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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: 1×7=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

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  $1.5 \text{ \AA}$ . 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  $10^{-2} \text{ m/coulomb}$ . 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.