Statistical Physics II Home examination 2011

V. PLASMA FREQUENCY

Problem 5 out of 6

Why is the quantity Ω_p in Eq. (12.113) called the plasma frequency? Answer: Because it corresponds to an eigenfrequency of the electron gas. Hence, it also corresponds to a resonance in the response to a perturbation, which you are here asked to illustrate.

Calculate the real-space, real-time density perturbation $\langle \delta n(\mathbf{r}, t) \rangle$ for an electron gas subject to an oscillatory electrostatic potential. Assume the potential $\phi(\mathbf{r}, t) = f(\mathbf{r}) \cos(\omega_0 t)$, where the function f varies so slowly with $\mathbf{r}$ that you can safely assume that $|\mathbf{q}|$ is small in calculating the mean-field response function. Make use of the results in Sec. 12.2.4.