

SEAT No. _____



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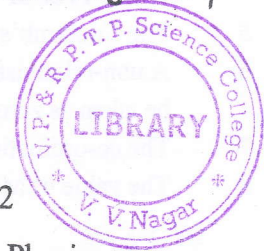
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SARDAR PATEL UNIVERSITY

S. Y. B.Sc. Examination: Semester-IV

COURSE: PHYSICS CODE: US04CPHY22

COURSE TITLE: Classical, Quantum and Solid State Physics



Date: 13-04-2022, Wednesday

Time: 03:00 PM To 05:00 PM

Total Marks: 70

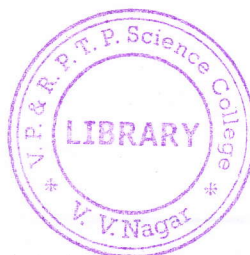
Q-1 Answer the following Multiple Choice Questions: (Attempt all, Each of 1 mark) [10]

- 1 The areal velocity of the particle in a central force field is _____.
(a) zero (b) constant (c) infinite (d) variable
- 2 _____ has an eccentricity of zero.
(a) A parabola (b) A hyperbola (c) A circle (d) An ellipse
- 3 In the graph of energy density $E_\lambda \rightarrow$ wavelength λ for black body radiation, the value of λ_m shift towards _____ as temperature increases.
(a) origin (b) center (c) infinity (d) no way
- 4 In Compton effect, the frequency of the scattered photon _____.
(a) increases (b) decreases (c) becomes constant (d) becomes ∞
- 5 Wave function has value as $\frac{1}{\sqrt{3}} + \frac{\sqrt{2}i}{\sqrt{3}}$ then its probability density will be _____.
(a) 1 (b) $\frac{2}{3}$ (c) $\frac{1}{2}$ (d) 2
- 6 Atomic Packing Factor (APF) for HCP structure is _____.
(a) 0.52 (b) 0.68 (c) 0.74 (d) 6.00
- 7 The unit cell having more than one lattice point is called _____ cell.
(a) primitive (b) non-primitive (c) primary (d) secondary
- 8 The total number of crystallographic symmetry elements of cubic system are _____.
(a) 2 (b) 7 (c) 14 (d) 23
- 9 The conversion of a substance from the solid to the gaseous state without it becoming liquid is due to _____ energy.
(a) dissociation (b) lattice (c) ionization (d) sublimation
- 10 At equilibrium separation $r = r_0$, the force $F = \frac{d}{dr} [U(r)]$ is _____.
(a) zero (b) half (c) double (d) infinite

Q-2 Answer the following questions as asked: (Attempt all, Each of 1 mark) [08]

Fill in the blanks:

- 1 If a particle system in the central force field has the spherical symmetry, the angular momentum of the particle is _____.
- 2 For larger wavelengths, Planck's radiation law becomes _____ law.
- 3 Miller indices of a plane which cuts the intercepts of 1, 2, 5 units along the X, Y, Z axes respectively are _____.
- 4 The Hydrogen bond is of _____ type of bond.



Write True or False:

- 5 The Coulomb's inverse square law is applicable to electrical charges in motion.
- 6 A non-relativistic free particle of velocity v is moving in one dimension, then its potential energy can be taken as zero.
- 7 The co-ordination number of SC structure is 6.
- 8 The value of Madelung constant is 1.75 for the CsCl structure.

Q-3 Answer the following questions in brief: (Attempt Any 10 out of 12, each of 2 marks) [20]

- 1 Write the equation for the laws of gravitational and electrostatic forces in the vector form.
- 2 Define a central force. Give the examples of motion in a central force field.
- 3 Give the equation and statement of the Gauss's law for a continuous distribution of charges within the closed surface.
- 4 A Hydrogen atom is 5.3×10^{-11} m in radius. Use the Heisenberg uncertainty principle to estimate the minimum energy an electron can have in this atom. [$h = 6.62 \times 10^{-34}$ J-s, $1 \text{ eV} = 1.6 \times 10^{-19}$ J, $m = 9.1 \times 10^{-31}$ kg, $e = 1.6 \times 10^{-19}$ C]
- 5 Write the equations that state the De Broglie's hypothesis. What will be the De Broglie wavelength of a wave which is associated with an electron accelerated through a potential difference of 150 volts?
- 6 Write the admissibility conditions on the wave function.
- 7 Define the terms: Lattice, Basis and the Crystal.
- 8 What is symmetry operation? Name the two groups of symmetry operation.
- 9 Draw $(\bar{1} 1 0)$ and $(2 1 1)$ planes in cubic crystal.
- 10 Draw the Born - Haber cycle for NaCl molecule. Write the equation for its lattice energy (U_0).
- 11 Explain the sp^3 hybridization steps for ${}_6\text{C}$ atom with the necessary sketch.
- 12 Draw the representation of covalent bond for the molecules of N_2 and CH_4 .

Q-4 Answer the following questions in detail: (Attempt Any 4 out of 8, each of 8 marks) [32]

- 1 How does a two-body problem reduce to an equivalent one-body problem? Compare the corresponding factors such as mass, distance and Centre of mass in the two cases.
- 2 Discuss the developments of Kepler's law of planetary motion by stating its three laws. Derive the Kepler's third law also.
- 3 State Planck's assumptions used to derive the law for black body radiation. Derive Planck's radiation law in terms of the wavelength.
- 4 Derive the Ehrenfest's theorem. Also write its significance.
- 5 What are the lattice parameters of a unit cell? Draw and discuss seven crystal systems for fourteen Bravais lattice types in 3-dimensions.
- 6 Define Atomic Packing Factor. Calculate APF for the SC and FCC structures.
- 7 What is Madelung constant? Calculate the Madelung constant for: (i) the one dimensional NaCl lattice in a linear chain of ions of alternative sign and (ii) the three dimensional lattice of NaCl structure.
- 8 Write the basic assumptions for formation of stable ionic crystal. Define the Radius Ratio (R_r) for MX compound. Calculate the Radius Ratio (R_r) for CsCl structure.

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