SAMPLE PAPER – I (SOLVED)

CHEMISTRY – XI

Time : 3 hrs. **M. M. : 70**

General Instructions

(i) All questions are compulsory.

(ii) Marks for each question are indicated against it.

(iii) Question number 1 to 8 are very short answer questions carrying **one** mark each. Answer these in one word or about one sentence.

(iv) Question number 9 to 18 are short answer questions carrying **two** marks each. Answer these in about 30 words.

(v) Question number 19 to 27 are also short answer questions carrying **three** marks each. Answer them in about 40 words.

(vi) Question number 28 to 30 are long answer questions carrying **Five** marks each. Answer them in about 70 words.

(vii) Use log tables, if necessary. Use of calculator is not allowed.

1. The following set of quantum numbers is not possible. Explain, why ?

$$n = 2,\ l = 3,\ m = -3,\ m = +½$$

2. Name a species which is isoelectronic with the following ion :

$$N^{3-}$$

3. For an isolated system $\Delta U = 0$, what will be ΔS ?

4. Explain the structure of CO_2 in terms of resonance.

5. What are the conditions under which gases deviate from ideality.

6. Justify that the following reaction is a redox reaction :

$$H_2O\ (s) + F_2\ (g) \rightarrow HF\ (g) + HOF\ (g)$$

7. Write the IUPAC name of following :

$$CH_2=CH-C\equiv CH$$

8. What is the oxidation state of K in KO_2. 1

9. Write balanced equation for reaction between : $1 \times 2 = 2$

(a) Na_2O_2 and water

(b) Ca metal with HCl

OR

Describe the hybridisation in case of PCl_5. Why are the axial bonds longer as compared to equatorial bonds ? 2

10. (a) Use molecular orbital theory to explain why Be_2 molecule does not exist. 1

(b) Explain the formation of σ and π bonds in C_2H_4 with the help of diagram. Mention the hybrid state of two carbon atoms. 1

11. Calculate the mass of a photon with wavelength 3.6 Å. 2
($h = 6.26 \times 10^{-34}$ JS)

12. Predict the products of electrolysis of an aqueous solution of $AgNO_3$ with silver electrodes. Write reaction that occurs at each electrode. 2

13. Write all the reactions involved in the preparation of sodium carbonate from sodium chloride in Solvay Process. 2

14. Complete the following equations : 2

(a) $Al + NaOH + H_2O \rightarrow$

(b) $H_3BO_3 \xrightarrow{\Delta} A \xrightarrow{\Delta} B$

15. A polluted water sample has been found to have 15 ppm $CHCl_3$ in it.

(a) Express this value in percent by mass.

(b) Determine the molality of chloroform in the water sample. 2

16. An alkene 'A' on ozonolysis gives a mixture of ethanal and pentan-3-one. Write the structure and IUPAC name of A. 2

17. What is the basic principle involved in the following process :

(a) Partition chromatography 1

(b) Distillation under reduced pressure 1

18. (a) Explain why Be and Mg do not give colour to the flame whereas other alkaline earth metals do. 1

(b) Why alkali and alkaline earth metals cannot be prepared by chemical reduction methods ? 1

19. (a) Calculate the concentration of nitric acid in moles per litre in a sample which has a density 1.41 gmL^{-1} and the mass percent of HNO_3 in it being 69%. 2

(b) How many atoms are present in 48u of C ? 1

20. (a) What are degenerate orbitals ? Give example. 1

(b) Show that the circumference of the Bohr's orbit for H atom is an integral multiple of de Broglie's wavelength associated with the electron revolving around the orbit. 2

OR

(a) Mention the difference between electromagnetic wave theory and Planck's quantum theory. 2

(b) How many electrons can have quantum number values $n = 4, m_s = ½$. 1

21. (a) Write the general outer electronic configuration of *f*-block elements. 1

(b) Predict the formula of a compound formed between silicon and oxygen. 1

(c) N has higher ionisation enthalpy than O and why? 1

22. (a) Calculate the total pressure in a mixture of 8 g O_2 and 4 g H_2 confined in a vessel of volume 1 dm^3 at 27°C. (R = 0.083 bar dm^{-3} K^{-1} mol^{-1}). 2

(b) In terms of Charle's law explain why -273.15° C is the lowest possible temperature. 1

23. (a) The species H_2O and NH_3 can act both Bronsted acids and Bronsted Bases. For each give the corresponding conjugate acid and conjugate base. 2

(b) What will be the pH of 0.002 M HCl ? 1

24. (a) Write the expression for Kp for the following reaction : 1

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$$

(b) How will the values of Kp and composition of equilibrium mixture be affected by : 1

(i) increasing the pressure

(ii) using a catalyst

25. (a) ●ut of NH_3, H_2O and HF which would you expect to have highest magnitude of hydrogen bonding and why ? 1

(b) Write chemical equations to justify that H_2O_2 can act as an oxidising agent as well as a reducing agent. 2

26. Give reasons : 3

(a) Why C● is a pois●nous gas ?

