Review for Final Exam

- Exam format:
  - 9 problems, 10 pts
  - Set of short-answer conceptual questions, 10 pts
  - Time: Thur. Dec. 9, 7:00-10:00pm
  - Place: Physics, Room 221
- Test materials:
  - Pencil, eraser, calculator, and student ID
  - formula sheet provided
- Responsible for:
  - Class notes for Chapters 1-12, 15, parts of 13, 16
  - All homework assignments, previous tests
  - Example problems done in class

Material Covered

1/3: Units, significant figures, scalars, vectors, components of a vector

2/4: 1D/2D kinematics (trans.), free-fall, projectile motion, relative velocity, rotational kinematics

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5/6/7: Forces, Newton's Laws (translational), friction, tension, normal force

8: Uniform circular motion, a_r, period

9: Energy, KE, gravitational potential, spring force and potential, potential energy diagrams

10: Work, scalar product, Conservation of Energy, Conservative and non-conservative forces, Power

11: Impulse, 1D/2D Collisions, Conservation of Momentum

12: Rotational dynamics, v_T, a_T, K_R, moment of inertia, torque, rotational Newton's Law, rolling motion

12(con't): Vector product, Conservation of Angular Momentum, Rotational/translational equilibrium, center of gravity

13: Gravitational force, escape speed, satellite orbits

15: Simple Harmonic Motion, spring, pendulum *(all sections, but 15.7 and 15.8)*

16: Waves, speed of sound, Doppler Effect *(except 16.4 and 16.6-16.8)*

Example: Problem 16.44

A mother hawk screeches as she dives at you. You recall from biology that female hawks screech at 800 Hz, but you hear the screech at 900 Hz. How fast is the hawk approaching?

Example Problem

A sound wave is described by $y(x,t) = (0.0200)\sin[(8.96 \text{ rad/m})x + (3140 \text{ rad/s})t]$, where y might be the pressure variation and t is in seconds.

a. In what direction is this wave traveling?

b. Along which axis are the air molecules oscillating?

c. What are the wavelength, the wave speed, and the period of the oscillation?

d. Draw a displacement-versus-time graph $y(x=1.00\text{m}, t)$ at $x=1.00$ m from $t=0$ to $t=4.00$ ms.

Example Problem

A 0.200-m bar with a mass of 0.750 kg is released from rest in the vertical position. A spring is attached, initially unstrained, and has a spring constant of 25.0 N/m. Find the tangential speed with which the free end strikes the horizontal surface. (drawing to be provided)

Solution:

Bar rotating with axis at one end → rotational KE, no translational KE

Bar falls from some height → gravitional PE (U_g)

A spring is attached to bar → spring PE (U_s)

Bar → rigid body → need moment of inertia

→ Use Conservation of Energy

$$E = K_R + U_g + U_s$$

$$\omega_i = 0, x_i = 0$$

$$E_i = mg\frac{h}{2}, \qquad E_i \neq mgh$$

y_i≠h since this would mean all mass of rod is at y_i=h, but mass is distributed. So, take mass to be located at center of gravity

$$y_f = 0, U_{g,f} = 0$$

$$E_f = \tfrac{1}{2} I\omega_f^2 + \tfrac{1}{2} kx_f^2$$

$$I_{rod} = \tfrac{1}{3} mL^2, \quad \mathbf{v}_f = \mathbf{v}_t = r\omega_f = L\omega_f$$

$$E_f = \tfrac{1}{2}\left(\tfrac{1}{3} mL^2\right)\left(\frac{\mathbf{v}_t}{L}\right)^2 + \tfrac{1}{2} kx_f^2$$

$$E_f = \tfrac{1}{6} m\mathbf{v}_t^2 + \tfrac{1}{2} kx_f^2$$

$$x_f = ?$$

From geometry of problem

$$x_f = \sqrt{0.2^2 + 0.1^2} - 0.1 = 0.1236\ \text{m}$$

Return to Conservation of Energy and solve for v_t

$$E_f = \tfrac{1}{6} m\mathbf{v}_t^2 + \tfrac{1}{2} kx_f^2 = E_i = mg\frac{h}{2} = mg\frac{L}{2}$$

$$\tfrac{1}{6} m\mathbf{v}_t^2 = mg\frac{L}{2} - \tfrac{1}{2} kx_f^2$$

$$\mathbf{v}_t = \sqrt{3gL - 3\frac{k}{m}x_f^2}$$

$$\mathbf{v}_t = \sqrt{3(9.80)(0.20) - 3\frac{25.0}{0.750}(0.1236)^2}$$

$$\mathbf{v}_t = \sqrt{5.88 - 1.528} = \boxed{2.09\ \mathbf{m/s}}$$