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(6th Semester)

PHYSICS

TWELFTH (A) PAPER

(Solid-state Physics—II)

(Pre-revised)

Full Marks : 55

Time : 2½ hours

(PART : A—OBJECTIVE)

(*Marks* : 20)

The figures in the margin indicate full marks for the questions

SECTION—A

(*Marks* : 5)

Tick (✓) the correct answer in the brackets provided : 1×5=5

1. Quantum of elastic vibration is

(a) phonon ( ) *(b)* photon ( )

(c) graviton ( ) *(d)* meson ( )

2. Susceptibility of a diamagnetic material is

(a) very large ( ) *(b)* small but negative ( )

(c) small but positive ( ) *(d)* zero ( )

3. The process of producing electric dipoles inside the dielectric by an external electric field is

(a) dipole moment ( ) *(b)* polarization ( )

(c) susceptibility ( ) *(d)* magnetization ( )

4. Separation between valence band and conduction band is measured in

(a) volts ( ) *(b)* metres ( )

(c) metre ^{1} ( ) *(d)* electron volts ( )

5. The superconducting state is perfectly _____ in nature.

(a) paramagnetic ( ) *(b)* diamagnetic ( )

(c) ferromagnetic ( ) *(d)* ferrimagnetic ( )

SECTION—B

(*Marks* : 15)

Answer the following questions : 3×5=15

1. Compute the cut-off frequency for a linear diatomic lattice if the velocity of sound and interatomic spacing in the lattice are 3 10^{3} ms ^{1} and 3 10 ^{10} m respectively.

2. Explain the domain theory of ferromagnetism.

3. Obtain an expression for London penetration depth.

4. Explain the origin of energy gap.

5. Explain what is meant by polarization in dielectrics.

(PART : B—DESCRIPTIVE)

(*Marks* : 35)

The figures in the margin indicate full marks for the questions

1. Show that the dispersion relation for the lattice waves in a monatomic linear lattice of mass *m*, spacing *a* and the nearest neighbour interaction *C* is $2\sqrt{\frac{C}{M}}\sin\left|\frac{1}{2}\vec{k}a\right|$, where is the angular frequency and $\vec{k}$ the wave vector. Discuss the dispersion behaviour at *(a)* low frequencies and *(b)* high frequencies. 4+1½+1½=7

OR

Discuss the vibrational modes of a diatomic linear lattice and also discuss the two branches of the dispersion relation curve. 4+3=7

2. Using quantum theory, obtain an expression for paramagnetic susceptibility. What is the difference with Langevin's classical theory? 6+1=7

OR

Discuss the formation and significance of the hysteresis loop. Show that the area under the hysteresis loop denotes the energy dissipated per unit volume of materials during each magnetizing cycle. 3+4=7

3. What is depolarization field? Obtain the expression for local electric field at an atom in dielectric material. 1+6=7

OR

Write short notes on *(a)* Lorentz field and *(b)* Clausius-Mosotti relation. 3½+3½=7

4. What is the basic assumption of Kronig-Penney model? Discuss the results of Kronig-Penney models for *(a)* small barrier strength (P 0) and *(b)* extremely large barrier strength (P). 2+2½+2½=7

OR

Discuss the concept of effective mass of an electron. Explain how electron in a crystal can behave dynamically like a particle with variable mass. 5+2=7

5. Give an elementary treatment of BCS theory of superconductivity. Explain how the superconducting energy gap varies with temperature. 4+3=7

OR

(a) Define superconductivity. What are type I and type II superconductors? 1+4=5

(b) Explain briefly certain isotope effect of superconducting material. 2

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