Exam 3 Review Notes

> **Key:**
> - **Category I:** most important stuff. Definitely on exam.
> - **Category II:** less important, but still "fair game." *Could* be on exam.
> - **Category III:** definitely *not* on exam.

Chapter 10

Category I

- Sec. 10-6: Conservation of Energy
  - If no nonconservative forces doing work, total mechanical energy is conserved, but now (if object rolling without slipping) there are *two* kinds of *K*. So conservation of energy says, in most general case:

    $$K_{trans}^{i} + K_{rot}^{i} + U_{grav}^{i} + U_{spring}^{i} = K_{trans}^{f} + K_{rot}^{f} + U_{grav}^{f} + U_{spring}^{f}$$

    $$\frac{1}{2}Mv_i^2 + \frac{1}{2}I\omega_i^2 + Mgy_i + \frac{1}{2}kx_i^2 = \frac{1}{2}Mv_f^2 + \frac{1}{2}I\omega_f^2 + Mgy_f + \frac{1}{2}kx_f^2$$
  - Problems like:
    - Example done in book, pp. 293-294
    - Example of object (hoop?) rolling down ramp (done in class)
    - Example 10-6
    - Prob. 60, end of chapter (given on take-home quiz)
    - #6, Practice Exam
- Sec. 10-2: Rotational Motion with Constant Angular Acceleration
  - use 4 facts:
    - $\omega = \omega_0 + \alpha t$
    - $\theta = \theta_0 + \frac{1}{2}(\omega_0 + \omega)t$
    - $\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$
    - $\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$
  - Problems like:
    - Example 10-1
    - Active Example 10-1
    - #1, Practice Exam
    - #2, Practice Exam
    - Prob. 20, HW

Category II

- Sec 10-5: Calculating Moments of Inertia
  - Collections of Point Masses: $I = \sum_{i=1}^{N} m_i r_i^2$ (for *N* point masses)
  - Could also ask you to derive formula for moment of inertia of thin hoop about axis through the center of the hoop, perpendicular to the plane of the hoop:

    $$I = MR^2$$
  - Problems like:
    - L-shaped object from take-home quiz
    - #5, Practice Exam
    - Exercise 10-7
- Sec. 10-3: Connections Between Linear and Rotational Quantities
  - $v = r\omega$
  - $a = r\alpha$
  - rigid objects: same ω and same α at every point
  - $a_{cp} = r\omega^2$
  - Problems like:
    - #3, Practice Exam
    - Example 10-3
    - Prob. 26, HW

- Sec. 10-4: Rolling Motion
  - *center* of rolling object translates forward with speed $v = R\omega$
  - Problems like:
    - #4, Practice Exam
    - Prob. 41, HW

Category III

- Sec 10-1

Chapter 11

Category I

- Sec 11-3: Equilibrium
  - Now *two* kinds (as contrasted with Sec. 6-3): translational *and* rotational:
    - $\sum F_x = 0$ and $\sum F_y = 0$ … translational equil.
    - $\tau_{net} = 0$ (about *any* axis)… rotational equi.
  - Problems like:
    - #16, Practice Exam
    - Active Example 11-1
    - Example 11-4
    - Active Example 11-2
    - Prob. 22, HW
    - Prob. 23, HW
- Secs 11-6 and 11-7: Conservation of Angular Momentum
  - L conserved if net external torque is zero. (Law of Conservation of Angular Momentum)
  - Problems like:
    - Example 11-10
    - Active Example 11-4
    - #17, Practice Exam
    - Prob. 63, HW

Category II

- Sec. 11-1: Torque
  - calculating net torque due to more than 1 force
  - definition of *moment arm* r
  - Problems like:
    - net torque exerted on LP by DJ (done in class)
    - Example 11-1
    - #8, Practice Exam
    - Prob. 5, HW
- Sec. 11-2: Torque and Angular Acceleration
  - $\tau_{net} = I\alpha$
  - Problems like:
    - Exercise 11-2
    - Prob. 9, HW
    - Prob. 13, HW

