ISC 2026 EXAMINATION
Sample Question Paper - 2
Chemistry

Time Allowed: 3 hours and 15 minutes **Maximum Marks: 70**

General Instructions:

1. You are allowed additional 15 minutes for only reading the question paper.
2. You must NOT start writing during the reading time.
3. This question paper has 11 printed pages.
4. It is divided into four sections and has 21 questions in all.
5. All questions are compulsory. Answer all questions.
6. Section A has fourteen subparts. Each question carries 1 mark.
7. While attempting Multiple Choice Questions in Section A, you are required to write only ONE option as the answer.
8. Section B has ten questions. Each question carries 2 marks.
9. Section C has seven questions. Each question carries 3 marks.
10. Section D has three questions. Each question carries 5 marks.
11. Internal choices have been provided in one question each in Sections B, C and D.
12. The intended marks for questions are given in brackets [ ].
13. All working, including rough work, should be done on the same sheet as, and adjacent to the rest of the answer.
14. Balanced equations must be given wherever possible and diagrams where they are helpful.
15. When solving numerical problems, all essential workings must be shown.

Section A

1. **Fill in the blanks by choosing the appropriate word(s) from those given in the brackets:** **[4]**

   (a) Fill in the blanks by choosing the appropriate word/ words from those given in the brackets: **[4]**

   (ethanol, mild, propanoic acid, deactivating, benzoic acid, positive inductive, increasing, methanol, ethanoic acid, negative inductive, para, increases, benzaldehyde, meta, decreases, hot, cold, decreasing)

   i. Hydrolysis of methyl propanoate gives _____ and _____.

   ii. _____ is more acidic than acetic acid because of _____ effect.

   iii. Carboxylic acid group present in aromatic acids and act as ring _____ and _____ directing.

   iv. Acidity of carboxylic acids _____ with _____ electronegativity of substituents.

   v. Benzoic acid is soluble in water _____ and _____ water.

2. **Select and write the correct alternative from the choices given below.** **[7]**

   (a) Correct the following statement and rewrite: **[1]**

   Freezing point of a solution is directly proportional to its molality.

(b) Correct the following statement and rewrite: **[1]**

Addition of sodium chloride lowers the boiling point and freezing point of water.

(c) Correct the following statement and rewrite: **[1]**

Correct the following statement by changing the underlined part of the sentence.

Water boils <u>below 100</u>^{o}<u>C</u> by the addition of NaCl.

(d) Correct the following statement and rewrite: **[1]**

Osmotic pressure and boiling point are colligative properties.

(e) Correct the following statement and rewrite: **[1]**

Chloroacetic acid is more acidic than acetic acid because of the -M effect.

(f) **Assertion (A):** If a solution contains both H^+ and Na^+ ions, the H^+ ions are reduced first at cathode. **[1]**

Reason (R): Cations with higher E^o value are reduced first at cathode.

a) Both (A) and (R) are correct and (R) is the correct explanation for (A).

b) Both (A) and (R) are correct but (R) is not the correct explanation for (A).

c) (A) is correct but (R) is incorrect.

d) (A) is incorrect but (R) is correct.

(g) **Assertion (A):** Specific conductiity of all electrolytes decreases on dilution. **[1]**

Reason (R): On dilution, the number of ions per unit volume decreases.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

3. i. The half-life period $\left(t_{\frac{1}{2}}\right)$ for decay of radioactive ^{14}C is 5730 years. An ancient piece of wood has only 80% of the ^{14}C found in a living tree. Calculate the age of the piece of wood. **[3]**

ii. The rate of most of the reactions becomes double when the temperature is raised from 298 K to 308 K . Calculate the activation energy.

