CHAPTER 7

FORCE AND LAWS OF MOTION

SOLUTIONS

TEXTUAL QUESTIONS AND ANSWERS
EXERCISES

1. **Define balanced and unbalanced forces.**

   Ans: If a system of forces acting on a body produces no net acceleration, then the forces are called balanced forces whereas if they produce a net acceleration, the forces are called unbalanced forces.

2. **Can non-living object exert a force? If yes give two examples.**

   Ans: Yes, non- living objects like running water, wind etc. can exert force.

   Examples: a) Water falling from a high altitude can rotate the turbine of hydroelectric generator. b) Wind can rotate the wind turbine of a wind mill.

3. **Why does a striker move through longer distance when some powder is sprinkled on a carom board?**

   Ans: The carom board exerts a resistive force on the motion of the striker. But this resistive force is much less when powder is sprinkled on the carom board, so striker travels much farther.

4. **Explain the Newton's laws of motion.**

   Ans: Newton's first law of motion states that "Everybody continues in its state of rest or uniform motion in a straight line unless compelled to change that state by an external unbalanced force".

   Second law of motion states that the rate of change of momentum of a body is proportional to the applied unbalanced force in the direction of force.

   Third law of motion states that when one body exerts a force on another body, the other body also exerts a force on the first body. These forces are always equal in magnitude but opposite in direction.

5. **Give an example to demonstrate Newton's third law of motion?**

   Ans: When a gun is fired, it exerts a forward force on the bullet. It is the action. At the same time, the bullet exerts an equal and opposite force on the gun as the reaction.

6. **Explain the meaning of inertia. Give appropriate examples to explain the inertia of rest and inertia of motion.**

Ans: The tendency of a body to continue in its the state of rest or of uniform motion in a straight line is called inertia.

a. ***Inertia of rest:*** the tendency of a body at rest to continue its state of rest is called inertia of rest. Example: Take a coin on a cardboard which is placed over a glass. Flick the card away horizontally using finger and thumb. The coin drops into the glass.

b. ***Inertia of Motion:*** the tendency of a body by virtue of which it tries to persists in its state of uniform motion is called inertia of motion. Example: A cycle runs though the pedalling is stopped for a while.

7. **When you pull your arms back while catching a fast-moving cricket ball, the chances of your hand getting hurt is less. Explain on the basis of Newton's law of motion.**

Ans: By doing so, the time duration in which the momentum of the ball becomes zero is increased. As time increases, smaller force comes into action to produce the desired change in momentum, so the force becomes smaller and the hand does not get hurt.

8. **When a hung carpet is beaten with a stick, dust particles come out of it. Explain.**

Ans: When a hung carpet is beaten with a stick, the carpet suddenly moves while the dust particles tends to remain at rest. So, the dust particles come out of it.

9. **A truck starting from rest travels down a hill with a constant acceleration. It travels a distance of 300 m in 15s. Calculate its acceleration. Find the force acting on it, if its mass is 10 metric tonnes. (1 metric tonne = 1000 kg)**

Ans: Here,

$u = 0 \text{ m s}^{-1}$
t = 15s
s = 300 m
a = ?
F =?

We have,

$$\mathbf{S = u\,t + \frac{1}{2}a\,t^2}$$

$\Rightarrow 300 \text{ m} = 0 \text{ m s}^{-1} \times 15\text{s} + \frac{1}{2} \times a \times (15\text{s})^2$

$\Rightarrow 300 = \frac{1}{2} \times a \times 225$

$\Rightarrow 300 \times 2 = a \times 225$

Then, the force acting on the truck is given by

$$\mathbf{F = ma}$$

$$= 10 \text{ metric tonnes} \times \frac{8}{3} \text{m s}^{-2}$$

$$= 10 \times 1000 \text{ kg} \times \frac{8}{3} \text{m s}^{-2}$$

$$= \frac{80000}{3} = 26666.66 \text{ N} \quad = 26666.7 \text{ N}$$

10. A force of 15 N acts on a body of mass 0.5 kg. Find the acceleration of the particle.

Ans: Here,

F = 15 N, M = 0.5 kg, a =?

