Physics 1402 Test 3 Review chapters 25-28

I. Light is a wave (for now, we will look at wave particle duality later) that carries its energy in perpendicular oscillating electric and magnetic fields.
   a. As with all wave the speed of propagation is medium dependant,
      i. In a vacuum c = $\frac{1}{\sqrt{\epsilon_0 \mu_0}}$=299,792,458m/s ~ 3•$10^8$ m/s
      ii. Slower in all other mediums, thus we define the index of refraction as n=c/v
   b. We classify light into the electromagnetic spectrum: Starting from lowest f, longest wavelength and lowest energy,
      i. Radio
      ii. Micro
      iii. Infrared
      iv. Visible
      v. Ultra Violet
      vi. X rays
      vii. Gamma Rays
   c. The intensity of light is proportional to the square of the field strength.
   d. Polarization: The orientation of the Electric field.
      i. Most light sources emit unpolarized light
      ii. Polarizing filters can be used to selectively transmit preferred polarizations
   e. Light carries a momentum (we will see more on this later)
      i. As a result light can push on objects. We consider this force in terms of the pressure it produces. P=I/c

II. Wave properties: You will notice most of the material in these chapters makes use of the various properties of waves
      i. Doppler effect: $f' = f\left(1 \pm \frac{u}{c}\right)$
      ii. Relation between speed, wavelength and frequency: v=λf
      iii. Reflection
         1. Law of reflection: $\theta_i = \theta_r$
            a. Specular and Diffuse reflections
         2. Mirrors
            a. Concave – Converging
            b. Convex – Diverging
            c. Ray diagrams

i. Rays parallel to principal axis reflect to or away from focal points
ii. A ray to the focal point reflects parallel to the principal axis
iii. A ray to the center of curvature reflects on itself

iv. Refraction
    1. Snell's Law: $n_1 \sin\theta_1 = n_2 \sin\theta_2$
    2. Mirages and Looming
    3. Total Internal Reflection
        a. Critical angle
    4. Total Polarization upon reflection
        a. Brewster's Angle
    5. Dispersion
        a. Higher frequency light refracts more
        b. Rainbows
    6. Lenses
        a. Convex – Converging
        b. Concave – Diverging
        c. Ray Diagrams
            i. A ray parallel to the principal axis will pass through or extrapolate back to the focal point
            ii. A ray through the midpoint passes undeflected
            iii. A ray drawn to the near focal point for convex lenses, and to the far focal point for concave lenses, refracts from the lens parallel to the principal axis
    7. Lens Combinations
        a. Image of the first lens is the object of the second
        b. Eye
            i. Near sighted: sees close but not far.
                1. Correct with lens to create an image at or inside the far point
            ii. Far sighted: sees far but not near
                1. Correct with lens to move the image at or beyond the near point.
        c. Simple telescope
            i. Length = $f_{eye} + f_{obj}$
            ii. Magnification $m = \frac{f_{obj}}{f_{eye}}$
    8. Thin-lens and Mirror equation $\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}$
        a. Magnification $m = \frac{h_i}{h_o} = \frac{-d_i}{d_o}$

9. Sign Conventions for both lenses and mirrors
    a. Focal Length
    b. $f > 0$ Converging optics
    c. $f < 0$ Diverging optics
10. Magnification
    a. $m > 0$ upright images
    b. $m < 0$ inverted images
    c. $|m| > 1$ magnified images
    d. $|m| < 1$ diminished images
11. Image distance
    a. $d_i > 0$ real images
    b. $d_i < 0$ virtual images
12. Object distance
    a. $d_o > 0$ real objects
    b. $d_o < 0$ virtual objects

v. Interference
1. Constructive interference occurs when two light waves meet in phase. Thus the difference in path lengths is given by
$$\Delta l = 0, \lambda, 2\lambda, ...$$
    a. Seen as bright fringes / areas of maximum intensity
2. Destructive interference occurs two light waves meet out of phase. Thus the difference in path lengths is given by
$$\Delta l = \frac{\lambda}{2}, \frac{3\lambda}{2}, \frac{5\lambda}{2} ...$$
    a. Seen as dark fringes / areas of minimum intensity
3. Applications
    a. Double slit
    b. Air wedge
    c. Thin film
    d. Thin film on substrate
    e. Single slit diffraction
    f. Multi-slit diffraction (diffraction gratings)