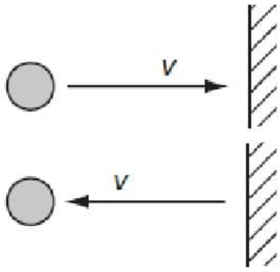
Linear Momentum

Q1 (11/O/N/12/11)
An object travelling with velocity v strikes a wall and rebounds as shown.

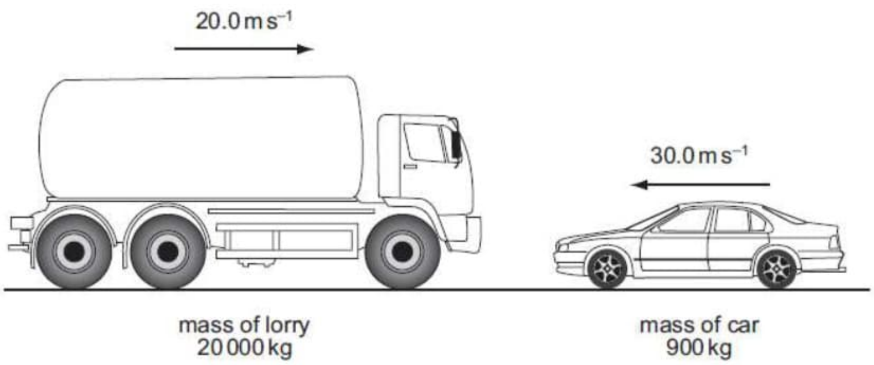


Which property of the object is not conserved?

A kinetic energy **B** mass

C momentum **D** speed

Q2 (11/M/J/7/1)
A lorry of mass 20 000 kg is travelling at 20.0 m s^{-1}. A car of mass 900 kg is travelling at 30.0 m s^{-1} towards the lorry.



What is the magnitude of the total momentum?

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

Q3 (10/M/J/11/11)
A molecule of mass m travelling horizontally with velocity u hits a vertical wall at right-angles to its velocity. It then rebounds horizontally with the same speed.
What is its change in momentum?

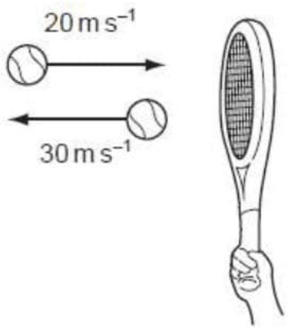
A zero **B** mu **C** –mu **D** –2mu

Q4 (8/M/J/17/12)
A golf ball of mass m is dropped onto a hard surface from a height h_1 and rebounds to a height h_2. The momentum of the golf ball just as it reaches the surface is different from its momentum just as it leaves the surface. What is the total change in the momentum of the golf ball between these two instants? (Ignore air resistance.)

A $m\sqrt{2gh_1} - m\sqrt{2gh_2}$ **B** $m\sqrt{2gh_1} + m\sqrt{2gh_2}$

C $m\sqrt{2g(h_1 - h_2)}$ **D** $m\sqrt{2g(h_1 + h_2)}$

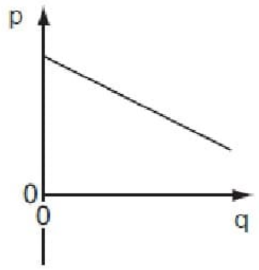
Q5 (9/M/J/9/1)
A tennis ball of mass 100 g is struck by a tennis racket. The velocity of the ball is changed as shown.



What is the magnitude of the change in momentum of the ball?

A $1\,\text{kg m s}^{-1}$ **B** $5\,\text{kg m s}^{-1}$ **C** $1000\,\text{kg m s}^{-1}$ **D** $5000\,\text{kg m s}^{-1}$

Q6 (12/O/N/7/1)
The graph shows how a certain quantity p varies with another quantity q for a parachutist falling at terminal speed.



What are the quantities p and q, and what is represented by the magnitude of the gradient of the graph?

	Quantity p	Quantity q	Magnitude of gradient
A	height	time	Terminal speed
B	momentum	time	Weight of parachutist
C	height	Potential energy	Mass of parachutist
D	velocity	time	Acceleration of free fall

Newton Second Law

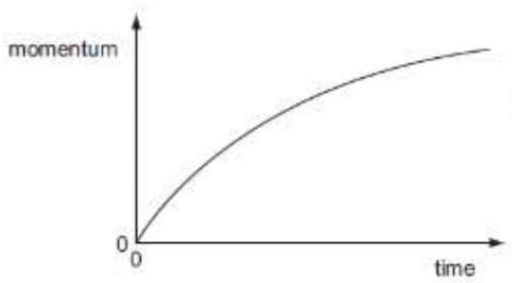
Q1 (14/M/J/15/11)
What is the definition of the force on a body?

- **A** the mass of the body multiplied by its acceleration
- **B** the power input to the body divided by its velocity
- **C** the rate of change of momentum of the body
- **D** the work done on the body divided by its displacement

Q2 (8/M/J/14/12)
A resultant force causes a body to accelerate. What is equal to the resultant force?

- **A** the acceleration of the body per unit mass
- **B** the change in kinetic energy of the body per unit time
- **C** the change in momentum of the body per unit time
- **D** the change in velocity of the body per unit time

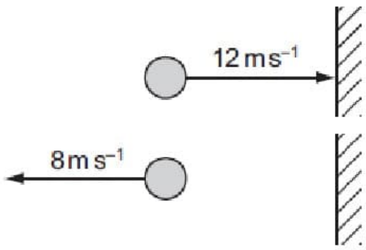
Q3 (11/O/N/11/11)
A car accelerates from rest. The graph shows the momentum of the car plotted against time.



What is the meaning of the gradient of the graph at a particular time?

A the resultant force on the car **B** the velocity of the car
C the kinetic energy of the car **D** the rate of change of kinetic energy of the car

Q4 (12/O/N/12/12)
A ball of mass 0.5 kg is thrown against a wall at a speed of $12\,m\,s^{-1}$. It bounces back with a speed of $8\,m\,s^{-1}$. The collision lasts for 0.10 s.

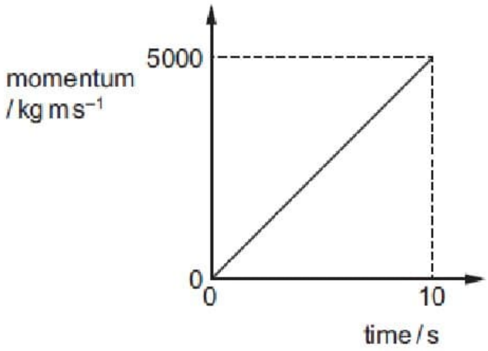


What is the average force on the ball due to the collision?

A 0.2 N **B** 1 N **C** 20 N **D** 100 N

Q5 (10/M/J/17/11)

The graph shows how the momentum of a motorcycle changes with time.



What is the resultant force on the motorcycle?

A 500 N **B** 5000 N **C** 25 000 N **D** 50 000 N

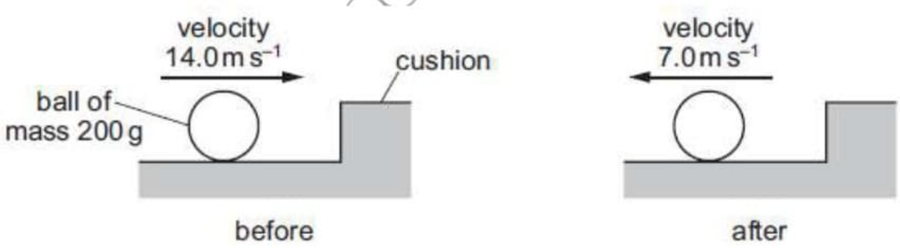
Q6 (9/M/J/17/13)

A ball of mass 2.0 kg travels horizontally with a speed of $4.0\,m\,s^{-1}$. The ball collides with a wall and rebounds in the opposite direction with a speed of $2.8\,m\,s^{-1}$. The time of the collision is 150 ms. What is the average force exerted on the wall?

A 16 N **B** 37 N **C** 53 N **D** 91 N

Q7 (9/O/N/17/13)

A snooker ball of mass 200 g hits the cushion of a snooker table at right-angles with a speed of $14.0\,m\,s^{-1}$.The ball rebounds with half of its initial speed. The ball is in contact with the cushion for 0.60 s.



What is the average force exerted on the ball by the cushion?

A 2.3 N **B** 7.0 N **C** 2300 N **D** 7000 N

Q8 (8/M/J/18/12)

A tennis ball of mass 55 g is travelling horizontally with a speed of $30\,m\,s^{-1}$. The ball makes contact with a wall before rebounding in the horizontal direction with a speed of $20\,m\,s^{-1}$. The ball is in contact with the wall for a time of 5.0×10^{-3} s. What is the average force exerted on the wall by the ball?

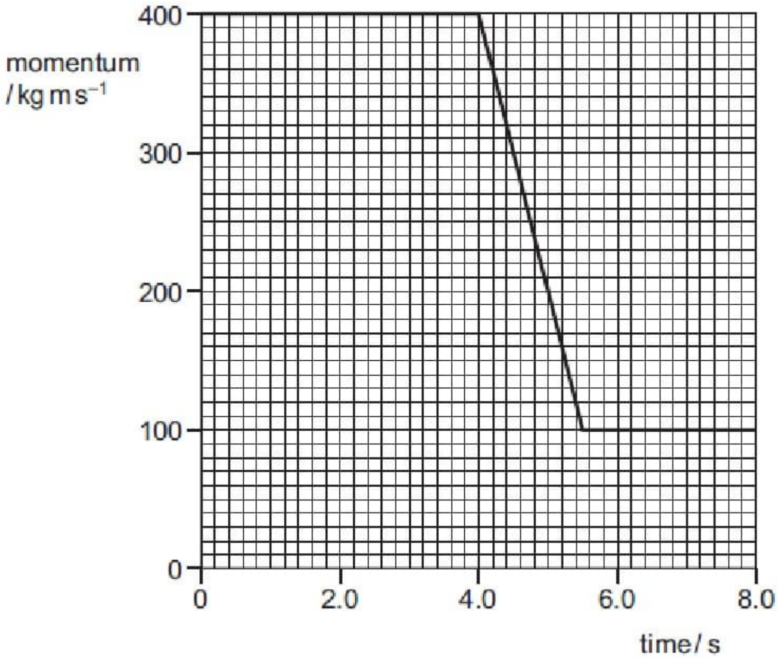
A 110 N **B** 220 N **C** 330 N **D** 550 N

Q9 (15/O/N/12/12)
A lorry of mass 20,000 kg has a constant resultant force F acting on it.

It accelerates from 6.0 ms^{-1} to 30 ms^{-1} in a time of 300 s.
What is the change in momentum of the lorry and the value of F?

	change in momentum / N s	force F / N
A	48 000	160
B	480 000	1600
C	600 000	2000
D	600 000	20 000

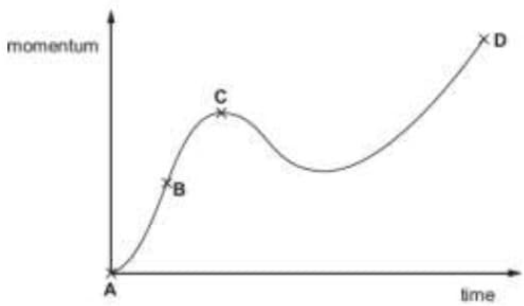
Q10 (14/O/N/12/13)
The graph shows the momentum of a cyclist over a period of 8.0 s.



At time 4.0 s, she applies the brakes.
What is the resultant force on the cyclist during the period when the brakes are applied?

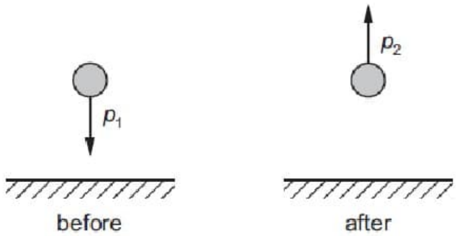
A 55 N **B** 200 N **C** 270 N **D** 450 N

Q11 (10/O/N/14/13)
A body experiences a varying resultant force that causes its momentum to vary, as shown in the graph. At which point does the resultant force have the largest value?



Q12 (9/M/J/16/12)

A ball falls vertically onto horizontal ground and rebounds, as shown.



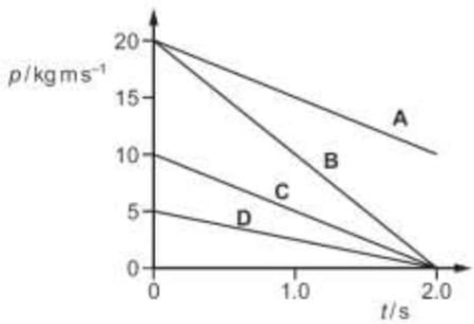
The ball has momentum p_1 downwards just before hitting the ground. After rebounding, the ball leaves the ground with momentum p_2 upwards. The ball is in contact with the ground for 0.020 s. During this time interval, an average resultant force of 25 N acts on the ball.

What is a possible combination of values for p_1 and p_2?

	p1 / kg m s^{-1}	p2 / kg m s^{-1}
A	0.15	0.65
B	0.20	0.30
C	0.30	0.20
D	0.65	0.15

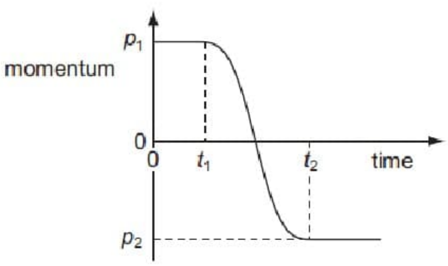
Q 13 (11/M/J/14/13)

A resultant force of 10 N acts on a body for a time of 2.0 s. Which graph could show the variation with time *t* of the momentum *p* of the body?



