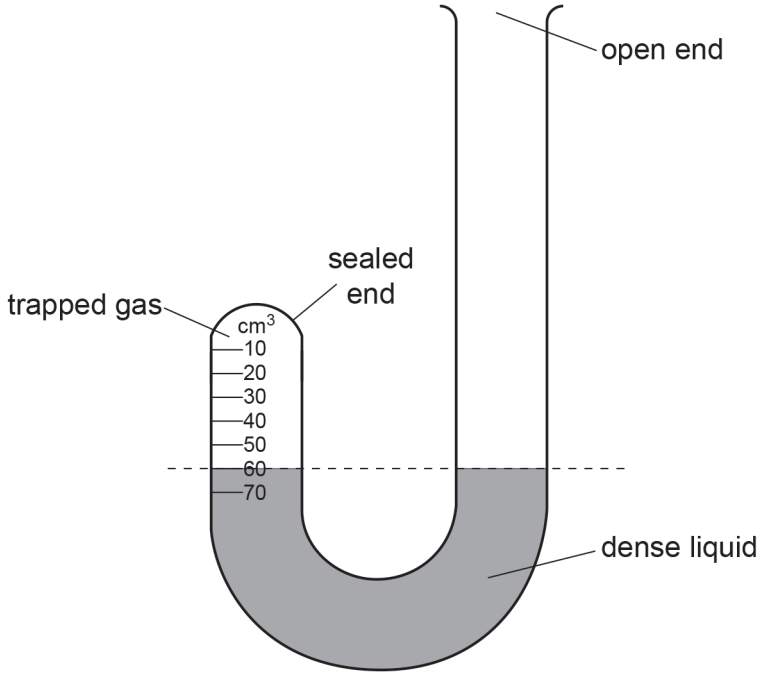
1 The diagram shows gas trapped in the sealed end of a tube by a dense liquid.



Explain, in terms of the momentum of its molecules, why the trapped gas exerts a pressure on the walls of the tube.

.....

.....

.....

..... [3]

[Total: 3]

2 An aeroplane of mass 2.5×10^5 kg lands with a speed of 62 m / s, on a horizontal runway at time $t = 0$. The aeroplane decelerates uniformly as it travels along the runway in a straight line until it reaches a speed of 6.0 m / s at $t = 35$ s.

(a) Calculate the deceleration of the aeroplane in the 35 s after it lands.

deceleration = ... [2]

(b) Calculate the resultant force acting on the aeroplane as it decelerates.

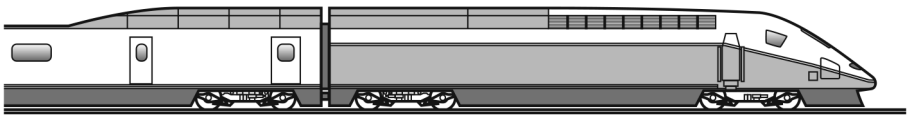
force = ... [2]

(c) Calculate the momentum of the aeroplane when its speed is 6.0 m / s.

momentum = ... [2]

[Total: 6]

3 The diagram shows a train.



The total mass of the train and its passengers is 750 000 kg. The train is travelling at a speed of 84 m / s. The driver applies the brakes and the train takes 80 s to slow down to a speed of 42 m / s.

(a) Calculate the impulse applied to the train as it slows down.

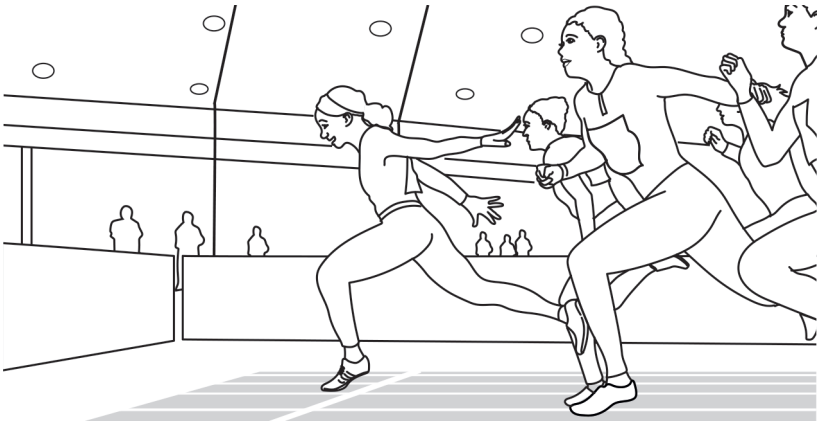
impulse = ... [3]

