Physics 325, Winter 2002 **Problem set #7** Due: Fri. 3/15/02

Assigned problems. *Note: Only one problem will be graded, and will be worth 100 points.*

1. *Gasiorowicz* Ch. 16, problem 2 ($m = 1$, $\ell = 0$ case only)

2. Consider a particle in one dimension, with the Hamiltonian

$$H = \frac{p^2}{2m} + V(x) \ , \qquad V(x) = V_0(x) + \epsilon V_1(x) \tag{1}$$

where

$$V_0(x) = \begin{cases} \infty & x < 0 \text{ or } x > a \\ 0 & 0 \le x \le a \end{cases} \ , \qquad V_1(x) = \begin{cases} 0 & x < 0 \text{ or } x > a \\ \frac{x}{a} & 0 \le x \le a \end{cases} \ . \tag{2}$$

Sketch $V(x)$. Find all energy eigenvalues of H to linear order in ϵ.

3. Consider 10^6 electrons confined to a 1 cm long wire, which you can treat as a one dimensional infinite square well. Assume the electrons are arranged in the lowest energy configuration possible.

(a) Compute the fermi momentum p_F, which is the momentum of the highest energy electron. Remember that for an electron in the n^{th} level of the square well, $p_n = \hbar k_n = \hbar \frac{n\pi}{a}$.

(b) Compute the fermi energy $E_F = \frac{p_F^2}{2m}$, in ergs. (See p. 460 in Gasiorowicz for physical constants). By comparing E_F to $m_e c^2$, estimate the size of relativistic corrections.

(c) What is the total kinetic energy (in ergs) of the 10^6 electrons?

(d) Roughly how thin does the wire have to be in order to justify treating this as a one dimensional system?