SAMPLE PAPER-04
CHEMISTRY (Theory)
(Questions)
Class – XII

Time allowed: 3 hours   Maximum Marks: 70

General Instructions:

a) All the questions are compulsory.
b) There are **26** questions in total.
c) Questions **1** to **5** are very short answer type questions and carry **one** mark each.
d) Questions **6** to **10** carry **two** marks each.
e) Questions **11** to **22** carry **three** marks each.
f) Questions **23** is value based question carrying **four** marks.
g) Questions **24** to **26** carry **five** marks each.
h) There is no overall choice. However, an internal choice has been provided in one question of two marks, one question of three marks and all three questions in five marks each. You have to attempt only one of the choices in such questions.
i) Use of calculators is **not** permitted. However, you may use log tables if necessary.

---

1. Give the structure of Propane-1,2,3-tricarbaldehyde.
2. Give the IUPAC name of $C_6H_5 – CH_2 – CH_2 COOH$.
3. Identify all the possible monochloro structural isomers expected to be formed on free radical monochlorination of $(CH_3)_2CHCH_2CH_3$.
4. What is prosthetic group? Give its function.
5. Why the hydrolysis of ester is slow in the beginning and becomes faster after sometimes?
6. How is cast iron different from pig iron?
7. Give reasons:
    i.   Aldehydes do not form stable hydrates but chloral exists as chloral hydrate.
    ii. Acetic acid can be halogenated in presence of red phosphorus and chlorine but formic acid cannot be halogenated.
8. Give the application of Henry's law on scuba drivers.
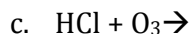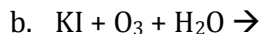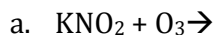9. Explain Frenkel defect.

Or

Silver forms ccplattice and X-ray studies of its crystals show that the edge length of its unit cell is 408.6 pm. Calculate the density of silver (Atomic mass = 107.9 u).

10. Write a note on order of a reaction.
11. Give a short note on:
    a. Reimer – Tiemann Reaction.
    b. Friedel Crafts Reaction.

12. Show that in a first order reaction, time needed for completion of 99.9% is ten times of half-life of the reaction.
13. Complete the following reactions:
    a. $KNO_2 + O_3 \rightarrow$
    b. $KI + O_3 + H_2O \rightarrow$
    c. $HCl + O_3 \rightarrow$
14. Differentiate between rate of reaction and reaction rate constant.
15. Explain the fact that in aryl alkyl ethers the alkoxy group activates the benzene ring towards electrophilic substitution reaction and it also directs the incoming substituents to o- and p-positions in benzene ring.
16.
    i. Why bithional is added to soaps?
    ii. Sulpha drugs work like antibiotics, but are not antibiotics. Comment.
    iii. What type of drug is phenacetin?
17.
    i. Define chelation.
    ii. What is meant by chelating ligand?
    iii. What is denticity?

    Or

    What are cationic complex, anionic complex and neutral complex? Give examples.
18.
    a) Give the sources of lead compounds.
    b) Define the term 'chemotherapy'.
    c) Name the macromolecules that are chosen as drug targets.
19. Write the possible sequences of the tripeptide which on complete hydrolysis gives glycine, alanine and phenylalanine.
20. What are the three ways to control the microbial diseases?
21. Explain pseudo first order reaction with an appropriate example.
22. Explain the term:
    a) Electro-osmosis
    b) Coagulation
23. The use of hydroelectricity is increasing day-by-day. Government is trying to reduce its dependency on thermal power plants
    Now answer the following question
    a. Why Government is trying to reduce its dependency on thermal power plant?
    b. What values are promoted by the use of hydroelectricity?
    c. Suggest two methods to promote above values.
24. Give the cause of lanthanoid contraction.

    Or

    Give five chemical characteristics of lanthanoids.

25. An organic compound (A) with molecular formula C_8H_8O forms an orange-red precipitate with 2,4-DNP reagent and gives yellow precipitate on heating with iodine in the presence of sodium hydroxide. It neither reduces Tollens' or Fehlings' reagent, nor does it decolourise bromine water or Baeyer's reagent. On drastic oxidation with chromic acid, it gives a carboxylic acid (B) having molecular formula $C_7H_6O_2$. Identify the compounds (A) and (B) and explain the reactions involved.