(b) Lead(IV) chloride is highly unstable towards heat.

(c) Boric acid is not protic acid.

27. Explain the following terms : 3

(a) Oz●ne hole

(b) B●D

(c) Green chemistry

28. (a) Derive the relationship between Cp and Cv for an ideal gas. 3

(b) Given $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ $\Delta H = -92.4$ kJ/mol.

What is the standard enthalpy of formation of NH_3 gas ?

(c) The equilibrium constant for a reaction is 10. What will be sign of ΔG ? Will this reaction be spontaneous ?

OR

(a) Compare the thermodynamic stabilities of NO and NO_2 from the following data :

$$\frac{1}{2}N_2 + \frac{1}{2}O_2 \rightarrow NO(g) \quad \Delta_r H^{\varnothing} = 90 \text{ k J mol}^{-1}$$

$$NO(g) + \frac{1}{2}O_2 \rightarrow NO_2(g) \quad \Delta_r H^{\varnothing} = -74 \text{ k J mol}^{-1}$$ 1

(b) Write the Born Haber Cycle for the formation of $CaCl_2$ (*s*). 2

(c) For the reaction at 298 K : $2A + B \rightarrow C$

$\Delta H = 400$ kJ mol^{-1} and $\Delta S = 0.2$ kJK^{-1} mol^{-1}

Determine the temperatures at which the reaction would be spontaneous.

29. (a) Give the reactions involved in the estimation of N and Cl by Lassiagene's test. 2

(b) Explain the following with examples : 3

(i) Electrophiles

(ii) Nucleophiles

(iii) Inductive effect

OR

(a) Explain why :

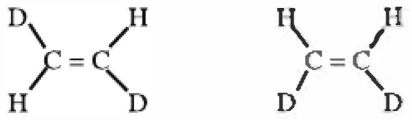
(i) $(CH_3)_3C^+$ is more stable than $CH_3CH_2^+$ and CH_3^+ is the least stable cation.

(ii) On adding $AgNO_3$ to CCl_4 solution, white precipitate of AgCl is not obtained.

(iii) Nitric acid is added to sodium extract before adding $AgNO_3$ for testing halogens.

(b) What is the relationship between the members of following pairs of structures ?

(i) 

(ii) 

30. (a) How will you convert : 3

(i) Benzene to acetophenone

(ii) Benzene to *p*-nitrophenone

(iii) Ethanoic acid to methane

(b) Write IUPAC name of the product obtained by addition reaction of HBr to hex-1-ene in the presence of a peroxide. 1

(c) Hydrogen atoms of ethyne are acidic in nature, why ? 1

OR

(a) Complete the following reactions :

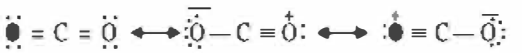
(i)  $+ H_2SO_4 \rightarrow$ (fuming) 1

(ii) $CaC_2 + H_3O \rightarrow$ 1

(iii) $CH_2 = CH_2 + H_2O + O \xrightarrow[273\ K]{\text{dil } KMnO_4}$ 1

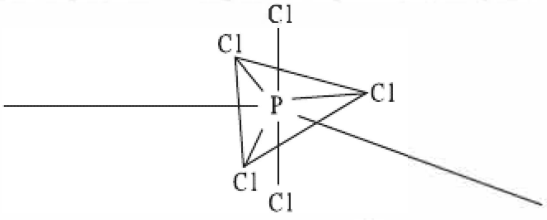
(b) $-NO_2$ group attached to benzene is meta directing but -OH group is ortho and para directing. Explain why ? 2

ANSWERS

1. The value of $l = 3$ is not possible for $n = 3$. Permissible values of l is 0 to n – 1.
2. Na^+ or F^- or Ne. 1
3. ΔS = +ve *e.g.* mixing of two gases separated by a partition at constant temperature. 1
4.  1
5. Low temperature and high pressure. 1
6. The reaction involvs oxidation of fluorine (F_2 to F^+) in HOF and reduction of fluorine (F_2) to F^- in HF . 1
7. But-1-en-3-yne 1
8. K(+1) 1
9. (a) $Na_2O_2 + H_2O \rightarrow H_2O_2 + 2NaOH$ 1
   (b) $Ca + 2HCl \rightarrow CaCl_2 + H_2$ 1

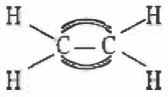
OR

sp^3d hybridisation. The axial bonds are longer because axial bond pairs suffer more repulsion as compared to equatorial bond pairs.