Category III

- Sec 11-4
- Sec 11-5
- Sec 11-8
- Sec 11-9

Chapter 12

Category I

- Sec 12-5: Energy Conservation
  - Once again, total mechanical energy is conserved if no nonconservative forces doing any work (Law of Conservation of Energy). But *this* time, use *corrected* formula for gravitational potential energy (corrected to be valid when not close to surface of Earth or surface of other planet, moon, etc):
    - $U_{grav} = -G\frac{mM_E}{r}$ (for gravitational potential energy due to *Earth*. If want gravitational potential energy due to some *other* planet or moon, replace M_E with mass of *that* planet or moon)
    - So conservation of energy becomes:

$$K_i + U^i_{grav} = K_f + U^i_{grav}$$

$$\frac{1}{2}mv_i^2 - G\frac{mM_E}{r_i} = \frac{1}{2}mv_f^2 - G\frac{mM_E}{r_f}$$

  - Problems like:
    - #11, Practice Exam
    - Prob. 47, HW
    - Prob. 58, HW
    - Example 12-6
    - Active Example 12-2
- Sec 12-1: Newton's Law of Universal Gravitation
  - $F_{grav} = G\frac{m_1 m_2}{r^2}$
  - Problems like:
    - #10, Practice Exam
    - Example 12-1
    - Prob. 8, HW

Category II

- Escape Speed (Sec 12-5)
  - $v_e = \sqrt{\frac{2GM}{R}}$. M , R are mass and radius, respectively, of whatever planet, moon, asteroid, etc., you're on.
  - Problems like:
    - Prob. 49, HW
    - Example 12-7

Category III

- Sec 12-3
- Sec 12-6

Chapter 13

Category I

- Sec. 13-4: Mass on Spring (Simple Harmonic Motion)
  - $\omega = \sqrt{\frac{k}{m}}$
  - $T = 2\pi\sqrt{\frac{m}{k}}$
  - Problems like:
    - #12, Practice Exam
    - Example 13-4

  - Active Example 13-2
  - Problems at end of chapter
- Simple Pendulum (Sec. 13-6)
  - o $T = 2\pi\sqrt{\frac{L}{g}}$
  - o Problems like:
    - #13, Practice Exam
    - Example 13-7
    - Prob. 46, HW
    - other problems from end of chapter

Category II
- Secs 13-1 and 13-2: Simple Harmonic Motion
  - o Properties of sinusoids:
    - most general form: $x = A\cos(\omega t + \phi)$
    - know how to identify amplitude, frequency, angular frequency, phase, period… both from the equation for the displacement, $x = A\cos(\omega t + \phi)$, and from a graph of the displacement versus time.
    - know relationships among period, frequency, angular frequency:
      - $f = \frac{1}{T}$
      - $\omega = 2\pi f = \frac{2\pi}{T}$
  - o know definitions:
    - restoring force
    - simple harmonic motion
  - o Problems like:
    - Prob. 10, HW
    - Prob. 13, HW
    - Exercise 13-1
    - Exercise 13-2
    - Example 13-1

Category III
- Sec 13-3
- Vertical Springs (Sec 13-4)
- Sec 13-5
- Physical Pendulum (Sec 13-6)
- Sec 13-7
- Sec 13-8

Chapter 14
Category I
- Sec 14-6: The Doppler Effect
  - o $f' = f\left(1 \pm \frac{u}{v}\right)$ (stationary source, moving observer)
  - o $f' = f\left(\frac{1}{1 \mp \frac{u}{v}}\right)$ (moving source, stationary observer)
  - o Problems like:
    - #15, Practice Exam

        - Example 14-5
        - Example 14-6
        - Prob. 34, HW
        - Prob. 35, HW
        - Prob. 40, HW
        - Prob. 46, HW

Category II

- Properties of Waves (Secs 14-1 and 14-4)
    - 2 types of waves: longitudinal and transverse. Be able to distinguish between them.
    - speed of propagation: $v = \lambda f$
    - definition of wavelength
    - Problems like:
        - Prob. 1, HW
        - Prob. 5, HW
        - Prob. 19, HW
        - Prob. 20, HW
        - Prob. 22, HW

Category III

- Sec 14-2
- Sec 14-5
- Sec 14-7
- Sec 14-8
- Sec 14-9