

CBSE Class 12 - Chemistry
Sample Paper - 02 (2019-20)

Maximum Marks:70

Time Allowed: 3 hours

General Instructions:

- a. All questions are compulsory.
 - b. Section A: Q.no. 1 to 16 are very short answer questions (objective type) and carry 1 mark each.
 - c. Section B: Q.no. 17 to 23 are short answer questions and carry 2 marks each.
 - d. Section C: Q.no. 24 to 30 are long answer questions and carry 3 marks each.
 - e. Section D: Q.no. 31 to 33 are also long answer questions and carry 5 marks each.
 - f. There is no overall choice. However an internal choice has been provided in two questions of two marks, two questions of three marks and all the three questions of five marks weightage. You have to attempt only one of the choices in such questions.
 - g. Use log tables if necessary, use of calculators is not allowed.
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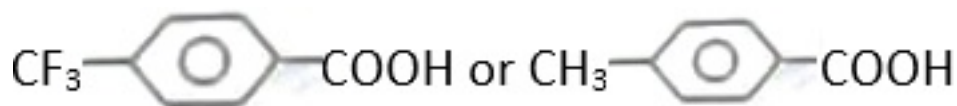
Section A

1. Vapour pressure of a liquid or a solution is the pressure exerted by the vapour in equilibrium with the liquid or solution at a particular temperature. It depends upon the nature of the liquid and temperature. The non-volatile solute in solution reduces the escaping tendency of the solvent molecules in the vapour phase because some of the solute particles occupy the positions of the solvent molecules on the liquid surface. The relative lowering of the vapour pressure of a solution containing a non-volatile solute is equal to the mole fraction of the solute in the solution. This is also known as Raoult's law. However, for solutions of volatile solutes, the vapour pressure of a component in a solution at a given temperature is equal to the mole fraction of that component in the solution multiplied by the vapour pressure of that pure

component. The solutions in which each component obeys Raoult's law is called an ideal solution. For ideal solutions ΔH_{mixing} and ΔV_{mixing} are also zero. Practically no solution is ideal. A non-ideal solution is that solution in which solute and solvent molecules interact with one another with a different force than the forces of interaction between the molecules of the pure components. There are two types of non-ideal solutions, showing positive deviations and negative deviations from ideal behaviour. If for the two components A and B, the forces of interaction between A and B molecules are less than the A-A and B-B interactions, the non-ideal solutions have positive deviations. On the other hand, if the forces of interaction between A and B molecules are more than the A-A and B-B interactions, the non-ideal solutions have negative deviations.

Answer the following questions:

- i. If a liquid is in equilibrium with its vapour at its boiling point. On average, what type of energy is equal in two-phase?
 - ii. What is the mole fraction of A in solution obeying result's law if the vapour pressure of a pure liquid A is 40 mm of Hg at 300 K. The vapour pressure of this liquid in solution with liquid B is 32 mm of Hg?
 - iii. Vapour pressure of a solution of heptane & octane is given by the equation:
 $P(\text{sol.})(\text{mm Hg}) = 35 + 65x$, where x is the mole fraction of heptane. Calculate the vapour pressure of pure octane.
 - iv. What is the value of ΔV_{mixing} & ΔH_{mixing} for non-ideal solution showing negative deviation?
 - v. Acetic acid + pyridine, the mixture is an example of which type of solution?
2. Galena (PbS) and cinnabar (HgS) on roasting often give their respective metals but zinc blend (ZnS) does not. Explain.
 3. Write the product obtained when D-glucose reacts with $\text{H}_2\text{N-OH}$.
 4. Write the name of bond between the two - amino acids.
 5. Name the synthetic polymer which is an ester.
 6. Which of the given acid of pair below would you expect to be stronger?



7. Ketones are reduced to the corresponding alcohols by catalytic hydrogenation to form
- primary alcohols
 - tertiary alcohols
 - None of these
 - secondary alcohols
8. The oxoacid of P having oxidation state +4 is:
- Phosphorus acid
 - Metaphosphoric acid
 - Phosphoric acid
 - Hypophosphoric acid
9. What is the shape of $\text{Fe}(\text{CN})_5$ molecule?
- Octahedral
 - Square pyramidal
 - Tetrahedral
 - Trigonal bipyramidal
10. Coordination compounds have great importance in biological systems. In this context, which of the following statement is incorrect?
- Carboxypeptidase- A is an enzyme and contains zinc
 - Chlorophylls are green pigments in plants and contain calcium
 - Haemoglobin is the end pigment of blood and contains iron

d. Cyanocobalamin is B₁₂ and contains cobalt

11. The condensation of hexamethylene diamine with adipic acid forms

a. Nylon 6, 6

b. Nylon 2,6

c. Buna-N

d. Terylene

12. **Assertion:** Cellulose is not digested by human beings.

Reason: Cellulose is a polymer of β -D-glucose.

a. Both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.

b. Both assertion and reason are CORRECT but, reason is NOT THE CORRECT explanation of the assertion.

c. Assertion is CORRECT but, reason is INCORRECT.

d. Assertion is INCORRECT but, reason is CORRECT.

13. **Assertion:** Ethanol gives iodoform test while methanol does not.

Reason: Ethanol is less reactive than methanol towards nucleophilic addition reactions.

a. Both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.

b. Both assertion and reason are CORRECT but, reason is NOT THE CORRECT explanation of the assertion.

c. Assertion is CORRECT but, reason is INCORRECT.

d. Assertion is INCORRECT but, reason is CORRECT.