(R = 8.314 J K^{-1} mol^{-1})

Section B

4. Draw a graph which is used to calculate the activation energy of a reaction. Give the appropriate expressions used to calculate the activation energy graphically. **[2]**

5. State two points of difference in order of a reaction and the molecularity of reaction? **[2]**

6. An aqueous solution containing 1.70 g of cane sugar in 100 mL water begins to freeze at -0.093^{o}C. The cryoscopic constant (molal depression constant) of water is 1.86 kg mol^{-1}. Calculate the molecular weight of cane sugar. **[2]**

7. A decinormal solution of sodium chloride exerts an osmotic pressure of 4.82 atm at 27^{o}C. Calculate the degree of dissociation of sodium chloride. **[2]**

8. If 200 cm^3 of an aqueous solution of protein contains 1.26 g of protein, the osmotic pressure of the solution at 300 K is found to be 2.57×10^{-3} atm. Calculate the molar mass of protein. (R = 0.0821 L atm K^{-1} mol^{-1}) **[2]**

9. $[Fe(CN)_6]^{4-}$ is a coordination complex ion. **[2]**

i. Is the complex ion diamagnetic or paramagnetic?

ii. What is the hybridisation state of the central metal atom?

10. i. What type of isomers are $[Co(NH_3)_5Br]\ SO_4$ and $[Co(NH_3)_5SO_4]\ Br$? Give a chemical test to distinguish between them. **[2]**

ii. Write the structures of optical isomers of the complex ion $[Co(en)_2Cl_2]^+$.

11. Describe the oxidising action of potassium dichromate and write the ionic equations for its reactions with **[2]**

i. iodide and

ii. H_2S.

OR

i. Give a reason to explain why transition metals can act as a good catalyst.

ii. Scandium (Z = 21) does not exhibit variable oxidation states and yet it is regarded as transition element. Why?

12. i. Arrange the following alcohols in order of decreasing activity towards Lucas' reagent. **[2]**
2-butanol, 2-methyl-2-propanol and 1-butanol

ii. Ethanol has a higher boiling point than methoxymethane. Justify the statement.

13. i. Aromatic aldehydes do not give a reddish-brown precipitate on heating with Fehling solution. Give a reason. **[2]**

ii. Why is benzaldehyde less reactive to electrophilic substitution reactions than benzene?

Section C

14. Give balanced equations for the following reactions: **[3]**

i. Acetaldehyde is heated with hydroiodic acid in the presence of red phosphorus.

ii. Calcium acetate is subjected to dry distillation.

iii. Benzaldehyde is treated with sodium bisulphite.

15. How would you differentiate between $S_N1$and S_N2 mechanism of substitution reactions? Give one example of each. **[3]**

16. For the complex ion of (At no. of Fe = 26): **[3]**

i. Show hybridisation diagrammatically.

ii. Is it an inner orbital complex or an outer orbital complex?

iii. State its magnetic property.

17. 0.3605 g of a metal is deposited on the electrode by passing 1.2 A of current for 15 min through a salt solution. The atomic weight of the metal is 96. What is the valency of metal? **[3]**

OR

Consider the following cell reaction at 298 K:

$2Ag^+ + Cd \longrightarrow 2Ag + Cd^{2+}$

The standard reduction potential (E°) for Ag^+/Ag and Cd^{2+}/Cd are +0.80 V and -0.40 V respectively.

i. Give the cell representation.

ii. What will be the emf of the cell if concentration of Cd^{2+} is 0.1 M and Ag^+ is 0.2 M?

iii. Will the cell work spontaneously for the condition shown in (ii) above?

18. i. What products are obtained when sucrose is subjected to acid hydrolysis? **[3]**

ii. Why are vitamin B and vitamin C essential for us?

iii. On being heated, egg white becomes solid and opaque. Give a reason.

19. i. The rate constant of a reaction at 500 K and 700 K are 0.02 s^{-1} and 0.07 s^{-1} respectively. Calculate the value of E_a (activation energy). **[3]**

ii. A radioactive substance which emits alpha particle follows first order reaction. The half-life period of this radioactive substance is 30 hours. Calculate the fraction in percent (%) of the radioactive substance which remains after 90 hours.