(b) Calculate the average resultant force applied to the train as it slows down.

force = ... [2]

[Total: 5]

4 The diagram shows an athlete crossing the finishing line in a race. As she crosses the finishing line, her speed is 10.0 m / s. She slows down to a speed of 4.0 m / s.



(a) The mass of the athlete is 71 kg. Calculate the impulse applied to her as she slows down.

impulse = ... [3]

(b) Define *impulse* in terms of *force* and *time*.

.....

..... [1]

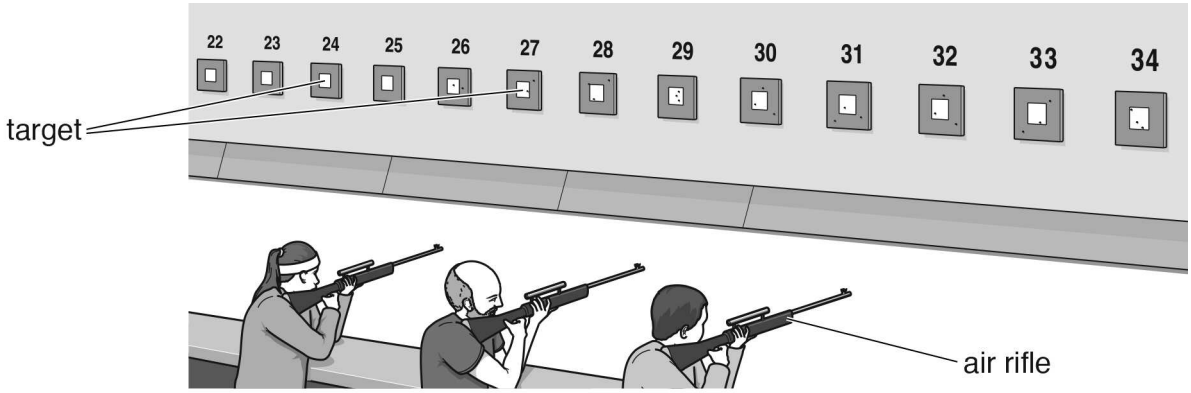
(c) The athlete takes 1.2 s to slow down from a speed of 10.0 m / s to a speed of 4.0 m / s.

Calculate the average resultant force applied to the athlete as she slows down.

force = ... [2]

[Total: 6]

5 The diagram shows a shooting competition, where air rifles fire soft metal pellets at distant targets.



When an air rifle is fired, it exerts an impulse of 0.019 N s on the pellet.

The pellet has a mass of 1.1×10^{-4} kg.

(a) Determine the speed with which the pellet leaves the rifle.

