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 - 1.38×10^{-23} JK^{-1}
Avogadro number - 6.022×10^{23} mol^{-1}
Plank's constant (h) - *6.626* $\times 10^{-34}$ Js
Electron charge (e) - 1.602 $\times$ *10*$^{-19}$ *C*
Electron mass (m) = 9.109 $\times$ *10*$^{-31}$ *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 90^0. 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

$$\Psi(x) = A \sin\left(\frac{\pi x}{a}\right) \qquad 0 < x < a$$
$$\Psi(x) = 0 \qquad \text{outside}$$

ii. Show that the eigenkets of any hermition operator are orthogonal to each other if the eigenvalues are different.

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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.