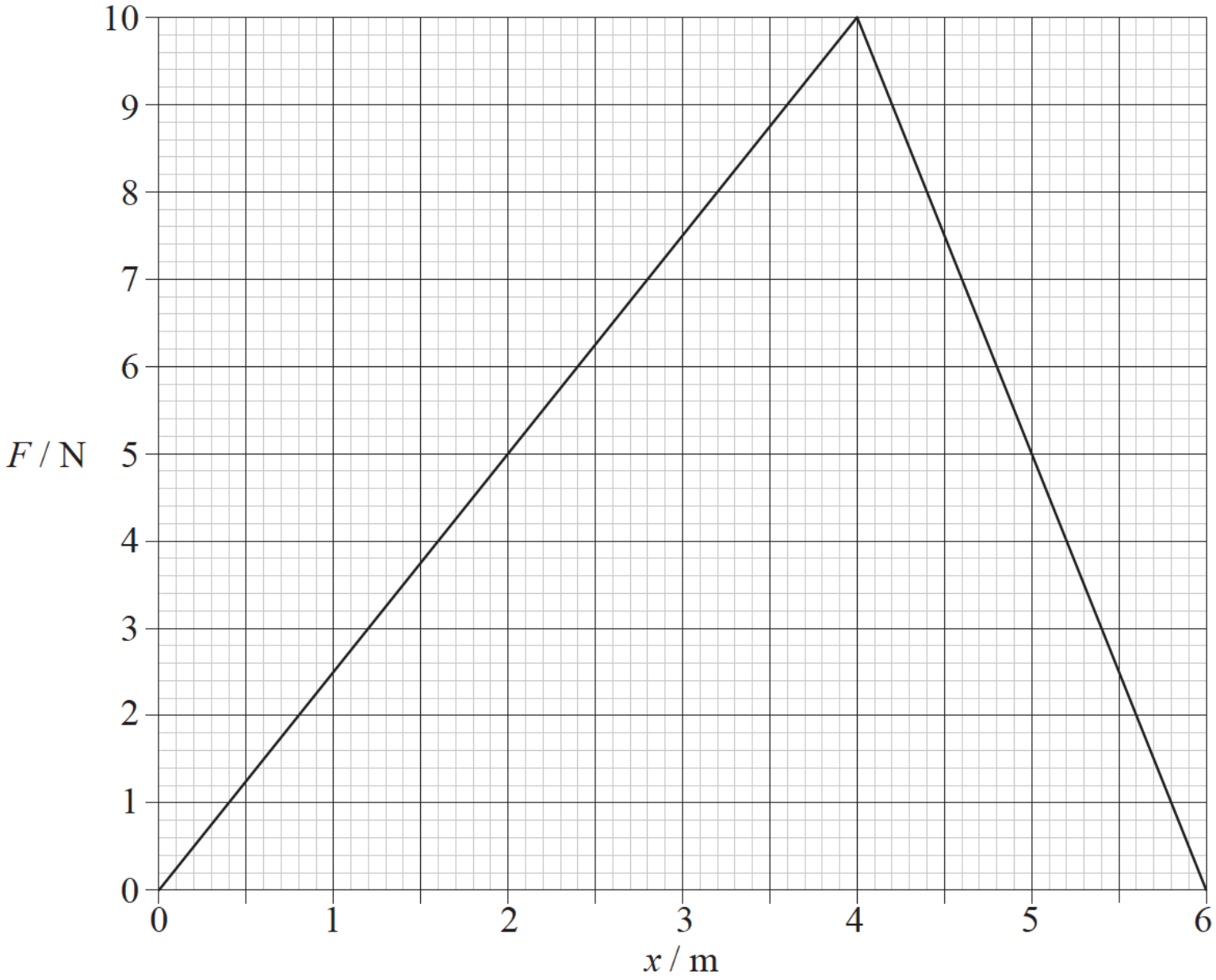
C.



D.



