IMPORTANT QUESTIONS CLASS – 11 PHYSICS CHAPTER – 6 SYSTEM OF PARTICLE AND ROTATIONAL MOTION |

Question 1.
What is the difference between the centre of gravity and C.M.?

Answer:
C.G.: It is the point where the whole of the weight of the body is supposed to be concentrated i.e. on this point, the resultant of the gravitational force on all the particles of the body acts.
C.M.: It is the point where the whole of the mass of the body may be supposed to be concentrated to describe its motion as a particle.

Question 2.
There are two spheres of the same mass and radius, one is solid and the other is hollow. Which of them has a larger moment of inertia about its diameter?

Answer:
The hollow sphere shall have greater M.I., as its entire mass is concentrated at the boundary of the sphere which is at maximum distance from the axis.

Question 3.
What shall be the effect on the length of the day if the polar ice caps of Earth melt?

Answer:
Melting of polar ice caps will produce water spread around the Earth going farther away from the axis of rotation that will increase the radius of gyration and hence M.I. In order to conserve angular momentum, the angular velocity ω shall decrease. So the length of the day ($T = 2\pi\omega$) shall increase.

Question 4.
If only an external force can change the state of motion of the C.M. of a body, how does it happen that the internal force of brakes can bring a vehicle to rest?

Answer:
The internal force of brakes converts the rolling friction into sliding friction. When brakes are applied, wheels stop rotating. When they slide, the force of friction comes into play and stops the vehicle. It is an external force.

Question 5.
What do you understand by a rigid body?

Answer:
A rigid body is that in which the distance between all the constituting particles remains fixed under the influence of external force. A rigid body thus conserves its shape during its motion.

Question 6.
Distinguish between internal and external forces.
Answer:

1. The mutual forces between the particles of a system are called internal forces.
2. The forces exerted by some external source on the particles of the system are called external forces.

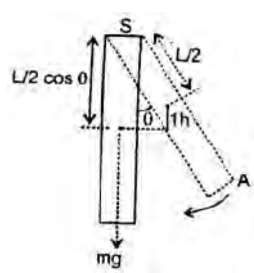
Question 7.
One end of a uniform rod of mass m and length L is supported by a frictionless hinge which can withstand a tension of 1.75mg. The rod is free to rotate in a vertical plane. To what maximum angle should the rod be rotated from the vertical position so that when left, the hinge does not break?

Answer:
Let θ = maximum angle = ?
T = 1.75 mg
When the rod is in a vertical position, then the net force acting on the rod
F= 1.75mg – mg = 0.75mg
when the rod rotates, centripetal force,

$$F = \frac{mv^2}{\left(\frac{L}{2}\right)} = m\omega^2\frac{L}{2} \quad \left(\because v = R\omega \text{ and here } R = \frac{L}{2}\right)$$

$$\therefore \qquad m\omega^2\frac{L}{2} = 0.75mg$$

$$\text{or} \qquad \omega^2 L = 1.50g \qquad \ldots (1)$$



When the rod is in the displaced position A, then K.E. of rotation is converted in RE.
∴ P.E. of the rod at displaced position = mg h

Here, $$h = \frac{L}{2} - \frac{L}{2}\cos\theta = \frac{L}{2}(1 - \cos\theta)$$

$$\therefore \quad P.E. = mg\frac{L}{2}(1 - \cos\theta)$$

For rod I = 13 mL²

∴ According to the law of conservation of energy,

$$\frac{1}{2}I\omega^2 = mg\frac{L}{2}(1 - \cos\theta)$$

$$\text{or} \quad \frac{1}{2} \times \frac{1}{3} mL^2\omega^2 = mg\frac{L}{2}(1 - \cos\theta)$$

$$\text{or} \quad \frac{1}{3}L\omega^2 = g(1 - \cos\theta)$$

$$\text{or} \quad \frac{1.5}{3}g = g(1 - \cos\theta)$$

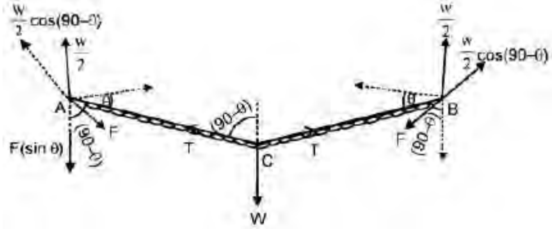
$$\text{or} \quad \frac{1}{2} - 1 = -\cos\theta$$

$$\text{or} \quad \cos\theta = \frac{1}{2} = \cos 60^\circ$$

$$\therefore \quad \theta = 60^\circ.$$

Question 8.
A flexible chain of weight W hangs between two fixed points A and B at the same level as shown here.
Find (i) force applied by a chain on each endpoint.
(ii) the tension in the chain at the lowest point.

