Home Work 2

30pt **Problem 1**: From the general equation for momentum of an electron in the Drude model

$$\mathbf{p}(t+dt) = \left(1 - \frac{dt}{\tau}\right)\mathbf{p}(t)$$

10pt 1) Solve for $\mathbf{p}(t)$

10pt 2) Calculate the following quantity:

$$T = \frac{P(0)\int_0^\infty t e^{-t/\tau} dt}{P(0)\int_0^\infty e^{-t/\tau} dt}$$

10pt 3) From 2 what is the physical meaning of T?

70pt **Problem 2:**

The Drude-Lorentz formula for the dielectric constant of a solid is

$$\varepsilon(\omega) = 1 + \frac{\omega_p^2}{(\omega_0^2 - \omega^2) - i\omega\tau^{-1}} .$$

Here ω_p is the plasma frequency, ω_0 is the energy gap for interband transitions and τ is the scattering time of the electron.

30pt (a) At room temperature a reasonable value for Cu is $\tau = 10^{-14}$sec. Give order of magnitude estimates of ω_p and ω_0 for this metal. You may want to make use of the characteristic "color" of the metal in determining ω_0. Plot the real and imaginary parts of $\varepsilon(\omega)$ as a function of ω (in eV).

20pt (b) At room temperature, calculate $\sigma(\omega)$, the complex frequency-dependent conduction of Cu.

20pt (c) What is $\sigma(\omega)$ for perfectly pure, defect-free Cu at zero temperature?

Hint: Color is a good measure of the energy gap in the interband transition ω_o.

Hint for (b) and (c) - For any finite T τ is finite. However, at zero temperature τ goes to infinity.