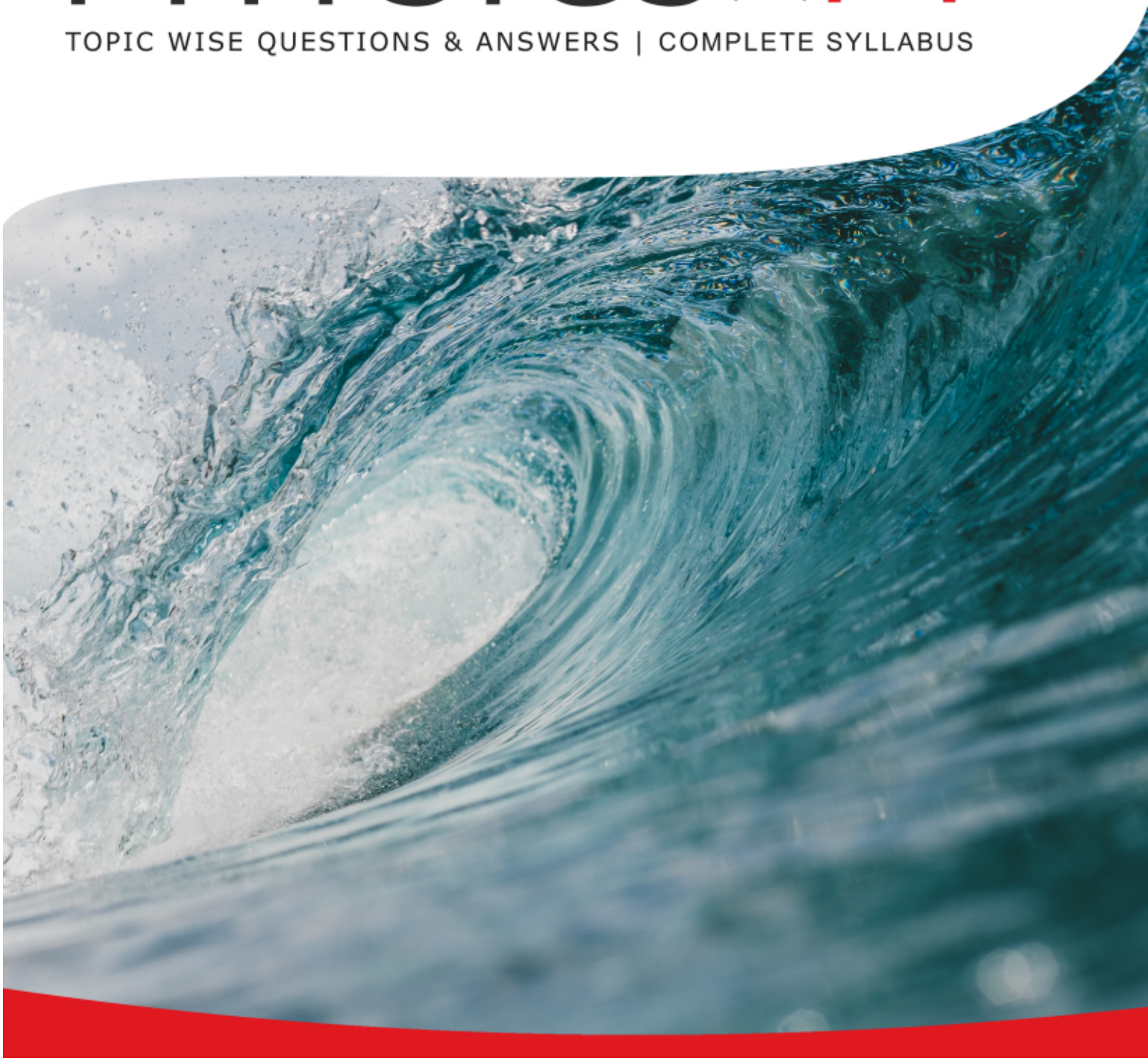
Cambridge International AS & A Level

PHYSICS (9702) P1

TOPIC WISE QUESTIONS & ANSWERS | COMPLETE SYLLABUS



PapaCambridge

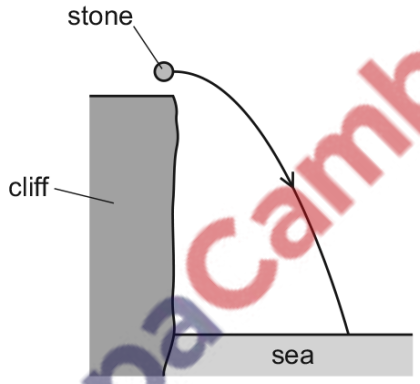
Chapter 4

Dynamics

4.1 Momentum and Newton's laws of motion

251. 9702_m20_qp_12 Q: 6

A stone is thrown horizontally from the top of a cliff and falls into the sea below. Air resistance is negligible. The path of the stone is shown.



In which direction does the resultant force on the stone act during its fall?

A horizontally to the right

B parallel to its velocity

C perpendicular to its velocity

D vertically downwards

252. 9702_m20_qp_12 Q: 8

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

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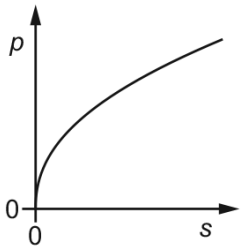
253. 9702_s20_qp_11 Q: 8

A car accelerates from rest in a straight line with constant acceleration.

Which graph best represents the variation of the momentum p of the car with the distance s travelled by the car?

A



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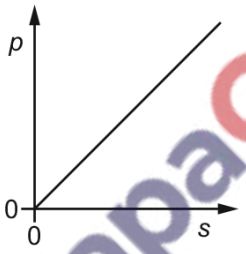

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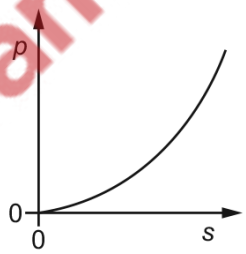

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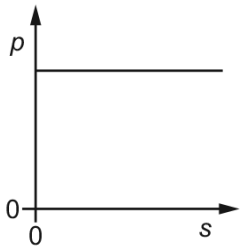

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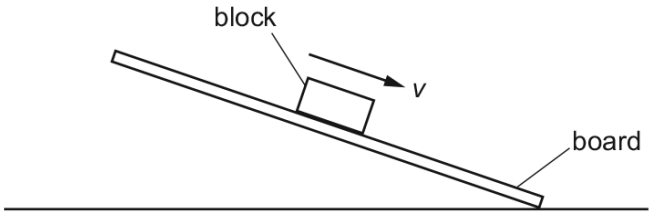
254. 9702_s20_qp_11 Q: 11

A wooden block rests on the rough surface of a board. One end of the board is then raised until the block slides down the board at constant velocity *v*.



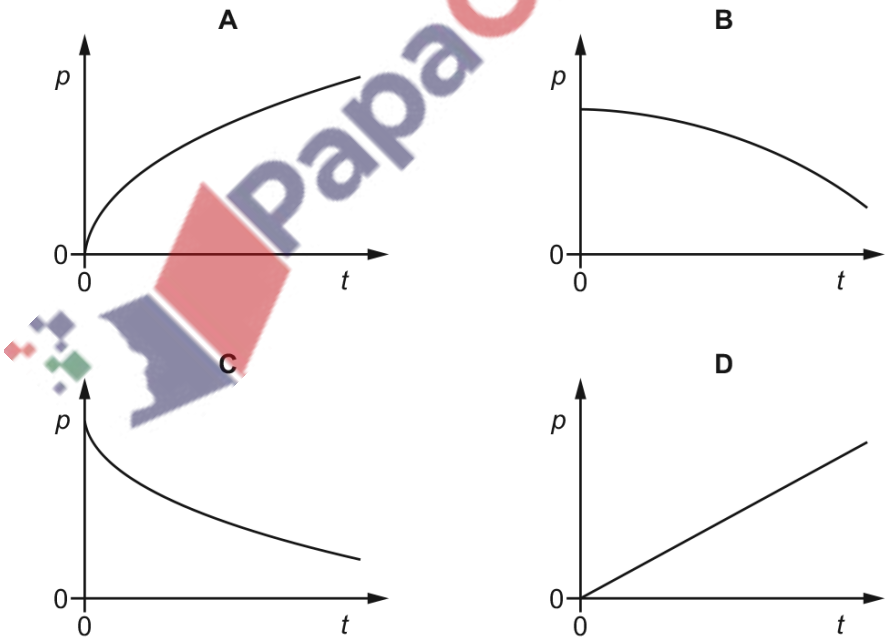
What describes the forces acting on the block when it is sliding with constant velocity?

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

255. 9702_s20_qp_12 Q: 7

The resultant force acting on an object is slowly increased.

Which graph could show the variation with time *t* of the momentum *p* of the object?



256. 9702_s20_qp_13 Q: 8

A ball of mass m travels vertically downwards and then hits a horizontal floor at speed u.

It rebounds vertically upwards with speed v.

The collision lasts a time Δt.

What is the average resultant force exerted on the ball during the collision?

A $\frac{mv - mu}{\Delta t}$ downwards

B $\frac{mv - mu}{\Delta t}$ upwards

C $\frac{mv + mu}{\Delta t}$ downwards

D $\frac{mv + mu}{\Delta t}$ upwards

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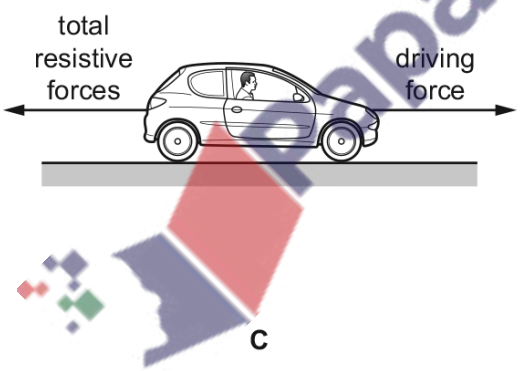
257. 9702_s19_qp_11 Q: 9

Each diagram illustrates a pair of forces of equal magnitude.

