



DOON UNIVERSITY, DEHRADUN
Mid Semester Examination, Second Semester, 2017-18
Department of Physics, School of Physical Sciences
M.Sc. Physics (Optoelectronics)
Course: PHC-453: Solid State Physics

Time Allowed: 2 Hours

Maximum Marks: 30

Note: Attempt All Questions from Sections A, B, C.

SECTION: A

(Marks: 2 X 3=6)

1. Differentiate between crystalline and amorphous materials with examples? Draw the X-ray pattern for crystalline and amorphous materials.
2. (a) Calculate the planar density of (111) plane of Na atom. Given $a = 0.5 \text{ nm}$.
 (b) What type of bonding would be expected for solid xenon?
3. (a) A plane intercepts the crystal axis at $a=1$, $b=2$ and $c=1$. What are the Miller indices?
 (b) For NaCl, bulk modulus is $2.4 \times 10^{10} \text{ N/m}^2$ and equilibrium distance between the atoms is 2.82 \AA . Calculate R_0/ρ . What is the significance of the calculated value?

SECTION: B

(Marks: 4 X 3=12)

4. (a) In a X-ray diffraction experiment on a material with lattice parameter 4.0 \AA , the first peak is obtained at $2\theta = 10^\circ$. If the same experiment is performed on a second material with the same crystal structure but a lattice parameter of 2.0 \AA . Calculate the value of 2θ at which the first peak will appear?
 (b) Why X-rays are used for determining crystal structure?
5. (a) What do you understand by Lennard Jones Potential? The potential of a diatomic molecule as a function of distance r between the atoms is given by $V = -\frac{A}{r^6} + \frac{B}{r^{12}}$. Calculate the value of potential at equilibrium separation between the atoms.
6. (a) What do you understand by closed packed structures? How many octahedral voids are present in Au crystal?
 (b) What do you understand by rotational symmetry? How the maximum symmetry can be achieved in a 2-D square structure?

SECTION: C

(Marks: 6 X 2=12)

7. (a) How would you explain Bragg's reflection in reciprocal space?
 (b) A beam of X-rays incident on chromium (Cr) crystal. If the difference between the incident and scattered wave vectors is $G = h\hat{x} + k\hat{y} + l\hat{z}$, where $\hat{x}, \hat{y}, \hat{z}$ are the unit vectors of the associated cubic lattice. Determine which X-ray reflections will be observed for Cr and write down the extinction rule for the allowed reflections.
8. (a) What is Brillouin Zone (BZ). Explain in detail about Ist, IInd and IIIrd BZ.
 (b) Describe in detail the rock salt structure. On the basis of crystal structure, compute the theoretical density for sodium chloride. Given parameters are: $A_{\text{Na}} = 22.99 \text{ g/mole}$, $A_{\text{Cl}} = 35.45 \text{ g/mol}$, $R_{\text{Na}^+} = 1.02 \text{ nm}$ and $R_{\text{Cl}^-} = 1.81 \text{ nm}$.