

directionality, and material properties. Explain why no real material exhibits purely one type of bonding. (7)

(b) The atomic weight of a metal is 27 g/mol, and its lattice parameter is 0.405 nm. If it crystallizes in a FCC structure, calculate its density. (Avogadro's number =  $6.022 \times 10^{23}$  atoms/mol). (4)

(c) A material has a diffusion coefficient of  $2 \times 10^{-10}$  m<sup>2</sup>/s. Calculate the average distance diffused in 10 seconds. (4)

7. Write short notes :

(a) Grain boundaries in materials.

(b) Kirkendall Effect and its experimental significance.

(c) Miller indices. (3×5=15)

Roll No. ....

Total Pages : 4

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May-2026

**B.Sc. IV SEMESTER**

**Basic Material Science**

**(MIC24-PH-401)**

Time: 3 Hours]

[Max. Marks : 75

*Instructions :*

1. It is compulsory to answer all the questions (1.5 marks each) of Part-A in short.
2. Answer any four questions from Part-B in detail.
3. Different sub-parts of a question are to be attempted adjacent to each other.

**PART-A**

1. (a) Why do crystalline materials exhibit anisotropy while amorphous materials do not? (1.5)  
(b) How does coordination number influence packing efficiency? (1.5)  
(c) Why are Miller indices always integers? (1.5)  
(d) Determine the nearest neighbor distance in a BCC crystal if the atomic radius is 0.15 nm. (1.5)  
(e) Why is diffusion faster in liquids than in solids? (1.5)

- (f) What is the atomic packing fraction of an SC structure? (1.5)
- (g) Why do edge dislocations move more easily than screw dislocations? (1.5)
- (h) Explain Burgers vector. (1.5)
- (i) Why is heterogeneous nucleation more common than homogeneous nucleation? (1.5)
- (j) Define Lever rule. (1.5)

### PART-B

2. (a) Compare SC, BCC, and FCC structures in terms of packing efficiency, coordination number, and stability. Explain why FCC structures are generally more ductile than BCC. (10)
- (b) An element crystallizes in BCC with atomic radius 0.14 nm. Calculate :
- (i) Lattice parameter.
- (ii) Atomic packing fraction.
- (iii) Comment on how packing affects density. (5)
3. (a) Discuss phase diagrams and explain the significance of eutectic reactions with a suitable diagram. (7)
- (b) Discuss the Hume-Rothery rules for solid solubility. (4)

- (c) Using the Lever rule, calculate the fraction of phases for a binary alloy containing 30% component A at a given temperature. (4)
4. (a) Analyze the role of point defects in modifying material properties such as electrical conductivity, diffusion, and strength. Compare Schottky and Frenkel defects with respect to energy and occurrence. (8)
- (b) Distinguish between complete and partial solid solubility in alloys. How do factors such as atomic size, crystal structure, and electronegativity influence the extent of solubility? Support your answer with suitable examples. (7)
5. (a) Explain Fick's first and second laws of diffusion. Explain how diffusion depends on concentration gradient and temperature? Why does diffusion play a critical role in alloy formation? (7)
- (b) Differentiate between homogeneous and heterogeneous nucleation. (4)
- (c) A material has a diffusion coefficient of  $2 \times 10^{-10}$  m<sup>2</sup>/s. Calculate the average distance diffused in 10 seconds. (4)
6. (a) Compare ionic, covalent, metallic, and van der Waals bonding in terms of bond strength,