

TIME - 3 hours

Answer from all the section as per instructions

### Section I

Compulsory multiple choice questions  $10 \times 2 = 20$

1. (a) which of the following is a crystalline solid
- (i) Isotropic substances
  - (ii) Anisotropic substances
  - (iii) Supercooled liquid
  - (iv) Amorphous solids

Ans (ii) Anisotropic substances.

- (b) What is the possible number of different types of lattices (3D)?
- (i) 4
  - (ii) 8
  - (iii) 14
  - (iv) 17

Ans (iii) 14.

- (c) What is the lattice constant for FCC crystal having atomic radius  $1.476 \text{ \AA}$ .
- (i)  $1.476 \text{ \AA}$
  - (ii)  $4.1748 \text{ \AA}$
  - (iii)  $5.216 \text{ \AA}$
  - (iv) 0

Ans (i)  $1.476 \text{ \AA}$

- (d) Which ~~are~~ one of the following is the property of an ionic compound.
- (i) High melting and boiling points
  - (ii) Low melting and boiling points
  - (iii) Weak interatomic forces
  - (iv) Nonconductors of electricity

Ans (i) High melting and boiling points

(P.T.O)

(1)

(e) Consider the energy  $E$  in the first Brillouin Zone as a function of the magnitude of the wavevector  $k$  for a crystal of lattice constant  $a$ , then

- (2) The slope of  $E$  versus  $k$  is proportional to group velocity
- (ii) The slope of  $E$  versus  $k$  has minimum value at  $|k| = \frac{\pi}{a}$
- (iii) The plot of  $E$  versus  $k$  is nonzero for all  $k$  in the interval  $-\frac{\pi}{a} < k < \frac{\pi}{a}$
- ~~(iv)~~ (iv) The plot of  $E$  versus  $k$  will be parabolic in the interval  $-\frac{\pi}{a} < |k| < \frac{\pi}{a}$ .

Ans (iv)

(f) The three dimensional graph of lattice points which sets the pattern for the whole lattice is called

- (2) space lattice (ii) simple lattice (iii) crystal lattice (iv) unit cell

Ans (iv) Unit Cell

(g) The discrete values of energy of atomic oscillators can have

- (2)  $hw^2$  (ii)  $n\hbar\omega$  (iii)  $n\hbar\omega$  (iv)  $2n\hbar\omega$

Ans (ii)  $n\hbar\omega$

(h) At low temperature the lattice specific heat varies as

- (2)  $T^3$  (ii)  $\frac{1}{T^3}$  (iii)  $T$  (iv)  $\frac{1}{T}$

Ans (2)  $T^3$

(2)

(P.T.O)



Q. Which of the following elements is a covalently bonded crystal

- (i) aluminium (ii) Sodium chloride (iii) Germanium  
(iv) Lead

Ans (iii) Germanium

Q. Which of the following relation gives the potential energy of a diatomic molecule

(i)  $-\frac{a}{r^m} + \frac{b}{r^n}$  (ii)  $\frac{a}{r^m} - \frac{b}{r^n}$  (iii)  $ar^m + br^n$

(iv)  $ar^m - br^n$

Ans (i)  $-\frac{a}{r^m} + \frac{b}{r^n}$

PART B.

(Short answer type questions)

Answer any four in brief

4x5=20.

2. What are Miller indices; illustrate with examples.

3. Define the terms lattice, basis, crystal structure and unit cell.

4. Find the Miller indices for planes with each of the following set of intercepts.

(i)  $6a, 2b, 3c$  (ii)  $a, 2b, 0$  (iii)  $2a, -b, 2c$

5. Obtain an expression for interplanar distance. Hence show that for simple cubic system

$$d_{hkl} = \frac{a}{\sqrt{h^2 + k^2 + l^2}}$$

6. Find the reciprocal lattice to FCC lattice

7. Explain technological use of magnetic materials.

(P.T.O) (3)

- ⑧ Outline classical theory of polarizability
- ⑨ Give Einsteins theory of specific heat of Solids. Discuss its limitations

### PART C

Long answer type questions  
Answer any two questions

15x2=30

- ⑩. What is "Geometrical structure factors". Calculate the geometrical structure factor of a crystal.
- ⑪ Deduce the dispersion relation i.e  $\omega - k$  relation in long linear chain of monoatomic atoms.
- ⑫ Describe the seven systems of crystals with suitable diagram.
- ⑬ What is Hall Effect? Define and calculate Hall voltage, Hall Electric field, Hall resistance, Hall Coefficient.

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