14. **Assertion:** Iodine dissolves in aqueous solution of potassium iodide.

Reason: Potassium iodide behaves as an organic solvent and therefore, dissolves non-polar iodine.

- a. Both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.
- b. Both assertion and reason are CORRECT but, reason is NOT THE CORRECT explanation of the assertion.
- c. Assertion is CORRECT but, reason is INCORRECT.
- d. Assertion is INCORRECT but, reason is CORRECT.

15. **Assertion:** Alcohols have higher boiling points than ethers of comparable molecular masses.

Reason: Alcohols and ethers are isomeric compounds.

- a. Both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.
- b. Both assertion and reason are CORRECT but, reason is NOT THE CORRECT explanation of the assertion.
- c. Assertion is CORRECT but, reason is INCORRECT.
- d. Assertion is INCORRECT but, reason is CORRECT.

16. **Assertion:** For a negatively charged sol., the coagulation value of NaCl and MgCl are 52.0 and 0.72 respectively.

Reason: Greater charge of cation causes slower coagulation.

- a. Both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.
- b. Both assertion and reason are CORRECT but, reason is NOT THE CORRECT explanation of the assertion.
- c. Assertion is CORRECT but, reason is INCORRECT.

d. Assertion is INCORRECT but, reason is CORRECT.

Section B

17. How is Bakelite prepared?
18. At 298K, the rate of the chemical reaction doubles on increase of temperature by 10 K. Calculate E_a of this reaction.
19. Given the standard electrode potentials:
- $K^+/K \quad E^0 = -2.93V$
- $Ag^+/Ag \quad E^0 = 0.80V$
- $Hg^{2+}/Hg \quad E^0 = 0.85V$
- $Mg^{2+}/Mg \quad E^0 = -2.36V, Cr^{3+}/Cr \quad E^0 = -0.74V$
- Arrange these metals in their increasing order of reducing power.
20. A coordination compound has the formula $CoCl_3 \cdot 4NH_3$. It does not liberate ammonia but forms a precipitate with $AgNO_3$. Write the structure and IUPAC name of the complex compound.
21. Write IUPAC names of the following coordination compounds:
- a. $K_3[Cr(C_2O_4)_3]$
- b. $Hg[Co(SCN)_4]$
- c. $[Co(NH_3)_5(CO_3)]Cl$

OR

Draw the structures and write the hybridized state of the central atom of each of the species.

- i. $Fe(CO)_5$
- ii. trans - $[Co(NH_3)_4Cl_2]^+$
22. Differentiate between "minerals" and "ores".

OR

Differentiate between "minerals" and "ores".

23. Describe the mechanism of alcohols reacting both as nucleophiles and as electrophiles in their reactions.

Section C

24. What is a salt bridge? What is it used for?
25. A first order reaction is 15% complete in 20 minutes. How long will it take to be 60% complete?

OR

Answer the following questions on the basis of curve for a first order reaction.

- i. What is the relation between slope of this time and log of concentration?
 - ii. Calculate the rate constant of the above reaction if the slope is $2 \times 10^{-4} \text{ s}^{-1}$.
 - iii. Derive the relationship between half life of a first order reaction and its rate constant.
26. The cell in which the following reactions occurs:
 $2\text{Fe}^{3+}_{(aq)} + 2\text{I}^{-}_{(aq)} \rightarrow 2\text{Fe}^{2+}_{(aq)} + \text{I}_{2(s)}$ has $E^\circ = 0.236 \text{ V}$ at 298 K. Calculate the standard Gibbs energy and the equilibrium constant of the cell reaction.
27. Complete and balance-
- i. $2\text{F}_2(g) + 2\text{H}_2\text{O}(l) \rightarrow$
 - ii. $4\text{NaCl} + \text{MnO}_2 + 4\text{H}_2\text{SO}_4 \rightarrow$
 - iii. $4\text{HCl} + \text{O}_2 \xrightarrow{\text{CuCl}_2}$
 - iv. $\text{C}_{10}\text{H}_{16} + 8\text{Cl}_2 \rightarrow$
 - v. $6\text{NaOH} + 3\text{Cl}_2 \rightarrow$
28. Which compound in each of the following pairs will react faster in $\text{S}_{\text{N}}2$ reaction with OH^- ?

- i. CH_3Br or CH_3I
- ii. $(\text{CH}_3)_3\text{CCl}$ or CH_3Cl

29. Name the following compounds according to IUPAC system of nomenclature:

1. $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_2\text{CHO}$
2. $\text{CH}_3\text{CH}=\text{CHCHO}$
3. $(\text{CH}_3)_3\text{CCH}_2\text{COOH}$
4. $\text{OHCC}_6\text{H}_4\text{CHO} - p$

OR

What happens when

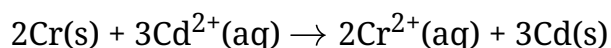
- a. Salicylic acid is treated with $(\text{CH}_3\text{CO})_2\text{O} / \text{H}^+$?
 - b. Anisole is treated with CH_3Cl /anhydrous AlCl_3 ?
 - c. Phenol is oxidised with $\text{Na}_2\text{Cr}_2\text{O}_7 / \text{H}^+$?
30. i. What type of drug is used in sleeping pills?
 ii. What type of detergents are used in toothpastes?
 iii. Why the use of alitame as artificial sweetener is not recommended?

