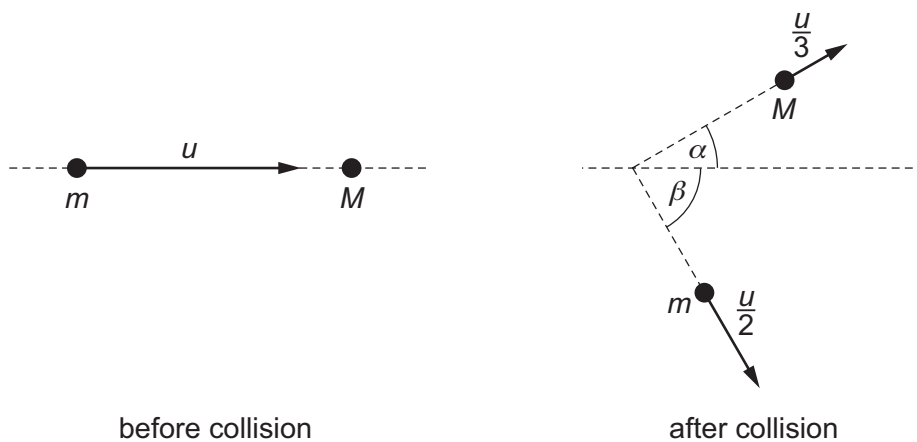


9 Which statement **defines** force?

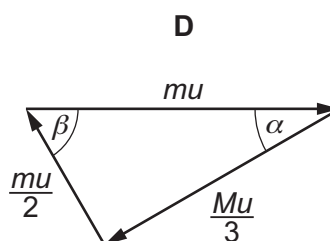
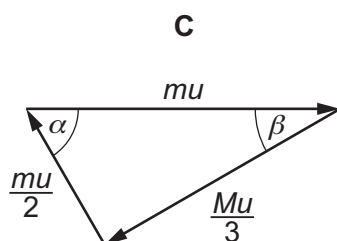
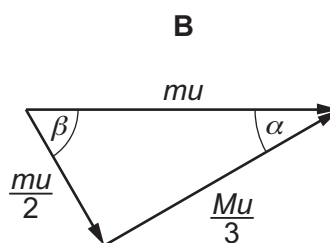
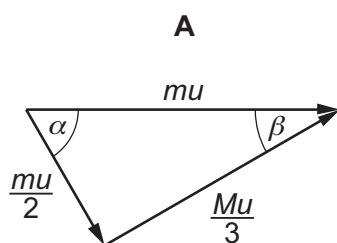
- A** When a force acts on a body that is free to move, the force is the product of the mass of the body and its acceleration.
- B** When a force acts on a body that is free to move, the force is the rate of change of momentum of the body.
- C** When a force acts on a body that is free to move, the force 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.

2. Question | 9702 Feb-March 2016 P1 V2 Q10

- 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.



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



3. Question | 9702 May-June 2016 P1 V1 Q9

- 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.

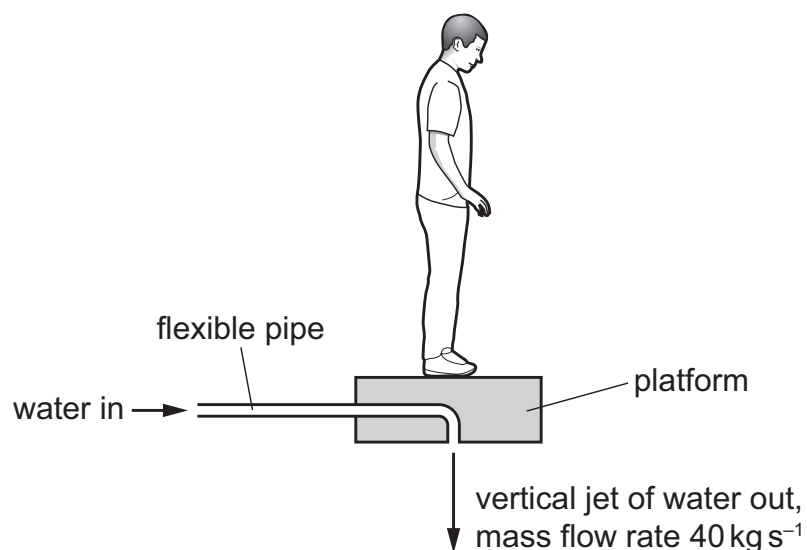
- 10** Two spheres approach each other along the same straight line. Their speeds are u_1 and u_2 before they collide. After the collision, the spheres separate with speeds v_1 and v_2 in the directions shown below.



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** $u_1 + u_2 = v_2 - v_1$

- 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.



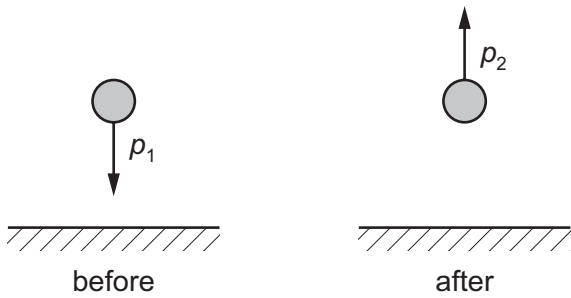
The resultant vertical force on the platform is zero. The combined mass of the man and platform is 96 kg . The mass of water that is discharged vertically downwards from the platform each second is 40 kg .

What is the speed of the water leaving the platform?

- A** 2.4 m s^{-1} **B** 6.9 m s^{-1} **C** 24 m s^{-1} **D** 47 m s^{-1}

6. Question | 9702 May-June 2016 P1 V2 Q9

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



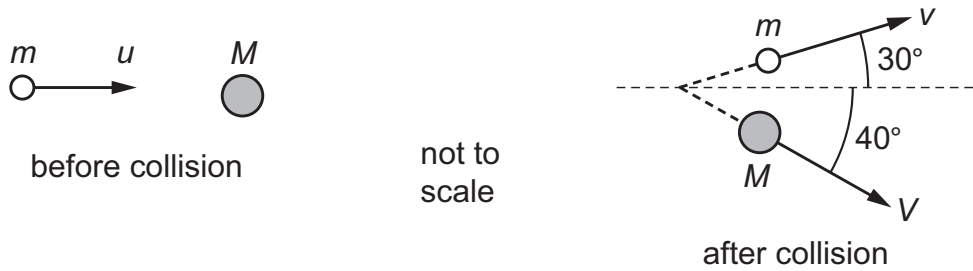
The ball has momentum p_1 downwards just before hitting the ground. After rebounding, the ball leaves the ground with momentum p_2 upwards. The ball is in contact with the ground for 0.020 s. During this time interval, an average resultant force of 25 N acts on the ball.

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

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

7. Question | 9702 May-June 2016 P1 V2 Q11

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?

	$mu = MV + mv$	$mv \sin 30^\circ = MV \sin 40^\circ$	$mu = mv \cos 30^\circ + MV \cos 40^\circ$
A	correct	correct	correct
B	incorrect	correct	incorrect
C	correct	incorrect	incorrect
D	incorrect	correct	correct

8. Question | 9702 May-June 2016 P1 V3 Q9

9 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

9. Question | 9702 May-June 2016 P1 V3 Q10

- 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}

10. Question | 9702 May-June 2016 P1 V3 Q11

- 11** The IKAROS satellite has mass 320 kg and moves through space using a solar sail of area 20 m^2 . The average solar wind pressure is $1.0 \times 10^{-5}\text{ N m}^{-2}$.

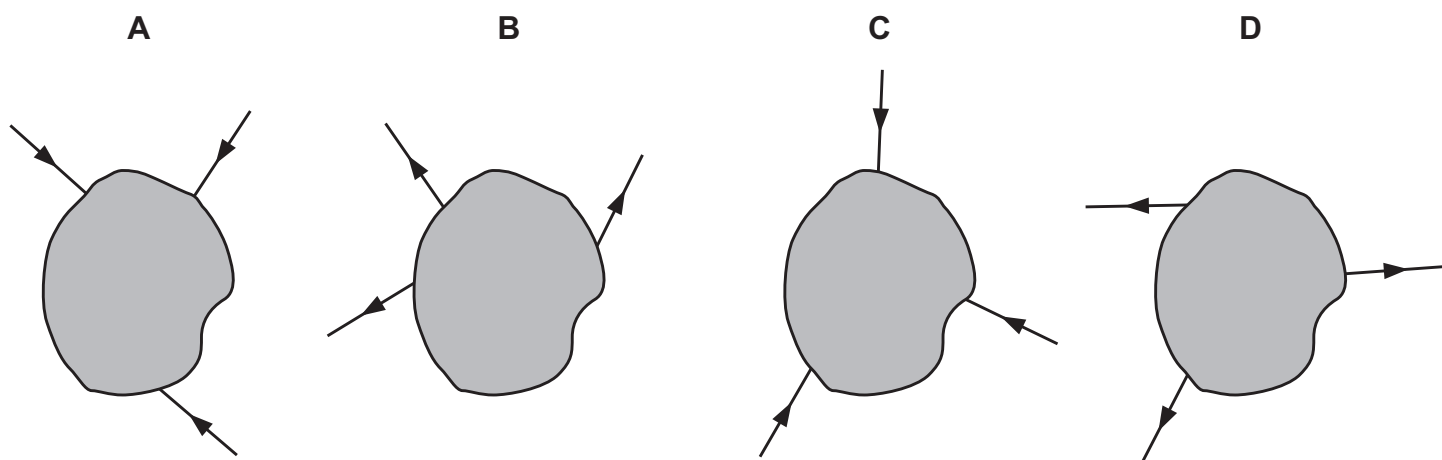
What is the acceleration of the satellite caused by the solar wind?

- A** $3.1 \times 10^{-8}\text{ m s}^{-2}$
B $6.3 \times 10^{-7}\text{ m s}^{-2}$
C $3.2 \times 10^{-3}\text{ m s}^{-2}$
D $6.4 \times 10^{-2}\text{ m s}^{-2}$

11. Question | 9702 May-June 2016 P1 V3 Q12

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

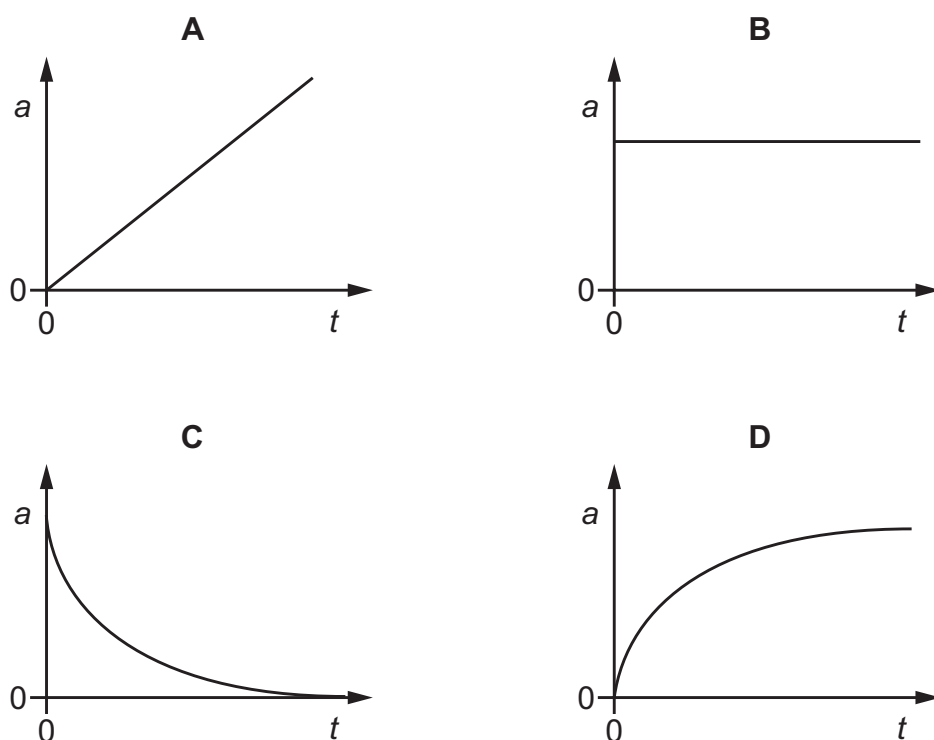
In which diagram could the object be in equilibrium?



12. Question | 9702 Oct-Nov 2016 P1 V1 Q10

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

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



13. Question | 9702 Oct-Nov 2016 P1 V1 Q11

- 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 $3a$.

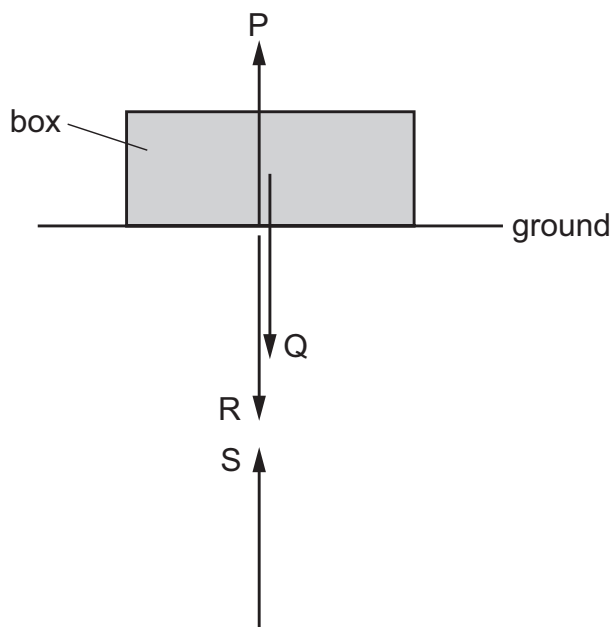
Which expression gives the constant resistive force opposing the motion of the car?

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

- 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.

15. Question | 9702 Oct-Nov 2016 P1 V1 Q13

- 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 .

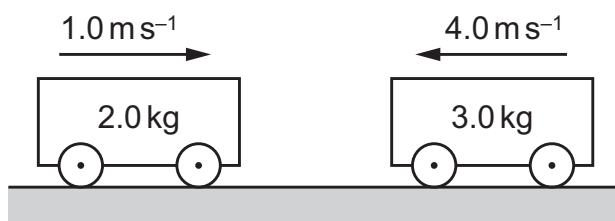


Which collision is **not** elastic?

	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

16. Question | 9702 Oct-Nov 2016 P1 V2 Q11

- 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 ms^{-1} to the left
- B** 2.0 ms^{-1} to the right
- C** 2.8 ms^{-1} to the left
- D** 2.8 ms^{-1} to the right

17. Question | 9702 Oct-Nov 2016 P1 V2 Q12

- 12** A bullet of mass 8.0 g travels at a speed of 300 ms^{-1} . The bullet hits a target and stops after a time of $100\text{ }\mu\text{s}$.

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

- A** 24 N **B** 240 N **C** 2400 N **D** $24\,000\text{ N}$

18. Question | 9702 Oct-Nov 2016 P1 V3 Q11

- 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 $3a$.

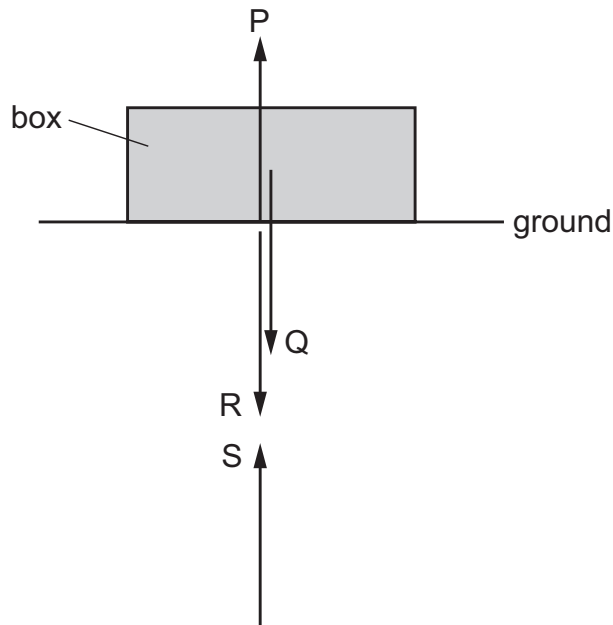
Which expression gives the constant resistive force opposing the motion of the car?

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

- 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.

20. Question | 9702 Oct-Nov 2016 P1 V3 Q13

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

21. Question | 9702 Feb-March 2017 P1 V2 Q8

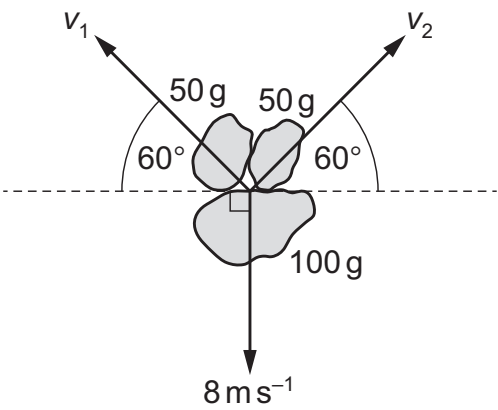
8 The acceleration of free fall on Pluto is 0.66 m s^{-2} .

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

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 ?

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

- 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?

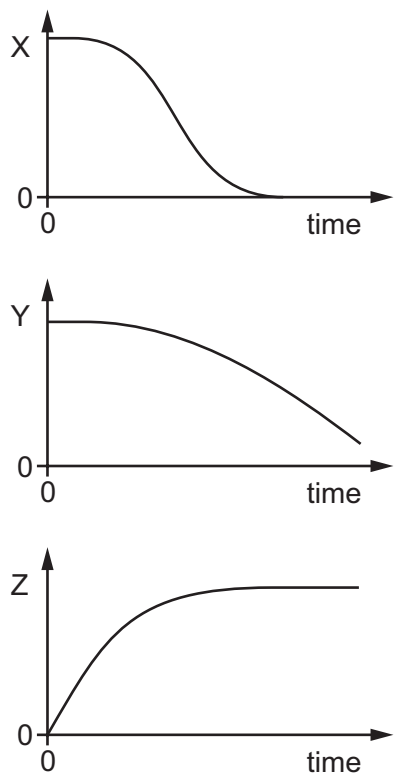
- A** The acceleration of the truck decreases as the fuel is consumed.
- B** The acceleration of the truck increases as the fuel is consumed.
- C** The acceleration of the truck remains constant.
- D** The acceleration of the truck is zero and the truck moves at a constant velocity.

24. Question | 9702 May-June 2017 P1 V1 Q8

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

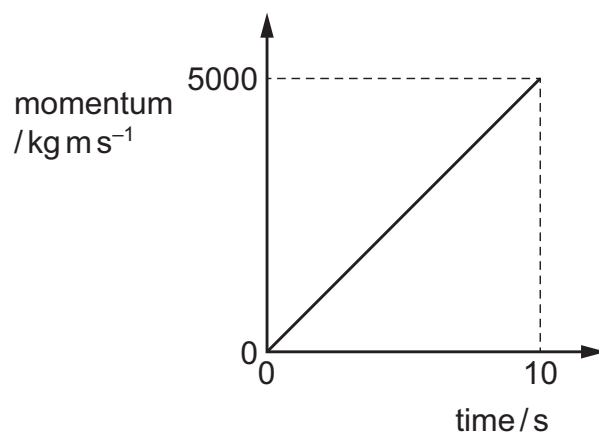


What are the quantities X, Y and Z?

	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

25. Question | 9702 May-June 2017 P1 V1 Q10

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



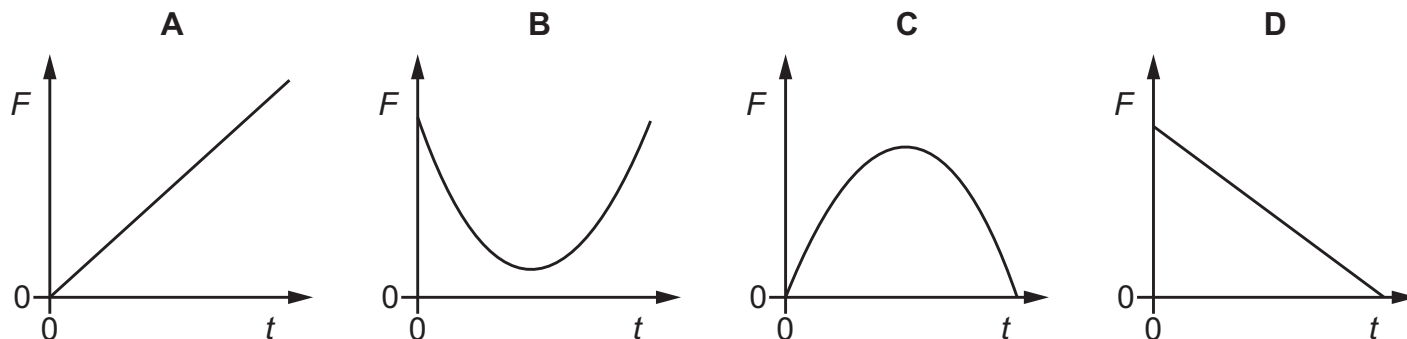
What is the resultant force on the motorcycle?

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

26. Question | 9702 May-June 2017 P1 V2 Q7

- 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?



27. Question | 9702 May-June 2017 P1 V2 Q8

- 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 .

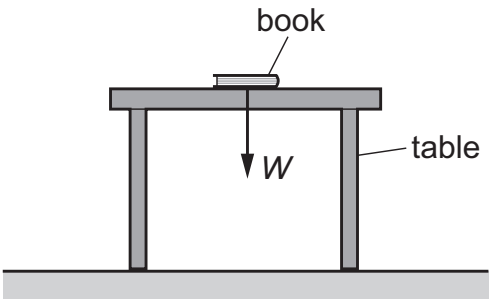
The momentum of the golf ball just as it reaches the surface is different from its momentum just as it leaves the surface.

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

28. Question | 9702 May-June 2017 P1 V2 Q9

- 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

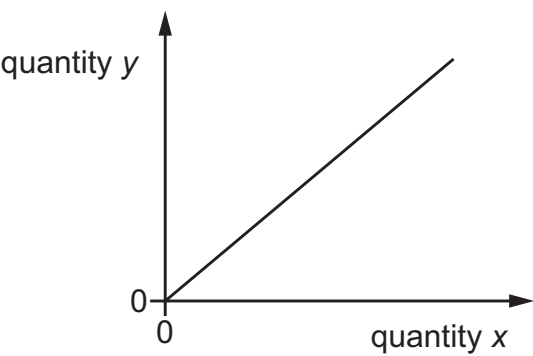
29. Question | 9702 May-June 2017 P1 V2 Q14

- 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

30. Question | 9702 May-June 2017 P1 V3 Q8

- 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

31. Question | 9702 May-June 2017 P1 V3 Q9

- 9 A ball of mass 2.0 kg travels horizontally with a speed of 4.0 ms^{-1} . The ball collides with a wall and rebounds in the opposite direction with a speed of 2.8 ms^{-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

32. Question | 9702 May-June 2017 P1 V3 Q10

- 10** An ice-hockey puck of mass 150 g moves with an initial speed of 2.0 ms^{-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

33. Question | 9702 May-June 2017 P1 V3 Q16

- 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** $\sqrt{v} \propto m$

34. Question | 9702 Oct-Nov 2017 P1 V1 Q8

- 8** 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** $4F$

35. Question | 9702 Oct-Nov 2017 P1 V1 Q9

- 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?

