
2009

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2009

Part I (Answer all questions)

Question: 1

a. Correct the following statements by changing the underlined part of the sentence. (Do not change the whole sentence): [5]

i. For all spontaneous processes the change in entropy is zero

Answer: For all spontaneous processes entropy is greater than zero.

ii. Formaldehyde undergoes Cannizzaro's reaction since it has one alpha hydrogen atom.

Answer: Formaldehyde undergoes Cannizzaro's reaction since it has no alpha hydrogen atom.

iii. In a co-ordination complex, donation of electron pair takes place from the central metal atom to the ligands.

Answer: In a co-ordination complex, donation of electron pair takes place from the ligand to the central metal atom.

iv. An aqueous solution of sodium sulphate is acidic in nature.

Answer: An aqueous solution of sodium sulphate is neutral in nature.

v. The solubility product of silver chloride in water decreases on addition of potassium chloride to the solution.

Answer: The solubility product of silver chloride in water decreases on addition of NaCl.

b. Complete the following statements by selecting the correct alternative from the choices given: [5]

1. The number of Faradays required to reduce one mol of $(\text{Cu})^{+2}$ to metallic copper is:

- a. One
- b. Two
- c. Three
- d. Four

Answer: a.

2. When oxalic acid is heated with glycerol we get:

- a. Formic acid
- b. Acetic acid

-
- c. Lactic acid
 - d. Tartaric acid

Answer: a.

3. The molecular weight of sodium chloride determined by measuring the osmotic pressure of its aqueous solution is:
- a. Double the theoretical value
 - b. Same as the theoretical value
 - c. Half the theoretical value
 - d. Three times the theoretical value

Answer: a.

4. In ethyne molecule there are:
- a. Only three sigma bonds
 - b. Only three pi bonds
 - c. Three sigma bonds and two pi bonds
 - d. Three pi bonds and two sigma bonds.

Answer: c.

5. An example of an electrophil is:
- a. NO_2^+
 - b. NO_2^-
 - c. NO_2
 - d. NO_3^-

Answer: a.

- c. Fill in the blanks from the word / words given in brackets: [5]

(paramagnetic, ethanol, diethyl ether, electron, proton, neutron, directly, Glucose, one, two depression, inversely, Fructose, Lewis acid, Lewis base, positive, ions, diamagnetic, negative, two, molecules, elevation, atoms)

1. _____ and _____ are functional isomers.

Answer: Ethanol, diethyl ether.

2. AlCl_3 is a _____ because it is an _____ deficient molecule.

Answer: Lewis acid, electron.

3. The _____ of the boiling point of a solvent by the addition of a solute is _____ proportional to the molality of the solution.

Answer: Elevation, directly.

4. The crystal of diamond is made of _____ while that of calcium chloride is made of _____.

Answer: Atoms, ions.

5. Oxygen molecule is _____ due to the presence of _____ unpaired electrons.**

d. Match the following:

i. Co-ordination compounds	a. Raoult's law
ii. Dilute solution	b. Group displacement law
iii. Electrolysis	c. Werner's theory
iv. Toluene	d. Faraday's law
v. Radioactivity	e. Friedel Craft's reaction

Answer:

- i. c
ii. a
iii. d
iv. e
v. b

Part II (Answer six questions choosing two from section A, two from section B. And two from section C)

Section A (Answer any two questions)

Question: 2

- a.
1. The boiling point of pure water is 373K. Calculate the boiling point of an aqueous solution containing 18 gms of glucose (MW = 180) in 100 gms of water. Molal elevation constant of water is 0.52 K kg/mol. [5]

Answer: Mass of solvent (W_A) = 100g
Mass of solute (W_B) = 18g
Molecular mass of solute (M_B) = 180

$$\text{Molality} = \frac{W_B \times 1000}{M_B \times W_A} = \frac{18 \times 1000}{180 \times 100} \\ = 1 \text{ mol. Kg}^{-1}$$

$$\Delta T_b = k_b \times m = 0.52 \times 1 = 0.52 \text{ K}$$

$$\text{Boiling point of solution} = \left[\text{Boiling point of pure solvent} \right] + \left[\text{Elevation in boiling point} \right]$$

$$= 373 + 0.52$$

$$= 373.52 \text{ K}$$

$$\pi = \frac{n}{V} \cdot RT$$

2. Equal weights of two substances X and Y are dissolved in equal volumes of water. The osmotic pressure of the solution containing Y is five times the osmotic pressure of the solution containing X. What is the molecular weight of X if that of Y is 60? [3]