10. (a) Be_2, $\sigma 1s^2$, $\sigma^* 1s^2$, $\sigma 2s^2 \sigma^* 2s^2$ and B. O. = ½ (4 –4) = 0

Since B. O. is zero, molecule does not exist. 1

(b)  C_1 and C_2 are sp^2 hybridised 1

11. $$\lambda = \frac{h}{mv}$$ 2

$$3.6\times10^{-10} = \frac{6.626\times10^{-34}}{m\times3\times10^{8}}$$

$$m = 6.135\times10^{-29}\ \text{kg}$$

12. Products of electrolysis 2

At anode : Ag (impure) $\rightarrow Ag^+ + e^-$ (oxidation)

At cathode : $Ag^+ (aq) + e^- \rightarrow$ Ag (Reduction)

13. $H_2● + NH_3 + C●_2 \rightarrow (NH_4)_2CO_3$ 2

$(NH_4)_2CO_3 + CO_2 + H_2O \rightarrow 2NH_4HCO_3$

$NH_4HCO_3 + NaCl \rightarrow NaHCO_3 + NH_4Cl$

$2NaHC●_3 \rightarrow Na_2C●_3 + H_2● + CO_2$

14. (a) $2Al + 2NaOH + 6H_2O \rightarrow 2Na[Al(OH)_4] + 3H_2$ 2

(b) $H_3BO_3 \xrightarrow{\Delta}$ $\underset{\text{Metaboric acid (A)}}{HBO_2}$ $\xrightarrow{\Delta} H_2O + \underset{\text{(B)}}{B_2O_3}$

15. (a) % by mass $= \frac{15}{106}\times100 = 15\times10^{-1}\%$ 1

(b) Molality $= \frac{15}{119.5}\times\frac{1000}{10^6} = 1.25\times10^{-4}$ m 1

16. A (Alkene) $\xrightarrow[\text{(ii) } Zn/H_2O]{\text{(i) } O_3}$ $CH_3CHO + CH_3CH_2\overset{●}{\overset{\|}{C}}CH_2CH_3$

(A) : $CH_3CH=C$ (with substituents CH_2CH_3 and CH_2CH_3)

3-Ethylpentan-2-ene

17. (a) Partition chromatography is based on continuous differential partitioning of components of a mixture between the stationary and mobile phases. 1

(b) Distillation under reduced pressure involves distillation at temperature lower than the normal boiling point of the liquid by reducing pressure on the surface of liquid.

18. (a) Be and Mg both having high ionisation enthalpy. 1

(b) Alkali metals and alkali earth metals are good reducing agents and have high -ve $E^0_{M^{n+}/M}$ values, therefore they can not be reduced by chemical methods. 1

19. (a) $$M = \frac{W_B \times 1000}{M_B \times V}$$

$$\text{Density of solution} = \frac{1.41\ g}{1\ m} \qquad M_B(HNO_3) = 1 + 14 + 48 = 63\ g/mol$$

Mass of 1 mL solution = 1.41 g

$$\text{Mass of } HNO_3 = W_B = \frac{69}{100} \times 1.41 = 0.97\ g$$

$$V = 1\ mL$$

$$M = \frac{0.97}{63} \times 1000 = 15.4\ mol\ L^{-1}$$ 2

(b) No. of C atoms $= \frac{48u}{12u} = 4$ 1

20. (a) The orbitals of a subshell having same energy are called degenerate orbitals, e.g., $2p_x$, $2p_y$, $2p_z$ are degenerate orbitals.

(b) According to Bohr, the orbital angular momentum is quantized.

$$mvr = \frac{nh}{2\pi}$$

$$2\pi r = \frac{nh}{mv} = n\lambda \qquad \text{(de Broglie wavelength, } \lambda = \frac{h}{mv}\text{)} \qquad 2$$

OR

(a) According to electromagnetic wave theory, energy is emitted in form of electrical and magnetic waves in continuous manner whereas Plank suggested energy cannot be emitted or absorbed continuously but in the form of small packets called quanta.