Section D

31. What are enzymes? Write in brief the mechanism of enzyme catalysis.

OR

- a. Define the terms specific conductance and molar conductivity for solution of electrolytes.
- b. Write the cell formulation and calculate the standard cell potential of the galvanic cell in operation of which the following reaction takes place.



Calculate $\Delta_r G^0$ for the above reaction.

Given : $E^0_{\text{Cr}^{3+}/\text{Cr}} = -0.74 \text{ V}$

$$E^0_{\text{Cd}^{2+}/\text{Cd}} = -0.40 \text{ V} \quad 1 \text{ F} = 96500 \text{ C mol}^{-1}$$

32. A. For the following conversion reactions write the chemical equations:

- i. Ethyl isocyanide to ethylamine
 - ii. Aniline to N-phenylethanamide
- B. Two isomeric compounds A and B having molecular formula $C_4H_{11}N$, both lose N_2 on treatment with HNO_2 and gives compound C and D, respectively. C is resistant to oxidation but immediately responds to Lucas reagent, whereas 'D' responds to Lucas reagent after 5 minutes and gives a positive iodoform test. Identify A and B.

OR

Give the reasons for the following:

- i. Aniline does not undergo Friedel-Crafts reaction.
 - ii. $(CH_3)_2NH$ is more basic than $(CH_3)_3N$ in an aqueous solution.
 - iii. Primary amines have a higher boiling point than tertiary amines.
33. i. Complete the following chemical equations:
- a. $Cr_2O_7^{2-}(aq) + H_2S(g) + H^+(aq) \longrightarrow$
 - b. $Cu^{2+}(aq) + I^-(aq) \longrightarrow$
- ii. How would you account for the following?
- a. The oxidising power of oxoanions are in the order
 $VO_2^+ < Cr_2O_7^{2-} < MnO_4^-$
 - b. The third ionisation enthalpy of manganese ($Z = 25$) is exceptionally high.
 - c. Cr^{2+} is a stronger reducing agent than Fe^{2+} .

OR

- a. Give balanced chemical equations of two reactions in which $KMnO_4$ acts as an oxidizing agent in acidic medium.
- b. Give reason:
 - i. Cr^{2+} is a strong reducing agent whereas Mn^{2+} is not ($Cr = 24$, $Mn = 25$)
 - ii. The transition metal ions such as Cu^+ , Ag^+ and Sc^{3+} are colourless
 - iii. Chemistry of the actinoids is much more complicated than that of the lanthanoids.

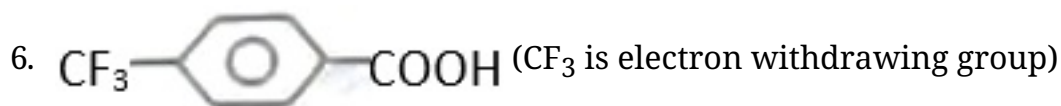
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Solution

Section A

1.
 - i. The total energy is equal in two-phase.
 - ii. $P_A = x_A \times P_A^\circ$
 $32 = x_A \times 40$
 $x_A = \frac{32}{40}$
 $x_A = 0.8$
 - iii. For pure octane, $x = 0$
 $\therefore p(\text{sol.})(\text{mm Hg}) = P(\text{octane}) = 35 + 65 \times 0 = 35 \text{ mm of Hg}$
 - iv. The value of ΔV_{mixing} & ΔH_{mixing} is negative.
 - v. It is an example of Non-ideal solution.
2. On roasting sulphides are partly converted to their respective oxides. Since the oxides of lead and mercury are unstable, these bring about the reduction of their respective sulphides to the corresponding metals.
$$\underset{\text{unstable}}{PbS} + 2PbO \xrightarrow{\text{Heat}} 3Pb + SO_2$$
$$\underset{\text{unstable}}{HgS} + 2HgO \xrightarrow{\text{Heat}} 3Hg + SO_2$$

However, zinc oxide is stable and it does not reduce ZnS to Zn.
3. D-glucose on reaction with NH_2OH (hydroxylamine) yield glucose oxime.
$$\begin{array}{c} CH=N-OH \\ | \\ (CHOH)_4 \\ | \\ CH_2OH \end{array}$$
4. α - amino acids are connected by peptide linkage.
5. Terylene or dacron



7. (d) secondary alcohols

Explanation: Carboxylic acids, esters, and acid halides can be reduced to either aldehydes or a step further to primary alcohols, depending on the strength of the reducing agent; aldehydes and ketones can be reduced respectively to primary and secondary alcohols.

8. (d) Hypophosphoric acid

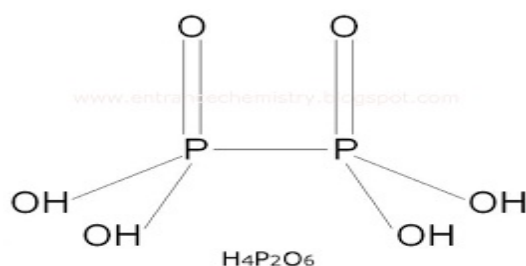
Explanation: The molecular formula for Hypophosphoric acid is $H_4P_2O_6$ and the Oxidation state for P is +4.