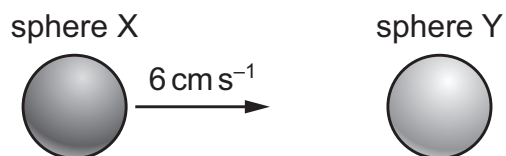
- A** 120 m **B** 125 m **C** 156 m **D** 250 m

36. Question | 9702 Oct-Nov 2017 P1 V1 Q10

- 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.

- 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}

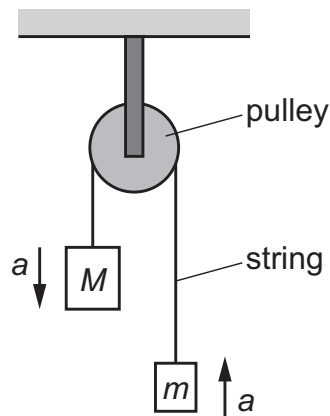
- 9** A slow vehicle and a fast vehicle travel towards each other in a straight line and then collide.

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.

39. Question | 9702 Oct-Nov 2017 P1 V2 Q10

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



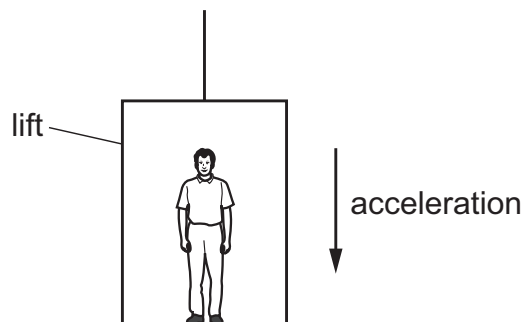
The acceleration of free fall is g .

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

40. Question | 9702 Oct-Nov 2017 P1 V3 Q8

- 8** A man stands in a lift that is accelerating vertically downwards, as shown.



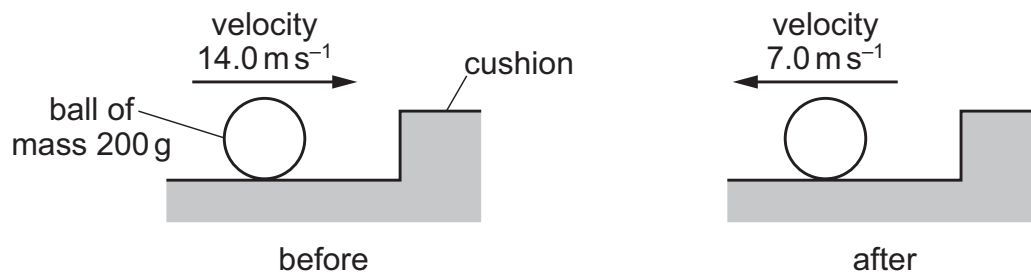
Which statement describes the force exerted by the man on the floor?

- 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.

41. Question | 9702 Oct-Nov 2017 P1 V3 Q9

- 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

42. Question | 9702 Oct-Nov 2017 P1 V3 Q10

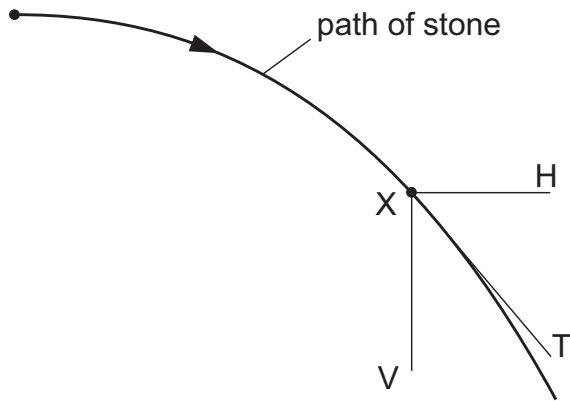
- 10** Two railway trucks of masses m and $3m$ move towards each other in opposite directions with speeds $2v$ and v respectively. These trucks collide and stick together.

What is the speed of the trucks after the collision?

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

43. Question | 9702 Oct-Nov 2017 P1 V3 Q11

11 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

44. Question | 9702 Feb-March 2018 P1 V2 Q7

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

45. Question | 9702 Feb-March 2018 P1 V2 Q10

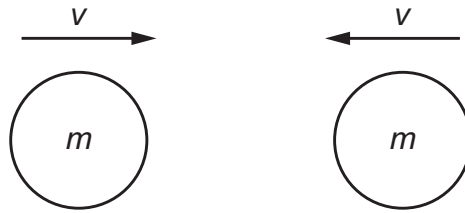
10 Steel pellets, each with a mass of 0.60g, fall vertically onto a horizontal plate at a rate of 100 pellets per minute. They strike the plate with a velocity of 5.0 ms^{-1} and rebound with a velocity of 4.0 ms^{-1} .

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

46. Question | 9702 May-June 2018 P1 V1 Q9

- 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 $2mv$.

47. Question | 9702 May-June 2018 P1 V2 Q8

- 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 $5.0 \times 10^{-3} \text{ s}$.

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

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

48. Question | 9702 May-June 2018 P1 V2 Q9

- 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 $\frac{1}{5}mv^2$

49. Question | 9702 May-June 2018 P1 V2 Q11

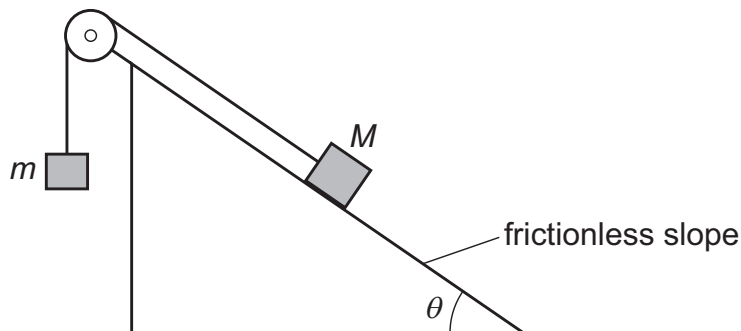
- 11 An astronaut throws a stone horizontally near to the surface of the Moon, where there is no atmosphere.

Which row describes the horizontal and vertical forces acting on the stone after release?

	horizontal force	vertical force
A	non-zero and constant	constant
B	non-zero and constant	decreasing
C	zero	constant
D	zero	decreasing

50. Question | 9702 May-June 2018 P1 V3 Q7

- 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.

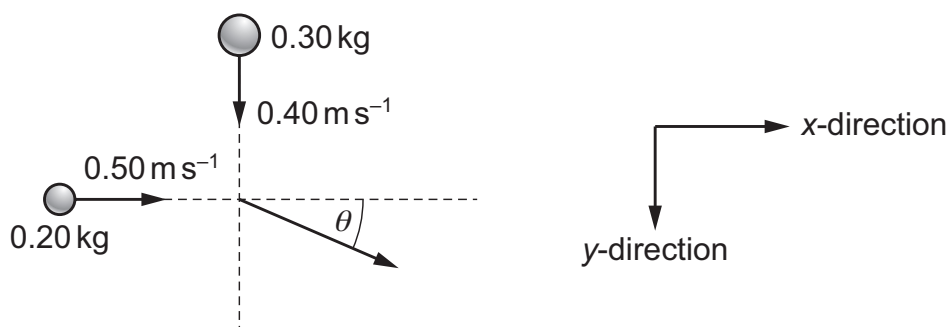
Which expression **must** be correct?

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

51. Question | 9702 May-June 2018 P1 V3 Q9

- 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°

52. Question | 9702 Oct-Nov 2018 P1 V1 Q7

- 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** 108000 N

53. Question | 9702 Oct-Nov 2018 P1 V1 Q8

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

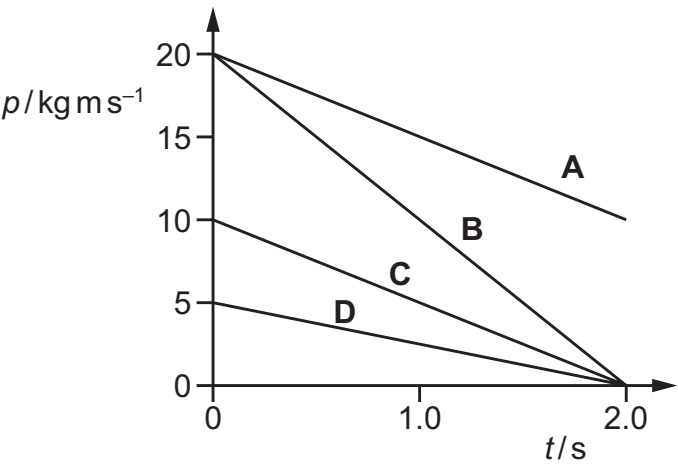
54. Question | 9702 Oct-Nov 2018 P1 V1 Q9

- 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.

55. Question | 9702 Oct-Nov 2018 P1 V2 Q7

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?



56. Question | 9702 Oct-Nov 2018 P1 V2 Q8

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

57. Question | 9702 Oct-Nov 2018 P1 V2 Q9

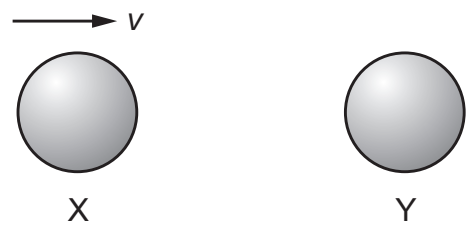
9 Two bodies travelling along the same straight line collide in a perfectly elastic collision.

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.

58. Question | 9702 Oct-Nov 2018 P1 V2 Q10

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

59. Question | 9702 Oct-Nov 2018 P1 V3 Q7

- 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}

60. Question | 9702 Oct-Nov 2018 P1 V3 Q8

- 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}

61. Question | 9702 Oct-Nov 2018 P1 V3 Q10

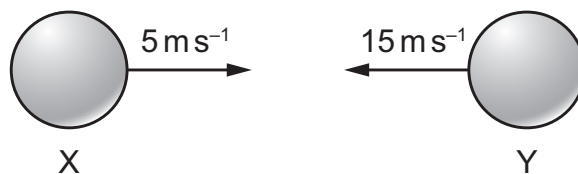
- 10** A ship of mass $8.4 \times 10^7 \text{ kg}$ is approaching a harbour with speed 16.4 m s^{-1} . By using reverse thrust it can maintain a constant total stopping force of 920 000 N.

How long will it take to stop?

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

62. Question | 9702 Feb-March 2019 P1 V2 Q8

- 8 Two balls X and Y are moving towards each other with speeds of 5 ms^{-1} and 15 ms^{-1} respectively.



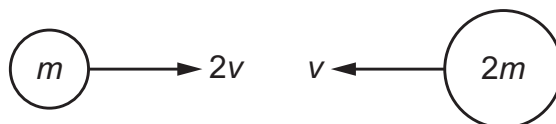
They make a perfectly elastic head-on collision and ball Y moves to the right with a speed of 7 ms^{-1} .

What is the speed and direction of ball X after the collision?

- A 3 ms^{-1} to the left
- B 13 ms^{-1} to the left
- C 3 ms^{-1} to the right
- D 13 ms^{-1} to the right

63. Question | 9702 Feb-March 2019 P1 V2 Q10

- 10 Two balls, of masses m and $2m$, travelling in a vacuum with initial velocities $2v$ and v respectively, collide with each other head-on, as shown.



After the collision, the ball of mass m rebounds to the left with velocity v .

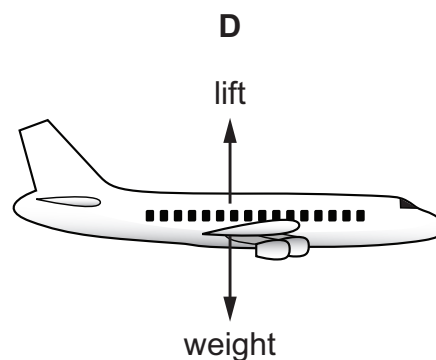
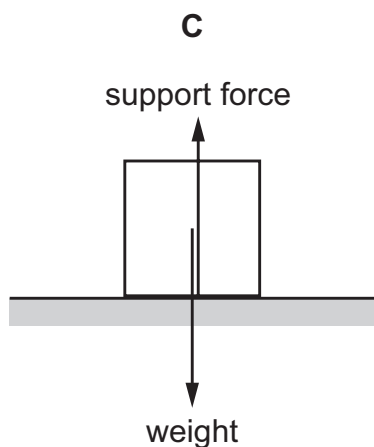
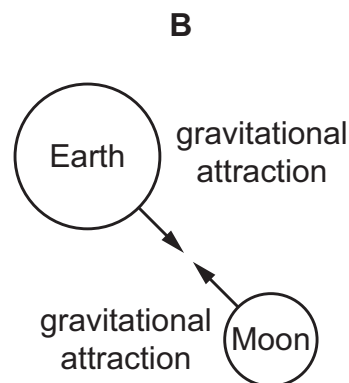
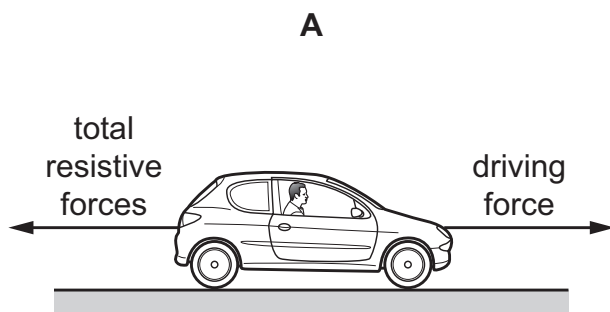
What is the loss of kinetic energy in the collision?

- A $\frac{3}{4}mv^2$
- B $\frac{3}{2}mv^2$
- C $\frac{9}{4}mv^2$
- D $\frac{9}{2}mv^2$

64. Question | 9702 May-June 2019 P1 V1 Q9

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?



65. Question | 9702 May-June 2019 P1 V1 Q11

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** $2mv$

66. Question | 9702 May-June 2019 P1 V2 Q9

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

67. Question | 9702 May-June 2019 P1 V2 Q10

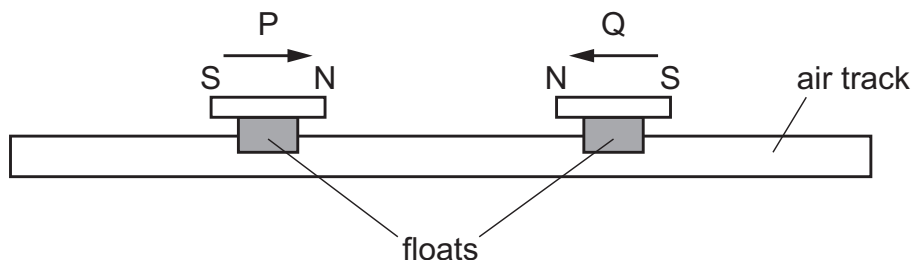
- 10** A car has mass m . A person needs to push the car with force F in order to give the car acceleration a . The person needs to push the car with force $2F$ in order to give the car acceleration $3a$.

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

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

68. Question | 9702 May-June 2019 P1 V2 Q11

- 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?

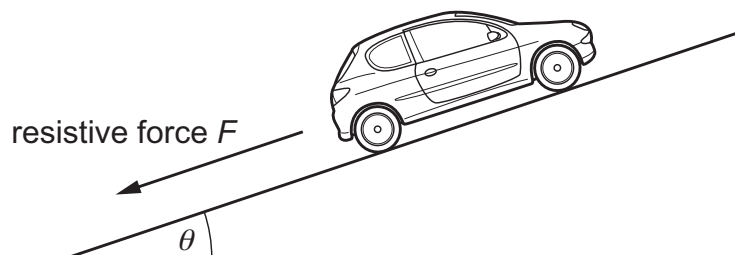
- A** During the interaction between P and Q some of the total kinetic energy is lost.
B During the interaction between P and Q some of the total momentum is lost.
C The momentum of Q after the interaction is equal to the momentum of P before the interaction.
D The values of (kinetic energy of P + kinetic energy of Q) before and after the interaction are equal.

- 12** A submarine descends vertically at constant velocity. The three forces acting on the submarine are viscous drag, upthrust and weight.

Which relationship between their magnitudes is correct?

- A** weight < drag
- B** weight = drag
- C** weight < upthrust
- D** weight > upthrust

- 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?

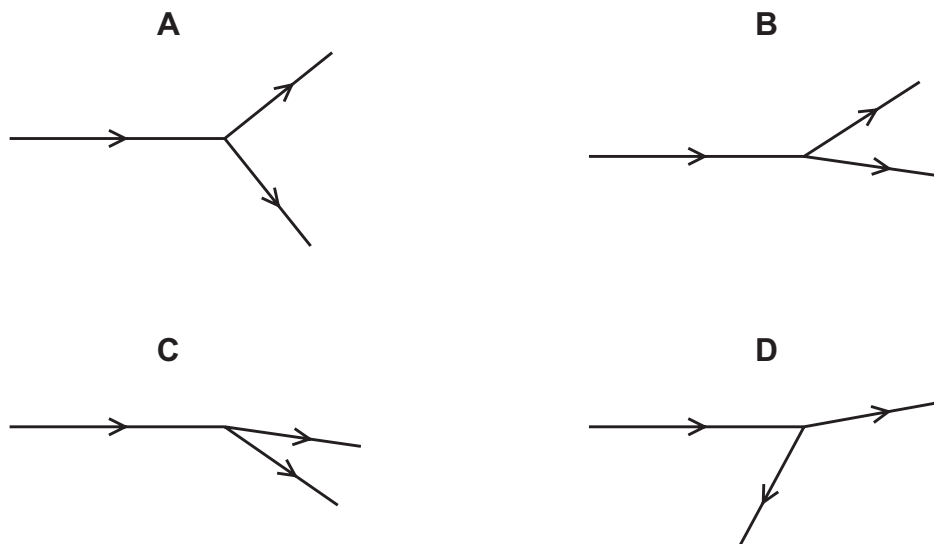
- A** $mg \cos \theta$
- B** $mg \sin \theta$
- C** $mg \cos \theta + F$
- D** $mg \sin \theta + F$

71. Question | 9702 May-June 2019 P1 V3 Q9

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

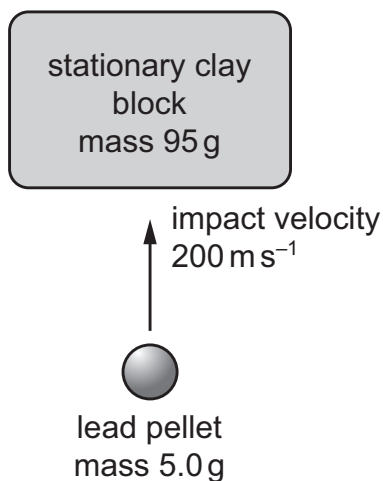
No other particles are involved in the collision.

Which diagram is **not** possible?



72. Question | 9702 May-June 2019 P1 V3 Q17

- 17** 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 mass of the pellet is 5.0 g and the mass of the clay block is 95 g.

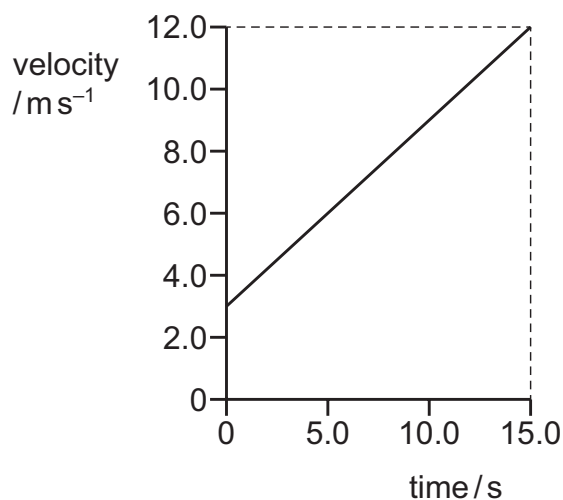
The pellet hits the block with an initial vertical velocity of 200 m s⁻¹. It embeds itself in the block and does not emerge.

How high above its initial position will the block rise?

- A** 5.1 m **B** 5.6 m **C** 10 m **D** 100 m

73. Question | 9702 Oct-Nov 2019 P1 V1 Q6

- 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

74. Question | 9702 Oct-Nov 2019 P1 V1 Q7

- 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.

75. Question | 9702 Oct-Nov 2019 P1 V1 Q8

- 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

76. Question | 9702 Oct-Nov 2019 P1 V1 Q9

- 9** A skydiver falls from an aircraft that is moving horizontally.

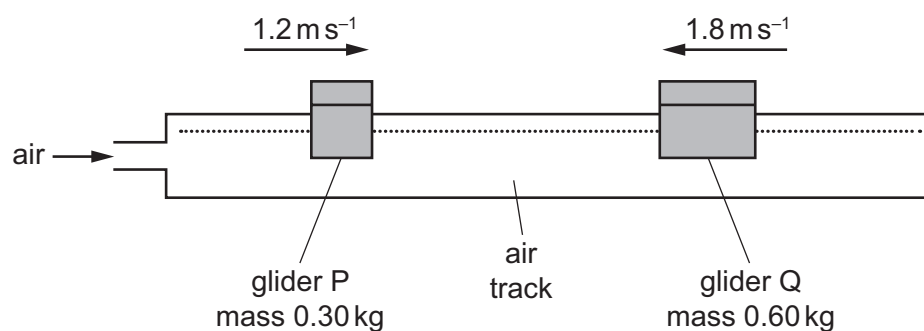
The vertical component of the velocity of the skydiver is v .

The vertical component of the acceleration of the skydiver is a .

Which row describes v and a during the first few seconds after the skydiver leaves the aircraft?

	v	a
A	constant	constant
B	constant	decreasing
C	increasing	constant
D	increasing	decreasing

- 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 ms^{-1} . Glider Q has mass 0.60 kg and is moving with a constant speed of 1.8 ms^{-1} .



The gliders have a perfectly elastic collision.

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

	speed of P $/\text{ms}^{-1}$	speed of Q $/\text{ms}^{-1}$
A	1.2	0.6
B	2.0	1.4
C	2.8	0.2
D	3.6	0.6

78. Question | 9702 Oct-Nov 2019 P1 V2 Q7

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

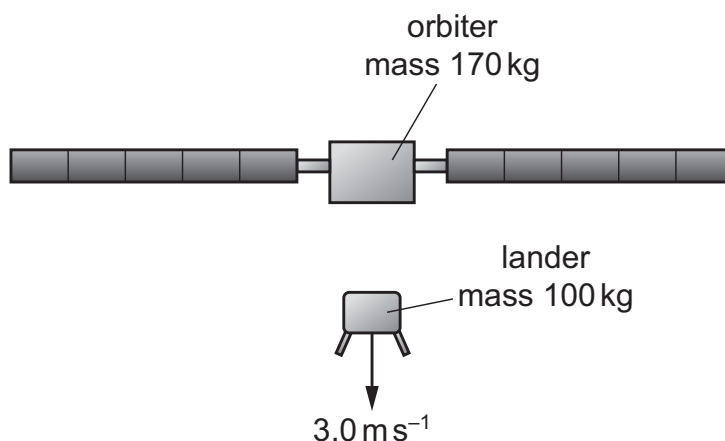
The ball arrives at the cushion with a speed of 14.0 m s^{-1} and then leaves it with a speed of 7.0 m s^{-1} . The ball and the cushion are in contact for a time of 0.60 s.

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

79. Question | 9702 Oct-Nov 2019 P1 V2 Q9

- 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.

