Chapter - 9 (Force and laws of motion)

Exercise questions (Page number : 136 to 139)

Q.NO 1: Ans:- When an object experiences a net zero external unbalanced force, its acceleration is zero (according to the Second law of motion).

If the object was initially in a state of motion, the object will continue to move in same direction with same speed (according to the first law of motion). It means that the object may be travelling with a non-zero velocity but the magnitude as well as direction of velocity must remain unchanged.

Q.NO 2: Ans:- When it is beaten with a stick, the carpet is set in motion but the dust particles remain at rest. Due to inertia of rest, the dust particles remain in their position of rest & falls down due to gravity.

Q.NO 3: Ans:- The luggage will resist any change in its state of rest or motion, due to inertia & this luggage has the tendency to fall sideways forward or backward. To avoid the fall of the luggage, it is tied with the rope.

Q.NO 4: Ans (c):- There is a force on the ball opposing the motion.

Q.NO 5: Sol^n: Given, $u = 0$ m/s, $s = 400$ m, $t = 20$ s, $a = ?$, $F = ?$

$m = 7$ tonnes $= 7 \times 1000$ kg $= 7000$ kg

we have, $s = ut + \frac{1}{2}at^2$

$400 = (0 \times 20) + \frac{1}{2} a (20 \times 20)$

$400 = (10 \times 20)a$

$\Rightarrow a = \frac{400}{10 \times 20}$

$\Rightarrow a = 2 \text{ m/s}^2$

Again, $F = ma$

$= 7000 \times 2 = 14000$ N

QNO 6; Soln: Given, $m = 1kg$, $u = 20 m/s$, $S = 50 m$, $V = 0$, $F = ?$, $a = ?$

We have, $V^2 - u^2 = 2as$

$(0)^2 - (20)^2 = 2 a \times 50$

$-400 = 100a$

$\therefore a = \frac{-400}{100}$

$a = -4 m/s^2$

Force of friction between the stone and the ice

$F = m \times a$

$= 1 \times (-4)$

$= -4 N$

QNO 7; Soln, (a) Net accelerating force = Force exerted by the engine - Force of friction

$= (40000 - 5000) N$

$= 35000 N$

(b) The acceleration of the train, $a = ?$

$F = 35000N$

Mass of 1 wagon of train = 2000 kg

Mass of 5 wagons pulled by engine = 5×2000

$= 10000 kg$

we have, $F = ma$

$35000 = 10000 \times a$

$\Rightarrow a = \frac{35000}{10000} = 3.5 m/s^2$

(c) Total no. of wagons = 5

ie, their are 4 wagons behind wagon 1

Force of wagon 1 on wagon 2

= Total mass of 4 wagon x acceleration of train

$= 2000 \times 4 kg \times 3.5 m/s^2$

$= 28000.0 kg\ m/s^2$

$= 28000 N$

Q NO 8: Sol^n. Given mass, $m = 1500kg$

$a = 1.7 m/s^2$

Force between vehicle and road

$= m \times a$

$= 1500 kg \times (-1.7 m/s^2)$

$= -2550 N$

Q NO 9: Ans: (d) mv

Q NO 10: Ans: Force applied = 200 N

Q NO 11: Sol^n: Mass of the objects $m_1 = m_2 = 1.5kg$

Velocity of first object $v_1 = 2.5 m/s$

Velocity of second object $v_2 = 2.5 m/s$

Momentum before collision $= m_1v_1 + m_2v_2$

$= (1.5 \times 2.5) + (1.5 \times -2.5)$

$= 0$

Total mass $= m_1 + m_2 = 1.5 + 1.5 = 3.0kg = 3kg$

Velocity after collision, $v = ?$

According to law of conservation of momentum,

Momentum before collision = Momentum after collision

$0 = 3 \times v$

$v = \frac{0}{3}$

$= 0$

Q NO 12: Ans: Because the mass of truck is too large. The small force exerted on the truck cannot move it and the truck remains at rest.

To attain motion for the truck, an external large amount of unbalanced force is needed to exert.

Q NO 13: Sol^n: Mass of hockey ball = 200g = 0.2 kg

Initial speed of hockey ball, $u = 10 m/s$

Final speed of hockey ball $v = -5 m/s$

Initial momentum of the hockey ball $= m \times u$

$= 0.2 kg \times 10 m/s$

$= \frac{2}{10} \times 10 = 2 kg\ m/s$

Final momentum of the hockey ball $= m \times v$

$= 0.2 kg \times (-5 m/s)$

$= -1 kg\ m/s$

change in momentum = Difference in the momentum
= final momentum − Initial momentum
= −1 − 2
= − 3 kg m/s

Q NO 14. Soln:

Given, Mass of bullet, $m = 10g = \frac{10}{1000} = 0.01\,kg$
Initial velocity, $u = 150\ m/s$
Final velocity $v = 0$
time, $t = 0.03\ s$

we have, $v = u + at$

$0 = 150\ m/s + a \times (0.03\ s)$

$\Rightarrow -150\ m/s = a \times 0.03\ s$

$\Rightarrow a = \frac{-150\ m/s}{0.03\ s}$

$= \frac{-150\ m}{\frac{3}{100}\ s \times s}$

$= \frac{-150 \times 100\ m}{3\ s^2}$

$= -5000\ m/s^2$

Again, $v^2 - u^2 = 2as$

$(0)^2 - (150)^2 = 2 \times (-5000) \times s$

$\Rightarrow -(150)^2 = 2 \times (-5000) \times s$

$\Rightarrow s = \frac{150 \times 150}{2 \times 5000}$

$= \frac{45}{2 \times 10} = 2.25\ m$

Distance of penetration of the bullet into the block $= 2.25\ m$

Magnitude of the force exerted by the wooden blocked on the bullet, $F = ma$

$= \frac{10}{1000} \times -5000$

$= -50\ N$

Q.NO 15; Sol^{n}; Given, mass of an object, $m_1 = 1kg$
velocity, $v_1 = 10 m/s$
Mass of wooden block = 5kg
Mass of combined objects, $m_2 = 5kg + 1kg = 6kg$
Total momentum just before the impact $= m_1 v_1$
$= 1kg \times 10 m/s$
$= 10 kg\ m/s$

We have,
Momentum before the impact = Momentum after impact
$m_1 v_1 = m_2 v_2$
$1kg \times 10 m/s = 6kg \times v_2$
$\Rightarrow v_2 = \frac{10 m/s}{6} = 1.67 m/s$
Velocity of the combined object = 1.67 m/s

Q.NO 16; Sol^{n}; Given mass of the object, $m = 100kg$
Initial velocity, $u = 5 m/s$
Final velocity $v = 8 m/s$
time, $t = 6s$
$\therefore$ Initial momentum $= m \times u$
$= 100 kg \times 5 m/s$
$= 500 kg\ m/s$
Final momentum $= m \times v$
$= 100kg \times 8 m/s$
$= 800 kg\ m/s$
Magnitude of force exerted on the object $= ma$
$= m \times \frac{v-u}{t}$
$= 100kg \times \frac{(8-5) m/s}{6s}$
$= 100kg \times \frac{3 m}{6 s^2}$
$= \frac{50}{6} kg\ m/s^2$
$= 50 kg\ m/s^2$
$= 50 N$

QNO 17; Ans; a) It is because when clothes are jerked suddenly, the water in them tends to continue in its state of rest. Thus, the droplets of water are left behind and fall of the clothes.

(b) It is because when wind blows, branches of trees are shaken, branches are in motion while fruits remain in rest due to the inertia of rest. Hence, fruits gets detached from the branches and fall off.

QNO 18; Ans; (a) The wheels of vehicle provided with mud guards to remove the muds sticking on to the wheels of the vehicles.

b) While catching a ball, a cricket player lowers his hand to increase the time of catch. Hence a small force is exerted by the ball on the hands and are not get injured.

c) Because the force applied by flying pebble on the glass pane is large.

QNO 19; Ans; Passengers in a car moving in straight line tends to continue in straight line motion but the passengers slips to one side of the seat when the car takes a sharp turn due to the inertia of the body.

QNO 20; Sol^{n}; Given, mass of the boy, $m_1 = 60kg$

velocity $u_1 = 3 m/s$

mass of the trolley, $m_2 = 140kg$

velocity $u_2 = 1.5 m/s$

Let common final velocity $= v$

According to law of conservation of momentum,

Final momentum = Initial momentum

$$m_1 v + m_2 v = m_1 u_1 + m_2 u_2$$

$$\Rightarrow 60 \times v + 140 \times v = 60 \times 3 + 140 \times 1.5$$

$$\Rightarrow v(60 + 140) = 180 + 210$$

$$\Rightarrow v \times 200 = 390$$

$$\Rightarrow v = \frac{390}{200} = 1.95 \, m/s.$$

Q.No.21 Sol^n: Given, Let the mass of first body, $m_1 = 3kg$.
Let the mass of second body, $m_2 = 1kg$.

1st case, acceleration, $a = 6\ m/s^2$
∴ Force applied on first body, $F = m \times a$
$= 3kg \times 6 = 18N$.

