3/3/2005. **Due:** Thursday, March 10, 2005 (in class).

Physics 302/572: Electromagnetic Theory II

Read: Griffiths 9.4-9.5

"**G**, **PS**" refer to Griffiths and Pollack & Stump books respectively.
Problems with stars are not for credit and will NOT be graded.

Homework 5

Exercise 1 (G 9.21)

Calculate the reflection coefficient for light at an air-to-silver interface ($\mu_1 = \mu_2 = \mu_0$, $\epsilon_1 = \epsilon_0$, $\sigma = 6 \times 10^7\,(\Omega \cdot m)^{-1}$), at optical frequencies ($\omega = 4 \times 10^{15}/s$).

Exercise 2 (PS 13.13)

The dispersion relation for deep water gravity waves is $\omega = \sqrt{gk}$. Show that the group velocity is one-half the phase velocity.

Exercise 3 (G 9.22b)

In quantum mechanics, a free particle of mass m traveling in the x direction is described by the wave function

$$\Psi(x,t) = Ae^{i(px-Et)/\hbar},$$

where p is the momentum, and $E = p^2/2m$ is the kinetic energy. Calculate the group velocity and the wave velocity. Which one corresponds to the classical speed of the particle? Note that the wave velocity is *half* the group velocity.

Exercise 4 (G 9.25)

Assuming negligible damping ($\gamma_j = 0$), calculate the group velocity ($v_g = d\omega/dk$) of the waves described by

$$\tilde{k} = \frac{\omega}{c}\sqrt{\tilde{\epsilon}_r} \approx \frac{\omega}{c}\left[1 + \frac{Nq^2}{2m\epsilon_0}\sum_j \frac{f_j}{\omega_j^2 - \omega^2 - i\gamma_j\omega}\right].$$

Show that $v_g < c$, even when $v > c$.

Exercise 5 (G 9.28)

Consider a rectangular wave guide with dimensions 2.28cm $\times$ 1.01cm. What TE modes will propagate in this wave guide, if the driving frequency is 1.70×10^{10} Hz? Suppose you wanted to excite only *one* TE mode; what range of frequencies could you use? What are the corresponding wavelengths (in open space)?