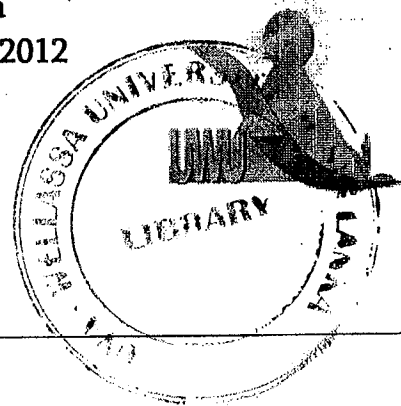


Uva Wellassa University, Sri Lanka
End Semester Examination – February 2012

MRT 332-2
Materials Physics
(Repeat)

Time: Two (02) hours



Total 04 Questions

Answer ALL questions

Each question contains 25 marks

Boltzmann constant - $1.38 \times 10^{-23} \text{ JK}^{-1}$

Avogadro number - $6.022 \times 10^{23} \text{ mol}^{-1}$

Plank's constant (h) - $6.626 \times 10^{-34} \text{ Js}$

Electron charge (e) - $1.602 \times 10^{-19} \text{ C}$

Electron mass (m) - $9.109 \times 10^{-31} \text{ kg}$

- 01) (a) Obtain the wave function and the probability density function of a particle of mass m confined to move in one dimensional box of length L .
- (b) Explain the comparison between classical and quantum ideas of the above results.
- (c) What is the minimum energy possible for the particle?
- 02) (a) i. Describe three concepts including Compton scattering that leads for the development of Quantum Mechanics.
- ii. A 100 keV photon collides with an electron at rest. It is scattered through 90° . What is its energy after the collision? What is the kinetic energy in eV of the electron and what is the direction of its recoil?
- (b) i. What is normalization of a wave function? Normalize the one dimensional wave function given by,
- $$\Psi(x) = A \sin\left(\frac{\pi x}{a}\right) \quad 0 < x < a$$
- $$\Psi(x) = 0 \quad \text{outside}$$
- ii. Show that the eigenkets of any hermitian operator are orthogonal to each other if the eigenvalues are different.

- 03) (a) Explain the free nature of the valence electrons in the free electron gas model.
(b) Define density of states and Fermi-energy. Explain the variation of density of electronic states $D(E)$ with energy, for a one-dimensional metallic crystal.
(c) Show that at the Fermi level, $D(E)$ may be expressed as

$$D(E) = \frac{3}{2} \frac{N}{E_F}$$

E_F = Fermi energy

N = Total number of free (valence) electrons

- 04) (a) Describe Band theory of solids.
(b) Show that the solutions of the wave equation in a periodic lattice are in the Bloch form.
(c) Explain metals, semiconductors and insulators on the basis of the Band theories.