To find the oxidation state of P, keep P as x and summate the valencies of O and H w.r.t to number of atoms from the molecular formula

$$H_4P_2O_6 \Rightarrow 4(1) + 2x + 6(-2) = 0 \Rightarrow 2x + 4 - 12 = 0 \Rightarrow 2x - 8 = 0 \Rightarrow 2x - 8 = 0 \Rightarrow 2x = 8 \\ \Rightarrow x = \frac{8}{2} \Rightarrow x = +4$$

\therefore One P has +4 oxidation state

Structure is



It contains

- Four P - OH bonds
- Two P = O bonds
- One P - P bond

9. (d) Trigonal bipyramidal

Explanation: Fe has 5 carbonyl ligands around it i.e. CN=5. It has trigonal bipyramidal geometry with dsp^3 hybridisation.

10. (b) Chlorophylls are green pigments in plants and contain calcium

Explanation: Chlorophylls are green pigments in plants and contain magnesium rather than calcium

11. (a) Nylon 6, 6

Explanation: The condensation polymers are formed by repeated condensation reaction between two different bi-functional or tri-functional monomeric units. For nylon- 6,6, hexamethylenediamine and adipic acid are monomeric units.



12. (b) Both assertion and reason are CORRECT but, reason is NOT THE CORRECT explanation of the assertion.

Explanation: Both assertion and reason are CORRECT but, reason is NOT THE CORRECT explanation of the assertion.

13. (b) Both assertion and reason are CORRECT but, reason is NOT THE CORRECT explanation of the assertion.

Explanation: Both assertion and reason are CORRECT but, reason is NOT THE CORRECT explanation of the assertion.

14. (c) Assertion is CORRECT but, reason is INCORRECT.

Explanation: Assertion is CORRECT but, reason is INCORRECT.

15. (b) Both assertion and reason are CORRECT but, reason is NOT THE CORRECT explanation of the assertion.

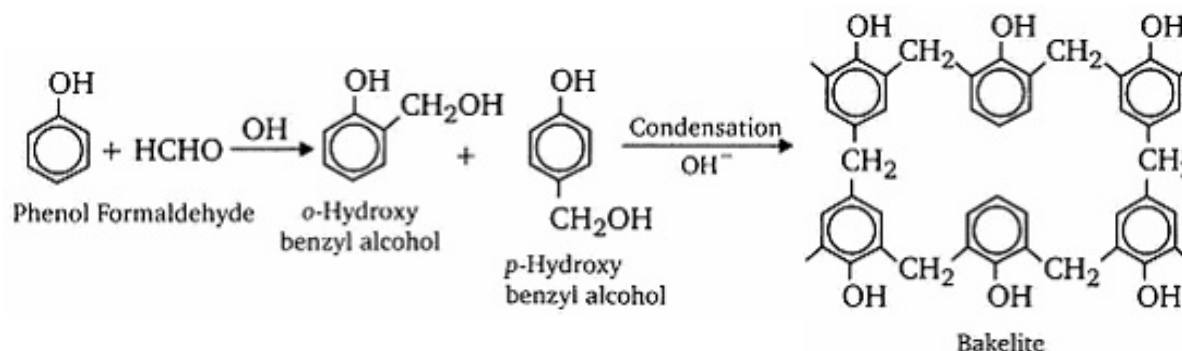
Explanation: Both assertion and reason are CORRECT but, reason is NOT THE CORRECT explanation of the assertion.

16. (c) Assertion is CORRECT but, reason is INCORRECT.

Explanation: Assertion is CORRECT but, reason is INCORRECT.

Section B

17. **Bakelite.** It is prepared by the condensation of phenol and formaldehyde.



18. It is given that $T_1 = 298\text{ K}$

$$\therefore T_2 = (298 + 10)\text{ K} = 308\text{ K}$$

We also know that the rate of the reaction doubles when temperature is increased by 10° .

Therefore, let us take the value of $k_1 = k$ and that of $k_2 = 2k$

Also, $R = 8.314 JK^{-1} mol^{-1}$

Now, substituting these values in the equation:

$$\log \frac{k_2}{k_1} = \frac{E_a}{2.303R} \left[\frac{T_2 - T_1}{T_1 T_2} \right]$$

We get:

$$\log \frac{2k}{k} = \frac{E_a}{2.303 \times 8.314} \left[\frac{10}{298 \times 308} \right]$$

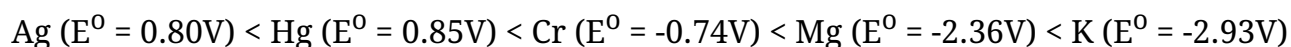
$$\Rightarrow \log 2 = \frac{E_a}{2.303 \times 8.314} \left[\frac{10}{298 \times 308} \right]$$

$$\Rightarrow E_a = \frac{2.303 \times 8.314 \times 298 \times 308 \times \log 2}{10}$$

$$= 52897.78 J mol^{-1}$$

$$E_a = 52.9 kJ mol^{-1}$$

19. Higher the oxidation potential, more easily it is oxidized and hence greater is the reducing power. Thus increasing order of reducing power will be:



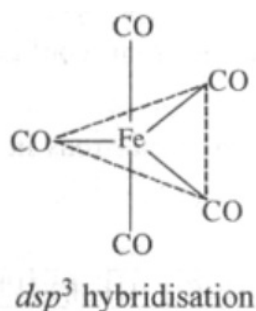
20. $[Co(NH_3)_4Cl_2]Cl$

Its IUPAC name - Tetraammine chloro cobalt III chloride.