(b) Maximum No. of electrons in $n = 4 = 2 \times 4^2$

But only half of them have $m_s = +½$

No. of electrons with $n = 4$, $m_s = +½$ are 16. 1

21. (a) f-block elements configuration $(n-2)f^{1\text{-}14}\,(n-1)d^{0\text{-}1}\,ns^2$

(b) SiO_2

(c) It is easier to remove one electron from $2p^4$ configuration of O than from extra stable half-filled $2p^3$ configuration of N. 1

22. (a) $nO_2 = -\frac{8}{32} = 0.25$

$$n_{H_2} = \frac{4}{2} = 2$$

$$n_T = n_{O_2} + n_{H_2} = 0.25 + 2 = 2.25$$

$V = 1\ dm^3 = 1L$, $T = 300\ K$

$$P = \frac{nRT}{V} = 2.25 \times 0.082 \times 300$$

$= 55.35$ atm 2

(b) Volume of gas becomes zero at -273.15° C, therefore the lowest possible temperature becomes -273.15°. 1

23. (a)

Species	**Conjugate base**	**Conjugate acid**
H_2O	OH^-	H_3O^+
NH_3	NH_2^-	NH_4^+

2

(b) $pH = -\log [H^+] / \text{mol } L^{-1}$ 1

$= -\log (2 \times 10^{-3})$

$= -(-3 + 0.3010) = 2.7$

24. (a) $K_p = \frac{P_{CO}}{P_{CH_4} \; P_{H_2O}}$ 1

(b) (i) Kp is not affected by increasing the pressure but the forward reaction is favoured. 1

(ii) Kp is not affected by a catalyst and the equilibriums composition also remains the same. 1

25. (a) HF has highest magnitude of hydrogen bonding because F is the most electronegative atom. 1

(b) $H_2●_2$ as oxidising agent :

$$2Fe^{2+}(aq) + 2H^+(aq) + H_2●_2(aq) \rightarrow 2Fe^{3+}(aq) + 2H_2O$$

Reducing action of H_2O_2 :

$$H●Cl + H_2O_2 \rightarrow H_3●^+ + Cl^- + O_2$$

26. (a) C● bonds with haemoglobin and reduces its ability to bind with oxygen. 1

(b) Pb(IV) state is unstable due to in inert pair effect. 1

(c) Boric acid, $B(OH)_3$ accept $\overline{OH}$ from water and H^+ is realeased by water molecule. 1

27. (a) **Ozone hole** - Depletion of ozone layer present over the south pole. 1

(b) **BOD** - The amount of oxygen required by the bacteria to break down the organic matter in a certain volume of a sample of water is called Biochemical Oxygen Demand. 1

(c) **Eutrophication** - The process in which nutrient enriched water bodies support a dense plant population which kills animal life due to less availability of oxygen is called Eutrophication. 1

28. (a) At constant volume $q_v = C_v\Delta T = \Delta U$

At constant pressure $q_p = C_p\Delta T = \Delta H$

For 1 mol of an ideal gas :

$$\Delta H = \Delta V + \Delta(PV)$$

$$\Delta H = \Delta V + \Delta(RT)$$

$$\Delta H = \Delta U + R\Delta T$$

$$C_p\Delta T = C_v\Delta T = R\Delta T$$

$$C_p - C_v = R$$ 2

(b) $\Delta_f H^{\oslash}(NH_3) = \frac{\Delta_r H^{\oslash}}{2} = \frac{-94.2}{2} = 47.1\ kJmol^{-1}$ 1

(c) $\Delta G = -2.303\ RT \log K_c$

When Kc = 10,

ΔG = –ve. The reaction will be spontaneous. 2

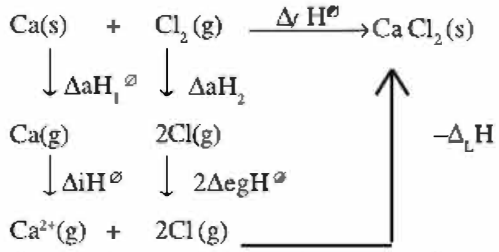
OR

(a) NO is an endothermic compound whereas NO_2 is an exothermic compound, i.e.,

$$\Delta H^{\oslash}(NO) > \Delta_f H^{\oslash}(NO_2)$$

Hence, NO is less stable than NO_2.