Which diagram gives an example of a pair of forces that is described by Newton's third law of motion?

A



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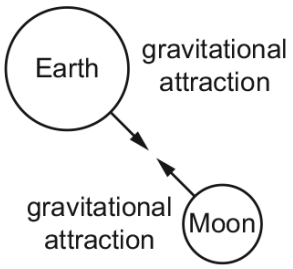

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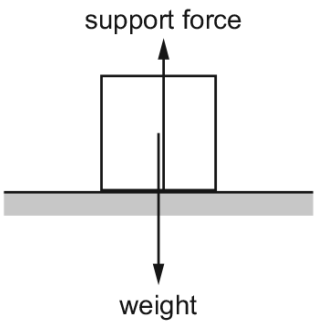

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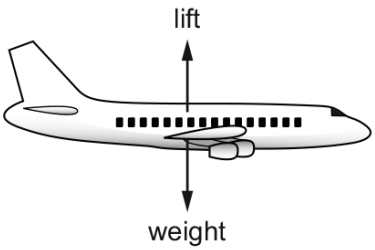

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258. 9702_s19_qp_12 Q: 9

What describes the mass of an object?

A the force the object experiences due to gravity

B the momentum of the object before a collision

C the resistance of the object to changes in motion

D the weight of the object as measured by a balance

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259. 9702_s19_qp_12 Q: 10

A car has mass *m*. A person needs to push the car with force *F* in order to give the car acceleration *a*. The person needs to push the car with force 2*F* in order to give the car acceleration 3*a*.

Which expression gives the constant resistive force opposing the motion of the car?

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

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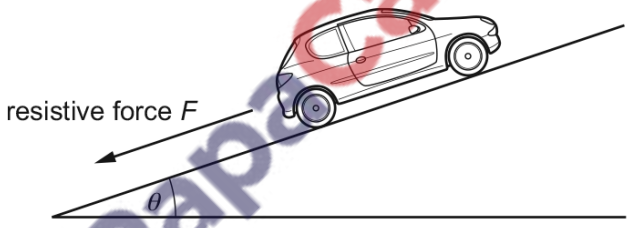
260. 9702_s19_qp_12 Q: 14

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*. The acceleration of free fall is *g*.



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

A $mg \cos \theta$

B $mg \sin \theta$

C $mg \cos \theta + F$

D $mg \sin \theta + F$

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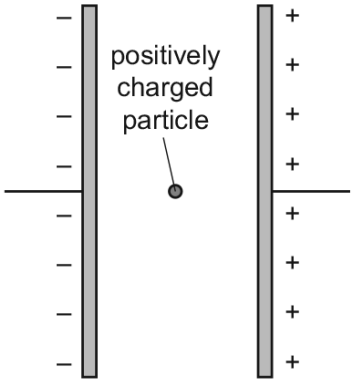
261. 9702_s19_qp_13 Q: 10

A uniform electric field is created by two parallel vertical plates. A positively charged particle is in the vacuum between the plates, as shown.



Which statement is correct?

A The electric field makes the particle move towards the negative plate with a constant speed.

B The electric field makes the particle move towards the negative plate with a constant acceleration.

C The electric field produces a uniform rate of decrease in the particle's acceleration.

D The electric field produces a uniform rate of increase in the particle's acceleration.

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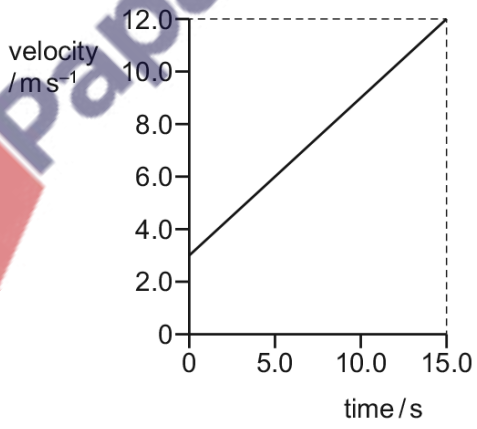
262. 9702_w19_qp_11 Q: 6

The velocity-time graph for an object of mass 2.5 kg is shown.



What is the resultant force acting on the object?

A 0.60 N **B** 0.80 N **C** 1.5 N **D** 2.0 N

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263. 9702_w19_qp_11 Q: 7

Which statement follows directly from Newton's first law?

A A body remains at constant velocity unless acted upon by a resultant force.

B A satellite in circular motion about the Earth has a constant velocity.

C A water drop leaving a spinning umbrella travels at a constant velocity.

D The force acting on an object is equal to its change in momentum.

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264. 9702_w19_qp_11 Q: 8

A resultant force causes an object to accelerate.

What is equal to the resultant force?

A the acceleration of the object per unit mass

B the change in kinetic energy of the object per unit time

C the change in momentum of the object per unit time

D the change in velocity of the object per unit time

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265. 9702_w19_qp_12 Q: 7

A snooker ball has a mass of 200 g. It hits the cushion of a snooker table and rebounds along its original path.

The ball arrives at the cushion with a speed of $14.0\,m\,s^{-1}$ and then leaves it with a speed of $7.0\,m\,s^{-1}$. The ball and the cushion are in contact for a time of 0.60 s.

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

A 1.4 N **B** 2.3 N **C** 4.2 N **D** 7.0 N

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266. 9702_w19_qp_13 Q: 8

A snowflake is falling from the sky on a still day. Its weight acts vertically downwards and air resistance acts vertically upwards. As the snowflake falls, air resistance increases until it is equal to the weight and there is no resultant force acting on the snowflake.

When the forces become equal, which statement is correct?

A The snowflake accelerates.

B The snowflake decelerates.

C The snowflake is stationary.

D The snowflake moves at a constant velocity.

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267. 9702_m18_qp_12 Q: 7

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

When the stone is falling at a constant (terminal) velocity, which information is correct?

	magnitude of the acceleration of the stone	magnitude of the force of gravity on the stone	magnitude of the force of air resistance on the stone
A	g	zero	mg
B	zero	mg	mg
C	zero	zero	mg
D	zero	mg	zero

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268. 9702_m18_qp_12 Q: 10

Steel pellets, each with a mass of 0.60 g, fall vertically onto a horizontal plate at a rate of 100 pellets per minute. They strike the plate with a velocity of 5.0 m s^{-1} and rebound with a velocity of 4.0 m s^{-1}.

What is the average force exerted on the plate by the pellets?

A 0.0010 N **B** 0.0054 N **C** 0.0090 N **D** 0.54 N

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269. 9702_s18_qp_11 Q: 8

The momentum of a car of mass m increases from p_1 to p_2.

What is the increase in the kinetic energy of the car?

A $\frac{(p_2^2 - p_1^2)}{2m}$ **B** $\frac{(p_2 - p_1)^2}{2m}$ **C** $\frac{p_2 - p_1}{2m}$ **D** $\frac{p_1 - p_2}{2m}$

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270. 9702_s18_qp_12 Q: 8

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

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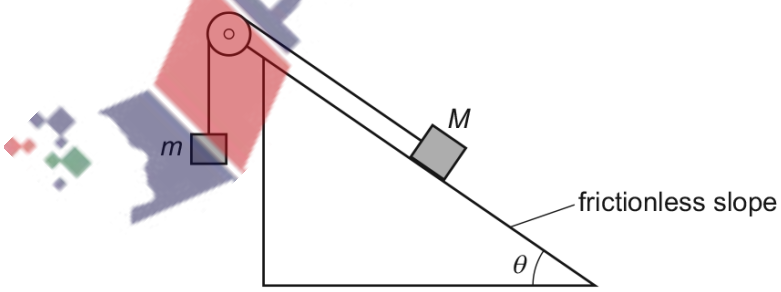
271. 9702_s18_qp_13 Q: 7

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** $\cos\theta > \frac{m}{M}$

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272. 9702_w18_qp_11 Q: 7

Water is pumped through a hose-pipe at a rate of 90 kg per minute. Water emerges horizontally from the hose-pipe with a speed of 20 m s^{-1}.

What is the minimum force required from a person holding the hose-pipe to prevent it moving backwards?

A 30 N **B** 270 N **C** 1800 N **D** 108 000 N

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273. 9702_w18_qp_11 Q: 8

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	$g + \frac{F}{m}$	$g + \frac{F}{m}$

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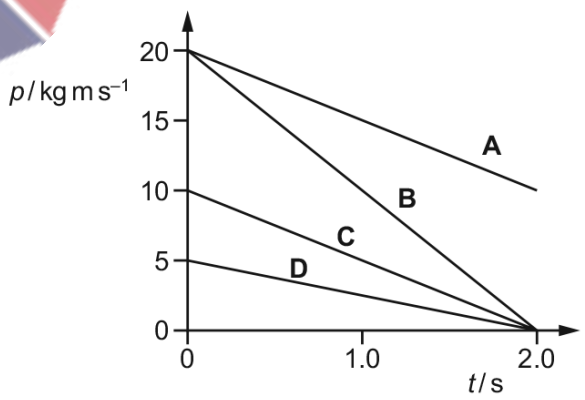
274. 9702_w18_qp_12 Q: 7

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?



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275. 9702_w18_qp_13 Q: 7

Two isolated spheres have masses 2.0 kg and 4.0 kg. The spheres collide and then move apart.

During the collision, the 2.0 kg mass has an average acceleration of $8.0\,m\,s^{-2}$.

What is the average acceleration of the 4.0 kg mass?