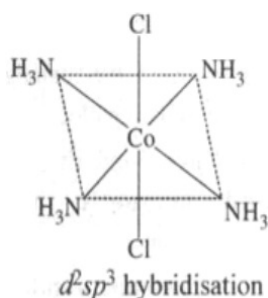
21. a. Potassium trioxalato electromate III
b. Mercuric tetrathiocyanatocobaltate III
c. Pentaamminecarbonatocobalt (III) chloride.

OR

i.



ii.

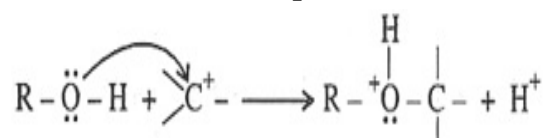


22. Minerals are naturally occurring chemical substances containing metals. They are found in the Earth's crust and are obtained by mining. Ores are rocks and minerals viable to be used as a source of metal. For example, there are many minerals containing zinc, but zinc cannot be extracted profitably (conveniently and economically) from all these minerals. Zinc can be obtained from zinc blende (ZnS), calamine ($ZnCO_3$), Zincite (ZnO) etc. Thus, these minerals are called ores of zinc.

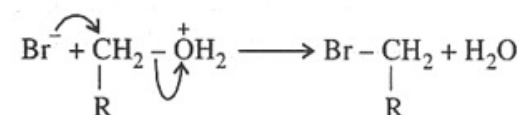
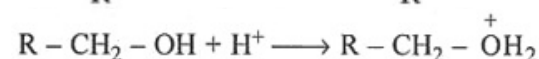
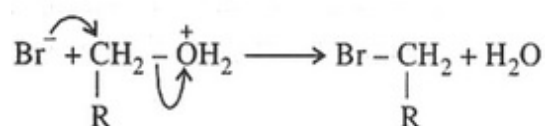
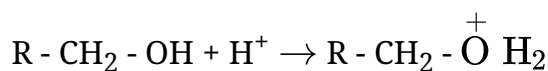
OR

Minerals are naturally occurring chemical substances containing metals. They are found in the Earth's crust and are obtained by mining. Ores are rocks and minerals viable to be used as a source of metal. For example, there are many minerals containing zinc, but zinc cannot be extracted profitably (conveniently and economically) from all these minerals. Zinc can be obtained from zinc blende (ZnS), calamine ($ZnCO_3$), Zincite (ZnO) etc. Thus, these minerals are called ores of zinc.

23. Alcohols as nucleophiles:



Alcohols as electrophiles: Protonated alcohols act as electrophiles:



Section C

24. A salt bridge is a U-shaped tube containing concentrated solution of an inert electrolyte like KCl, KNO₃ etc. or solidified solution of such an electrolyte in agar-agar and gelatine.

It is used for:

- To complete the electrical circuit by allowing ions to flow from one solution to the other without mixing the two solutions.
- To maintain the electrical neutrality of the solution in the two half cells.

25. A first order reaction 15% completes in 20 minutes. So, [R]₀ = 100M, [R] = 85M and t = 20 minutes.

$$k = \frac{2.303}{t} \log \frac{[R]_0}{[R]} = \frac{2.303}{20} \log \left[\frac{100}{85} \right]$$

$$k = \frac{2.303}{20} [\log 100 - \log 85]$$

$$k = \frac{2.303}{20} [2 - 1.9294]$$

$$K = k = \frac{2.303}{20} \times 0.0706 = 0.0081 \text{ min}^{-1}$$

Time taken for 60% completion of reaction

[R]₀ = 100M, [R] = 40 M and t = ?

$$t = \frac{2.303}{k} \log \frac{[R]_0}{[R]} \Rightarrow \frac{2.303}{0.0081} \log \left[\frac{100}{40} \right]$$

$$t = \frac{2.303}{0.0081} [\log 10 - \log 4]$$

$$t = \frac{2.303}{0.0081} \times [1 - 0.6021]$$

$$t = \frac{2.303}{0.0081} \times 0.379 = 113.13 \text{ min.}$$

OR

i. $Slope = \frac{K}{2.303}$

ii. As slope = $2 \times 10^{-4} s^{-1}$

$$\therefore K = 2.303 \times 2 \times 10^{-4} s^{-1}$$

$$K = 4.606 \times 10^{-4} s^{-1}$$

iii. For a first order reaction $t = \frac{2.303}{K} \log \frac{[R]_0}{[R]}$

$$\text{At } t_{1/2} [R] = \frac{[R]_0}{2}$$

$$t_{1/2} = \frac{2.303}{K} \log 2$$

$$t_{1/2} = \frac{0.693}{K}$$

26. Here, $n = 2$, $E_{cell}^{\ominus} = 0.236V$, $T = 298 K$

We know that:

$$\Delta_r G^{\ominus} = nFE_{cell}^{\ominus}$$

$$= -2 \times 96487 \times 0.236$$

$$= -45541.864 \text{ J mol}^{-1}$$

$$= -45.54 \text{ kJ mol}^{-1}$$

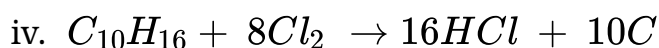
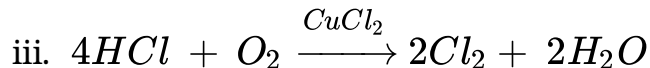
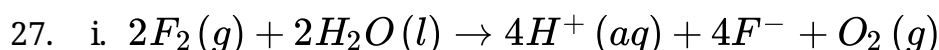
$$\text{Again, } \Delta_r G^{\ominus} = -2.303RT \log K_c$$

$$\log K_c = -\frac{\Delta_r G^{\ominus}}{2.303RT}$$

$$= -\frac{-45.54 \times 10^3}{2.303 \times 8.314 \times 298}$$

$$= 7.981$$

$$\therefore K_c = \text{Antilog}(7.981) = 9.57 \times 10^7$$



28. i. Since I^- ion is a better leaving group than Br^- ion, therefore, CH_3I will react faster than CH_3Br in S_N2 reaction with OH^- ion.

ii. On steric grounds 1° alkyl halides are more reactive than tert-alkyl halide in S_N2 reactions. Since this reaction requires the approach of the nucleophile to the carbon bearing the leaving group, the presence of bulky substituents on or near the carbon atom have a dramatic inhibiting effect. Therefore, CH_3Cl will react at a faster rate than $(CH_3)_3CCl$ in a S_N2 reaction with OH^- ion.

29. 1. 4-Methylpentanal

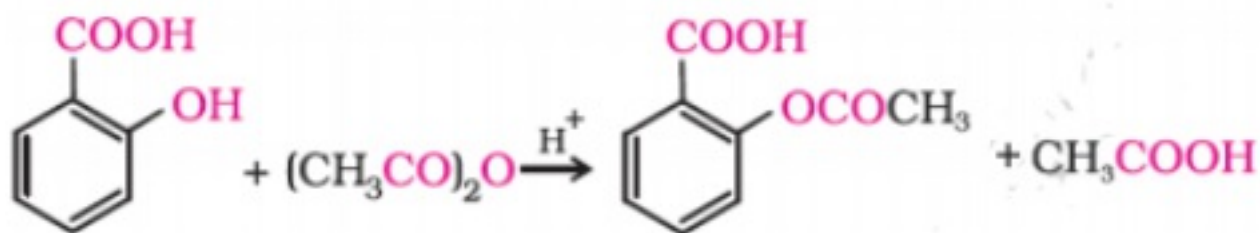
2. But-2-enal

3. 3,3-Dimethylbutanoic acid

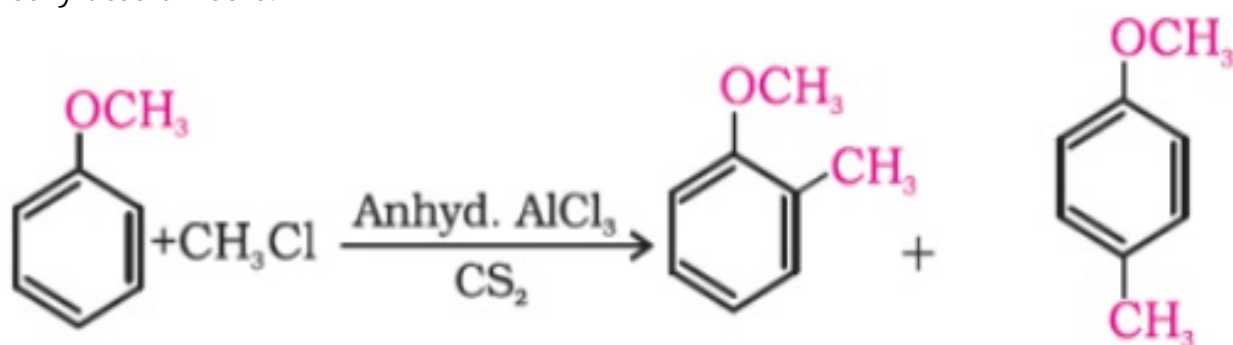
4. Benzene-1,4-dicarbaldehyde

OR

- a. Salicylic acid is treated with acetic anhydride in the presence of H^+ to give aspirin.



- b. Anisole is treated with CH_3Cl /anhydrous $AlCl_3$ to obtain ortho and para substituted methylated anisole.

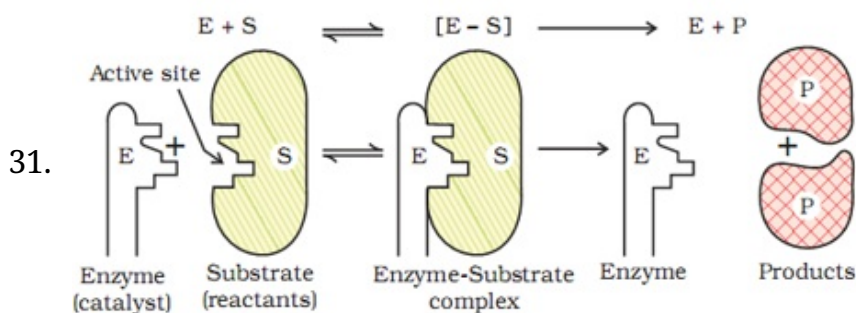


- c. Phenol in the presence of acidified sodium dichromate gives benzoquinone.



30. i. Tranquilizers are used as sleeping pills.
ii. Anionic detergents are used in toothpastes
iii. It is difficult to control the sweetness.