Q14 (10/M/J/7/1)

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

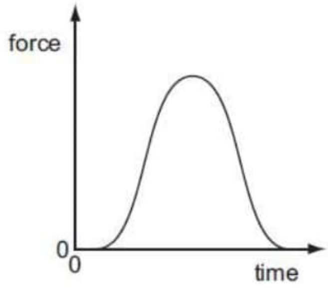


Initially, the momentum is p_1 at time t_1. At time t_2 the momentum is p_2.

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

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

Q15 (10/O/N/15/11)
A golf ball is hit by a club. The graph shows the variation with time of the force exerted on the ball by the club.



Which quantity, for the time of contact, cannot be found from the graph?

A the average force on the ball
B the change in momentum of the ball
C the contact time between the ball and the club
D the maximum acceleration of the ball

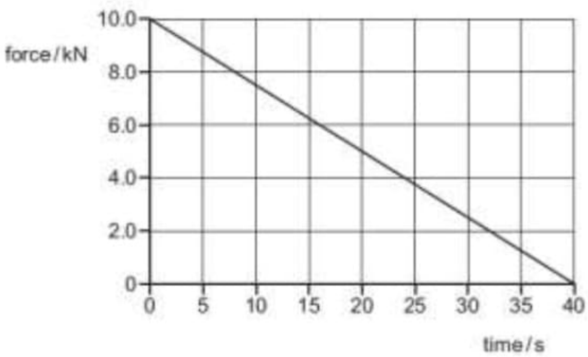
Q16 (11/M/J/11/12)
The momentum of an object changes from 160 kg m s^{-1} to 240 kg m s^{-1} in 2 s.
What is the mean resultant force on the object during the change?

A 40 N **B** 80 N **C** 200 N **D** 400 N

Q17 (9/O/N/9/12)
A super market trolley, total mass 30 kg, is moving at 3.0 ms^{-1}. A retarding force of 60 N is applied to the trolley for 0.50 s in the opposite direction to the trolley's initial velocity.
What is the trolley's new velocity after the application of the force?

A 1.0 ms^{-1} **B** 1.5 ms^{-1} **C** 2.0 ms^{-1} **D** 2.8 ms^{-1}

Q18 (11/O/N/15/11)
A glider of mass 1500 kg is launched from rest on a straight and level track using a catapult. The graph shows the variation with time of the resultant force.

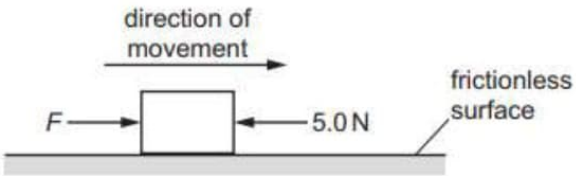


What is the speed of the glider when the resultant force acting on it reaches zero?

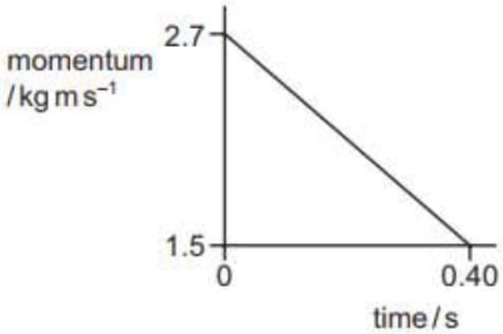
A 133 m s^{-1} **B** 200 m s^{-1} **C** 250 m s^{-1} **D** 267 m s^{-1}

Q19 (6/M/J/24/13)

A block is moving along a horizontal frictionless surface. A constant force Fand a constant resistive force of 5.0N act on the block as it is moving in the direction of the force F, as shown.



The graph shows the variation with time of the momentum of the block.

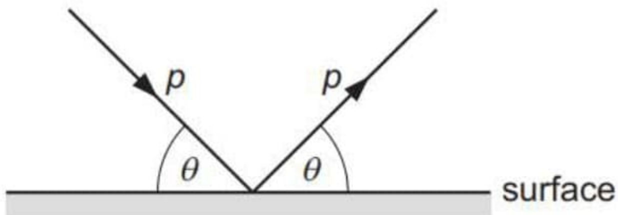


What is the magnitude of force F?

A 2.0N B 3.0N C 5 N D 8N

Q20 (8/F/M/21/12)

A ball strikes a horizontal surface with momentum p at an angle θ to the surface, as shown.



The ball rebounds with the same magnitude of momentum at an angle θ to the surface.
The ball is in contact with the surface for time t.
What is the magnitude of the average resultant force acting on the ball during the collision?

A. Zero B. $\frac{2p}{t}$ C $\frac{2p\cos\theta}{t}$ D $\frac{2p\sin\theta}{t}$

Special case of Newton's Second law

Q1 (10/M/J/11/12)
A force F is applied to a freely moving object. At one instant of time, the object has velocity v and acceleration a. Which quantities must be in the same direction?

A a and v only **B** a and F only
C v and F only **D** v, F and a

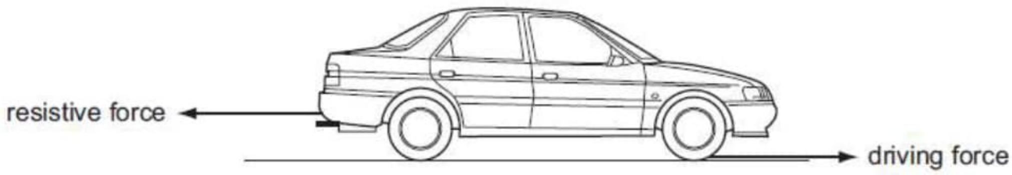
Q2 (10/M/J/17/13)

An ice-hockey puck of mass 150 g moves with an initial speed of 2.0 m s^{-1} along the surface of an ice rink. The puck slides a distance of 30 m in a straight line before stopping.
What is the average frictional force acting on the puck?

A 0.010 N **B** 0.020 N **C** 0.067 N **D** 0.44 N

Q3 (12/M/J/13/11)

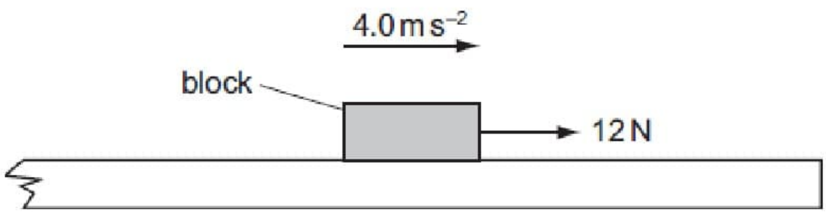
A car of mass 750 kg has a horizontal driving force of 2.0 kN acting on it. It has a forward horizontal acceleration of 2.0 m s^{-2}.



What is the resistive force acting horizontally?

A 0.50 kN **B** 1.5 kN **C** 2.0 kN **D** 3.5 kN

Q4 (10/O/N/7/1)
A block of mass 0.60 kg is on a rough horizontal surface. A force of 12 N is applied to the block and it accelerates at 4.0 ms^{-2}.



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

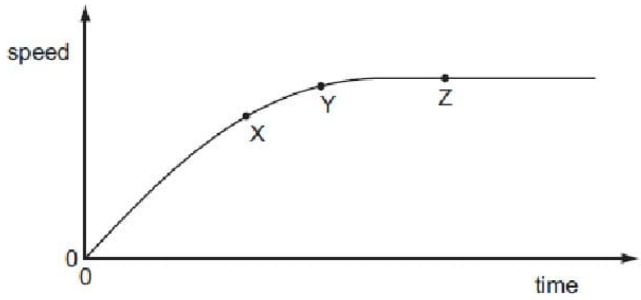
A 2.4N **B** 5.3N **C** 6.7N **D** 9.6N

Q5 (11/O/N/15/13)
A rocket of mass 30 000 kg sits on a launch pad on the Earth's surface. The rocket motors provide an upward force of 330 kN on the rocket.
What is the initial acceleration of the rocket?

A 0.12 m s^{-2} **B** 1.1 m s^{-2}
C 1.2 m s^{-2} **D** 11 m s^{-2}

Q6 (7/M/J/15/13)

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



Which statement about the raindrop is correct?

A At point X, the raindrop has an acceleration of $9.81\,m\,s^{-2}$.

B At point Z, the force on the raindrop due to air resistance has reached its maximum value and so the acceleration of the raindrop has also reached its maximum value.

C At point Z, the force due to air resistance is equal and opposite to the weight of the raindrop and so the speed of the raindrop is zero.

D The resultant force on the raindrop at point Y is less than the resultant force on the raindrop at point X.

Q7 (10/M/J/15/12)

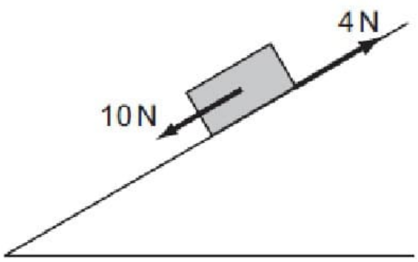
A firework rocket is fired vertically upwards. The fuel burns and produces a constant upwards force on the rocket. After 5 seconds there is no fuel left. Air resistance is negligible.

What is the acceleration before and after 5 seconds?

	before 5 seconds	after 5 seconds
A	constant	constant
B	constant	zero
C	increasing	constant
D	increasing	zero

Q8 (11/M/J/10/11)

A brick weighing 20N rests on an inclined plane. The weight of the brick has a component of 10N parallel with plane. The brick also experiences the frictional force of 4N.

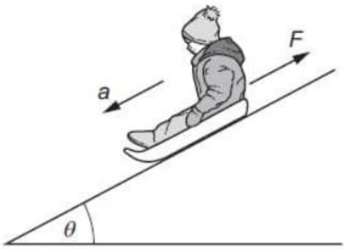


What is the acceleration of the brick down the plane? Assume that the acceleration of free fall g is equal to $10\,m\,s^{-2}$.

A $0.3\,m\,s^{-2}$ **B** $0.8\,m\,s^{-2}$ **C** $3.0\,m\,s^{-2}$ **D** $8.0\,m\,s^{-2}$

Q9 (12/M/J/15/11)

A child on a sledge slides down a hill with acceleration a. The hill makes an angle θ with the horizontal.



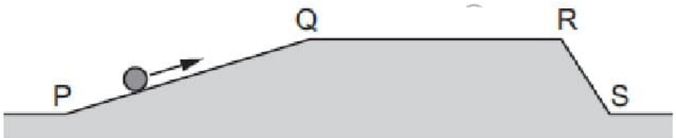
The total mass of the child and the sledge is m.
The acceleration of free fall is g. What is the friction force F?

A m(gcosθ - a) **B** m(gcosθ + a)

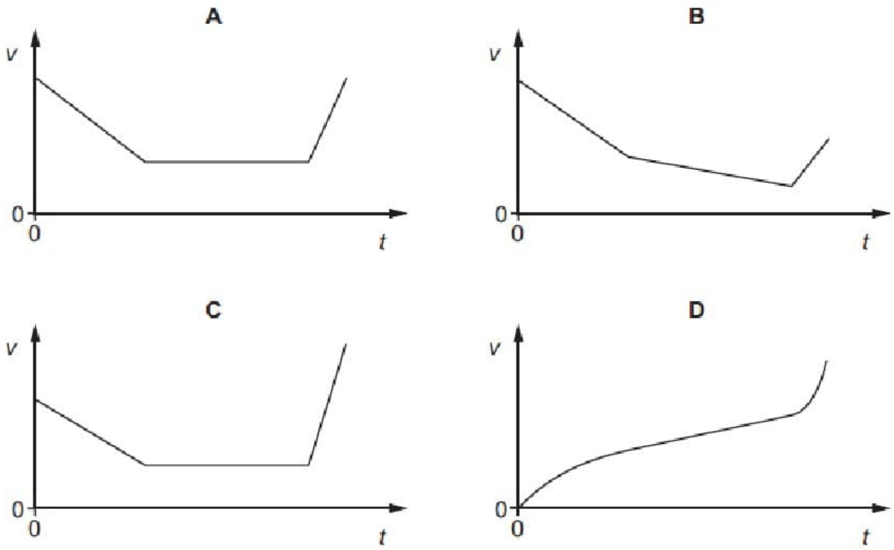
C m(gsinθ - a) **D** m(gsinθ + a)

Q10 (6/M/J/17/12)

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



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



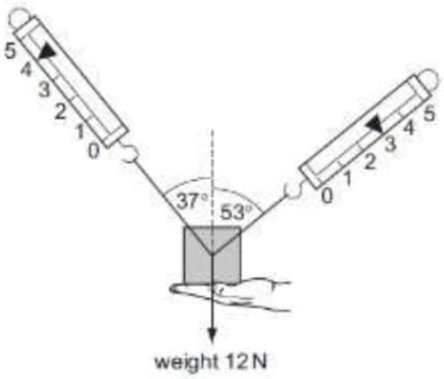
Q11 (8/F/M/20/12)

A person of mass 60 kg stands on accurate bathroom scales, placed on the floor of an elevator (lift) which operates in a tall building. At a certain instant the bathroom scales read 58 kg.
Which row could give the person's direction of movement and type of motion?

	direction	motion
A	downwards	constant speed
B	downwards	slowing down
C	upwards	constant speed
D	upwards	slowing down

Q12 (14/O/N/12/12):

A 1.2 kg mass is supported by a person's hand and two newton-meters as shown.

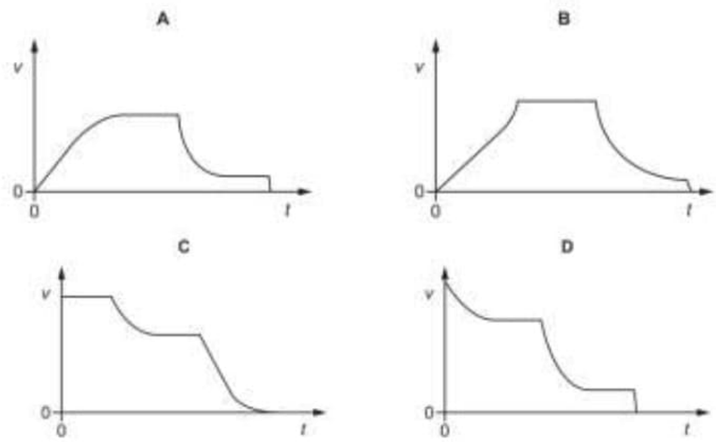


When the person's hand is removed, what is the initial vertical acceleration of the mass?

