Fourth Year (BSc)   **Phys 4107**
(Physics Specialization)   **Condensed Matter Physics**
                                                             Time Allowed: (3) Hours

Answer any Six questions.

1 (a) Define Miller indices. Write down the steps involved to determine the Miller indices of a plane.

   (b) A plane makes intercepts of 1, 2 and 3 Å on the crystallographic axes of an orthorhombic crystal with a:b:c = 3:2:1. Determine the Miller indices of this plane.

2 (a) (i) What is the coordination number? What are coordination numbers for sc, bcc and fcc lattices?

         (ii) A certain metal has an fcc structure. Its density is 8.96×10^3 kgm^{-3} and its lattice constant is 3.61 Å. Calculate its atomic weight.

   (b) What are the differences between cubic and tetragonal crystal structure? How many unit cells are there in 1g cube shape crystal of NaCl? The molecular weight of NaCl is 58.5 g $mole^{-1}$.

3 (a) Draw a table to show the crystal systems, number of Bravais lattice together with lattice symbol, restrictions on cell axes and angles.

   (b) In a cubic crystal show that the interplanar spacing d, is given by $d = \dfrac{a}{(h^2+k^2+l^2)^{\frac{1}{2}}}$.

4 (a) Describe the crystal structure of sodium chloride and specifies the position of ions with the necessary diagram.

   (b) Calculate the packing fraction and density of sodium chloride from the following data: radius of sodium iron is 0.98 Å, radius of chlorine iron is 1.81 Å, atomic weight of sodium is 22.99 and atomic weight of chlorine is 35.45.

5 (a) Describe the covalent bond if necessary draw the diagram to show this bond.

   (b) How many atoms are there in a unit cell of diamond? Show that the angle between the tetrahedral bonds of diamond is $109°28'$.

6 (a) State Bragg's law. What are the permitted diffracted beams in cubic systems?

   (b) X- rays with a wavelength of 1.54 Å are used to calculate the spacing of (2 0 0) plane in platinum. The Bragg angle for first order reflection is 22.4°. What is the size of the unit cell of this crystal?

7 (a) How many methods in x-ray diffraction and what are they? Determine the wavelength of the diffracted beam when a beam of x-rays having wavelengths in the range 0.2 Å to 1 Å incident at an angle of 9° with the cube face of a rock salt crystal. (d = 2.814 Å)

   (b) Discuss Bragg's treatment of X-ray diffraction. Find the angle at which second order diffraction pattern will observed when X-ray of wavelength 1.5 Å strikes a crystal with grating spacing 2.5 Å.

8 (a) Derive the crystal diffraction by using Bragg's law. Can X-rays be diffracted by ordinary optical grating? How must the wavelength of rays be for Bragg's reflection to occur?

   (b) The Bragg angle corresponding to the first order reflection from (111) plane in a crystal is 30° when X-rays of wavelength 1.75 Å are used. Calculate the interatomic spacing.