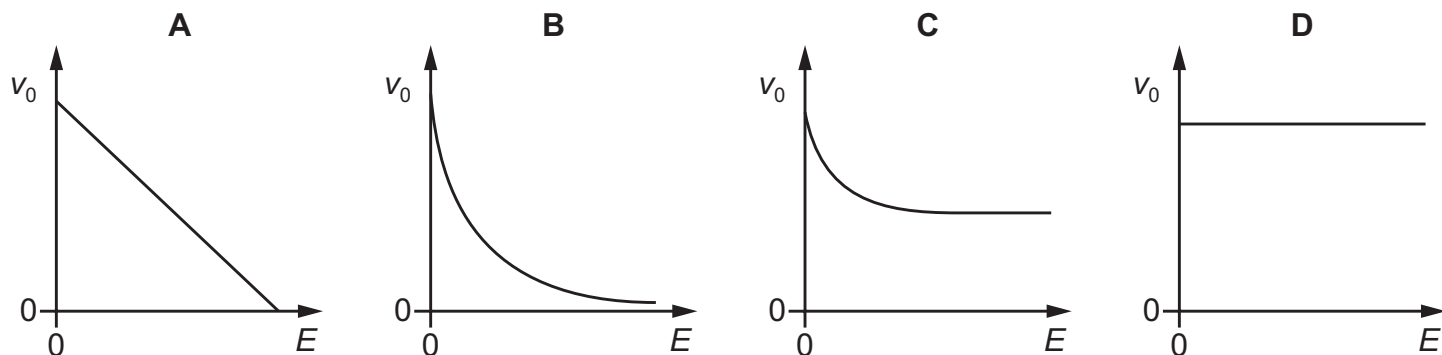
What was the change in the speed of the orbiter?

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

- 10** A positively charged oil droplet falls in air in a uniform electric field that is vertically upwards. The droplet has a constant terminal speed v_0 and the electric field strength is E .

The magnitude of the force due to air resistance acting on the droplet is proportional to the speed of the droplet.

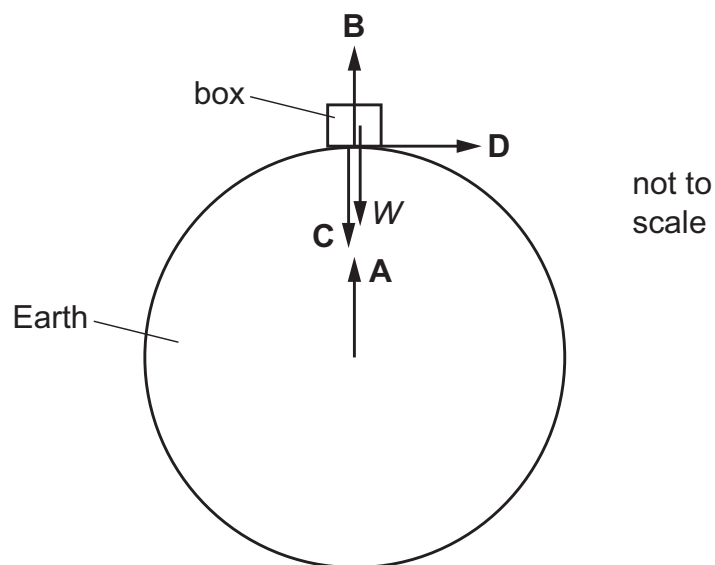
Which graph shows the variation with E of v_0 ?



7 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?



- 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.

- 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.

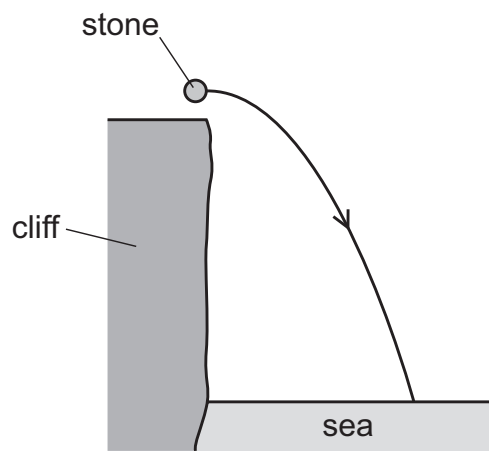


What is the speed v of Y after the collision?

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

84. Question | 9702 Feb-March 2020 P1 V2 Q6

- 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
85. Question | 9702 Feb-March 2020 P1 V2 Q8
- 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.

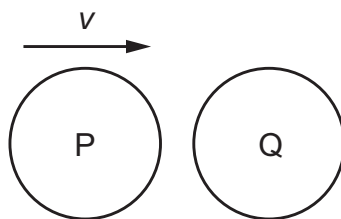
At a certain instant the bathroom scales read 58 kg.

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

86. Question | 9702 Feb-March 2020 P1 V2 Q10

- 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.



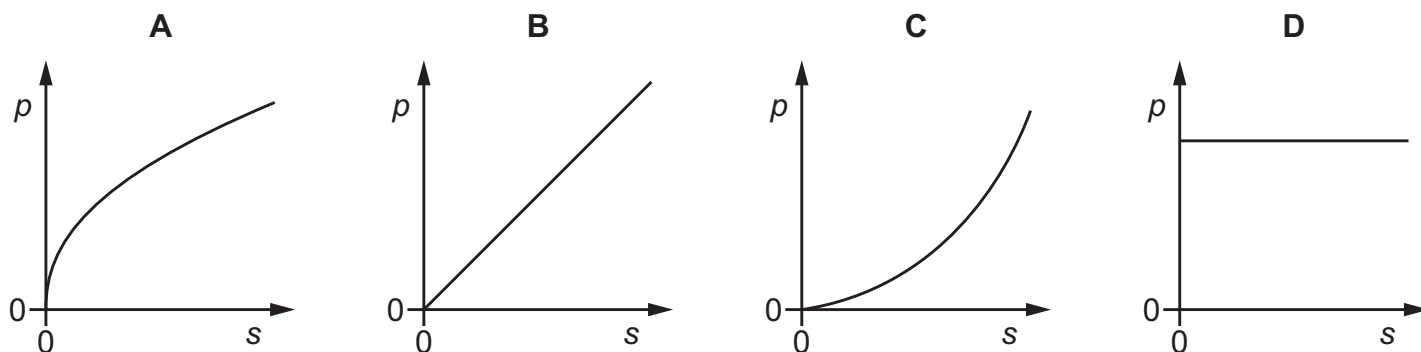
Which statement describes the motion of P and of Q immediately after the collision?

- 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.

87. Question | 9702 May-June 2020 P1 V1 Q8

- 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?



88. Question | 9702 May-June 2020 P1 V1 Q9

- 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** $\frac{mg}{k}$

89. Question | 9702 May-June 2020 P1 V1 Q10

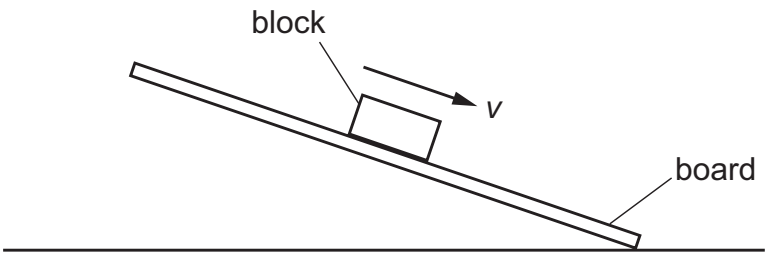
10 A stationary toy gun fires a bullet.

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.

90. Question | 9702 May-June 2020 P1 V1 Q11

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 .



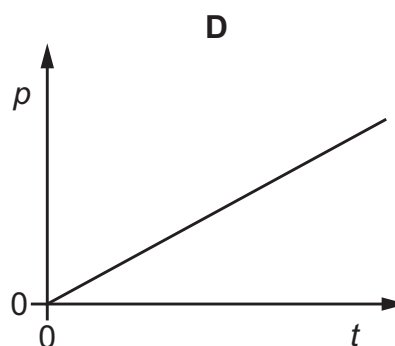
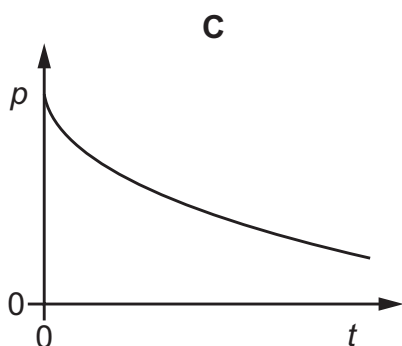
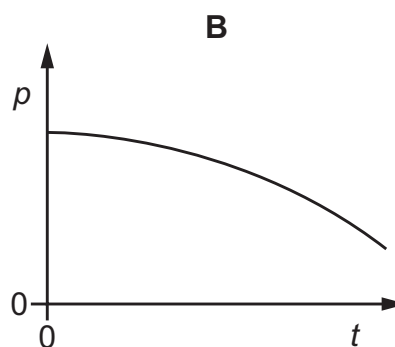
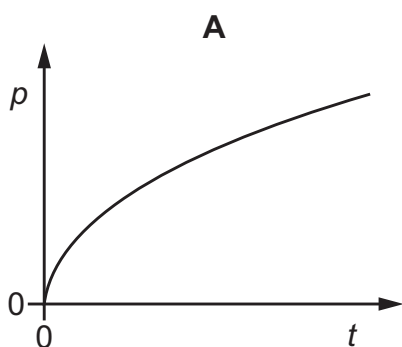
What describes the forces acting on the block when it is sliding with constant velocity?

	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

91. Question | 9702 May-June 2020 P1 V2 Q7

- 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?



92. Question | 9702 May-June 2020 P1 V2 Q8

- 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

- 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** $m_1 u_1^2 - m_1 v_1^2 = m_2 v_2^2 - m_2 u_2^2$
- B** $v_2 + u_2 = v_1 + u_1$
- C** $m_1(u_1 - v_1) = m_2(v_2 - u_2)$
- D** $m_1(u_1 - v_1)^2 = m_2(u_2 - v_2)^2$

94. Question | 9702 May-June 2020 P1 V3 Q8

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

95. Question | 9702 May-June 2020 P1 V3 Q9

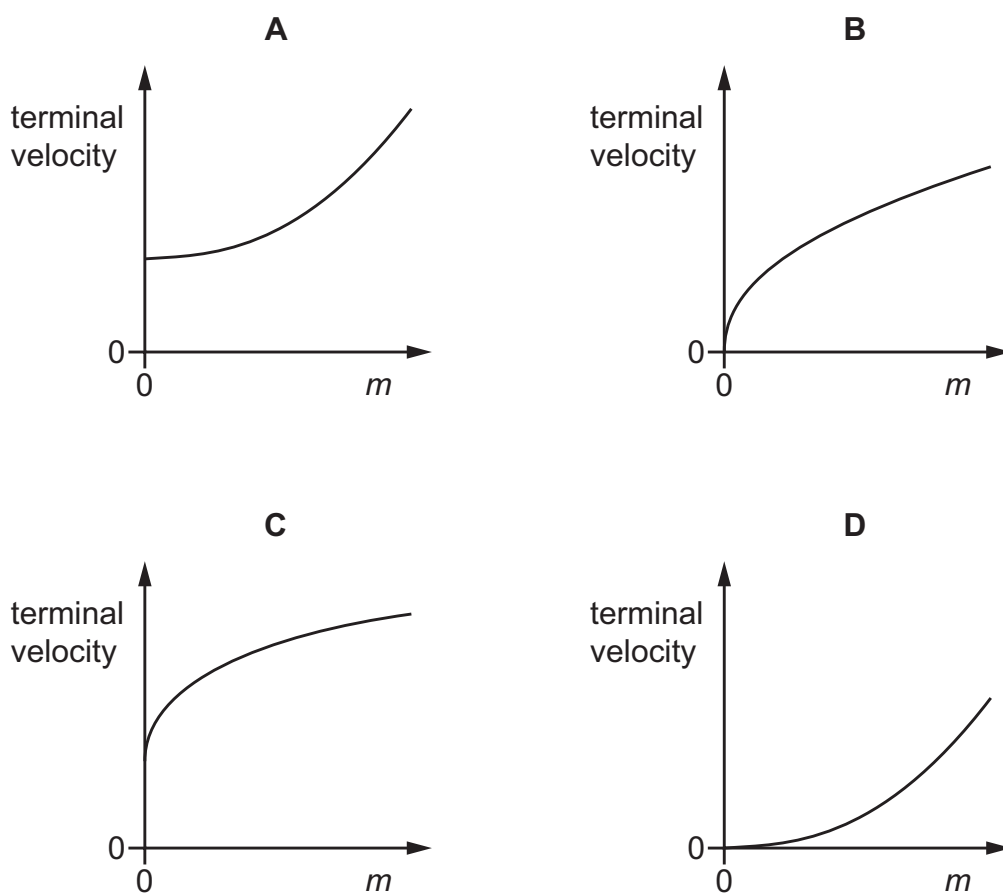
- 9 The resultant force F on a raindrop of mass m falling vertically with velocity v is given by the equation

$$F = mg - kv^2$$

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 ?



96. Question | 9702 May-June 2020 P1 V3 Q10

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

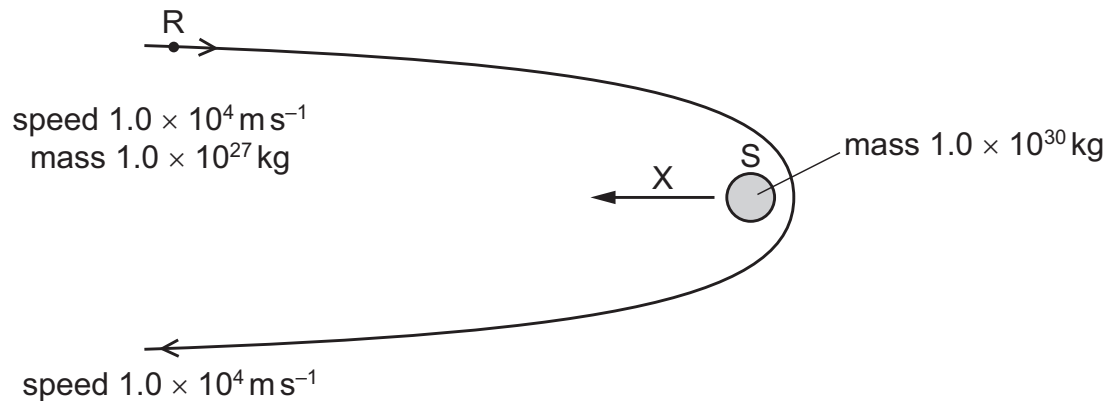
The two balls stick together.

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

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

97. Question | 9702 Oct-Nov 2020 P1 V1 Q9

- 9 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 $1.0 \times 10^4 \text{ m s}^{-1}$. 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.

98. Question | 9702 Oct-Nov 2020 P1 V1 Q10

- 10 The diagram shows the masses and velocities of two trolleys that are about to collide.



After the impact they move off together.

What is the kinetic energy lost in the collision?

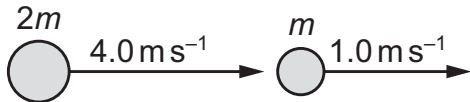
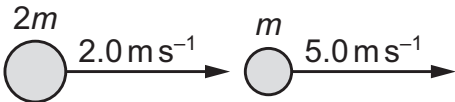
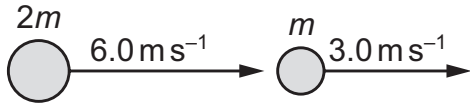
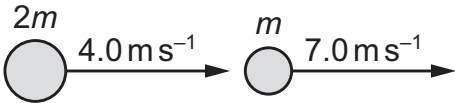
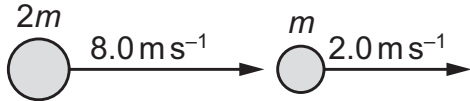
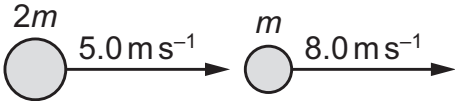
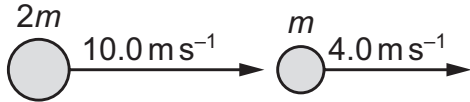
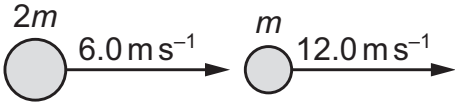
- A 4 J
- B 6 J
- C 12 J
- D 14 J

- 8** What is **not** a statement of one of Newton's laws of motion?
- A** If body X exerts a force on body Y, body Y exerts an equal and opposite force on body X.
 - B** If no resultant force acts on a body it has constant velocity.
 - C** The rate of change of momentum of a body is proportional to the resultant force acting on it and takes place in the direction of the force.
 - D** The total momentum of a system of interacting bodies is constant if there is no external force.

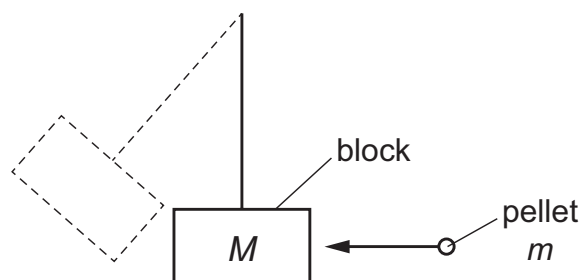
- 10** Two balls, one of mass $2m$ and one of mass m , collide.

The diagrams show the initial and final velocities of the balls.

Which collision is **not** elastic?

	before collision	after collision
A		
B		
C		
D		

- 11** The diagram shows a 'ballistic pendulum'.



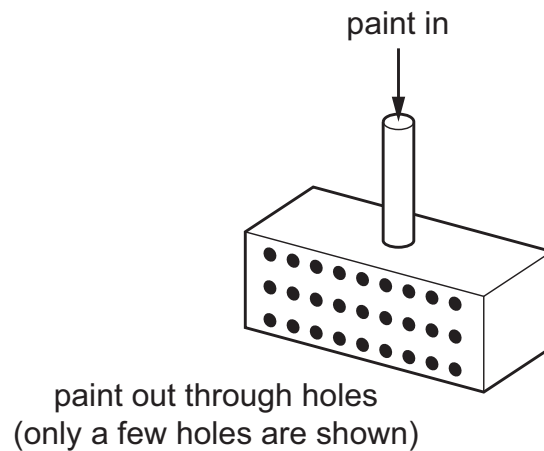
A pellet of mass m travelling at a speed u hits a stationary block of mass M . The pellet becomes embedded in the block and causes the block to move at a speed v immediately after the impact.

When a pellet of mass $2m$, travelling at a speed $2u$, hits a block of mass $2M$, what is the speed of the block immediately after the impact? (Neglect the small increase in the mass of the block as the pellet's mass is added during the collision.)

- A** v **B** $v\sqrt{2}$ **C** $2v$ **D** $4v$

102. Question | 9702 Oct-Nov 2020 P1 V3 Q8

- 8 A device for spraying paint consists of a box with its axes horizontal and vertical. One of its vertical faces contains small holes. Paint is fed into the box under pressure via a vertical tube and exits through the holes as fine streams moving horizontally.



The paint is ejected at a speed of 2.5 m s^{-1} through 400 holes, each of area 0.4 mm^2 . The density of the paint is 900 kg m^{-3} .

What is the horizontal force required to hold the device stationary as it ejects the paint?

- A** 0.36 N **B** 0.90 N **C** 2.3 N **D** 900 N

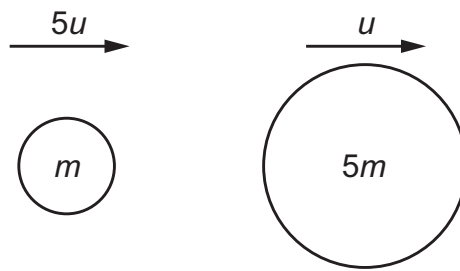
103. Question | 9702 Oct-Nov 2020 P1 V3 Q9

- 9 A party balloon is filled with air and held stationary at a height of several metres above the ground. The balloon is then dropped in still air.

Which statement describes the motion of the balloon from the moment of release until just before it hits the floor?

- A** The balloon decelerates continuously.
B The balloon falls at a constant speed and then decelerates.
C The balloon falls at a constant speed.
D The balloon initially accelerates and then reaches a constant speed.

- 10** An object of mass m travelling with speed $5u$ collides with, and sticks to, an object of mass $5m$ travelling in the same direction with speed u .

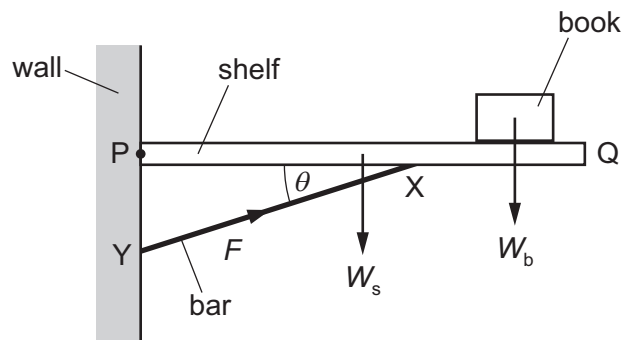


What is the speed with which the two objects travel together in the original direction?

- A** $\frac{3}{10}u$ **B** u **C** $\frac{6}{5}u$ **D** $\frac{10}{6}u$

13 A shelf PQ is attached to a vertical wall at P and supports a book.

The shelf is held horizontal by a rigid bar XY, as shown.



The weight of the shelf is W_s and the weight of the book is W_b .

The bar is at an angle θ to the shelf and exerts a force F on the shelf.

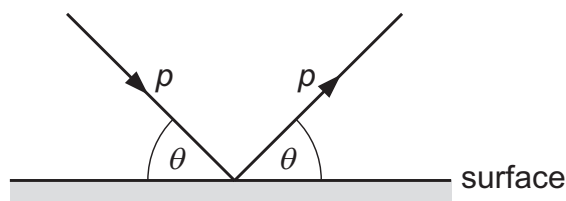
The shelf is in equilibrium.

What are the magnitudes of the horizontal and the vertical components of the force of the wall on the shelf at P?

	horizontal component	vertical component
A	$F \cos \theta$	$(W_s + W_b - F \cos \theta)$
B	$F \cos \theta$	$(W_s + W_b - F \sin \theta)$
C	$F \sin \theta$	$(W_s + W_b - F \cos \theta)$
D	$F \sin \theta$	$(W_s + W_b - F \sin \theta)$

106. Question | 9702 Feb-March 2021 P1 V2 Q8

- 8** 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.

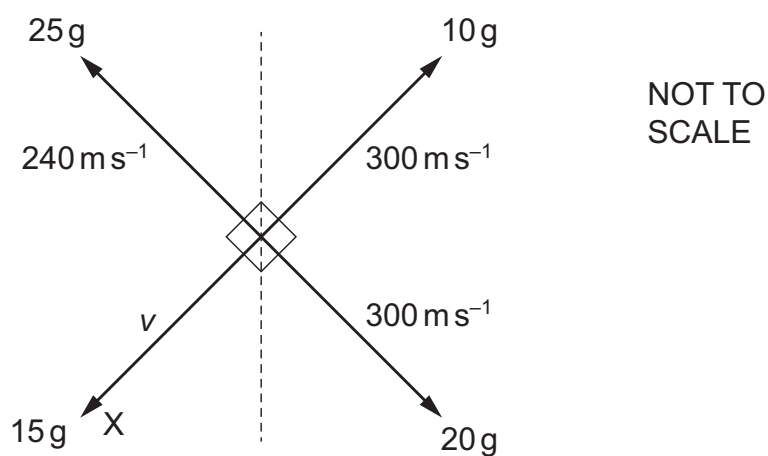
The ball is in contact with the surface for time t .

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** $\frac{2p\sin\theta}{t}$

107. Question | 9702 Feb-March 2021 P1 V2 Q10

- 10** 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.