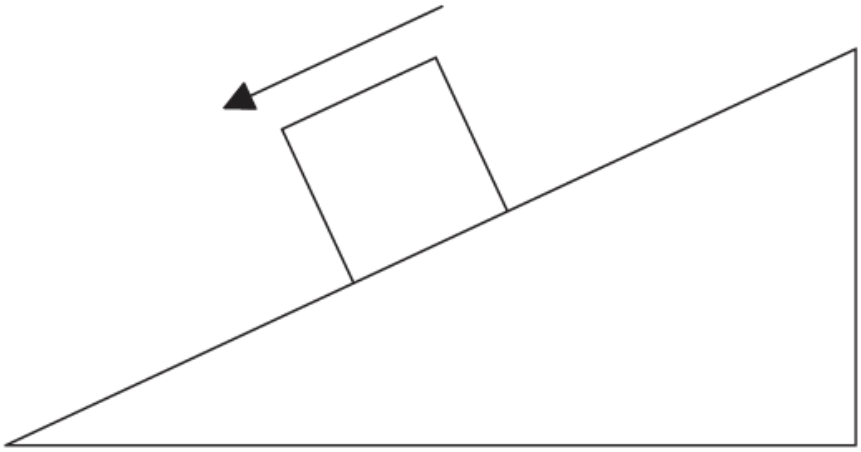
The graph shows how the net force *F* that acts on a body varies with the distance *x* that the body has travelled.



After travelling 6 m, the change in the kinetic energy of the body is

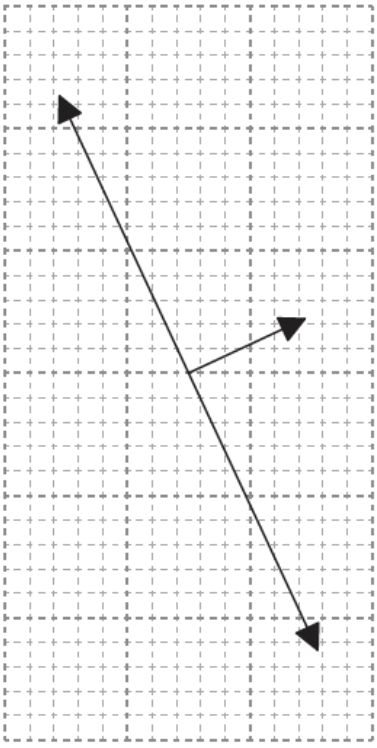
A. 0 J.
B. 20 J.
C. 30 J.
D. 60 J.

A block slides down an inclined plane at constant speed.

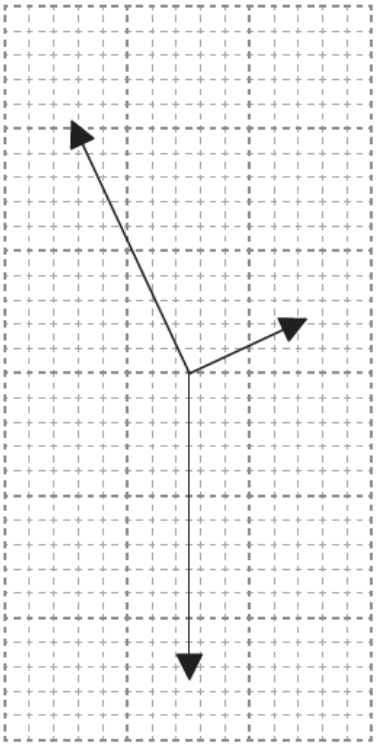


Which diagram represents the free-body diagram of the forces acting on the block?

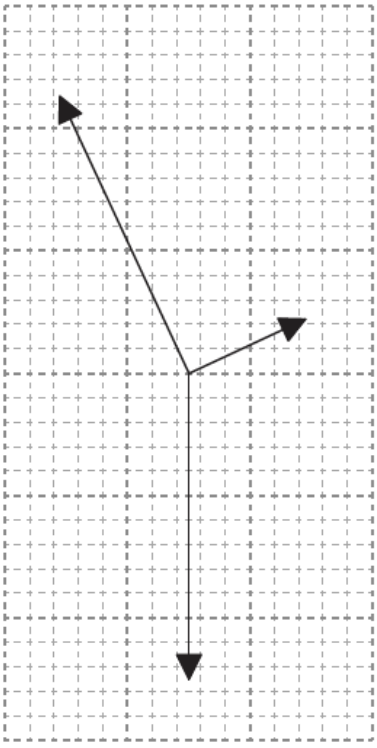
A.



