

MATERIAL SCIENCE
(CHEN 2204)

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group - A
(Multiple Choice Type Questions)

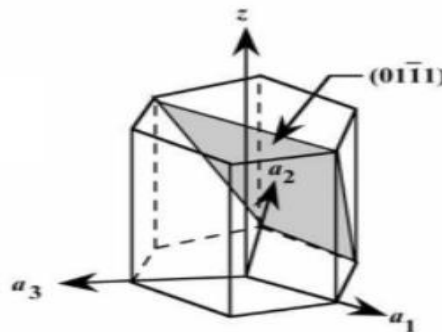
1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) A Frenkel defect is found in
(a) polymers (b) metals
(c) ionic bonds in metals (d) ceramics.
- (ii) Screw dislocation is a
(a) point defect (b) interfacial defect
(c) linear defect (d) bulk defect.
- (iii) A slip plane is characterized by
(a) low stress (b) highest atomic packing
(c) lowest linear density (d) none of above.
- (iv) The austenite phase has a crystalline structure that is
(a) FCC (b) HCP
(c) BCC (d) amorphous.
- (v) Goldschmidt's Alumino-thermite reaction is
(a) mild exothermic reaction (b) mild endothermic reaction
(c) highly exothermic reaction (d) highly endothermic reaction.
- (vi) We cannot use iron ore fines as a feed material in blast furnace because
(a) Fines decrease the bed permeability
(b) Fines increase the bed permeability
(c) Fines increase the bed reactivity
(d) Fines decrease the bed reactivity.
- (vii) Quartz and other gangue materials often act as catalysts during
(a) Roasting reaction (b) Calcination reaction
(c) Smelting reaction (d) Autocatalytic reaction.

- (viii) Blast furnace slag is a raw material of
 (a) Urea production (b) Portland cement production
 (c) Ethylene production (d) Steel production.
- (ix) Hot metal pre-treatment reagent name is
 (a) Oxide (b) Soda ash
 (c) Hematite (d) Sulphuric acid.
- (x) Blast furnace hot metal contains
 (a) 20 to 30% C (b) 3 to 4% C
 (c) 0.01 to 0.05% C (d) 50 to 60% C.

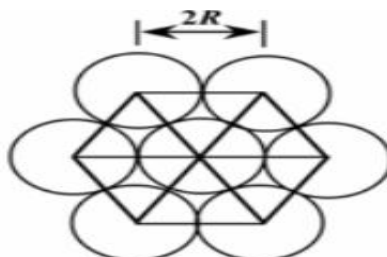
Group- B

2. (a) Within a unit cubic cell, sketch the following planes: $(1\bar{1}1)$, $(\bar{2}12)$. [[CO1](Analyse/IOCQ)]
 (b) Determine the planar density of BCC (110) plane. State the crystallographic indices of points intersected by the BCC (110) plane. [[CO1](Analyse/IOCQ)]
 (c) What are the type of point defects found in ceramics? How are these defects formed? [[CO1](Remember/LOCQ)]
- 4 + 4 + 4 = 12**

3. (a) Tantalum has BCC cubic structure and density of 16.6 gm/cc. Calculate the radius of Tantalum atom. [[CO1](Estimate HOCQ)]
 (b) The figure below shows a plane in HCP crystalline structure. Calculate the Miller-Bravais indices of the plane showed by the arrow if each side of the hexagon is a . [[CO1](Estimate/HOCQ)]



- (c) A (0001) plane for the HCP unit cell looks like the following:



[[CO1](Analyse/IOCQ)]

Find the planar density along the plane in terms of the atomic radius. Each side of the polygon is of dimension, a .

4 + 4 + 4 = 12

Group - C

4. (a) For BCC Fe crystals determine the interplanar distance for the plane (220). The atomic radius of Fe is 0.126 nm. Considering a first order reflection in X-ray diffraction, where the Fe surface is subjected to a monochromatic radiation of 0.018 nm with a diffraction angle of 62.13 deg., verify the interplanar distance calculated above. [(CO1)(Estimate/IOCQ)]
- (b) Explain the type of microstructure formation when eutectoid steel is slowly cooled. [(CO3)(Remember/LOCQ)]
- (c) Cadmium sulphide takes on a yellow orange color in daylight. Can you explain the reason from its bandgap considerations. [(CO2)(Analyze/IOCQ)]
- 4 + 4 + 4 = 12**
5. (a) What do you mean by viscoelastic deformation and visco elastic creep? [(CO2)(Remember/LOCQ)]
- (b) Explain with a sketch how a semiconductor material can be electroluminescent. Give an example. [(CO2)(Analyze/IOCQ)]
- (c) State two properties of soft magnetic materials? What are eddy currents? [(CO2)(Remember/LOCQ)]
- 4 + 4 + 4 = 12**

Group - D

6. (a) Explain the roasting thermodynamic of Ni-S-O with the help of predominance area diagram. [(CO3,CO4)(Analyze/HOCQ)]
- (b) What is matte? [(CO3)(Remember/LOCQ)]
- 10 + 2 = 12**
7. (a) Briefly describe the different parts of LD converter with the help of a neat sketch. [(CO5)(Remember/LOCQ)]
- (b) Describe the different reactions that occur in the upper zone of blast furnace. [(CO5)(Understand/IOCQ)]
- 6 + 6 = 12**

Group - E

8. (a) Write short note on comparative analysis between electrorefining and electrowinning processes. [(CO5)(Analyze/IOCQ)]
- (b) Explain the possible leaching mechanisms of aqueous oxidation of sulphide ores. [(CO5)(Understand/LOCQ)]
- 6 + 6 = 12**
9. Discuss the pyrometallurgical extraction process of copper with the help of a neat block diagram. [(CO5)(Remember/IOCQ)]

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Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	31.25	50	18.75

Course Outcome (CO):

After the completion of the course students will be able to

1. Understand structure of various materials and inherent defects.
2. Identify the mechanical, electronic and optical properties of various materials
3. Classify different metal extraction processes from their ores.
4. Analyze solid and liquid phase behavior from phase equilibrium study.
5. Explain the process flow in the manufacturing/extraction of relevant metal/alloy.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.