(b)



$$\Delta_f H^{\oslash} = \Delta_a H_1^{\oslash} + \Delta_i H^{\oslash} + \Delta_a H_2^{\oslash} + 2\Delta_{eg} H^{\oslash} - \Delta_L H^{\oslash}.$$

(c) At equilibrium, $\Delta G = \Delta H - T\Delta S = O$

$$T = \frac{\Delta H}{\Delta S}$$

$$T = \frac{400\ kJ\ mol^{-1}}{0.2\ kJ\ mol^{-1}}$$

$$T = 2000\ K$$

Above this temperature $T\Delta S > \Delta H$ and therefore, reaction will be spontaneous. 2

29. (a) Na + C + N → NaCN

Na + Cl → NaCl

$$6CN^- + Fe^{2+} \rightarrow [Fe(CN)_6]^{4-}$$

$$3\left[Fe(CN)_6\right]^{4-} + 4Fe^{3+} \xrightarrow{H_2O} \underset{\text{Prussian Blue}}{Fe_4\left[Fe(CN)_6\right]}$$

$$AgNO_3\,(aq) + NaCl\,(aq) \rightarrow AgCl + NaNO_3\,(aq)$$

(white ppt.)

(b) (i) Electrophile takes away an electron pair *e.g.*, NO_2^+.

(ii) Nucleophile accepts an electron pair *e.g.*, OH^-. 1

(iii) **Inductive Effect** : The polarisation of a sigma bond due to the polarisation of adjacent sigma bond is called inductive effect. 1

OR

(a) (i) $(CH_3)_3C^+$ is stable due to hyperconjugation but CH_3^+ lacks hyperconjugation stability. 1

(ii) In CCl_4 the C-Cl bonds are covalent which do not furnish Cl^- in solution. 1

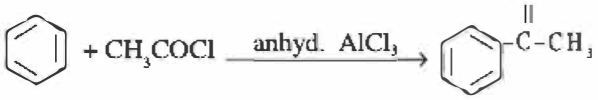
(iii) Conc. HNO_3 is added to the sodium extract to decompose cyanide or sulphide of sodium if present. 1

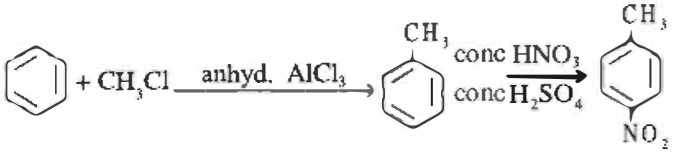
$$Na_2S + H^+ \rightarrow Na^+ + H_2S$$

$$NaCN + H^+ \rightarrow Na^+ + NCN$$

(b) (i) Position isomers 1

(ii) Geometrical isomers 1

30. (a) (i) 

(ii) 

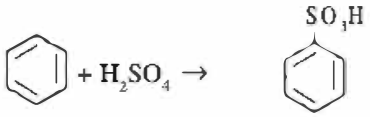
(iii) $CH_3COOH + NaOH \rightarrow CH_3COONa \xrightarrow[NaOH]{CaO} CH_4$

(b) $CH_3CH_2CH_2CH_2CH=CH_2 + HBr \rightarrow CH_3CH_2CH_2CH_2CH_2CH_2Br$ 1

1-Bromohexane

(c) The H attached to *sp* hybrid carbon becomes acidic due to high electronegativity of (*sp* hybridised). C 1

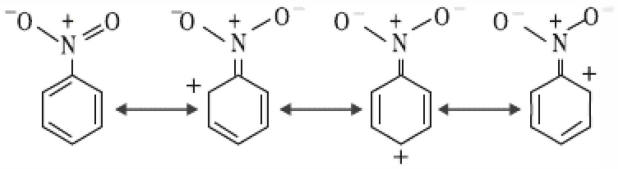
OR

(a) 

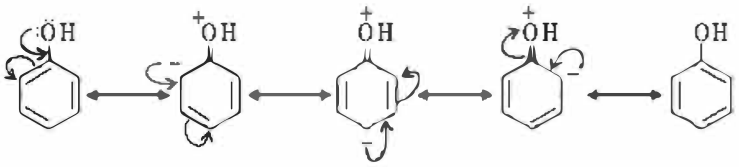
(fuming) (Benzene sulphonic acid)

(b) $CaC_2 + 2H_2O \rightarrow Ca(OH)_2 + C_2H_2$

(c) $CH_2 = CH_2 + H_2O + O \xrightarrow{KMnO_4} \underset{\displaystyle OH}{\overset{\displaystyle CH_2}{|}} - \underset{\displaystyle OH}{\overset{\displaystyle CH_2}{|}}$

(d) 

The electron density decreases on *o*- and *p*- positions as a result the electrophile attacks on *m*-position.



The electron density increases on *o*- and *p*- positions, therefore electrophile attacks on *o*- and *p*- positions.