Section D

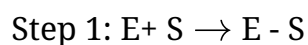


Enzymes are basically protein molecules of high molecular masses. They form colloidal solutions when dissolved in water. These are complex, nitrogenous organic compounds produced by living plants and animals. Enzymes are also called 'biochemical catalysts'.

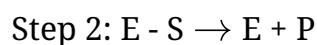
Mechanism of enzyme catalysis:

On the surface of the enzymes, various cavities are present with characteristic shapes. These cavities possess active groups such as $-NH_2$, $-COOH$ etc. The reactant molecules having a complementary shape fit into the cavities just like a key fits into a lock. This leads to the formation of an activated complex. This complex then decomposes to give the product.

Hence,



(Activated complex)



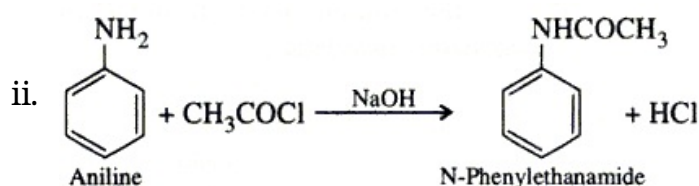
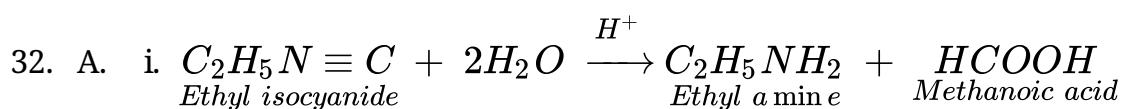
OR

- a. **Specific conductance:** It is defined as conductance of electrolyte when electrodes are 1 cm apart and have area of cross section is 1 cm^2 .

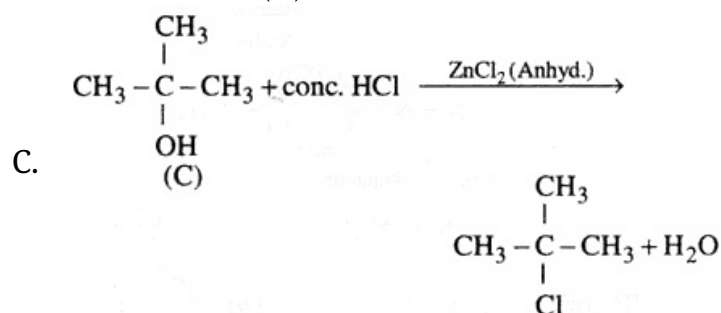
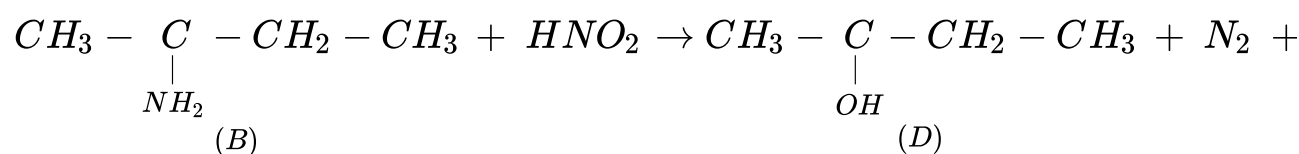
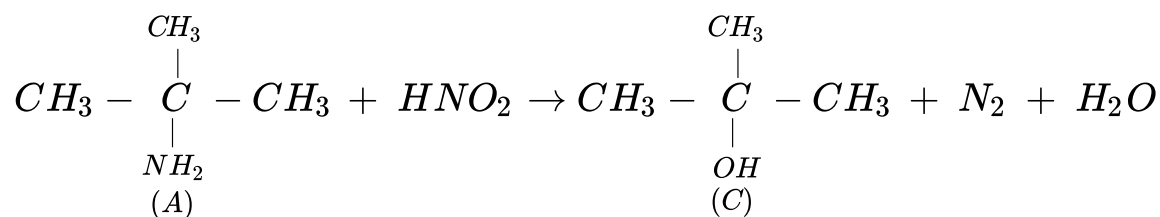
Molar conductivity: It is defined as conductance of all the ions produced from 1 mole of electrolyte when electrodes are unit distance apart and have sufficient area of cross section to hold electrolyte.

- b. $\text{Cr(s)} \mid \text{Cr}^{3+}(1\text{M}) \parallel \text{Cd}^{2+}(1\text{M}) \mid \text{Cd(s)}$

