INDIAN SCHOOL MUSCAT
Department Of Chemistry
SUBJECT: CHEMISTRY
CLASS: XII

CASE BASED QUESTIONS

1 The structures of crystalline metals and simple ionic compounds can be described in terms of packing of spheres. Metal atoms can pack in hexagonal close-packed structures, cubic close-packed structures, body-centered structures, and simple cubic structures. The anions in simple ionic structures commonly adopt one of these structures, and the cations occupy the spaces remaining between the anions. Small cations usually occupy tetrahedral holes in a closest-packed array of anions. Larger cations usually occupy octahedral holes. Still larger cations can occupy cubic holes in a simple cubic array of anions. The structure of a solid can be described by indicating the size and shape of a unit cell and the contents of the cell. The type of structure and dimensions of the unit cell can be determined by X-ray diffraction measurements.

i. The unit cell of highest symmetry is
   a) cubic
   b) triclinic
   c) hexagonal
   d) monoclinic

ii. The unit cell of a metallic element of atomic mass 108 and density 10.5 g/cm^3 is a cube with edge length of 409 pm.The structure of the crystal lattice is
   a) FCC
   b) BCC
   c) edge-centred cubic
   d) simple cubic

iii. Atoms of the element 'A' form HCP and atoms of element 'C' occupy only two-third of octahedral voids in it, then the general formula of the compound is
   (a) CA (b) CA_2 (c) C_2A_3 (d) C_3A_2

iv. NaCl is doped with 2×10^{-3} mole % SrCl2, the concentration of cation vacancies is:
   a) 6.02×10^{18} mol^{-1}
   b) 1.204×10^{19} mol^{-1}
   c) 3.01×10^{18} mol^{-1}
   d) 1.204×10^{21} mol^{-1}

v. In a compound, oxide ions are arranged in CCP arrangement. Cations A occupy one sixth of the tetrahedral voids and cations B occupy one-third of the octahedral voids. The formula of the compound is
   (a) AB_2O_4 (b) ABO_3 (c) ABO_2 (d) ABO_4

2. Properties of a solution that depend only on the concentration of solute particles are called colligative properties. They include changes in the vapor pressure, boiling point, and freezing point of the solvent in the solution. The magnitudes of these properties depend only on the total concentration of solute particles in solution, not on the type of particles .The total concentration of solute particles in a solution also determines its osmotic pressure. This is the pressure that must be applied to the solution to prevent diffusion of molecules of pure solvent through a semipermeable membrane into the solution.

   i. The solution containing 4.0 g of PVC in 1 L of dioxane was found to have osmotic pressure of 0.006 atm at 300 K. The molecular mass of the polymer PVC is
   (a) 16,420 u (b) 1642 u (c) 1,64,200 u (d) 4105 u

   ii. The molal boiling point elevation constant of water is 0.513°C kg mol^{-1}. When 0.1 mole of sugar is dissolved 200 g of water, the solution boils under a pressure of 1 atm at
   (a) 100.513°C (b) 102.565°C (c) 100.256°C (d) 101.025°C

   iii. When the depression in freezing point is carried out, the equilibrium exist between
   (a) liquid solvent and solid solvent (b) liquid solute and solid solvent
   (c) liquid solute and solid solute (d) liquid solvent and solid solute

   iv. The vapour pressure of pure benzene at 88°C is 960 mm and that of toluene at the same temperature is 380 mm of benzene. At what mole fraction of benzene, the mixture will boil at 88°C?
   (a) 0.655 (b) 0.345 (c) 0.05 (d) 0.25

3. Conductance measurements are frequently employed to find the end points of acid-base and other titrations. The principle involved is that electrical conductance of a solution depends upon the number and mobility of ions. In the conductometric titrations, the conductance of the resulting solution is measured at different stages on adding some volume of the standard solution and then a graph is plotted from the experimental observations to get the end point. Conductometric titrations have several advantages. Coloured solutions, titration of weak acid and weak base, etc. cannot be titrated by normal methods, but can be titrated successfully by this method. Further, no special care is needed in titration because the end point is determined graphically.