Answer: Where π = Osmotic pressure

N = Number of molecules

V = Volume of solution

R = Solution constant

$$\text{for solution X } \pi_x = \frac{n_x}{V} R.T$$

$$\text{for solution Y } \pi_y = \frac{n_y}{V} R.T$$

from equation (i) and (ii)

$$\frac{\pi_x}{\pi_y} = \frac{n_x}{n_y}$$

$$\text{but number of moles, } n = \frac{\text{Weight of the substance, } W}{\text{Mol wt. of the substance, } M}$$

$$\text{hence } n_x = \frac{W_x}{M_x} \text{ and } n_y = \frac{W_y}{M_y}$$

$$\text{but } W_x = W_y$$

$$\text{and } \pi_y = 5\pi_x$$

therefore from equation (iii)

$$\frac{\pi_x}{5\pi_x} = \frac{W_x / M_x}{W_y / M_y} \quad \left[\begin{array}{l} \because W_x = W_y \\ \text{and } \pi_y = 5\pi_x \end{array} \right]$$

$$\frac{1}{5} = \frac{M_y}{M_x}$$

$$\text{but molecular weight of Y, } M_y = 60$$

$$\text{hence, molecular wt. Of X. } M_x = 5 \times 60$$

3. Which of the following solutions will have a lower vapour pressure and why?

- A 5% solution of cane sugar ($C_{12}H_{22}O_{11}$)
- A 5% solution of urea ($NH_2CO NH_2$)

Answer: According to Raoult's law: The relative lowering of vapour pressure is equal to the ratio of the moles of solute and the total number of moles in the solution i.e. equal to the mole fraction of the solvent

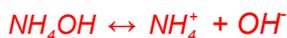
$$\text{Moles of urea} = \frac{5}{60} = .08 \text{ (5\% solution)}$$

$$\text{Moles of cane sugar} = \frac{5}{342} = 0.14 \text{ (5\% solution)}$$

Lowering of vapour will be low in the case of urea than cane sugar as the concentration increases vapour pressure will decrease.

-
- b. i. When ammonium chloride and ammonium hydroxide are added to a solution containing both $(Al)^{+3}$ and $(Ca)^{+2}$ ions, which ion is precipitated? Why? [3]

Answer: In the presence of ammonium chloride, the ionization of ammonium hydroxide is suppressed due to the common ion NH_4^+

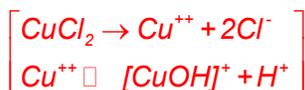


Due to the common ion (NH_4^+) the concentration of OH^- will be decrease and both Al^{3+} and Ca^{2+} will form hydroxide. But only Al^{3+} will be precipitated in the form of $Al(OH)_3$ as the ionic product i.e. Al^{3+} and OH^- exceed the solubility product of $Al(OH)_3$.

But the concentration of OH^- ions is not sufficient to exceed the value of K_{sp} of $Ca(OH)_2$, therefore it would remain in the solution and not get precipitated.

- ii. Explain why a solution of copper chloride is acidic while that of sodium chloride is neutral.

Answer: Solution of copper chloride is acidic because it is a salt of weak base and strong acid i.e. $Cu(OH)_2$, a weak base and HCl a strong acid. It undergoes hydrolysis and yield slightly acidic solutions.



The accumulation of H^+ ions in solution makes it acidic on the other hand $NaCl$ is an example of salt of strong base and strong acid.

It dissociates in water to give the anion Cl^- , HCl and Cl^- constitute and acid base conjugate pair.



Since HCl is a strong acid, Cl^- is very weak base, Cl^- is unable to accept a proton (H^+) from an acid, particularly water. That is why Cl^- does not hydrolyse. It cannot generate OH^- ions as follows:



Therefore $NaCl$ solution is neutral.

Question: 3

- a.
- i. In a body centred and face centred arrangement of atoms of an element, what will be the number of atoms present in respective unit cells?

Answer: See topics on 'Body centred BCC'.

-
- ii. Explain why graphite is soft and can be used as a lubricant. **
- b. 1.0 gm. of strontium – 90 was reduced to 0.953 gm after two years. Calculate the half life period of strontium – 90. ** [3]

- c. Mention any two factors affecting the electrode potential of a metal. [2]

Answer: Factors affecting the electrode potential of a metal are:

- (i) Nature of metal: Extremely active metals have a high electrode potential, while less active has lower electrode potential.
- (ii) Temperature: The change in the temperature of the solution also changes the electrode potential.

