DAV PUBLIC SCHOOL, MCL,KALINGA AREA

PRACTICE PAPER - 04

CHEMISTRY

Time : **3 hrs**

Max. Marks : **70**

Instructions

1. There are 33 questions in this question paper. All questions are compulsory.
2. **Section A :** Q. no. 1-2 are case-based questions having four MCQs or Assertion-Reason type based on given passage each carrying 1 mark and Question 3 to 16 are MCQs and Assertion-Reason type questions carrying 1 mark each.
3. **Section B :** Q. no. 17 to 25 are short answer type I questions and carry 2 marks each.
4. **Section C :** Q. no. 26 to 30 are short answer type II questions and carry 3 marks each.
5. **Section D :** Q. no. 31 to 33 are long answer questions carrying 5 marks each.
6. There is no overall choice. However, an internal choices have been provided.
7. Use of calculators and log tables is not permitted.

SECTION A : *Objective Questions*   *(1 Mark)*

Passage Based Questions

1. Read the passage given below and answer the following questions :   (1 × 4 = 4 Mark)

The crystal field theory (CFT) is an electrostatic model which considers the metal-ligand bond to the ionic arising purely from electrostatic interactions between the metal ion and the ligand.

In an octahedral coordination entity with six ligands surrounding the metal atom/ion, there will be repulsion between the electrons in metal d-orbitals and the electrons (or negative charges) of the ligands. Such a repulsion is more when the metal d-orbital is directed towards the ligand than when it is away from the ligand.

Thus, the $d_{x^2-y^2}$ and d_{z^2} orbitals which point towards the axes along the direction of the ligand will experience more repulsion and will be raised in energy and the d_{xy}, d_{zx} and d_{yz} orbitals which are directed between the axes will be lowered in energy relative to the average energy in the spherical crystal field.

Thus, the degeneracy of the d-orbitals has been removed due to ligand-metal electron repulsions in the octahedral complex to yield three orbitals of lower energy, t_{2g} set and two orbitals of higher energy, e_g set. This splitting of the degenerate levels due to the presence of ligands in a definite geometry is termed as crystal field splitting.

The difference of energy between the two sets of degenerate orbitals as a result of crystal field splitting is known as **Crystal Field Stabilisation Energy** (CFSE), it is denoted by Δ_o (the subscript o is for octahedral). Thus, the energy of the two e_g orbitals will increase by $(3/5)\Delta_o$ and that of the three t_{2g} will decrease by $(2/5)\Delta_o$.

The following questions (i-iv) are multiple choice questions. Choose the most appropriate answer :

(i) Which one of these statements about $[Co(CN)_6]^{3-}$ is correct?

(a) $[Co(CN)_6]^{3-}$ has no unpaired electrons and will be in a low-spin configuration.

(b) $[Co(CN)_6]^{3-}$ has four unpaired electrons and will be in a low-spin configuration.

(c) $[Co(CN)_6]^{3-}$ has four unpaired electrons and will be in a high-spin cofiguration.

(d) $[Co(CN)_6]^{3-}$ has no nupaired electrons and will be in a high-spin configuration.

(ii) Among the ligands NH_3, en, CN^- and CO, the correct order of their increasing field strength, is

(a) $CO < NH_3 < en < CN^-$

(b) $NH_3 < en < CN^- < CO$

(c) $CN^- < NH_3 < CO < en$

(d) $en < CN^- < NH_3 < CO$

(iii) Identify the correct trend given below (Atomic number, Ti = 22, Cr = 24 and Mo = 42)

(a) Δ_o of $[Cr(H_2O)_6]^{2+} < [Mo(H_2O)_6]^{2+}$ and Δ_o of $[Ti(H_2O)_6]^{3+} < [Ti(H_2O)_6]^{2+}$

(b) Δ_o of $[Cr(H_2O)_6]^{2+} > [Mo(H_2O)_6]^{2+}$ and Δ_o of $(Ti(H_2O)_6)^{2+} > [Mo(H_2O)_6]^{2+}$

(c) Δ_o of $[Cr(H_2O)_6]^{2+} > [Mo(H_2O)_6]^{2+}$ and Δ_o of $[Ti(H_2O)_6]^{2+} < [Mo(H_2O)_6]^{2+}$