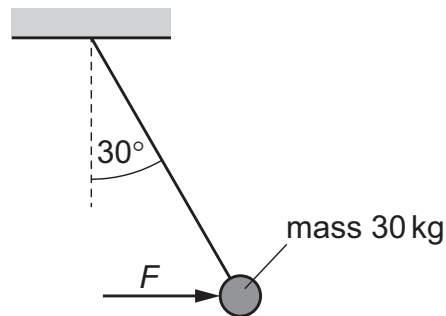


What is the speed v of fragment X?

- A** 200 ms^{-1} **B** 240 ms^{-1} **C** 300 ms^{-1} **D** 360 ms^{-1}

108. Question | 9702 Feb-March 2021 P1 V2 Q13

- 13** A mass of 30 kg is suspended from the end of a wire. A horizontal force F acts on the mass so that it is in equilibrium, with the wire at an angle of 30° to the vertical, as shown.



What is the magnitude of F ?

- A** 17 N **B** 150 N **C** 170 N **D** 510 N

109. Question | 9702 May-June 2021 P1 V1 Q8

- 8** A rocket is fired from the Earth into space.

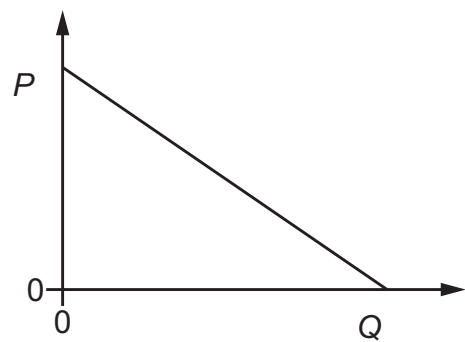
Newton's third law of motion describes how forces act in pairs. One of the forces of a pair is the weight of the rocket.

What is the other force of this pair?

- A** air resistance
B force of the exhaust gases on the rocket
C force of the rocket on the exhaust gases
D gravitational force of the rocket on the Earth

110. Question | 9702 May-June 2021 P1 V1 Q9

- 9 The graph shows how quantity P varies with quantity Q for a body falling vertically downwards in a uniform gravitational field with air resistance.



Which pair of quantities could be represented by P and Q ?

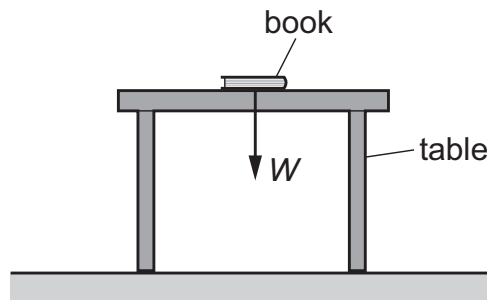
	P	Q
A	acceleration	force of air resistance
B	acceleration	time
C	velocity	force of air resistance
D	velocity	time

111. Question | 9702 May-June 2021 P1 V1 Q10

- 10 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

- 8** 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

- 9** Four balls are dropped at the same time from the top of a very tall tower. There is no wind blowing.

Which ball hits the ground first?

A



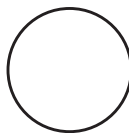
mass M
diameter D

B



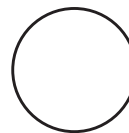
mass $4M$
diameter D

C



mass M
diameter $2D$

D



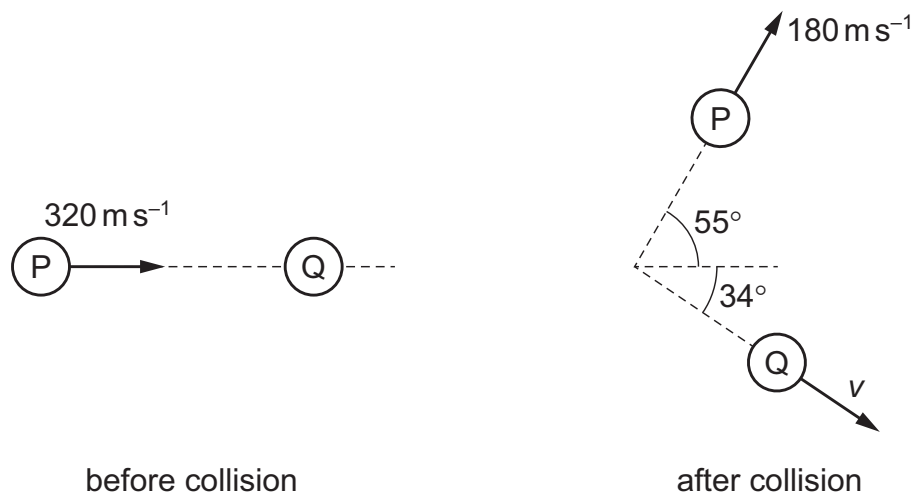
mass $4M$
diameter $2D$

114. Question | 9702 May-June 2021 P1 V2 Q10

- 10** A nitrogen molecule P travelling at a speed of 320 m s^{-1} in a vacuum collides with a stationary nitrogen molecule Q.

After the collision, P travels at a velocity of 180 m s^{-1} at an angle of 55° to its original path.

Q travels in a direction at an angle of 34° to the initial path of P.



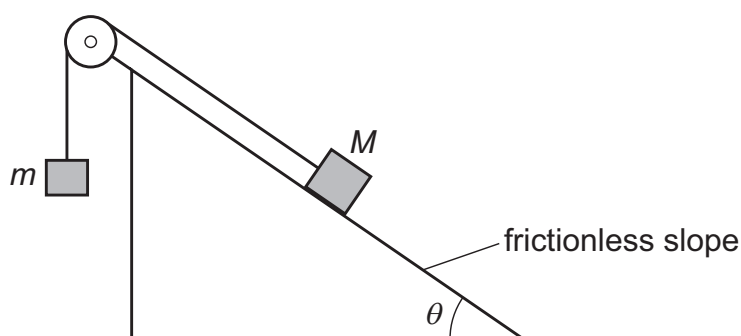
Assume that there are no external forces acting on the molecules.

What is the magnitude v of the velocity of Q after the collision?

- A** 120 m s^{-1} **B** 140 m s^{-1} **C** 180 m s^{-1} **D** 260 m s^{-1}

115. Question | 9702 May-June 2021 P1 V3 Q8

- 8** 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 accelerates 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** $\cos \theta > \frac{m}{M}$

116. Question | 9702 May-June 2021 P1 V3 Q10

10 A rock in deep space is travelling towards a distant star and collides with a stationary spacecraft.

What is **not** a possible outcome of the collision?

- A** The rock becomes stationary and the spacecraft moves towards the star.
- B** The rock moves away from the star and so does the spacecraft.
- C** The rock moves away from the star and the spacecraft moves towards the star.
- D** The rock moves towards the star and so does the spacecraft.

117. Question | 9702 May-June 2021 P1 V3 Q11

11 A steel ball is falling at a constant (terminal) speed in still air. The forces acting on the ball are upthrust, viscous drag and weight.

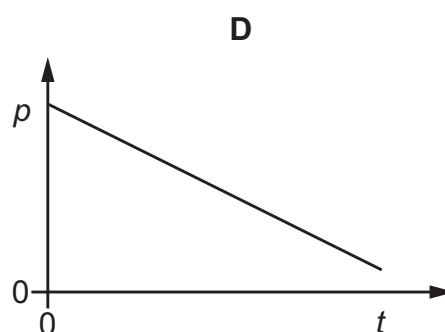
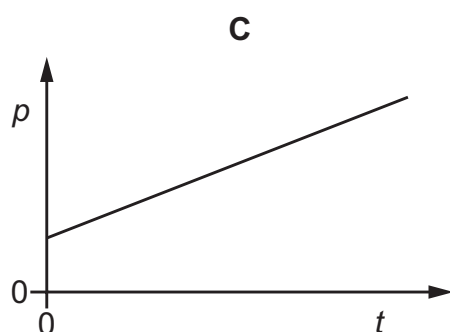
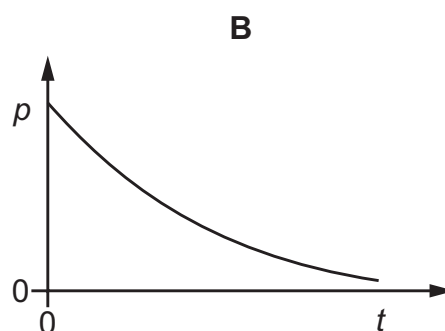
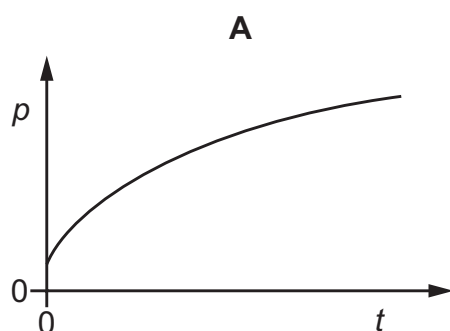
What is the order of increasing magnitude of these three forces?

- A** upthrust → viscous drag → weight
- B** viscous drag → upthrust → weight
- C** viscous drag → weight → upthrust
- D** weight → upthrust → viscous drag

118. Question | 9702 Oct-Nov 2021 P1 V1 Q8

- 8** A constant resultant force acts on an object in the direction of the object's velocity.

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



119. Question | 9702 Oct-Nov 2021 P1 V1 Q9

- 9** Which statement **must** be true for an object in a gravitational field?

- A** If the object has mass then the field causes it to accelerate.
- B** If the object has mass then the field causes it to have weight.
- C** If the object has weight then the field causes it to accelerate.
- D** If the object has weight then the field causes it to have mass.

120. Question | 9702 Oct-Nov 2021 P1 V1 Q10

- 10** A ball of mass 0.16 kg is travelling horizontally at a speed of 20 m s^{-1} .

It collides with a wall and rebounds with a speed of 15 m s^{-1} along its original path. The ball is in contact with the wall for a time of 1.0 ms .

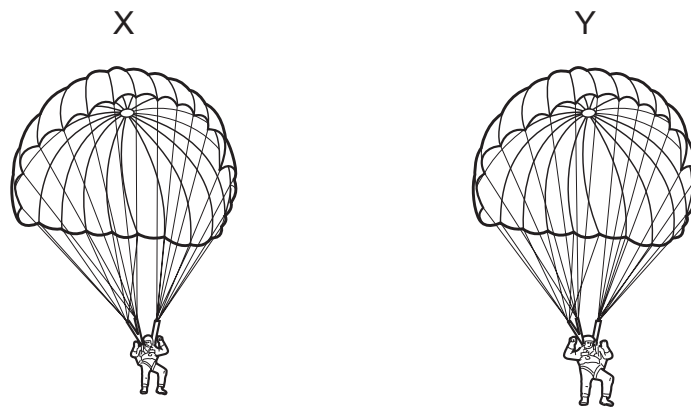
What is the average force exerted by the wall on the ball?

- A** 800 N **B** 2400 N **C** 3200 N **D** 5600 N

121. Question | 9702 Oct-Nov 2021 P1 V2 Q8

- 8** What is meant by the mass of an object?
- A** the property of the object that resists a change in motion
 - B** the pull of the Earth on the object
 - C** the total number of atoms in the object
 - D** the weight of the object

- 9 The diagram shows two parachutists, X and Y, moving vertically downwards.



The total mass of parachutist Y and his parachute is twice the total mass of parachutist X and his parachute. At this moment, the air resistance on parachute Y is twice the air resistance on parachute X. Neither parachutist has reached his constant (terminal) velocity.

Which statement describes the acceleration of Y compared with the acceleration of X?

- A The acceleration of Y is half the acceleration of X.
- B The acceleration of Y is the same as the acceleration of X.
- C The acceleration of Y is more than the acceleration of X, but less than twice the value.
- D The acceleration of Y is twice the acceleration of X.

123. Question | 9702 Oct-Nov 2021 P1 V2 Q10

10 The table shows four different collisions between two blocks, each of mass 0.50 kg.

Which collision is perfectly elastic?

	before collision	after collision
A	4.0 ms⁻¹ → 0.0 ms⁻¹ 0.50 kg 0.50 kg	2.0 ms⁻¹ → 0.50 kg 0.50 kg
B	2.0 ms⁻¹ → ← 2.0 ms⁻¹ 0.50 kg 0.50 kg	0.0 ms⁻¹ 0.50 kg 0.50 kg
C	2.0 ms⁻¹ → ← 1.0 ms⁻¹ 0.50 kg 0.50 kg	← 2.0 ms⁻¹ 3.0 ms⁻¹ → 0.50 kg 0.50 kg
D	4.0 ms⁻¹ → 1.0 ms⁻¹ → 0.50 kg 0.50 kg	1.0 ms⁻¹ → 4.0 ms⁻¹ → 0.50 kg 0.50 kg

124. Question | 9702 Oct-Nov 2021 P1 V3 Q8

8 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 ms⁻¹.

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

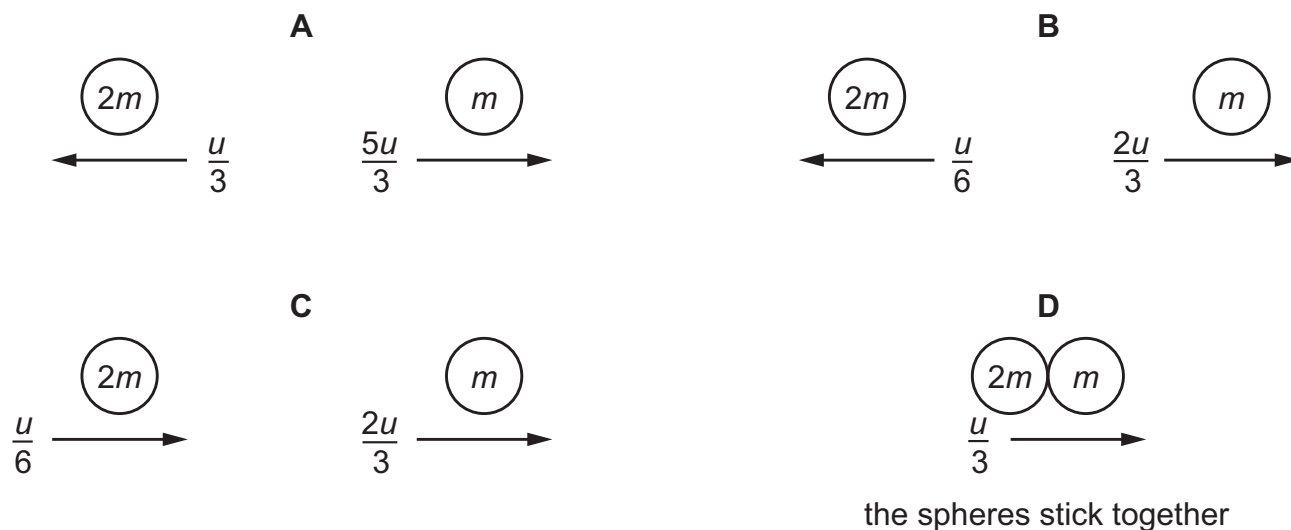
- A 30 N
- B 270 N
- C 1800 N
- D 110000 N

125. Question | 9702 Oct-Nov 2021 P1 V3 Q10

- 10** The diagram shows two spheres approaching each other head-on. Each sphere has speed u . One sphere has mass $2m$ and the other has mass m .



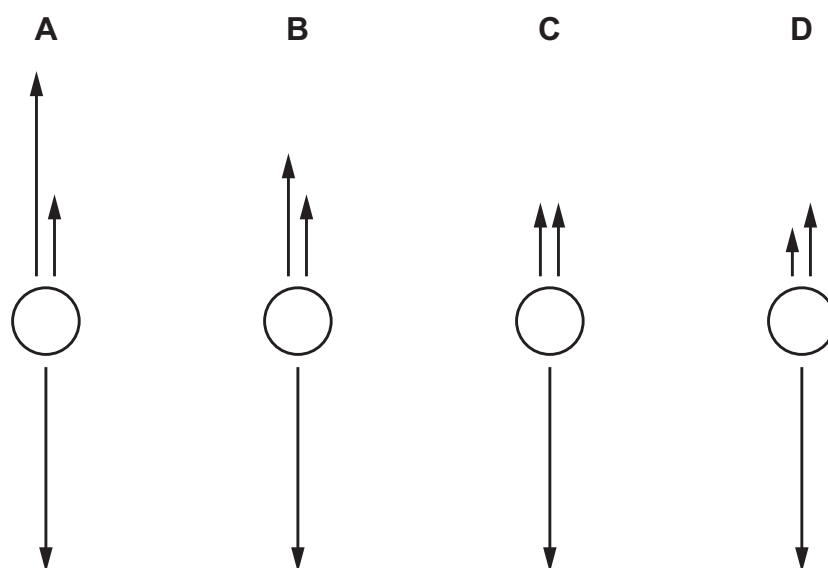
Which diagram shows the result of a perfectly elastic collision?



126. Question | 9702 Oct-Nov 2021 P1 V3 Q11

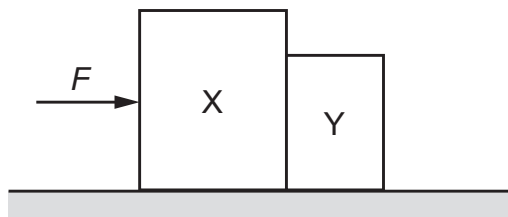
- 11** A spherical object falls through water at a constant speed. Three forces act on the object.

Which diagram, showing these three forces to scale, is correct?



127. Question | 9702 Feb-March 2022 P1 V2 Q7

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



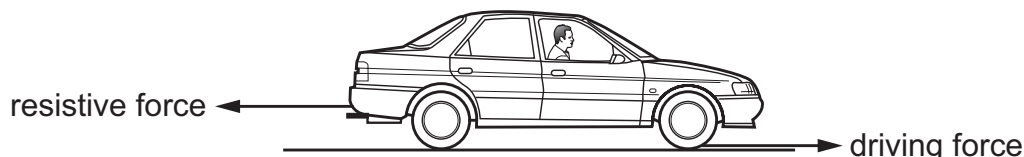
The blocks remain in contact as they accelerate along a horizontal frictionless surface. Air resistance is negligible. X has a greater mass than Y.

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.

128. Question | 9702 Feb-March 2022 P1 V2 Q8

- 8 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

129. Question | 9702 Feb-March 2022 P1 V2 Q10

- 10 A rock of mass $2m$, travelling in deep space at velocity v , explodes into two parts of equal mass, one of which is then stationary.

What is the kinetic energy of the moving part after the explosion?

- A $\frac{1}{2}mv^2$
- B mv^2
- C $\frac{3}{2}mv^2$
- D $2mv^2$

130. Question | 9702 May-June 2022 P1 V1 Q7

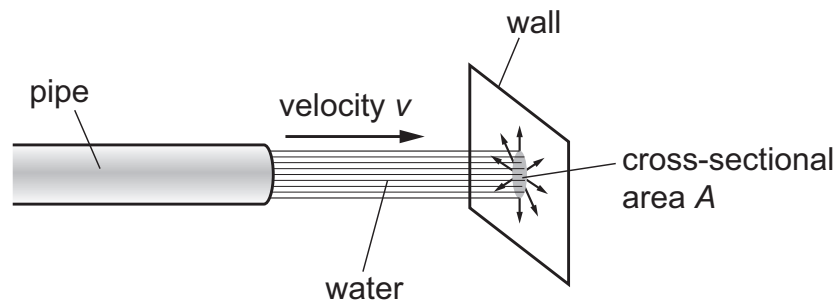
- 7** An object is moving along the ground in a straight line at a constant speed.

Which statement about the resultant force acting on the object is correct?

- A** The resultant force acting on the object is equal to its weight.
- B** The resultant force acting on the object is equal to the product of its mass and its velocity.
- C** The resultant force acting on the object is equal to the resistive force.
- D** The resultant force acting on the object is equal to zero.

131. Question | 9702 May-June 2022 P1 V1 Q8

- 8** Water flows out of a pipe and hits a wall.



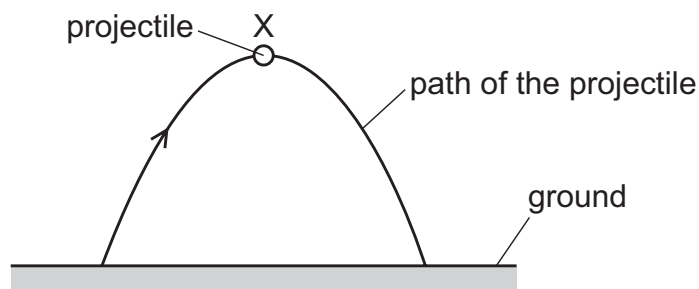
When the jet of water hits the wall, it has horizontal velocity v and cross-sectional area A .

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?

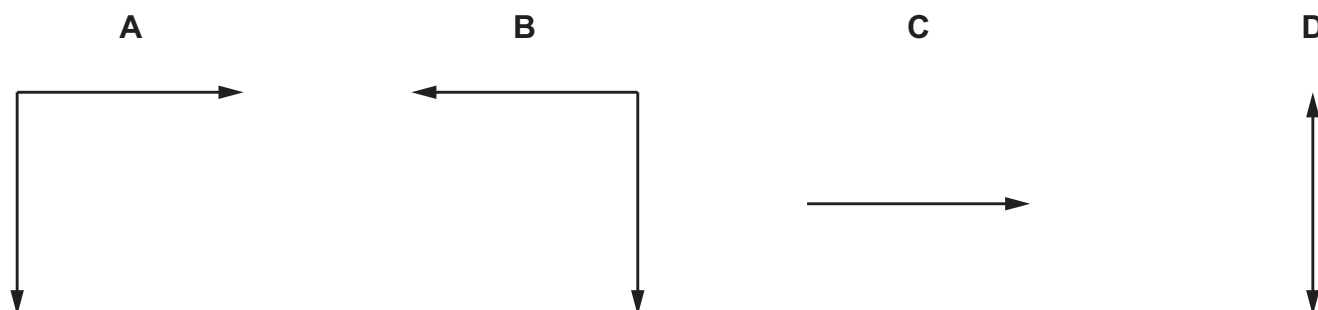
- A** $\frac{\rho v}{A}$
- B** $\frac{\rho v^2}{A}$
- C** $\rho A v$
- D** $\rho A v^2$

- 9 A projectile is launched at an angle above horizontal ground and travels through the air.



The projectile reaches its maximum height at position X. Assume that no upthrust acts on the projectile.

Which diagram shows the **directions** of the force or forces acting on the projectile at position X?



- 10** 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 object upon which it acts.
 - B** In a perfectly elastic collision, the relative momentum of the objects before impact is equal to their relative momentum after impact.
 - C** The momentum of an object is the product of the mass of the object and its velocity.
 - D** The total momentum of a system of interacting objects remains constant, providing no resultant external force acts on the system.

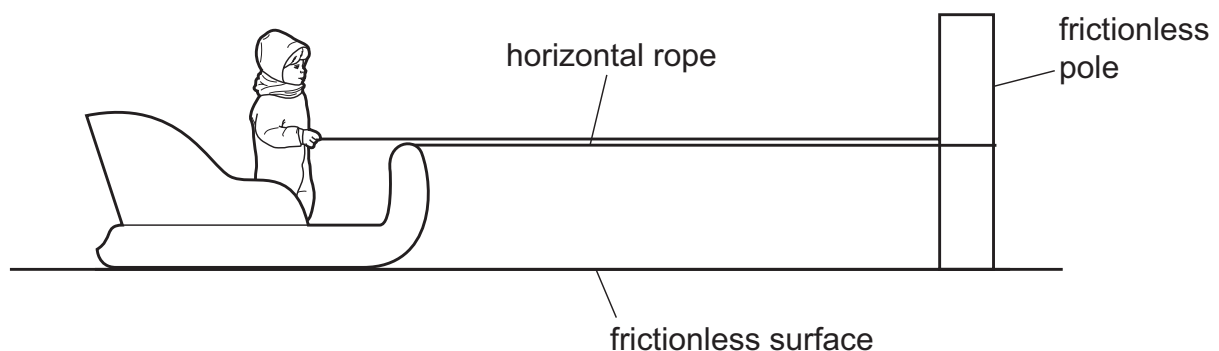
134. Question | 9702 May-June 2022 P1 V2 Q7

- 7 Which statement is **not** a requirement of a pair of forces that obey Newton's third law of motion?
- A The forces act in opposite directions.
 - B The forces act on different objects.
 - C The forces act on objects in contact.
 - D The forces are of equal magnitude.

