

Instructions: 1. Symbols have their usual meaning.

2. Figures on right hand side show marks of that question.

1. (a) Derive dispersion relation for the monatomic crystal and discuss different cases. [14]

OR

1. Write note on : (1) "Optical Branch of diatomic lattice" and (2) "Phonon" [14]
2. (a) Mention the drawbacks of classical theory and Einstein's theory of specific heat. Write the formula total energy of a solid according to Debye's theory and prove that for high temperatures it follows the classical nature and for extreme low temperatures it follows the  $T^3$  nature. [10]
- (b) Explain the terms : Einstein Temperature and Debye Temperature [04]

OR

2. (a) Discuss Debye's cut off approximation for theory of specific heat. [04]
- (b) Obtain an expression for the specific heat capacity of a solid on basis of Einstein's theory. Discuss its cases. [10]
3. (a) Discuss the classical theory of free electron gas for metals. [07]
- (b) Mention features of Sommerfeld quantum theory discuss how Sommerfeld quantum theory of free electron gas explains the occurrence of long mean free path. [07]

OR

3. (a) Give conceptual explanation of Fermi energy and Fermi function. [06]
- (b) Discuss Kronig-Penney Model of Solids. [08]
4. (a) Mention the drawbacks of F-H Landon's of Superconductivity , discuss how BCS theory resolves the drawbacks of F-H Landon's of Superconductivity [10]
- (b) Write note on : "Coherence Length" [04]

OR

4. (a) Explain striking features of superconductor. [08]
- (b) Discuss a role of temperature and magnetic field on occurrence of superconductivity. [06]
5. (a) Discuss in brief the applications of superconductivity . [09]
- (b) Calculate the temperature required to bring mercury superconductor to its normal state under magnetic field 2 T. ( $T_c = 4.12$  K,  $H_0 = 3.3 \times 10^4$  T) [05]

OR

5. (a) State and prove Bloch theorem. [09]
- (b) The Debye temperature of diamond is 1850 K. Calculate the specific heat per K mol for diamond at 40 K. [05]