A $2.0\,m\,s^{-2}$ **B** $4.0\,m\,s^{-2}$ **C** $8.0\,m\,s^{-2}$ **D** $16\,m\,s^{-2}$

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276. 9702_w18_qp_13 Q: 8

A mass is placed on a frictionless slope inclined at 30° to the horizontal. The mass is then released.

What is its acceleration down the slope?

A $4.9\,m\,s^{-2}$ **B** $5.7\,m\,s^{-2}$ **C** $8.5\,m\,s^{-2}$ **D** $9.8\,m\,s^{-2}$

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277. 9702_w18_qp_13 Q: 10

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

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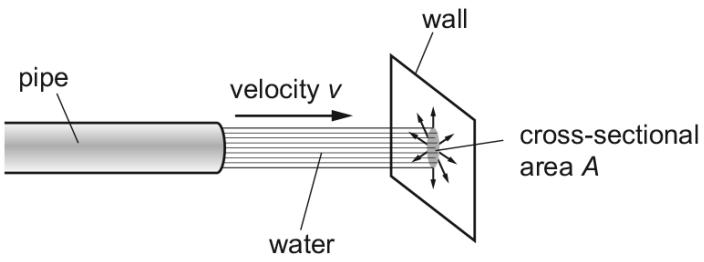
278. 9702_m17_qp_12 Q: 9

Water flows out of a pipe and hits a wall.



When the jet of water hits the wall, it has horizontal velocity v and cross-sectional area A.

The density of the water is ρ. The water does not rebound from the wall.

What is the force exerted on the wall by the water?

A $\frac{\rho v}{A}$ **B** $\frac{\rho v^2}{A}$ **C** $\rho A v$ **D** $\rho A v^2$

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279. 9702_s17_qp_11 Q: 7

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.

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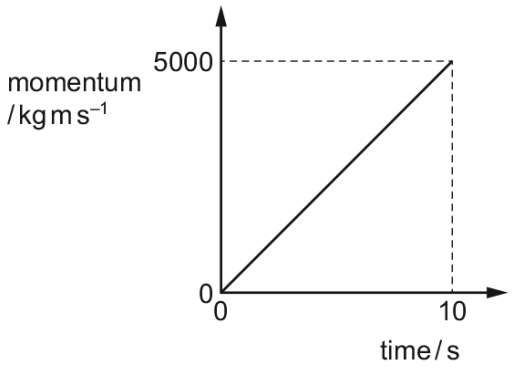
280. 9702_s17_qp_11 Q: 10

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

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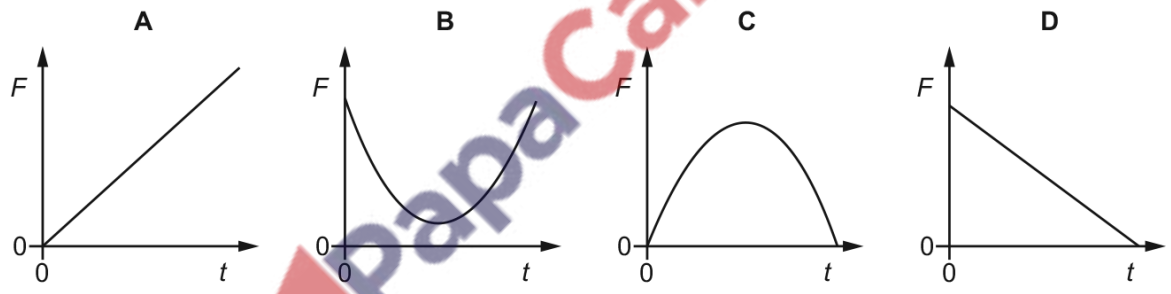
281. 9702_s17_qp_12 Q: 7

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?



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282. 9702_s17_qp_12 Q: 8

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 $m\sqrt{2g(h_1 + h_2)}$

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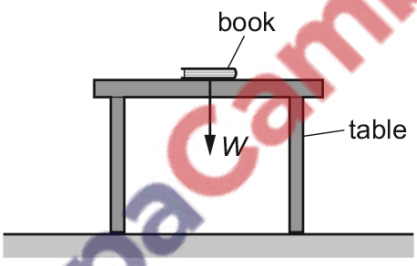
283. 9702_s17_qp_12 Q: 9

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

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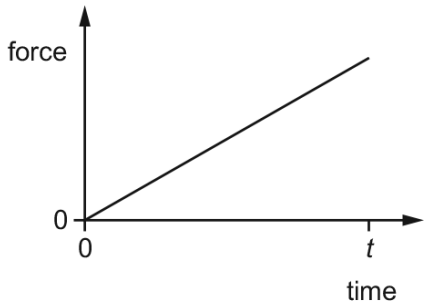
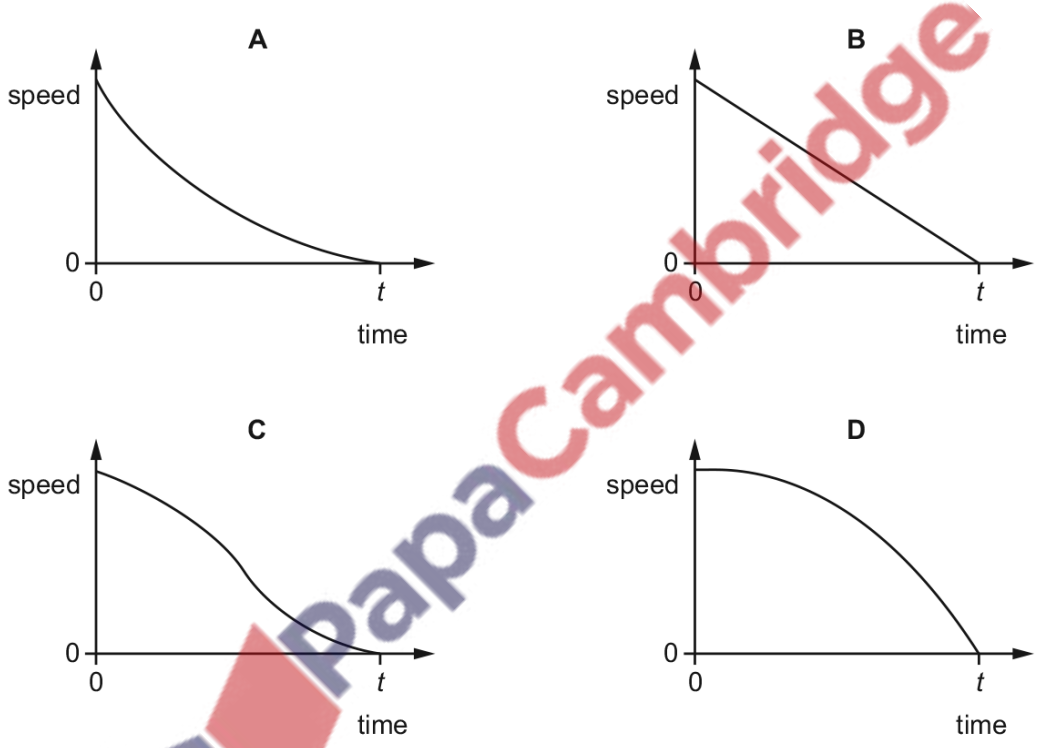
284. 9702_s17_qp_13 Q: 7

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



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



285. 9702_s17_qp_13 Q: 9

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

286. 9702_s17_qp_13 Q: 10

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

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287. 9702_s17_qp_13 Q: 16

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** $v \propto \frac{1}{\sqrt{m}}$ **D** $\sqrt{v} \propto m$

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288. 9702_w17_qp_11 Q: 9

A car is moving at constant speed in a straight line with the engine providing a driving force equal to the resistive force F.

When the engine is switched off, the car is brought to rest in a distance of 100 m by the resistive force.

It may be assumed that F is constant during the deceleration.

The process is then repeated for the same car with the same initial speed but with a constant resistive force of 0.800 F.

How far will the car travel while decelerating?

A 120 m **B** 125 m **C** 156 m **D** 250 m

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289. 9702_w17_qp_11 Q: 10

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.

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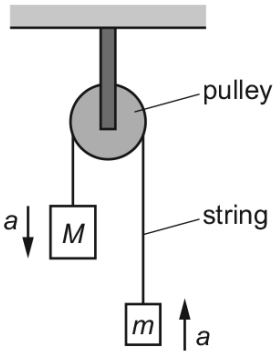
290. 9702_w17_qp_12 Q: 10

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** $\frac{m}{M}g$

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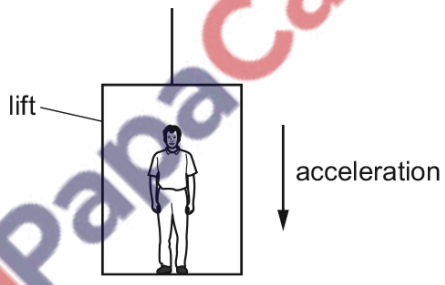
291. 9702_w17_qp_13 Q: 8

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.

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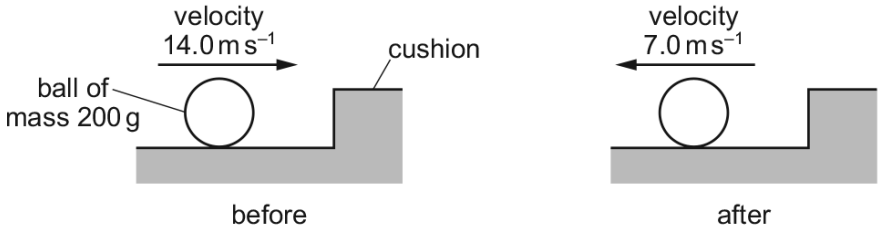
292. 9702_w17_qp_13 Q: 9

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.