A $0.6\,m\,s^{-2}$ **B** $2\,m\,s^{-2}$ **C** $4\,m\,s^{-2}$ **D** $6\,m\,s^{-2}$

Q13 (9/O/N/18/13)

A parachutist falls vertically from rest at time t = 0 from a hot-air balloon. She falls for some distance before opening her parachute. Which graph best shows the variation with time t of the speed v of the parachutist?



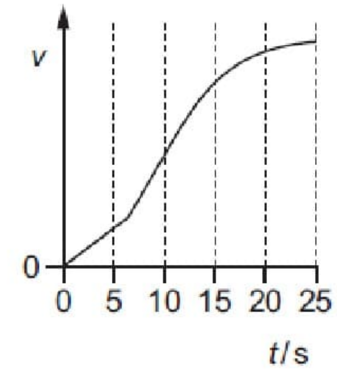
Q14 (8/O/N/17/11)

The three forces acting on a hot-air balloon that is moving vertically are its weight, the force due to air resistance and the upthrust force. The hot-air balloon descends vertically at constant speed. The force of air resistance on the balloon is F. Which weight of material must be released from the balloon so that it ascends vertically at the same constant speed?

A F **B** 2F **C** 3F **D** 4F

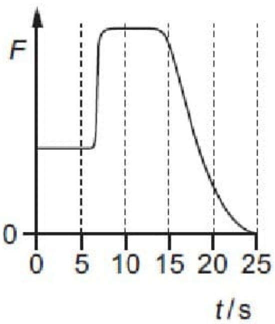
Q15 (10/O/N/15/12)

A bus takes a time of 25 s to reach a constant speed while travelling in a straight line. A graph of speed v against time t is shown.

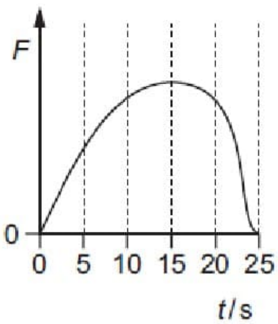


Which graph shows the variation with t of the resultant force F on the bus?

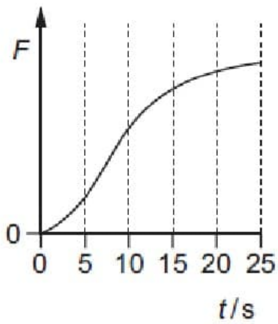
A



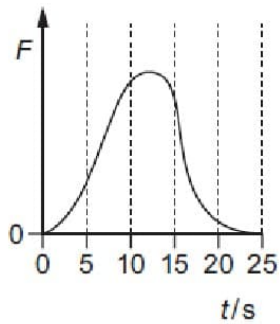
B



C



D



Q16 (9/M/J/14/12)
A ship of mass 8.4 × 10^7 kg is approaching a harbour with speed 16.4 m s^{-1}. By using reverse thrust it can maintain a constant total stopping force of 920 000 N.
How long will it take to stop?

A 15 seconds **B** 150 seconds
C 25 minutes **D** 250 minutes

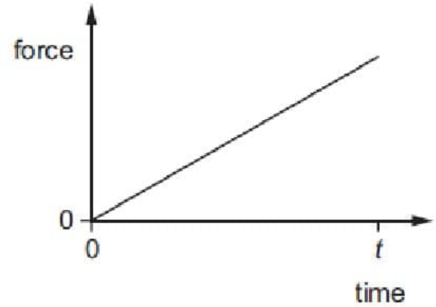
Q17 (17/M/J/14/13)
A shot-put champion accelerates a 7.0 kg metal ball in a straight line. The ball moves from rest to a speed of 12 m s^{-1} in a distance of 1.2 m. What is the average resultant force on the metal ball?

A 70 N **B** 210 N **C** 420 N **D** 840 N

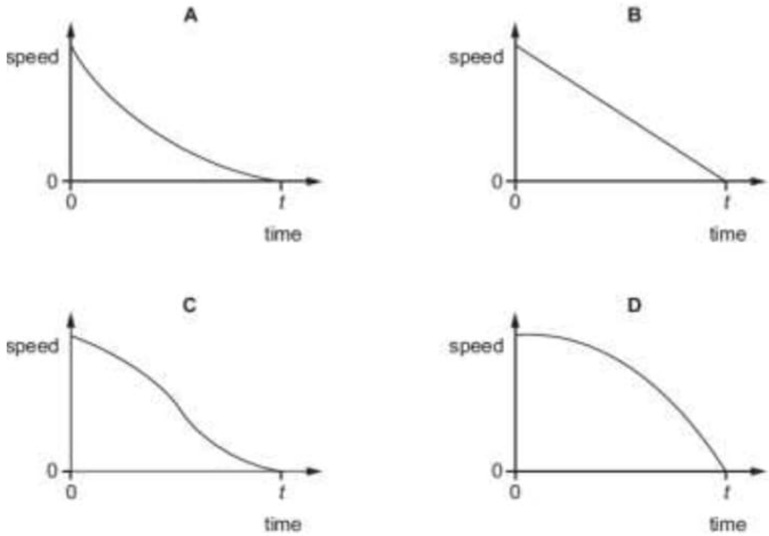
Q18 (10/O/N/13/12)
An astronaut of mass m in a spacecraft experiences a gravitational force F = mg when stationary on the Launchpad. What is the gravitational force on the astronaut when the spacecraft is launched vertically upwards with an acceleration of 0.2 g?
A 1.2 mg **B** mg **C** 0.8 mg **D** 0

Q19 (7/M/J/17/13)

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

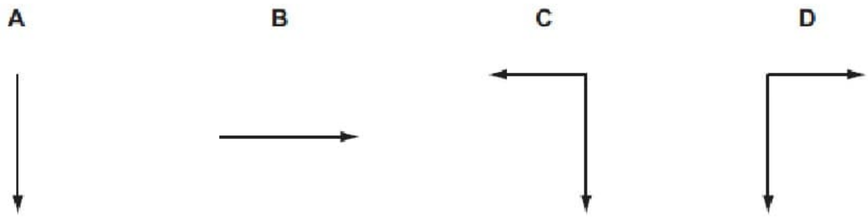


Which graph shows how the speed of the car will vary during this time?



Q20 (12/O/N/13/12)

An object in air is thrown upwards and towards the left.
Which diagram shows the force(s) acting on the body when it is at its highest point?



Q21 (7/M/J/17/11)

The mass of a rocket-propelled truck is approximately equal to the mass of the fuel in its tank. The fuel is ignited and the truck is propelled along horizontal tracks by a constant force. The effect of air resistance is negligible. During a test run the fuel is consumed at a constant rate. Which statement describes the acceleration of the truck during the test run?

A The acceleration of the truck decreases as the fuel is consumed.
B The acceleration of the truck increases as the fuel is consumed.
C The acceleration of the truck remains constant.
D The acceleration of the truck is zero and the truck moves at a constant velocity.

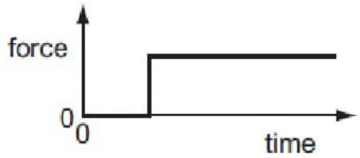
Q22 (8/O/N/18/11)

A ball of mass *m* is thrown vertically into the air. When the ball has speed *v*, the air resistance acting on the ball is *F*. What is the magnitude of the acceleration of the ball when its speed is *v* as it rises and as it falls?

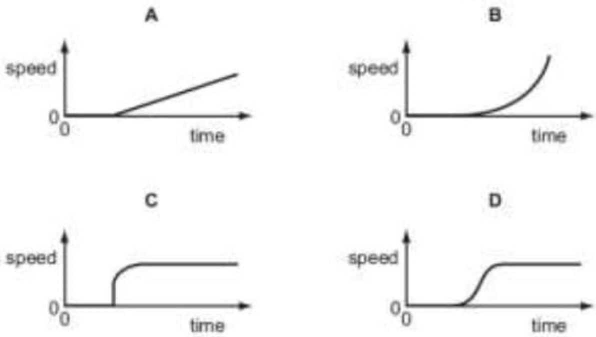
	acceleration when ball is rising	acceleration when ball is falling
A	$g - \frac{F}{m}$	$g - \frac{F}{m}$
B	$g - \frac{F}{m}$	$g + \frac{F}{m}$
C	$g + \frac{F}{m}$	$g - \frac{F}{m}$
D	$g + \frac{F}{m}$	$g + \frac{F}{m}$

Q23 (9/M/J/13/11)

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

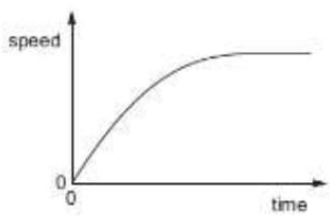


Which graph shows the variation with time of the speed of the car?



Q24 (11/M/J/14/12)

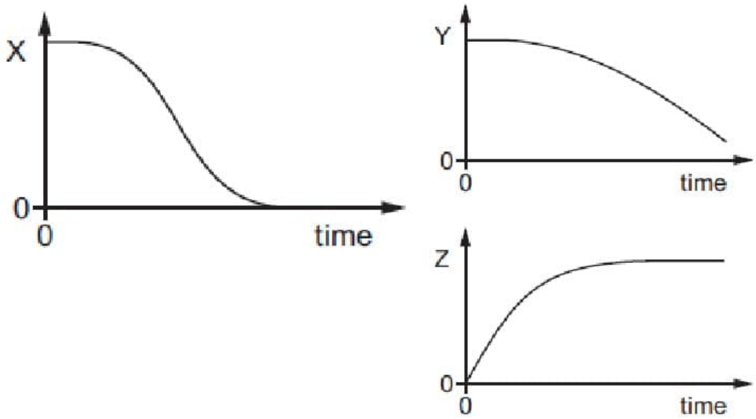
The graph shows the variation with time of the speed of a raindrop falling vertically through air.



Which statement is correct?

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

Q25 (8/M/J/17/11)
An object is dropped at time t = 0 from a high building. Air resistance is significant.
Three graphs are plotted against time. The height of the object above the ground the speed of the object the magnitude of the resultant force on the object



What are the quantities X, Y and Z?

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

Q26 (16/M/J/17/13)
A constant force pushes a block along a horizontal frictionless surface. The block moves from rest through a fixed distance.
What is the relationship between the final speed v of the block and its mass m?

A $\sqrt{v} \propto \frac{1}{m}$ **B** $v \propto \sqrt{m}$ **C** $\sqrt{v} \propto \frac{1}{\sqrt{m}}$ **D** $\sqrt{v} \propto \mathrm{m}$

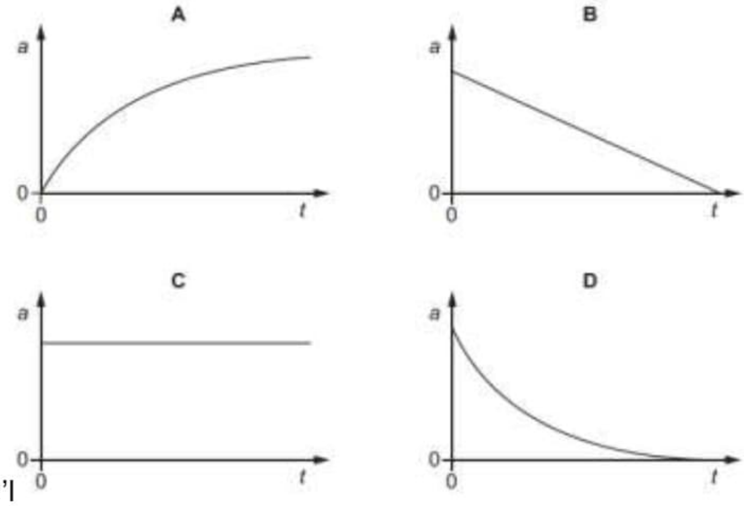
Q27 (16/M/J/17/12)
A stone of mass m falls from rest at the top of a cliff of height h into the sea below. Just before hitting the sea the stone has speed v.
What is the average force of air resistance acting on the stone during its fall?

A mg **B** $\frac{m(v^2-2gh)}{h}$ **C** $m\left(g-\frac{v^2}{2h}\right)$ **D** $m\left(gh-\frac{v^2}{2}\right)$

Q28 (8/O/N/17/12)

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

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



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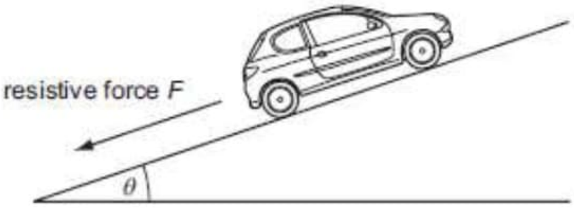
Q29 (14/M/J/12/11)

A car of mass m travels at constant speed up a slope at an angle θ to the horizontal, as shown in the diagram. Air resistance and friction provide a resistive force F.



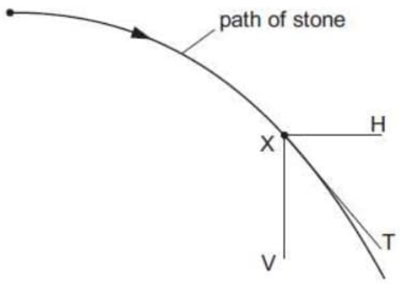
What force is needed to propel the car at this constant speed?