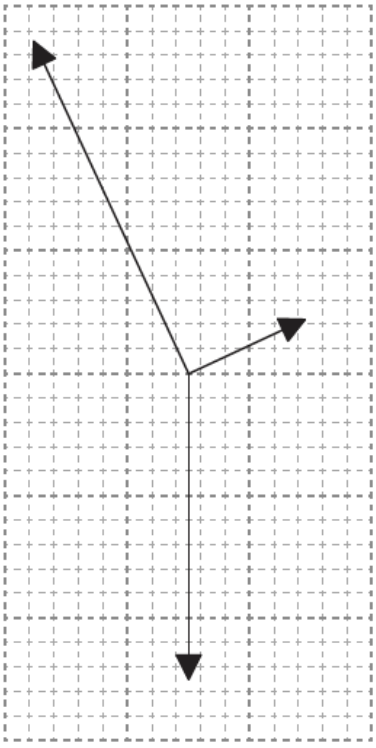
B.



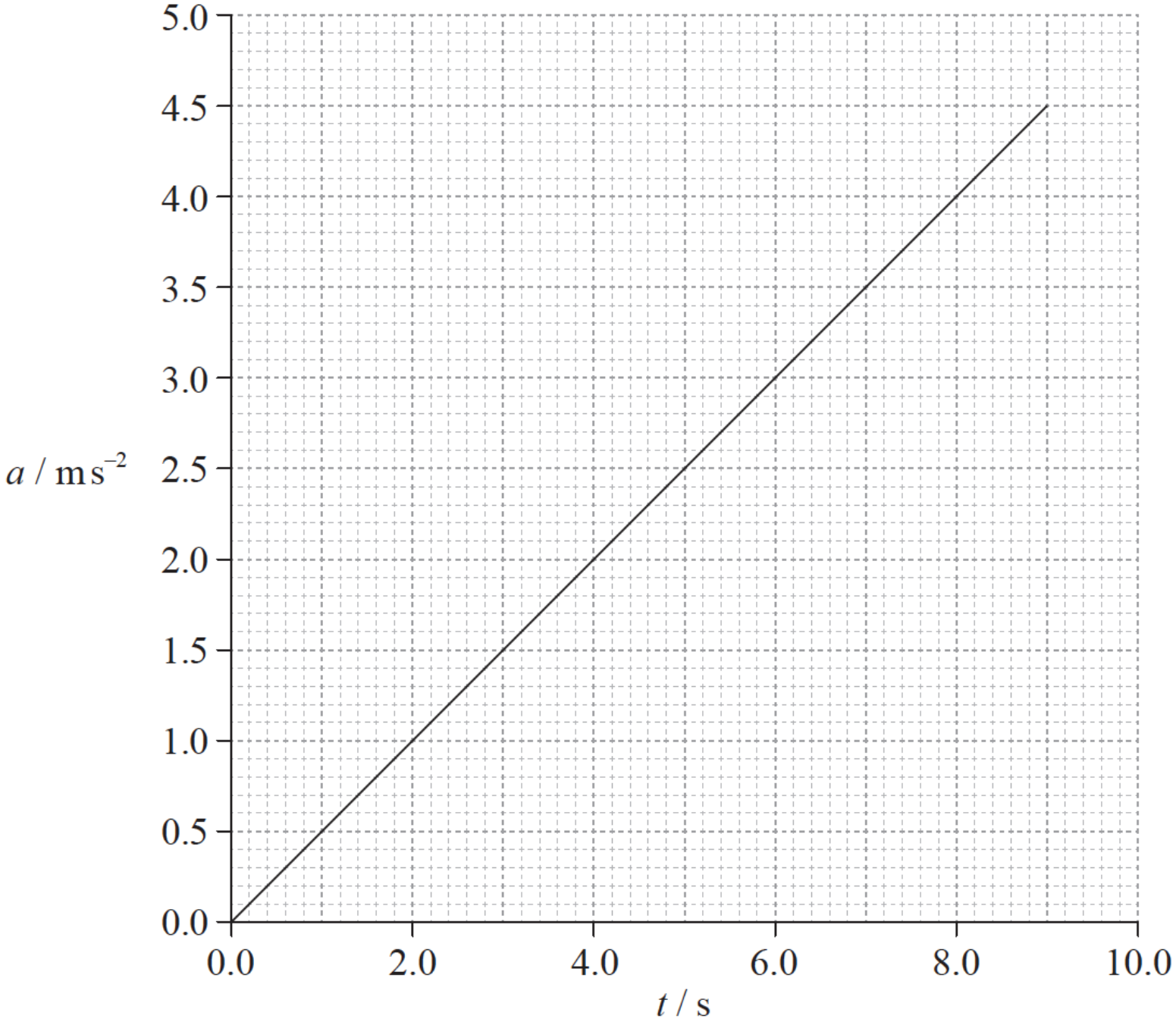
C.