20. The data in the table given below was obtained in a series of experiments on the rate of the reaction between compounds [A] and [B] at a constant temperature: **[3]**

Experiment	The initial concentration of [A] mol dm-3	The initial concentration of [B] mol dm-3	Initial rate mol dm-3 s-1
1	0.15	0.30	1.10 × 10-4
2	0.30	0.30	4.40 × 10-4
3	0.60	0.15	8.80 × 10-4

Show how this data can be used to deduce the rate expression for the reaction between [A] and [B].

Section D

21. Identify A, B, C, D and E, **[5]**

$$\text{Benzoic acid} \xrightarrow[\text{Heat}]{NH_3} [A] \xrightarrow{Br_2/KOH} [B] \xrightarrow[\text{Ice cold}]{NaNO_2+HCl} [C] \xrightarrow[HCl]{CuCl} [D]$$

22. i. Write chemical equations to illustrate the following name reactions: **[5]**

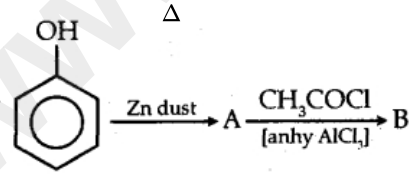
a. Williamson's synthesis

b. Esterification reaction

c. Reimer-Tiemann reaction

ii. Identify the compounds A and B in the given reactions:

a. $C_2H_5OH \xrightarrow[\Delta]{Cu} A \xrightarrow{\text{Dil. NaOH}} B$

b. 

23. The following data were obtained during the first order thermal decomposition of SO_2Cl_2 at constant volume. $SO_2Cl_2(g) \rightarrow SO_2(g) + Cl_2(g)$ **[5]**

Experiment	Times/s	Total pressure/atm
1	0	0.5
2	100	0.6

Calculate the rate of reaction when total pressure is 0.65 atm.

OR

The following results were obtained for the decomposition of nitrogen peroxide in an inert solvent:

t(c)	0	300	600	900	∞
Vol. of O_2 evolved (cm^3)	0	3.42	6.30	8.95	34.75

Show that the reaction is of first order and also calculate the rate constant.

Solution

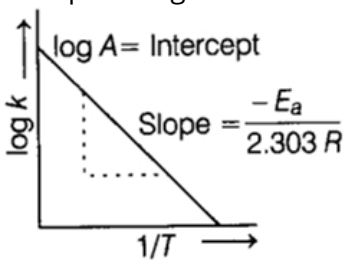
Section A

1. Fill in the blanks by choosing the appropriate word(s) from those given in the brackets:
   (a) i. Methanol, propanoic acid.
   ii. benzoic acid, negative inductive
   iii. Deactivating, meta
   iv. Increases, increasing
   v. Hot, cold
2. Select and write the correct alternative from the choices given below.
   (a) Depression in freezing point of a solvent is directly proportional to its molality.
   i.e. $\Delta T_f \propto m$
   (b) Addition of sodium chloride increases the boiling point and decreases the freezing point of water.
   (c) Water boils **above 100°C** by the addition of NaCl. It is because, NaCl is a strong electrolyte and it dissociates into 2 ions, therefore its van't Hoff value, i is 2 and the elevation of boiling point ΔT_b proportional to i.
   (d) Osmotic pressure and elevation in boiling point are colligative properties.
   (e) The correct statement is chloroacetic acid is more acidic than acetic acid because of the -I effect of Cl group.
   (f) **(a)** Both (A) and (R) are correct and (R) is the correct explanation for (A).
   Explanation:
   When a solution contain both H^+ and Na^+ ions H^+ ions are reduced first because E^o for hydrogen is 0V which is higher than $E^\circ_{(Na^+)}$ = -2.71 V.
   (g) **(a)** Both A and R are true and R is the correct explanation of A.
   Explanation:
   Both Assertion and Reason are true and the Reason is the correct explanation of Assertion.
3. i. Decay constant
   k = $\frac{0.693}{t_{\frac{1}{2}}} = \frac{0.693}{5730\text{year}}$ = 1.209×10^{-4}/year
   The rate of counts is proportional to the number of C-14 atoms in the sample.
   N_0 = 100, N = 80
   The age of the sample $t = \frac{2.303}{k}\log\left(\frac{N_0}{N}\right)$
   $t = \frac{2.303}{1.209\times10^{-4}} \times \log\left(\frac{100}{80}\right)$
   = 1846 years
   ii. Using Arrhenius equation, $k = A_0 e^{-\frac{E_a}{RT}}$
   $log\frac{k_2}{k_1} = \frac{E_a}{2.303}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$
   Given, rate of reaction doubles when temperature is raised from 208 to 308 K.
   $\frac{k_2}{k_1}$ = 2
   $E_a = \frac{2.303\times8.314\times298\times308\times0.3014}{1000}$
   = 52.89 kJ/mol