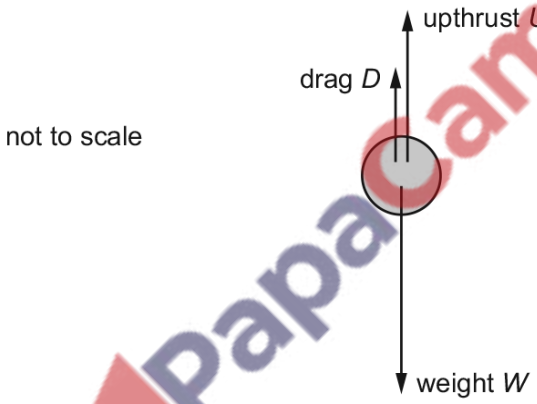
What is the average force exerted on the ball by the cushion?

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

---

293. 9702_w17_qp_13 Q: 13

A solid sphere falls at constant (terminal) velocity in a liquid. The three forces acting on the sphere are shown in the diagram.



How are the three forces related?

A $W + D = U$

B $W > U + D$

C $W - U = D$

D $W < D + U$

---

294. 9702_m16_qp_12 Q: 9

Which statement **defines** force?

A When a force acts on a body that is free to move, the force is the product of the mass of the body and its acceleration.

B When a force acts on a body that is free to move, the force is the rate of change of momentum of the body.

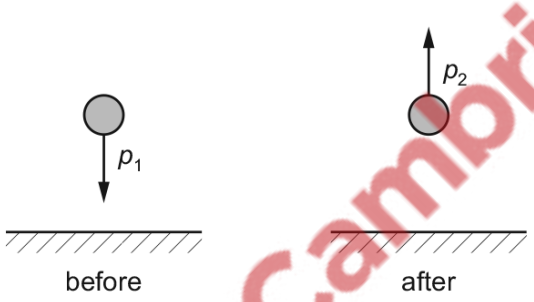
C When a force acts on a body that is free to move, the force is the work done by the force divided by the distance moved by the body.

D When a force acts on a lever and causes a moment, the force is the moment divided by the perpendicular distance of the force from the pivot.

---

295. 9702_s16_qp_12 Q: 9

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.

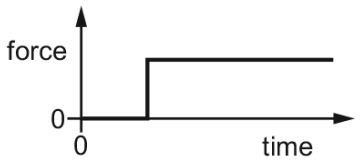
What is a possible combination of values for p_1 and p_2?

	p_1 / kg m s^{-1}	p_2 / kg m s^{-1}
A	0.15	0.65
B	0.20	0.30
C	0.30	0.20
D	0.65	0.15

---

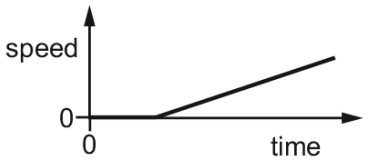
296. 9702_w16_qp_11 Q: 9

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

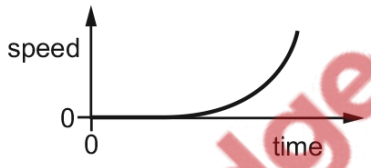


Which graph shows the variation with time of the speed of the car?

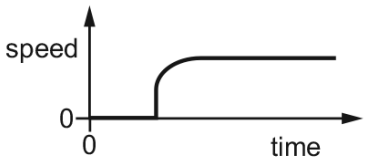
A



B



C



D

---

297. 9702_w16_qp_11 Q: 11

A car has mass m. A person needs to push the car with force F in order to give the car acceleration a. The person needs to push the car with force $2F$ in order to give the car acceleration $3a$.

Which expression gives the constant resistive force opposing the motion of the car?

A ma **B** $2ma$ **C** $3ma$ **D** $4ma$

---

298. 9702_w16_qp_12 Q: 12

A bullet of mass 8.0 g travels at a speed of 300 $m\,s^{-1}$. The bullet hits a target and stops after a time of 100 μs.

What is the average force exerted by the target on the bullet?

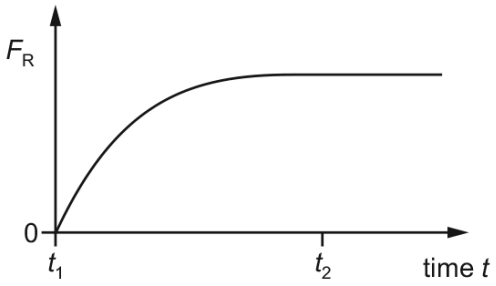
A 24 N **B** 240 N **C** 2400 N **D** 24 000 N

---

299. 9702_w16_qp_12 Q: 13

A light ball is falling vertically through air.

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

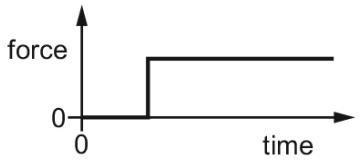


At which times are the speed of the ball zero, the speed at a maximum and the acceleration zero?

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

300. 9702_w16_qp_13 Q: 9

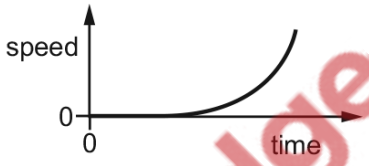
A car is stationary at traffic lights. When the traffic lights change to green, the driver presses down sharply on the accelerator. The resultant horizontal force acting on the car varies with time as shown.



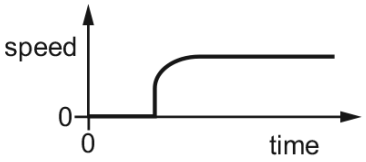
Which graph shows the variation with time of the speed of the car?

A

B



C



D

---

301. 9702_w16_qp_13 Q: 11

A car has mass m. A person needs to push the car with force F in order to give the car acceleration a. The person needs to push the car with force $2F$ in order to give the car acceleration $3a$.

Which expression gives the constant resistive force opposing the motion of the car?

A ma **B** $2ma$ **C** $3ma$ **D** $4ma$

---

302. 9702_s15_qp_11 Q: 14

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

---

303. 9702_s15_qp_12 Q: 10

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

---

304. 9702_s15_qp_12 Q: 13

Newton's third law of motion is often summarised as 'Every action (force) has an equal and opposite reaction.'

A book rests on a table.

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

A the pull of the book on the Earth

B the pull of the Earth on the book

C the push of the book on the table

D the push of the table on the book

4.2 Non-uniform motion

305. 9702_s20_qp_11 Q: 9

The resultant force F on a raindrop of mass m falling with velocity v is given by the equation

$$F = mg - kv^2$$

where k is a constant and g is the acceleration of free fall.

What is the velocity of the raindrop when it reaches a constant (terminal) velocity?

A $\sqrt{\frac{k}{mg}}$ **B** $\frac{k}{mg}$ **C** $\sqrt{\frac{mg}{k}}$ **D** $\frac{mg}{k}$

---

306. 9702_s20_qp_12 Q: 8

An astronaut has a weight of 660 N when she is standing on the Earth's surface.

The acceleration of free fall on the surface of Mars is 3.71 $m\,s^{-2}$.

What would be the weight of the astronaut if she stood on the surface of Mars?

A 67.3 N **B** 178 N **C** 250 N **D** 660 N

---

307. 9702_s20_qp_13 Q: 9

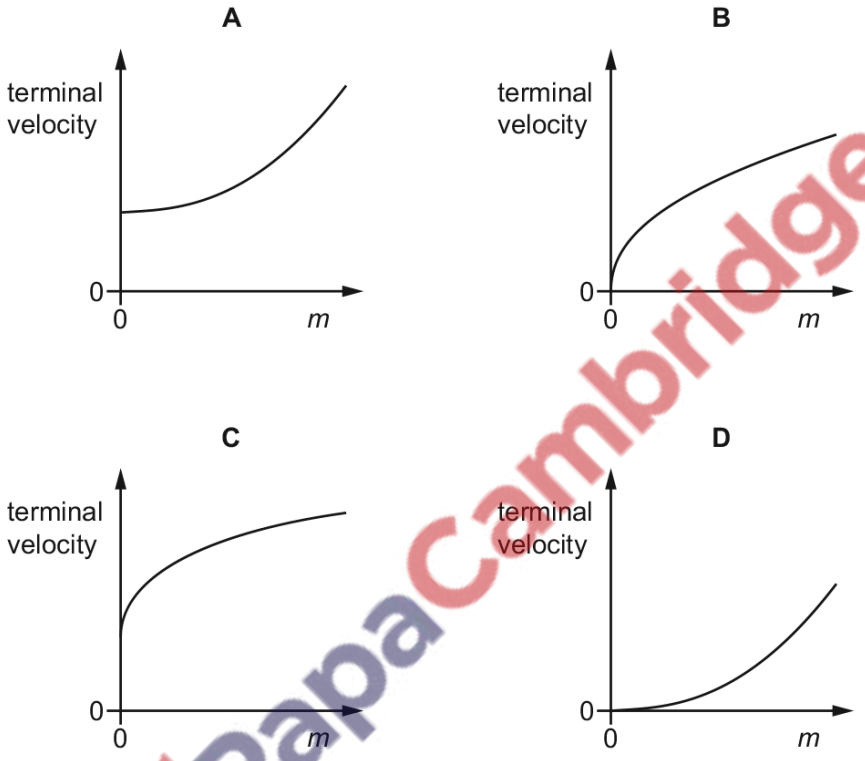
The resultant force F on a raindrop of mass m falling vertically with velocity v is given by the equation

$$F = mg - kv^2$$

where k is a constant and g is the acceleration of free fall.

The falling raindrop eventually reaches a constant (terminal) velocity.

Which graph shows the variation of the terminal velocity of the raindrop with mass m?



308. 9702_m19_qp_12 Q: 7

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

Air resistance is negligible.

