Momentum – 2023 IGCSE 0625 Physics

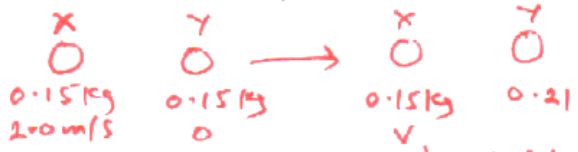
1. Nov/2023/Paper_ 0625/21/No.7

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

The mass of each sphere is 0.15 kg.

Impulse = $F \times t = mv - mu$; for Y $mu = 0$, $mv = 0.21$ Ns.

Sphere X is travelling at a velocity of 2.0 m/s before the collision and produces an impulse of 0.21 Ns 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

$(0.15 \times 2) + (0.15 \times 0) = (0.15 \times V) + 0.21$

$3 + 0 = 0.15V + 0.21$

$0.15V = 3 - 0.21$

$v = \frac{0.09}{0.15} = 0.6\ ms^{-1}$

2. Nov/2023/Paper_ 0625/22/No.7

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 $Ft = v$

$F = m \times a$

$a = \frac{v - u}{t}$ but $u = 0$.

$a = \frac{v}{t}$

$p = m \times v = mv$

$F = \frac{m \times v}{t}$

$F \times t = mv$

$Ft = p$.

3. Nov/2023/Paper_ 0625/23/No.7

A car of mass 1200 kg is travelling along a straight horizontal road.

Which impulse is needed to accelerate the car from 5.0 m/s to 10 m/s?

A ✓ 6000 Ns B 12000 Ns C 15000 Ns D 18000 Ns

Impulse $= mv - mu$

$= m(v - u)$

$= 1200(10 - 5)$

$= 1200 \times 5$

$= 6000$ Ns

4. Nov/2023/Paper_ 0625/42/No.3(a)

(a) A balloon of mass 15g is glued to a straw. The straw is threaded onto a horizontal string, as shown in Fig. 3.1. → 0.015 kg
The balloon is filled with air and then the air is released.

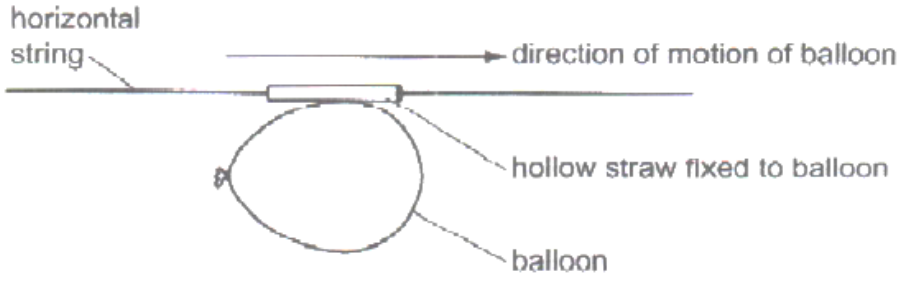


Fig. 3.1

As the air leaves the balloon, the balloon experiences a force.
The balloon accelerates from rest until it reaches a constant speed. It then travels 0.67 m in 0.18 s at this constant speed.

(i) Explain in words what is meant by the term impulse.

Is force multiplied by time for which the force acts. [1]

(ii) Calculate the resultant impulse on the balloon while it is accelerating.

Impulse = Ft

$Ft = mv - mu$

$= 0.015\left(\frac{0.67}{0.18} - 0\right)$.

$= 0.0558$ Ns

≈ 0.056 Ns impulse = 0.056 Ns [3]

(iii) Explain how momentum is conserved as the balloon accelerates.

- Released air is in opposition direction to balloon motion.
- Momentum of balloon and straw is equal in size (magnitude) to the momentum of air. [2]

5. Nov/2023/Paper_ 0625/43/No.3

Fig. 3.1 shows a boy throwing a ball at an object in a fairground.

Fig. 3.1

The ball has a mass of 190 g and travels horizontally with a constant speed of 6.9 m/s.