- d. Draw the electron-dot or equivalent structure of perchloric acid. ** [1]

Question: 4

- a. What is the hybridization of the central atom in ammonia, water and methane? Arrange them in the order of increasing bond angle. Give reasons. [3]

Answer: Hybridisation in NH_3 , H_2O , CH_4
- sp^3 hybridisation
 $\text{CH}_4 > \text{NH}_3 > \text{H}_2\text{O}$
 $109.5 > 107 > 104.5$

In CH_4 molecules the central carbon atom has shared pairs of electrons in three hybrid orbitals while fourth sp^3 orbital has a lone pair. Electrostatic repulsion between bp-bp electrons is less than the repulsion between lp-bp electrons.

This results in distortion of tetrahedral shape of molecule and bond angle between H-N-H decreases from 109° to 107° .

In H_2O molecule central oxygen has two bond pair electrons in its two sp^3 orbitals and two lone pair in other two sp^3 orbitals. The two lp electron pairs repel each other even more than lp and bp electrons.

This results further bending of molecular shape and a decreased H-O-H angle which is 104.5° .

- b. Name the type of isomerism shown by the following pairs of co-ordination compounds: [2]
- i. $[\text{Co}(\text{NH}_3)_5\text{NO}_2]\text{Cl}_2$ and $[\text{Co}(\text{NH}_3)_5\text{ONO}]\text{Cl}_2$

Answer: Linkage

- ii. $[\text{Cr}(\text{H}_2\text{O})_5\text{Cl}]\text{Cl}_2 \cdot \text{H}_2\text{O}$ and $[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl} \cdot 2\text{H}_2\text{O}$ **

- c. For the following cell, calculate the emf: [2]



Given: $E^0_{\text{Al}^{+3}/\text{Al}} = -1.66 \text{ V}$
 $E^0_{\text{Fe}^{+2}/\text{Fe}} = -0.44 \text{ V}$

Answer: *E.M.F of the cell*

$$E^0_{\text{cell}} = E^0_{\text{cathode}} - E^0_{\text{Anode}} = 1.22$$

$$E^0_{\text{cell}} = E^0_{\text{cell}} + \frac{0.059}{n} \log \frac{[\text{Fe}^{+2}]}{[\text{Al}^{+3}]^2}$$

$$= 1.22 + \frac{0.059}{n} \log \frac{0.02}{[0.01]^2}$$

$$E^0_{\text{cell}} = 1.209 \text{ V}$$

d. Mention one use each of Co_{60} and I_{131} .

Answer: *Use of Co^{60} – Co^{60} is used for testing deeply seated cancer growth.*
Use of I^{131} – It is used in the treatment of hyper-thyroidism and the cancer of thyroid.

Section B (Answer any two questions)

Question: 5

a.

- i. Write the mathematical expression for the first law of thermodynamics. One mole of an ideal gas is expanded isothermally against a constant pressure of 3 atmospheres from 10 litres to 35 litres. Calculate the work done, change in internal energy and heat absorbed during the process. [3]

Answer: *See topics on 'Mathematical Form of First Law'.*

- ii. Calculate the free energy change of the reaction: [3]

$\text{C}_{(\text{graphite})} + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$ $\Delta H = -300 \text{ kJ mol}^{-1}$ and $\Delta S = 3 \text{ JK}^{-1} \text{ mol}^{-1}$ at 300 K. Predict whether the reaction is spontaneous or not at 300 K

Answer: $\Delta G = \Delta H - T \Delta S$

$$\Delta G = -300000 \text{ joules} - 300 \times 3$$

$$= -30.000 - 900$$

$$= -30,000 \text{ joules/mol}$$

The reaction is spontaneous because ΔG is –ve.

- b. An alkyl bromide undergoes reaction in the alkaline medium to form the corresponding alcohol. When the concentration of the alkyl bromide is doubled keeping the concentration of the alkali constant, the rate of the reaction is doubled.

When the concentration of the alkali is doubled keeping the concentration of the alkyl bromide constant, the rate of the reaction remains the same. [3]

Answer: $\text{R Br} + \text{NaOH} \rightarrow \text{ROH} + \text{Na Br}$

$$\text{Rate} = K [\text{R Br}]$$

Concentration of RCl is doubled the rate of reaction is doubled. The rate law for this reaction is $\text{rate} = k [R Br]$.

It is clear from the rate law that order with respect to RBr is one, thus on making the concentration of R Br doubled the rate also doubled.

Concentration of NaOH is doubled the rate remains the same. This is because NaOH is not present in the rate law hence on making the concentration of NaOH doubled it would not effect the rate and it remains the same.

Question: 6 **

a. Describe the extraction of silver from its sulphide ore by the cyanide process.

