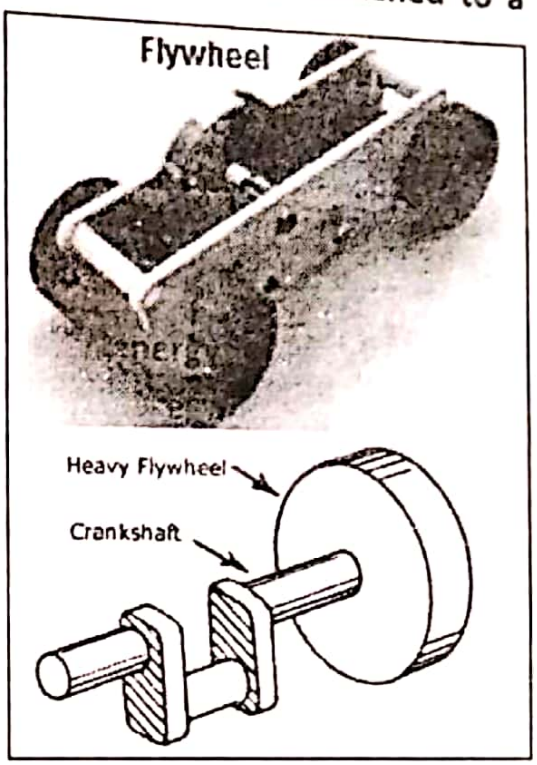
SHORT QUESTIONS

Write short answer questions of the following.

1. Why is the fly wheel of an engine made heavy in the rim?

Ans. The flywheel is made heavy in the rim because the wheel is attached to a rotating shaft and it smoothes out the delivery of power from a motor to a machine.



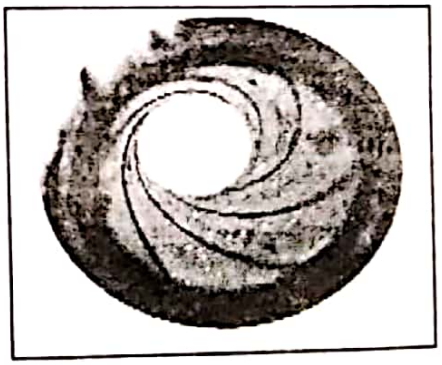
The inertia of the flywheel opposes and moderates fluctuations in the speed of the engine. To oppose speed fluctuations effectively, a flywheel is given a high rotational inertia; i.e., most of its weight is well out from the axis (in the rim). A wheel with a heavy rim has a high rotational inertia because the rotational inertia depends on mass for a constant radius. i.e;

$$I = m r^2 \qquad (1)$$

This helps in avoiding serious damages due to sudden changes.

2. Why is a rifle barrel 'rifled'?

Ans. Rifling is the process of making helical grooves in the barrel of a gun or firearm, which imparts a spin to a projectile around its long axis. This spin has three important functions;



i. It serves to stabilize the projectile (bullet),
ii. Improves its aerodynamic stability and
iii. Increases its accuracy.

The spin angular momentum is parallel to linear momentum and the net momentum of the bullet increases. Hence the bullet has maximum momentum and it imparts maximum momentum to the target.

3. Is it possible for a person to distinguish between a raw egg and a hard boiled one by spinning each on a table? Explain.

Ans. Yes it is possible for a person to distinguish between a raw (uncooked/unpasteurized egg) and hard-boiled egg through spinning by applying the concept of conservation of angular momentum. i.e.

$$L = I\omega = \text{constant}$$

$$\Rightarrow \quad I \propto \frac{1}{\omega}$$

The internal material of a hard-boiled egg gets harder and contracts so that the internal radius (r) of the material decreases which will decrease its moment of inertia. Therefore to conserve the angular momentum its angular velocity "ω" (or) spinning will increases.

On the other hand, when a raw egg is made to spin, the liquid inside the egg spreads out. Therefore to conserve the angular momentum its angular velocity "ω" (or) spinning will decrease due to which it comes to rest quickly.

Thus a hard-boiled egg will be the one that can spin more easily than the raw egg.

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

Ans. When a body is moving in a circle with constant speed, then acceleration is produced only due to change in the direction of the linear velocity of the body. This happens when force is acting perpendicular to the direction of linear velocity of the body. Such a force is called as centripetal force which is always directed towards the center of the circle. According to Newton's 2nd law the acceleration is produced in the direction of the force therefore the acceleration of a body moving with constant speed in a circle is always directed towards the center of the circle.

