# Unit 6: Rotational Mechanics

**Text:**
Chapters 10 & 11.

*Problems (p. 266-274)*

| | |
|---|---|
| #1: 2, 4, 11, 13, 17 | *rotational variables* |
| #2: 19, 20, 26, 29, 30 | *linear and angular* |
| #3: 33, 35, 38, 39 | *rotational inertia and kinetic energy* |
| #4: 46, 47, 49, 51, 55 | *torque* |
| #5: 58, 63, 65, 66 | *work and energy* |

*Problems (p. 297-304)*

| | |
|---|---|
| #6: 5, 6, 8 | *rolling* |
| #7: 33, 36, 41, 43, 49, 58 | *angular momentum* |

**Vocabulary:**
Moment of Inertia, rotational inertia, radian, linear vs. angular measurements, torque, precession, radial acceleration, tangential acceleration, angular momentum, stability

**Math:**
definitions:

$$\omega = \frac{d\theta}{dt} \qquad \alpha = \frac{d\omega}{dt} \qquad s = r\theta \qquad \vec{\tau} = \vec{r} \times \vec{F}$$

$$\vec{l} = \vec{r} \times \vec{p} \qquad I = \sum mr^2 = \int r^2 dm$$

derived formulas:

$$\overline{\omega} = \frac{\omega_i + \omega_f}{2} \qquad \theta = \tfrac{1}{2}\alpha t^2 + \omega_i t + \theta_i \qquad \omega_f^2 = \omega_i^2 + 2\alpha\Delta\theta$$

$$v = r\omega \qquad a_t = r\alpha \qquad a_c = r\omega^2 \qquad K = \tfrac{1}{2} I\omega^2$$

$$\sum \tau = \frac{dL}{dt} = I\alpha \qquad L = I\omega \qquad W = \int \tau d\theta \qquad I = I_{cm} + Mh^2$$

skills: cross products

**Key Objectives:**

- ☐ be able to show/derive the derived formulas listed above.
- ☐ be able to solve a variety of word problems involving angular position, velocity and acceleration and their linear counterparts.
- ☐ be able to apply Newton's Second Law in angular form to a variety of situations.
- ☐ be able to calculate the moment of inertia for a given situation. (be prepared for a choice: one requiring calculus and one using just algebra. You will be given the chart from page 253 of the book.)
- ☐ be able to apply energy principals to solve a variety of word problems.
- ☐ be able to apply the conservation of angular momentum to a variety of situations.
- ☐ be able to explain/use/understand the vocabulary and formulas listed above.
- ☐ be able to solve word problems numerically and symbolically.
- ☐ be able to use the right hand rules discussed in class.
- ☐ be able to explain why a gyroscope precesses. (the rotating bicycle wheel hanging from the ceiling is an example of this.)
- ☐ be able to explain why an object is much more stable when rotating/rolling than non-rotating.