

Physics 25 Problem Set 5

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due Monday, May 5

Please make your work neat, clear, and easy to follow. It is hard to grade sloppy work accurately. Generally, make a clear diagram, and label quantities. Derive symbolic answers, and then plug in numbers after a symbolic answer is available.

1. For a plasma, the index of refraction is

$$n(\omega) = 1 - \frac{\omega_p^2}{\omega^2},$$

where $\omega_p = 2 \times 10^{15} \text{s}^{-1}$ is the ‘plasma frequency’. Note that for $\omega > \omega_p$, the index of refraction is less than one.

- (a) Numerically evaluate the wavenumber, k_p in cm^{-1} , and the wavelength, λ_p in nanometers, that correspond to ω_p .
- (b) The *phase velocity* v_p , is

$$v_p(\omega) = \frac{\omega}{k} = \frac{c}{n(\omega)}.$$

Plot v_p/c as a function of *wavelength* for wavelengths in the visible range of 400 to 700 nanometers.

- (c) The *group velocity*, v_g , is $d\omega/dk$. Plot v_g/c for the wavelengths in the visible range.
2. Crawford, 9.1
 3. Crawford, 9.2
 4. Crawford, 9.4
 5. Crawford, 9.6
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