135. Question | 9702 May-June 2022 P1 V2 Q8

- 8 A child of mass 20 kg stands on the rough surface of a sledge of mass 40 kg. The sledge can slide on a horizontal frictionless surface.

One end of a rope is attached to the sledge. The rope passes around a fixed frictionless pole, and the other end of the rope is held by the child, as shown.



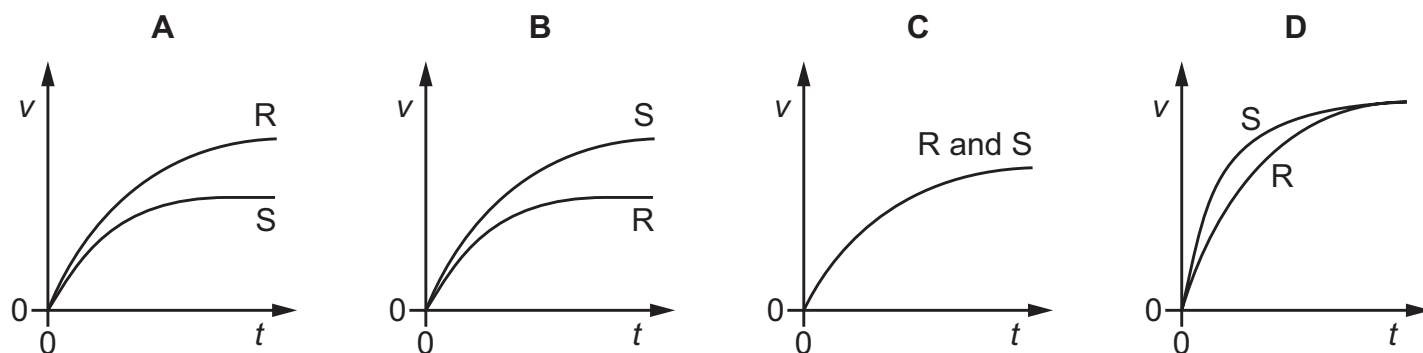
The rope is horizontal. The child pulls on the rope with a horizontal force of 12 N. This causes the child and the sledge to move with equal acceleration towards the pole.

What is the frictional force between the child and the sledge?

- A 4.0 N B 6.0 N C 8.0 N D 12 N

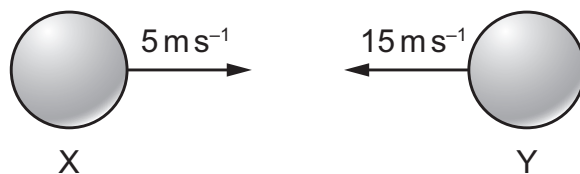
- 9 A stone S and a foam rubber ball R are identical spheres of equal volume. They are released from rest at time $t = 0$ and fall vertically through the air. Both reach terminal velocity.

Which graph best shows the variation with time t of the speed v of the stone and of the rubber ball?



137. Question | 9702 May-June 2022 P1 V2 Q10

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



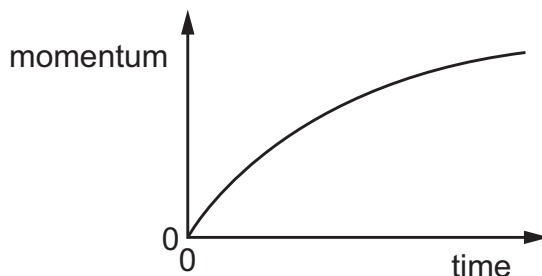
They make a perfectly elastic head-on collision and ball Y moves to the right with a speed of 7 m s^{-1} .

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

138. Question | 9702 May-June 2022 P1 V3 Q8

- 8** A car accelerates from rest. The graph shows the variation of the momentum of the car with time.



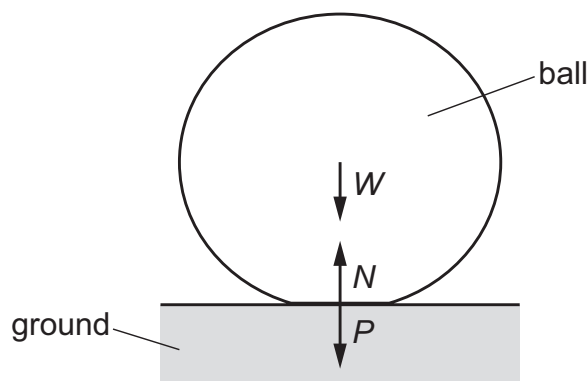
What is the meaning of the gradient of the graph at a particular time?

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

139. Question | 9702 May-June 2022 P1 V3 Q9

9 A ball is dropped onto horizontal ground and bounces vertically upwards. When the ball is in contact with the ground, the following forces act:

- the weight W of the ball
- the contact force P exerted on the ground by the ball
- the contact force N exerted on the ball by the ground.



When the ball is in contact with the ground, the ball is momentarily stationary.

At this instant, which relationship is correct?

- A** $N = P + W$ **B** $N > P + W$ **C** $N = W$ **D** $N > W$

140. Question | 9702 May-June 2022 P1 V3 Q11

11 Skaters of masses 80 kg and 40 kg move directly towards each other and collide.

Before the collision, the heavier skater is moving to the right at a speed of 2.0 m s^{-1} and the lighter skater is moving to the left at a speed of 1.0 m s^{-1} .

After the collision, the heavier skater moves to the right at a speed of 0.80 m s^{-1} .

What is the relative speed of separation of the two skaters?

- A** 0.6 m s^{-1} **B** 1.4 m s^{-1} **C** 2.2 m s^{-1} **D** 2.6 m s^{-1}

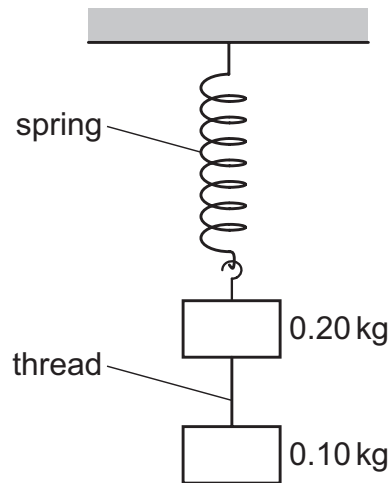
141. Question | 9702 Oct-Nov 2022 P1 V1 Q7

7 What is the definition of linear momentum?

- A force per unit time
- B product of force and time
- C product of velocity and mass
- D velocity per unit mass

142. Question | 9702 Oct-Nov 2022 P1 V1 Q8

8 A mass of 0.20 kg is suspended from the lower end of a light spring. A second mass of 0.10 kg is suspended from the first mass by a thread. The arrangement is allowed to come into static equilibrium and then the thread is cut.



Immediately after the thread is cut, what is the upward acceleration of the 0.20 kg mass?

- A 4.9 ms^{-2} B 6.5 ms^{-2} C 9.8 ms^{-2} D 15 ms^{-2}

143. Question | 9702 Oct-Nov 2022 P1 V1 Q9

- 9** A snowflake and a raindrop are in still air. They both fall from rest at the same time and from the same height, far above the ground.

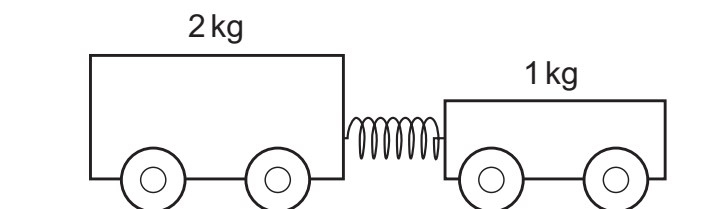
The snowflake and raindrop contain the same mass of water. Assume that there is no evaporation or melting. Also assume that, for a given speed, the drag force acting on the snowflake is greater than the drag force acting on the raindrop.

Which statement about the snowflake and raindrop is correct?

- A** The raindrop takes more time than the snowflake to reach terminal velocity.
- B** The raindrop takes more time than the snowflake to reach the ground.
- C** They reach the same terminal velocity.
- D** They take the same amount of time to reach the ground.

144. Question | 9702 Oct-Nov 2022 P1 V1 Q10

- 10** Two trolleys are held together on a horizontal surface with a compressed spring between them.



When they are released, the trolleys lose contact with the spring. The trolley of mass 2 kg moves to the left at a final speed of 2 m s^{-1} .

How much elastic potential energy was stored in the spring?

- A** 4 J
- B** 6 J
- C** 8 J
- D** 12 J

145. Question | 9702 Oct-Nov 2022 P1 V2 Q8

- 8** A constant resultant force F acts on an object of mass m for time t .

What is the change in momentum of the object?

- A** $\frac{F}{t}$
- B** $\frac{Ft}{m}$
- C** Ft
- D** $\frac{F}{mt}$

146. Question | 9702 Oct-Nov 2022 P1 V2 Q9

- 9 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, an object has a mass of 1.0 kg and a weight of 1.0 N.

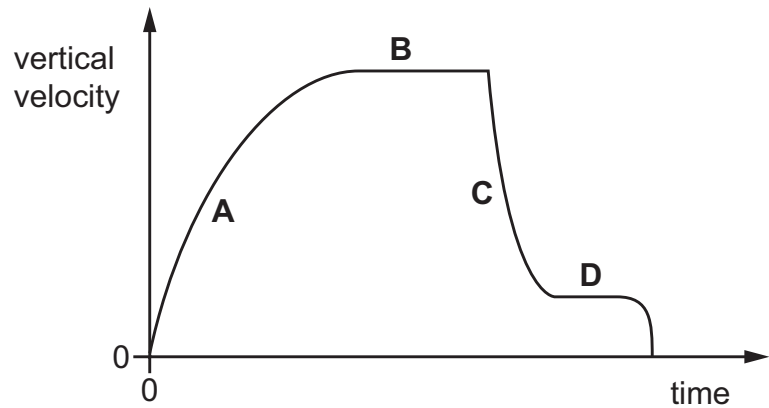
What are the mass and the weight of the same object on the surface of planet Q?

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

147. Question | 9702 Oct-Nov 2022 P1 V2 Q10

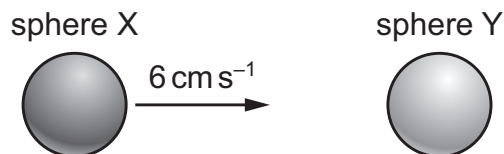
- 10 A parachutist falls from rest from a balloon. The variation with time of the vertical velocity of the parachutist is shown.

In which region is the force due to air resistance much greater than the weight of the parachutist?



148. Question | 9702 Oct-Nov 2022 P1 V2 Q11

- 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}

149. Question | 9702 Oct-Nov 2022 P1 V3 Q7

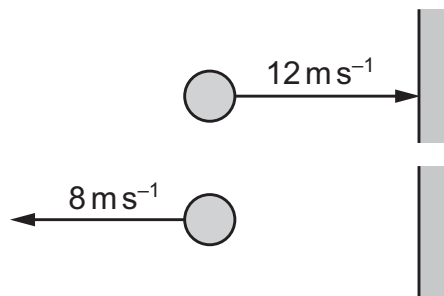
- 7** A cyclist in still air pedals as hard as she can. She reaches a maximum speed. However, after a certain time her maximum speed increases.

What could be a possible cause for this?

- A** She cycles into a wind.
B She cycles over rougher ground.
C She sits more upright on the bicycle.
D She starts to travel downhill.

150. Question | 9702 Oct-Nov 2022 P1 V3 Q8

- 8** A ball of mass 0.5 kg hits a vertical wall at a speed of 12 m s^{-1} . It bounces back along its original path 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?

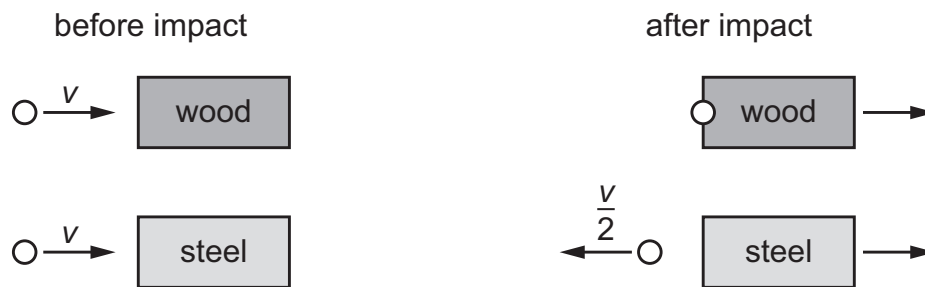
- A** 0.2 N **B** 1 N **C** 20 N **D** 100 N

151. Question | 9702 Oct-Nov 2022 P1 V3 Q10

- 10** Two blocks are at rest on a frictionless horizontal surface. One block is made of wood and the other block is made of steel.

A steel ball is fired horizontally with a speed v at the wooden block. The ball embeds itself in the block, and the ball and block move together after impact.

A second identical steel ball is fired horizontally with speed v at the steel block. The steel ball then rebounds back along its original path with speed $\frac{v}{2}$.



The wooden block and the steel block have equal mass.

Which statement about the blocks immediately after the collisions is correct?

- A** Both blocks must travel with the same speed.
- B** The steel block must travel faster than the wooden block.
- C** The wooden block must travel faster than the steel block.
- D** The masses of the blocks and the steel ball are needed to determine which block travels faster.

152. Question | 9702 Specimen 2022 P1 Q7

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

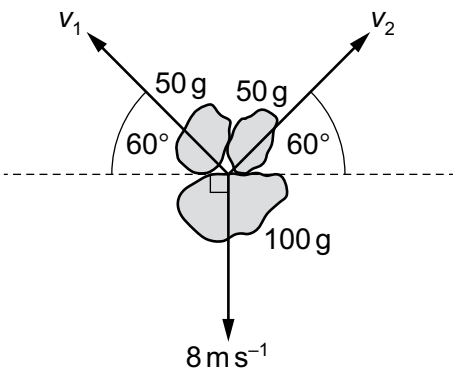
An object weighs 6.0 N on Earth.

What would this object weigh on Pluto?

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

153. Question | 9702 Specimen 2022 P1 Q8

- 8
- A stationary firework explodes into three pieces moving in the same plane. The masses and the velocities of the three pieces immediately after the explosion are shown.

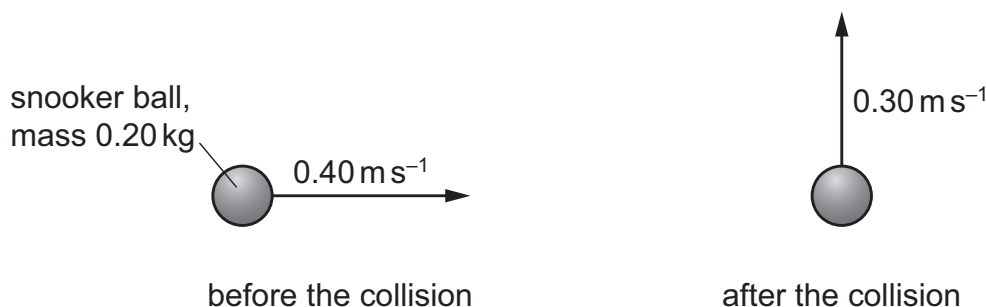


What are speeds v_1 and v_2 ?

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

154. Question | 9702 Feb-March 2023 P1 V2 Q4

- 4 A snooker ball of mass 0.20 kg has a collision so that its direction of movement changes by an angle of 90° , as shown.



The ball has a speed of 0.40 m s^{-1} before the collision and a speed of 0.30 m s^{-1} after the collision.

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

- A 0.020 kg m s^{-1}
- B 0.10 kg m s^{-1}
- C 0.14 kg m s^{-1}
- D 0.50 kg m s^{-1}

155. Question | 9702 Feb-March 2023 P1 V2 Q7

- 7 Which expression defines force?

- A $(\text{mass} \times \text{change in speed}) \times \text{time taken}$
- B $\frac{\text{mass} \times \text{change in speed}}{\text{time taken}}$
- C $(\text{change of momentum}) \times \text{time taken}$
- D $\frac{\text{change of momentum}}{\text{time taken}}$

156. Question | 9702 Feb-March 2023 P1 V2 Q8

- 8 A ship of mass $8.4 \times 10^7 \text{ kg}$ is approaching a harbour with speed 16.4 ms^{-1} . By using reverse thrust it can maintain a constant total stopping force of $920\,000 \text{ N}$.

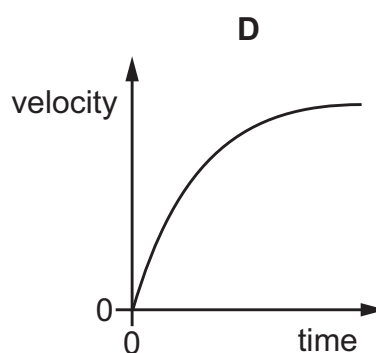
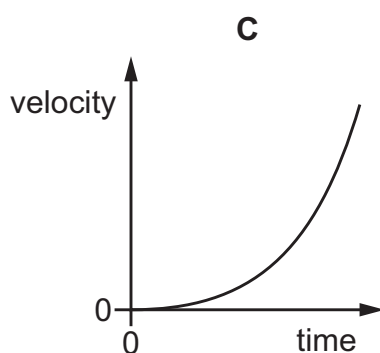
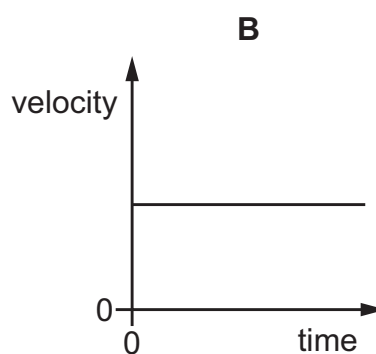
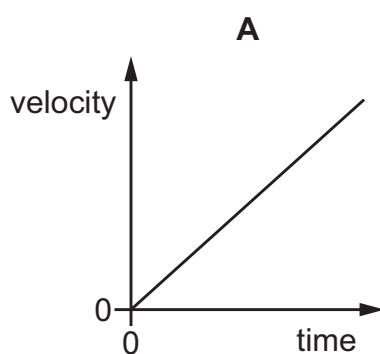
How long will it take to stop?

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

157. Question | 9702 Feb-March 2023 P1 V2 Q9

- 9 The velocity–time graphs of four different objects are shown.

Which graph represents an object falling from rest through a long distance in the Earth's atmosphere?



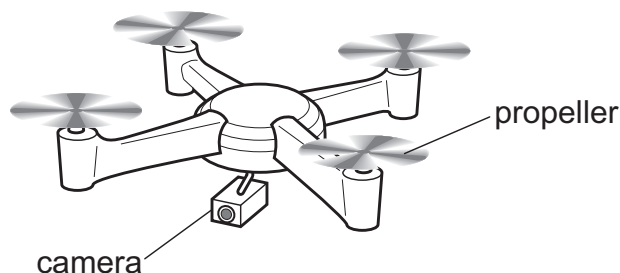
158. Question | 9702 Feb-March 2023 P1 V2 Q10

10 Which statement about collisions is correct?

- A** Kinetic energy is conserved in all collisions.
- B** Momentum is only conserved in perfectly elastic collisions.
- C** The relative speed of approach is equal to the relative speed of separation for perfectly elastic collisions.
- D** When two objects of different masses collide, they exert forces of different magnitudes on each other.

159. Question | 9702 May-June 2023 P1 V1 Q7

- 7** A camera drone of mass 1.20 kg hovers at a fixed point above the ground. The drone has four propellers.



In a time of 1.00 s , each propeller pushes a mass of 0.400 kg of air vertically downwards.

Assume that the air above the propellers is stationary.

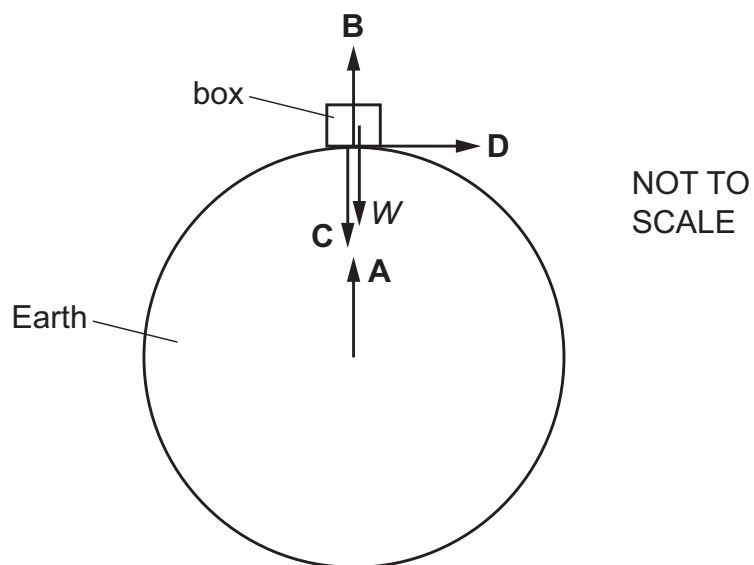
What is the speed of the air leaving each propeller?

- A** 0.750 ms^{-1} **B** 3.00 ms^{-1} **C** 7.36 ms^{-1} **D** 29.4 ms^{-1}

- 8** 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.

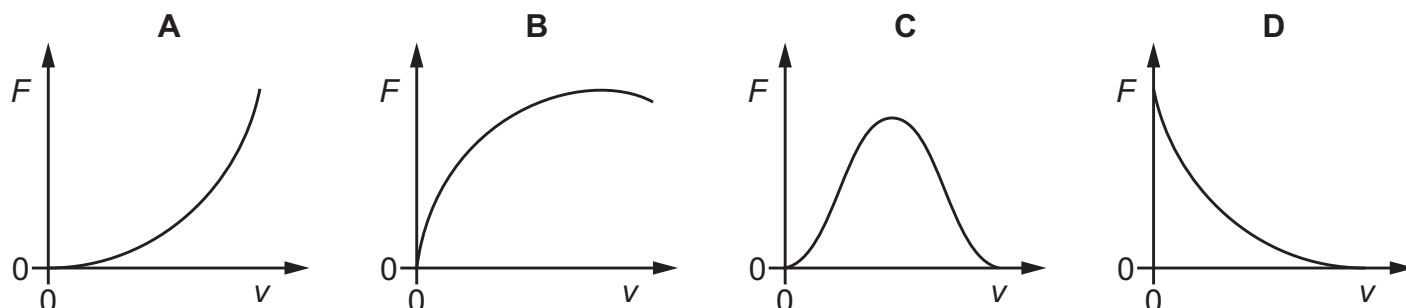
Which arrow represents the other force of this pair?



161. Question | 9702 May-June 2023 P1 V1 Q9

- 9 A small ball is held at the surface of liquid oil in a container. The ball is released from rest and falls through the oil. The ball has velocity v . A viscous (drag) force F acts on the ball.

Which graph could show the variation with v of F ?



162. Question | 9702 May-June 2023 P1 V1 Q10

- 10 An object of mass m , moving at speed u along a frictionless horizontal surface, collides head-on with a stationary object of mass $4m$.



