Physics 101 **Due Dec 3, 2004**

Homework 10

Problem 1. Assume that the electric power consumption rate of your house is 2,000 watts. What is the total energy consumed per day, and per year? Assume that there are 200 million households in the United States, each consuming the same amount of energy as your house. Then, how much is the total energy consumed by those houses per year. Calculate in Joules, and calculate in kilograms using Einstein's $E = mc^2$. Compare your number with the mass of your body.

Problem 2. The mass of the π meson is $140MeV$(million electron volts). It is originally at rest. The particle decays into two photons moving in opposite directions. Use the conservation of energy and momentum to calculate the frequency and wavelength of the photons.

Problem 3. According to Einstein, the total energy of a moving particles is

$$E = \frac{mc^2}{\sqrt{1-b^2}},$$

where $b = v/c$. The speed parameter b cannot be greater than 1. Thus the kinetic energy is

$$KE = \frac{mc^2}{\sqrt{1-b^2}} - mc^2. \tag{1}$$

On the other hand, we are more familiar with the expression

$$KE = \frac{1}{2}mv^2 = \frac{1}{2}mc^2\ b^2. \tag{2}$$

This expression can be regarded as an approximation valid for small values of b. On the same graph, plot both Eq.(1) and Eq.(2). What is the value of b for electrons in TV picture tubes (30,000 volts)? For these electrons, can Einstein's kinetic energy of Eq.(1 be approximated by the approximate expression of Eq.(2)?