

Ph.D. ENTRANCE EXAMINATION, APRIL 2021**NANO SCIENCE AND TECHNOLOGY**

Time : Two Hours

Maximum : 100 Marks

- The specific heat of a superconducting material shows an abrupt change at $T = T_c$ jumping to a large value for :
 - $T < T_c$.
 - $T > T_c$.
 - $T = T_c$.
 - $T_c = 0$.
- The electronic configuration of the element iron is :
 - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^7$.
 - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^0 3d^8$.
 - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^0 3d^7$.
 - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$.
- The third subshell of an atom can have a maximum of :
 - 2 electrons.
 - 14 electrons.
 - 10 electrons.
 - 6 electrons.
- If the principle quantum number and the azimuthal quantum number in the relativistic model of the atom are 3 and 1 respectively, then the magnitude of the semiminor axis b in terms of the semimajor axis a is given by :
 - $b = a/3$.
 - $b = 2a/3$.
 - $b = a/2$.
 - $b = a$.
- The nature of binding for a crystal with alternate and evenly spaced positive and negative ions is :
 - Ionic.
 - Covalent.
 - Metallic.
 - Dipole.

6. In NaCl, the Na ions are positively charged and chlorine ions are negatively charged. In spite of the coulomb attraction between them, why do the two ions not collapse ?
- (a) Because of the presence of free ions.
 - (b) Because of its low melting point.
 - (c) Because of its high specific heat.
 - (d) Because of short range repulsive forces.
7. If r is the radius of the atom in a crystal, crystallising in the simple cubic structure, then the nearest neighbor distance is :
- (a) $r/2$.
 - (b) $4r$.
 - (c) $2r$.
 - (d) $r/4$.
8. Classify the following unit cell into proper crystal system :
- $a = 1.08 \text{ nm}$, $b = 0.947 \text{ nm}$, $c = 0.52 \text{ nm}$ and $\alpha = 41^\circ$, $\beta = 82^\circ$, $\gamma = 95^\circ$.
- (a) Triclinic.
 - (b) Monoclinic.
 - (c) Orthorhombic.
 - (d) Hexagonal.
9. The number of lattice points in a primitive cell are :
- (a) 1.
 - (b) $1/2$.
 - (c) 3.
 - (d) $3/2$.
10. The packing factor of diamond cubic crystal structure is :
- (a) 60 %.
 - (b) 56 %.
 - (c) 90 %.
 - (d) 34 %.
11. The metallic iron changes from bcc structure of fcc structure at 910°C with an increase in the atomic radii. The density of iron in this structural.
- (a) Remains constant.
 - (b) Increases.
 - (c) Decreases.
 - (d) None of these.
12. If $(3\ 2\ 6)$ are the Miller indices of a plane, the intercepts made by the plane on the three crystallographic axes are :
- (a) $(a, 2b, 3c)$.
 - (b) (a, b, c) .
 - (c) $(2a, 3b, c)$.
 - (d) $(2a, 2b, c)$.

13. In the simple cubic lattice $d_{100} : d_{110} : d_{111}$ is :
- (a) 6 : 3 : 2. (b) 6 : 3 : $\sqrt{2}$.
(c) $\sqrt{6} : \sqrt{3} : \sqrt{2}$. (d) $\sqrt{6} : \sqrt{3} : \sqrt{4}$.
14. The de Broglie wavelength associated with an electron of mass m and accelerated by a potential V is :
- (a) $h / \sqrt{2meV}$. (b) $\sqrt{2meV}/h$.
(c) h / meV . (d) $h / 2meV$.
15. Because of which property of the crystals, X-rays can be diffracted from the crystal :
- (a) Random arrangement of atoms.
(b) Colour of the crystal.
(c) Periodic array of atoms.
(d) Irregular arrangements.
16. Which among the following is not an example of hydrogen bond ?
- (a) H_2O . (b) Liquid HCl.
(c) NH_3 . (d) $CHCl_3$.
17. When an acid reacts with a metal, which one of the following gas is usually liberated ?
- (a) Ammonia gas. (b) Chlorine.
(c) Oxygen. (d) Hydrogen gas.
18. What is the pH of 0.01 molar HCl solution ?
- (a) 1. (b) 2.
(c) 3. (d) 4.
19. Which among the following formations is not an example of Covalent bond ?
- (a) LiF. (b) NH_3 .
(c) CF_4 . (d) HF.

20. Isomers with similar groups on the same side are called :
- (a) Trans isomers. (b) Cis isomers.
(c) Stereo isomers. (d) Meso isomers.
21. Which among the following is formed when alkenes are hydrated ?
- (a) Alcohol. (b) Alkane.
(c) Alkyne. (d) Aldehyde.
22. Which of the following yields soap on hydrolysis ?
- (a) Glycerol. (b) Ethanol.
(c) Fat. (d) Glycerol and ethanol.
23. What are chiral molecules ?
- (a) Optically active molecules. (b) Optically inactive molecules.
(c) Thermally stable molecules. (d) Thermally unstable molecules.
24. Name the process associated with acylation of benzene :
- (a) Friedel Craft reaction. (b) Wurtz reaction.
(c) Wurtz fitting reaction. (d) Debey-Huckel reaction.
25. Liquid hydrocarbon is converted into gaseous hydrocarbon by :
- (a) Distillation with high temperature.
(b) Distillation with low temperature.
(c) Cracking with high temperature.
(d) Cracking with low temperature.
26. In alkanes, free radical chlorination is a reaction that substitutes a chlorine for a :
- (a) Carbon. (b) Hydrogen.
(c) Oxygen. (d) Nitrogen.
27. Identify the smallest cycloalkane :
- (a) Cyclomethane. (b) Methane.
(c) Cyclopropane. (d) Propane.