D.



A particle accelerates from rest. The graph shows how the acceleration *a* of the particle varies with time *t*.



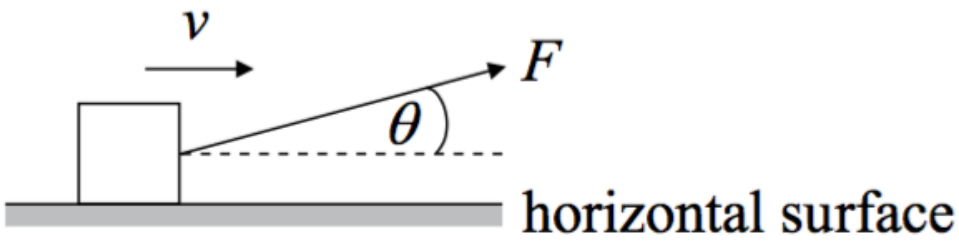
What is the speed of the particle at t=6.0s?

A. 0.5 ms^{-1}
B. 2.0 ms^{-1}
C. 9.0 ms^{-1}
D. 18 ms^{-1}

A metal sphere is at rest on a bench. According to Newton's third law of motion, what is a possible action-reaction pair for this situation?

	Action	Reaction
A.	downwards gravitational force of Earth on the sphere	upwards gravitational force of the sphere on Earth
B.	upwards gravitational force of Earth on the sphere	downwards gravitational force of the sphere on Earth
C.	upwards electrostatic force acting on the sphere due to the atoms in the bench surface	upwards gravitational force of the sphere on Earth
D.	upwards electrostatic force acting on the sphere due to the atoms in the bench surface	downwards gravitational force of the sphere on Earth

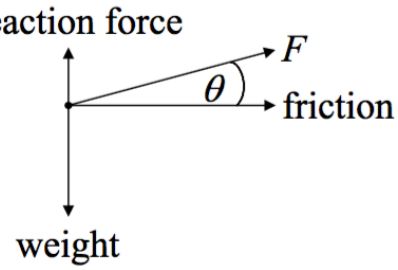
A force *F* acts on a block at an angle *θ* with respect to a horizontal surface.



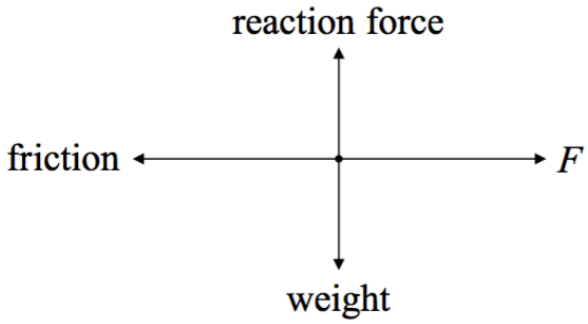
The block is moving with a constant velocity *v* along the surface. A resistive force acts on the block.

Which of the following correctly represents the forces acting on the block?

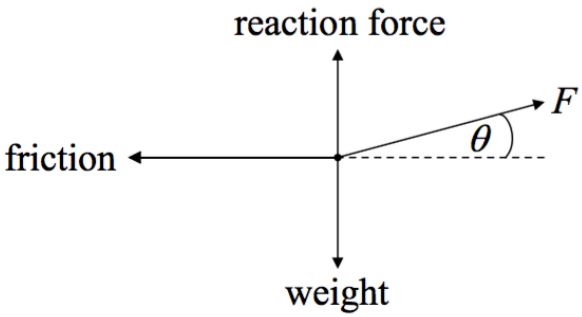
A.



