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3 (Sem-5/CBCS) PHY HC 2

2021

(Held in 2022)

PHYSICS

(Honours)

Paper : PHY-HC-5026

(Solid State Physics)

Full Marks : 60

Time : Three hours

The figures in the margin indicate full marks for the questions.

1. Choose the correct answer from the following: $1 \times 7 = 7$

(a) The Miller indices of the plane parallel to x and z axes are

(i) (1 0 0)

(ii) (0 0 1)

(iii) (0 1 0)

(iv) (1 1 1)

Contd.

- (b) The most unsymmetrical crystal system is
- (i) cubic
 - (ii) orthorhombic
 - (iii) triclinic
 - (iv) trigonal
- (c) Above Curie temperature, a ferromagnetic material becomes
- (i) antiferromagnetic
 - (ii) paramagnetic
 - (iii) diamagnetic
 - (iv) ferrimagnetic
- (d) Fermi level in n -type semiconductor lies
- (i) in between the bottom of the conduction band and donor level
 - (ii) in between the top of valence band and acceptor level
 - (iii) midway between conduction band and valence band

- (iv) outside the gap between conduction band and valence band
- (e) Superconductivity state is perfectly
- (i) paramagnetic
 - (ii) diamagnetic
 - (iii) ferromagnetic
 - (iv) ferrimagnetic
- (f) The number of different Bravais lattices in three dimensions is
- (i) 3
 - (ii) 14
 - (iii) 167
 - (iv) unlimited
- (g) Piezoelectric effect is the production of electricity by
- (i) chemical effect
 - (ii) varying field
 - (iii) temperature
 - (iv) pressure

2. Give short answers of the following questions: $2 \times 4 = 8$

(a) What are primitive and non-primitive unit cells?

(b) State Wiedemann-Franz law.

(c) Define symmetry operation in crystalline solids. Mention different types of fold rotation axes that are permissible.

(d) What are ferroelectrics? Mention the chief characteristics of ferroelectric materials.

3. Answer **any three** from the following questions: $5 \times 3 = 15$

(a) Why are crystalline solids used for X-ray diffraction? Explain why visible light cannot be used for the determination of crystal structure.

An X-ray beam of frequency 10^{20} Hz undergoes diffraction from a set of plane with spacing 1.5 \AA . What is the direction of first-order diffraction?

$1 + 2 + 2 = 5$

(b) Explain Meissner effect. What are type II superconductors? $3 + 2 = 5$

(c) Define hysteresis. Draw hysteresis loop for ferromagnetic material and label different parts. What is ferromagnetic domain? $1 + 2 + 2 = 5$

(d) What are phonons? Mention its characteristics. $2 + 3 = 5$

(e) Discuss the important conclusions of Kronig-Penney model. 5

4. Answer the following questions:

$10 \times 3 = 30$

(a) What are reciprocal lattice vectors? Obtain expressions for them. Show that the reciprocal lattice to a simple cubic is itself a simple cubic. $3 + 5 + 2 = 10$

Or

Show that a monatomic linear lattice can be regarded as a low-pass filter.

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- (b) Explain polarisability of atoms. Derive Clausius-Mossotti equation between polarisability and dielectric constant of solid. $4+6=10$

Or

Explain classical Langevin theory of diamagnetism. What is the essential condition for an atom to be diamagnetic? $8+2=10$

- (c) What is Hall effect? Find Hall coefficient in a metal where the carriers are only electrons. Why is Hall coefficient positive in some metals?

An n -type germanium strip, 1 mm wide and 1 mm thick, has a Hall coefficient of 10^{-2} m/coulomb . If for a current of 1 mA the Hall voltage produced inside the strip is 1 mV , calculate the strength of the magnetic field.

$$2+5+1+2=10$$

Or

Write short notes on: (any two)

$$5 \times 2 = 10$$

- (i) Plasma oscillations
- (ii) Einstein's theory of specific heat
- (iii) Bragg's law
- (iv) Curie-Weiss law.