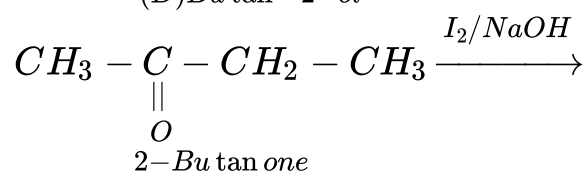
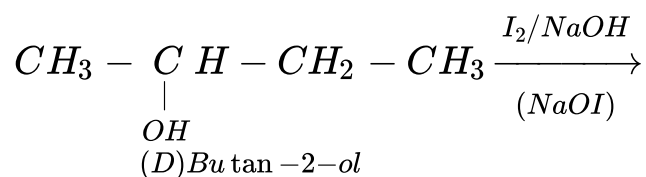
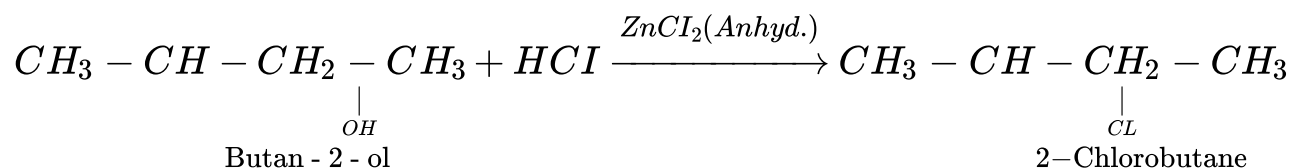
$$\begin{aligned} E_{\text{cell}}^0 &= E_{\text{Cd}^{2+}/\text{Cd}}^0 - E_{\text{Cr}^{3+}/\text{Cr}}^0 \\ &= -0.40 \text{ V} - (-0.74 \text{ V}) \\ &= 0.34 \text{ V} \end{aligned}$$



- B. The following reactions lead to the identification of A and B:



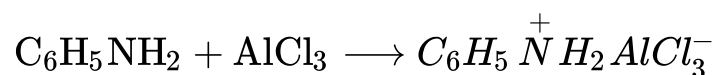
‘C’ is resistant to oxidation because tertiary alcohols do not undergo oxidation. It gives turbidity immediately with Lucas reagent. ‘D’ responds to Lucas reagent within 5 minutes because it is secondary alcohol and turbidity appears after 5 minutes.



OR

i. Aniline is a Lewis base and forms a salt with Lewis acid.

Aniline being a Lewis base reacts with Lewis acid ($AlCl_3$) to form a salt.



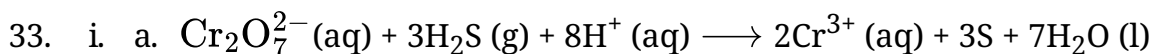
As a result, N acquires a positive charge so, it acts as a strong deactivating group for electrophilic substitution reaction. Thus, aniline does not undergo Friedel-Crafts reaction.

- ii. In aqueous solution, basic nature depends on + I-effect, H-bonding, and steric-effect.

The combined effect shows that $(\text{CH}_3)_2\text{NH}$ is more basic than $(\text{CH}_3)_3\text{N}$ as H-bonding is more in case of $(\text{CH}_3)_2\text{NH}$ than in $(\text{CH}_3)_3\text{N}$, which predominates over the stability due to +I- effect of three $-\text{CH}_3$ groups.

- iii. Large pK_b value means a weak base

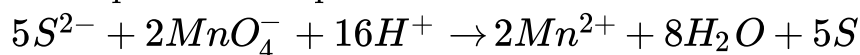
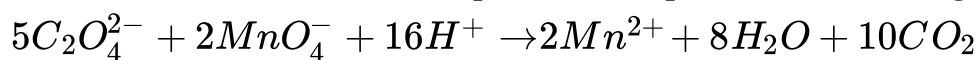
In aniline, the lone pair of electrons on N-atom is delocalized over the benzene ring. As a result, electron density on the nitrogen decreases and electrons are not available for donation. In contrast, in $\text{CH}_3\text{-NH}_2$, +I effect of $-\text{CH}_3$ group increases the electron density on the N-atom. Therefore, aniline is a weaker base than methylamine and hence, its pK_b value is higher than that of methylamine.



- ii. a. It is because V in the lower oxidation state is less stable than Cr which in turn is less stable than Mn. Thus, MnO_4^- has a great tendency to get reduced and hence, behave as a good oxidising agent. Similarly, VO_2^+ has the least oxidising power.
- b. The third ionisation enthalpy of Mn is very high because the third electron has to be removed from stable half-filled $3d^5$ -configuration.
- c. The electrode reduction potential values are:
 $E_{\text{Cr}^{3+}/\text{Cr}}^o = -0.74\text{V}$ and $E_{\text{Fe}^{2+}/\text{Fe}}^o = -0.44\text{V}$
As we know, the more negative the electrode potential, the greater is the reducing power of the electrode. The highest oxidation state for Cr is +6, therefore, it can lose 3 more electrons, whereas Fe needs to lose only 1 electron to achieve its highest oxidation state of +3. Thus, Cr^{3+} is more reducing than Fe^{2+} .

OR

-
- a. Acidified permanganate solution act as a strong oxidising agent. KMnO_4 oxidises oxalates to carbon dioxide, sulphides to sulphur etc and itself get reduced to Mn^{+2} .



- b. i. Cr^{2+} is less stable than Cr^{3+} therefore it is good reducing agent. Cr^{3+} is stable because outer most electronic configuration of Cr^{3+} is $3d^3$, which makes a stable half filled t_{2g} configuration. Whereas Mn^{2+} has outermost electronic configuration as $3d^5$ which is stable due to half filled d-orbitals therefore it is not reducing agent.
- ii. Cu^+ , Ag^+ , Sc^{3+} are colourless because they do not have unpaired electrons. Due to absence of unpaired electrons in them, no d-d transition occurs.
- iii. Actinoids show large number of oxidation states, that is why their chemistry is more complicated. Secondly all of them are radioactive and the earlier members have relatively long half-lives, the latter ones have half-life values ranging from a day to some minutes. The latter members could be prepared only in nanogram quantities. These facts render their study more difficult.