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

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

309. 9702_m19_qp_12 Q: 9

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

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

A The ball lands with a horizontal velocity less than v after more than T seconds.

B The ball lands with a horizontal velocity less than v after T seconds.

C The ball lands with a horizontal velocity v after more than T seconds.

D The ball lands with a horizontal velocity v after T seconds.

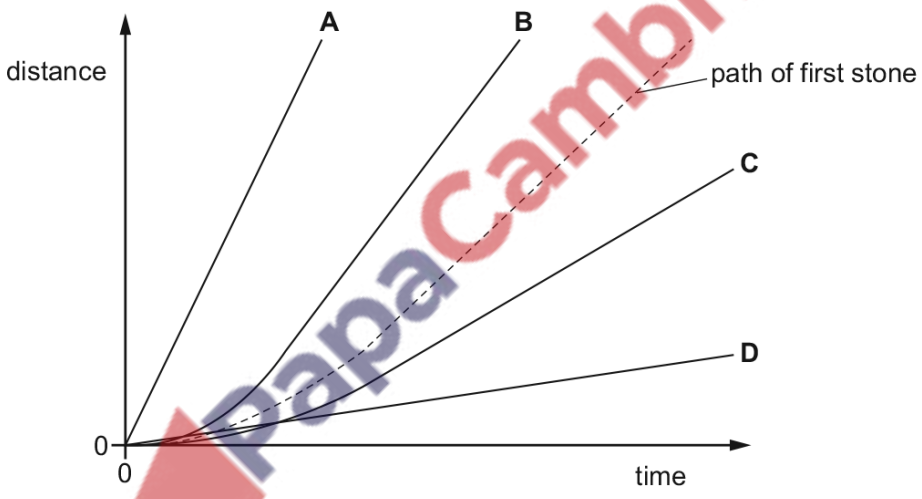
---

310. 9702_s19_qp_11 Q: 10

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

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

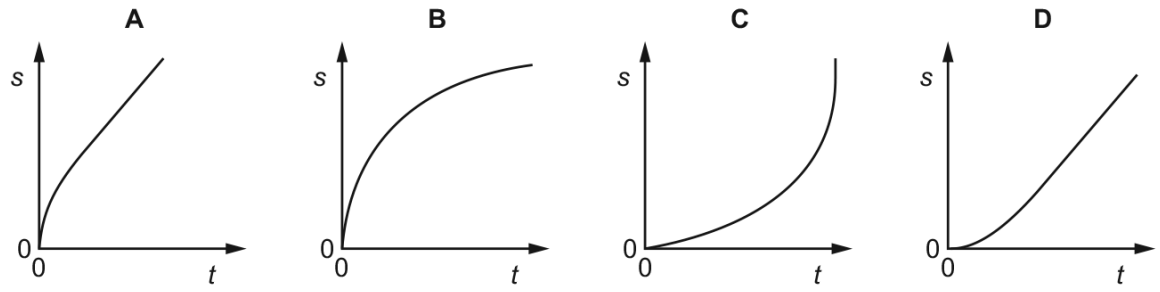
Which line represents the motion of the second stone?



311. 9702_w19_qp_12 Q: 8

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

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



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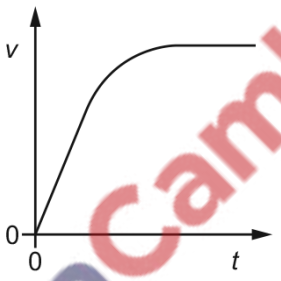
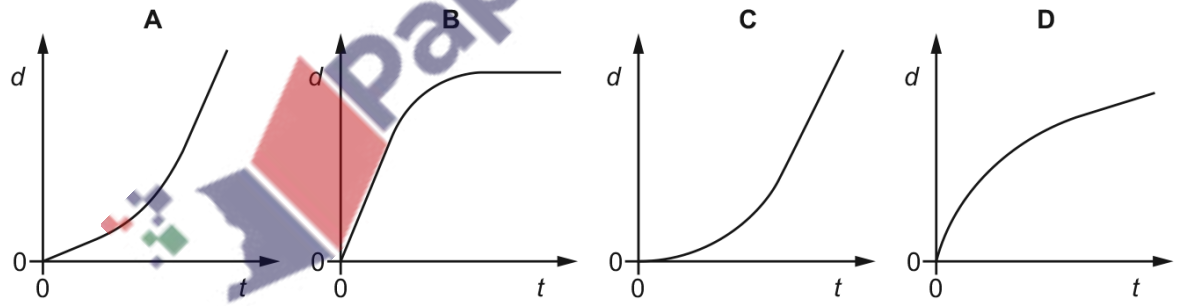
312. 9702_s18_qp_12 Q: 7

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



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



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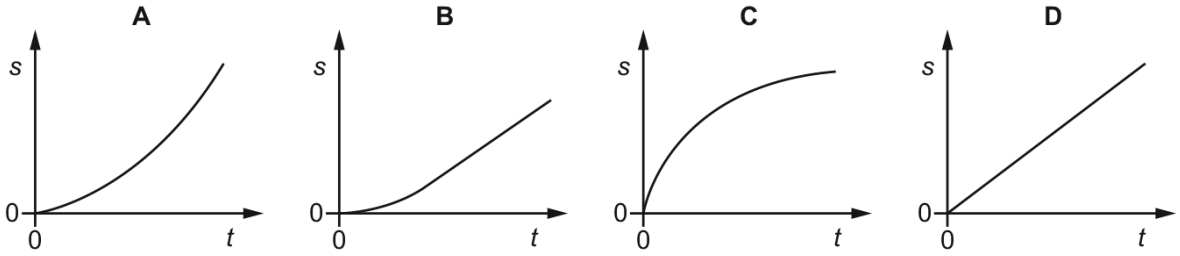
313. 9702_s18_qp_13 Q: 8

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

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



---

314. 9702_w18_qp_12 Q: 8

The acceleration of free fall 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 the 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

---

315. 9702_m17_qp_12 Q: 8

The acceleration of free fall on Pluto is 0.66 m s^{-2}.

An object weighs 6.0 N on Earth.

What would this object weigh on Pluto?

A 0.40 N **B** 0.93 N **C** 4.0 N **D** 39 N

---

316. 9702_s17_qp_11 Q: 8

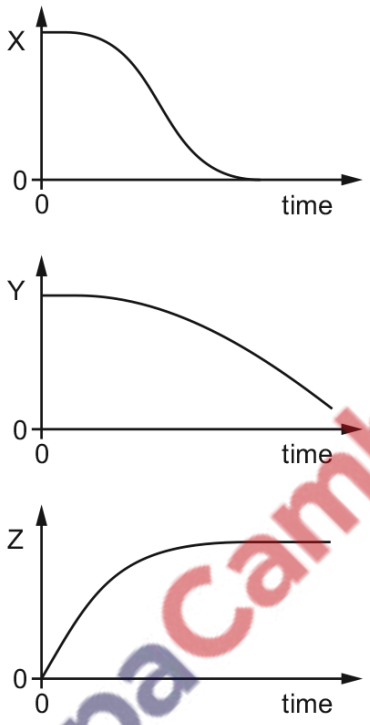
An object is dropped at time $t = 0$ from a high building. Air resistance is significant.

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

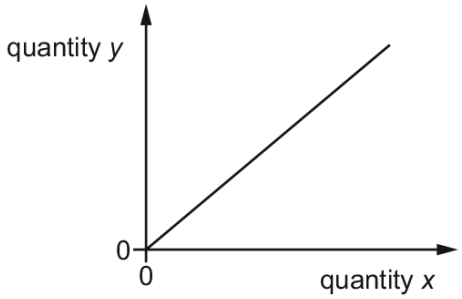


What are the quantities X, Y and Z?

	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

317. 9702_s17_qp_13 Q: 8

The graph shows the variation of a quantity y with a quantity x for a body that is falling in air at constant (terminal) velocity in a uniform gravitational field.

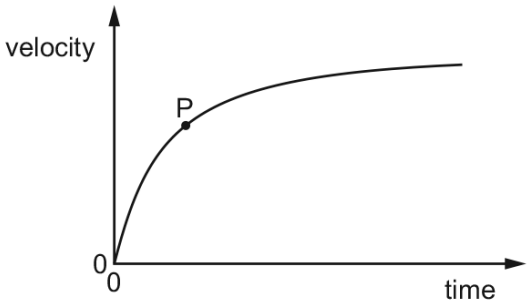


Which quantities could x and y represent?

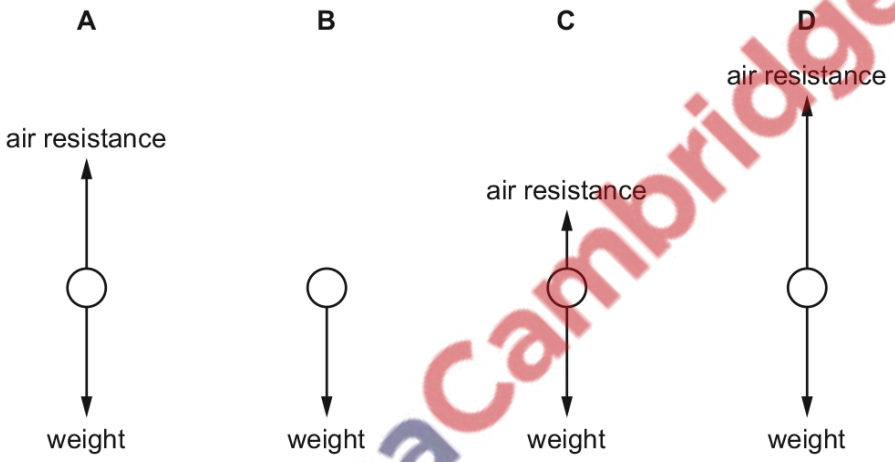
	x	y
A	air resistance	acceleration
B	loss of height	gain in kinetic energy
C	loss of potential energy	work done against air resistance
D	time	velocity

318. 9702_s16_qp_12 Q: 10

A sphere falls from rest through the air. The graph shows the variation with time of the sphere's velocity.



