Problem Set 1
Physics 386 / Spring 1997
Professor Klaus Schulten

Problem 1: Establish e-mail contact

Send an e-mail to Justin Gullingsrud at:
cyclonus@alecto.physics.uiuc.edu
Please indicate that you are a Physics 386 student and give your first and last name, possibly a phone number .

Problem 2: Planck's radiation law

(a) Use Planck's radiation frequency distribution law to obtain the energy density as a distribution in wave length λ. Determine the wave length λ_{max} at which the energy density assumes its maximum value. Demonstrate the relationship $\lambda_{max} = b/T$ and determine the value of the constant b.

(b) At which temperature is λ_{max} in the middle of the visible spectrum of electromagnetic radiation, i.e., $\lambda_{max} = 6000$ Å?

Problem 3: De Broglie wave length

(a) Calculate the de Broglie wave length of a 10 eV and of a 10 MeV electron.

One can direct a beam of accelerated electrons onto targets to resolve the structure of the target. For this purpose the wave length of the electrons needs to match the size of the features one seeks to resolve.

(b) Scattering electrons off a target, which energy is needed to resolve the size of the atoms in a target, i.e., 1 Å.

(c) As in (b), but to resolve the nuclei of size 10^{-17} cm.

Problem 3: Klein-Gordon Equation

Schrödinger initially arrived at a wave equation for a particle of mass m that reads as follwos in one dimension:

$$\frac{1}{c^2}\partial_t^2\psi(x,t) \;=\; \partial_x^2\psi(x,t) \;-\; \frac{m^2c^2}{\hbar^2}\psi(x,t) \tag{1}$$

Show that a plane wave solution of this equation is consistent with the relativistic energy-momentum relationship. (The equation above is the one-dimensional analog of what is now called the Klein-Gordon equation.)

This problem set needs to be handed in by Wednesday, February 5, 1997 into the mail box of Justin Gullingsrud in Loomis.