Section B

4. According to Arrhenius equation,
   $k = Ae^{\frac{-E_a}{RT}}$
   Taking log on both sides, we get
   $\log k = \log A - \frac{E_a}{2.303RT}$

Comparing the above equation with straight line equation, i.e. y = mx + c
where, y = log k, x = $\frac{1}{T}$
m(slope) = $-\frac{E_a}{2.303R}$
Intercept c = log A



Graph between log *k* and 1/*T*

After plotting, log k vs $\frac{1}{T}$ graph, slope of line will be $-\frac{E_a}{2.303R}$. Knowing the value of the slope and gas constant, the activation energy can be calculated with the help of equation, E_a = -2.303 R $\times$ slope.

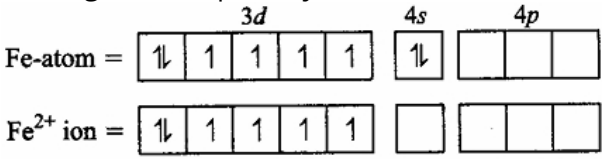
5.

Order of reaction	**Molecularity**
Order of reaction is the sum of exponents in the rate law equation.	Molecularity is the total number of molecules of reactants taking part in a elementary step of reaction.
Order of reaction may have fractional values or it may be zero.	There is always a whole number other than zero.

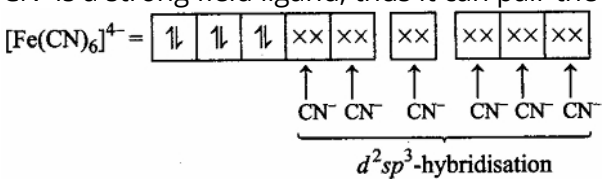
6. We know that, molecular mass = $\frac{i\times1000\times K_f\times w}{\Delta T\times W(\text{ g})}$
For cane sugar i = 1, w(cane sugar) = 1.70g, W = 100 g water
ΔT = 0 - (-0.093) = 0.093
K_f = 1.86 K kg mol^{-1}
$\therefore$ Molecular mass $= \frac{1\times1000\times1.86\times1.7}{0.093\times100}$
= 340 g mol^{-1}
7. Equivalent weight of NaCl = Molecular weight of NaCl
$\therefore$ 0.1 N NaCl = 0.1 M NaCl
If NaCl does not dissociate in aqueous solution then for a given solution, it is given that,
C = 0.1M, T = 300 K(27 + 273)
π = CRT
$= 0.1\text{M} \times 0.082\ \text{L atm K}^{-1}\ \text{mol}^{-1} \times 300\ \text{K}$
= 2.46 atm
But observed π = 4.82 atm
van't Hoff factor,
$i = \frac{\text{Observed magnitude of }\pi}{\text{Normal magnitude of }\pi} = \frac{4082}{2046} = 1.95 \approx 2$
If degree of dissociation is α, then
For NaCl, m = 2 as the number of solute particles formed in its aqueous solution is almost double the number of NaCl molecules.
$\therefore \alpha = \frac{i-1}{m-1} = \frac{2-1}{2-1} = 1$ or 100%
8. Given, Volume of aqueous solution of a protein $= 200\ cm^3$
Amount of protein = 1.26 g
Osmotic pressure, $\pi = 2.57 \times 10^{-3}\ atm$
R = 0.0821 L atm K^{-1} mol^{-1} or T = 300 K as $\pi = CRT$
$\therefore 2.57 \times 10^{-3} = \frac{1.26\times1000\times0.0821\times300}{M\times200}$
$M = \frac{1.26\times1000\times0.0821\times300}{2.57\times10^{-3}\times200}$
$= 0.06 \times 10^6\ g/mol^{-1}$

