Physics 2220 (Schroeder)
fall 2005

Wave Optics Study Guide

For constructive interference with two or more slits (or a diffraction grating),

$$d \sin\theta = m\lambda.$$

You should understand why this formula is correct and be able to derive it using an appropriate diagram. You should be able to draw the diffraction pattern for two slits or a grating.

You should be able to determine which wavelengths of light will interfere constructively and destructively at a thin film. This entails understanding both the difference in path lengths for rays reflecting off the front and back surfaces and also any possible phase changes upon reflection (which depend on whether the material surrounding the film has a higher or lower index of refraction).

You should understand and be able to draw the diffraction pattern produced by a single slit. The formula for the angles of *de*structive interference is

$$a \sin\theta = p\lambda.$$

You should be able to derive this formula using an appropriate diagram.

Quantum Mechanics Study Guide

Basic formulas:

$$E = hf \qquad \text{(Einstein)}; \qquad\qquad p = h/\lambda \qquad \text{(de Broglie)}.$$

The first relation is useful only for photons (for which $E = pc$). To relate the wavelength of some other particle to its energy, use $K = p^2/2m$. Don't forget the numerical value $h = 6.63 \times 10^{-34}$ J-s.

You should be able to explain the experimental evidence that light behaves like particles (photoelectric effect) and electrons behave like waves (diffraction and interference).

You should understand the concept of a "wavefunction", and be able to draw wavefunctions with definite position and definite momentum. You should understand the interpretation of the square of the wavefunction as being proportional to the probability of finding the particle at a given location.

You should be able to draw the definite-energy wavefunctions for a particle in a one-dimensional "box", and explain why only certain energies are allowed. You should know the energy level formulas

$$E_n = \frac{h^2 n^2}{8mL^2} \qquad \text{(1-D box)}, \qquad\qquad E_n = -\frac{13.6 \text{ eV}}{n^2} \qquad \text{(H atom)},$$

and be able to derive the former (but not the latter). You should understand why, and under what conditions, energy is quantized in quantum mechanics.

You should understand the concept of transitions between energy levels, and be able to compute the photon energies and wavelengths for transitions between levels for any system whose energy levels you know.