2nd case, acceleration, $a = ?$
Force $= 18N$.
Mass, $m_2 = 1kg$.
Acceleration $= \frac{F}{m} = \frac{18N}{1kg} = 4.5\ m/s^2$

Q.No.22; Sol^n: Given, Total mass (cardboard and it's contents)
$m = 30kg$
Initial velocity, $u = 0.8\ m/s$
Final velocity, $v = 0\ m/s$
Distance, $s = 0.5\ m$
We have,
$$v^2 - u^2 = 2as$$
$$\Rightarrow (0)^2 - (0.8\ m/s)^2 = 2 \times a \times 0.5\ m$$
$$\Rightarrow -0.8 \times 0.8\ m^2s^{-2} = 2 \times a \times 0.5\ m$$
$$\Rightarrow a = \frac{-0.8 \times 0.8\ m^2s^{-2}}{2 \times 0.5\ m}$$
$$\Rightarrow a = \frac{-4/8 \times 8\ m \times 16}{10 \times 16 \times 2 \times 5\ s^2}$$
$$\Rightarrow a = \frac{-32}{50} m/s^2 = -0.64\ m/s^2$$
Frictional force acting on the box, $F = m \times a$
$= 30kg \times (-0.64\ m/s^2)$
$= -30 \times \frac{64}{100}\ kg\ m/s^2$
$= -\frac{192}{10}\ kg\ m/s^2$
$= -19.2\ N$

Q.NO 23: Ans, Rahul gave the correct reasoning and explaination, According to law of Conservation of momentum, when two bodies collide, Initial momentum before collision is equal to final momentum after collision. But Insect suffer more because its mass is very small.

Q.NO 24: Sol^n: Given. mass of dumb-bell $m = 10\,kg$

height, $h = 80\,cm$

$= \frac{80}{100}\,m = 0.8\,m$

Accelecration, $a = 10\,m/s^2$

Initial velocity, $u = 0$

We have, $v^2 - u^2 = 2as$

$\Rightarrow v^2 - (0)^2 = 2 \times 10\,m/s^2 \times 0.8\,m$

$\Rightarrow v^2 = 2 \times \frac{10\,m}{s^2} \times \frac{8}{10}\,m$

$\Rightarrow v^2 = 16\,m^2/s^2$

$\Rightarrow v = \sqrt{16\,m^2/s^2}$

$\Rightarrow v = 4\,m/s$

momentum $p = mv$

$= 10\,kg \times 4\,m/s$

$= 40\,kg\,m/s$

Tick the correct option:

1. (iv), 2. (iv) 3. (ii), 4 (iv), 5. (ii)

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Q.NO 1: Ans (a) a stone of the same size

(b) a train

(c) a five rupees coin

As the mass of an object is a measure of its inertia objects with more mass have more inertia.

Q.NO2; Ans: First player kicks a football → velocity from '0' changes to 'u'

Second player kicks the football towards → velocity of the ball changes again.

The goalkeeper collects → velocity of the ball becomes 0.

Goalkeeper kicks it towards a player of his team → change in velocity takes place again.

The velocity of football changed 4 times.

Q.NO 3; Ans: Due to inertia of rest, the leaves tend to remain on its position and hence detaches from the tree to fall down.

Q.NO 4; Ans: When the bus is moving, our body is also in motion, but due to sudden brakes, the lower part of our body comes to rest as soon as the bus stops. But the upper part of our body continues to be in motion and hence we fall in forward direction due to inertia of motion.

When the bus is stationary, our body is rest but when the bus accelerates, the lower part of our body being in contact with the floor of the bus comes in motion but the upper part of the our body remains at rest due to inertia of rest. Hence, we fall in backward direction.

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Q.NO 1; Ans: In this case, horse exerts a force on the ground, with its feet while walking, the ground also exerts an equal and opposite force on the feet of horse which enables the horse to move forward.

Q.NO 2; Ans: Because the water is ejected out from the hose in the forward direction comes out with a large momentum and equal amount of momentum is developed in the hose in the opposite direction and hence the hose is pushed backward.

Q.NO3: Sol^n: Given, mass of rifle, $m_1 = 4\,kg$

mass of bullet, $m_2 = 50\,g = 0.05\,kg$

$= \frac{50}{1000}$

Velocity of bullet, $v_2 = 35\,m/s$

Recoil velocity of rifle, $v_1 = ?$

According to the law of Conservation of momentum,

Momentum of rifle = momentum of bullet

$$m_1 v_1 = m_2 v_2$$

$$4kg \times v_1 = 0.05 \times 35 m/s$$

$$v_1 = \frac{0.05 \times 35 m/s}{4}$$

$$= \frac{1.75}{4} = 0.4375\,m/s.$$

Q.NO 4: Sol^n: Given,

$m_1 = 100g = 0.1\,kg$

$m_2 = 200g = 0.2\,kg$

Before collision,

$v_1 = 1.67\,m/s$

$v_2 = ?$

After collision

$v_1 = 1.67\,m/s$

$v_2 = ?$

We have, $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

$$(0.1 \times 2) + (0.2 \times 1) = (0.1 \times 1.67) + (0.2 \times v_2)$$

$$0.2 + 0.2 = 0.167 + 0.2v_2$$

$$0.4 - 0.167 = 0.2v_2$$

$$v_2 = \frac{0.4 - 0.167}{0.2}$$

$$v_2 = \frac{-0.2333}{0.2}$$

$$= -1.165\,m/s$$