Which diagram shows the forces acting on the sphere when it is at the velocity corresponding to point P on the graph?



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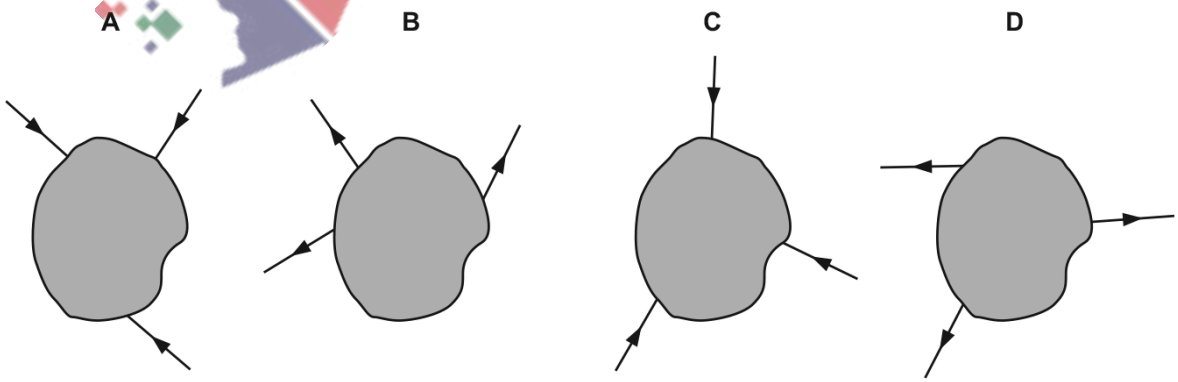
319. 9702_s16_qp_13 Q: 12

Three coplanar forces act on an object in the directions shown.

In which diagram could the object be in equilibrium?



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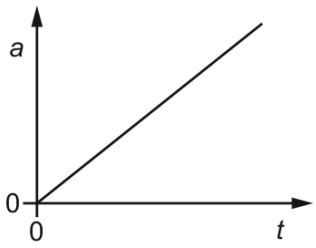
320. 9702_w16_qp_11 Q: 10

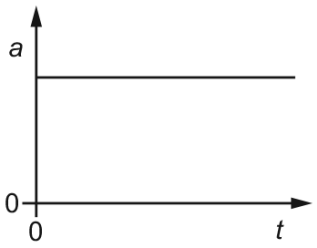
A beach-ball falls vertically from a high hotel window. Air resistance is **not** negligible.

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

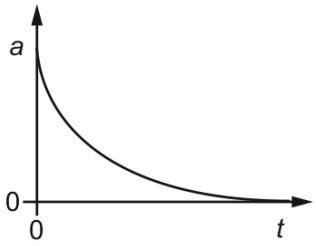
A



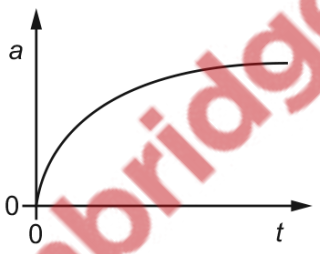
B



C



D

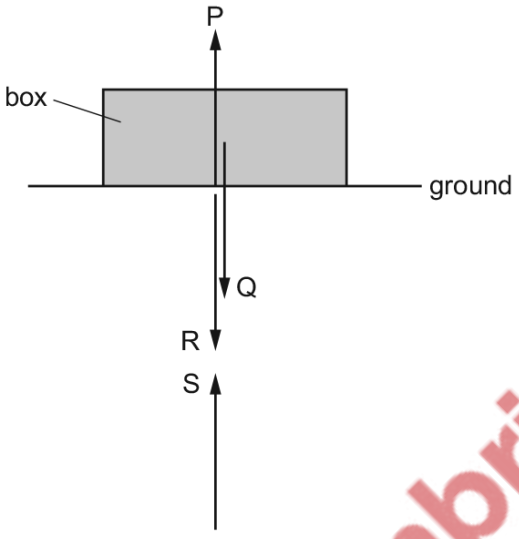


321. 9702_w16_qp_11 Q: 12

A box is shown resting on the ground. Newton's third law implies that four forces of equal magnitude are involved. These forces are labelled P, Q, R and S.

Forces P and Q act on the box. Forces R and S act on the Earth.

For clarity, the forces are shown slightly separated.



Which statement about the forces is correct?

A P is the equal and opposite force to Q and both are forces of contact.

B Q is the equal and opposite force to P and both are gravitational forces.

C R is the equal and opposite force to S and both are forces of contact.

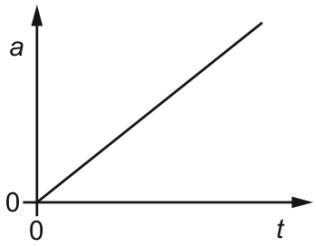
D S is the equal and opposite force to Q and both are gravitational forces.

322. 9702_w16_qp_13 Q: 10

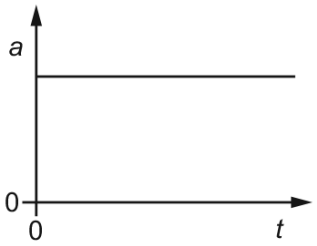
A beach-ball falls vertically from a high hotel window. Air resistance is **not** negligible.

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

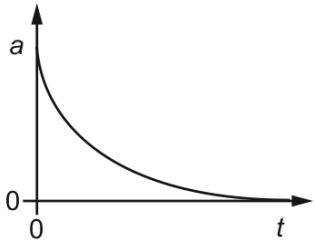
A



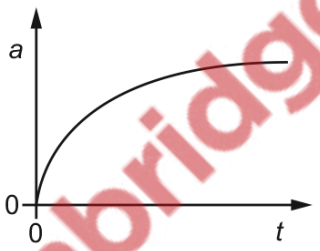
B



C



D

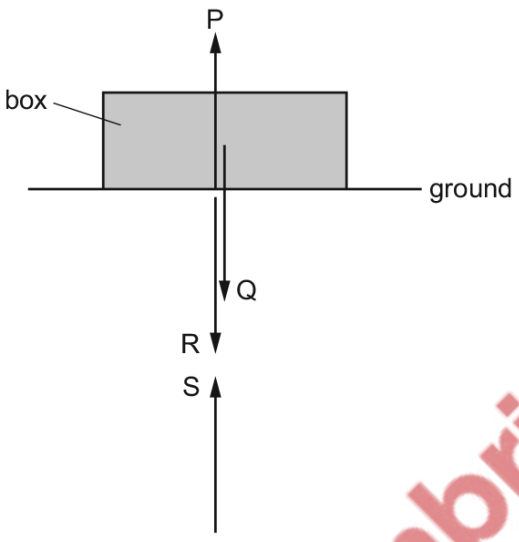


323. 9702_w16_qp_13 Q: 12

A box is shown resting on the ground. Newton's third law implies that four forces of equal magnitude are involved. These forces are labelled P, Q, R and S.

Forces P and Q act on the box. Forces R and S act on the Earth.

For clarity, the forces are shown slightly separated.



Which statement about the forces is correct?

A P is the equal and opposite force to Q and both are forces of contact.

B Q is the equal and opposite force to P and both are gravitational forces.

C R is the equal and opposite force to S and both are forces of contact.

D S is the equal and opposite force to Q and both are gravitational forces.

---

324. 9702_s15_qp_11 Q: 10

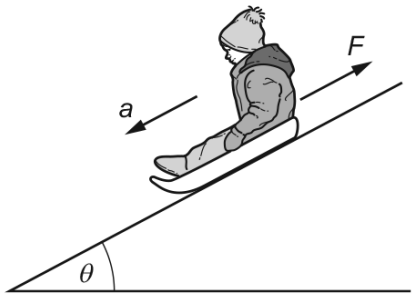
What is a reasonable estimate of the average gravitational force acting on a fully grown woman standing on the Earth?

A 60 N **B** 250 N **C** 350 N **D** 650 N

---

325. 9702_s15_qp_11 Q: 12

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 $m(g\cos\theta - a)$

B $m(g\cos\theta + a)$

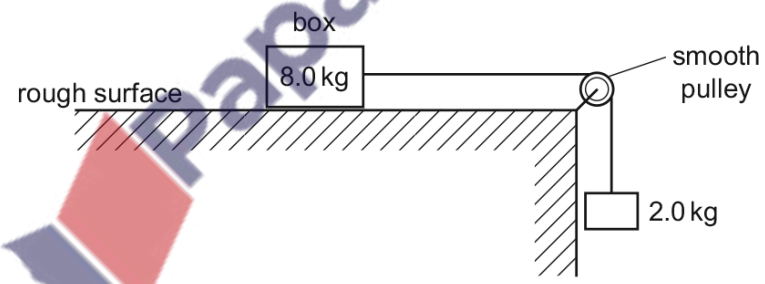
C $m(g\sin\theta - a)$

D $m(g\sin\theta + a)$

---

326. 9702_s15_qp_11 Q: 13

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 the box is released, a frictional force of 6.0 N acts on it.

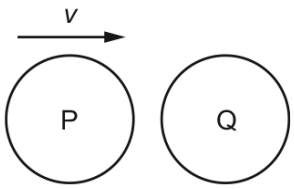
What is the acceleration of the box?

A $1.4\,\text{m s}^{-2}$ **B** $1.7\,\text{m s}^{-2}$ **C** $2.0\,\text{m s}^{-2}$ **D** $2.6\,\text{m s}^{-2}$

4.3 Linear momentum and its conservation

327. 9702_m20_qp_12 Q: 10

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



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

A P and Q both travel in the same direction with speed $\frac{1}{2}v$.

