

Module 5 Problems

TPHYS 121 Workshop Week 9

Exercise 1

A solid disk with mass $m = 4\text{kg}$ and radius $r = 0.5\text{m}$ is mounted on a frictionless axle. ($I_{\text{disk}} = \frac{1}{2}mr^2$)

- (a) Calculate the moment of inertia of the disk about its central axis.
- (b) A force of 8N is applied tangentially at the rim of the disk counterclockwise. Find the resulting torque.
- (c) Determine the angular acceleration of the disk.
- (d) Using the Right-Hand Rule, determine whether the torque vector points into or out of the page.

Exercise 2

A hollow cylinder (a thin-walled hoop) with a mass 2kg and radius 0.4m is initially at rest. A force of 5N is applied tangentially to the rim for 3.0s ($I_{\text{hoop}} = mr^2$)

- (a) Find the moment of inertia of the hoop about its central axis.
- (b) Determine the angular acceleration of the hoop.
- (c) Calculate the final angular velocity after 3 seconds.
- (d) Find the rotational kinetic energy of the hoop at 3 seconds.

Exercise 3

An ice skater is spinning with an initial angular velocity of 2rad/s and a moment of inertia of $I_1 = 3\text{kg} \cdot \text{m}^2$. They pull their arms in reducing their moment of inertia to $I_2 = 1.2\text{kg} \cdot \text{m}^2$. (Angular momentum: $L = I\omega$)

- (a) What happens to the skater's angular speed after pulling their arms in? Why?
- (b) Find the skater's new angular velocity.
- (c) Calculate the initial and final rotational kinetic energy.
- (d) Use the right-hand rule to determine the direction of the skater's angular momentum vector when spinning counterclockwise when viewed from above.

Exercise 4

A 6kg bowling ball with radius $r = 0.3\text{m}$ starts from rest and rolls down a 1.5m tall incline without slipping.

- (a) Find the moment of inertia of the bowling ball.
- (b) Determine the final rotational kinetic energy at the bottom of the incline.
- (c) What is the final velocity and angular velocity of the sphere.