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(6th Semester)

PHYSICS

TWELFTH (A) PAPER

(Solid-State Physics—II)

(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. For a solid with diatomic linear chain of atoms, acoustical branch disappears

(a) if mass of the heavier atom tends to zero ()

(b) if mass of the lighter atom tends to zero ()

(c) if mass of the heavier atom tends to infinity ()

(d) if mass of the lighter atom tends to infinity ()

2. The permanent magnetic moment in ferromagnetic material arises due to

(a) partially filled electronic shells ()

(b) completely filled electronic shells ()

(c) innermost electronic shells ()

(d) empty electronic shells ()

3. The electronic polarizability ϵ_e of a monatomic gas atom is
 (a) $4 \epsilon_0 R$ () (b) $4 \epsilon_0 R^2$ ()
 (c) $4 \epsilon_0 R^3$ () (d) $4 \epsilon_0 R^4$ ()
 where the symbols have their usual meanings.
4. The energy of the lowest state in a one-dimensional potential box of length a is
 (a) zero () (b) $2h^2 / ma^2$ ()
 (c) $h^2 / 8ma^2$ () (d) ()
5. A superconducting material when placed in a magnetic field will
 (a) attract the magnetic field toward its centre ()
 (b) repel all the magnetic lines of forces passing through it ()
 (c) not influence the magnetic field ()
 (d) reflect all the magnetic lines of forces ()

SECTION—B

(Marks : 15)

Write short answers of the following questions :

3×5=15

- Determine the phase velocity and group velocity of wave motion along a one-dimensional monatomic lattice. What happens to the group velocity when $ka \rightarrow \pi$?
- How does internal field (Weiss field) arise in ferromagnetic crystals?
- Write a short note on anomalous dispersion.
- What is the concept of effective mass of an electron?
- What is Meissner effect? Deduce that a superconductor is a perfect diamagnetic.

(PART : B—DESCRIPTIVE)

(Marks : 35)

The figures in the margin indicate full marks for the questions

- Derive the expressions for phase and group velocity of a wave. What do they signify physically? 4+3=7

OR

What is dispersion relation in the vibration of lattice? Give some important facts about the vibration of a diatomic lattice. What is the difference between the two branches of the dispersion relation? 1+4+2=7

2. What is the origin of magnetic moment in an atom? Discuss the origin of magnetic property in diamagnetic, paramagnetic and ferromagnetic materials. How does the susceptibility vary with temperature in these three types of magnetic materials? 1+3+3=7

OR

Discuss the quantum theory of paramagnetism and hence deduce the expression for susceptibility. What difference is observed in the result in comparison to the expression obtained from Classical Langevin theory? 5+2=7

3. What are polar and non-polar dielectrics? Discuss Classical theory of electronic polarizability. 2+5=7

OR

Derive Clausius-Mossotti equation. 7

4. State and prove Bloch theorem. 7

OR

Explain how an energy gap originates in the energy bands of a solid. Show from (E, K) graph that materials can be classified into conductors, insulators and semiconductors. 4+3=7

5. What is superconductivity? Explain the term critical magnetic field in a superconductor. How does superconducting energy gap vary with temperature? 1+3+3=7

OR

Discuss BCS theory to give an account for zero resistivity at $T = T_C$ of the superconductors. 7