(d) Δ_o of $[Cr(H_2O)_6]^{2+} < [Mo(H_2O)_6]^{2+}$ and Δ_o of $[Ti(H_2O)_6]^{3+} > [Ti(H_2O)_6]^{2+}$

Or

Crystal field stabilisation energy for high spin d^4 octahedral complex is

(a) $-0.6\Delta_o$ (b) $-1.8\Delta_o$ (c) $-1.6\Delta_o + P$ (d) $-1.2\Delta_o$

(iv) The CFSE for octahedral $[CoCl_6]^{4-}$ is $18{,}000\ cm^{-1}$. The CFSE for tetrahedral $[CoCl_4]^{2-}$ will be

(a) $18000\ cm^{-1}$ (b) $16000\ cm^{-1}$

(c) $8000\ cm^{-1}$ (d) $20000\ cm^{-1}$

2. *Read the passage given below and answer the following questions :*   (1×4=4 Mark)

Conductivity always decreases with decrease in concentration (i.e. with dilution) of both the strong and weak electrolytes. This is due to the fact that the number of ions that carry current in a unit volume of solution always decreases with decrease in concentration.

The conductivity of a solution is the conductances of a unit volume of the solution, kept between two platinum electrodes with unit area of cross-section and at a distance of unit length, while the molar conductivity is the conductance of that volume of the solution which contains one mole of the electrolyte.

Conductivity is expressed as :

$$G = \frac{\kappa A}{l} = \kappa$$

(both A and l are unity in their appropriate units in m or cm).

While molar conductivity is expressed is $\Lambda_m = \kappa V$

It is because $\Lambda_m = \frac{\kappa A}{l}$

$\because l = 1$ and $A = V$ [volume containing 1 mole of electrolyte]

Therefore, $\Lambda_m = \kappa V$

Molar conductivity increases with decrease in concentration (i.e. with dilution). This is because the total volume V solution containing one mole of electrolyte also increases.

In these questions (i-iv) 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.

(i) **Assertion** Conductivity always increases with decrease in concentration for strong and weak electrolytes.

Reason Number of ions per unit volume decreases on dilution.

(ii) **Assertion** Conductivity of pure water is 3.5×10^{-5} S m^{-1}.

Reason High amounts of hydrogen ions and hydroxyl ions are present in water.

(iii) **Assertion** Conductivity of electrolytes decreases when dissolved in water.

Reason They furnish their own ions.

(iv) **Assertion** Conductivity of strong electrolytes decreases on dilution.

Reason On dilution number of ions per unit volume decreases.

Or

Assertion Λ_m for weak electrolytes shows a sharp increase, when the electrolytic solution is diluted.

Reason For weak electrolytes degree of dissociation increases with dilution of solution.

Multiple Choice Questions

Following questions (No. 3-11) are multiple choice questions carrying 1 mark each :

3. In an alkaline medium, glycine predominantly exists as an
   (a) cation
   (b) anion
   (c) Zwitter ion
   (d) covalent form

4. Which of the following does not affect half-life of first order reaction?
   (a) Initial concentration
   (b) Catalyst
   (c) Temperature
   (d) Pressure

5. A student accidentally splashes few drops of conc. H_2SO_4 on his cotton shirt. After a while, the splashed parts get blackened and the holes appear. This happens because sulphuric acid
   (a) heats up the cotton
   (b) removes the elements of water from cotton
   (c) causes the cotton to react with water
   (d) dehydrates the cotton with burning

Or

Electronic configuration of group 17 elements is
   (a) $ns^2 np^5$
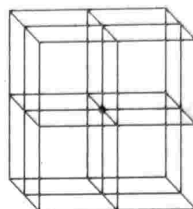   (b) $ns^2 np^6$
   (c) $ns^2 np^4$
   (d) $ns^2 np^3$

6. The standard reduction potentials of several ions are as follows:

S.No.	Ions	E°
1.	Ca^{2+}	-2.87
2.	Fe^{3+}	0.77
3.	Co^{3+}	1.82
4.	Zn^{2+}	-0.76

The strongest reducing agent among the following ions is
   (a) Co^{3+}
   (b) Zn^{2+}
   (c) Ca^{2+}
   (d) Fe^{3+}

7. Consider the following

In the above figure, structure of unit cell represent that each corner atom is shared between
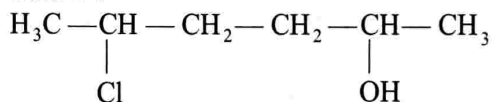   (a) 8 unit cell
   (b) 6 unit cell
   (c) 4 unit cell
   (d) 2 unit cell

