The exam will cover Chapters 13, 16, 17, 18, 34, 35, 36, 37 & 38 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 the entire class period to complete the exam, 12:00 – 2:00 PM, Tuesday, June 12, 2001.

The following topics may be helpful in guiding you as you study for the exam:

**Chapter 13 Oscillations**
- Period, \( T = 1/f \)
- Frequency, \( f = 1/T \) [Hz = 1 cycle/second]
- Amplitude, \( A \) (maximum displacement)

**Simple Harmonic Motion**
- \( y = A \cos(\omega t + \phi) \)
- \( v = -A \omega \sin(\omega t + \phi) \)
- \( a = -A \omega^2 \sin(\omega t + \phi) \)

- \( \omega = \frac{2\pi}{T} \) [radians/second]
- Mass on a Spring - \( \omega^2 = \frac{k}{m} \)
- \( E = \frac{1}{2}mv^2 + \frac{1}{2}kx^2 = \frac{1}{2}kA^2 = \frac{1}{2}mv^2 \)

**Pendulum** - \( \omega^2 = g/L \)

**Damped harmonic oscillator**: \( y = A_0 e^{-bt/2m} \cos(\omega t + \phi) \); amplitude, \( A = A_0 e^{-bt/2m} \); Energy, \( E = E_0 e^{-bt/m} \)

**Chapter 16 Waves**
- Wavelength - \( \lambda \)
- Angular wavenumber - \( k = \frac{2\pi}{\lambda} \) [radians/meter]
- Wavespeed - \( v = f \lambda = \omega k \)
- Traveling waves - \( y = f(x \pm vt) \) (- to the right, + to the left)
- Traveling Sine Waves - \( y = A \sin(kx \pm \omega t + \phi) \); (- to the right, + to the left)
- Waves on strings and springs, wave speed, \( v^2 = \frac{T}{\mu} \); \( T \) = tension, \( \mu \) = mass/unit length

**Chapter 18 Standing Waves and Resonance**
- Standing Waves - nodes, anti-nodes, \( y = A \sin(kx) \cos(\omega t) = \frac{A}{2}(\sin(kx+\omega t) + \sin(kx-\omega t)) \)
- Resonant modes (of a string, spring, etc... fixed at both ends)
- Distance between consecutive nodes or anti-nodes = \( \frac{\lambda}{2} \)
- Beats: \( y = 2A \sin(\alpha_n t) \cos(\Delta \omega t/2) \) \( \alpha_n = (\alpha_1 + \alpha_2)/2 \) \( \Delta \omega = \omega_1 - \omega_2 \)
- \( f_0 = |f_1 - f_2| \)

**Chapter 34 Electromagnetic Waves**
- Plane waves: \( E = E_{m0} \sin(kx \pm \omega t + \phi) \); \( B = B_{m0} \sin(kx \pm \omega t + \phi) \); (\( E \perp B \)) \perp \) Direction
- Speed of light, \( c^2 = \frac{1}{\mu_0 \varepsilon_0} \) \( c = 3.00 \times 10^8 \) m/s
- \( E_{m0} = cB_{m0} \)
- Electromagnetic Spectrum
- Average Intensity: \( I = \frac{E_{m0} B_{m0}}{2\mu_0} = \frac{E_{m0}^2}{2\mu_0 c} = cB_{m0}^2/\mu_0 \) (= \( P/4\pi r^2 \) for spherical waves)

**Chapter 35 Laws of Geometric Optics**
- The Law of Reflection - incident angle = reflected angle
- Index of refraction: \( n = c/\nu \)
- The Law of Refraction (Snell's Law): \( n_1 \sin \theta_1 = n_2 \sin \theta_2 \)
- The Critical Angle - \( \theta_c = \sin^{-1}(n_{\text{low}}/n_{\text{high}}) \)
- Total Internal Reflection
Chapter 36 Geometric Optics (Lenses, Mirrors and Images)

Planar mirror images - virtual image, q = -p
Thin lenses: converging (f>0), diverging (f<0), focal length: f
Ray Tracing
Images: real, virtual, sign conventions
Thin lens equation: \( \frac{1}{f} = \frac{1}{p} + \frac{1}{i} \)
Magnification: \( M = -\frac{i}{p} \)
Spherical Mirrors: f = r/2, convex = diverging (f<0), concave = converging (f>0)
Multiple lenses and mirrors

Chapter 37 Interference

Double slit (double source) interference
When both sources (slits) are in phase
Construction interference: \( R_2 - R_1 = m\lambda \)  \( m = 0, \pm 1, \pm 2, \pm 3, \pm 4, \ldots \)
Destructive interference: \( R_2 - R_1 = (m+1/2)\lambda \)
When \( R_2 & R_1 \gg d \) (the distance between the slits (sources))
\( R_2 - R_1 = d\sin \theta \)
Intensity: \( I = I_o \cos^2(\pi d\sin \theta/\lambda) \)

Interference in thin films
Low to high to low or high to low index
Construction: \( 2nt = (m+1/2)\lambda \)  \( m = 0, 1, 2, 3, \ldots \)
Destructive: \( 2nt = m\lambda \)
Low to high to higher or higher to low to high index
Construction: \( 2nt = m\lambda \)
Destructive: \( 2nt = (m+1/2)\lambda \)
Waves are inverted on reflection when entering a higher index region.
Waves are not inverted on reflection when entering a lower index region.

Chapter 38 Diffraction and Polarization

Single Slit Diffraction
Minima: \( a\sin \theta = m\lambda \)  \( a = \) slit width, \( m = \pm 1, \pm 2, \pm 3, \ldots \)
Intensity: \( I = I_o \left( \frac{\sin(\pi d\sin \theta/\lambda)}{(\pi d\sin \theta/\lambda)} \right)^2 \)

Diffraction grating
Maxima: \( d\sin \theta = m\lambda \)  \( d = \) grating spacing, \( m = 0, \pm 1, \pm 2, \pm 3, \ldots \)
Circular Aperture Diffraction
1st minimum: \( a\sin \theta = 1.22\lambda \)  \( a = \) diameter
Resolution, the Rayleigh Criterion
Polarized and Unpolarized light
Polarizing filters:
Make unpolarized light polarized, \( I = I_o/2 \)
Only pass the component of light polarized along the axis
Acting on polarized light: \( I = I_o \cos^2 \theta \)
Polarization on reflection: Brewster’s angle \( \theta_b = \sin^{-1}(n_i/n_r) \)

Chapter 17 Sound Waves

Speed of Sound, \( n = (343\text{m/s})(T_k/293\text{K})^{1/2} \)
Pressure Amplitude: \( \Delta P_m = \rho \omega \delta _m \)
Intensity: \( I = \Delta P_m^2/(2\rho \nu) \)  For Spherical waves: \( I = P/4\pi^2 \)
Decibel Scale: \( \beta = 10\text{dB} \log(I/I_o), \ I_o = 1.0 \times 10^{-12} \text{W/m}^2 \)
Doppler Effect for sound: \( f' = [(v + v_a)/(v - v_s)]f_o \)  \( v_o, v_s > 0 \) : Toward
Shock waves (Sonic Boom): \( \sin \theta = v / v_s \)