The exam will cover Chapters 15, 16, 17, 18, 34 & 35 from the text. You will be allowed two 8.5 x 11 inch sheets of notes to refer to during the exam. (You may write on both sides). You will also need a calculator for the exam. You will have two hours to complete the exam, (2:00 - 4:00 PM, Friday, June 14, 2002, in PS 10). The following topics may be helpful in guiding you as you study for the exam:

**Chapter 16 Oscillations**
- Period, T (=1/f)
- Frequency, f (=1/T) [Hz = 1 cycle/second]
- Amplitude, $x_m$ (maximum displacement)

Simple Harmonic Oscillator

$$ y = y_m \cos(\omega t + \phi) $$

$$ v = -v_m \sin(\omega t + \phi) \quad -v_m = \omega y_m $$

$$ a = d^2y/dt^2 = -\omega^2 y \quad -a_m = \omega^2 y_m $$

Angular frequency - $\omega = 2\pi f = 2\pi/T$ [radians/second]

Mass on a Spring - $\omega^2 = k/m \quad k =$ spring constant

$$ E = (1/2)mv^2 + (1/2)kx^2 = (1/2)kx_m^2 = (1/2)mv_m^2 $$

Pendulum - $\omega^2 = g/l$

**Chapter 17 Waves**
- Wavelength - $\lambda$
- Wavenumber - $k = 2\pi\lambda$ [radians/meter]
- Wavespeed - $v = f \lambda = \lambda/T = \omega/k$
- Traveling waves $y = f(x \pm vt)$; (- to the right, + to the left)
- Traveling Sine Waves $y = y_m \sin(kx \pm \omega t - \phi)$; (- to the right, + to the left)
- Standing Waves - nodes, anti-nodes, $y = y_m \sin(kx + \psi)\cos(\omega t + \phi)$
- Waves on strings and springs, wavespeed, $v^2 = \tau/\mu$; $\tau =$ tension, $\mu =$ mass/unit length
- Resonant modes (of a string, spring, etc... fixed at both ends)
  - Standing waves with a node at each end
  - $\lambda_n = 2L/n \quad n=1,2,3,4,... \quad L =$ length of string, spring, etc...
  - $f_m = nv/2L = nf_1$
  - distance between consecutive nodes $= \lambda/2$

**Chapter 18 Sound**
- Sound Waves
- Speed of Sound, (in air, $v = (331\text{m/s})(T_K/273)^{1/2} = 343 \text{ m/s}$ at room temperature
- Drop of intensity with distance: $I = \mathcal{P}/4\pi r^2$
- Decibel Scale: $\beta = 10\text{dB} \log(I/I_o), \quad I_o = 1.0\times10^{-12} \text{ W/m}^2$
- Doppler Effect for sound: $f' = ((v-v_D)/(v- v_s))f_0, \quad v_D>0$: Away; $v_s > 0$: Toward
- Interference from two sources vibrating in phase
  - Maximum: $r_2-r_1 = m\lambda$,
  - Minimum: $r_2-r_1 = (m+1/2)\lambda$,
  - $m = 0, \pm1, \pm2, \pm3, \ldots$
  - When $R_2&R_1 >> d$ (the distance between the slits (sources))
  - $R_2-R_1 = d\sin\theta$

- Beats: beat frequency, $f_b = |f_2-f_1|$
Plane waves: \( E = E_m \sin(kx \pm \omega t - \phi) \); \( B = B_m \sin(kx \pm \omega t - \phi) \);  \((E \perp B) \perp \) Direction

Poynting vector, \( S = E \times B / \mu_o \), in direction of propagation of wave

average magnitude, \( S_{avg} = I = Intensity \)

Speed of light, \( c^2 = 1/\mu_o \varepsilon_o \quad c = 3.00 \times 10^8 \text{ m/s} \)

Intensity, \( I = S_{avg} = E_m B_m / 2 \mu_o = E_m^2 / 2 \mu_o c = c B_m^2 / 2 \mu_o = \mathcal{P} / 4 \pi \epsilon_o \)

Electromagnetic Spectrum

The Law of Reflection - incident angle = reflected angle

The Law of Refraction - \( n_1 \sin \theta_1 = n_2 \sin \theta_2 \) or \( \sin \theta_1 / \nu_1 = \sin \theta_2 / \nu_2 \)

The Critical Angle - \( \theta_c = \sin^{-1}(n_{\text{low}} / n_{\text{high}}) \)

Total Internal Reflection

Chapter 35 Lenses and Mirrors

Planar mirror images - virtual image, \( i = -p \)

Thin lenses: converging (\( f > 0 \)), diverging (\( f < 0 \)), focal length

Ray Tracing

Images: real, virtual, sign conventions

Thin lens equation: \( 1/\nu = 1/p + 1/i \)

Magnification: \( M = -i/p \)

Multiple lenses and mirrors

Chapter 15

Fluids: liquids, gases, density, pressure

Hydrostatics: \( P = P_0 - \rho g y \)

Archimedes Principle

Continuity in a steady flow: \( \rho_1 A_1 \nu_1 = \rho_2 A_2 \nu_2 \)

Incompressible fluids (liquids):

density, \( \rho \) = constant

Steady Fluid Flow:

Continuity: \( A_1 \nu_1 = A_2 \nu_2 \)

Bernoulli’s Equation: \( P_1 + (1/2) \rho \nu_1^2 + \rho g y_1 = P_2 + (1/2) \rho \nu_2^2 + \rho g y_2 \)