Or

Write chemical equations for the following conversions:
   i. $CH_3–CH_2–Cl$ into $CH_3–CH_2–CH_2–NH_2$
   ii. $C_6H_5–CH2–Cl$ into $C_6H_5–CH_2–CH_2–NH$
   iii.   Benzyl alcohol to phenylethanoic acid
   iv.   4-Methylacetophenone to benzene-1,4-dicarboxylic acid

26. Calculate its resistivity, conductivity and molar conductivity, if the electrical resistance of a column of 0.05 mol L^{-1} NaOH solution of diameter 1 cm and length 50 cm is $5.55 × 10$ ohm.

Or

a) A solution of $CuSO_4$ is electrolysed for 10 minutes with a current of 1.5 amperes. What is the mass of copper deposited at the cathode?

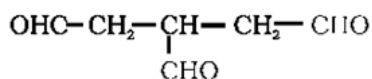b) What are the observations made in a galvanic cell after the circuit is completed?

Answers

1.

OHC– CH₂– CH— CH₂– CHO
              |
             CHO

2. 3-Phenylpropanoic acid.

3.
   i. $(CH_3)_2CHCH_2CH_2Cl$
   ii. $(CH_3)_2CHCH(Cl)CH_3$
   iii. $(CH_3)_2C(Cl)CH_2CH_3$
   iv. $CH_3CH(CH_2Cl)CH_2CH_3$

4. It is a non-protein portion obtained by hydrolysis of conjugated proteins. The main function of the prosthetic group is to control the biological function of proteins.

5. This is due to the process of autocatalysis. In the beginning of the hydrolysis of ester gives an acid which starts as a catalyst later and so, the reaction becomes fast.

6. The iron obtained from blast furnace is pig iron. It contains about 4% of carbon and many impurities in small amount. Cast iron is obtained by melting pig iron with scrap iron and coke using hot air blast. It contains slightly lower carbon content and is extremely hard and brittle.

7.
   a) The reaction between water and aldehydes is a reversible reaction and so equilibrium lies almost towards left. On the other hand, in chloral the presence of three electron withdrawing chlorine atoms increases the positive charge on the carbonyl carbon. So, the weak nucleophiles readily add to the carbonyl group forming chloral hydrate and therefore shift the equilibrium towards right.
   b) Acetic acid can be halogenated due to the presence of α-carbon atom. However, formic acid has no α-hydrogen atom and so cannot be halogenated.

8. Scuba divers must cope with high concentrations of dissolved gases while breathing air at high pressure underwater. Increased pressure increases the solubility of atmospheric gases in blood. When the divers come towards surface, the pressure gradually decreases. This releases the dissolved gases and leads to the formation of bubbles of nitrogen in the blood. This blocks capillaries and creates a medical condition known as bends, which are painful and dangerous to life.

9. This defect is shown by ionic solids. The smaller ion (usually cation) is dislocated from its normal site to an interstitial site. It creates a vacancy defect at its original site and an interstitial defect at its new location. Frenkel defect is also called dislocation defect. It does not change the density of the solid. Frenkel defect is shown by ionic substance in which there

is a large difference in the size of ions, for example, ZnS, AgCl, AgBr and AgI due to small size of Zn^{2+} and Ag^+ ions.

Or

Since the lattice is ccp, the number of silver atoms per unit cell = z = 4

Molar mass of silver = 107.9 g mol^{-1} = 107.9×10^{-3} kg mol^{-1}

Edge length of unit cell = a = 408.6 pm = 408.6×10^{-12} m

$$Density \ d = \frac{z.M}{a^3.N_A}$$

$$= \frac{4x\left(107.9x10^{-3} kgmol^{-1}\right)}{\left(408.6x10^{-12} m\right)^3 \left(6.022x10^{23} mol^{-1}\right)} = 10.5x10^3 kgm^{-3}$$

= 10.5 g/cm^3.

10.
  i.   Order of a reaction is an experimental quantity. It can be zero and even a fraction but molecularity cannot be zero or a non integer.
  ii. Order is applicable to elementary as well as complex reactions whereas molecularity is applicable only for elementary reactions. For complex reaction molecularity has no meaning.
  iii. For complex reaction, order is given by the slowest step and molecularity of the slowest step is same as the order of the overall reaction.

11.

  a. Reimer – Tiemann Reaction.