A mg cos θ **B** mg sin θ

C mg cos θ + F **D** mg sin θ + F

Q30 (11/O/N/17/13)

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



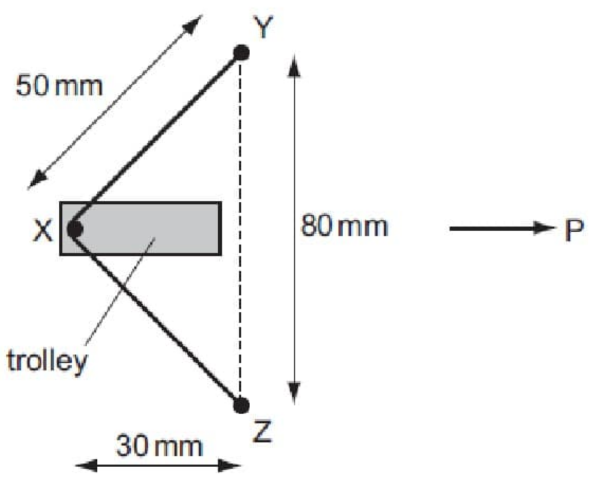
X is a point on this path. XV and XH are vertical and horizontal lines respectively through X. XT is the tangent to the path at X.

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

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

Q31 (17/M/J/11/12)

The diagram shows two fixed pins, Y and Z. A length of elastic is stretched between Y and Z and around pin X, which is attached to a trolley.



X is at the center of the elastic and the trolley is to be propelled in the direction P at right angles to YZ. The tension in the elastic is 4 N.
What is the force accelerating the trolley in the direction P when the trolley is released?

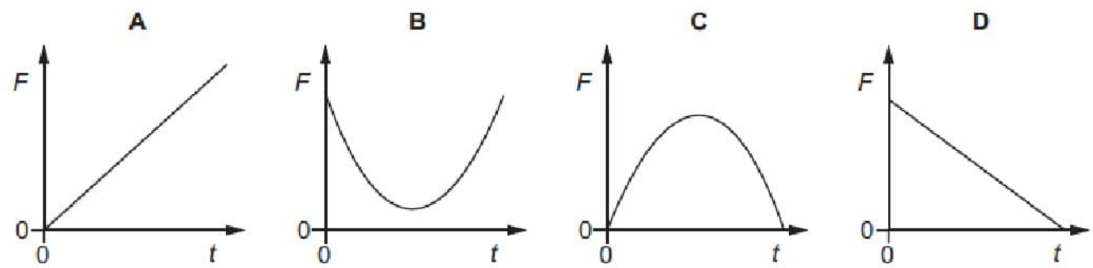
A 2.4 N **B** 3.2 N **C** 4.8 N **D** 6.4 N

Q32 (9/M/J/15/13)
A body falling in a uniform gravitational field encounters air resistance. The air resistance increases until terminal velocity is reached.
Which factor does not affect its terminal velocity?

A the density of the air **B** the height from which the body falls

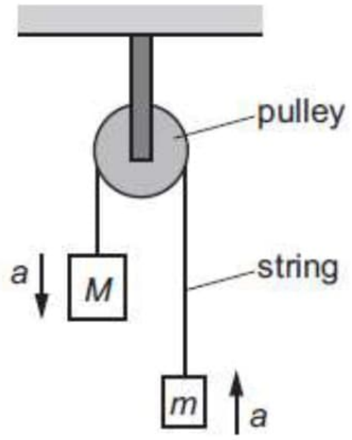
C the mass of the body **D** the shape of the body

Q33 (7/M/J/17/12)
A rubber ball is dropped onto a table and bounces back up. The table exerts a force F on the ball.
Which graph best shows the variation with time t of the force F for the short time that the ball is in contact with the table?



Q34 (10/O/N/17/12)

Two blocks of masses M and m are joined by a thin string which passes over a frictionless pulley, as shown.

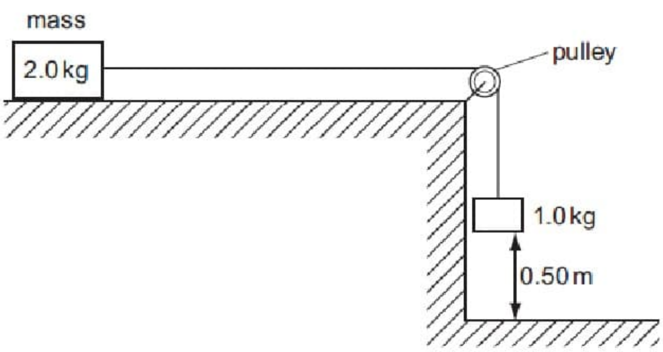


The acceleration of free fall is g. What is the acceleration a of the two blocks?

A $\frac{(M+m)}{(M-m)}g$ **B** $\frac{(M-m)}{(M+m)}g$ **C** $\frac{M}{m}g$ **D** $\frac{m}{M}g$

Q35 (13/O/N/12/11)

A mass of 2.0 kg rests on a frictionless surface. It is attached to a 1.0 kg mass by a light, thin string which passes over a frictionless pulley. The 1.0 kg mass is released, and it accelerates downwards.

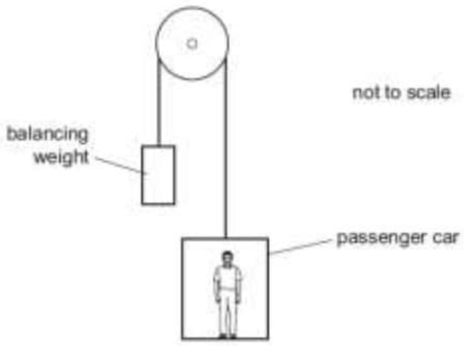


What is the speed of the 2.0 kg mass as the 1.0 kg mass hits the floor, having fallen a distance of 0.50m?

A 1.8 m s^{-1} **B** 2.2 m s^{-1} **C** 3.1 m s^{-1} **D** 9.8 m s^{-1}

Q36 (9/M/J/13/13)

A lift (elevator) consists of a passenger car supported by a cable which runs over a light, frictionless pulley to a balancing weight. The balancing weight falls as the passenger car rises.



Some masses are shown in the table.

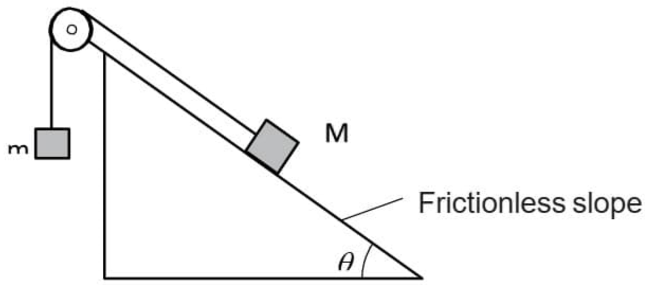
	mass / kg
passenger car	520
balancing weight	640
passenger	80

What is the magnitude of the acceleration of the car when carrying just one passenger and when the pulley is free to rotate?

A 0.032 m s^{-2} **B** 0.32 m s^{-2} **C** 0.61 m s^{-2} **D** 0.65 m s^{-2}

Q37 (7/M/J/18/13)

Two masses, M and m, are connected by an inextensible string which passes over a frictionless pulley. Mass M rests on a frictionless slope, as shown.



The slope is at an angle θ to the horizontal.

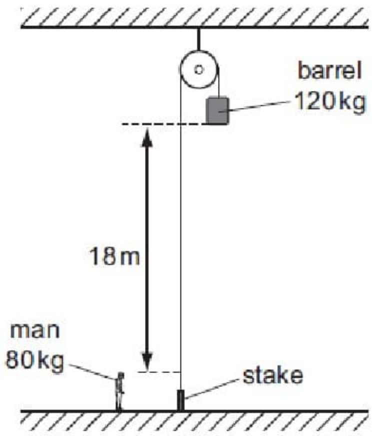
The two masses are initially held stationary and then released. Mass M moves down the slope.

Which expression **must** be correct?

A $\sin\theta < \frac{m}{M}$ **B** $\cos\theta < \frac{m}{M}$ **C** $\sin\theta > \frac{m}{M}$ **D** $\cos\theta > \frac{m}{M}$

Q38 (12/M/J/12/11)

The diagram shows a barrel suspended from a frictionless pulley on a building. The rope supporting the barrel goes over the pulley and is secured to a stake at the bottom of the building.



A man stands close to the stake. The bottom of the barrel is 18 m above the man's head. The mass of the barrel is 120 kg and the mass of the man is 80 kg.
The man keeps hold of the rope after untying it from the stake and is lifted upwards as the barrel falls.
What is the man's upward speed when his head is level with the bottom of the barrel?
(Use g = 10 m^{-2})

A 6ms^{-1} **B** 8ms^{-1} **C** 13ms^{-1} **D** 19ms^{-1}

Q39 (10/M/J/14/12)

A tractor of mass 1000 kg is connected by a tow-bar to a trailer of mass 1000 kg. The total resistance to motion has a constant value of 4000 N. One quarter of this resistance acts on the trailer.
When the tractor and trailer are moving along horizontal ground at a constant speed of 6 m s^{-1}, what is the force exerted on the tractor by the tow-bar?

A 0 N **B** 1000 N **C** 3000 N **D** 4000 N

Q40 (13/M/J/15/11)

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

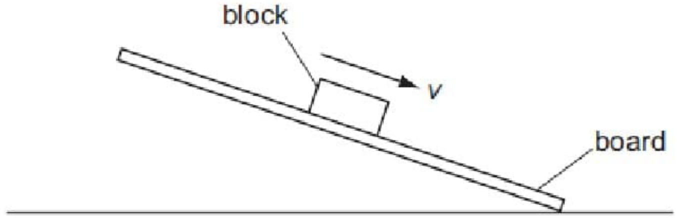
When box is released, a frictional force of 6.0 N acts on it.
What is the acceleration of the box?

A 1.4 m s^{-2} **B** 1.7 ms^{-2} **C** 2.0 m s^{-2} **D** 2.6 m s^{-2}

Q41 (8/O/N/11/11)
A boy throws a ball vertically upwards. It rises to a maximum height, where it is momentarily at rest, and then falls back to his hands.
Which row gives the acceleration of the ball at various stages in its motion? (Take vertically upwards as positive. Ignore air resistance.)

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

Q42 (13/M/J/13/13)
A wooden block rests on a rough board. The end of the board is then raised until the block slides down the plane of the board at constant velocity v.



Which row describes the forces acting on the block when sliding with constant velocity?

	frictional force on block	resultant force on block
A	down the plane	down the plane
B	down the plane	zero
C	up the plane	down the plane
D	up the plane	zero

Q43 (7/M/J/13/11)
A body is released from rest and falls vertically in air of constant density.
Which statement about the motion of the falling body is correct?

A As it accelerates, its weight decreases so that its acceleration decreases until it travels with constant velocity.

B It accelerates initially at $9.8\,m\,s^{-2}$ but the drag force increases so its acceleration decreases.

C Its velocity increases at a constant rate until its velocity becomes constant.

D The drag force of the air increases continually and eventually the velocity decreases

Weight

Q1 (9/O/N/14/13)

A man weighs 240 N on Mars where the acceleration of free fall g is $4\,m\,s^{-2}$. On the Moon, g is $2ms^{-2}$. Which statement is correct?

A The man has a mass on Mars of 60 N.
B The man has a mass on the Moon of 120 kg.
C The man weighs 120 N on the Moon.
D The man weighs 240 N on the Moon.

Q2 (9/O/N/13/12)

What is meant by the mass and by the weight of an object on the Earth?

	mass	weight
A	its momentum divided by its velocity	the work done in lifting it one metre the
B	the gravitational force on it	property that resists its acceleration
C	the pull of the Earth on it	its mass divided by the acceleration of free fall
D	the property that resists its acceleration	the pull of the Earth on it

Q3 (8/M/J/11/11)

A body has a weight of 58.9 N when on the Earth. On the Moon, the acceleration of free fall is $1.64\,m\,s^{-2}$. What are the weight and the mass of the body when it is on the Moon?

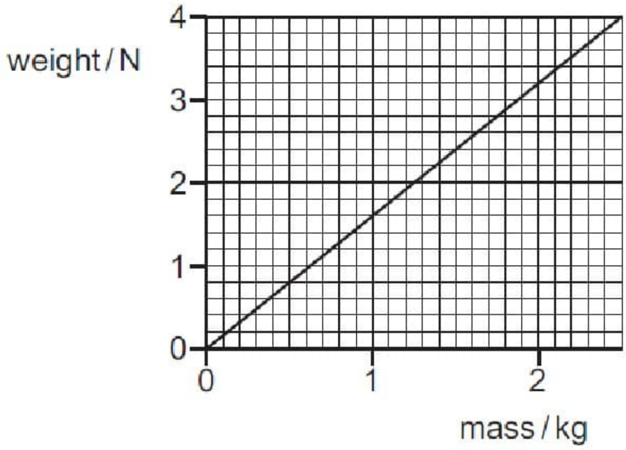
	weight / N	mass / kg
A	9.85	1.00
B	9.85	6.00
C	58.9	1.00
D	58.9	6.00

Q4 (10/O/N/10/11)

The gravitational field strength on the surface of planet P is one tenth of that on the surface of planet Q. On the surface of P, a body has a mass of 1.0 kg and a weight of 1.0 N.
What are the mass and weight of the same body on the surface of planet Q?

	mass on Q / kg	weight on Q / N
A	1.0	0.1
B	1.0	10
C	10	10
D	10	100

Q5 (7/M/J/18/11)
The graph shows the variation with mass of the weight of objects on a particular planet.



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

A $0.63\,m\,s^{-2}$ **B** $1.6\,m\,s^{-2}$ **C** $3.2\,m\,s^{-2}$ **D** $9.8\,m\,s^{-2}$

Q6 (7/O/N/7/1)
The symbol g represents the acceleration of free fall.
Which of these statements is correct?

