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5 SEM TDC PHYH (CBCS) C 12

2024

(November)

PHYSICS

(Core)

Paper : C–12

(Solid-State Physics)

Full Marks : 53

Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct option from the following : 1×5=5

(a) Repeatable entity of a crystal structure is known as

(i) crystal

(ii) lattice

(iii) unit cell

(iv) Miller indices

(b) For solids, the optical and acoustic branches coincide and forbidden band vanishes at

$$k = \pm \frac{\pi}{2a}$$

when (mass of light and heavy atoms are m and M respectively)

(i) $m < M$

(ii) $m > M$

(iii) $m = M$

(iv) $mM = 1$

(c) The paramagnetic susceptibility varies as

(i) T

(ii) T^2

(iii) $\frac{1}{T}$

(iv) $\frac{1}{T^2}$

(d) Ionic polarizability

(i) increases with T

(ii) decreases with T

(iii) is independent of T

(iv) None of the above

(e) Hall effect can be used to measure the

(i) charge carrier density only

(ii) type of semiconductor only

(iii) mobility of charge carrier only

(iv) All of the above

2. Answer any *five* from the following : 2×5=10

(a) Define reciprocal lattice. State the mathematical relation of this lattice with direct lattice.

(b) Define geometrical structure factor. How is it related to atomic scattering factor?

(c) Explain ferrimagnetism. What are ferrites?

(d) What are optical absorption and infrared absorption in a dielectric?

(e) What is piezoelectricity? Give an example of a crystal that is piezoelectric but not ferroelectric.

(f) Define mobility of charge carrier and write its unit.

3. (a) Find the Miller indices of a plane having intercepts of $8a$, $4b$ and $2c$ on the a- , b- and c- axes, respectively. 2

(b) Write Bragg's law of crystal diffraction. Give its significance. 1+1=2

4. (a) Derive the vibrational modes of a diatomic lattice. Name the different branches of the dispersion relation curve. 4+2=6

(b) State Dulong and Petit law of specific heat of solid. 2

5. Obtain an expression for diamagnetic susceptibility using the Langevin's theory. What is the significance of negative susceptibility? 5+1=6

Or

Give an account of quantum theory of paramagnetism and derive an expression for susceptibility. 6

6. (a) Obtain an expression for dipolar polarizability at moderate temperature. 4

(b) Classify different groups of ferroelectric materials on the basis of symmetry. Also give one example of each group. 4

7. (a) Discuss the formation of allowed and forbidden energy bands on the basis of the Kronig-Penney model. 4

(b) A semiconducting crystal of 1·2 cm length, 5 mm width and 1 mm thick is placed in a magnetic field 0·5 Tesla perpendicularly to its flat surface. When a current of 20 mA flows through its sample along its length, a Hall voltage of 37 micro-Volt is developed across its width. Determine the Hall Coefficient of the specimen. 3

Or

What is an extrinsic semiconductor and how can they be achieved? Draw the energy band diagram of *(a)* *n*-type semiconductor and *(b)* *p*-type semiconductor. 2+1=3

8. *(a)* What is superconductivity? How do magnetic and electrical properties of superconductors differ from those of normal conductor? 1+2=3

(b) What do you mean by flux exclusion and what is Meissner effect? 2

Or

Define isotope effect in superconductor mentioning its importance.