B P comes to rest and Q acquires speed v.

C P rebounds with speed $\frac{1}{2}v$ and Q acquires speed $\frac{1}{2}v$.

D P rebounds with speed v and Q remains stationary.

---

328. 9702_s20_qp_11 Q: 10

A stationary toy gun fires a bullet.

Which statement about the bullet and the gun, immediately after firing, is **not** correct?

A The force exerted on the bullet by the gun has the same magnitude as the force exerted on the gun by the bullet.

B The force exerted on the bullet by the gun is in the opposite direction to the force exerted on the gun by the bullet.

C The gun and the bullet have the same magnitude of momentum.

D The kinetic energy of the gun must equal the kinetic energy of the bullet.

---

329. 9702_s20_qp_12 Q: 9

A mass m_1 travelling with speed u_1 collides with a mass m_2 travelling with speed u_2 in the same direction. After the collision, mass m_1 has speed v_1 and mass m_2 has speed v_2 in the same direction. The collision is perfectly elastic.

before the collision after the collision

Which equation is **not** correct?

A $m_1u_1^2 - m_1v_1^2 = m_2v_2^2 - m_2u_2^2$

B $v_2 + u_2 = v_1 + u_1$

C $m_1(u_1 - v_1) = m_2(v_2 - u_2)$

D $m_1(u_1 - v_1)^2 = m_2(u_2 - v_2)^2$

---

330. 9702_s20_qp_13 Q: 10

A ball of mass m, moving at a velocity v, collides with a stationary ball of mass $2m$.

The two balls stick together.

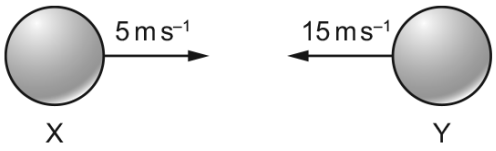
Which fraction of the initial kinetic energy is lost on impact?

A $\frac{1}{9}$ **B** $\frac{1}{3}$ **C** $\frac{2}{3}$ **D** $\frac{8}{9}$

---

331. 9702_m19_qp_12 Q: 8

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

---

332. 9702_s19_qp_11 Q: 11

A helium atom of mass m collides normally with a wall. The atom arrives at the wall with speed v and then rebounds along its original path. Assume that the collision is perfectly elastic.

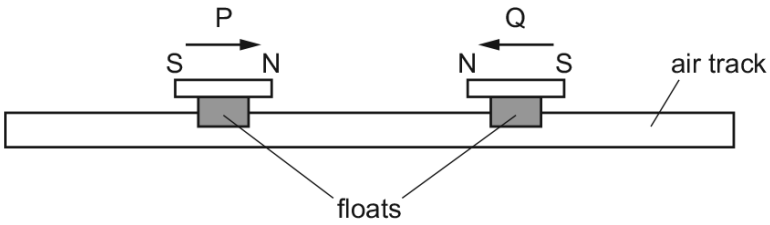
What is the change in the momentum of the atom during its collision?

A zero **B** $0.5mv$ **C** mv **D** $2mv$

---

333. 9702_s19_qp_12 Q: 11

Two bar magnets P and Q are mounted on floats which can slide without friction along an air track.



The two magnets slide towards each other along the air track and interact, without making contact.

The relative speed of approach of the magnets is equal to their relative speed of separation.

Which statement about P and Q must be correct?

A During the interaction between P and Q some of the total kinetic energy is lost.

B During the interaction between P and Q some of the total momentum is lost.

C The momentum of Q after the interaction is equal to the momentum of P before the interaction.

D The values of (kinetic energy of P + kinetic energy of Q) before and after the interaction are equal.

---

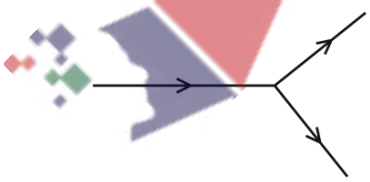
334. 9702_s19_qp_13 Q: 9

A nucleus collides with a stationary nucleus in a vacuum. The diagrams show the paths of the nuclei before and after the collision.

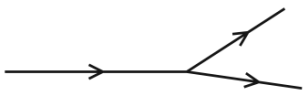
No other particles are involved in the collision.

Which diagram is **not** possible?

A

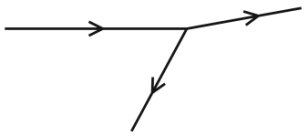


B



C

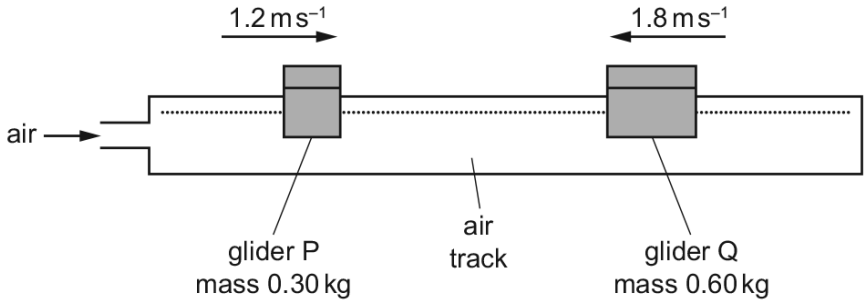
D



---

335. 9702_w19_qp_11 Q: 10

Two gliders are travelling towards each other on a horizontal air track. Glider P has mass 0.30 kg and is moving with a constant speed of 1.2 m s^{-1}. Glider Q has mass 0.60 kg and is moving with a constant speed of 1.8 m s^{-1}.



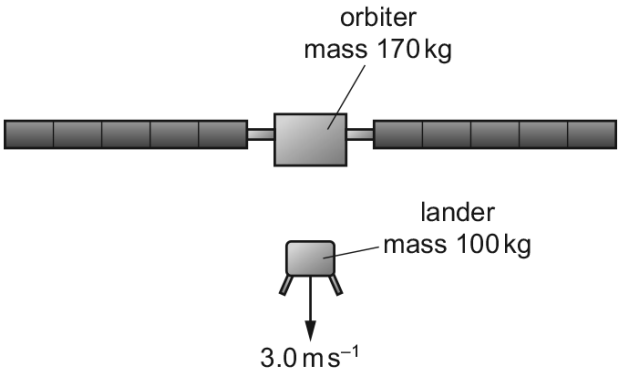
The gliders have a perfectly elastic collision.

What are the speeds of the two gliders after the collision?

	speed of P / m s^{-1}	speed of Q / m s^{-1}
A	1.2	0.6
B	2.0	1.4
C	2.8	0.2
D	3.6	0.6

336. 9702_w19_qp_12 Q: 9

The space probe Rosetta was designed to investigate a comet. The probe consisted of an orbiter and a lander. The orbiter had a mass of 170 kg and the lander had a mass of 100 kg. When the two parts separated, the lander was pushed towards the surface of the comet so that its change in velocity towards the comet was $3.0\,m\,s^{-1}$.



Assume that the orbiter and lander were an isolated system.

The orbiter moved away from the comet during the separation.

What was the change in the speed of the orbiter?

A $1.8\,m\,s^{-1}$ **B** $2.3\,m\,s^{-1}$ **C** $3.0\,m\,s^{-1}$ **D** $5.1\,m\,s^{-1}$

---

337. 9702_w19_qp_13 Q: 9

Two objects X and Y in an isolated system undergo a perfectly elastic collision. The velocities of the objects before and after the collision are shown.

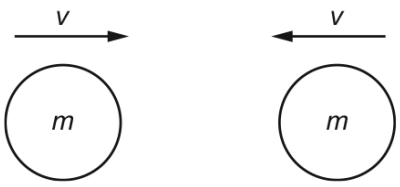
What is the speed v of Y after the collision?

A $2.0\,m\,s^{-1}$ **B** $18\,m\,s^{-1}$ **C** $22\,m\,s^{-1}$ **D** $24\,m\,s^{-1}$

---

338. 9702_s18_qp_11 Q: 9

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 $2mv$.

---

339. 9702_s18_qp_12 Q: 9

An elastic collision occurs between two bodies X and Y. The mass of body X is m and the mass of body Y is $4m$. Body X travels at speed v before the collision and speed $\frac{3v}{5}$ in the opposite direction after the collision. Body Y is stationary before the collision.

What is the kinetic energy of body Y after the collision?

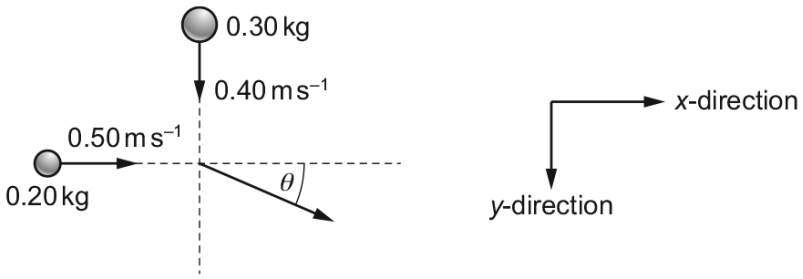
A $\frac{8}{10}mv^2$ **B** $\frac{34}{50}mv^2$ **C** $\frac{16}{50}mv^2$ **D** $\frac{1}{5}mv^2$

---

340. 9702_s18_qp_13 Q: 9

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°

---

341. 9702_w18_qp_11 Q: 9

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.

---

342. 9702_w18_qp_12 Q: 9

Two bodies travelling along the same straight line collide in a perfectly elastic collision.

Which statement **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.

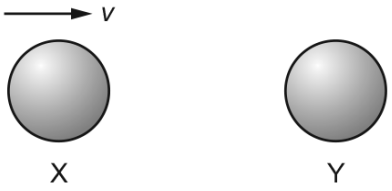
C The total momentum is conserved but the total kinetic energy will be reduced.