Answer:
Let W = weight of the chain
∴ w2 = reaction at each endpoint A and B vertically upward



w2 balances downward

(i) Component F sin o of force F applied by a chain on each point

$$\text{i.e.} \qquad \frac{w}{2} = F \sin \theta$$

$$\text{or} \qquad F = \frac{w}{2 \sin \theta}$$

(ii) At lowest point C, the tension T is horizontal and equals the horizontal component of force F

$$\text{i.e.} \qquad T = F \cos \theta = \frac{w}{2 \sin \theta} \cos \theta = \frac{w}{2} \cot \theta.$$

Question 9.

The moment of inertia of a body about a given axis is 1.2 kg m². Initially, the body is at rest. In order to produce a rotational K.E. of 1500J, for how much duration, an acceleration of 25 rads^{-2} must be applied about that axis.

Answer:

$$\text{Here,} \qquad I = 1.2 \text{ kg m}^2$$

$$\text{rotational K.E.} = \frac{1}{2} I\omega^2 = 1500\text{J}$$

$$\omega_0 = 0$$

$$\alpha = 25 \text{ rads}^{-2}$$

$$t = ?$$

$$\therefore \qquad \frac{1}{2} I\omega^2 = 1500 \text{ gives,}$$

$$\omega = \sqrt{\frac{2 \times 1500}{1.2}} = \sqrt{\frac{30000}{12}}$$

$$= \sqrt{2500} = 50 \text{ rads}^{-1}$$

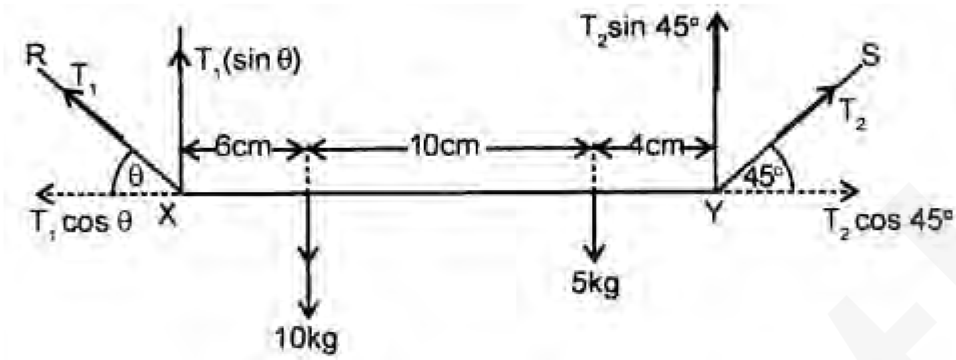
$$\text{Using relation,} \qquad \omega = \omega_0 + \alpha t, \text{ we get}$$

$$t = \frac{\omega - \omega_0}{\alpha} = \frac{50 - 0}{25} = 2\text{s}.$$

Question 10.

A thin bar XY of negligible weight is suspended by strings R and S shown in fig. The bar carries masses of 10 kg and 5 kg. Find the tensions in the strings and the angle θ if the system is in the static equilibrium.

Answer:
$T_1, T_2 = ?$
$\theta = ?$



Taking moments about point X, we get

$$T_2 \sin 45° \times 20 = 10 \times 6 + 5 \times 16$$

or $$\frac{T_2}{\sqrt{2}} \times 20 = 60 + 80 = 140$$

or $$T_2 = \frac{140}{10\sqrt{2}} = \frac{14\sqrt{2}}{2}$$
$$= 7\sqrt{2} \text{ kgf} \quad \dots (1)$$

Again taking moment about point Y, we get

$$T_1 \sin\theta \times 20 = 10 \times 14 + 5 \times 4 = 140 + 20$$
or $$20\, T_1 \sin\theta = 160$$
or $$T_1 \sin\theta = 8 \quad \dots (2)$$

Also for horizontal equilibrium

$$T_1 \cos\theta = T_2 \cos 45° = 7\sqrt{2} \times \frac{1}{\sqrt{2}} = 7 \quad \dots (3)$$

$(2)^2 + (3)^2$ gives,
$$T_1^2 = 8^2 + 7^2 = 64 + 49 = 113$$
or $$T_1 = \sqrt{113} = 10.6 \text{ kgf} \quad \dots (4)$$

$\frac{(2)}{(3)}$ gives, $$\frac{\sin\theta}{\cos\theta} = \frac{8}{7} = 1.143$$
or $$\tan\theta = \tan 48.8°$$
or $$\theta = 48.8°.$$