MAY 2016 **P/ID 40009/PPHJ**

Time : Three hours Maximum : 100 marks

PART A — (10 × 2 = 20 marks)

Answer ALL questions.

1. Draw the structure of Diamond cubic crystal and mention the equivalent positions.

2. Define the term Brillouin zone for a lattice with a diagram.

3. Explain group velocity with an example.

4. What is meant by quantization of lattice vibrations?

5. Explain the Wiedmann and Franz's law.

6. Explain Matthiessen's rule for electrical resistivity of metals.

7. "Diamagnetism is present in all materials". Justify this statement.

8. State Hund's rule for the ground state.

9. Define London penetration depth. What is its importance?

10. What is meant by coherence length in superconductors?

PART B — (5 × 6 = 30 marks)

Answer ALL questions.

11. (a) Prove that the reciprocal lattice for an fcc lattice is bcc. Also prove that vice versa is also true.

Or

(b) Explain the hydrogen bonding in single crystals and discuss its salient features.

12. (a) Derive an expression for the thermal conductivity coefficient of a solid from the phonon gas model.

Or

(b) Discuss the salient features of Einstein model for specific heat capacity of solids and compare it with the classical theory.

13. (a) What is a semimetal? Give an example. Explain the allowed energy band for a semimetal with a neat diagram.

Or

(b) Explain the method of construction of Fermi surface using reduced zone scheme.

14. (a) Discuss in detail the quantum theory of paramagnetism.

Or

(b) Explain Weiss mean field theory of ferromagnetism. Mention its success and failures.

15. (a) Explain Meissner effect with a neat diagram. Discuss how the Meissner effect contradicts Maxwell's equation.

Or

(b) Give a brief account of BCS theory of superconductivity. Explain with necessary diagrams, how tunneling experiments support this theory.

PART C — (5 × 10 = 50 marks)

Answer ALL questions.

16. (a) Explain atomic scattering factor and structure factor. Obtain an expression for the geometrical structure factor for a fcc lattice. Discuss the absent reflections.

Or

(b) Describe the formation of ionic crystals. Explain Madelung energy and Madelung constant. Evaluate the Madelung constant for the one dimensional chain.

17. (a) Obtain the equation of motion for the vibration of lattices for a diatomic crystal structure. Derive the vibrational spectrum. Show that there are two branches for each mode of the wave.

Or

(b) Obtain an expression for the lattice heat capacity on the basis of Debye model. Compare the theory with the experiment and draw a graph to illustrate it.

18. (a) Explain electron orbits, hole orbits and open orbits on the basis of Fermi surface concept with the diagrams.

Or

(b) Discuss the experimental observations on the temperature variation of resistivity of metals.

19. (a) What is a magnon? Show that the magnon disperson relation for antiferromagnetic magnon is similar to that of a phonon for small values of the wave vector.

Or

(b) What are ferromagnetic domains? How can one observe the domain structure? Obtain an expression for the total Bloch wall energy per unit area.

20. (a) Discuss the principle of dc Josephson effect. Prove that with no applied voltage a dc current flow across the junction.

Or

(b) What are high temperature superconductors? Draw the crystal structure of Y-Ba-Cu-O superconducting material. Explain its method of preparation and characteristics.

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