     On treating phenol with chloroform in the presence of sodium hydroxide, a –CHO group is introduced at orthoposition of benzene ring. This reaction is known as Reimer - Tiemannreaction. The intermediate substituted benzal chloride is hydrolysed in the presence of alkali to produce salicylaldehyde.
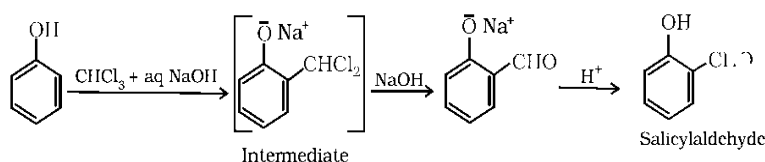
  b. Friedel –Crafts Reaction:
     Anisole undergoes Friedel-Crafts reaction, *i.e.*, the alkyl and acyl groups are introduced at orthoandparapositions by reaction with alkyl halide and acyl halide in the presence of anhydrous aluminium chloride (a Lewis acid) as catalyst.

Ethanoyl chloride | 2-Methoxy-acetophenone (Minor) | 4-Methoxy-acetophenone (Major)
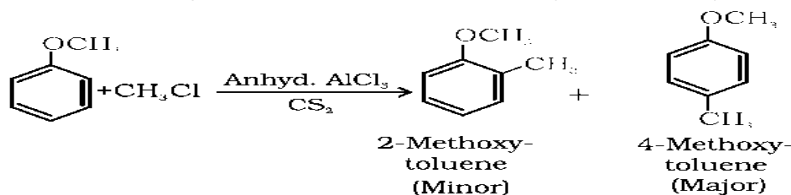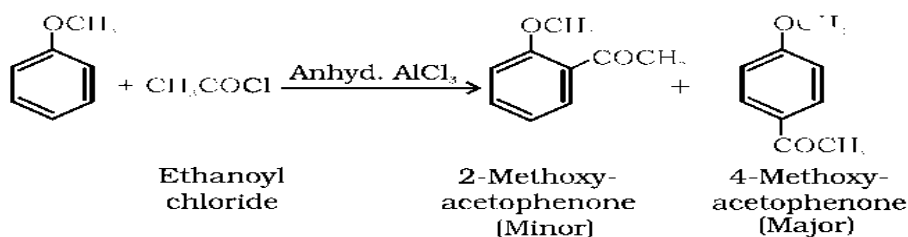
12. When reaction is completed 99.9% $[R]_n = [R]_0 - 0.999[R]_0$

$$k = \frac{2.303}{t} \log \frac{[R]_0}{[R]}$$

$$k = \frac{2.303}{t} \log \frac{[R]_0}{[R]_0 - 0.999[R]_0} = \frac{2.303}{t} \log 10^3$$

t = 6.909/k

For half-life of the reaction

$t_{1/2} = 0.6963 / k$

$$\frac{t}{t_{1/2}} = \frac{6.909}{k} x \frac{k}{0.693} = 10$$

13.
    a. KNO₂ + O₃→ KNO₃ + O₂
    b. 2 KI + O₃ + H₂O → 2 KOH + I₂+ O₂
    c. 2 HCl + O₃→ H₂O + Cl₂ + O₂

14.

Rate of reaction	Reaction rate constant
It is the speed with which reactants are converted into products.	It is the proportionality constant in the rate law which is defined as the rate of reaction when the concentration of the reactants is unity.
It depends on the initial concentration of the reactants.	It does not depend on the initial concentration of the reactants.
Its units are mol/L/time.	Its unit depend on the order of the reaction.

15. The alkoxy group increases the electron density on the benzene ring and so activates the aromatic ring towards electrophilic substitution reaction as given below:

I   II   III   IV   V
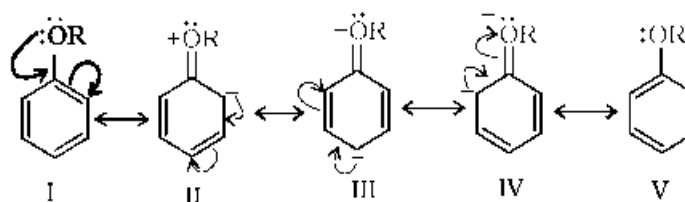
The structures, III – V show high electron density at o-and p-positions and so direct the incoming substituents to o- and p- positions in the benzene ring.

16.

    i.   Bithional acts as an antiseptic agent and reduces the odours produced by bacterial decomposition of organic matter on the skin.

    ii.   Sulpha drugs act against micro-organism like antibiotics. But these are not obtained from micro-organism like antibiotics.

    iii.   It is antipyretic.

17.

    i.   When a di- or polydendate ligand uses its two or more donor atoms to bind the same central metal atom or ion, it is called chelation.

    ii.   The resulting complex structure having ring structure and the ligand coordinating through two or more donor groups are called chelating ligand.

    iii.   The number of ligating groups indicates the denticity of the ligand.