After the collision, the object of mass m rebounds along its initial path with $\frac{1}{4}$ of its kinetic energy before the collision.

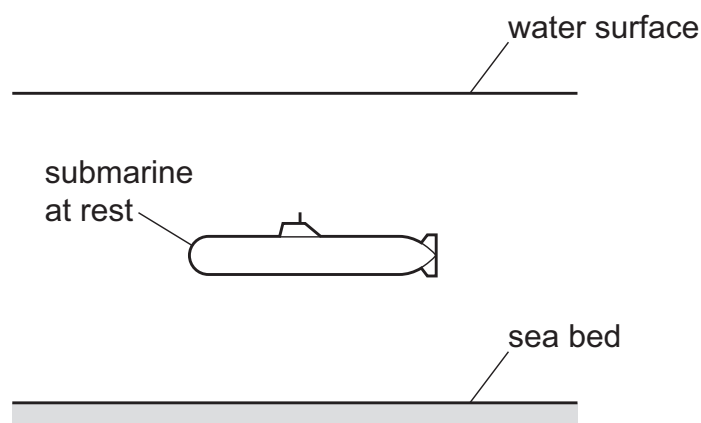
What is the speed of the object of mass $4m$ after the collision?

- A** $\frac{u}{8}$ **B** $\frac{3u}{16}$ **C** $\frac{5u}{16}$ **D** $\frac{3u}{8}$

163. Question | 9702 May-June 2023 P1 V2 Q7

- 7** Which statement 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

- 8** A submarine of total mass 3200 kg is at rest underwater.



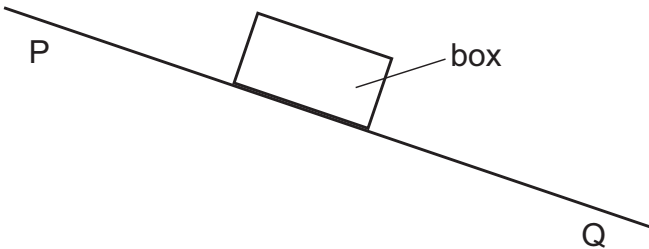
The total mass of the submarine is suddenly decreased by 200 kg by pumping water out of the submarine horizontally in a negligible time. The upthrust acting on the submarine is unchanged.

The change in the total weight of the submarine causes it to accelerate vertically upwards.

What is the initial upwards acceleration of the submarine?

- A** 0.613 ms^{-2} **B** 0.654 ms^{-2} **C** 9.81 ms^{-2} **D** 10.5 ms^{-2}

9 A box in air slides with increasing speed down a rough slope from point P to point Q.



The slope surface exerts a constant frictional force on the box.

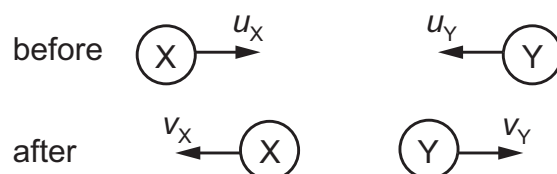
As the box moves from P to Q, there are changes to the magnitudes of its acceleration and the total resistive force acting on it.

Which row describes the changes?

	magnitude of acceleration	magnitude of total resistive force
A	increases	decreases
B	decreases	decreases
C	increases	increases
D	decreases	increases

- 10** Two balls, X and Y, approach each other along the same straight line and collide. The collision is perfectly elastic.

Their initial speeds are u_X and u_Y respectively. After the collision they move apart with speeds v_X and v_Y respectively. Their directions are shown.

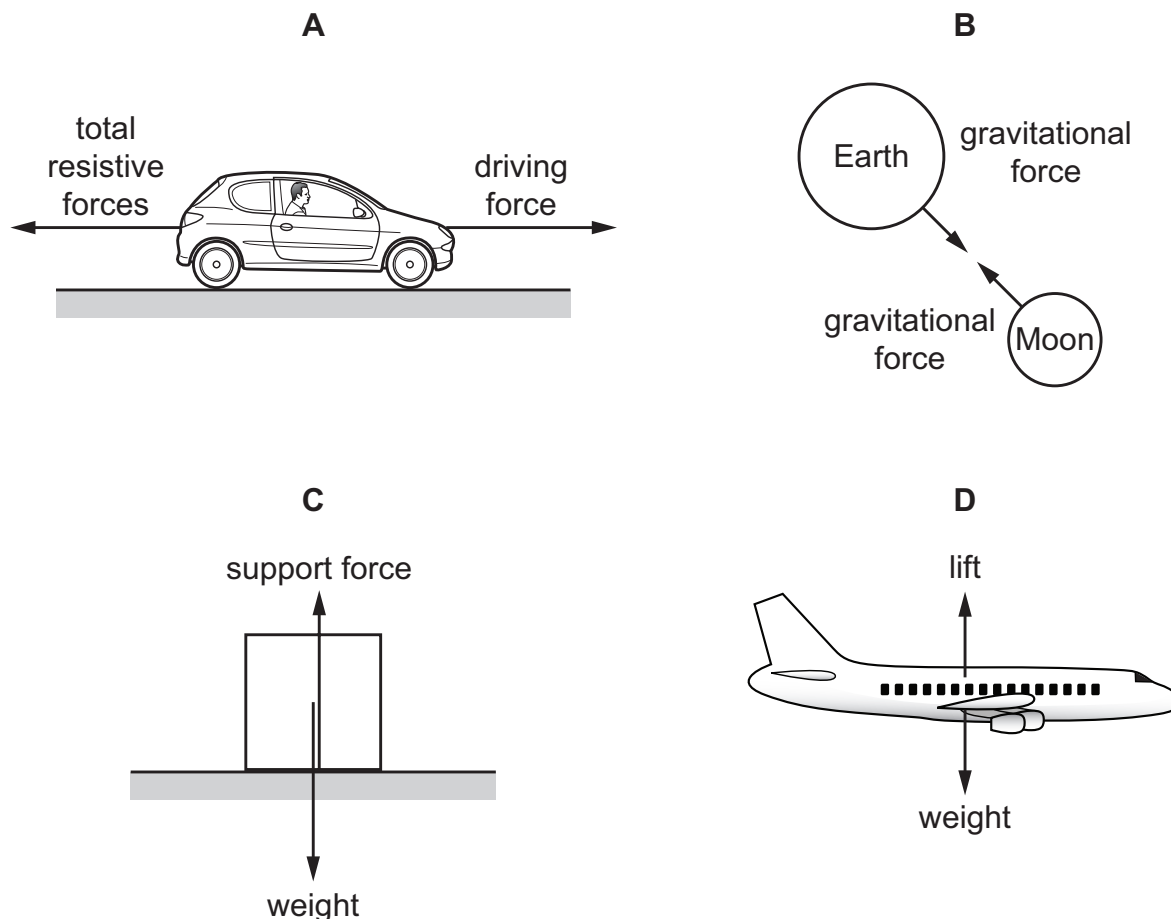


Which equation is correct?

- A** $u_X + u_Y = v_X + v_Y$
- B** $u_X + u_Y = v_X - v_Y$
- C** $u_X - u_Y = v_X + v_Y$
- D** $u_X - u_Y = v_X - v_Y$

8 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?



9 Two balls of identical shape and size but different masses are falling through the same liquid.

The sum of the drag force and upthrust acting on each ball is equal to its weight.

Which statement about the two balls is correct?

- A** The heavier ball has a larger acceleration than the lighter ball.
- B** The heavier ball has a smaller deceleration than the lighter ball.
- C** The heavier ball is falling at the same speed as the lighter ball.
- D** The heavier ball is falling at a larger speed than the lighter ball.

169. Question | 9702 May-June 2023 P1 V3 Q10

- 10** A perfectly elastic collision occurs between two objects X and Y. The mass of X is m and the mass of Y is $4m$. Object X travels at speed v before the collision and speed $\frac{3v}{5}$ in the opposite direction after the collision. Object Y is stationary before the collision.

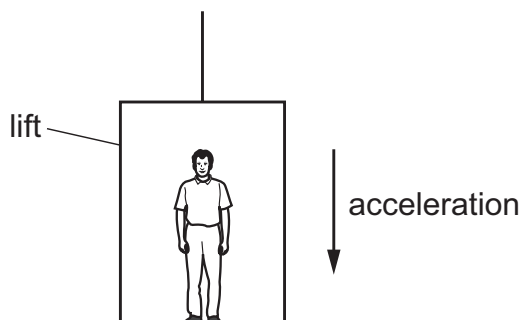


What is the kinetic energy of Y after the collision?

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

170. Question | 9702 Oct-Nov 2023 P1 V1 Q7

- 7** 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.

171. Question | 9702 Oct-Nov 2023 P1 V1 Q8

- 8 A ball of mass 200 g is thrown horizontally with a speed of 20 m s^{-1} against a vertical wall.

The ball is in contact with the wall for a time of 0.10 s before rebounding back along its original path with a speed of 10 m s^{-1} .

What is the average force exerted by the wall on the ball during the collision?

- A 20 N B 60 N C 20 kN D 60 kN

172. Question | 9702 Oct-Nov 2023 P1 V1 Q9

- 9 In an experiment, a metal ball is dropped into a viscous liquid. The terminal velocity of the ball in the liquid is measured.

The experiment is repeated four times. For each repeat, a change is made to one of the following.

- 1 the density of the metal of the ball
- 2 the height from which the ball is dropped
- 3 the density of the liquid
- 4 the depth of the liquid

Which two changes separately affect the terminal velocity of the ball in the liquid?

- A 1 and 2 B 1 and 3 C 2 and 4 D 3 and 4

173. Question | 9702 Oct-Nov 2023 P1 V1 Q10

- 10 Two objects move towards each other along the same straight line.



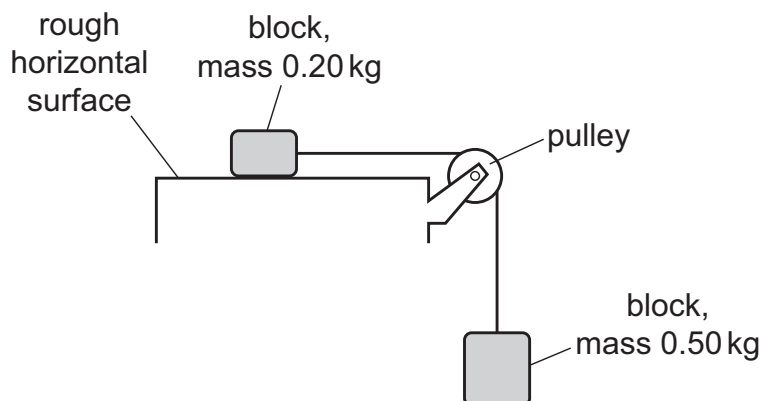
After colliding, the two objects stick together and are stationary.

Which statement **must** be correct?

- A The total kinetic energy of the two objects does not change during the collision.
B The total momentum of the two objects before the collision is zero.
C The two objects have equal mass.
D The two objects have the same speed before the collision.

174. Question | 9702 Oct-Nov 2023 P1 V2 Q7

- 7 Two blocks, of mass 0.20 kg and 0.50 kg, are connected by a light inextensible string that passes over a frictionless pulley.



The blocks are initially held stationary. The block of mass 0.20 kg rests on a rough horizontal surface.

The block of mass 0.50 kg is suspended in air. Air resistance is negligible.

When the blocks are released, they have an acceleration of magnitude 2.0 m s^{-2} .

What is the magnitude of the frictional force between the block of mass 0.20 kg and the rough surface?

- A** 3.5 N **B** 3.9 N **C** 4.5 N **D** 6.3 N

175. Question | 9702 Oct-Nov 2023 P1 V2 Q8

- 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

176. Question | 9702 Oct-Nov 2023 P1 V2 Q9

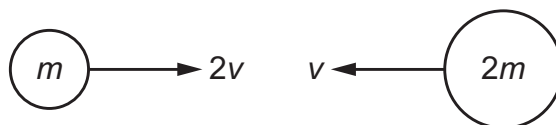
- 9 An object falls from a stationary helicopter and reaches terminal velocity.

What happens to the acceleration of the object between leaving the helicopter and reaching terminal velocity?

- A It decreases to 9.81 m s^{-2} .
- B It decreases to zero.
- C It increases to 9.81 m s^{-2} .
- D It remains constant at 9.81 m s^{-2} .

177. Question | 9702 Oct-Nov 2023 P1 V2 Q10

- 10 Two balls, of masses m and $2m$, travelling in a vacuum with initial velocities $2v$ and v respectively, collide with each other head-on, as shown.



After the collision, the ball of mass m rebounds to the left with velocity v .

What is the loss of kinetic energy in the collision?

- A $\frac{3}{4}mv^2$
- B $\frac{3}{2}mv^2$
- C $\frac{9}{4}mv^2$
- D $\frac{9}{2}mv^2$

178. Question | 9702 Oct-Nov 2023 P1 V3 Q7

- 7 Which statement about mass is correct?

- A Mass has a magnitude and a direction.
- B Mass resists changes in motion.
- C The greater the mass of an object, the greater its acceleration when falling in a vacuum.
- D The mass of an object depends on its location.

179. Question | 9702 Oct-Nov 2023 P1 V3 Q8

- 8 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 ms^{-1} and then leaves it with a speed of 7.0 ms^{-1} . The ball and the cushion are in contact for a time of 0.60 s.

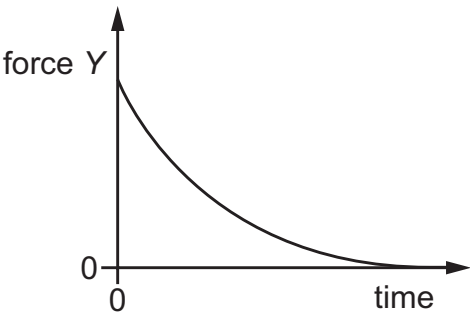
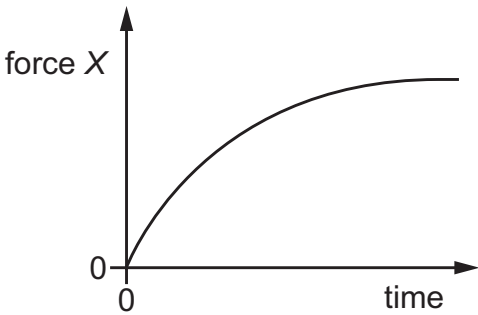
What is the average force exerted on the ball by the cushion?

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

180. Question | 9702 Oct-Nov 2023 P1 V3 Q9

- 9 A ball falls from rest through air and eventually reaches a constant velocity.

For this fall, forces X and Y vary with time as shown.



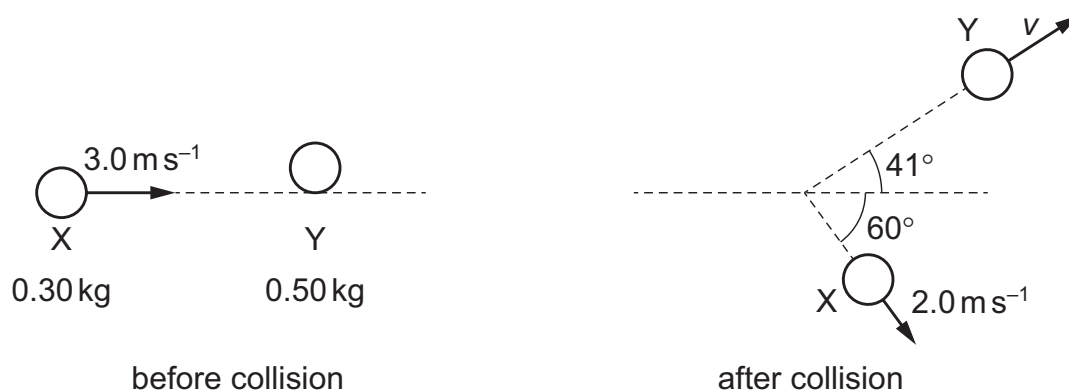
What could be forces X and Y ?

	force X	force Y
A	air resistance	resultant force
B	air resistance	weight
C	upthrust	resultant force
D	upthrust	weight

181. Question | 9702 Oct-Nov 2023 P1 V3 Q10

- 10** An object X of mass 0.30 kg is travelling in a straight line at a constant velocity of 3.0 ms^{-1} on a horizontal frictionless surface. Object X collides with a stationary object Y of mass 0.50 kg .

After the collision, X moves with a velocity of 2.0 ms^{-1} at an angle of 60° to its direction before the collision. Object Y moves with a velocity v at an angle of 41° to the direction of X before the collision, as shown.



What is the value of v ?

- A** 0.80 ms^{-1} **B** 1.2 ms^{-1} **C** 1.6 ms^{-1} **D** 1.8 ms^{-1}

182. Question | 9702 Feb-March 2024 P1 V2 Q2

- 2** A car of mass 850 kg is travelling in a horizontal straight line. The diagram shows the two horizontal forces acting on the car in opposite directions.



One force has magnitude 1200 N , and the other force has magnitude 1600 N .

What is the magnitude of the acceleration of the car?

- A** 0.47 ms^{-2} **B** 1.4 ms^{-2} **C** 1.9 ms^{-2} **D** 3.3 ms^{-2}

183. Question | 9702 Feb-March 2024 P1 V2 Q4

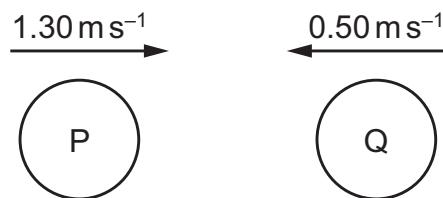
- 4 An object of fixed mass is initially at rest at point P. The object then moves away from point P with uniform acceleration.

Which statement describes the resultant force acting on the object when it is moving?

- A It increases uniformly with respect to time.
- B It is constant but not zero.
- C It is proportional to the displacement from point P.
- D It is zero.

184. Question | 9702 Feb-March 2024 P1 V2 Q8

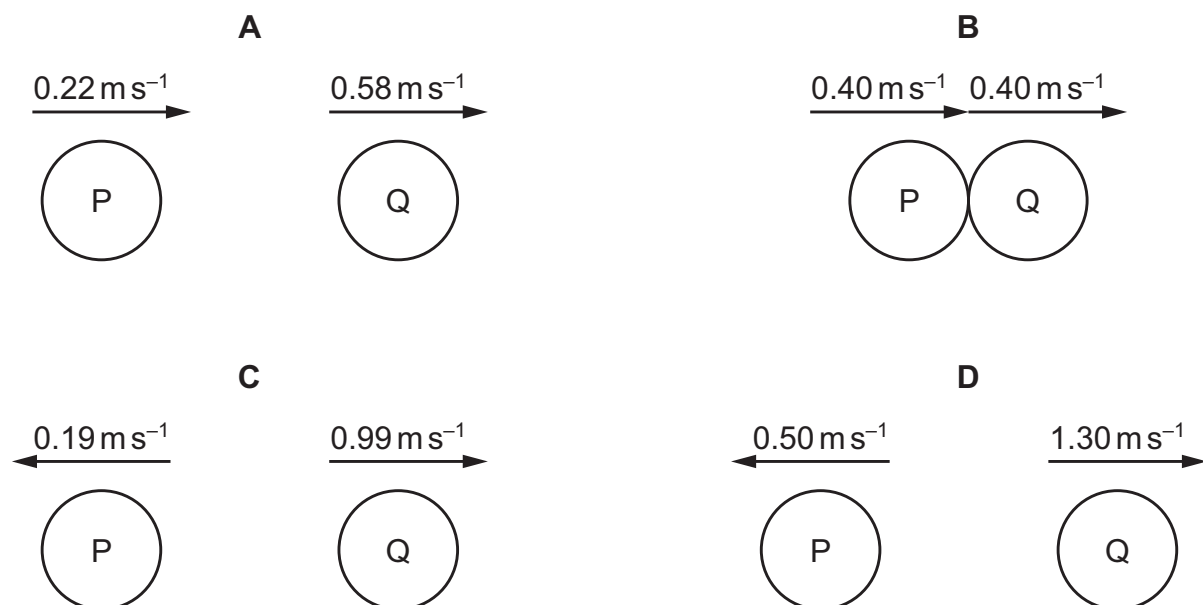
- 8 Two balls P and Q, of equal mass, move along a straight line directly towards each other as shown.



Ball P has velocity 1.30 m s^{-1} to the right. Ball Q has velocity 0.50 m s^{-1} to the left.

P and Q collide with one another. The collision is perfectly elastic and the total momentum is conserved.

Which diagram correctly shows the motion of P and Q after the collision?



185. Question | 9702 Feb-March 2024 P1 V2 Q11

- 11** Some small solid cubes each have mass 1.0 kg and sides of length 5.0 cm . These small cubes are stacked together to form a large solid cube with sides of length 2.0 m .

What is the weight of the large cube?

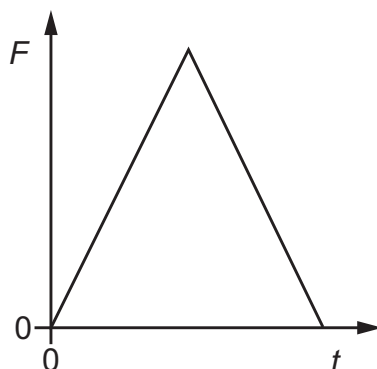
- A** 0.39 kN **B** 0.39 MN **C** 0.63 MN **D** 0.63 GN

186. Question | 9702 Feb-March 2024 P1 V2 Q15

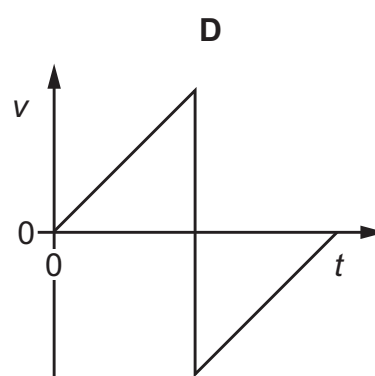
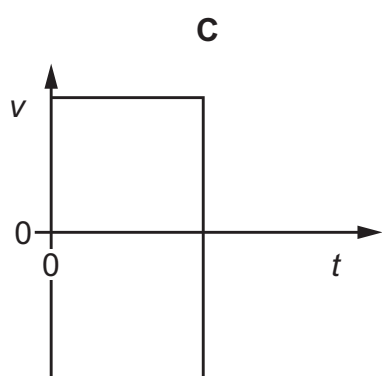
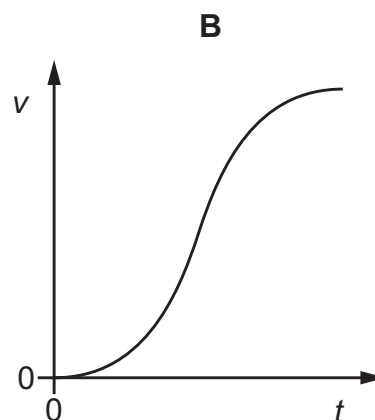
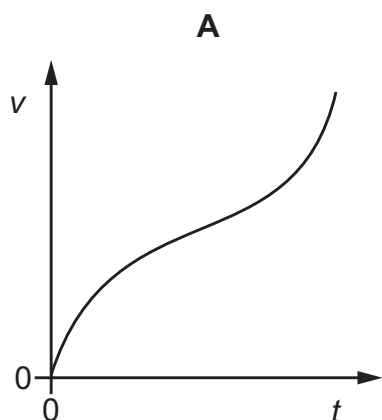
- 15** What is the definition of force?

- A** the product of mass and acceleration
B the product of mass and velocity
C the rate of change of momentum
D the rate of transfer of energy

- 9 A golf club hits a golf ball. The graph shows how the force F on the ball varies with time t .



