



Name :

Roll No. :

Invigilator's Signature :

CS/B.TECH (CT)/SEM-7/CT-701/2012-13

2012

PHYSICAL CERAMICS

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

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

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following : $10 \times 1 = 10$

i) Which of the following is/are not Bravais lattice (s) ?

- a) End centered cubic
- b) Body centered tetragonal
- c) Face centered tetragonal
- d) End centered orthorhombic
- e) Face centered orthorhombic.



- ii) Match the properties in Column I with appropriate units in Column II :

Column I

Column II

- | | |
|---------------------------|-----------------------|
| P. Fracture Toughness | 1. Pa |
| Q. Magnetic permeability | 2. $\text{Nm}^{-3/2}$ |
| R. Surface Tension | 3. Fm^{-1} |
| S. Cold crushing strength | 4. Hm^{-1} |
| | 5. D cm^{-1} |

- | | |
|-----------------------|------------------------|
| a) P-2, Q-5, R-4, S-1 | b) P-2, Q-4, R-5, S-1 |
| c) P-3, Q-5, R-4, S-3 | d) P-5, Q-3, R-5, S-1. |

- iii) Which combination of the following ceramic materials shows polytypism and is maximum covalent ?

- | | |
|------------------------------------|--|
| a) SiC and Al_2O_3 | b) Al_2O_3 and SiC |
| c) SiC and SiC | d) Al_2O_3 and Al_2O_3 . |

- iv) Diamagnetic susceptibility has the value

- | | |
|---------------|--------------------------|
| a) $+10^{-5}$ | b) -10^{-5} |
| c) -10^5 | d) $10^{-5} - 10^{-2}$. |

- v) Match the materials in Column I with the application in Column II. Tick the appropriate combination below :

Column I

Column II

- | | |
|-----------------------------------|------------------------------|
| P. Titanium dioxide | 1. Photocatalyst |
| Q. Molybdenum disilicide | 2. Heating element |
| R. Hydroxyapatite | 3. Ultra high temp. material |
| S. Nanocrystalline TiO_2 | 4. Tough ceramic |
| | 5. Artificial bone joint. |

- | | |
|-----------------------|------------------------|
| a) P-4, Q-3, R-5, S-1 | b) P-5, Q-3, R-2, S-1 |
| c) P-3, Q-4, R-1, S-5 | d) P-3, Q-2, R-5, S-1. |



- vi) Visible light's wavelength range is
- a) 0.39 - 0.77 mm b) 0.39 - 0.77 μm
- c) 0.39 - 0.77 nm d) 0.39 - 0.77 cm.
- vii) The colour forming species in the actinide series of elements is/are
- a) thorium b) plutonium
- c) neptunium d) uranium.
- viii) A solid phase results in a solid phase plus another solid phase up on heating during
- a) eutectoid reaction b) peritectoid reaction
- c) monotectoid reaction d) all of these.
- ix) In ferromagnetic crystals, the spins are aligned
- a) in one direction and switchable in the opposite direction
- b) in two direction and switchable
- c) in two direction and not switchable
- d) none of these.
- x) When MgO is doped in Al_2O_3 , which type of defect is formed ?
- a) Cation vacancy b) Cation interstitial
- c) Anion vacancy d) Anion interstitial.



GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following $3 \times 5 = 15$

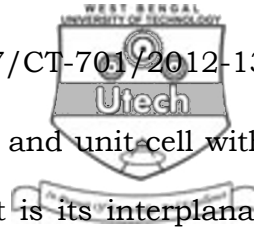
2. Narrate the differences between homogeneous and heterogeneous nucleation.
3. Discuss briefly sintering process with a reactive liquid with example.
4. Discuss primary and secondary recrystallization in brief with example.
5. Discuss some properties and applications of soft ferrites.
6. Discuss with sketch the stress-optic effect in glass.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) What are the three most common crystal structures known ? Name some metals which have each of these crystal structures.
- b) Calculate the volume of the zinc crystal structure unit cell by using the following data : Pure Zn has HCP crystal structure with $a = 0.2665 \text{ nm}$ and $c = 0.4947 \text{ nm}$.



- c) Copper has an FCC crystal structure and unit cell with a lattice constant of 0.361 nm. What is its interplanar spacing d_{220} ?
- d) Discuss ionic-covalent mixed bonding and Pauling's equation. Calculate the % ionic character of GaAs and ZnSe when electronegativities of Ga, As, Zn and Se have values 1.8, 2.2, 1.7 and 2.5 respectively.

$$(1 + 3) + (3 + 2) + (3 + 3)$$

8. a) Discuss why conductivity increases with temperature for a semiconductor while it decreases with temperature for a metal ?
- b) Draw and explain briefly energy band diagrams of extrinsic semiconductors.
- c) Discuss the effect of doping on carrier concentrations in extrinsic semiconductors.
- d) With sketch, discuss the effect of temperature on intrinsic and extrinsic semiconductors. $3 + 4 + 4 + 4$
9. a) Define para, ferro, anti-ferro and ferromagnetism with examples. Define magnetic susceptibility and draw susceptibility-temp. curves for dia, para, ferro, antiferro and ferromagnetic materials.



- b) Explain why Fe, Co and Ni are ferromagnetic materials, while Mn and Cr are not ?
- c) What is magnetic moment of a single unpaired electron called ? Write its expression with numerical value and unit.
10. a) Discuss with sketches Ligand Field Theory of the 1st transition series and discuss method of development of colour in silicate glass environment.
- b) What are the main contributing factors that affect the opacity of a two-phase system ? How do porosity and refractive index affect translucency of porcelains and bone china wares ?
11. a) Schematically draw and mention the alternate paths for matter transport during the initial stages of solid state processes of sintering.
- b) Discuss in detail the evaporation condensation mechanism and obtain a relation for the rate of growth of bond area between particles.
12. a) Illustrate the gravity-centre principle for calculating the phases in ternary mixtures with a near sketch.



b) Considering the case of binary compound formation without the formation of solid-solution, draw and mark phase fields of

- i) a ternary phase diagram with component A , B and C , where recurrent crystallization of A takes place.
- ii) a ternary diagram where a binary compound is stable only when it is formed above a certain minimum temperature.

5 + 5 + 5

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