Or

    i.   A complex ion or coordination entity which has a net positive charge is called cationic complex. Example – $[Co(NH_3)_6]^{3+}$

    ii.   A complex ion or coordination entity which has a net negative charge is called anionic complex. Example – $[Ag(CN)_2]^-$

    iii.   A complex or coordination entity which has no net charge is called neutral complex. Example – $[Ni(CO)_4]$

18.

    a) Lead compounds can be obtained from natural sources such as plants, trees, bushes, venoms and metabolites of micro-organisms. These compounds have also been isolated from fish, coral sponges and marine micro-organisms.

    b) The branch of chemistry which deals with the treatment of diseases using chemicals is called chemotherapy.

    c) It includes carbohydrates, proteins, lipids and nucleic acids.

19. The possible sequences are:

    a. Gly – Ala – Phe

    b. Gly – Phe – Ala

    c. Ala – Gly – Phe

    d. Ala – Phe – Gly

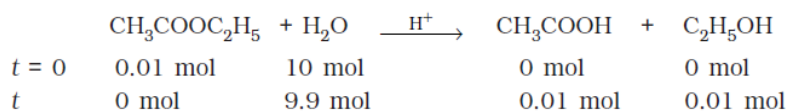   e. Phe – Gly – Ala

    f. Phe – Ala – Gly

20.

    a. By drugs which kill the organism in the body – bactericidal.

    b. By drugs which inhibit the growth of the organism – bacteriostatic.

    c. By increasing immunity and resistance to infection of the body – immunity.

21. The order of a reaction is sometimes altered by conditions. Consider a chemical reaction between two substances when one reactant is present in large excess. During the hydrolysis

of 0.01 mol of ethyl acetate with 10 mol of water, amounts of the various constituents at the beginning ($t = 0$) and completion (t) of the reaction are given as

$$CH_3COOC_2H_5 + H_2O \xrightarrow{H^+} CH_3COOH + C_2H_5OH$$

	$CH_3COOC_2H_5$	H_2O	CH_3COOH	C_2H_5OH
$t = 0$	0.01 mol	10 mol	0 mol	0 mol
t	0 mol	9.9 mol	0.01 mol	0.01 mol

The concentration of water does not get altered much during the course of the reaction. So, in the rate equation,

Rate = k'[CH₃COOC₂H₅] [H₂O] the term [H₂O] can be taken as constant.

The equation, thus, becomes

Rate = k [CH₃COOC₂H₅]   where k = k'[H₂O]

This reaction behaves as first order reaction. Such reactions are called pseudo first order reactions.

22.
   a) When electrophoresis, i.e., movement of particles is prevented by some suitable means, it is observed that the dispersion medium begins to move in an electric field. This phenomenon is termed electro-osmosis.
   b) The stability of the lyophobic sols is due to the presence of charge on colloidal particles. If, somehow, the charge is removed, the particles will come nearer to each other to form aggregates (or coagulate) and settle down under the force of gravity. The process of settling of colloidal particles is called coagulation or precipitation of the sol.

23.
   a. Thermal power plant causes air pollution. They use coal, which is non-renewable source of energy.
   b. Promoted values – Reducing environmental pollution. Reducing dependency of fossil fuels,
   c. Organizing mass campaigns for spreading awareness. Increase in the use of renewable sources energy such as solar energy etc.,

24. In the lanthanoid series, as we move from one element to another, the nuclear charge increases by one unit and one electron is added. The new electrons are added to the same inner 4f-subshells. However, the 4f-electrons shield each other from the nuclear charge quite poorly because of the very diffused shapes of f-orbitals. The nuclear charge increases by one step. Hence, with increasing atomic number and nuclear charge, the effective nuclear charge experienced by each 4f-electron also increases. As a result, there is a gradual decrease in size of lanthanoids with increase in atomic number.

Or

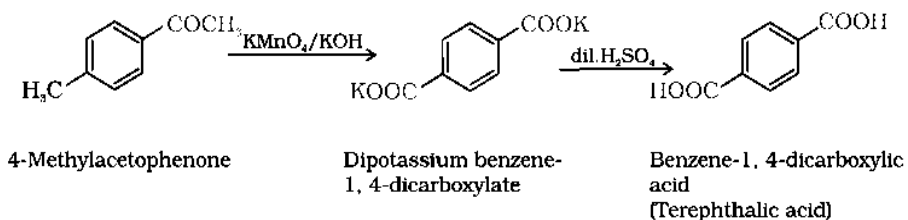   a) The hardness of lanthanoids increases with increasing atomic number.

b) In their chemical behaviour, the earlier members of the series are quite reactive but with increase in atomic number they behave like aluminium.

c) They combine with nitrogen to form nitrides.

d) They liberate hydrogen from dilute acids.

e) When the metals are heated with carbon, they form carbides of the formula Ln_3C, Ln_2C_3 and LnC_2.