D One of the bodies will be stationary at one instant.

---

343. 9702_w18_qp_12 Q: 10

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.

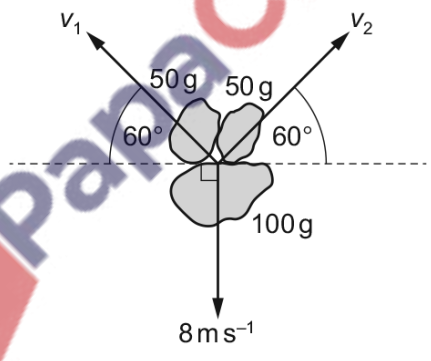
What happens?

	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

---

344. 9702_m17_qp_12 Q: 10

A stationary firework explodes into three pieces. The masses and the velocities of the three pieces immediately after the explosion are shown.



What are speed v_1 and speed v_2?

	v_1 / m s^{-1}	v_2 / m s^{-1}
A	4.0	4.0
B	9.2	9.2
C	14	14
D	16	16

---

345. 9702_s17_qp_12 Q: 14

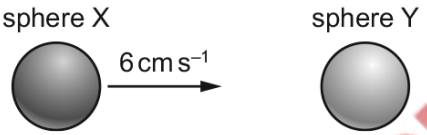
Which quantities are conserved in an inelastic collision?

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

---

346. 9702_w17_qp_11 Q: 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** $8\,cm\,s^{-1}$

---

347. 9702_w17_qp_12 Q: 9

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.

---

348. 9702_w17_qp_13 Q: 10

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.

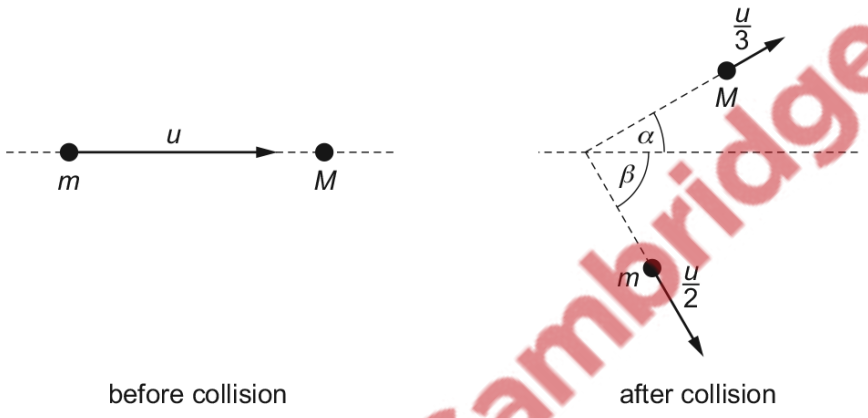
What is the speed of the trucks after the collision?

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

---

349. 9702_m16_qp_12 Q: 10

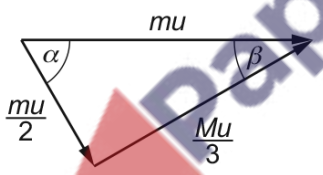
A particle of mass m, travelling with speed u, collides with a stationary particle of mass M. The velocities of the two particles before and after the collision are shown.



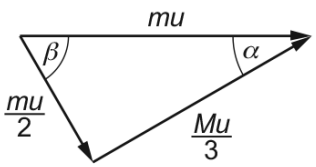
before collision after collision

Which vector diagram correctly shows the momenta before and after the collision?

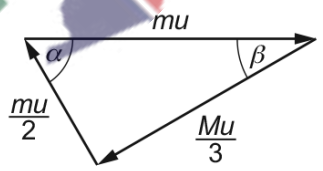
A



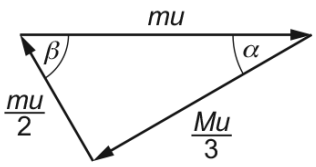
B



C



D



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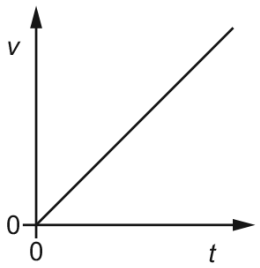
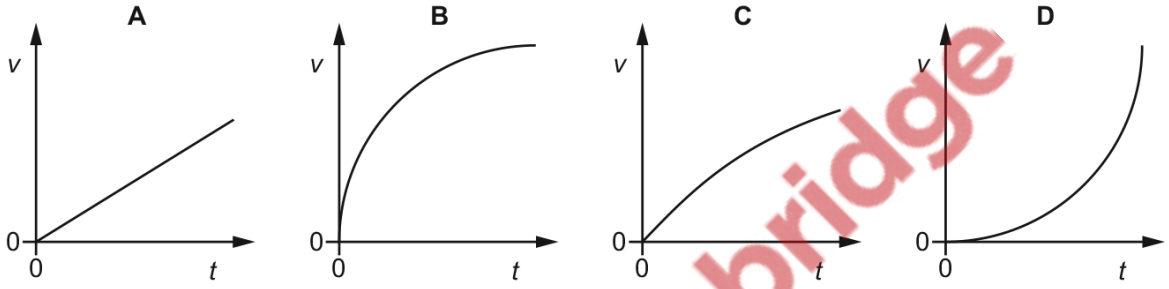
350. 9702_m16_qp_12 Q: 11

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



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



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351. 9702_s16_qp_11 Q: 9

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.

---

352. 9702_s16_qp_11 Q: 10

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 $u_1 - u_2 = v_2 - v_1$

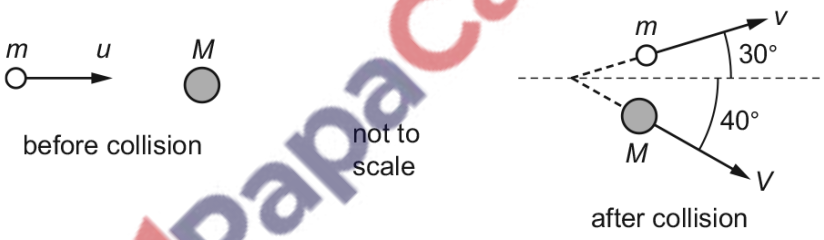
C $u_1 + u_2 = v_2 + v_1$

D $u_1 + u_2 = v_2 - v_1$

---

353. 9702_s16_qp_12 Q: 11

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.



A 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

---

354. 9702_s16_qp_13 Q: 10

Two equal masses travel towards each other on a frictionless track at speeds of $60\,cm\,s^{-1}$ and $30\,cm\,s^{-1}$. 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** $45\,cm\,s^{-1}$

---

355. 9702_w16_qp_11 Q: 13

Two spheres travel along the same line with velocities u_1 and u_2. They collide and after collision their velocities are v_1 and v_2.

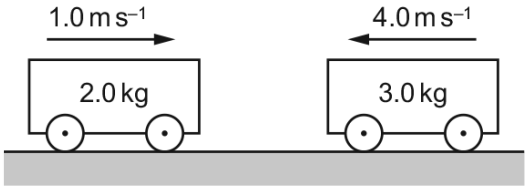
Which collision is **not** elastic?

	u_1/ms^{-1}	u_2/ms^{-1}	v_1/ms^{-1}	v_2/ms^{-1}
A	2	–5	–5	–2
B	3	–3	0	6
C	3	–2	1	6
D	5	2	3	6

---

356. 9702_w16_qp_12 Q: 11

Two frictionless trolleys are moving towards each other along the same horizontal straight line. Their masses and velocities are shown.



The trolleys collide and stick together.

What is the velocity of the trolleys after the collision?

A 2.0 m s^{-1} to the left

B 2.0 m s^{-1} to the right

C 2.8 m s^{-1} to the left

D 2.8 m s^{-1} to the right

---

357. 9702_w16_qp_13 Q: 13

Two spheres travel along the same line with velocities u_1 and u_2. They collide and after collision their velocities are v_1 and v_2.

Which collision is **not** elastic?

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

---

358. 9702_s15_qp_11 Q: 11

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 momentum and in the kinetic energy 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

---

359. 9702_s15_qp_12 Q: 11

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 this 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.

---

360. 9702_s15_qp_13 Q: 10

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.

---

361. 9702_s15_qp_13 Q: 11

A moving object strikes a stationary object. The collision is inelastic. The objects move off together.

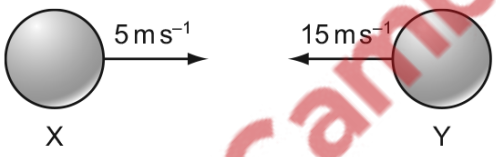
Which row shows the possible values of total momentum and total kinetic energy for the system before and after the collision?

	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

---

362. 9702_s15_qp_13 Q: 12

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

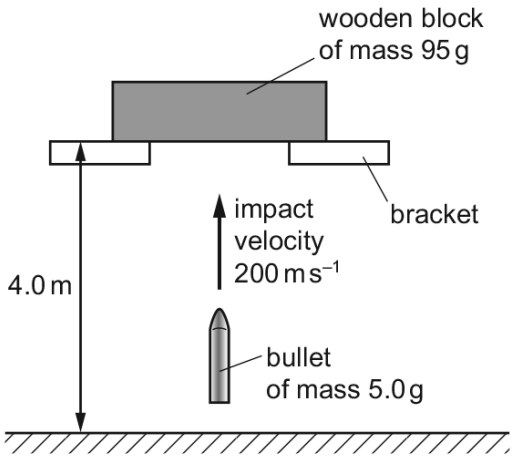
C 3 m s^{-1} to the right

D 13 m s^{-1} to the right

---

363. 9702_s15_qp_13 Q: 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 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