We have,

$$\mathbf{F = m\,a}$$

$$\therefore a = \frac{F}{m} = \frac{15N}{0.5\,Kg} = \frac{15 \times 10}{5} = 30 \text{ m s}^{-2}$$

11. The velocity of a body of mass 125 g changes from 10m/s to 5 m/s in 5 second assuming that a constant force acts on it, find the magnitude of force.

Ans: Here, u = 10 m/s, v = 5m/s, t = 5s, m = 125g = $\frac{125}{1000}$ kg

A = ? , F = ?

We have,

$\mathbf{V = u + at}$

$\Rightarrow$ 5 m/s = 10 m/s + a ×5s

$\Rightarrow$ 5 -10 = a × 5

$\Rightarrow$ -5 = a × 5

$\therefore a = \frac{-5}{5} = -1 \text{ m/s}^2$

Then, $\mathbf{F = ma}$

$$= \frac{125}{1000} \text{kg} \times (-\ 1\text{m/s}^2) = -\frac{125}{1000} = -\frac{1}{8} \text{ N}$$

The -ve sign indicates that the force is against the motion of the body.

12. A coin of mass 25g is pushed on a table. The coin starts moving at speed of 25 cms^{-1} and stops in 5s. Find the force of friction exerted by the table on the coin.

Ans: Here, $u = 25\ cms^{-1} = \frac{25}{100}\ ms^{-1}$

$v = 0\ ms^{-1}$ $\quad$ $m = 25g$

$t = 5s$

$m = \frac{25}{1000}\,kg$

$a = ?$

$F = ?$

We have, **v = u + at**

$$\Rightarrow 0\ ms^{-1} = \frac{25}{100}\ ms^{-1} + a \times 5s$$

$$\Rightarrow -\frac{25}{100} = a \times 5$$

$$\therefore a = -\frac{25}{100 \times 5} = -\frac{1}{20}\,ms^{-2}$$

The force of friction exerted by the table on the coin is given by

F= ma

$$= \frac{25}{100}\,kg \times \left(-\frac{1}{20}\,ms^{-2}\right)$$

$$= -\frac{25}{100} \times \frac{1}{20} = -\frac{1}{800} = 0.00125\ N$$

The –ve sign indicates that the force is against the motion of the coin.

13. A hockey ball of mass 200g travelling at 10ms^{-1} is struck by a hockey stick so as return it along its original path with a velocity of 5ms^{-1}. Calculate the change in momentum occurred in the motion of the ball by the force applied by the hockey stick.

Ans: Here, $m = 200g$

$= \frac{200}{1000}\,Kg$

$= \frac{1}{5}\,Kg$

$u = 10ms^{-1}$

$v = -5\ ms^{-1}$ (the ball returns along its original path)

The change in momentum = mv – mu

$$= \frac{1}{5}\,kg \times (-5\ ms^{-2}) - \frac{1}{5}\,kg \times 10\ ms^{-1}$$

$= -1-2$

$= -3$

$= 3Kgms^{-1}$ (neglecting –ve sign).

14. A horizontal force of 200 N is required to move a wooden cabinet across a floor at a constant velocity. Calculate the friction force exerted on the cabinet.

Ans: Here no acceleration is to be produced. Therefore, force of friction should be equal and opposite to the force applied. i.e. same force of 200 N.

15. Two bodies having each of mass 2 kg are moving in the same straight line but in opposite directions. The velocity of each before collision in 3ms $^{-1}$. In the collision they stick together. What will be the velocity of the combined body after collision?