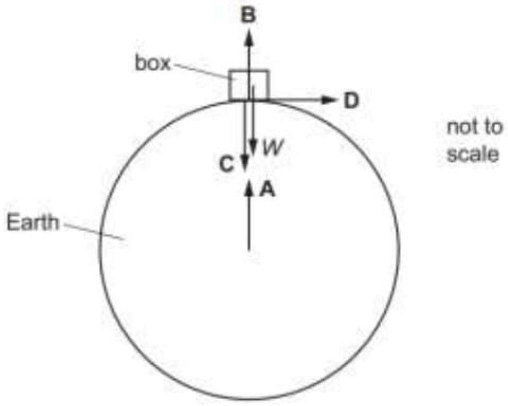
A g is gravity.
B g is reduced by air resistance.
C g is the ratio weight / mass.
D g is the weight of an object.

Newton Third Law

Q1 (7/O/N/19/13)

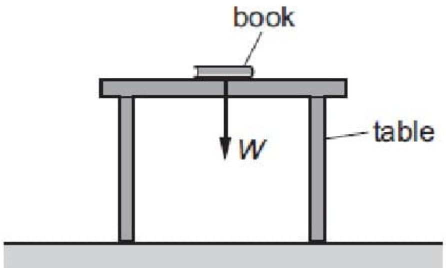
A box rests on the Earth, as shown.

Newton's third law describes how forces of the same type act in pairs. One of the forces of a pair is the weight W of the box. Which arrow represents the other force of this pair?



Q2 (9/M/J/17/12)

A book of weight W is at rest on a table. A student attempts to state Newton's third law of motion by saying that 'action equals reaction'.

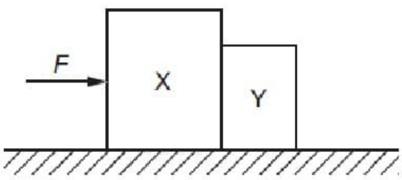


If the weight of the book is the 'action' force, what is the 'reaction' force?

- **A** the force W acting downwards on the Earth from the table
- **B** the force W acting upwards on the book from the table
- **C** the force W acting upwards on the Earth from the book
- **D** the force W acting upwards on the table from the floor

Q3 (11/O/N/15/12)

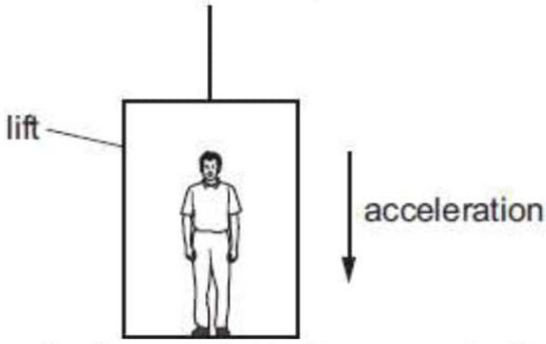
A single horizontal force F is applied to a block X which is in contact with a separate block Y as shown.



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

- **A** The acceleration of X is equal to force F divided by the mass of X.
- **B** The force that X exerts on Y is equal to F.
- **C** The force that X exerts on Y is less than F.
- **D** The force that X exerts on Y is less than the force that Y exerts on X.

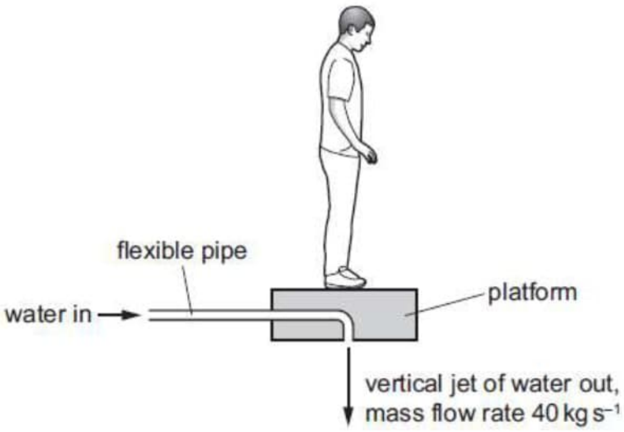
Q4 (8/O/N/17/13)
A man stands in a lift that is accelerating vertically downwards, as shown.



Which statement describes the force exerted by the man on the floor?

A It is equal to the weight of the man.
B It is greater than the force exerted by the floor on the man.
C It is less than the force exerted by the floor on the man.
D It is less than the weight of the man.

Q5 (11/M/J/16/11)
The diagram shows a man standing on a platform that is attached to a flexible pipe. Water is pumped through the pipe so that the man and platform remain at a constant height.



The resultant vertical force on the platform is zero. The combined mass of the man and platform is 96 kg. The mass of water that is discharged vertically downwards from the platform each second is 40 kg.
What is the speed of the water leaving the platform?

A $2.4 ms^{-1}$ **B** $6.9 ms^{-1}$ **C** $24 ms^{-1}$ **D** $47 ms^{-1}$

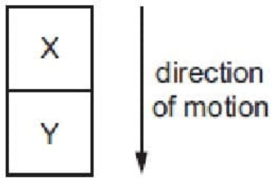
Q6 (8/O/N/14/12)
Water is pumped through a hose-pipe at a rate of 90 kg per minute. It emerges from the hose-pipe horizontally with a speed of $20\,m\,s^{-1}$.
Which force is required from a person holding the hose-pipe to prevent it moving backwards?

A 30 N **B** 270 N **C** 1800 N **D** 10 800 N

Q7 (9/O/N/8/1)
A ball falls vertically and bounces on the ground.
The following statements are about the forces acting while the ball is in contact with the ground.
Which statement is correct?

A The force that the ball exerts on the ground is always equal to the weight of the ball.
B The force that the ball exerts on the ground is always equal in magnitude and opposite in direction to the force the ground exerts on the ball.
C The force that the ball exerts on the ground is always less than the weight of the ball.
D The weight of the ball is always equal in magnitude and opposite in direction to the force that the ground exerts on the ball.10

Q8 (14/O/N/15/11)
Two blocks X and Y are falling through a vacuum in a uniform gravitational field, as shown.



Block X has weight 2w. **B**lock Y has weight w.

The blocks do not move apart.
Which value best represents the force exerted by block X on block Y?

A 0 **B** w **C** 1.5w **D** 2w

Q9(10/M/J/6/1)
A cyclist is riding at a steady speed on a level road.
According to Newton's third law of motion, what is equal and opposite to the backward push of the back wheel on the road?

A the force exerted by the cyclist on the pedals
B the forward push of the road on the back wheel
C the tension in the cycle chain
D the total air resistance and friction force

Law of Conservation of momentum

Q1 (10/O/N/17/11)
What is a statement of the principle of conservation of momentum?

A In an elastic collision momentum is constant.
B Momentum is the product of mass and velocity.
C The force acting on a body is proportional to its rate of change of momentum.
D The momentum of an isolated system is constant.

Q2 (9/O/N/18/11)
What is a statement of the principle of conservation of momentum?

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

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

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

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

Q3 (10/O/N/17/13)
Two railway trucks of masses m and 3m move towards each other in opposite directions with speeds 2v and v respectively. These trucks collide and stick together.
What is the speed of the trucks after the collision?

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

Q4 (10/M/J/15/13)
Which of the following is a statement of the principle of conservation of momentum?

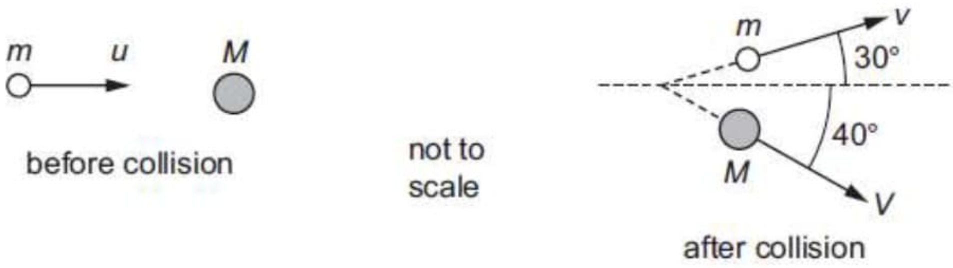
A Momentum is the product of mass and velocity.
B In an elastic collision, momentum is constant.
C The momentum of an isolated system is constant.
D The force acting on a body is proportional to its rate of change of momentum

Q5 (7/O/N/14/12)
What is the principle of conservation of momentum?

A Force is equal to the rate of change of momentum.
B Momentum is the product of mass and velocity.
C The total momentum of a system remains constant provided no external force acts on it.
D The total momentum of two bodies after collision is equal to their total momentum before collision.

Q6 (11/M/J/16/12)

A ball of mass m travelling at velocity u collides with a stationary ball of mass M. After collision the two balls travel at velocities v and V respectively, in the directions shown.

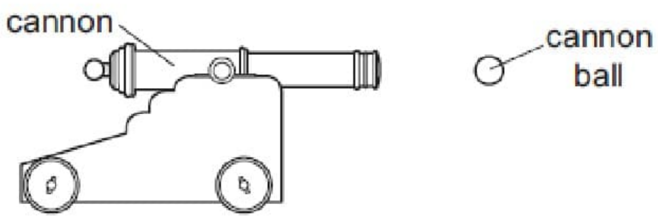


Student writes three equations relating to the collision.
Which row in the table indicates the correct and incorrect equations?

	mu = MV + mv	mv sin 30° = MV sin 40°	mu = mv cos 30° + MV cos 40°
A	correct	correct	correct
B	incorrect	correct	incorrect
C	correct	incorrect	incorrect
D	incorrect	correct	correct

Q7 (12/O/N/6/1)

The diagram shows a cannon ball fired from a cannon.

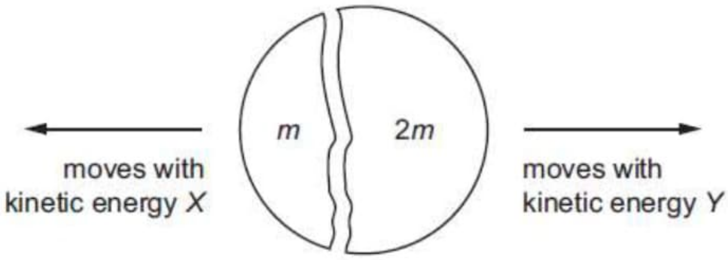


The mass of the cannon is 1000 kg and the mass of the cannon ball is 10 kg. The recoil velocity of the cannon is 5 ms^{-1} horizontally. What is the horizontal velocity of the cannon ball?

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

Q8 (12/M/J/14/13)

A stationary body explodes into two components of masses m and 2m.
The components gain kinetic energies X and Y respectively.



What is the value of the ratio $\frac{X}{Y}$?

A $\frac{1}{4}$ **B** $\frac{1}{2}$ **C** $\frac{2}{1}$ **D** $\frac{4}{1}$

Q9 (12/M/J/7/1)

The diagram shows the masses and velocities of two trolleys about to collide.

After the impact they move off together.
What is the total kinetic energy of the trolleys after the collision?

A 1.3 J **B** 12 J **C** 18 J **D** 19 J

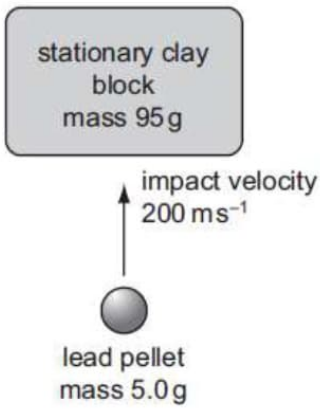
Q10 (10/M/J/13/13)

A stationary nucleus has nucleon number A.
The nucleus decays by emitting a proton with speed v to form a new nucleus with speed u. The new nucleus and the proton move away from one another in opposite directions.
Which equation gives v in terms of A and u?

A $v = (\frac{A}{4} - 1)u$ **B** $v = (A - 1)u$
C $v = Au$ **D** $v = (A + 1)u$

Q11 (14/O/N/12/1)

A lead pellet is shot vertically upwards into a clay block that is stationary at the moment of impact but is able to rise freely after impact.



The pellet hits the block with an initial velocity of 200 m s^{-1}. It embeds itself in the block and does not emerge. How high above its initial position will the block rise?
(Mass of pellet = 5.0g; mass of clay block = 95g.)

A 5.1 m **B** 5.6 m **C** 10 m **D** 2000 m

Q12 (11/O/N/11/12)

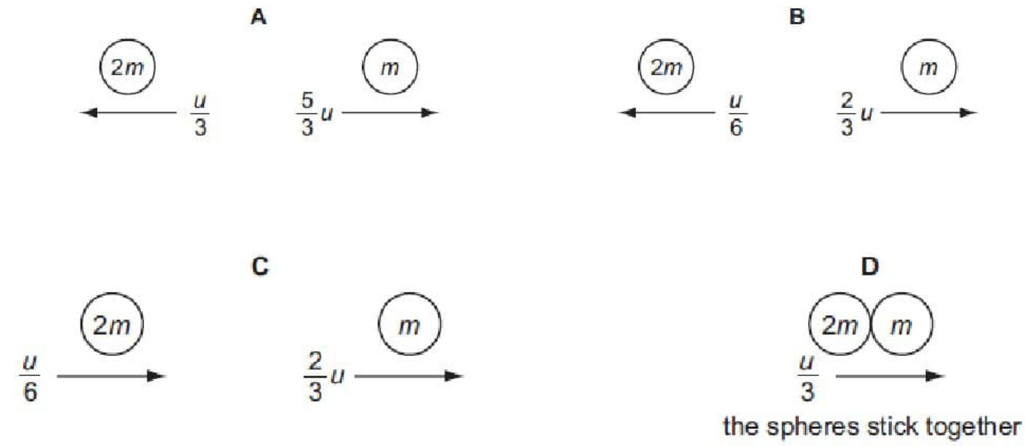
An object of mass 20 kg is travelling at a constant speed of 6.0 m s^{-1}. It collides with an object of mass 12 kg travelling at a constant speed of 15 m s^{-1} in the opposite direction. The objects stick together. What is the speed of the objects immediately after the collision?