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



10 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
B	the gravitational force on it	the 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

12 Spheres X and Y form an isolated system. The mass of Y is greater than the mass of X.

Sphere Y is initially stationary.

Sphere X collides elastically with sphere Y.

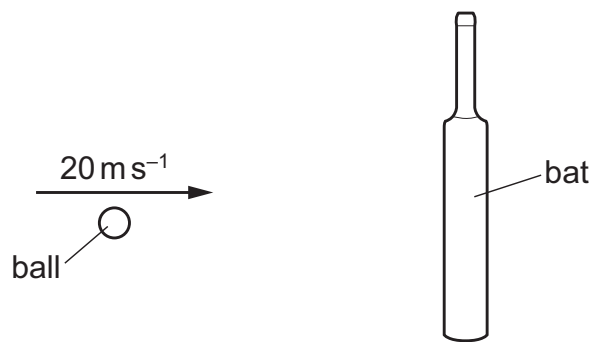
The speed of sphere X before the collision is u .

Which statement **must** be correct?

- A Sphere X rebounds with a speed that is greater than u , and sphere Y moves off with a speed that is less than u .
- B Sphere X rebounds with a speed that is less than u , and sphere Y moves off with a speed that is also less than u .
- C Sphere X rebounds with speed u , and sphere Y remains stationary.
- D Sphere X remains stationary, and sphere Y moves off with a speed that is less than u .

190. Question | 9702 May-June 2024 P1 V1 Q13

13 A ball of mass 0.10 kg is thrown towards a stationary vertical bat. The ball hits the bat with a horizontal velocity of 20 m s^{-1} .



The ball rebounds and leaves the bat with a horizontal velocity of 15 m s^{-1} .

What is the change in momentum of the ball?

- A** 0.20 N s **B** 0.50 N s **C** 1.5 N s **D** 3.5 N s

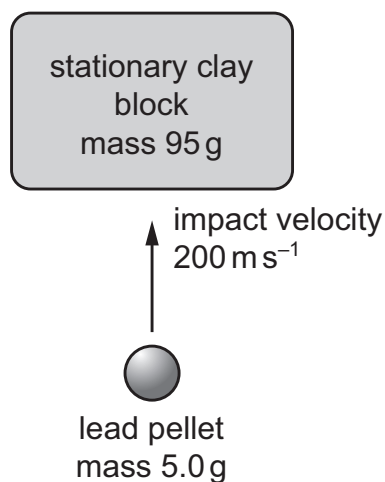
191. Question | 9702 May-June 2024 P1 V2 Q7

7 Two satellites in deep space collide inelastically.

What happens to the total kinetic energy and total momentum?

	total kinetic energy	total momentum
A	conserved	conserved
B	conserved	reduced
C	reduced	conserved
D	reduced	reduced

- 10** 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 mass of the pellet is 5.0 g and the mass of the clay block is 95 g.

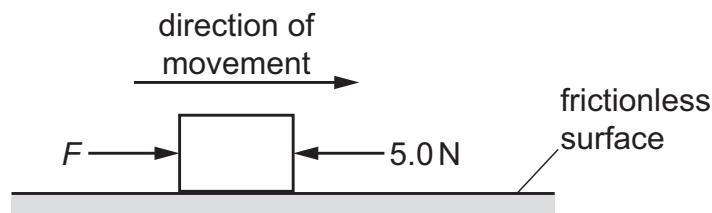
The pellet hits the block with an initial vertical velocity of 200 m s^{-1} . It embeds itself in the block and does not emerge.

How high above its initial position will the block rise?

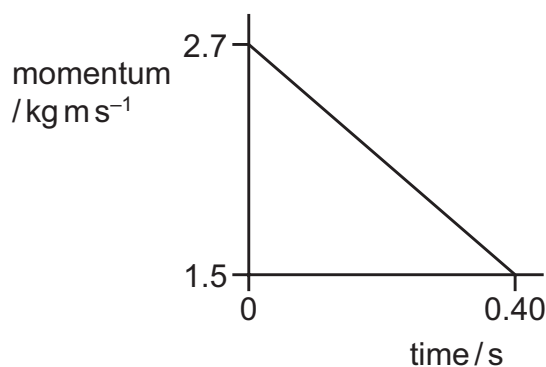
- A** 5.1 m **B** 5.6 m **C** 10 m **D** 100 m

193. Question | 9702 May-June 2024 P1 V3 Q6

- 6 A block is moving along a horizontal frictionless surface. A constant force F and a constant resistive force of 5.0 N 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** 2.0 N **B** 3.0 N **C** 5.0 N **D** 8.0 N

194. Question | 9702 May-June 2024 P1 V3 Q7

- 7 Newton's third law describes two forces that are equal in magnitude and form a pair.

Which description of the two forces in such a pair is **not** correct?

- A** They act in opposite directions.
B They act on different objects.
C They are the same type of force.
D They cause an object to be in equilibrium.

195. Question | 9702 May-June 2024 P1 V3 Q9

- 9** Which statement about a perfectly elastic collision between two objects is correct?
- A** Total kinetic energy is conserved and the relative speed of approach equals the relative speed of separation.
 - B** Total kinetic energy is conserved but the relative speed of approach does **not** equal the relative speed of separation.
 - C** Total kinetic energy is **not** conserved and the relative speed of approach does **not** equal the relative speed of separation.
 - D** Total kinetic energy is **not** conserved but the relative speed of approach does equal the relative speed of separation.

196. Question | 9702 May-June 2024 P1 V3 Q12

- 12** The total number of forces acting on an object is two. The object is in equilibrium.

Which statements about the forces are correct?

- 1 The two forces must have equal magnitudes.
- 2 The two forces must act in the same direction.
- 3 The two forces must act through the same point.

- A** 1 and 2 only **B** 1 and 3 only **C** 2 and 3 only **D** 1, 2 and 3

197. Question | 9702 Oct-Nov 2024 P1 V1 Q7

- 7** A car of mass 1200 kg has momentum $18\,000\text{ kg m s}^{-1}$.

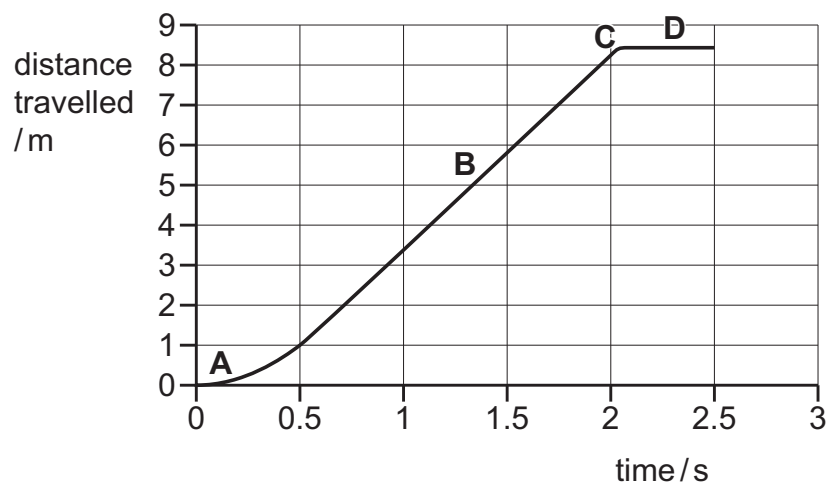
What is the kinetic energy of the car?

- A** 4.65 kJ **B** 6.57 kJ **C** 135 kJ **D** 270 kJ

9 A toy parachute is dropped from a bridge and falls vertically through the air.

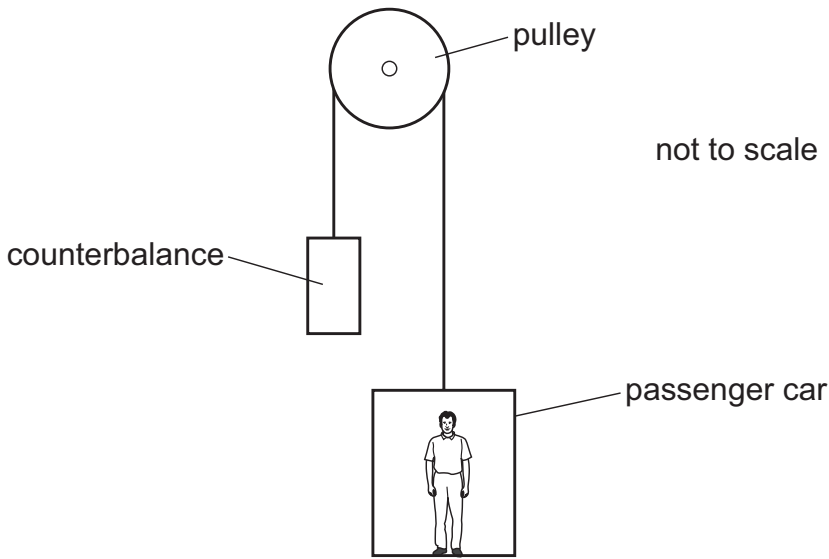
The graph shows the distance travelled by the parachute against time.

Which region of the graph shows when the parachute is at terminal velocity?



199. Question | 9702 Oct-Nov 2024 P1 V1 Q10

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



Some masses are shown in the table.

	mass / kg
passenger car	520
counterbalance	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 ms^{-2} **B** 0.32 ms^{-2} **C** 0.61 ms^{-2} **D** 0.65 ms^{-2}

200. Question | 9702 Oct-Nov 2024 P1 V1 Q11

11 A stationary ball of mass m is hit by a bat. The ball leaves the bat with velocity v .

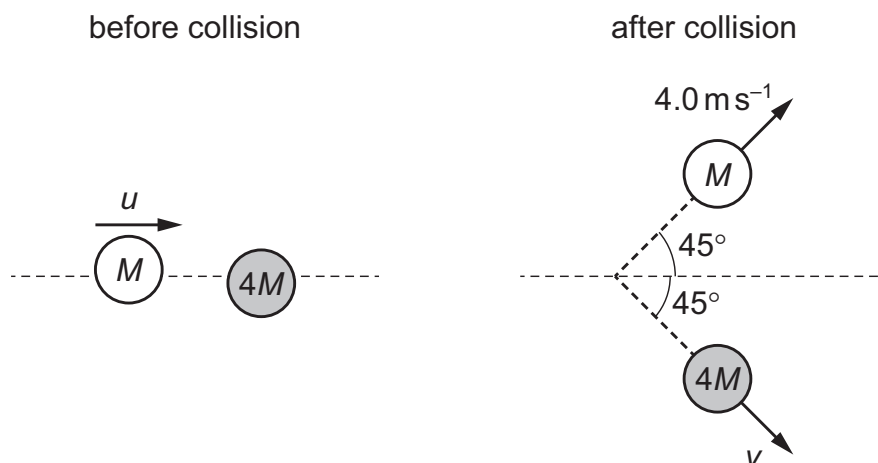
The bat is in contact with the ball for a short time Δt .

What is the average force of the bat on the ball?

- A** $mv\Delta t$ **B** $\frac{mv}{\Delta t}$ **C** $\frac{1}{2}mv^2\Delta t$ **D** $\frac{\frac{1}{2}mv^2}{\Delta t}$

- 12** 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** 1.1 m s^{-1} **B** 1.4 m s^{-1} **C** 3.5 m s^{-1} **D** 5.7 m s^{-1}

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

Assume that the two objects form an isolated system.

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

203. Question | 9702 Oct-Nov 2024 P1 V2 Q9

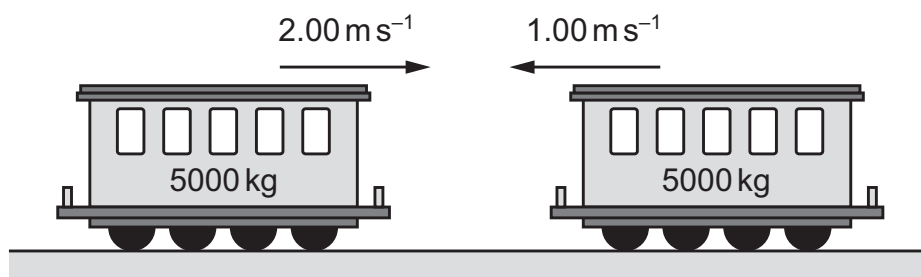
9 A ball of mass 2.0 kg travels horizontally with a speed of 4.0 ms^{-1} . The ball collides with a wall and rebounds in the opposite direction with a speed of 2.8 ms^{-1} . The time of the collision is 150 ms .

What is the average force exerted on the wall?

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

204. Question | 9702 Oct-Nov 2024 P1 V2 Q10

10 Two train carriages each of mass 5000 kg roll toward one another on a horizontal frictionless track. One is travelling at a speed of 2.00 m s^{-1} and the other at a speed of 1.00 m s^{-1} , as shown.

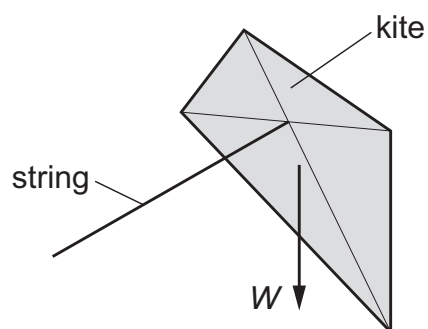


They collide and join together.

What is the kinetic energy lost during the collision?

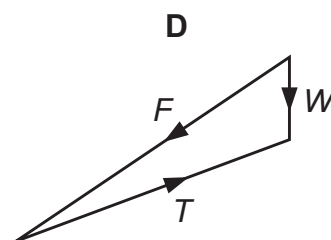
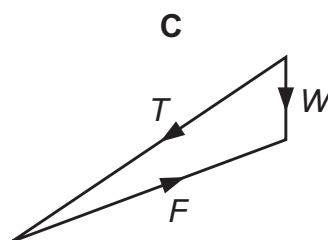
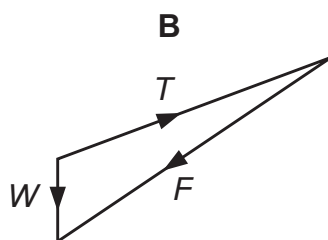
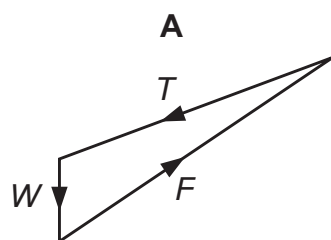
A 1250 J **B** 7500 J **C** 11250 J **D** 12500 J

12 A kite is in equilibrium at the end of a string, as shown.



The kite has three forces acting on it: the weight W , the tension T in the string, and the force F from the wind.

Which vector diagram represents the forces acting on the kite?

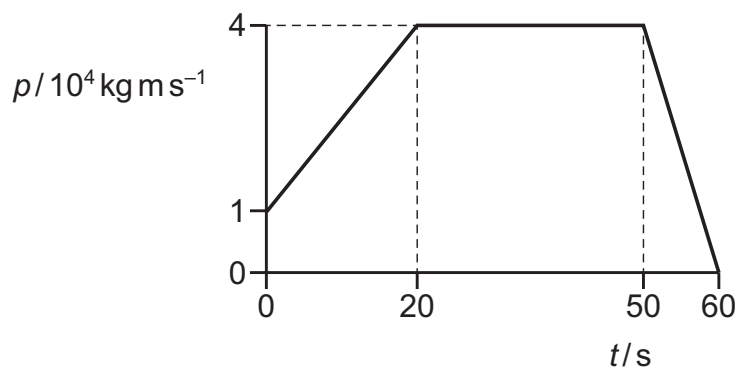


206. Question | 9702 Oct-Nov 2024 P1 V3 Q6

- 6 In which example is it **not** possible for the underlined object to be in equilibrium?
- A An aeroplane climbs at a steady rate.
 - B An aeroplane tows a glider at a constant altitude.
 - C A speedboat changes direction at a constant speed.
 - D Two boats tow a ship into harbour.

207. Question | 9702 Oct-Nov 2024 P1 V3 Q9

- 9 The graph shows the variation of the momentum p with time t for a car.



What is the resultant force on the car at $t = 10$ s?

- A 0 B 1500 N C 2000 N D 4000 N

208. Question | 9702 Oct-Nov 2024 P1 V3 Q10

- 10 Two objects X and Y form an isolated system. X and Y collide and then separate. The mass of X is greater than the mass of Y.

Which statement about the collision is correct?

- A The change of momentum of Y is greater than the change of momentum of X.
- B The force on Y is greater than the force on X.
- C The forces that X and Y exert on each other act for the same length of time.
- D The forces that X and Y exert on each other are gravitational forces only.

209. Question | 9702 Oct-Nov 2024 P1 V3 Q11

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

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

210. Question | 9702 Oct-Nov 2024 P1 V3 Q12

12 A tennis ball is thrown vertically upwards. The tennis ball reaches its highest point and then falls back down to the point from which it was thrown.

Air resistance is significant.

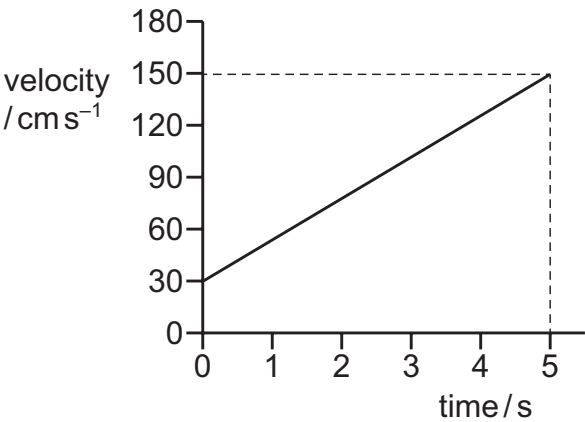
At which position on the path of the tennis ball is the resultant force on the tennis ball greatest?

- A at the start just after the tennis ball is released
- B when the tennis ball is halfway to its highest point on the way up
- C when the tennis ball is at its highest point
- D when the tennis ball is halfway from its highest point on the way down

211. Question | 9702 Feb-March 2025 P1 V2 Q3

3 A car is accelerated by a constant resultant force of 300 N for 5.0 s.

The variation with time of the velocity, in cm s^{-1} , of the car is shown.



What is the mass of the car?

- A 13 kg B 1000 kg C 1300 kg D 10 000 kg

212. Question | 9702 Feb-March 2025 P1 V2 Q6

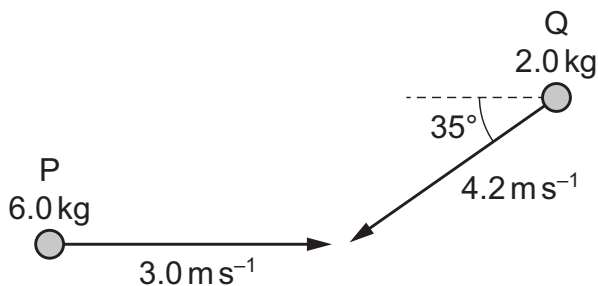
- 6** What is a statement of the principle of conservation of momentum for a system?
- A** The total momentum and the total kinetic energy are always conserved.
 - B** The total momentum is conserved only in elastic collisions.
 - C** The total momentum is conserved provided that no external forces act.
 - D** The total momentum of each object in the system is the product of its mass and velocity.

213. Question | 9702 Feb-March 2025 P1 V2 Q7

- 7** 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}

214. Question | 9702 Feb-March 2025 P1 V2 Q8

8 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 $0.2g$?

- A** $1.2mg$ **B** mg **C** $0.8mg$ **D** 0

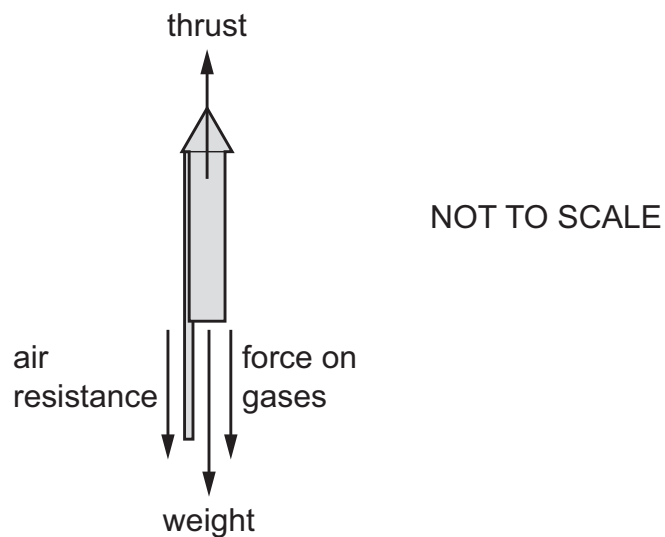
215. Question | 9702 May-June 2025 P1 V1 Q9

9 What is always conserved in elastic collisions?

	total kinetic energy	total velocity
A	yes	yes
B	yes	no
C	no	yes
D	no	no

- 10** A firework travels vertically upwards in air. Gases are pushed vertically downwards from the firework.

Several forces that act on the firework and gases are shown.



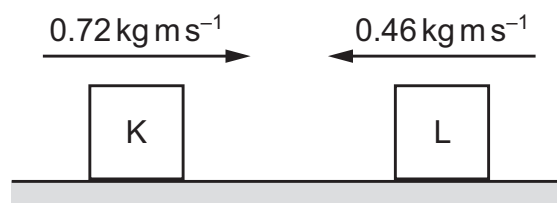
Which forces are a Newton's third law pair?

- A** air resistance and force on gases
- B** air resistance and thrust
- C** force on gases and thrust
- D** thrust and weight

217. Question | 9702 May-June 2025 P1 V1 Q11

- 11** Two blocks K and L slide towards each other along a horizontal frictionless surface.

The diagram shows the momentum of the two blocks just before they collide.



During the collision, the blocks are in contact with each other for a time of 0.084 s .

After the collision, the blocks separate and block L moves back along its original path with a momentum of 0.12 kg m s^{-1} .

What is the magnitude of the average force exerted on block L by block K during the collision?

- A** 3.1 N **B** 4.0 N **C** 6.9 N **D** 7.1 N

218. Question | 9702 May-June 2025 P1 V2 Q7

- 7** A solid object of mass 1.0 kg falls vertically downwards in a vacuum.

When the speed of the object is 60 m s^{-1} , an additional constant force of 50 N suddenly starts to act vertically upwards on the object.

What is the speed of the object 2.0 s after the additional force starts to act?

- A** 20 m s^{-1} **B** 40 m s^{-1} **C** 80 m s^{-1} **D** 100 m s^{-1}

219. Question | 9702 May-June 2025 P1 V2 Q9

- 9** A rocket engine ejects 90 kg of exhaust gas per second at a velocity of 190 ms^{-1} relative to the rocket.

What is the force acting on the rocket due to the ejected gas?

- A** 2.1 kN **B** 17 kN **C** 18 kN **D** 162 kN

220. Question | 9702 May-June 2025 P1 V2 Q10

- 10** Which statement does **not** describe an elastic collision between two objects?
- A** The relative speed of approach of the two objects equals the relative speed of separation.
- B** The total kinetic energy of the objects is conserved.
- C** The total kinetic energy of the objects is reduced.
- D** The total linear momentum of the objects is conserved.

