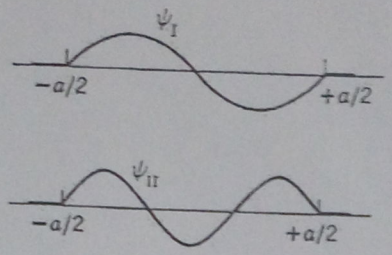
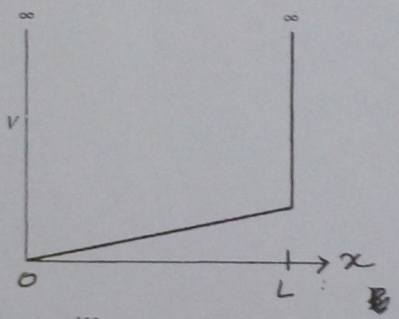
PHL 120: Physics of Materials

Duration: 60 Minutes **Minor II (October 10, 2014)** **Max. Marks: 20**

Q.1. (a) Two possible eigenfunctions for a particle moving freely in a region of length 'a', but strictly confined to that region, are shown in the figure below. When the particle is in the state corresponding to the eigenfunction ψ_I, its total energy is 4 eV. **(i)** What is its total energy in the state corresponding to ψ_{II}? **(ii)** What is the lowest possible total energy for the particle in this system?



(b) Sketch the possible wave function of a particle in the potential well shown in the figure below. Justify/explain the sketched wavefunction. **[3+3]**



Q.2 . (a) Which one of the following will exert the greatest and the least pressure at the same temperature?

(i) A gas of classical molecules **(ii)** A gas of bosons **(iii)** A gas of fermions

Justify your answer.

(b) Why the electronic contribution to the specific heat is detectable only at very low and high temperatures?

Q.3. (a) Find the ratio between the kinetic energies of an electron in a two dimensional square lattice which has $k_x=k_y=\pi/a$ and an electron which has $k_x=\pi/a$, $k_y=0$. **[2+2]**

(b) State two conditions under which Fermi-Dirac and Bose-Einstein distributions go over to Maxwell- Boltzmann distribution.

(c) Draw N(E) versus E cuves for of one and two dimensional systems. **[2+2+1]**

Q.4.(a) How does the energy-band structure of a solid determine whether it is a conductor, a semiconductor or an insulator?

(b) Represent a monovalent metal, a divalent metal and an insulator in k-space corresponding to a square lattice. **[2+3]**