

नोट:- दोनों खण्डों से निर्देशानुसार उत्तर दीजिए। प्रश्नों के अंक उनके दाहिनी ओर अंकित हैं।

Note: Answer From Both the Section as Directed. The Figures in the right-hand margin indicate marks.

SECTION-A

1x10

1. Answer the following questions.

- For which type of materials superconducting transitions are sharp?
- What do you mean by super-electrons?
- Coherence length in superconducting materials is a function of temperature. State True or False.
- Write the expression for Clausius-Mossotti relation.
- Define relaxation time.
- write two application of ferroelectric materials.
- What do you mean by antiferroelectric crystals?
- What is the SI unit of mobility of a charge carrier?
- Mention the name of two methods used to synthesize nanostructured materials.
- Define 'forbidden frequency band' for a linear diatomic lattice.

2x5

2. Answer the following questions.

- Explain the magnetic behavior of Type-I Superconductors.
- Define Polar and Non-polar dielectrics.
- Why a semiconductor is transparent to infrared light?
- How the interatomic forces are responsible for holding atoms together in solid?
- How anharmonicity is related to thermal expansion of solid?

SECTION-B

15x4

Answer the following questions.

- (a) "Perfect diamagnetism is an essential property of superconducting state." - Explain this. 5
(b) Discuss the macroscopic theory of superconducting phase transition using thermodynamical approach. 7
(c) A superconducting lead has a critical temperature of 7.26 K at zero magnetic field and a critical field of 8×10^5 A/m at 0 K. Find the critical field at 5 K. 3

OR

- The penetration depth of mercury at 3.5 K is 750 \AA . Given, molecular weight of Hg is 200.6 molecular density is $13.55 \times 10^3 \text{ kg/m}^3$.
(i) Calculate the penetration depth at 0 K. 2
(ii) Calculate the order parameter 'w'. 5
- Give a qualitative description about the mechanism of Cooper pair formation, responsible for superconductivity. 8
- (a) Derive an expression for the local field to polarize an atom of a solid when placed inside a dielectric. 5
(b) Discuss the classical theory of electronic polarizability and find an expression of Complex Dielectric constant. 10

OR

- Give the theory of ferroelectricity and discuss properties of ferroelectric materials. 10
(b) How ferroelectric domains arise inside a ferroelectric crystal? 5
- (a) Write a short note on type semiconductor. 3
(b) Find suitable expressions for carrier densities in terms of energy band gap (E_g) in an intrinsic semiconductor. 12

OR

- Explain the Mechanical, Electrical and Optical properties of nanostructured materials. 15
- What do you mean by acoustical mode and optical mode of vibration of atoms? 3
(b) Discuss the wave motion of monoatomic linear lattice and hence find dispersion relation. What happens to the lattice chain when the angular frequency becomes.
(i) maximum (ii) high, and (iii) low respectively? 12

OR

- What do you mean by thermal conductivity of solids? 3
(b) Considering a crystal as a container enclosing gas of phonons, deduce an expression for thermal conductivity and apply it to the lattice of crystal. 12

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