Bachelor of Science (T.Y. B.Sc.) Fifth Semester

B.Sc.3535-5S-PHY 502 : Physics Paper-II (X-Rays and Solid State Physics)

P. Pages : 3 **GUG/W/18/1321**

Time : Three Hours * 1 0 3 4 * Max. Marks : 50

Notes : 1. All questions are compulsory.
2. Draw neat labelled diagrams wherever necessary.

Either

1. a) i) What are X-rays? Mention their properties. **3**

ii) Discuss the origin and mechanism of production of continuous X-ray spectra. Also show that the lowest wavelength limit of continuous X-ray spectra is inversely proportional to the accelerating potential of X-ray tube. **4**

iii) If K, L and M levels of platinum are 78000, 12000 and 3000 eV respectively. calculate the wavelength of K_α and K_β lines **3**

(lev $= 1.6 \times 10^{-19}$ J, h $= 6.55 \times 10^{-34}$ Js) .

OR

b) i) Explain the terms **5**

a) Crystalline solid b) Amorphous solid
c) Lattice d) Unit cell
e) Transition vectors

ii) What is crystal structure? State the relation between crystal structure, lattice and basis. **2**

iii) Explain the concept of Miller indices. Also find the Miller indices for planes in each of the following sets with intercepts $\bar{a}$, $\bar{b}$ and $\bar{c}$ at **3**

1) 3a, 3b, 2c 2) $a, \frac{b}{2}, c$ 3) 2a, ∞, 2b

Either

2. a) i) What do you mean by bonding? How crystals are classified according to their bonding? **2**

ii) Discuss the formation of stable bond using potential energy verses interatomic distance curve. Also show that the formation of chemical bond requires that the repulsive force be of shorter range than the attractive force. **4**

iii) Find the expression for total potential or cohesive energy in an ionic crystal. **2**

iv) Find the energy required to separate the ions in a gaseous $K^+C\ell^-$ molecule. The bond length is 0.26667nm. Given $\frac{1}{4\pi \in_0} = 9 \times 10^9$ Nm^2 C^{-2} **2**

OR

b) i) Discuss the failure of free electron theory. **3**

ii) What are the basic assumptions of Kronig Penney model? **2**

iii) Explain the Kronig Penney model for energy band structure of solids. **5**

Either

3. a) Explain X-ray emission spectra with the help of energy level diagram. **2½**

b) Show that in a crystal of cubic structure the distance between plane with miller indices h, k, ℓ is $d = \frac{a}{\sqrt{h^2 + k^2 + \ell^2}}$ **2½**

c) What is co-valent bonding? Mention the characteristics of co-valent solids. **2½**

d) Distinguish between metals, insulators and semiconductors on the basis of band theory of solids. **2½**

OR

e) State Moseley's law and derive it on the basis of Bohr's theory. **2½**

f) A substance with F. C. C. lattice has density 6250kg/m^3 and molecular weight 60.2. Calculate the lattice constant a (Given: Avogadro number 6.02×10^{26} kg $mole^{-1}$ **2½**

g) Why metallic bonds are not directional? Also mention properties of metallic bonds. **2½**

h) Derive Wiedemann – Franz Law. **2½**

Either

4. a) Explain Auger effect and mention two of its applications. **2½**

b) What are Bravais lattices? Discuss Bravais lattices in two dimensions. **2½**

c) Discuss Langevin's theory of diamagnetism. **2½**

d) The number of electrons per unit length of a crystal is 0.5 electrons per Aº. Calculate the fermi energy. (Given: $h = 6.626 \times 10^{-34}$ Js $m = 9 \times 10^{-31}$ kg). **2½**

OR

e) Explain characteristics X-ray absorption spectra with the help of graph. **2½**

f) Calculate the glancing angle on the cube (100) of a rock salt crystal (a = 2.814Aº), corresponding to second order diffraction maximum for x-rays of wavelength 0.710Aº. **2½**

g) Explain the process of formation of Van der Waal bonding in crystals and explain why Van der Waal bonds are the weakest. **2½**

h) An insulator has an optical absorption which occurs for all wavelengths shorter than 1800Aº Find the width of the forbidden energy band for the insulator. **2½**
(Given $h = 6.626 \times 10^{-34}$ Js)

5. Attempt **any ten** of the followings.

a) Mention application of x-rays. **1**

b) Find accelerating voltage for an x-ray tube producing 0.1Aº x-rays. **1**

c) Mention any two differences between x-rays and visible light. **1**

d) Define unit cell. **1**

e) For simple cubic structure a = 2.14Aº, Find radius r. **1**

f) Mention two characteristics of space group. **1**

g) Define cohesive energy. **1**

h) Define magnetization vector. **1**

i) What is atomic magnetic moment? **1**

j) Explain concept of hole. **1**

k) What is Hall effect? **1**

l) What is fermi level? **1**

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