Or

Contribution of each atom per unit cell at face centre in a fcc unit cell is
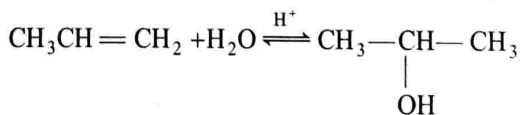   (a) 1
   (b) 2
   (c) 0.5
   (d) 2.5

8. Give IUPAC name of the compound given below :

$$H_3C - CH - CH_2 - CH_2 - CH - CH_3$$
$$\qquad\;\; | \qquad\qquad\qquad\qquad |$$
$$\qquad\;\; Cl \qquad\qquad\qquad\quad\; OH$$

   (a) 5-chlorohexan-2-ol
   (b) 2-chlorohexan-5-ol
   (c) 2-hydroxy-5-chlorohexane
   (d) 2-chloro-5-hydroxyhexane

Or

Alkenes react with water in the presence of acid as catalyst to form alcohols.

$$CH_3CH = CH_2 + H_2O \xrightarrow{H^+} CH_3 - CH - CH_3$$
$$\qquad\qquad\qquad\qquad\qquad\qquad\qquad |$$
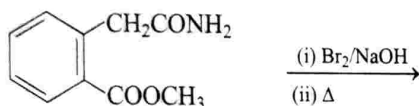$$\qquad\qquad\qquad\qquad\qquad\qquad\quad OH$$

The reaction takes place in accordance with
   (a) Hoffmann elimination rule
   (b) Saytzeff rule
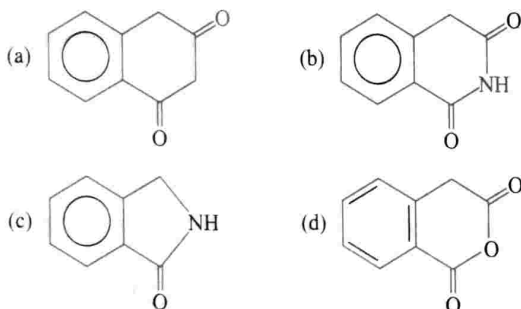   (c) Markownikoff's rule
   (d) Anti-Markownikoff's addition

9. Identify the primary alcohol among the given options.

(a)

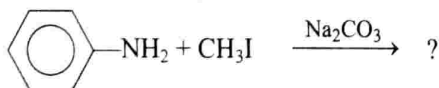(b) $CH_3-\overset{\overset{\displaystyle CH_3}{|}}{\underset{\underset{\displaystyle CH_3}{|}}{C}}-CH_2OH$

(c)

(d)
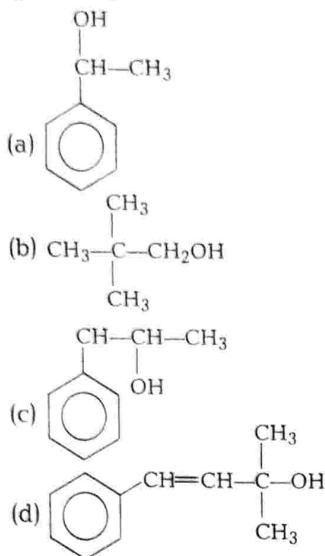
10. In the given reaction,

$$\xrightarrow[\text{(ii) }\Delta]{\text{(i) }Br_2/NaOH}$$

What would be the final product formed?

(a)   (b)

(c)   (d)

Or

What is the final alkylation product in the given reaction?

$$\xrightarrow{Na_2CO_3} \ ?$$

(a) N, N, N-trimethylanilinium iodide
(b) N, N, N-trimethylanilinium carbonate
(c) N, N-dimethylanilinium iodide
(d) N, N-dimethylanilinium carbonate

11. Which of the following is the starting material use for the industrial preparation of phenol ?
(a) Anisole   (b) Resorcinol
(c) Cumene   (d) o-cresol

Assertion-Reason

12. Assertion Benzaldehyde on heating with concentrated alkali give α, β-unsaturated carbonyl compound.

Reason Benzaldehyde do not have any α-hydrogen atom.

13. Assertion All alkylbenzenes yield benzoic acid on vigorous oxidation with alkaline $KMnO_4$.

Reason The entire side chain of the aromatic compound is oxidised to a —COOH group irrespective of the length of the carbon chain.