28. The first step in IUPAC nomenclature is :
- (a) To identify the total number of carbon atoms present in the compound.
 - (b) To identify the total number of carbon atoms present in the longest chain.
 - (c) To identify the total number of hydrogen atoms present in the compound.
 - (d) To identify the total number of hydrogen atoms present in the longest chain.
29. Acyclic compounds are otherwise called as :
- (a) Alicyclic compounds.
 - (b) Ring compounds.
 - (c) Closed chain compound.
 - (d) Aliphatic compounds.
30. Which of the following is used as the catalyst for ammonia production by Haber's process ?
- (a) Titanium.
 - (b) Iron.
 - (c) Zinc.
 - (d) Molybdenum.
31. The three major components that are necessary in a fertilizer are ?
- (a) Na, K, O.
 - (b) Fe, P, S.
 - (c) N, Cl, K.
 - (d) N, P, K.
32. The upper temperature limit of cryogenics is :
- (a) 100 K.
 - (b) 123 K.
 - (c) 127 K.
 - (d) 273 K.
33. Iron pyrite is a raw material used to manufacture :
- (a) Iron.
 - (b) Sulphur.
 - (c) Sulphuric acid.
 - (d) Hydrochloric acid.
34. Mathematically, Boyle's law can be represented as :
- (a) $v = K/P$.
 - (b) $p = k/v$.
 - (c) $VP = k$.
 - (d) All of these.

35. Under same conditions of temperature and pressure, the rates of diffusion of different gases are :
- (a) Directly proportional to the square root of the molecular masses.
 - (b) Directly proportional to the square root of the vapour densities.
 - (c) Inversely proportional to the square roots of their molecular masses.
 - (d) Inversely proportional to the square roots of their molar volumes.
36. The unit of the van der Waals constant are :
- (a) Atm lit mol^{-1} .
 - (b) $\text{Atm lit}^{-1} \text{ mol}^{-1}$.
 - (c) $\text{Atm lit}^{-2} \text{ mol}^{-2}$.
 - (d) $\text{Atm lit}^{-1} \text{ mol}^{-2}$.
37. Graphite and Diamond is a :
- (a) Covalent crystal.
 - (b) Metallic crystal.
 - (c) Ionic crystal.
 - (d) Molecular crystal.
38. The average velocity of a gas is given by the equation :
- (a) $v = \sqrt{8RT/nM}$.
 - (b) $v = \sqrt{3RT/nM}$.
 - (c) $v = \sqrt{2RT/nM}$.
 - (d) $v = RT/nM$.
39. The van der Waals reduced equation of state is :
- (a) $[\pi + 3/\phi^2](3\phi - 1) = 8\theta$.
 - (b) $[\pi + 3/\phi](3\phi + 1) = 8\theta$.
 - (c) $[\pi - 3/\phi^2](3\phi + 1) = 8\theta$.
 - (d) $[\pi + 3/\phi^2](\phi / 3 + 1) = 8\theta$.
40. In a closed flask of one litre, 2g. of hydrogen gas is heated from 27°C to 327°C. Which of the following is incorrect ?
- (a) The pressure of the gas increases.
 - (b) The kinetic energy of gaseous molecules increases.
 - (c) The rate of collision increases.
 - (d) The number of moles of the gas increases.

41. NaCl, CsCl are the example of the :
- (a) Cubic crystal system. (b) Tetragonal crystal system
(c) Orthorhombic crystal system. (d) Rhombohedral system.
42. Which of the following defect is generally found in sodium chloride and caesium chloride ?
- (a) Schottky defect. (b) Frenkel defect.
(c) Interstitial defect. (d) None of these.
43. For an ionic crystal of formula AX, the ratio lies between 0.732 and 0.414. Its Co-ordination number is :
- (a) 4. (b) 6.
(c) 8. (d) 12.
44. The root mean square velocity of a certain gas at 27 degree Celsius is y cm sec⁻¹ the temperature at which its velocity will be $2y$ is :
- (a) 54 degree Celsius. (b) 108 degree Celsius.
(c) 600 K. (d) 1200 K.
45. The boiling point of a liquid is that temperature at which ?
- (a) The vapour pressure of the liquid is equal to the atmospheric pressure.
(b) The vapour pressure of the liquid is less than the atmospheric pressure.
(c) The vapour pressure of the liquid is greater than the atmospheric pressure.
(d) The vapour pressure of the liquid is equal to the square root of the atmospheric pressure.
46. For normalized wave function $\Psi \rightarrow 0$ as $r \rightarrow \text{————}$.
- (a) 0. (b) 1.
(c) α . (d) -1 .
47. ——— principle states that the actual path taken by the light ray is one which minimizes the integral.
- (a) Heisenberg. (b) Hamilton's.
(c) Maupertuis. (d) Fermat's.

48. The operator ∇ is called _____ operator.

- (a) Hamiltonian. (b) Laplacian.
(c) Poisson. (d) Vector.

49. The square of the magnitude of the wave function is called _____.

- (a) Current density. (b) Probability density.
(c) Zero density. (d) Volume density.

50. The Non-normalized wave function must have _____ norm.

- (a) Infinite. (b) Zero.
(c) Finite. (d) Complex.

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