Answer: See topics on 'Silver'.

b. Arrange the following in increase order of acidity and explain your order: Formic acid, acetic acid, chloroacetic acid. [5]

Answer: Increasing order:



PKa value	4.74	3.75	2.86
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Carboxylic acids are quite strong acids due to the presence of polar OH group. Carboxylic acids as well as carboxylate ion both are stabilized by resonance. The factors which increases the stability of carboxylate ion more than carboxylic acids, increases the acid strength.

The electron withdrawing groups (-Cl) stabilize the carboxylate anion on the other hand electron releasing group (-CH₃) destabilizes the carboxylate ion. Further pKa value supports the answer.

Question 7

a. How can crystalline sodium thiosulphate be prepared starting from sulphur ? What particular property of sodium thiosulphate is responsible for its use as an antichlor in the textile industry? ** [4]

b. Write balanced equations for each of the following reactions:

i. Fluorine and dilute sodium hydroxide.



ii. Ozone and hydrogen sulphide.



iii. Hydrogen peroxide and sodium hydroxide. **

c. What are alums? Give two uses of potash alum. ** [2]

Section C (Answer any two questions)

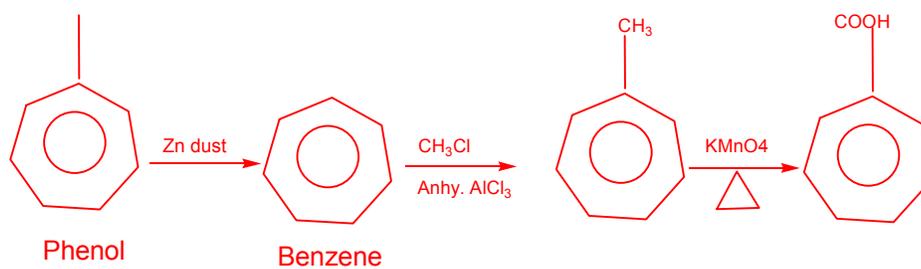
Question: 8

a. How will you carry out the following conversions:

i. Acetaldehyde to acetamide. [7]

Answer: See topics on 'Amino acids'.

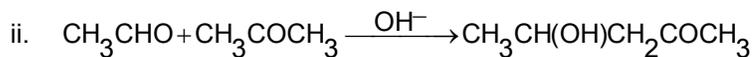
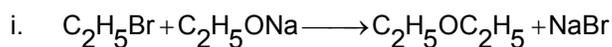
ii. Phenol to benzoic acid [2]



iii. Glucose to saccharic acid.

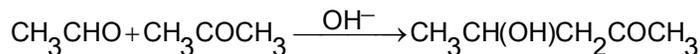


b. Give the names of the following reactions:



Question: 9

a. How will you distinguish between the following:



pairs of compounds? (Give one good chemical test.) [3]

i. Ethylamine and Acetamide

Answer: Ethylamine and Acetamide: Take a small amount of substance and add 2cc of NaOH solution and heat. Ammonia gas is evolved. Bring a moist red litmus paper over the mouth of the test tube. It turns blue. Amide confirmed.

ii. Oxalic acid and Acetic acid

Answer: Oxalic Acid and Acetic acid: To 2ml of neutral solution of acid and few drops of CaCl_2 , white ppt is obtained in the cold [the ppt. is insoluble in acetic acid but soluble in mineral acids]. Dissolve this ppt. in dil H_2SO_4 and add 2-3 drops of dil KMnO_4 . Pink colour of KMnO_4 disappears.

b. An Organic compound A with molecular formula $\text{C}_2\text{H}_7\text{N}$ on reaction with nitrous acid gives a compound B. B on controlled oxidation gives a compound C. C reduces Tollen's reagent to give silver mirror and D. B reacts with D in the presence of concentrated sulphuric acid to give a sweet smelling compound E. Identify A, B, C, D and E. Give the reaction of C with ammonia and name the product. ** [3]

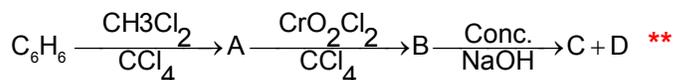
c. Draw the isomers of a compound with the molecular formula $\text{C}_4\text{H}_4\text{O}_4$. Name the isomers. ** [3]

Question: 10

- a.
- What type of polymerisation takes place when polyester is formed? Give one example of polyester and name the monomers from which it is formed.
 - Give two examples of natural polymers.

Answer: See topics on 'polymerisation'.

b. Identify the products A, B, C and D.



- c. Give balanced equations for the following reactions: **
- Formic acid heated with Tollen's reagent.
 - Phenol heated with chloroform and sodium hydroxide.
 - Acetaldehyde reacted with phenyl hydrazine.
 - Aniline treated with benzoyl chloride.

** Out of syllabus. Answer should be provided up on request