M.Sc.—Phy-IIS (203)

2018

Time : 3 hours

Full Marks : 80

Answer from **both** the Sections as per direction

The figures in the right-hand margin indicate marks

Candidates are required to answer in their own words as far as practicable

(BASIC SOLID STATE PHYSICS)

SECTION—A

1. Answer any *four* questions : 4 × 4

   (*a*) Explain ionic and convalent crystals. Calculate the potential energy of the system of Na^+ and Cl^- ions when they are 2.0 Å apart.

   (*b*) Derive an expression for dispersion relation for a one dimensional lattice of identical atoms and also show dispersion curve.

(*c*) Explain Wiedemann-Franz law and its physical significance.

(*d*) Define Bloch functions and prove Bloch theorem.

(*e*) Why point defects are called as zero dimensional defects ? Differentiate between Schottky and Frenkel defects with example.

(*f*) How dielectrics are different from insulators ? Explain dielectric constant and its relation with permittivity.

Or

2. Answer *all* questions : 2 × 8

(*a*) Explain acoustic and optic modes of vibrations.

(*b*) Explain crystals of inert gases with example.

(*c*) Define phonon heat capacity.

(*d*) Explain Hall Effect and informations available from it.

(*e*) Explain origin of band gap in short.

(*f*) Explain basic assumptions of nearly free electron model.

(*g*) Explain the concept of effective mass and its significance.

(*h*) Explain role of diffusion in ionic conductivity.

SECTION– B

Answer **all** questions : 16 × 4

3. Show that a diatomic linear chain with two types of atoms of mass m and M, the density of phonon mode per unit frequency interval diverges at maximum frequency on either side of the gap : while it tends to acquire a constant value as $q \to 0$, assuming the nearest neighbor interaction describe by a single force constant K for all interacting pairs.

Or

What are ionic crystals ? Explain the formation of an ionic crystal and obtained an expression for cohesive energy. Find relation between Madelung constant and cohesive energy.

4. Expain the major difference between Einstein theory and Debye theory of specific heat. Show that the Einstein's relation for the specific per K- mol of a solid reduces to the classical value $kT > h\nu$.

Or

In aluminimum, longitudinal frequency is $6{\cdot}32 \times 10^3$ m/s and transverse frequency is $3{\cdot}10 \times 10^3$ m/s. The density of alluminium is $2{\cdot}70 \times 10^3$ kg/m^3 and atomic weight is 26·97 :

(*a*) Calculate the Debye cut-off frequency

(*b*) The Debye temperature for aluminium, as obtained from specific heat measurement is 375 K.

Find cut off frequency and compare with above result.

5. What are the basic assumptions of the Kronig-Penney model ? Solve Schrodinger equations electron in periodic potential and draw energy-wave number plot for one dimensional lattice.

Or

Describe three dimensional electron gas model. Discuss heat capacity of electron gas and explain thermal conductivity using free electron gas model.

6. Differentiate between intrinsic and extrinsic semiconductors using band diagram. Show the prositions of donar and accepter states along with Fermi energy level. Discuss thermal ionization of donors and acceptors.

Or

Explain various types of polarizations in dielectric materials. Discuss mechanism of orientational polarization. Derive Classius-Mossotti relation.