Or

Assertion A bright silver mirror is produced during the warming of an aldehyde with freshly prepared ammoniacal silver nitrate solution.

Reason A bright silver mirror is produced due to the formation of silver metal.

14. Assertion In close packing of spheres, a tetrahedral void is surrounded by four spheres whereas an octahedral void is surrounded by six spheres.

Reason A tetrahedral void has a tetrahedral shape whereas an octahedral void has an octahedral shape.

15. Assertion Neopentyl chloride is formed when neopentyl alcohol reacts with HCl.

Reason Neopentyl alcohol is a primary alcohol.

16. Assertion S_N1 mechanism is ruled out in case of haloarene.

Reason Phenyl cation is formed as a result of self ionisation which is not stabilised by resonance.

SECTION B : Short Answer Type I Questions (2 Marks)

17. Compound 'A' on reaction with $(CH_3CO)_2O$ and NaOH gives acetanilide which on bromination gives compound 'B' which on hydrolysis gives compound 'C'. Identify A, B and C.

Or Account for the following:
  (i) pK_b of aniline is more than that of methylamine.
  (ii) Ethylamine is soluble in water whereas aniline is not.

18. Explain, why the melting points and solubility of amino acids in water are generally higher than that of the corresponding haloacids?

19. A first order reaction takes 40 min for 30% decomposition. Calculate $t_{1/2}$.

20. How will you carry out the following conversion :
  (i) Aniline to benzyl alcohol
  (ii) Benzene to m-bromophenol

21. Account for the following :
  (i) Noble gases have very low boiling point. Why?.
  (ii) SF_6 is inert towards hydrolysis. Why?
        Or
Given reason :
  (i) Electron gain enthalpies of halogens are largely negative.

  (ii) Thermal stability decreases from H_2O to H_2Te

22. What are interstitial compounds? Why are such compounds well known for transition metals.

23. $FeSO_4$ solution mixed with $(NH_4)_2SO_4$ solution in $1:1$ molar ratio gives the test of Fe^{2+} ion but $CuSO_4$ solution mixed with aqueous ammonia in $1:4$ molar ratio does not give the test of Cu^{2+} ion. Why?

24. Knowing the electron gain enthalpy values of $O \longrightarrow O^-$ and $O \longrightarrow O^{2-}$ as -141 and 702 kJ mol^{-1} respectively, how can you account for the formation of a large number of oxides having O^{2-} species not O^-?
        Or
  (i) What prompted Bartlett to the discovery of noble gas compounds?
  (ii) State two important uses of noble gases.

25. An element occurs in bcc structure. It has a cell edge length of 250 pm. Calculate the molar mass if its density is 8.0 g cm^{-3}. Also, calculate the radius of an atom of this element.

SECTION C : Short Answer Type II Questions (3 Marks)

26. Define the following :
  (i) Wurtz-Fittig reaction
  (ii) Fittig reaction
  (iii) Swarts reaction
        Or
Complete the following reactions:
  (i) $CH_3CH_2Cl \xrightarrow{KCN} (A) \xrightarrow{2H_2O/H^+} (B)$
  (ii) $CH_3CH_2CH_2Br \xrightarrow[\Delta]{Alc.\ KOH} (A) \xrightarrow{HBr} (B)$

27. One gram of charcoal adsorbs 100 mL of 0.5 M acetic acid to form a monolayer and the molarity of acetic acid reduces to 0.49. Calculate the surface area of

charcoal adsorbed by each molecule of acetic acid. The total surface area of charcoal is $3.01 \times 10^2 m^2$.

28. (i) Give chemical tests to distinguish between the following pairs of compounds.
    (a) Propanal and propanone
    (b) Acetophenone and benzophenone.
  (ii) Arrange the following compounds in increasing order of reactivity towards HCN.

Acetaldehyde, acetone, di- $tert$-butylketone, methyl-$tert$-butylketone.

29. (i) What is the order of following reaction?

$$N_2O_5(g) \rightleftharpoons N_2O_4(g) + \frac{1}{2}O_2(g)$$
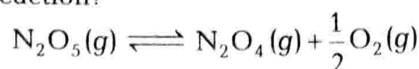
(ii) Sucrose decomposes in acid solution into glucose and fructose according to the first order rate law, with $t_{1/2} = 3$ h. What fraction of sample of sucrose remains after 8h ?

