Physics 123  Final Exam Review     Spring 2001     Instructor: John McGill

The exam will cover Chapters 16, 17, 18, 34, 35, 36 & 37 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 15, 2001, 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, $x_m$, $y_m$ (maximum displacement)
- Simple Harmonic Oscillator
  - $y = y_m \cos(\omega t + \phi)$
  - $v = -y_m \sin(\omega t + \phi)$
  - $a = -y_m \omega^2$
  - $\omega = 2\pi f = 2\pi / T$ [radians/second]
- Mass on a Spring
  - $\omega^2 = k/m$   $k =$ spring constant
  - $E = (1/2)mv^2 + (1/2)kx^2 = (1/2)mv_m^2 + (1/2)kx_m^2$
- Pendulum
  - $\omega^2 = g/l$
- Damped harmonic oscillator: $y = y_mE^{-bt/2m} \cos(\omega t + \phi)$;  $E = E_0e^{-bt/m}$

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

**Chapter 18 Sound**
- Sound Waves
- Speed of Sound, (in air, $v = (343m/s)(T_K/293)^{1/2}$
- Drop of intensity with distance:  $I = P/4\pi^2$
- Decibel Scale:  $\beta = 10\log(I/I_o)$,  $I_o = 1.0x10^{-12}$ W/m$^2$
- Doppler Effect for sound:  $f' = ((v-v_D)/(v- v_s))f_o$   $v_D>$ Away;  $v_s >$ Toward

**Chapter 34 Electromagnetic waves**
- Plane waves:  $E = E_0\sin(kx \pm \omega t - \phi)$;  $B = B_0\sin(kx \pm \omega t - \phi)$;  $(E \perp B) \perp \text{Direction}$
- Speed of light, $c^2 = 1/\mu_0\epsilon_0$   $c = 3.00 \times 10^8$ m/s
- Intensity, $I = E_0B_0/2\mu_0 = E_m^2/2\mu_o c = cB_m^2/2\mu_o = P/4\pi^2$
- Electromagnetic Spectrum
- The Law of Reflection - incident angle = reflected angle

**Chapter 34 Electromagnetic waves (continued)**
- Planar mirror images - virtual image, $i = -p$
The Law of Refraction - \( n_1 \sin \theta_1 = n_2 \sin \theta_2 \)

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

Total Internal Reflection

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 \( \theta_b = \sin^{-1}(n_r/n_i) \)

**Chapter 35 Lenses and Mirrors**

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

Ray Tracing

Images: real, virtual, sign conventions

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

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

Spherical Mirrors: \( f = r/2 \), convex (\( f<0 \)), concave (\( f>0 \))

Multiple lenses and mirrors

**Chapter 36 Interference**

Double slit (double source) interference
- When both sources (slits) are in phase
  - Constructive interference: \( R_2-R_1 = m\lambda \) \( m=0, \pm 1, \pm 2, \pm 3, \pm 4,... \)
  - Destructive interference: \( R_2-R_1 = (m+1/2)\lambda \)

- When \( R_2-R_1 >> d \) (the distance between the slits (sources))
  \( R_2-R_1 = dsin \theta \)
- Intensity: \( I = I_o \cos^2(\pi asin \theta/\lambda) \)

Interference from thin films on reflection
- Low to high to low index
  - Constructive: \( 2nt = (m+1/2)\lambda \) \( m=0, \pm 1, \pm 2, \pm 3, \pm 4,... \)
  - Destructive: \( 2nt = m\lambda \)

- Low to high to higher index
  - Constructive: \( 2nt = m\lambda \)
  - Destructive: \( 2nt = (m+1/2)\lambda \) \( m=0, \pm 1, \pm 2, \pm 3, \pm 4,... \)

**Chapter 37 Diffraction**

Single Slit Diffraction
- Minima: \( asin \theta = m\lambda \) \( a = \) slit width, \( m = \pm 1, \pm 2, \pm 3,... \)
- Intensity: \( I = I_m (\sin(\pi asin \theta/\lambda)/(\pi asin \theta/\lambda))^2 \)

Diffraction grating
- Maxima: \( dsin \theta = m\lambda \) \( d = \) grating spacing, \( m=0, \pm 1, \pm 2, \pm 3,... \)

Circular Aperture Diffraction
- \( 1^{\text{st}} \) minimum: \( asin \theta = 1.22\lambda \) \( a = \) diameter
- Resolution, the Rayleigh Criterion