5. A ball is just supported by a string without breaking. If it is set swinging, it breaks. Why?

Ans. When a ball is just supported by a string without breaking, it is in equilibrium condition under the action of two equal and opposite forces i.e. the weight W and the tension T in the string.

$$T = W$$

When the ball is set to swinging then the tension in the string plays the role of centripetal force but the centrifugal force thus produced according to Newton's 2nd law will add up with the weight of the body and will cause the string to break.

$$T < F_{centrifugal} + W$$

6. An insect is sitting close to the axis of a wheel. If the friction between the insect and the wheel is very small, describe the motion of the insect when the wheel starts rotating.

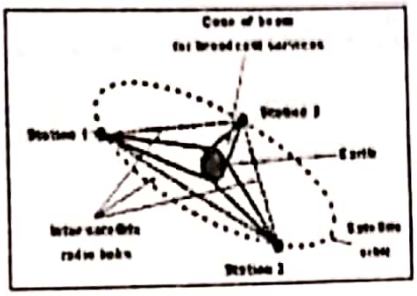
Ans. The force which stick the insect to the wheel is the frictional force between the insect and the wheel. But as the wheel start rotation more frictional force is needed by the insect to provide it the required centripetal force .i.e

$$\text{Friction} = F_c = mV^2/r \qquad (1)$$

But since we are given that the friction between insect and wheel is very small, so the insect will not be able to made itself stick to the wheel as it start rotation. So the insect will fly off in the direction of tang...

7. Explain how many minimum number of geo-stationary satellites are required for global coverage of T.V transmission.

Ans. Since we know that the geo stationary satellites move around the earth from west to east in the equatorial plane at the same rate as that of the rotation of the earth about its own axis. A single geo stationary satellite covers a longitude of 120°, so that the whole earth longitude can be covered by at least three geo stationary satellites at proper positions.



8. Explain the significance of moment of inertia in rotatory motion.

Ans. Since we know that Newton's 2nd law of motion for rotational motion can be written as;

$$\tau = I\alpha \quad (1)$$

Comparing with Newton's 2nd law for translational motion;

$$F = ma \quad (2)$$

From Eq.1 and Eq.2, it is clear that the moment of inertia "I" perform the same role in rotational motion as mass (measure of inertia) perform in translational motion. Hence the significance of moment of inertia is to oppose any change in the rotational motion of a body. Also we can say that the importance of the moment of inertia for a body is its ability to maintain its state of rotational motion.

9. Why does the coasting rotating system slow down as water drips into the beaker?

Ans. The coasting system works according to the principle of law of conservation of angular momentum which states that, in the absence of any external torque, the total angular momentum of the system always remains constant.

Mathematically;

$$L = I\omega = \text{Constant}$$

$$\Rightarrow \quad I \propto \frac{1}{\omega}$$

So as the water is put (drops) in to the beaker the mass of beaker and hence its moment of inertia will increase. Therefore to conserve angular momentum its rotation or angular velocity will decrease. This is why coasting rotating system slows down as water drops in to the beaker.

10. A body will be weightless when the elevator falls down just like a free falling body. Explain.

Ans. Consider an elevator moves downward with some acceleration "a". The mass "m" also moves downward with the same acceleration "a". The net force acting on the mass is given as;

$$W - T = F_{net}$$

$$T = W - F_{net}$$

$$\Rightarrow \quad T = mg - ma \qquad (1)$$

$$\Rightarrow$$

The tension T reads the apparent weight of the body which is now less than the real weight of the body by an amount "ma". Now if the elevator is falling freely under the action of gravity, then the acceleration of such a freely falling body is equal to gravitational acceleration "g". By putting "a = g" in Eq.1, we get;

$$T = mg - mg = 0$$

Hence the body will be weightless when the elevator falls down just like a free falling body.

11. When a tractor moves with uniform velocity, its heavier wheel rotates slowly than its lighter wheel, why? Explain.

Ans. When a tractor moves with uniform velocity, the net torque acting on it must be zero.

Mathematically $\tau = \frac{\Delta L}{\Delta t}$

When $\tau = 0$

Then $\Delta L = 0$

$\Rightarrow$ $L = I\,\omega = \text{Constant}$

$\Rightarrow$ $\omega \propto \frac{1}{I}$

Since its lighter wheel is also of small size having small moment of inertia so it will rotate faster due to large value of angular velocity. But the heavier wheels are also of large size having large moment of inertia hence it rotates slowly due to small value of angular velocity (ω) just in accordance with the law of conservation of angular momentum.