A 1.9 m s^{-1} **B** 9.0 m s^{-1} **C** 9.4 m s^{-1} **D** 21 m s^{-1}

Q13 (11/O/N/12/13)

The diagram shows two spherical masses approaching each other head-on at an equal speed u. One is of mass m and the other of mass 2m.

Which diagram, showing the situation after the collision, is not consistent with the principle of conservation of momentum?



Q14 (11/O/N/10/11)

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

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

A $\frac{M_1}{M_2}$ **B** $\frac{M_2}{M_1}$ **C** $\sqrt{\frac{M_1}{M_2}}$ **D** $\sqrt{\frac{M_2}{M_1}}$

Q15 (10/M/J/10/11)

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

What is the speed of the masses after impact?

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

Q16 (10/O/N/11/12)

A group of students investigating the principle of conservation of momentum use a small truck travelling over a frictionless surface. Sand is dropped into the truck as it passes X. At Y, a trapdoor in the bottom of the truck opens and the sand falls out.

How does the velocity of the truck change when the sand is added to the truck at X and then leaves the truck at Y?

	at X	at Y
A	decreases	increases
B	decreases	stays the same
C	stays the same	increases
D	stays the same	stays the same

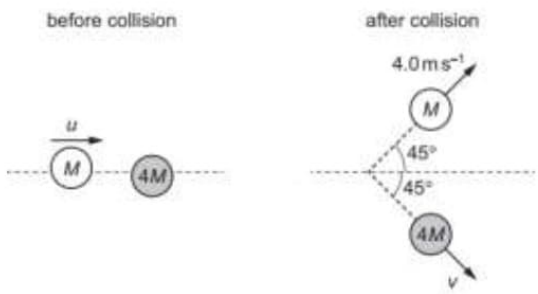
Q17 (9/M/J/11/11)

A body of mass m, moving at velocity v, collides with a stationary body of the same mass and sticks to it. Which row describes the momentum and kinetic energy of the two bodies after the collision?

	momentum	Kinetic energy
A	mv	$\frac{1}{4}mv^2$
B	mv	$\frac{1}{8}mv^2$
C	2mv	$\frac{1}{2}mv^2$
D	2mv	mv^2

Q18 (12/O/N/24/11)

A disc of mass M is moving across a horizontal frictionless surface with constant velocity u. It collides with a stationary disc of mass 4M. The diagram shows the view from above of the motion of the two discs before and after the collision.

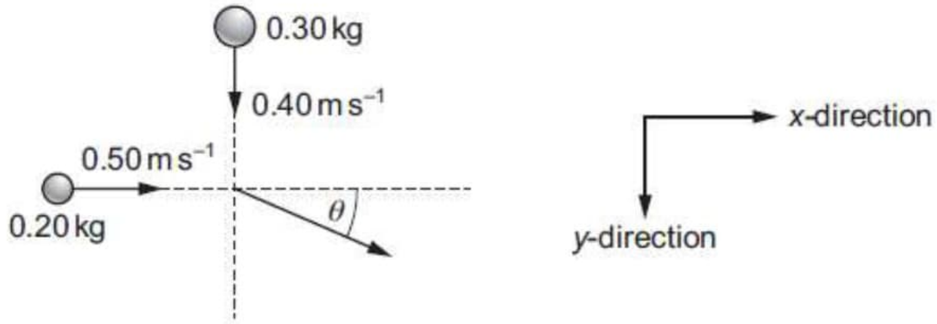


What is the initial velocity u of the disc of mass M?

A 1.1ms–1 B 1.4ms–1 C 3.5ms–1 D 5.7ms–1

Q19 (9/M/J/18/13)

A ball of mass 0.20 kg, travelling in the *x*-direction at a speed of 0.50 m s^{-1}, collides with a ball of mass 0.30 kg travelling in the *y*-direction at a speed of 0.40 m s^{-1}.
The two balls stick together after the collision, travelling at an angle θ to the *x*-direction.

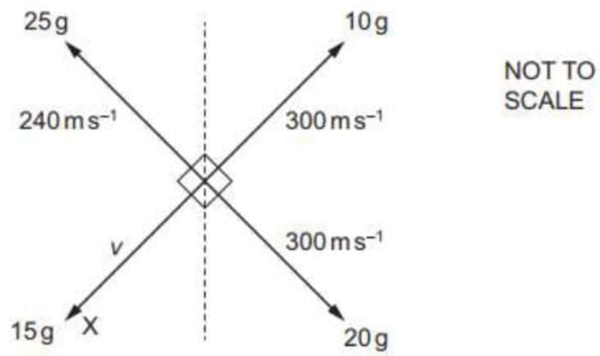


What is the value of θ

A 39° **B** 40° **C** 50° **D** 51°

Q20(10/F/M/21/12)

A stationary firework explodes into four fragments which travel in different directions in a horizontal plane. The diagram shows the velocity and mass of each fragment.

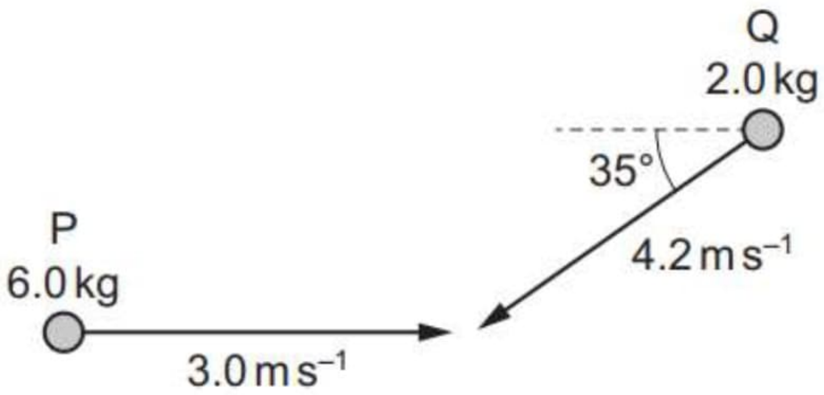


What is the speed v of fragment X?
A 200 m s^{-1} B 240 m s^{-1} C 300 m s^{-1} D 360 m s^{-1}

Q21(7/F/M/25/12)

Objects P and Q form an isolated system.

Object P has mass 6.0 kg and is moving at a speed of 3.0 m s^{-1}.
Object Q has mass 2.0 kg and is moving at a speed of 4.2 m s^{-1} at an angle of 35° to the path of P.

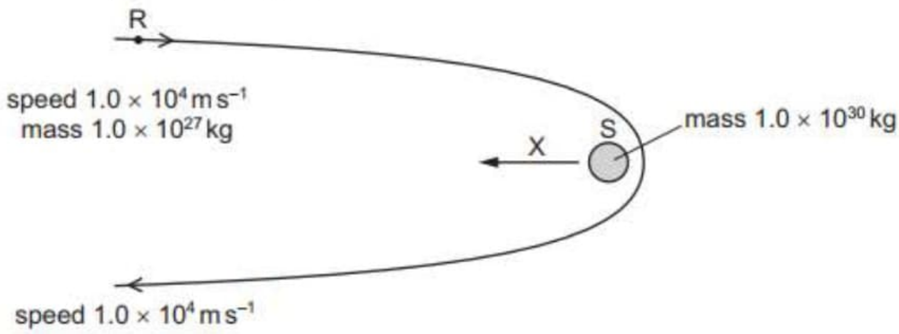


Objects P and Q collide and stick together.
What is the magnitude of the component of the final momentum of the combined objects in the original direction of P?

A 9.6 kg m s^{-1} **B** 11 kg m s^{-1} **C** 13 kg m s^{-1} **D** 25 kg m s^{-1}

Q22 (9/O/N/20/11)

A rock R of mass 1.0×10^{27} kg is a large distance from a star S and is travelling at a speed of 1.0×10^{4} m s^{-1}. The star has mass 1.0×10^{30} kg. The rock travels around the star on the path shown so that it reverses its direction of motion and, when finally again a large distance from the star, has the same speed as initially.



Which statement is correct?

A The change in the momentum of S is in the direction of arrow X.

B The change in the velocity of S is approximately 20 m s^{-1}.

C The magnitude of the change of momentum of R is 10^{3} times greater than the magnitude of the change of momentum of S.

D The momentum of R does not change.

Elastic Collision

Q1 (9/M/J/16/11)

Which statement about a perfectly elastic collision between two bodies in an isolated system is correct?

- **A** Both total kinetic energy and total momentum are conserved.
- **B** Total kinetic energy is conserved, but total momentum is not conserved.
- **C** Total momentum is conserved, but total kinetic energy is not conserved.
- **D** Neither total kinetic energy nor total momentum is conserved.

Q2 (12/O/N/15/11)

Which statement about a ball that strikes a tennis racket and rebounds is always correct?

- **A** The total kinetic energy of the ball is conserved.
- **B** The total kinetic energy of the system is conserved.
- **C** The total momentum of the ball is conserved.
- **D** The total momentum of the system is conserved.

Q3 (13/O/N/15/13)

Which statement is correct with reference to perfectly elastic collisions between two bodies?

- **A** Neither total momentum nor total kinetic energy need be conserved but total energy must be conserved.
- **B** Total momentum and total energy are conserved but total kinetic energy may be changed into some other form of energy.
- **C** Total kinetic energy and total energy are both conserved but total momentum is conserved only if the two bodies have equal masses.
- **D** Total momentum, total kinetic energy and total energy are all conserved.

Q4 (10/M/J/13/12)

Two bodies travelling in a straight line collide in a perfectly elastic collision. Which of the following statements must be correct?

- **A** The initial speed of one body will be the same as the final speed of the other body.
- **B** The relative speed of approach between the two bodies equals their relative speed of separation.
- **C** The total momentum is conserved but the total kinetic energy will be reduced.
- **D** One of the bodies will be stationary at one instant.

Q5 (11/M/J/6/1)

In perfectly elastic collisions between two atoms, it is always true to say that

- **A** the initial speed of one atom will be the same as the final speed of the other atom.
- **B** the relative speed of approach between the two atoms equals their relative speed of separation.
- **C** the total momentum must be conserved, but a small amount of the total kinetic energy may be lost in the collision.
- **D** whatever their initial states of motion, neither atom can be stationary after the collision.

Q6 (18/M/J/14/13)

A ball drops onto a horizontal surface and bounces elastically. What happens to the kinetic energy of the ball during the very short time that it is in contact with the surface?

A Most of the kinetic energy is lost as heat and sound energy.
B The kinetic energy decreases to zero and then returns to its original value.
C The kinetic energy remains constant because it is an elastic collision.
D The kinetic energy remains constant in magnitude but changes direction.

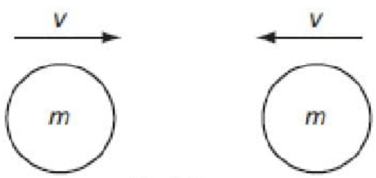
Q7 (9/M/J/16/13)

Which row in the table gives the quantities that are conserved in a perfectly elastic collision between two gas molecules?

	total momentum	total kinetic energy
A	conserved	conserved
B	conserved	not conserved
C	not conserved	conserved
D	not conserved	not conserved

Q8 (11/M/J/12/11)

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

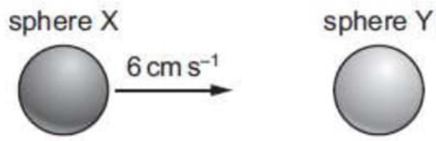


The spheres have a head-on elastic collision. Which statement is correct?

A The spheres stick together on impact.
B The total kinetic energy after impact is mv^2.
C The total kinetic energy before impact is zero.
D The total momentum before impact is $2mv$.

Q9 (11/O/N/17/11)

Two solid spheres form an isolated system. Sphere X moves with speed $6\,cm\,s^{-1}$ in a straight line directly towards a stationary sphere Y, as shown.



The spheres have a perfectly elastic collision. After the collision, sphere X moves with speed $2\,cm\,s^{-1}$ in the same direction as before the collision.
What is the speed of sphere Y?

A $2\,cm\,s^{-1}$ **B** $4\,cm\,s^{-1}$ **C** $6\,cm\,s^{-1}$ **D** $8\,cm\,s^{-1}$

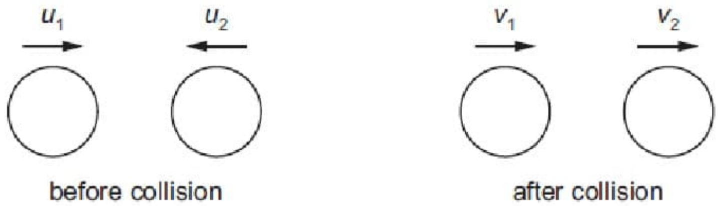
Q10 (12/O/N/12/13)

A molecule of mass m travelling at speed v hits a wall in a direction perpendicular to the wall. The collision is elastic. What are the changes in the kinetic energy and in the momentum of the molecule caused by the collision?

	change in momentum	change in kinetic energy
A	0	0
B	0	mv^2
C	2mv	0
D	mv^2	0

Q11 (10/M/J/16/11)

Two spheres approach each other along the same straight line. Their speeds are u_1 and u_2 before they collide. After the collision, the spheres separate with speeds v_1 and v_2 in the directions shown below.



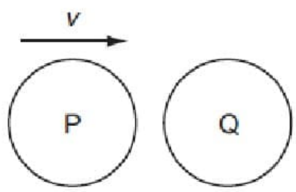
The collision is perfectly elastic. Which equation must be correct?

A $u_1 - u_2 = v_2 + v_1$ **B** $u_1 - u_2 = v_2 - v_1$

C $u_1 + u_2 = v_2 + v_1$ **D** $u_1 + u_2 = v_2 - v_1$

Q12 (13/M/J/11/12)

The diagram shows a particle P, travelling at speed v, about to collide with a stationary particle Q of the mass. The collision is perfectly elastic.



