Rotational Dynamics, Energy, & Momentum: Chapter 9.4 – 9.6

Moment of Inertia (I) – in rotational motion, moment of inertia plays the same role as mass in translational motion. I is a measure of the rotational inertia of a body.

$$I = mr^2$$

I represents the sum of the individual moments of inertia of the rigid body.

The moment of inertia (I) of an object depends on the total mass of an object, its shape, and the location and orientation of the axis.

- **Table 9.1 on p. 254**

Newton's 2nd Law for Rotational Motion – torque is the product of a body's moment of inertia (I) and its angular acceleration

$$\tau = I\alpha$$

- example 10 on p. 255 – A motor in an electric saw brings the circular blade from rest to an angular velocity of 80 rev/s in 240 revolutions. If the blade has a moment of inertia of 1.41×10^{-3} kgm^2, what is the net torque on the blade?

Rotational Work (W_R) – product of torque and angular displacement

$$W_R = \tau\theta$$

In rotational motion, work is still the transfer or change of energy ($W_R = \Delta E$).

Rotational Kinetic Energy – product of ½ the moment of inertia and the square of the angular velocity of a rotating rigid object

$$KE_R = \frac{1}{2}I\omega^2$$

The total mechanical energy of an object can include translational and rotational energies. (Example of a bike tire as it coasts down a hill.)

$$ME = KE + KE_R + PE_g$$

- example 13 on p. 262

Angular Momentum (L) – product of a body's moment of inertia and its angular velocity

$$L = I\omega$$

In rotational motion, momentum is still the difficulty in bringing an object to rest.

Conservation of Angular Momentum

Angular momentum is conserved if the net external torque on a system is zero.

$$L = L'$$

- example 14 on p. 263

- example 15 on p. 264

- example 17 on p. 266

- **Table 9.2 on p. 260**