   i. Which process occurs in the electrolysis of an aqueous solution of nickel chloride at nickel anode?
   (a) $Ni \rightarrow Ni^{2+} + 2e-$
   (b) $Ni^{2+} + 2e^- \rightarrow Ni$
   (c) $2Cl^- \rightarrow Cl_2 + 2e^-$
   (d) $2H^+ + 2e^- \rightarrow H_2$

   ii. For the cell $Zn \mid Zn^{2+} \parallel Cu^{2+} \mid Cu$, if the concentration of both, Zn^{2+} and Cu^{2+} ions are doubled, the EMF of the cell
   (a) doubles (b) reduces to half (c) remains same (d) becomes zero

   iii. Which of the following option will be the limiting molar conductivity of CH3COOH if the limiting molar conductivity of CH3COONa is 91 Scm^2mol^{-1}? Limiting molar

conductivity for H^+ ,Na^+K^+ and OH^- are349.6,50.1,73.5 and 199.1 Scm^2mol^{-1} respectively.

a) 350 Scm^2mol^{-1} b) 375.3 Scm^2mol^{-1} c) 390.5 Scm^2mol^{-1} d) 340.4 Scm^2mol^{-1}

In the following questions ,a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

iv. **Assertion:** The conductivity of metals decreases while that of electrolytic solution increases with increase in temperature.
Reason: Electrons in metals are very tightly held by the nucleus and are not free to move.

v. Assertion: The cell constant of a conductivity cell depends on the nature of the material of the electrodes.
Reason:The electrodes of the cell are coated with Platinum black to avoid polarisation effects

4. Rate laws provide a mathematical description of how changes in the amount of a substance affect the rate of a chemical reaction. Rate laws are determined experimentally and cannot be predicted by reaction stoichiometry. The order of reaction describes how much a change in the amount of each substance affects the overall rate, and the overall order of a reaction is the sum of the orders for each substance present in the reaction. Reaction orders are typically first order, second order, or zero order, but fractional and even negative orders are possible. Differential rate laws can be determined by the method of initial rates or other methods. We measure values for the initial rates of a reaction at different concentrations of the reactants. From these measurements, we determine the order of the reaction in each reactant. Integrated rate laws are determined by integration of the corresponding differential rate laws. Rate constants for those rate laws are determined from measurements of concentration at various times during a reaction.

i. The time taken in 75% completion of a zero-order reaction is 10 h. In what time, the reaction will be 90% completed?
(a) 12.0 h (b) 16.6 h (c) 10.0 h (d) 20.0 h

ii. For the first-order reaction t 99% = x × t 90%. The value of 'x' will be
(a) 10 (b) 6 (c) 3 (d) 2

iii. The rate of change in concentration of *C* in the reaction $2A + B \rightarrow 2C + 3D$ was reported as
1.0 mol L^{-1} sec^{-1} Calculate the reaction rate:
(a) 0.05 mole L^{-1} sec^{-1} (b) 0.01 mol L^{-1} sec^{-1}
(c) 0.5 mol L^{-1} sec^{-1} (d) None of these

iv. For a chemical reaction $A + 3B \rightarrow$ Product It was observed that rate of reaction increases nine times when concentration of *B* increased three times by keeping concentration of *A* as constant.On doubling concentration of both rate increases eight times. Differential rate equation can be given as

(a) $r = k[A][B]^3$ (b) $r = k\,[A]\,[B]^2$ (c) $r = k[A]^2[B]$ (d) $r = k[A]^2[B]^{1/3}$

5. Adsorption is a spontaneous process and involves unequal distribution of the molecules of the gaseous substance on the surface and the bulk of the solid or liquid. Adsorption of gases on solids is generally controlled by factors like temperature, pressure etc. In colloids, even the sol particles acquire positive or negative charge by preferential adsorption of positive or negative ions. Colloidal medicines are more effective because they have more surface area and are therefore easily assimilated.

(a)Give the empirical relationship between the quantity of gas adsorbed by a given mass of solid absorbent and pressure at a particular temperature.

(b)Name the process in which a colloid is produced by dispersion followed by condensation.

(c)What happens when a freshly prepared precipitate of Fe(OH)3 is shaken with small amount of $FeCl_3$ solution.

(d)What ion is preferentially adsorbed by AgI colloid when drops of AgNO3 solution is added to excess of KI solution?

(e)Which of the following gases is adsorbed by charcoal to maximum extent?