Or (i) What are pseudo first order reactions? Give one example of such reactions.

(ii) The decomposition of phosphine, PH_3 proceeds according to the following equation.

$$4PH_3(g) \longrightarrow P_4(g) + 6H_2(g)$$
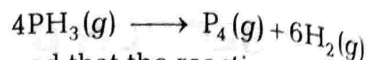
It is found that the reaction follows the following rate equation,

$$Rate = k[PH_3]$$

The half-life of PH_3 is 37.9 s at 20°C.

(a) What fraction of original sample of PH_3 remains behind after 1 min?

(b) How much time is required of 3/4th of PH_3 to decompose?

30. Show how will you synthesise

(i) cyclohexyl methanol using an alkyl halide by S_N2 mechanism?

(ii) pentan-1-ol using an alkyl halide?

SECTION D : Long Answer Type Questions (5 Marks)

31. (i) A transition metal A has "spin only" magnetic moment value of 1.8 BM. When it is reacted with dil. H_2SO_4 in the presence of air, a compound B is formed. B reacts with compound C to give compound D with liberation of iodine. Determine metal A, B, C and D.

(ii) Describe the cause of the following variation:

(a) Zn, Cd and Hg normally not regarded as transition elements.

(b) Compounds of transition metals are coloured.

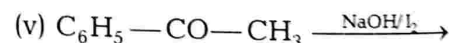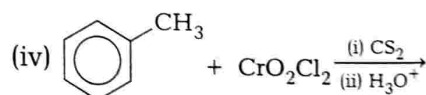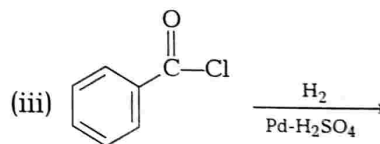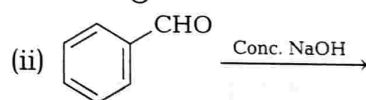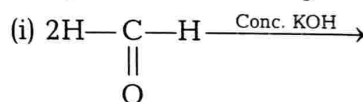(c) Mn^{2+} compounds are more stable than Fe^{2+} compounds towards oxidation to their + 3 state.

Or

(i) What happens when, Europium shows + 2 oxidation state.

(ii) Explain the following:

(a) Among d^4 species, Cr^{2+} is strongly reducing while Mn (III) is strongly oxidising.

(b) Cobalt (II) is stable in an aqueous solution but in the presence of complexing reagents it is easily oxidised.

(c) The d^1-configuration is very unstable in ions.

32. An organic compound A on treatment with acetic acid in the presence of sulphuric acid produces an ester B. A on mild oxidation gives C. C with 50% KOH followed by acidification with dil. HCl generates A and D. D with PCl_5 followed by reaction with NH_3 gives E, which on dehydration produces HCN. Identify A to E.

Or

Complete the following reactions :

(i) $2H-\overset{\overset{\displaystyle O}{\|}}{C}-H \xrightarrow{\text{Conc. KOH}}$

(ii) C₆H₅CHO $\xrightarrow{\text{Conc. NaOH}}$

(iii) $\overset{\overset{\displaystyle O}{\|}}{C}-Cl \xrightarrow[\text{Pd-H}_2\text{SO}_4]{H_2}$

(iv) CH_3 + $CrO_2Cl_2 \xrightarrow[\text{(ii) H}_3\text{O}^+]{\text{(i) CS}_2}$

(v) $C_6H_5-CO-CH_3 \xrightarrow{\text{NaOH/I}_2}$

33. (i) 1000 g of 1 molal aqueous solution of sucrose is cooled and maintained at $-3.534°$ C. Calculate the ice that will separate out at this temperature.

(ii) The solubility of $Ba(OH)_2 \cdot 8H_2O$ in H_2O is 5.6 g per 100 g of H_2O at 288 K. Calculate the molality of hydroxide ion in saturated solution of $Ba(OH)_2 \cdot 8H_2O$ at that temperature.

Or A solution containing 30 g of a non-volatile solute exactly in 90 g of water has a vapour pressure of 2.8 kPa at 298 K. Further, 18 g of water is then added to the solution and the new vapour pressure becomes 2.9kPa at 298K. Calculate

(i) molar mass of the solute

(ii) vapour pressure of water at 298 K.