1. Motion, forces and energy

1.6 Momentum

Paper 2

Question Paper

Paper 2

Questions are applicable for extended candidates only

1   Which equation gives the momentum change of an object?

   A   momentum change = $\dfrac{\text{force}}{\text{area}}$

   B   momentum change = force × distance

   C   momentum change = force × $\dfrac{\text{distance}}{\text{time}}$

   D   momentum change = force × time

2   Which expression can be used to determine the impulse on a tennis ball?

   A   force × time

   B $\dfrac{\text{momentum}}{\text{time}}$

   C   mass × initial velocity

   D   mass × acceleration

3   A ball of mass m falls vertically and hits a hard surface.

Its speed on hitting the surface is v_1.

It rebounds vertically upwards with speed v_2.

What is the change in momentum of the ball?

   A mv_1 **B** mv_2 **C** $m(v_1 + v_2)$ **D** $m(v_2 - v_1)$

4   A sphere X collides head on with a second identical sphere Y which is stationary.

The mass of each sphere is 0.15 kg.

Sphere X is travelling at a velocity of 2.0 m/s before the collision and produces an impulse of 0.21 N s on sphere Y.

What is the velocity of sphere X after collision?

A   0.60 m/s in the opposite direction to Y

B   0.60 m/s in the same direction as Y

C   1.4 m/s in the opposite direction to Y

D   1.4 m/s in the same direction as Y

5   A resultant force F accelerates a car of mass m along a straight horizontal road from rest to a speed v in time t, giving it momentum p.

Which pair of relationships for this situation is correct?

A $pt = mv$ and $F = pt$

B $p = mv$ and $F = pt$

C $p = mv$ and $Ft = p$

D $p = mvt$ and $Ft = v$

6   An object of mass 1.2 kg is moving with a velocity of 2.0 m/s when it is acted on by a force of 4.0 N. The velocity of the object increases to 5.0 m/s in the same direction.

For which period of time does the force act on the object?

A   0.90 s   B   1.1 s   C   1.5 s   D   3.6 s

7   A trolley of mass 4.0 kg travelling with a velocity of 4.0 m/s collides with a trolley of mass 2.0 kg travelling with a velocity of 2.0 m/s in the same direction. After the collision, the velocity of the 4.0 kg trolley is reduced to 3.0 m/s.

4.0 m/s	2.0 m/s		3.0 m/s	v
4.0 kg	2.0 kg		4.0 kg	2.0 kg
before collision			after collision	

What is the velocity *v* of the 2.0 kg trolley after the collision?

A   0.25 m/s   B   4.0 m/s   C   5.0 m/s   D   16 m/s

8   Three situations are listed.

    1   An object has a resultant force acting on it.

    2   A moving object experiences an impulse.

    3   An object is decelerating.

In which situations is the momentum of the object changing?

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

9   A ball of mass 0.16 kg is moving forwards at a speed of 0.50 m/s. A second ball of mass 0.10 kg is stationary. The first ball strikes the second ball. The second ball moves forwards at a speed of 0.50 m/s.

What is the speed of the first ball after the collision?

A   0.0 m/s   B   0.19 m/s   C   0.31 m/s   D   0.50 m/s

10   Which statement describes the impulse acting on an object?

    A   Impulse is the change in kinetic energy of the object.

    B   Impulse is the change in momentum of the object.

    C   Impulse is the rate of change of force acting on the object.

    D   Impulse is the rate of change of momentum of the object.

11   A ball of mass 0.16 kg is moving forwards at a speed of 0.50 m/s. A second ball of mass 0.10 kg is stationary. The first ball strikes the second ball. The second ball moves forwards at a speed of 0.50 m/s.

What is the speed of the first ball after the collision?

A   0.0 m/s   B   0.19 m/s   C   0.31 m/s   D   0.50 m/s

12   What is the relationship between the impulse acting on an object and the change in momentum of the object?

A   impulse = change in momentum

B   impulse = change in momentum × time

C   impulse = $\dfrac{\text{change in momentum}}{\text{time}}$

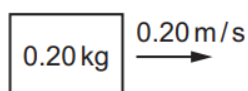D   impulse = $\dfrac{\text{change in momentum}}{\text{mass}}$

13   A ball has a mass of 2.0 kg. The ball approaches a wall at a speed of 3.0 m/s and rebounds at a speed of 1.0 m/s.
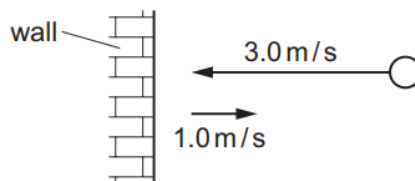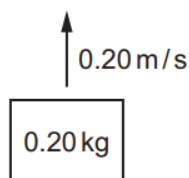

What is the impulse on the wall?

A   4.0 N   B   4.0 N s   C   8.0 N   D   8.0 N s

14   An object with a mass of 0.20 kg moves at 0.20 m/s, as shown.
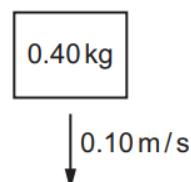
$$\boxed{0.20\,\text{kg}} \quad \begin{array}{c} 0.20\,\text{m/s} \\ \longrightarrow \end{array}$$

Which other object has a momentum that is identical to the momentum of this object?