(a) Calculate the momentum of the ball.

↑ 0.19 kg

$p = m \times v$

$= 0.19 \times 6.9$

$= 1.311$ kg m/s

$\simeq 1.3$ kg m/s

momentum = 1.3 [2]

(b) After hitting the object, the ball bounces back along the same straight path with a speed of 1.5 m/s. The object has a mass of 1.8 kg.

↑ velocity in opposite direction is -ve. (velocity is a vector).

Calculate the speed of the object after it is hit by the ball.

p before = p after collision

$1.3 + 0 = (0.19 \times -1.5) + (1.8 \times v)$

$1.3 = -0.285 + 1.8v$

$v = \frac{1.3 + 0.285}{1.8}$

$= 0.88$ m/s

speed = 0.88 m/s [3]

(c) The kinetic energy of the ball is 4.5 J before the collision and 0.2 J after the collision.

Calculate the change in total kinetic energy of the ball and object during the collision.

K.E before − K.E after

$K.E = \frac{1}{2}mv^2$

$4.5 - (0.2 + \frac{1}{2} \times 1.8 \times 0.88^2)$

$4.5 - (0.2 + 0.696)$

$4.5 - 0.896 = 3.6\ J$

change in total kinetic energy = 3.6 J. [3]

[Total: 8]

6. June/2023/Paper_0625/21/No.9

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

$F = m \times a$

$a = \frac{F}{m}$

$= \frac{4}{1.2}$

$a = 3.3\ m/s^2$

$a = \frac{v-u}{t}$

$t = \frac{v-u}{a}$

$u = 2.0\ m/s$

$v = 5.0\ m/s$

$t = \frac{5.0 - 2.0}{3.3}$

$= 0.90\ s$

7. June/2023/Paper_0625/22/No.9

A resultant force of 2.0 N acts on an object of mass 3.0 kg for 6.0 s.

What is the change in velocity of the object?

A 0.25 m/s B 1.0 m/s C ✓ 4.0 m/s D 36 m/s

$a = \frac{R.F}{m} = \frac{2.0}{3.0}$

$= 0.67\ m/s^2$

$\frac{v-u}{t} = a$

$v - u = a \times t$

$= 0.67 \times 6$

$= 4.02\ m/s$

$\approx 4.0\ m/s$

v − u is change in velocity

8. June/2023/Paper_0625/23/No.9

A ball of mass 0.25 kg hits a wall at a speed of 16 m/s. It then rebounds back along its original path at a speed of 12 m/s.

What is the impulse experienced by the ball during its impact with the wall?

A 1.0 Ns B 3.0 Ns C 4.0 Ns D 7.0 Ns ✓

Impulse = F x t

F x t = mv − mu

u = 16 m/s

v = −12 m/s

impulse = m (v − u)

= 0.25 (−12 − 16)

= −7.0 N s

9. June/2023/Paper_0625/42/No.2

A student catches a cricket ball. The speed of the ball immediately before it is caught is 18 m/s. The mass of the cricket ball is 160 g. → 0.16 kg

(a) Calculate the kinetic energy stored in the cricket ball immediately before it is caught.

$K.E = \frac{1}{2} mv^2$

$= \frac{1}{2} \times 0.16 \times 18^2$

$= 25.92$ J

≈ 26 J

kinetic energy = 26 J [3]

(b) It takes 0.12 s to catch the ball and bring it to rest.

Calculate the average force exerted on the ball.

$F = \frac{mv - mu}{t}$

$= \frac{m(v-u)}{t}$

$= \frac{0.16 \times (0 - 18)}{0.12}$

$= 24$ N

average force = 24 N [2]

(c) As the student catches the ball, she moves her hands backwards.

Explain the effect of this action on the student's hands.

- This increases the time of impact
- so smaller force will act on the students hand, thus it does not hurt as much. [1]

[Total: 6]

$F = \frac{mv - mu}{t}$, $F \propto \frac{1}{t}$

when t is large, the F will be smaller, since F is inversely proportional to time.