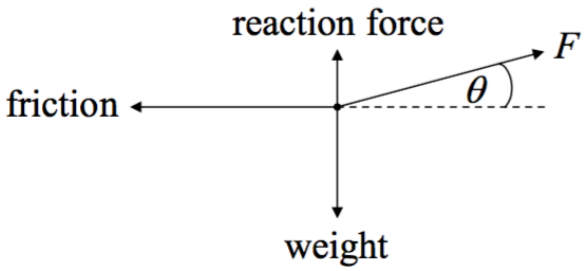
B.



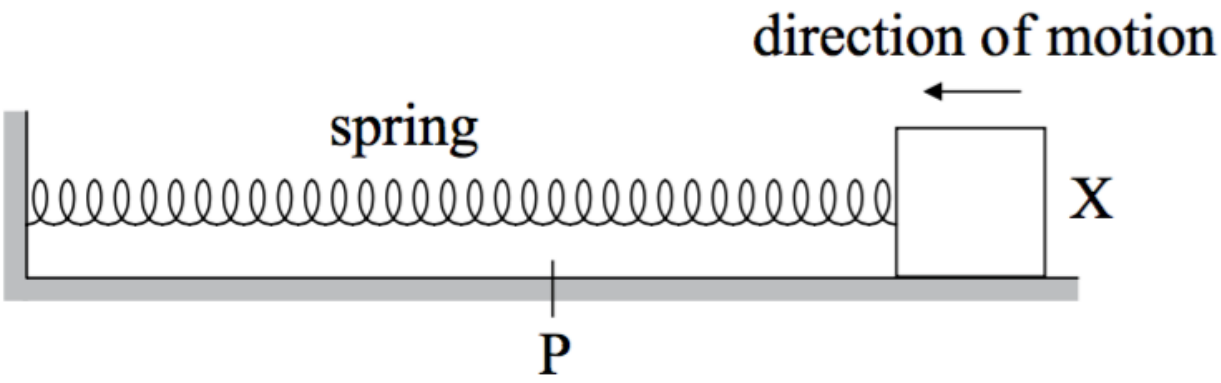
C.

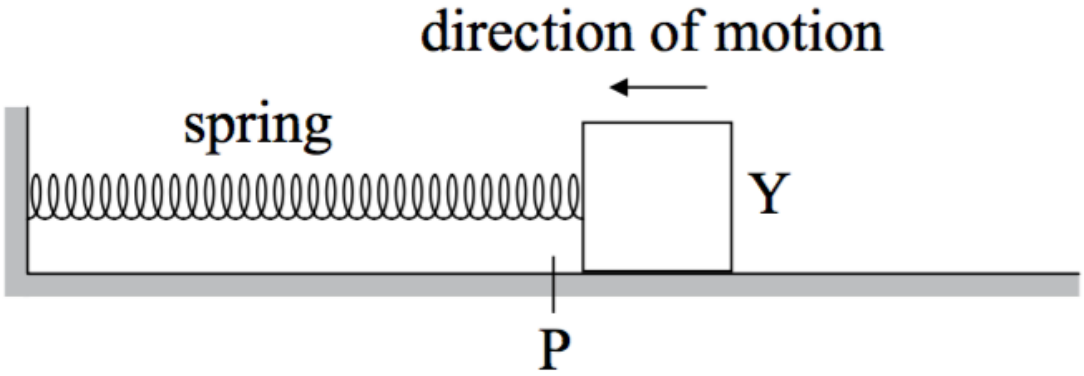


D.



A block is attached to a stretched spring and then released. It moves from X to Y along a horizontal frictionless surface in the direction shown. The mass of the spring is negligible.





The equilibrium position of the system is P.

Which of the following is correct with respect to the changes in kinetic energy and potential energy of the block and of the spring as the block moves from X to Y?

	Block	Spring
A.	kinetic energy decreases	potential energy increases
B.	kinetic energy increases	potential energy decreases
C.	potential energy decreases	kinetic energy increases
D.	potential energy increases	kinetic energy decreases