N_2, CO_2, He, O_2

6. The p-block elements are found on the right side of the periodic table. Group 16 elements are called as chalcogens. Halogens are highly reactive elements having strong affinity for hydrogen. But noble gases are inert gases which are monoatomic .The compounds of xenon exhibit rich stereochemistry and their geometries can be explained on the basis of VSEPR theory as well as the concept of hybridization.
   i. What happens when HCl is added to MnO_2?
   ii. XeF_6 on partial hydrolysis gives_____
   iii. Give the name of a xenon compound which is isostructural with ICl_4^-.
   iv. What happens when SO_2 is passed through an aqueous solution of Fe(III) salt?
   v. Draw the shape of BrF_5 using VSEPR theory.
7. The d block of the periodic table contains the elements of the groups 3-12 in which the d orbitals are progressively filled in each of the four long periods. Transition elements show variable oxidation states, form alloys, coloured ions, complexes and interstitial compounds. They can also act as good catalyst. They have high enthalpies of atomization and high melting and boiling points

   i. Transition metals have great tendency for complex formation. Why?
   ii. Name a transition element which does not exhibit variable oxidation state.
   iii. Zn^{2+} salts are white while Cu^{2+} salts are coloured.

iv. Ce in + 4 state is oxidizing why?

8. When degenerate d-orbitals of an isolated atom/ion are brought under the impact of magnetic field of ligands, the degeneracy is lost. The two newly formed sets of d-orbitals, depending upon nature and magnetic field of ligands are either stabilized or destabilized. The energy difference between the two sets whenever lies in the visible region of the electromagnetic spectrum, then the electronic transition t_2g to eg are responsible for colours of the co- ordination compounds

(i)Ti^{3+}(aq) is purple while Ti^{4+}(aq) is colourless because
(a) The difference between t_2g and eg of Ti^{4+} is quite high and does not fall in visible region.
(b) There is no crystal field effect in Ti^{4+}
(c) Ti^{4+} has d^0 configuration.
(d) Ti^{4+} is very small ion than Ti^{3+} and does not adsorb any radiation.

ii)Which of the following complex ions will be coloured in aqueous solution?
(a) $[Ni(CN)_4]^{2-}$
(b) $[Ni(H_2O)_6]^{2+}$
(c) $[Sc(H_2O)_6]^{3+}$
(d) Both (b) and (c)
iii)Calculate the oxidation number and coordination number of central atom in $[Co(C_2O_4)_3]^{3-}$.
iv)Write the IUPAC name of $[Co(CN)_2(NH_3)_4]C\ell$

9. The substitution reaction of alkyl halide mainly occurs by S_N1 or S_N2 mechanism. Whatever mechanism alkyl halides follow for the substitution reaction to occur, the polarity of the carbon halogen bond is responsible for these substitution reactions. The rate of S_N1 reactions are governed by the stability of carbocation whereas for S_N2 reactions steric factor is the deciding factor. If the starting material is a chiral compound,we may end up with an inverted product or racemic mixture depending upon the type of mechanism followed by alkyl halide. Cleavage of ethers with HI is also governed by steric factor and stability of carbocation, which indicates that in organic chemistry, these two major factors helpus in deciding the kind of product formed.

i. Predict the major product formed when 2-Bromopentane reacts with alcoholic KOH.
ii. Predict the stereochemistry of the product formed if an optically active alkyl halide undergoes substitution reaction by S_N1 mechanism.
iii. Electrophilic reactions in haloarenes occur slowly. Why ?
iv. Arrange the following compounds in the increasing order of reactivity towards SN2 reaction, CH_3Cl, CH_3CH_2Cl, $(CH_3)_2CHCl$ and $(CH_3)_3CCl$

10. Phenol is a weaker acid than the carboxylic acid ;hence it dissolves only in strong bases like NaOH,but not in weak bases like $NaHCO_3$.It reacts with acid chlorides and acid anhydrides in the absence of $AlCl_3$ to form esters.As far as electrophilic substitution in phenol is concerned the –OH is an activating group,hence its presence enhances the electrophilic substitution in ortho and para positions.

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(i)Assertion: Phenols are more acidic than aliphatic alcohols.
Reason: The phenoxide ion is more resonance stabilised than alkoxide ion.
(ii) Assertion (A) : o-nitrophenol is a weaker acid than p-nitrophenol.
Reason (R) : Intramolecular hydrogen bonding makes ortho isomer weaker than para isomer

(iii) Assertion : Like bromination of benzene, bromination of phenol is also carried out in the presence of Lewis acid
Reason :- OH group is an activating group
(iv) Assertion : Bond angle in ethers is slightly less than the tetrahedral angle.
Reason : There is a repulsion between the two bulky (—R) groups