Ans: Here,

$m_1 = 2kg$,
$m_2 = 2 kg$
$u_1 = 3 ms^{-1}$
$u_2 = -3ms^{-1}$
(the two bodies are moving in the same straight line but in opposite direction)

Total momentum before collision = $m_1u_1 + m_2u_2$

$= 2kg \times 3 ms^{-1} + 2kg \times (-3)$

$= 0 kg ms^{-1}$

Let vms^{-1} be the velocity of the combined body
Total momentum after collision = $(m_1 + m_2) \times v$
$= (2kg + 2kg) \times v$
$= 4v$
Then, m 4v = 0

$\therefore v = \frac{0}{4} = 0ms^{-1}$

16. A sharp object of mass 0.5 kg travelling horizontally at a velocity of 100 ms^{-1} strikes a stationary wooden block of mass 2.5 kg. Thereafter, the two moves together in the same straight line. Calculate the total momentum before and after the impact. Also calculate the velocity of the combined system.

Ans: Here, $m_1 = 0.5$ kg, $m_2 = 2.5kg$

$u_1 = 100 ms^{-1}$ $u_2 = 0ms^{-1}$

Total momentum before the impact = $m_1u_1 + m_2u_2$

$= 0.5 \text{ kg} \times 100 \text{ ms}^{-1} + 2.5\text{kg} \times 0\text{ms}^{-1}$

$= 50 \text{ kg ms}^{-1} + 0$

$= 50 \text{ kg ms}^{-1}$

Let vms^{-1} be the velocity of the combined system

Total momentum after the impact = $(m_1 + m_2) \times v$

$= (0.5 \text{ kg} + 2.5 \text{ kg}) \times v$

$= 3 \times v$

We have,

$3 \times v = 50$

$\therefore v = \frac{50}{3} \text{ ms}^{-1}$

17. A ball of iron of mass 10kg falls from a height of 0.8 m. If the downward acceleration of the ball is 10ms^{-2}, calculate the momentum transfer to the floor by the ball, provided the ball does not rebound.

Ans: Here,

$m = 10$ kg

$u = 0\text{ms}^{-1}$, $v = ?$, $h = 0.8$m

$a = 10\text{ms}^{-2}$

We have,

$v^2 = u^2 +$ b $2as$

$= (0 \text{ ms}^{-1})^2 + 2 \times (10 \text{ ms}^{-2}) \times 0.8\text{m}$

$= 0+16$

$\Rightarrow v^2 = 16$

$\Rightarrow v = \sqrt{16} = 4\text{ms}^{-1}$

The momentum transfer to the floor by the ball = mv-mu

$= 10\text{kg} \times 4\text{ms}^{-1} - 10\text{kg} \times 0\text{ms}^{-1}$

$= 40-0$

$= 40 \text{ kg ms}^{-1}$

18. An unbalanced force act on a body, the body must

(a) remain at rest
(b) more with uniform velocity
(c) be accelerated
(d) move along a circle
Ans: (c) be accelerated

19. When a bus suddenly starts the standing passengers lean backward in the bus. It is an example of Newton's

(a) First law of motion
(b) Second law of motion
(c) Third law of motion
(d) any one of the above/law of motion

Ans: a) first law of motion

20. Action reaction forces act

a) On the same body
b) on different bodies
c) In the same direction
d) d) along different lines
Ans: b) on different bodies

21. Suppose a constant force act on a body initially kept at rest. The distance covered by the body in time t form start is proportional to

a) t
b) t^{-1}
c) t^2
d) t^3
Ans: c) t^2

TRY TO ANSWER

1. Which one has the greater inertia?
i) A rubber ball and a stone having the same size
ii) A bicycle and a Scooter
iii) A fine rupee coin and a one-rupee coin

Ans: i) A stone has more inertia than a rubber ball.

ii) Scooter has the more inertia than a bicycle

iii) A fine rupee coin has the more inertia than one-rupee coin.

2. **Some of the leaves of a tree may get detached if we vigorously shake its branch. Explain why.**

Ans: When we shake the branch, it moves suddenly while the leaves remain in their rest due to inertia. Hence, the leaves are detached.

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