Which statement describes the motion of P and of Q immediately after the collision?

A P rebounds with speed $\frac{1}{2}v$ and Q acquires speed $\frac{1}{2}v$
B P rebounds with speed v and Q remains stationary
C P and Q both travel in the same direction with speed $\frac{1}{2}v$
D P comes to a standstill and Q acquires speed v.

Q13 (14/O/N/15/12)

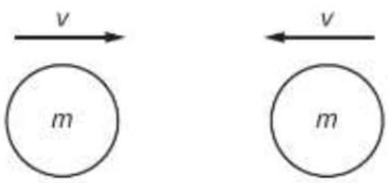
Two identical spheres X and Y approach each other with the speeds shown and undergo a head-on elastic collision.

What are the velocities of the spheres after the collision?

	sphere X	sphere Y
A	$0\,\text{m s}^{-1}$	$2\,\text{m s}^{-1}$ →
B	$2\,\text{m s}^{-1}$ →	$4\,\text{m s}^{-1}$ →
C	$2\,\text{m s}^{-1}$ ←	$4\,\text{m s}^{-1}$ →
D	$4\,\text{m s}^{-1}$ ←	$2\,\text{m s}^{-1}$ →

Q 14 (9/M/J/18/11)

Two similar spheres, each of mass m and travelling with speed v, are moving towards each other. The spheres have a head-on elastic collision.

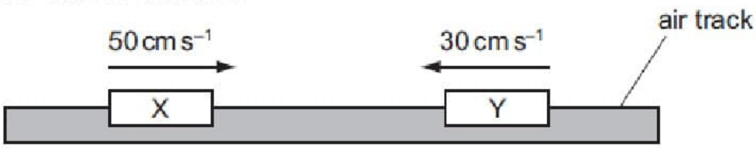


Which statement is correct?

- **A** The spheres stick together on impact.
- **B** The total kinetic energy after impact is mv^2
- **C** The total kinetic energy before impact is zero.
- **D** The total momentum before impact is $2mv$

Q15 (12/O/N/15/13)

Two equal masses X and Y are moving towards each other on a frictionless air track as shown. The masses make an elastic collision.

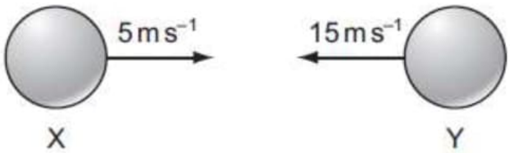


Which row gives possible velocities for the two masses after the collision?

	velocity of X	velocity of Y
A	zero	$20\,\text{cm s}^{-1}$ to the right
B	$10\,\text{cm s}^{-1}$ to the right	$10\,\text{cm s}^{-1}$ to the right
C	$20\,\text{cm s}^{-1}$ to the left	zero
D	$30\,\text{cm s}^{-1}$ to the left	$50\,\text{cm s}^{-1}$ to the right

Q16 (12/M/J/15/13)

Two balls X and Y are moving towards each other with speeds of $5\,m\,s^{-1}$ and $15\,m\,s^{-1}$ respectively.



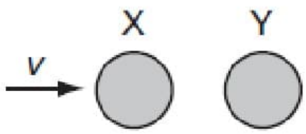
They make a perfectly elastic head-on collision and ball Y moves to the right with a speed of $7\,m\,s^{-1}$.
What is the speed and direction of ball X after the collision?

A $3\,m\,s^{-1}$ to the left **B** $13\,m\,s^{-1}$ to the left

C $3\,m\,s^{-1}$ to the right **D** $13\,m\,s^{-1}$ to the right

Q17 (12/O/N/12/11)

A particle X has speed v and collides with a stationary identical particle Y. The collision is perfectly elastic.

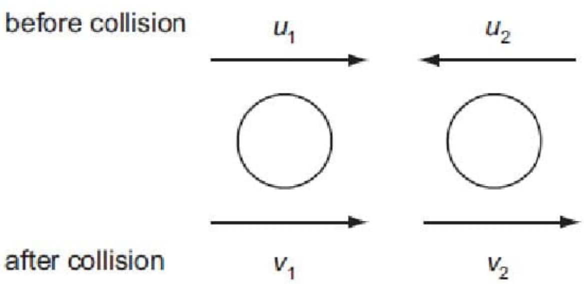


What are the speed and direction of motion of each of the two particles after the collision?

	X	Y
A	stationary	v to the right
B	$\frac{v}{2}$ to the right	$\frac{v}{2}$ tot the right
C	$\frac{v}{2}$ to the left	$\frac{v}{2}$ to the right
D	v to the left	stationary

Q18 (10/O/N/8/1)

Two spheres approach each other along the same straight line. Their speeds are u_1 and u_2 before collision, and v_1 and v_2 after collision, in the directions shown below.



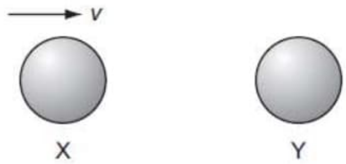
Which equation is correct if the collision is perfectly elastic?

A $u_1 - u_2 = v_2 + v_1$ **B** $u_1 - u_2 = v_2 - v_1$

C $u_1 + u_2 = v_2 + v_1$ **D** $u_1 + u_2 = v_2 - v_1$

Q19 (12/M/J/10/11)

The diagram shows two identical spheres X and Y.

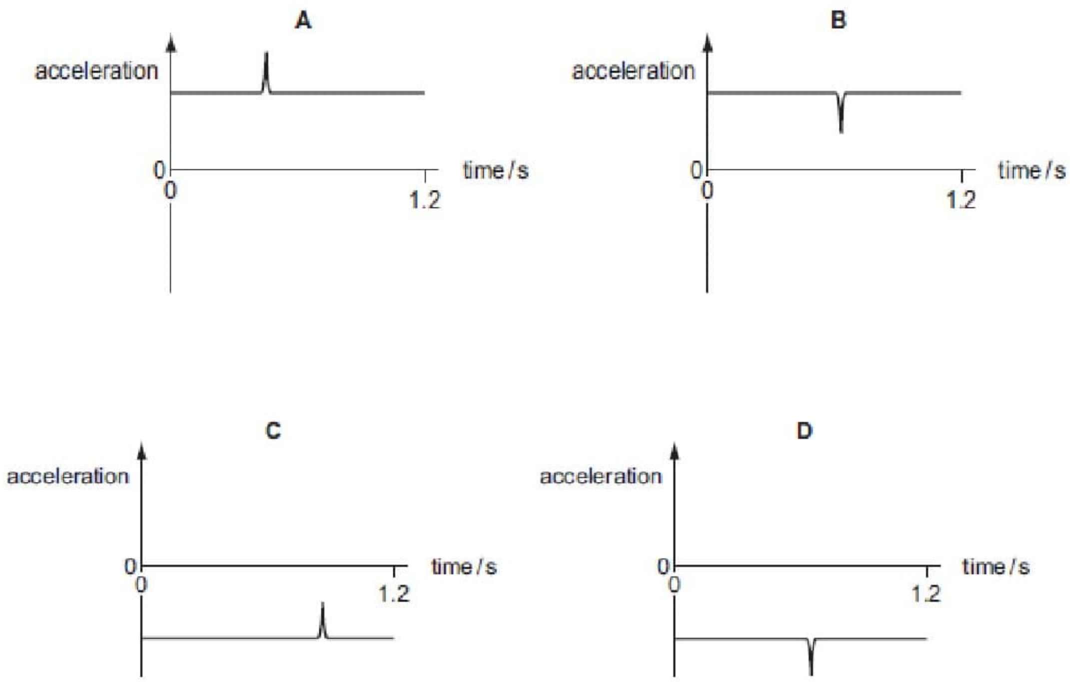


Initially, X moves with speed v directly towards Y. Y is stationary. The spheres collide elastically.
What happens?

	X	Y
A	Moves with speed $\frac{1}{2}$v to the right	Moves with speed $\frac{1}{2}$v to the right
B	Moves with speed v to the left	Remains stationary
C	Moves with speed $\frac{1}{2}$v to the left	Moves with speed $\frac{1}{2}$v to the right
D	Stops	Moves with speed v to the right

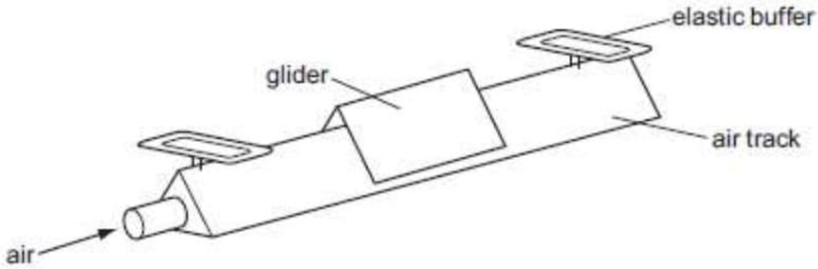
Q20 (7/O/N/10/12)

A student throws a ball in the positive direction vertically upwards. The ball makes an elastic collision with the ceiling, rebounds and accelerates back to the student's hand in a time of 1.2 s.
Which graph best represents the acceleration of the ball from the moment it leaves the hand to the instant just before it returns to the hand?



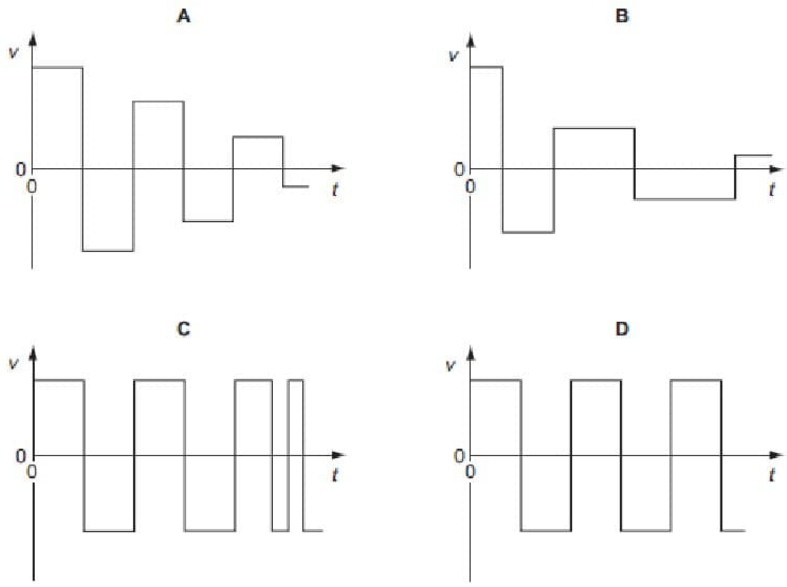
Q21 (9/M/J/11/12)

A small glider moves along a friction-free horizontal air track as shown below.



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

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



Inelastic Collision

Q1 (11/O/N/13/13)

An isolated system consists of two bodies on which no external forces act. The two bodies collide with each other and stick together on impact. Which row correctly compares the total kinetic energy and the total momentum of the bodies before and after the collision?

	total kinetic energy before and after the collision	total momentum before and after the collision
A	different	different
B	different	the same
C	the same	different
D	the same	the same

Q2 (11/M/J/12/12)

Which row correctly states whether momentum and kinetic energy are conserved in an inelastic collision in which there are no external forces?

	momentum	kinetic energy
A	conserved	conserved not
B	conserved	conserved
C	not conserved	conserved
D	not conserved	not conserved

Q3 (10/M/J/16/13)

Two equal masses travel toward each other on a frictionless track at seeds of 60ms^{-1} and 30 cms^{-1}. They stick together on impact.

What is the speed of the masses after impact?

A 15 cm s^{-1} **B** 20 cm s^{-1} **C** 30 cm s^{-1} **D** 45 cms^{-1}

Q4 (13/O/N/15/12)

An object of mass m travelling with speed v has a head-on collision with another object of mass m travelling with speed v in the opposite direction. The two objects stick together after the collision. What is the total loss of kinetic energy in the collision?

A 0 **B** $\frac{1}{2}mv^2$ **C** mv^2 **D** $2mv^2$

Q5 (9/M/J/14/11)

An object of mass 4.0 kg moving with a speed of 3.0 m s^{-1} strikes a stationary object in an inelastic collision. Which statement is correct?

A After collision, the total kinetic energy is 18 J.
B After collision, the total kinetic energy is less than 18 J.
C Before collision, the total kinetic energy is 12 J.
D Before collision, the total kinetic energy is less than 12 J.

Q6 (11/M/J/15/13)

A moving object strikes a stationary object. The collision is inelastic. The objects move off together. Which row shows the possible values of total momentum and total kinetic energy for the system before and after the collision?

	total momentum before collision / kg m s^{-1}	total momentum after collision / kg m s^{-1}	total kinetic energy before collision / J	total kinetic energy after collision / J
A	6	2	90	30
B	6	6	30	90
C	6	6	90	30
D	6	6	90	90

Q7 (11/M/J/15/12)

Trolley X, moving along a horizontal frictionless track, collides with a stationary trolley Y. The two trolleys become attached and move off together.
Which statement about the interaction is correct?

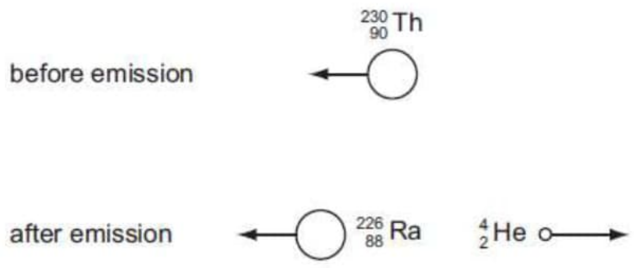
A Some of the kinetic energy of trolley X is changed to momentum in the collision
B Some of the momentum of trolley X is changed to kinetic energy in the collision.
C Trolley X loses some of its momentum as heat in the collision.
D Trolley X shares its momentum with trolley Y but some of its kinetic energy is lost.