221. Question | 9702 May-June 2025 P1 V2 Q11

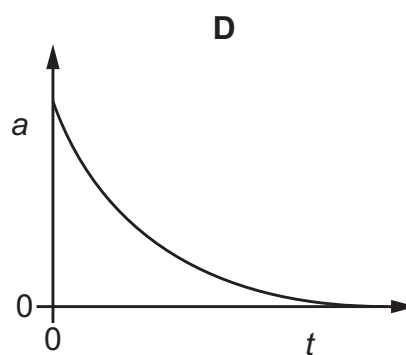
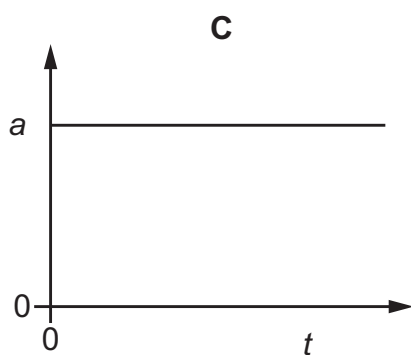
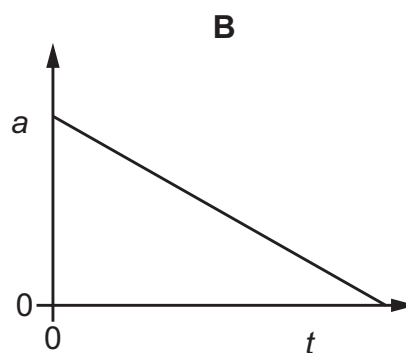
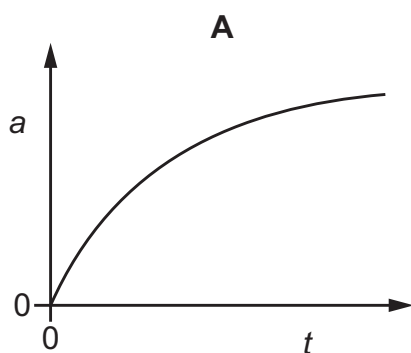
- 11** A cyclist is riding at a constant speed on a level road.

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

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

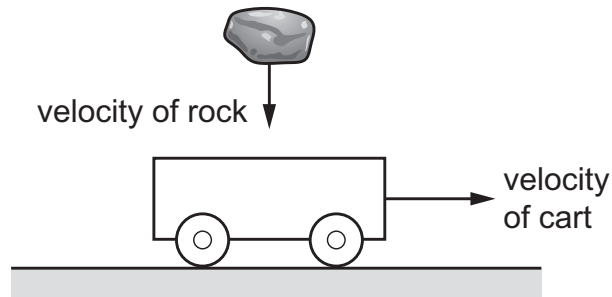
Which graph could show the variation with time t of the acceleration a of the stone?



13 An empty cart is moving along a horizontal track at a constant velocity.

Resistive forces acting on the cart are negligible.

A heavy rock is dropped vertically into the cart.



The cart continues to move horizontally with the rock inside.

How does the momentum and kinetic energy of the cart with the rock inside compare with the momentum and kinetic energy of the empty cart?

- A** The cart with the rock inside has a smaller momentum and a smaller kinetic energy.
- B** The cart with the rock inside has a smaller momentum and the same kinetic energy.
- C** The cart with the rock inside has the same momentum and a smaller kinetic energy.
- D** The cart with the rock inside has the same momentum and the same kinetic energy.

224. Question | 9702 May-June 2025 P1 V3 Q8

8 Two spheres are released from rest at equal heights above the ground.

Both spheres reach terminal velocity.

One sphere has a larger density than the other sphere.

Both spheres have equal volumes.

Which statement is correct while both spheres are at terminal velocity?

- A** The drag forces on the spheres are equal.
- B** The resultant forces on the spheres are equal.
- C** The velocities of the spheres are equal.
- D** The weights of the spheres are equal.

225. Question | 9702 May-June 2025 P1 V3 Q9

9 Which statement **defines** force?

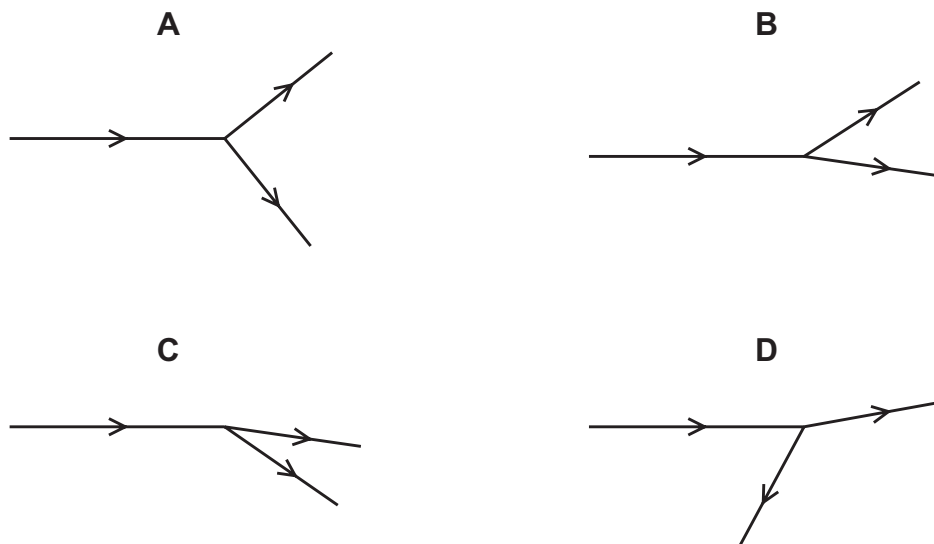
- A** When a force acts on a body that is free to move, the force is the product of the mass of the body and its acceleration.
- B** When a force acts on a body that is free to move, the force is the rate of change of momentum of the body.
- C** When a force acts on a body that is free to move, the force 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.

226. Question | 9702 May-June 2025 P1 V3 Q11

- 11** 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?



227. Question | 9702 May-June 2025 P1 V4 Q7

- 7** Which word equation is **not** correct?

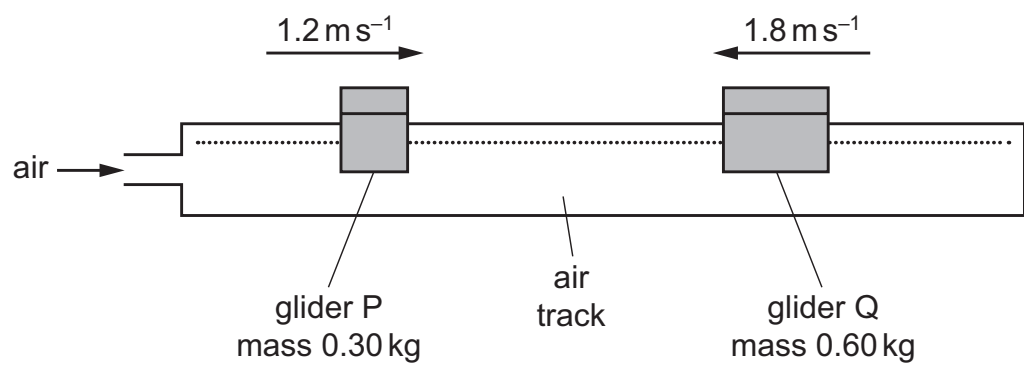
- A** force = change of momentum
- B** force = mass $\times$ acceleration
- C** force = $\frac{\text{moment}}{\text{perpendicular distance from the pivot}}$
- D** force = $\frac{\text{work done}}{\text{displacement in the direction of the force}}$

- 8** A skydiver is falling vertically with terminal velocity when their parachute opens fully.

Which statement describes the motion of the skydiver for the first few seconds after the parachute opens fully?

- A** falling with non-uniform acceleration and increasing speed
- B** falling with non-uniform acceleration and decreasing speed
- C** falling with uniform acceleration and increasing speed
- D** falling with uniform acceleration and decreasing speed

- 9 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} .



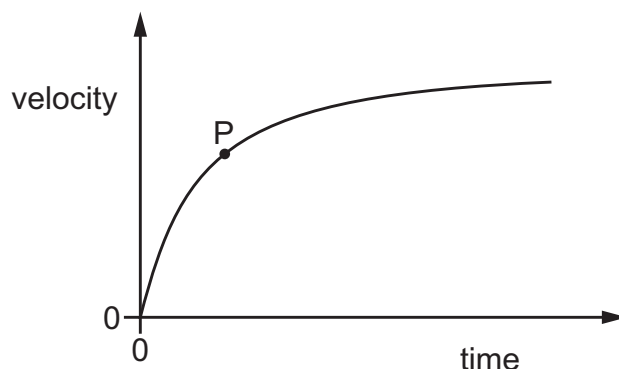
The gliders have a perfectly elastic collision.

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

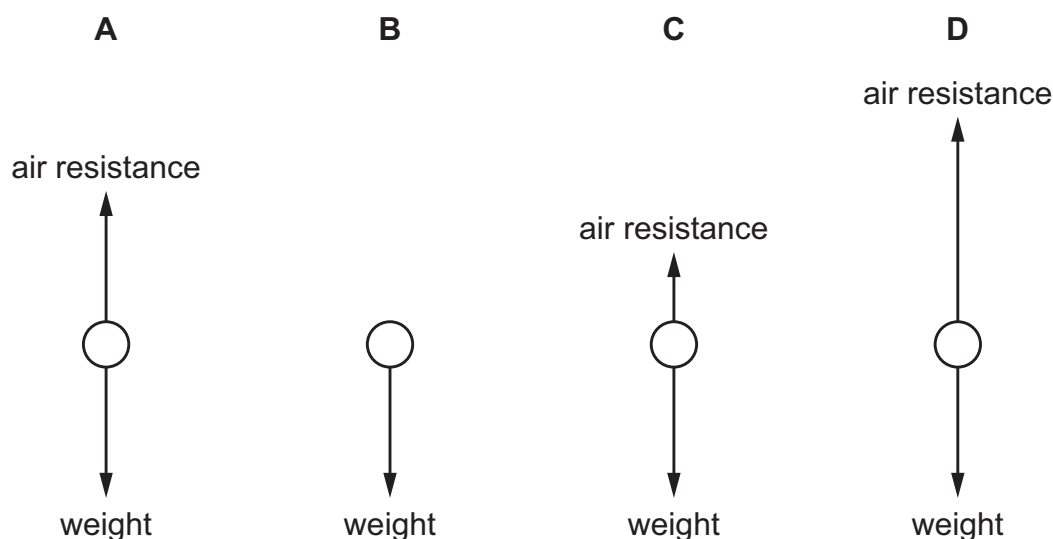
	speed of P / m s^{-1}	speed of Q / m s^{-1}
A	1.2	0.6
B	2.0	1.4
C	2.8	0.2
D	3.6	0.6

230. Question | 9702 Oct-Nov 2025 P1 V1 Q8

- 8 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?



231. Question | 9702 Oct-Nov 2025 P1 V1 Q9

- 9 In which situation is total linear momentum **always** conserved?
- A in all collisions between two objects
 - B in collisions between two objects moving at equal and opposite velocity
 - C in collisions between two objects that form an isolated system
 - D in collisions between two objects with the same mass

232. Question | 9702 Oct-Nov 2025 P1 V1 Q10

- 10** An object of mass m moving with velocity 9.0 ms^{-1} has a head-on elastic collision with a stationary object of mass $2m$.

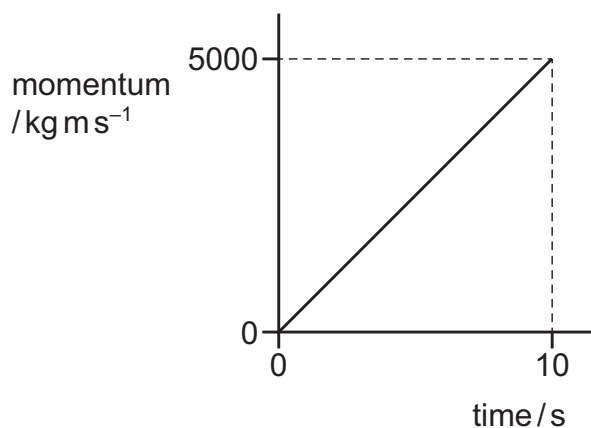
After the collision, both objects are moving. No external forces act on the system.

What is the velocity of the object of mass $2m$ after the collision?

- A** -6.0 ms^{-1} **B** -3.0 ms^{-1} **C** 4.5 ms^{-1} **D** 6.0 ms^{-1}

233. Question | 9702 Oct-Nov 2025 P1 V1 Q11

- 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

234. Question | 9702 Oct-Nov 2025 P1 V1 Q12

- 12** A rocket has a weight of W and an initial acceleration of a as the rocket leaves the ground vertically. The acceleration of free fall is g .

Which expression gives the initial upward force exerted on the rocket due to the engine?

- A** $\frac{Wa}{g} + W$ **B** $\frac{Wa}{g}$ **C** $\frac{Wa}{g} - W$ **D** $Wa + W$

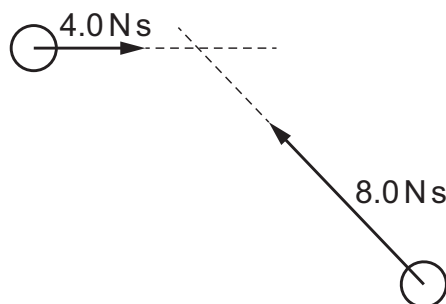
235. Question | 9702 Oct-Nov 2025 P1 V2 Q8

- 8** Which statement describes the weight of an object?
- A** It is equal to the mass of the object multiplied by its acceleration.
 - B** It is equal to the resultant force when the object falls at terminal (constant) velocity.
 - C** It is the force acting on the object due to a gravitational field.
 - D** It is the property of the object that resists change in motion.

236. Question | 9702 Oct-Nov 2025 P1 V2 Q9

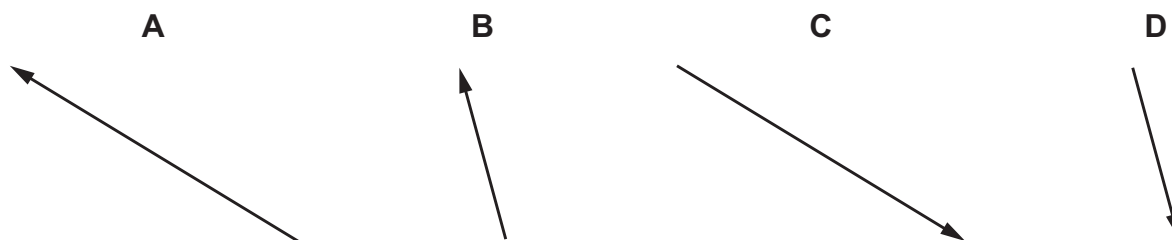
- 9** What is a statement of the principle of conservation of momentum?
- A** In an elastic collision, momentum is constant.
 - B** Momentum is the product of mass and velocity.
 - C** The force acting on a body is proportional to its rate of change of momentum.
 - D** The momentum of an isolated system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

- 10** The diagram shows the view from above of two balls moving along a horizontal frictionless surface before they collide. The momentum of each ball is also shown.

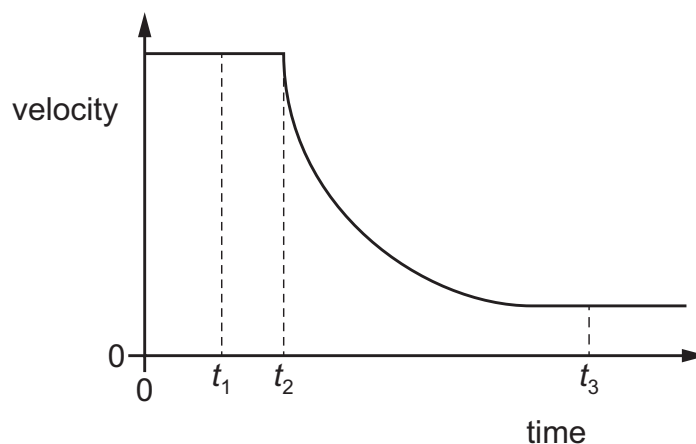


The balls stick together during the collision.

Which vector diagram represents the combined momentum of the balls after the collision?



- 11** A skydiver is falling at constant velocity. She then opens her parachute. The graph shows the variation with time of her velocity.



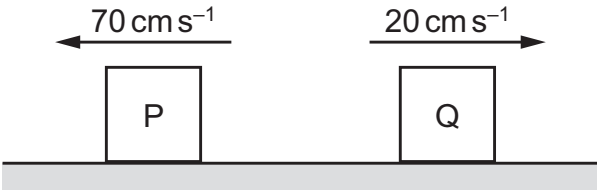
Which statements about the motion of the skydiver are correct?

- 1 The magnitude of the acceleration is maximum at time t_2 .
- 2 The magnitude of the drag force at time t_1 equals the magnitude of the drag force at time t_3 .
- 3 The magnitude of the drag force is maximum at time t_1 .

A 1 and 2 **B** 1 and 3 **C** 2 only **D** 3 only

12 Two different blocks, P and Q, slide towards each other on a horizontal frictionless surface. The blocks have an elastic collision.

The diagram shows the velocities of the two blocks immediately after the collision.

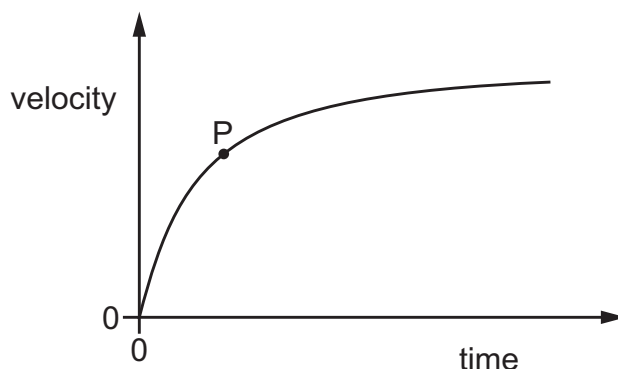


Which row gives possible velocities of the two blocks immediately before the collision?

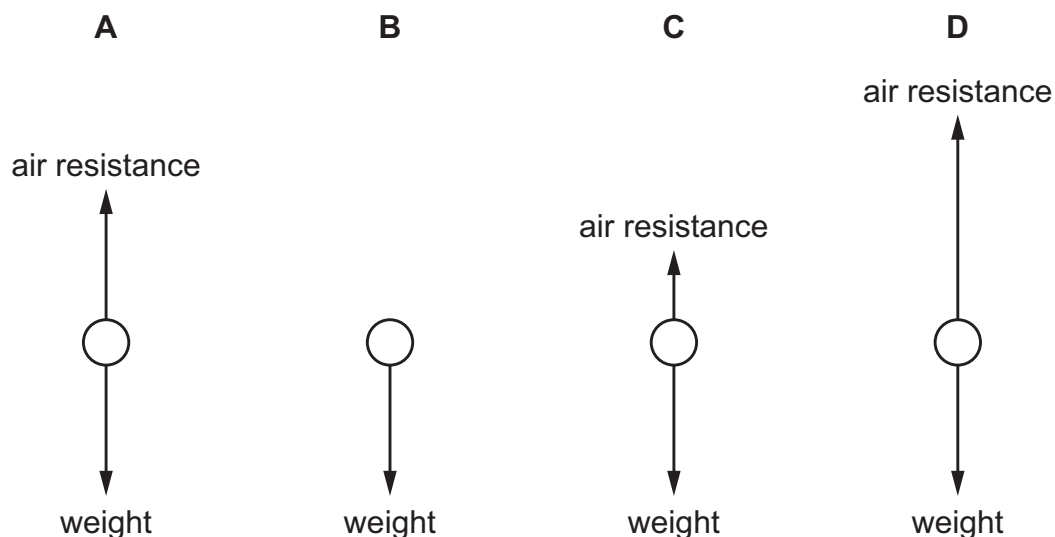
	velocity of P	velocity of Q
A	10 cm s^{-1} to the right	60 cm s^{-1} to the left
B	50 cm s^{-1} to the right	zero
C	20 cm s^{-1} to the left	70 cm s^{-1} to the right
D	60 cm s^{-1} to the right	30 cm s^{-1} to the left

240. Question | 9702 Oct-Nov 2025 P1 V3 Q8

- 8 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?



241. Question | 9702 Oct-Nov 2025 P1 V3 Q9

- 9 In which situation is total linear momentum **always** conserved?
- A** in all collisions between two objects
 - B** in collisions between two objects moving at equal and opposite velocity
 - C** in collisions between two objects that form an isolated system
 - D** in collisions between two objects with the same mass

242. Question | 9702 Oct-Nov 2025 P1 V3 Q10

- 10** An object of mass m moving with velocity 9.0 ms^{-1} has a head-on elastic collision with a stationary object of mass $2m$.

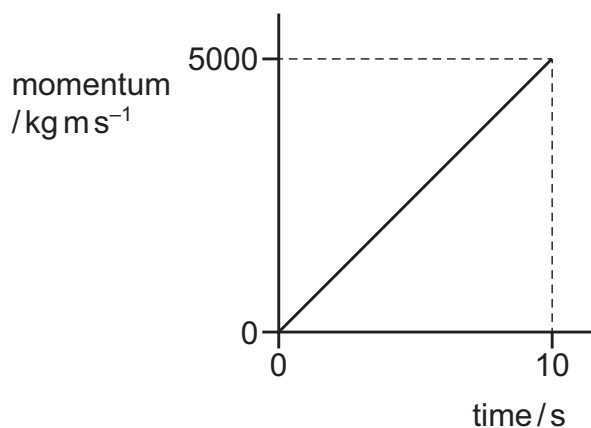
After the collision, both objects are moving. No external forces act on the system.

What is the velocity of the object of mass $2m$ after the collision?

- A** -6.0 ms^{-1} **B** -3.0 ms^{-1} **C** 4.5 ms^{-1} **D** 6.0 ms^{-1}

243. Question | 9702 Oct-Nov 2025 P1 V3 Q11

- 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

244. Question | 9702 Oct-Nov 2025 P1 V3 Q12

- 12** A rocket has a weight of W and an initial acceleration of a as the rocket leaves the ground vertically. The acceleration of free fall is g .

Which expression gives the initial upward force exerted on the rocket due to the engine?

- A** $\frac{Wa}{g} + W$ **B** $\frac{Wa}{g}$ **C** $\frac{Wa}{g} - W$ **D** $Wa + W$

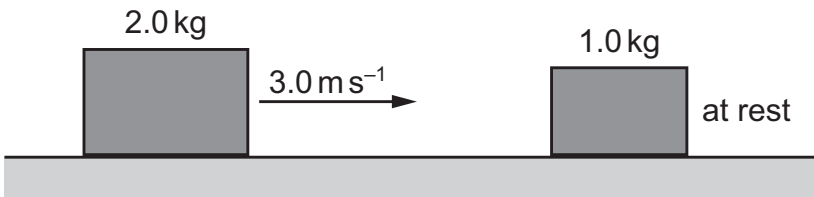
245. Question | 9702 Oct-Nov 2025 P1 V4 Q8

- 8** The acceleration of free fall on the Earth is different to the acceleration of free fall on the Moon.
- How do the mass and weight of an object on the Earth compare to its mass and weight on the Moon?

	mass	weight
A	different	different
B	different	same
C	same	different
D	same	same

246. Question | 9702 Oct-Nov 2025 P1 V4 Q10

- 10** An object of mass 2.0 kg is travelling at a speed of 3.0 m s^{-1} on a horizontal frictionless surface. This object collides head-on with a stationary object of mass 1.0 kg . The two objects 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

11 A moving object X collides with a stationary object Y.

The objects separate after the collision.

The collision is perfectly elastic and there are no external forces acting.

Which word equation is **not** correct?

- A** during the collision, (force acting on object X) + (force acting on object Y) = zero
- B** (relative speed of approach of X and Y) + (relative speed of separation of X and Y) = zero
- C** (total kinetic energy before collision) = (total kinetic energy after collision)
- D** (total momentum before collision) = (total momentum after collision)