Assignment 8

1) For the circular disk we found assuming $R \gg \lambda$ that

$$\psi(P) = \frac{AR}{2} \frac{e^{2ik\sqrt{R^2+a^2}}}{R^2+a^2}$$

For the circular aperture we found also assuming $R \gg \lambda$ that

$$\psi(P) = -\frac{AR}{2}\left\{ \frac{e^{2ik\sqrt{R^2+a^2}}}{R^2+a^2} - \frac{e^{2ikR}}{R^2} \right\}$$

Adding the two amplitudes we get:

$$\psi_{TOT} = \frac{AR}{2} \frac{e^{2ikR}}{R^2}$$

$$= A \frac{e^{2ikR}}{2R}$$

= value of incident wave at P with no diffracting object

This is called Babinet's Principle.

2a) For single slit, light intensity is given by:

$$I(P) = 4c^2a^2\left(\frac{\sin\gamma}{\gamma}\right)^2.$$

Note $I(P) = 0$ when $\gamma = \pm\pi, \pm 2\pi, \ldots$

but $I(P) \neq 0$ when $\gamma = 0$!

$\therefore$ central maximum is twice as wide as other maxima.

b) Fraunhofer limit is $\frac{d^2}{\lambda} = \frac{(.1 cm)^2}{6328 \times 10^{-8} cm}$

$= 158$ cm.

c) Angular width of central maximum $\Delta\theta = \frac{\lambda}{a}$

where $2a$ = slit width

$\therefore$ distance between minima surrounding central maxima is $\frac{l\lambda}{a} = 400 cm \times \frac{6328 \times 10^{-8} cm}{.05 cm}$

$= .50$ cm.

3) See pg. 386-388 of Marion & Heald.