Concept Questions with Answers

8.01
W09D1

Today’s Reading Assignment:
MIT 8.01 Course Notes:
Chapter 16 Two Dimensional Rotational Kinematics
Sections 16.1-16.4
Chapter 17 Two Dimensional Rotational Dynamics
Sections 17.2

Concept Question: Angular Speed
Object A sits at the outer edge (rim) of a merry-go-round, and object B sits halfway between the rim and the axis of rotation. The merry-go-round makes a complete revolution once every thirty seconds. The magnitude of the angular velocity of Object B is

1. half the magnitude of the angular velocity of Object A.
2. the same as the magnitude of the angular velocity of Object A.
3. twice the magnitude of the angular velocity of Object A.
4. impossible to determine.

Answer: 2. All points in a rigid body rotate with the same angular velocity.

Concept Q.: Moment of Inertia Same Masses
All of the objects below have the same mass. Which of the objects has the largest moment of inertia about the axis shown?

(1) Hollow Cylinder (2) Solid Cylinder (3) Thin-walled Hollow Cylinder

Answer 3. The mass distribution for the thin-hollow walled cylinder is furthest from the axis, hence it’s moment of inertia is largest.
Concept Q.: Moment of Inertia about Center
Which has the smallest $I$ about its center?

1) Ring $(M,R)$
2) Disk $(M,R)$
3) Sphere $(M,R)$
4) All have the same $I$

Answer 3. The mass of the sphere is on average closer to an axis of rotation passing through its center than in the case of the ring or the disc.

Concept Q.: Moment of Inertia about Different Axes
Which axis gives the largest $I$ for the disk?

1) 
2) 
3) 
4) All have the same $I$

Answer 2. The mass of the ring is furthest on average from an axis passing perpendicular to the plane of the disc and passing through a point on the edge of the disc.

Concept Question: Moment of Inertia of Rod
Consider a thin uniform rod of length $L$ and mass $M$. The moment of inertia about the center of mass is $(1/12) ML^2$. Calculate the moment of inertia about an axis that passes perpendicular to the rod through one end of the rod is

a) $l_{end} = (1/12) ML^2$.
b) $l_{end} = ML^2$.
c) $l_{end} = (1/4) ML^2$.
d) None of the above.

Answer 4.

$I_{end} = M(L/2)^2 + (1/12) ML^2 = (1/3) ML^2$
Concept Question: Kinetic Energy

A disk with mass $M$ and radius $R$ is spinning with angular speed $\omega$ about an axis that passes through the rim of the disk perpendicular to its plane. Moment of inertia about cm is $(1/2)M R^2$. Its total kinetic energy is:

1. $\frac{1}{4}M R^2 \omega^2$
2. $\frac{1}{2}M R^2 \omega^2$
3. $\frac{3}{4}M R^2 \omega^2$
4. $\frac{1}{4}M R\omega^2$
5. $\frac{1}{2}M R\omega^2$
6. $\frac{1}{4}M R\omega$

Concept Q. Ans.: Kinetic Energy

**Answer 3.** The parallel axis theorem states the moment of inertia about an axis passing perpendicular to the plane of the disc and passing through a point on the edge of the disc is equal to

$$I_{\text{edge}} = I_{\text{cm}} + mR^2$$

The moment of inertia about an axis passing perpendicular to the plane of the disc and passing through the center of mass of the disc is equal to

$$I_{\text{cm}} = \frac{1}{2}mR^2$$

Therefore

$$I_{\text{edge}} = \frac{3}{2}mR^2$$

The kinetic energy is then

$$K = \frac{1}{2}I_{\text{edge}}\omega^2 = \frac{3}{4}mR^2\omega^2$$