A

$$\uparrow 0.20\,\text{m/s}$$
$$\boxed{0.20\,\text{kg}}$$

B

$$\boxed{0.40\,\text{kg}}$$
$$\downarrow 0.10\,\text{m/s}$$

C

$$\boxed{0.40\,\text{kg}} \quad \begin{array}{c} 0.10\,\text{m/s} \\ \longrightarrow \end{array}$$

D

$$\begin{array}{c} 0.20\,\text{m/s} \\ \longleftarrow \end{array} \quad \boxed{0.20\,\text{kg}}$$
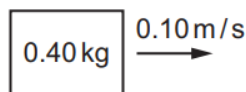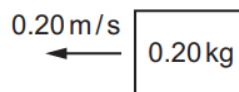
15   An object of mass 1.2 kg is moving with a velocity of 2.0 m/s when it is acted on by a force of 4.0 N. The velocity of the object increases to 5.0 m/s.

For what period of time does the force act on the object?

A   0.90 s   B   1.1 s   C   1.5 s   D   3.6 s

16   An object is moving at +3.0 m/s.

A force acts on the object.

After a time, the object is moving at −4.0 m/s.

The mass of the object is 5.0 kg.

What is the change in momentum of the body?

A   −35 kg m/s   B   −5.0 kg m/s   C   +5.0 kg m/s   D   +35 kg m/s

17 Two objects X and Y move directly towards each other. The objects have the same mass.

Object X has a velocity of 5.0 m/s to the right. Object Y has a velocity of 3.0 m/s to the left.
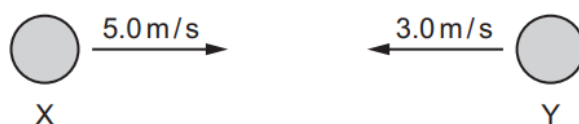
Object X and object Y collide and stick together.

What is their velocity after colliding?

A   1.0 m/s to the left

B   1.0 m/s to the right

C   4.0 m/s to the left

D   4.0 m/s to the right

18 A ball is at rest on the ground. A boy kicks the ball. The boy's boot is in contact with the ball for 0.040 s.

The average force on the ball is 200 N. The ball leaves the boy's boot with a speed of 20 m/s.

Which row gives the impulse of the boot on the ball and the average acceleration of the ball?

	impulse on ball N s	average acceleration of ball m/s^2
A	8	0.8
B	8	500
C	5000	0.8
D	5000	500

19 An object P of mass 80 g collides with another object Q of mass 40 g.

After the collision, P and Q stick together and then travel on together.

Before the collision, P is travelling at a speed of 6.0 m/s and Q is at rest.

What is the speed of P and Q after the collision?

A   2.0 m/s   B   3.0 m/s   C   4.0 m/s   D   6.0 m/s

20   A ball of mass 0.50 kg falls and hits the floor at 10 m/s.

It rebounds at speed 8.0 m/s, as shown.

before collision   after collision

10 m/s   8 m/s

The collision between the ball and the floor lasts for 0.50 s.

What is the average force acting on the ball during the collision?

A   2.0 N upwards

B   2.0 N downwards

C   18 N upwards

D   18 N downwards

21   An object of mass 4.0 kg is moving with a velocity of 3.0 m/s in a straight line.

What is the momentum of the object?

A   0.75 kg m/s   B   1.3 kg m/s   C   12 kg m/s   D   24 kg m/s

22   A moving ball with a momentum of 25 kg m/s collides head-on with a wall.
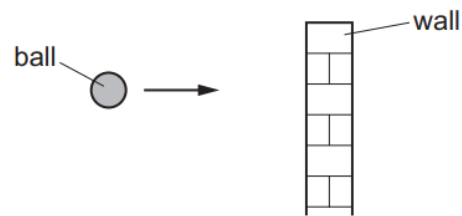
wall

ball

It rebounds from the wall with the same speed but in the opposite direction. The time of collision is 50 ms.

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

A   0.50 N   B   1.00 N   C   500 N   D   1000 N

23   An object of mass 3.0 kg, travelling at a speed of 6.0 m/s, collides with an object of mass 2.0 kg, travelling in the opposite direction at a speed of 2.0 m/s.

6.0 m/s ⟶   ⟵ 2.0 m/s

(3.0 kg)   (2.0 kg)

The objects stick together during the collision.

What is the speed and direction of the combined mass after the collision?

A   4.4 m/s to the left

B   4.4 m/s to the right

C   2.8 m/s to the left

D   2.8 m/s to the right

24   Which expression gives the momentum of an object?

A   mass × acceleration

B   mass × gravitational field strength

C   mass × velocity

D $\frac{1}{2}$ × mass × (velocity)^2

25   A car of mass 1000 kg travelling at 8.0 m/s collides with a lorry of mass 3000 kg that is travelling at 2.0 m/s in the same direction. After colliding, the two vehicles stick together.

What is their speed after the collision?

A   2.0 m/s   B   2.5 m/s   C   3.5 m/s   D   5.0 m/s