Q8 (7/M/J/14/12)

Two train carriages each of mass 5000 kg roll toward one another on a level track. One is travelling at 2.00 m s^{-1} and the other at 1.00 m s^{-1}, as shown.
They collide and join together. What is the kinetic energy lost during the collision?

A 1250 J **B** 7500 J **C** 11 250 J **D** 12 500 J

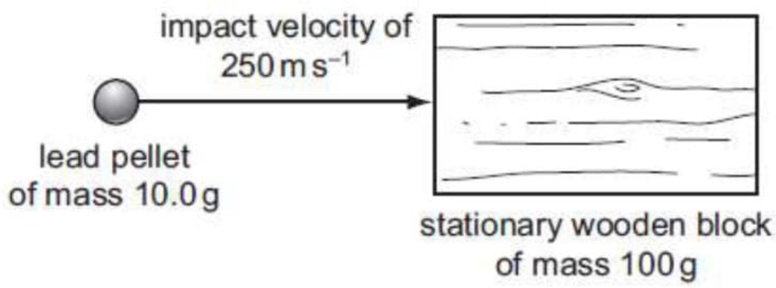
Q9 (10/O/N/13/13)
A moving thorium nucleus ${}^{230}_{90}Th$ spontaneously emits an α-particle. The nucleus formed is a radium nucleus ${}^{226}_{88}Ra$, as shown



Which statement is correct?

A The kinetic energy of the α-particle equals the kinetic energy of the radium nucleus.
B The momentum of the α-particle equals the momentum of the radium nucleus.
C The total momentum before the emission equals the total momentum after the emission.
D The velocity of the α-particle equals the velocity of the radium nucleus.

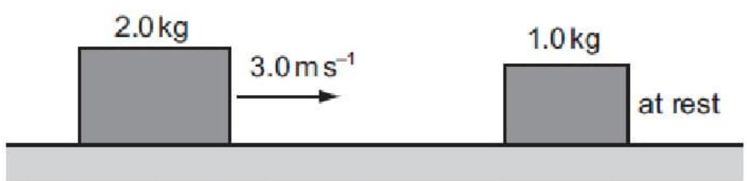
Q10 (13/O/N/13/13)
A lead pellet of mass 10.0 g is shot horizontally into a stationary wooden block of mass 100 g. The pellet hits the block with an impact velocity of $250\,m\,s^{-1}$. It embeds itself in the block and it does not emerge.



What will be the speed of the block immediately after the pellet is embedded?

A $23\,m\,s^{-1}$ **B** $25\,m\,s^{-1}$ **C** $75\,m\,s^{-1}$ **D** $79\,m\,s^{-1}$

Q11 (11/M/J/13/11)
A 2.0 kg mass travelling at $3.0\,m\,s^{-1}$ on a frictionless surface collides head-on with a stationary 1.0 kg mass. The masses stick together on impact.



How much kinetic energy is lost on impact?

A zero **B** 2.0 J **C** 2.4 J **D** 3.0 J

Q12 (11/M/J/13/13)

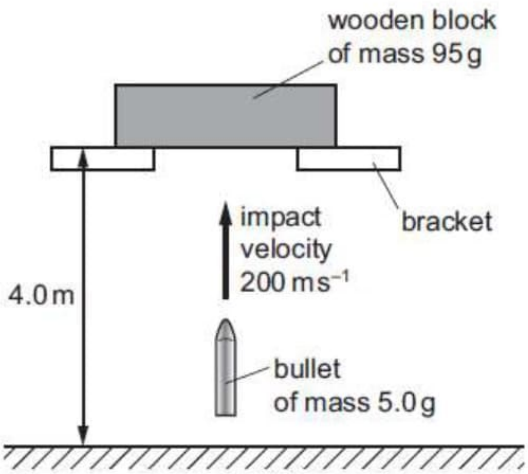
Two spheres travel along the same line with velocities u_1 and u_1. They collide and after collision their velocities are v_1 and v_2.

Which collision is not elastic?

	$u_1\,/\,\mathrm{m\,s^{-1}}$	$u_2\,/\,\mathrm{m\,s^{-1}}$	$v_1\,/\,\mathrm{m\,s^{-1}}$	$v_2\,/\,\mathrm{m\,s^{-1}}$
A	2	–5	–5	–2
B	3	–3	0	6
C	3	–2	1	6
D	5	2	3	6

Q13 (13/M/J/15/13)

A wooden block is freely supported on brackets at a height of 4.0 m above the ground, as shown.



A bullet of mass 5.0 g is shot vertically upwards into the wooden block of mass 95 g. It embeds itself in the block. The impact causes the block to rise above its supporting brackets.

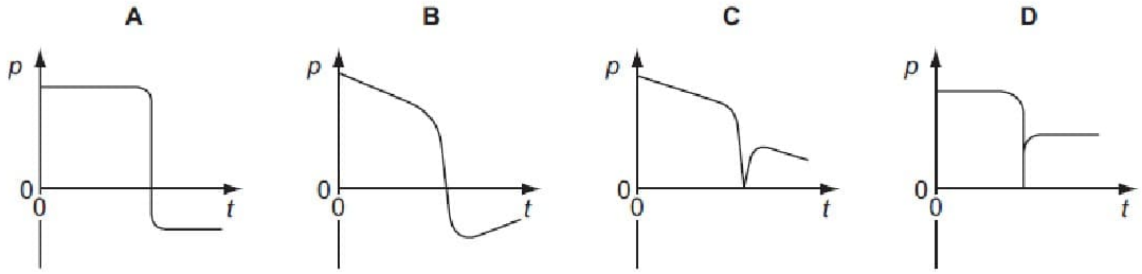
The bullet hits the block with a velocity of $200\,\mathrm{m\,s^{-1}}$. How far above the ground will the block be at the maximum height of its path?

A 5.1 m **B** 5.6 m **C** 9.1 m **D** 9.6 m

Q14 (12/O/N/11/11)

An ice-hockey puck slides along a horizontal, frictionless ice-rink surface. It collides inelastically with a wall at right angles to its path, and then rebounds along its original path.

Which graph shows the variation with time t of the momentum p of the puck?



Q15 (12/O/N/10/11)

Two experiments are carried out using two trolleys of equal mass. All moving parts of the trolleys are frictionless, as is the surface that the trolleys move over. In both experiments, trolley X moves towards trolley Y, which is initially stationary.

After the collision in experiment 1, X is stationary and Y moves off to the right.

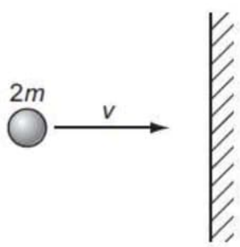
After the collision in experiment 2, the trolleys join and move off together.

What types of collision occur in these experiments?

	experiment 1	experiment 2
A	elastic	elastic
B	elastic	inelastic
C	inelastic	elastic
D	inelastic	inelastic

Q16 (9/O/N/10/12)

A particle of mass 2m and velocity v strikes a wall.



The particle rebounds along the same path after colliding with the wall. The collision is inelastic.

What is a possible change in the momentum of the ball during the collision?

A mv **B** 2mv **C** 3mv **D** 4mv

Q17 (7/O/N/9/12)
Which statement about a ball that strikes a tennis racket and rebounds is always correct?

- **A** Total kinetic energy of the ball is conserved.
- **B** Total kinetic energy of the system is conserved.
- **C** Total momentum of the ball is conserved.
- **D** total momentum of the ball is conserved.

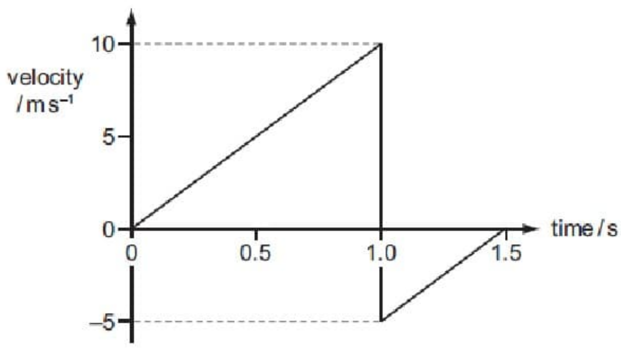
Q18 (17/M/J/8/1)
Which quantities are conserved in an inelastic collision?

	kinetic energy	total energy	linear momentum
A	conserved	not conserved	conserved not
B	conserved	not conserved	conserved
C	not conserved	conserved	conserved
D	not conserved	conserved	not conserved

Q19 (9/O/N/17/12)
A slow vehicle and a fast vehicle travel towards each other in a straight line and then collide.
Which outcome is never possible, regardless of the masses of the vehicles?

- **A** Both vehicles stop.
- **B** Only one vehicle stops.
- **C** The fast vehicle's speed increases.
- **D** The slow vehicle's speed increases

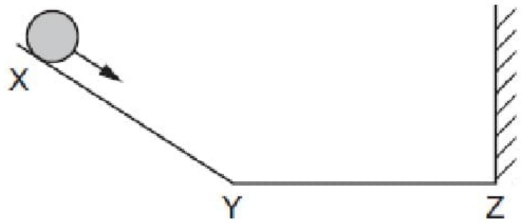
Q20 (7/M/J/11/11)
A ball is released from rest at time zero. After 1.0 s it bounces inelastically from a horizontal surface and rebounds, reaching the top of its first bounce after 1.5 s.



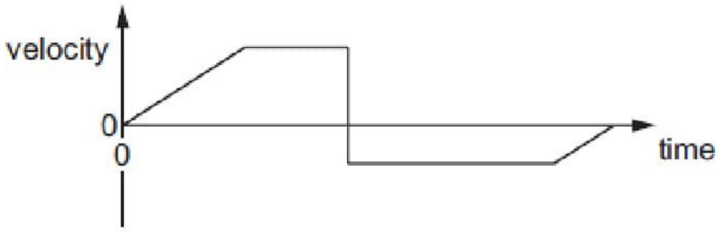
What is the total displacement of the ball from its original position after 1.5 s?

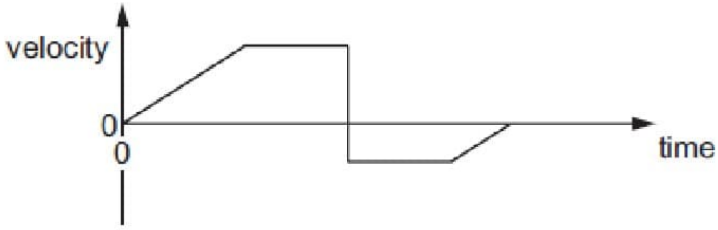
A 1.25 m **B** 3.75 m **C** 5.00 m **D** 6.25 m

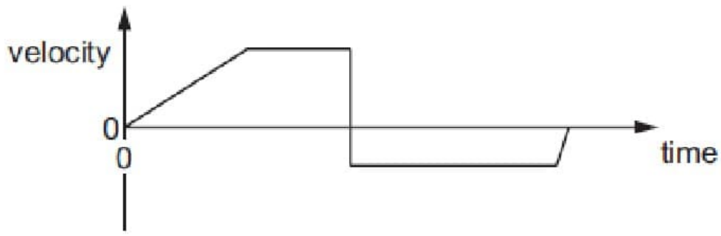
Q21 (8/O/N/14/13)
A ball is released from rest on a smooth slope XY.
It moves down the slope, along a smooth horizontal surface YZ and rebounds inelastically at Z. Then it moves back to Y and comes to rest momentarily somewhere on XY.

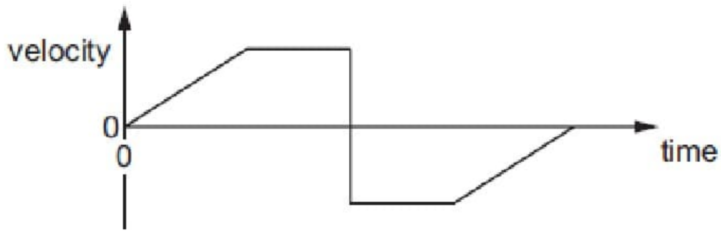


Which velocity-time graph represents the motion of the ball?

A


B


C


D


Linear Momentum

1	C	5	A
2	B	6	A
3	D		
4	B		

Newton's Second Law

1	C	7	B	13	B	19	A
2	C	8	D	14	B	20	D
3	A	9	B	15	D		
4	D	10	B	16	A		
5	A	11	B	17	C		
6	D	12	C	18	A		

Special case of Newton's Second Law

1	B	18	B	35	A
2	A	19	D	36	B
3	A	20	D	37	C
4	D	21	B	38	A
5	C	22	C	39	B
6	D	23	A	40	A
7	C	24	A	41	B
8	C	25	C		
9	C	26	C		
10	A	27	C		
11	D	28	D		
12	D	29	D		
13	A	30	B		
14	B	31	C		
15	A	32	B		
16	C	33	C		
17	C	34	B		

Weight

1	C	4	B
2	D	5	B
3	B	6	C

Newton's Third Law

1	A	5	C	9	B
2	C	6	A		
3	C	7	B		
4	D	8	A		

Law of Conservation of momentum

1	D	7	B	13	A	19	C
2	D	8	C	14	B	20	A
3	A	9	B	15	A	21	B
4	C	10	B	16	B	22	B
5	C	11	A	17	A		
6	D	12	A	18	D		

Elastic Collision

1	A	8	B	15	D
2	D	9	D	16	B
3	D	10	C	17	A
4	B	11	D	18	D
5	B	12	D	19	D
6	B	13	C	20	D
7	A	14	B	21	D

Inelastic Collision

1	B	8	C	15	B
2	B	9	C	16	C
3	A	10	A	17	D
4	C	11	D	18	C
5	B	12	A	19	C
6	C	13	C	20	B
7	D	14	A	21	A