11. Catalytic hydrogenation of carbonyls leads to an addition product in which hydrogen gas is added across the carbonyl double bond.To do this, we use a special catalyst called Raney nickel to form the corresponding alcohol. Both acetals and ketals are very stable to strong bases and nucleophiles, but they can be easily converted back into their ketone or aldehyde counterpart using acidic hydrolysis, essentially reversing the reaction by adding water. These characteristics make acetals and ketals useful as protecting groups in synthesis, masking reactive carbonyl sites that can be unmasked later after chemically modifying other regions of a molecule

i. Which of the following does not undergo Hell-volhard Zelinsky reaction ?
(a) HCOOH (b) CCl_3COOH (c) C_6H_5COOH (d) All

ii. Product in following reaction is : CH3MgI + HCHO→ Product
(a) CH_3CHO (b) CH_3OH (c) C_2H_5OH (d) $CH_3 – O – CH_3$

iii. Reagent that can distinguish a set of benzaldehyde and formaldehyde is
(a) I_2/NaOH (b) Tollens' reagent (c) Fehling's solution (d) Baeyer's reagent

iv. Among the following the order of reactivity toward nucleophilic addition is
(a) $HCHO > CH_3CHO > CH_3COCH_3$
(b) $CH_3CHO > HCHO > CH_3COCH_3$
(c) $CH_3CHO > CH_3COCH_3 > CH_3COCH_3$
(d) $CH_3COCH_3 > CH_3CHO > HCHO$

v. On warming with I_2 and aqueous NaOH, iodoform and sodium succinate are formed. The formula of the compound should be
(a) $CH_3COCH_2CH_2CH_3$
(b) $CH_3COC_6H_5$
(c) $CH_3 – CO –CH_2 – CH_2 – COOH$
(d) $CH_3COCH_2CH_2COCH_3$

12. Amines are derivatives of the inorganic compound ammonia, NH_3. Naturally occurring amines include the alkaloids, which are present in certain plants; Amines are classified as primary, secondary, or tertiary depending on whether one, two, or three of the hydrogen atoms of ammonia have been replaced by organic groups. Most aliphatic amines are not highly toxic, and many are harmless, natural components of foods and pharmaceuticals. Ammonia is a fairly good nucleophile, and it can be coerced to react by S_N2 reaction with a primary or methyl alkyl halide like ethyl chloride. When mixed, a nucleophilic substitution reaction takes place, generating a primary amine and one mole of hydrochloric acid. So, here we run into a potential problem. The product amine is also nucleophilic and, in theory, can react with yet another alkyl halide to form a secondary amine, which could again react to form a tertiary alkyl halide .

i. Aniline is a weaker base than ethyl amine because
   a) Phenyl group in aniline is a +R group
   b) Ethyl group in ethyl amine decreases the electron density on nitrogen atom
   c) The lone pair of electron on nitrogen atom in aniline is delocalized over aniline.
   d) Aniline is less soluble in water than ethylamine

ii. The product formed by the reaction of acetamide with bromine in presence of NaOH is
   a) CH_3CN b) CH_3CHO c) CH_3CH_2OH d) CH_3NH_2

iii. Out of the following, the strongest base in aqueous solution is
   a) Methylamine b) Dimethylamine c) Trimethylamine d) Aniline

iv. N-Ethyl pthalimide on hydrolysis gives:
   (a) Methyl alcohol (b) Ethyl amine (c) Dimethyl amine (d) Diethyl amine

13. Biomolecules are the organic compounds present as essential constituents in different cells of living organisms. Biomolecules include carbohydrates, proteins, fats or lipids, nucleic acids and their derivatives. Bio chemistry deals with chemical composition, structure of living organisms and chemical changes occurring with them. The main function of carbohydrates is to support the plant structure (cellulose), and to store chemical energy .Amino acids are bifunctional having – COOH and – NH_2 groups. Depending upon the position, they may by α-amino acids, β, γ, or δ-amino acids. There are about 20 α - amino acids, commonly found in proteins.

(i)Which statements are correct about peptide bond?
(1) –CONH– group is planar
(2) C–N bond length in protein is longer than usual bond length of C–N bond
(3) C–N bond length in protein is smaller than usual bond length of C–N bond
(a) 2 and 3 (b) 1 and 2 (c) 2 only (d) 1 and 3

(ii)Which of the following amino acid is optically inactive?
(a) phenyl amine (b) asparagine
(c) glutamic acid (d) glycine

(iii)In addition to aldehyde group glucose contains
(a) one secondary OH and four primary OH groups

(b) one primary OH and four secondary OH groups
(c) two primary OH and three secondary OH groups
(d) three primary OH and two secondary OH groups

(iv)In both DNA and RNA heterocyclic base and phosphate ester linkages are at
(a) C_5' and C_2' respectively of the sugar molecule
(b) C_2' and C_5' respectively of the sugar molecule
(c) C_1' and C_5' respectively of the sugar molecule
(d) C_5' and C_1' respectively of the sugar molecule