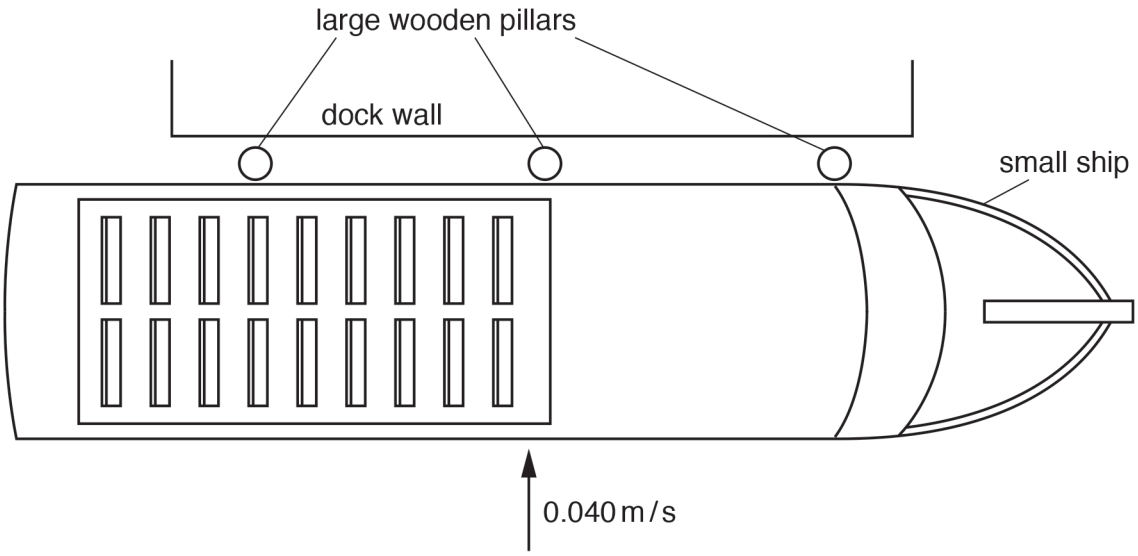
speed = ... [2]

(b) Determine the kinetic energy of the pellet as it leaves the rifle.

kinetic energy = ... [3]

[Total: 5]

6 A small ship is moving slowly sideways as it comes in to dock.



The ship hits the wooden pillars which move towards the dock wall.

Dock walls sometimes have the pillars replaced with rubber car tyres.

Explain how this reduces the possibility of damage when a boat docks.

.....

.....

..... [1]

[Total: 1]

7 A rocket is launched and travels far from the Earth. The effect of the Earth's gravity on the motion of the rocket is insignificant. As the rocket accelerates, its momentum increases.

State the principle of the conservation of momentum.

.....

.....

..... [2]

[Total: 2]

8 A rocket is launched and travels far from the Earth. The effect of the Earth's gravity on the motion of the rocket is insignificant. As the rocket accelerates, its momentum increases.

Explain how the principle of the conservation of momentum applies to the accelerating rocket and the exhaust gases.

.....

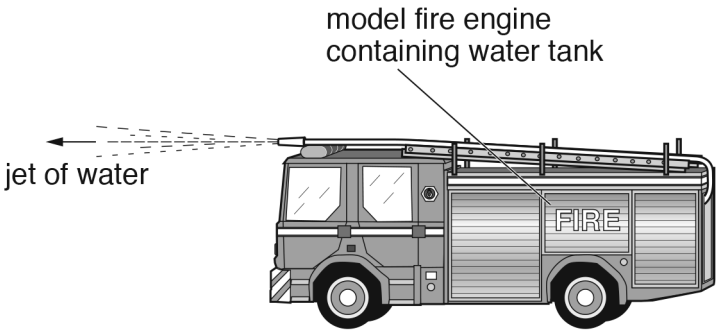
.....

.....

..... [2]

[Total: 2]

9 The diagram shows a model fire engine. Its brakes are applied.



0.80 kg of water is emitted in the jet every 6.0 s at a velocity of 0.72 m / s relative to the model.

(a) Calculate the change in momentum of the water that is ejected in 6.0 s.

