

Section B. Electricity and Magnetism

1. Plasma Waves

A ‘tenuous plasma’ consists of free electrons with mass m and charge e . There are n electrons per unit volume. Assume that the electron density is uniform and that interactions between the electrons may be neglected. Electromagnetic waves (frequency ω and wave number k) are incident on the plasma.

(a) Find the conductivity σ of the plasma as a function of ω .

(b) Find the dispersion relation; i.e. find the relation between k and ω .

(c) Find the index of refraction as a function of ω . What does it tell you about the speed of wave propagation in the plasma? The plasma frequency is defined as $\omega_p^2 = ne^2/m\epsilon_0$ (in SI units). What happens if $\omega < \omega_p$?