

2022

ELECTRONICS — HONOURS

Paper : CC-3

(Applied Physics)

Full Marks : 50

*The figures in the margin indicate full marks.**Candidates are required to give their answers in their own words as far as practicable.*Answer **question no. 1** and **any four** questions from the rest.1. Answer **any ten** questions :

1×10

(a) What is the possible number of different types of lattices (3D)?

(i) 4

(ii) 8

✓(iii) 14

(iv) 17.

(b) Which of the following is not a property of crystalline solid?

(i) Sharp melting point

✓(ii) isotropy

(iii) definite geometry

(iv) anisotropy.

(c) Crystals having low melting points are in

✓(i) van der Waal's bond

(ii) ionic bond

(iii) Covalent bond

(iv) metallic bond.

(d) The number of lattice points in a primitive cell are

✓(i) 1

(ii) $\frac{1}{2}$

(iii) 2

(iv) $\frac{1}{3}$.

(e) The nearest neighbour distance in the case of bcc structure is

✓(i) $(a\sqrt{3})/2$ (ii) $(a\sqrt{2})/2$ (iii) $2a/\sqrt{3}$ (iv) $2a/\sqrt{2}$.(f) The Miller Indices of the plane parallel to y and z axes are

(i) (100)

(ii) (010)

(iii) (001)

(iv) (111).

Please Turn Over

- (g) In a simple cubic lattice $d_{100} : d_{110} : d_{111}$ is
- (i) $6 : 3 : 2$ (ii) $6 : 3 : \sqrt{2}$
 (iii) $\sqrt{6} : \sqrt{3} : \sqrt{2}$ (iv) $\sqrt{6} : \sqrt{3} : \sqrt{4}$.
- (h) At low temperatures, the mean free path and collision time of an electron in a metal are proportional to
- (i) $1/T$ (ii) $1/T^2$
 (iii) $1/T^3$ (iv) independent of T.
- (i) Diamagnetic materials process
- (i) permanent magnetic dipoles (ii) no permanent magnetic dipoles
 (iii) induced dipole moment (iv) none of these.
- (j) The density of carriers in a pure semiconductor is proportional to
- (i) $e^{-E_g/KT}$ (ii) $e^{-2E_g/KT}$
 (iii) e^{-E_g/KT^2} (iv) $e^{-E_g/2KT}$.
- (k) The de Broglie expression for the wavelength associated with a particle of known wavelength has been verified by
- (i) Davisson and Germer (ii) Heisenberg
 (iii) Dirac (iv) Millikan.
- (l) Electron obey
- (i) Maxwell-Boltzmann statistics (ii) Fermi-Dirac statistics
 (iii) Bose-Einstein statistics (iv) All of these.
2. (a) Explain the terms : primitive cell and unit cell.
 (b) What is coordination number? Obtain the coordination number for fcc lattice.
 (c) Derive an expression for the interplanar spacing for planes of the (hkl) type in the case of a cubic structure. (1+1)+(2+3)+3
3. (a) Discuss the salient features of Debye's theory of specific heat.
 (b) State the Clausius statement of the 2nd law of thermodynamics.
 (c) What is Gibb's free energy function?
 (d) What do you mean by Helmholtz free energy function? 3+3+2+2

4. (a) Outline the basic facts of the photoelectric effect.
(b) Write down the physical significance of Heisenberg's Uncertainty Principle.
(c) Starting from the wave function for a free particle moving along the positive x direction, derive the momentum operator.
(d) Write down Schrodinger's Time Dependent wave equation for a free particle in 3 dimension. 3+2+3+2
5. (a) Derive the relationship between the phase velocity and group velocity.
(b) What do you mean by the physical interpretation of Max Born?
(c) What is meant by wave particle density?
(d) According to band theory write down the differences between metals, insulators and semiconductors. 3+2+2+3
6. (a) Write down the basic postulates of Bose Einstein statistics.
(b) What do you mean by a 6 dimensional phase space?
(c) What do you mean by Entropy?
(d) Derive the relationship between Fermi energy and temperature. 3+2+2+3
7. (a) What are the main drawbacks of classical free electron theory?
(b) Discuss electrical conductivity in metals.
(c) What are superconductors?
(d) Draw E-K diagrams of a direct and indirect bandgap semiconductors. 3+2+2+3
8. (a) How do you classify a material as dia, para or ferromagnetic?
(b) Explain antiferromagnetism.
(c) What is meant by hysteresis in magnetic materials?
(d) Explain that the magnetic behaviour of magnetic substances decreases with increasing temperature. 3+2+2+3
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