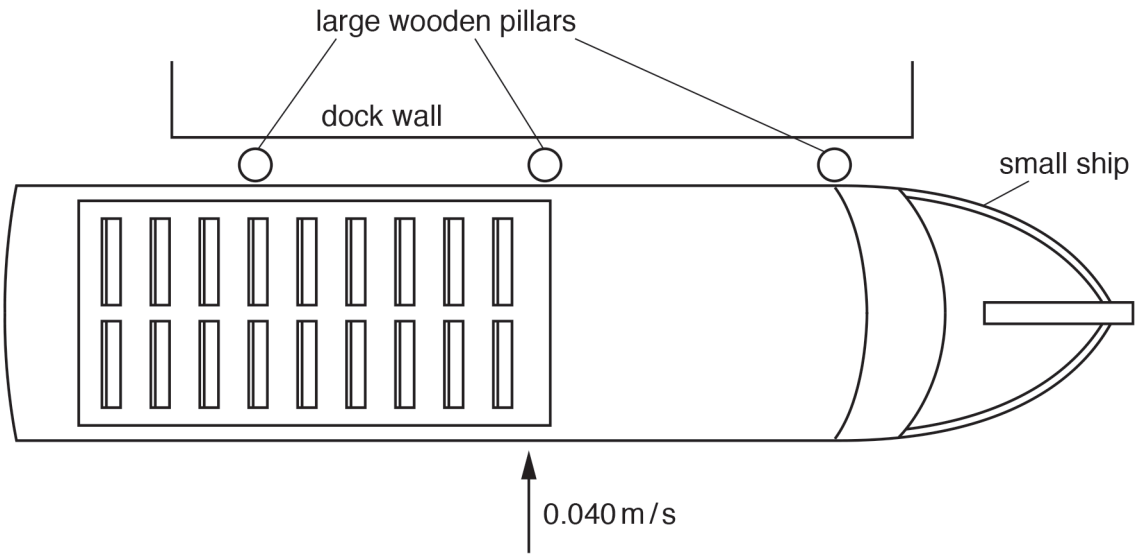
momentum = ... [2]

(b) Calculate the magnitude of the force acting on the model because of the jet of water.

force = ... [2]

[Total: 4]

10 The diagram is the top view of a small ship of mass 1.2×10^6 kg. The ship is moving slowly sideways at 0.040 m / s as it comes to the dock.



The ship hits the wooden pillars which move towards the dock wall.

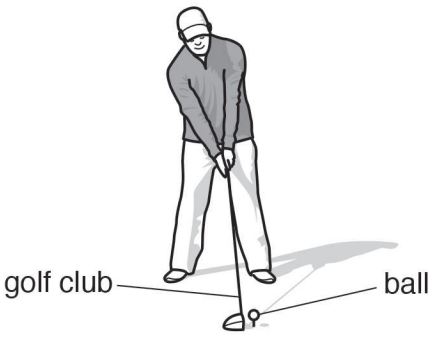
The ship is in contact with the pillars for 0.30 s as it comes to rest.

Calculate the average force exerted on the side of the ship.

force = ... [4]

[Total: 4]

11 The diagram shows a man hitting a ball with a golf club.



The ball has a mass of 0.046 kg. The golf club is in contact with the ball for 5.0×10^{-4} s and the ball leaves the golf club at a speed of 65 m / s.

(a) Calculate the momentum of the ball as it leaves the golf club.

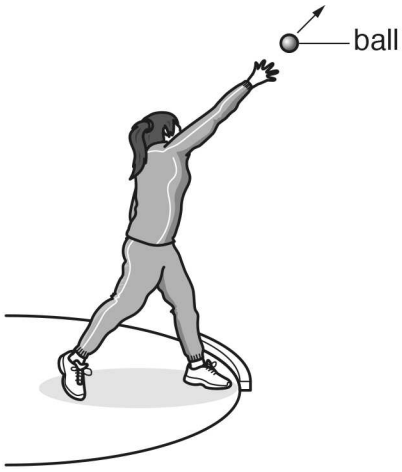
momentum = ... [2]

(b) Calculate the average resultant force acting on the ball while it is in contact with the golf club.

average force = ... [2]

[Total: 4]

12 The diagram shows a girl throwing a heavy ball.



The mass of the ball is 4.0 kg. The girl exerts a force on the ball for 0.60 s. The speed of the ball increases from 0 m / s to 12 m / s before it leaves the girl's hand.

