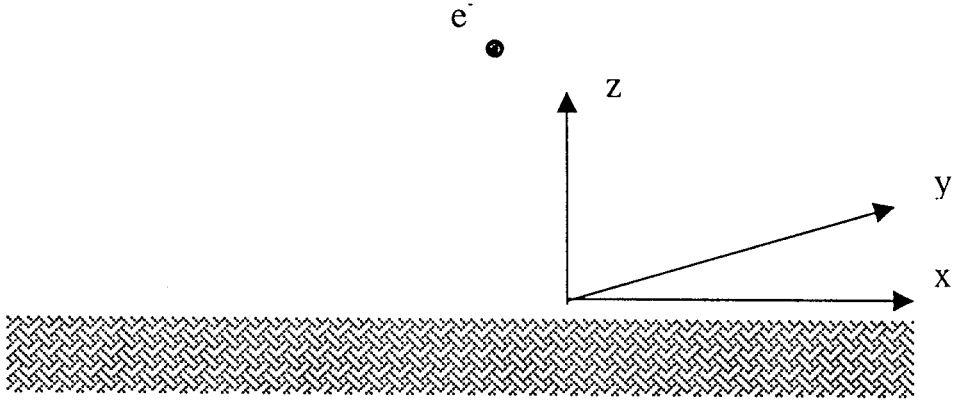
QMSpring99A

Suppose a non-relativistic electron is trapped in a state above a semi-infinite flat insulator. Due to the interaction of the electron with the insulator there is an attractive potential energy between the electron and the surface of the form:

$$v(z) = \begin{cases} -A/z & z>0 \\ +\infty & z<0 \end{cases}$$

where A is a positive constant and z is the perpendicular distance between the electron and the surface. The form of the potential suggests that the system is a 1 dimensional analogue of a hydrogen atom.



(a) Assume that the electron cannot penetrate into the insulator. Sketch the ground state wave function in the z direction and justify its boundary conditions.

(b) Determine the (un-normalized) spatial ground state wave function.

(c) What is the ground state binding energy in terms of A, $\hbar$ and m_e?

(d) State **all** the quantum numbers for **all** of the bound states and write down the bound state energies in terms of those quantum numbers. Take electron spin and the fact that it can move in all 3 directions into account.

(e) What is the maximum value of the momentum in the x-y plane for a bound electron?