25. (A) forms 2,4-DNP derivative. Therefore, it is an aldehyde or a ketone. Since it does not reduce Tollens' or Fehling reagent, (A) must be a ketone. (A) responds to iodoform test. Therefore, it should be a methyl ketone. The molecular formula of (A) indicates high degree of unsaturation, yet it does not decolourise bromine water or Baeyer's reagent. This indicates the presence of unsaturation due to an aromatic ring. Compound (B), being an oxidation product of a ketone should be a carboxylic acid. The molecular formula of (B) indicates that it should be benzoic acid and compound (A) should, therefore, be a monosubstituted aromatic methyl ketone. The molecular formula of (A) indicates that it should be phenyl methyl ketone (acetophenone).

Reactions:

(A) C_8H_8O + 2, 4-Dinitrophenylhydrazine $\xrightarrow{-H_2O}$ 2, 4-DNP derivative

(B) $C_7H_6O_2$

(A)

Or

i. $CH_3-CH_2-Cl \xrightarrow{Ethanolic NaCN} CH_3-CH_2-C\equiv N \xrightarrow{Reduction} CH_3-CH_2-CH_2-NH_2$

Chloroethane   Propanenitrile   Propan–1–amine

ii. $C_6H_5-CH_2-Cl \xrightarrow{Ethanolic NaCN} C_6H_5-CH_2-C\equiv N \xrightarrow{H_2/Ni} C_6H_5-CH_2-CH_2-NH_2$

Chlorophenylmethane   Phenylethanehitrile   2–Phenylethanamine

iii.

$C_6H_5CH_2OH \xrightarrow{HBr} C_6H_5CH_2Br \xrightarrow{KCN} C_6H_5CH_2CN$

Benzyl alcohol   Benzyl bromide   Benzyl cyanide

$\xrightarrow{\triangle \ H_3O^+}$

$C_6H_5CH_2COOH$

Phenylethanoic acid

iv.

4-Methylacetophenone → (KMnO₄/KOH) → Dipotassium benzene-1,4-dicarboxylate → (dil. H₂SO₄) → Benzene-1,4-dicarboxylic acid (Terephthalic acid)

26.

$A = \pi r^2 = 3.14 \times 0.5^2 \ cm^2 = 0.785 \ cm^2 = 0.785 \times 10^{-4} \ m^2$

$l = 50 \ cm = 0.5 \ m$

$R = \dfrac{\rho l}{A} \ or \ \rho = \dfrac{RA}{l} = \dfrac{5.55 \ x \ 10^3 \Omega \ x \ 0.785 \ cm^2}{50 cm} = 87.135 \ \Omega \ cm$

Conductivity = k = $\dfrac{1}{\rho} = \left(\dfrac{1}{87.135}\right) S \ cm^{-1} = 0.01148 \ S \ cm^{-1}$

Molar conductivity $\wedge_m = \dfrac{kx1000}{c} \ cm^3 L^{-1}$

$= \dfrac{0.01148 \ S \ cm^{-1} x \ 1000 \ cm^3 L^{-1}}{0.05 \ molL^{-1}}$

= 229.6 S cm² mol⁻¹

Or

a) T = 600 sec, charge = current x time = 1.5 x 600 = 900 C

According to the reaction,

Cu²⁺ + 2e⁻ = Cu
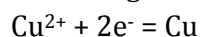
We need, 2F = 2 x 96487 C to deposit 1 mol or 63 g of Cu.

For 900 C, the mass of Cu deposited = 63 x 900/ 2 x 96487 = 0.2938 g.

b) It is observed that the electric current flows through external circuit as indicated by the ammeter. The following observations are made:

i.   Zn rod gradually loses its weight.

ii.   The concentration of Zn ions in the zinc sulphate solution increases.

iii.   Cu gets deposited on the electrode.

iv.   The concentration of Cu ions in copper sulphate solution decreases.

v.   There is flow of electrons from Zn rod to Cu rod and so current flows from Cu to Zn rod.