

(Time: 3 Hours)

Total marks: 100

N.B. (1) All Questions are compulsory.

(2) Figures to the right indicate full marks.

(3) Use of the logarithmic table / non-programmable calculator is allowed.

Q.1. Answer Any Four of the following: -

- (A) Discuss the following symmetry elements with one example each. 5
(a) centre of symmetry (b) identity
- (B) Discuss the constituents of point group with reference to boron trichloride molecule. 5
- (C) (a) Compare homonuclear and heteronuclear diatomic molecules. 3
(b) What is point group? 2
- (D) Draw the molecular orbital diagram for CO (without mixing of orbitals) and explain its bond order. 5
- (E) Draw the molecular orbital energy level diagram for BeH_2 . 5
- (F) Write note on structure of H_3^+ ion on the basis of molecular orbital theory. 5

Q.2. Answer Any Four of the following: -

- (A) What do you understand by packing density or atomic packing factor? Show that packing factor for the bcc structure is $\sqrt{3} \pi/8$ or 68%. 5
- (B) Show that the packing factor for fcc lattice is $\sqrt{2} \pi/6$ or 74%. 5
- (C) Platinum crystallises in face centered cubic (fcc) crystal with a unit length of 3.9231 \AA . Calculate the density and atomic radius of platinum. 5
(Mass of 1 mol. of Pt is 195.08)
- (D) Define the following terms in crystal structure study.
(a) space lattice 3
(b) lattice points 2
- (E) Give the applications of superconducting materials. 5
- (F) (a) With a neat diagram, discuss Meissner effect. 3
(b) Differentiate between Schottky and Frenkel defects. 2

Q.3. Answer Any Four of the following: -

- (A) Discuss the position of lanthanides in the periodic table. Give observed electronic configurations of Cerium, Gadolinium, Terbium and Lutecium. 5
- (B) Explain magnetic properties exhibited by lanthanides. 5
- (C) How are lanthanides separated from each other by solvent extraction method? 5
- (D) What is lanthanide contraction? Explain its consequences on the members of the periodic table. 5
- (E) Write a note on complex formation tendency of lanthanides. 5
- (F) Give any five applications of lanthanides. 5

Q.4. Answer **Any Four** of the following: -

- (A) What are protonic and aprotic solvents? Explain with suitable examples. 5
- (B) With reference to liquid ammonia as nonaqueous solvent, give balanced equations for (i) Acid-base reactions, (ii) Redox reactions. 5
- (C) Explain trends in the physical properties of group 16 elements with regard to (i) metallic & non-metallic character, (ii) oxidation states. 5
- (D) What is allotropy? Explain in brief allotropic modifications of the members of group 16. 5
- (E) Discuss anomalous behavior of fluorine. 5
- (F) Explain with diagram, structure and bonding in (i) Hypochlorite ion (ClO^-) 5
(ii) Chlorite ion (ClO_2^-)

Q.5. A. State whether the following statements are **true** or **false**: - 5
(Attempt any **five**)

- (a) The rotation axis C_n for water is C_2 .
- (b) The symbol C_n means; C is cycle and n is order of axis.
- (c) Ammonia molecule belongs to C_{3v} point group.
- (d) Atomic orbitals are monocentric and molecular orbitals are polycentric.
- (e) NO molecule is diamagnetic in nature.
- (f) In HCl molecule, the 3p orbital of chlorine involved in bonding is $3p_x$.
- (g) The photoelectron spectrum of H_2O shows two bands.
- (h) The diagrams which show the change in energy of molecular orbitals with variation in bond angle are called molecular orbital diagrams.

B. Fill in the blanks with appropriate words given in the bracket: - 5
(Attempt any **five**)

- (smallest, equidimensional spheres, unit cell, six, coordination number, zero, high temperature, two, biggest, four, low temperature)
- (a) Unit cell is the _____ geometrical portion of the crystal which can be used to build up the whole crystal.
 - (b) Closest packing is the way of arranging _____ in space so that available space is filled up effectively.
 - (c) Atomic packing factor (APF) is defined as the fraction of space occupied by atoms in a _____.
 - (d) In two dimensions closest packing, each sphere is in contact with other _____ sphere.
 - (e) The number of nearest neighbours for an atom is called _____.
 - (f) $\text{YBa}_2\text{CH}_3\text{O}_{7.8}$ is an example of _____ superconductors.
 - (g) Critical temperature is a temperature below which material shows _____ resistance.

C. Select and write appropriate answer:- (**Attempt Any Five**) 5

- (a) In addition to +3 oxidation state terbium also exhibits _____ oxidation state.
(i) +2 (ii) +4 (iii) +1
- (b) Electronic configuration of Uranium is _____.
(i) $[\text{Rn}]5f^16d^17s^2$ (ii) $[\text{Rn}]5f^76d^07s^2$ (iii) $[\text{Rn}]5f^36d^17s^2$

(c) Pr^{3+} ions exhibit _____ colour.

(i) Reddish (ii) Yellow (iii) Green

(d) Yb^{2+} is isoelectronic with _____.

(i) Lu^{3+} (ii) La^{3+} (iii) Gd^{3+}

(e) Absorption spectra of lanthanides are _____.

(i) diffused, band like (ii) sharp, line like (iii) sharp, band like

(f) Cerium is very stable in _____ oxidation state.

(i) +1 (ii) +2 (iii) +4

(g) _____ is colourless in +3 oxidation state.

(i) Neodymium (ii) Gadolinium (iii) Dysprosium

(h) Only lanthanide member which is radioactive is _____.

(i) samarium (ii) thulium (iii) promethium

D. Match the columns:- (**Attempt Any Five**)

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(a) Ionising solvent

(b) Liquid dinitrogen tetroxide

(c) Manufacture of Sulphuric acid

(d) Non-ionising solvent

(e) ClF_3

(f) IF_7

(g) Highest electronegativity

(i) Contact process

(ii) Haber's process

(iii) Pentagonal bipyramidal geometry

(iv) H_2O

(v) Fluorine

(vi) Chlorine

(vii) Carbon tetrachloride

(viii) Bent-T structure

(ix) Aprotic solvent