

Chapter	3 Circular and Rotational Motion	Class	1 st Year	Subject	Physics
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Give Short Answers of the Following Questions

1. State second law of motion in case of rotation.

Ans. Second law of motion in case of rotation: The second law of rotation motion in case of rotation states that the torque (τ) acting on a body is equal to the product of its moment of inertia (I) and its angular acceleration (α).

As $F = ma$

Multiplying both sides by r

$$rF = r(ma)$$

$$\tau = rm(r\alpha) \quad \because \tau = rF, a = r\alpha$$

$$\tau = I\alpha$$

This is the rotational analogue of Newton's second law ($F = ma$).

2. What is the effect of changing the position of a diver while diving in the pool?

Ans. The diver changes his body position to make **extra somersaults**.

Explanation:

When a diver lifts off from the diving board, his legs and arms are full extended. In this case his moment of inertia is large (I_1) but angular velocity (ω_1) is small.

When the legs and arms of the diver are drawn into the closed tuck position, his moment of inertia is reduced considerably so that his angular velocity will increase to **conserve the angular momentum**.

$$I_1\omega_1 = I_2\omega_2$$

3. How do we get butter from the milk?

Ans. Butter is obtained from milk by a process called centrifugation, in a machine called cream separator.

Explanation: In this machine, milk is whirled rapidly. Since milk is a mixture of light and heavy particles, when it is rotated, the light particles (cream) gather near the axis of rotation whereas the heavy particles (like skim milk) will go outward and hence cream can easily be separated from milk. The cream is then collected and further churned to separate butter.

4. Mass is a measure of inertia in linear motion. What is its analogue in rotational motion? Describe briefly.

Ans. Second law of motion can be expressed as,

For linear motion: $F = ma$

For angular motion: $\tau = I\alpha$

So torque is rotational analogy of force. Whereas mass is rotational analogy of moment of inertia. Just as mass resists changes in linear motion, moment of inertia resists changes in rotational motion. Moment of inertia depends on both the mass of the object and its distribution about the axis of rotation.

5. Why is it harder for a car to take turn at higher speed than at lower speed?

Ans. It is harder for a car to take turn at higher speed than at lower speed.

Reason: While turning a car requires centripetal force, given by

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$$F_c = \frac{mv^2}{r}$$

At higher speed, the term v^2 increases rapidly, so more force is required to maintain the turn. If the required frictional force is not available, the car may skid. Hence, turning is harder at higher speeds due to increased centripetal force demand.

6. What are the benefits of using rare wheels of heavy vehicles consisted of double tires?

Ans. Heavy vehicles often uses double or multiple tires on rear wheels, having benefits.

(i) Increased contact area: More tyres increase the surface area in contact with the road, reducing pressure ($P = \frac{F}{A}$) on each tyre, which prevents sinking on soft surfaces.

(ii) Improved load bearing: The load is shared among more tyres, reducing wear and tear and improving safety.

(iii) Better stability: Most important is that the multiple wheels provide greater stability, especially during turns and on uneven roads due to their large value of moment of inertia.

7. When a moving car turns around a corner to the left, in what direction do the occupants tend to fall? Explain briefly.

Ans. When a moving car turns left, the occupants tend to fall to the right.

Reason:

- When the car changes direction to the left, the bodies of the occupants continue moving in a straight line due to inertia (Newton's first law).
- Since the car is turning left and the bodies want to keep moving straight, they appear to move right relative to the car.

8. Why is the acceleration of a body moving uniformly in a circle, directed towards the centre?

Ans. The acceleration of a body moving uniformly in a circle is directed toward the centre.

Reason: In uniform circular motion, the direction of velocity changes continuously. Since velocity is vector, a change in its direction implies an acceleration.

This acceleration is called centripetal acceleration which is always points towards the centre of the circle, given by

$$a_c = \frac{v^2}{r}$$

This inward acceleration is necessary to keep the body moving along a circular path.

9. How does an astronaut feel weightlessness while orbiting from the Earth in a space-ship?

Ans. Reason:

- An astronaut feels weightlessness while orbiting, because both the astronaut and tile spaceship are in the state of free fall towards the Earth under the influence of gravity.
- In orbit, the centripetal force required to keep the spaceship moving in a circular path is provided by gravity.

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- Since both the spaceship and the astronaut inside are falling with same acceleration (i.e., $a = g$), there is no normal reaction force acting on the astronaut. Thus astronaut experiences apparent weightlessness.