MINOR II

PHL 120 PHYSICS OF MATERIALS

25th March 2014

Answer **all** questions | Time **One** Hour | Maximum Marks **20**

Constants : $\hbar = 6.582 \times 10^{-16}$ eV.sec. $\quad m_e = 9.109 \times 10^{-31}$ Kg.
$N_A = 6.023 \times 10^{23}$ mole^{-1} $\quad k_B = 8.617 \times 10^{-5}$ eV/K

Q.1. State **with justifications** whether the following statements are TRUE or FALSE
($2 \times 4 = 8$)

(a) The difference of the expectation values $< p\,x >$ and $< x\,p>$ is $\hbar$.

(b) The wave function
$$\psi(x) = A \exp(kx^2) + B \exp(-kx^2),$$
where A, B and k are constants, represents a realistic state of a particle.

(c) The wave function of a particle at a given time is
$$\psi(x) = \sqrt{(2/L)}\,\sin(\pi x/L), \text{ for } 0 < x < L$$
$$= 0, \text{ otherwise.}$$
The probability of finding the particle in the range L/4 to 3L/4 is zero.

(d) An electron is incident on a potential barrier of height V_0. Its total energy E is greater than V_0 . The electron has finite probability of reflection over the barrier.

Q.2. An electron is trapped in an infinite one dimensional potential well of width 0.314 nm. Find the energy required to excite the electron from the ground state to the first excited state. (3)

Q.3. Find the penetration depth for a small dust particle of radius 1.0 nm and density 10^4 Kg/m^3, moving with a very slow velocity $v = 10^{-2}$ m/sec., impinging on a potential step of height equal to twice its kinetic energy in the region below the step. (3)

Q.4. Electrons with energy of 1.0 eV are incident on a potential barrier of 10 .0 eV height and 0.5 nm width. What is the probability of transmission of the electrons through the barrier? . (3)

Q.5. Each sodium atom contributes one free electron per atom to the metal. Compute the Fermi energy of sodium metal ($\rho = 0.971$ g/cm^3 and at. wt. 23 amu). (3)

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16