(a) Calculate the momentum of the ball on leaving the girl's hand.

momentum = ... [2]

(b) Calculate the average resultant force exerted on the ball.

average resultant force = ... [2]

[Total: 4]

13 The velocity of an object of mass m increases from u to v.

State, in terms of m, u and v, the change of momentum of the object.

..... [1]

[Total: 1]

14 In a game of tennis, a player hits a stationary ball with his racquet.

(a) The racquet is in contact with the ball for 6.0 ms. The average force on the ball during this time is 400 N.

Calculate the impulse on the tennis ball.

impulse = ... [2]

(b) The mass of the ball is 0.056 kg.

Calculate the speed with which the ball leaves the racquet.

speed = ... [2]

[Total: 4]

15 Complete the table by writing in the right-hand column the name of the quantity given by the product in the left-hand column.

product	quantity
mass × acceleration	
force × time	

[2]

[Total: 2]

16 A tennis player is practising by hitting a ball many times against a wall.

The ball hits the wall 20 times in 60 s. The average change in momentum for each collision with the wall is 4.2 kg m / s.

Calculate the average force that the ball exerts on the wall.

average force = ... [3]

[Total: 3]

17 A ball of mass 2.0 kg is travelling at a speed of 12 m / s. It moves towards an object of mass 3.0 kg which is at rest.

The ball hits the object and sticks to it.

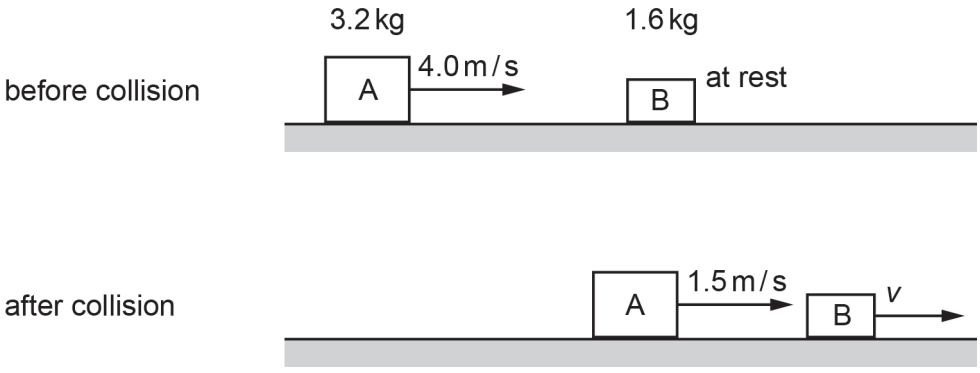
Which row gives the total momentum, and the speed of both objects immediately after the collision?

	$\frac{\text{total momentum}}{\text{kg m / s}}$	$\frac{\text{speed}}{\text{m / s}}$
A	0	4.8
B	0	8.0
C	24	4.8
D	24	8.0

[1]

[Total: 1]

18 A metal block A, travelling in a straight line at 4.0 m / s on a smooth surface, collides with a second metal block B which is at rest. The diagram shows the two metal blocks A and B before and after the collision.



(a) The mass of A is 3.2 kg. The mass of B is 1.6 kg.
After the collision, the velocity of A is 1.5 m / s.

Calculate

(i) the momentum of A before the collision,

momentum = ... [2]

(ii) the velocity v of B after the collision.

v = ... [3]

(b) In the collision that occurred in **(a)**, block A and block B are in contact for 0.050 s.

Calculate the average force that is exerted on B during the collision.

average force = ... [2]

(c) After the collision in **(a)**, the total kinetic energy of the two blocks is less than the kinetic energy of block A before the collision.

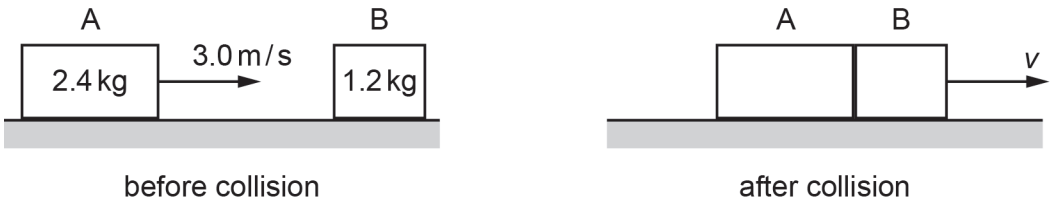
Suggest **one** reason for this.

.....

..... [1]

[Total: 8]

19 The diagram shows a collision between two blocks A and B on a smooth, horizontal surface.



before collision

after collision

Before the collision, block A, of mass 2.4 kg, is moving at 3.0 m / s. Block B, of mass 1.2 kg, is at rest.

After the collision, blocks A and B stick together and move with velocity *v*.

(a) **(i)** Calculate the momentum of block A before the collision.

momentum = ... [2]

(ii) Calculate the velocity *v*.

velocity = ... [2]

(iii) Calculate the impulse experienced by block B during the collision.

impulse = ... [2]

(b) Suggest why the total kinetic energy of blocks A and B after the collision is less than the kinetic energy of block A before the collision.

.....

..... [1]

[Total: 7]

20 A footballer kicks a ball vertically upwards. Initially, the ball is stationary.

(a) His boot is in contact with the ball for 0.050 s. The average resultant force on the ball during this time is 180 N. The ball leaves his foot at 20 m / s.

Calculate:

(i) the impulse of the force acting on the ball,

impulse = ... [2]

(ii) the mass of the ball,

mass = ... [2]

(iii) the height to which the ball rises. Ignore air resistance.

height = ... [3]

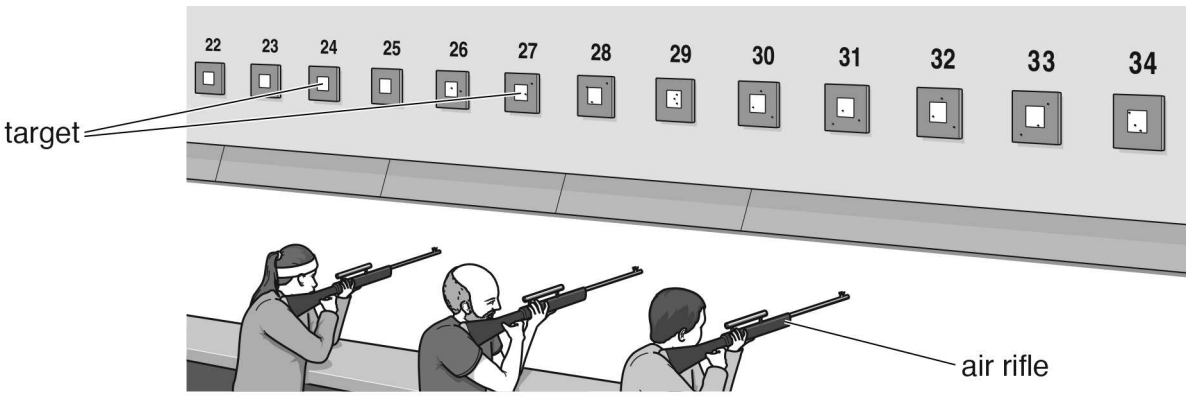
(b) While the boot is in contact with the ball, the ball is no longer spherical.

State the word used to describe the energy stored in the ball.

..... [1]

[Total: 8]

21 The diagram shows a shooting competition, where air rifles fire soft metal pellets at distant targets.



When an air rifle is fired, it exerts an impulse of 0.019 N s on the pellet.

Define *impulse*.

.....

..... [1]

[Total: 1]

22 Underline the pair of quantities which must be multiplied together to calculate *impulse*.

force and mass	force and velocity	mass and time
time and velocity	weight and velocity	force and time

[1]

[Total: 1]

23 State the word equation that defines *momentum*.

..... [1]

[Total: 1]