9. i. In the complex $[Fe(CN)_6]^{4-}$, iron exists in the + 2 oxidation state. Electronic configuration of Fe^{2+} is $4s^0 3\ d^6$, As CN^- is a strong field ligand, it causes the pairing of the unpaired 3d electrons. Hence, it is diamagnetic.

ii. In the given complex, hybridisation state of the central metal atom is d^2sp^3.



CN^- is a strong field ligand, thus it can pair the unpaired electrons of Fe^{2+}.



10. i. The compounds will give different ions in solution, although they have same composition. Hence, they represent ionisation isomers. These compounds ionise in solution as given below

$[\mathrm{CoBr(NH_3)_5}]\,\mathrm{SO_4} \longrightarrow [\mathrm{CoBr(NH_3)_5}]^{2+} + \mathrm{SO_4^{2-}}$

$[Co(SO_4)\ (NH_3)_5]Br \longrightarrow [Co(SO^4)(NH_3)_5]^+ + Br^-$

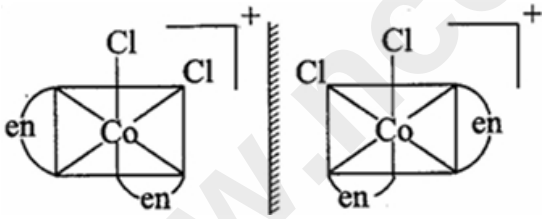
The complex $[CoBr(NH_3)_5]SO_4$ is red violet and its aqueous solution gives a white precipitate of $BaSO_4$ with $BaCl_2$.

Thus this reaction confirms the presence of $SO_4{}^{2-}$ ions in the solution. Whereas the complex $[Co(SO_4)\ (NH_3)_5]Br$ is red in colour and its aqueous solution gives a light yellow precipitate of AgBr with $AgNO_3$ thus confirming the presence of Br^- ions in the solution.

$$\underset{Red\ violet}{[CoBr(NH_3)_5]SO_4} + BaCl_2 \rightarrow White\ ppt.\ \underset{SO_4^{2-}\ ion}{due\ to}$$

$$\underset{Red}{[Co(NH_3)_5SO_4]Br} + BaCl_2 \rightarrow No\ ppt.$$

ii. cis-form of $[Co(en)_2Cl_2]^+$ give optical isomers.



Non-superimposable mirror image structure

11. Potassium dichromate is a strong oxidising agent.In acidic solution,its oxidising action is represented as

$$\mathrm{Cr_2O_7{}^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O}$$

i. Reaction of $K_2Cr_2O_7$ with I^-

$$\mathrm{Cr_2O_7{}^{2-} + 14H^+ + 6I^- \longrightarrow 2Cr^{3+} + 3I_2 + 7H_2O}$$

ii. Reaction of $K_2Cr_2O_7$ with H_2S

$$\mathrm{Cr_2O_7{}^{2-} + 8H^+ + 3H_2\ S \longrightarrow 2Cr^{3+} + 3\ S + 7H_2O}$$

OR

i. Transition elements can act as good catalyst because they are capable of exhibiting different oxidation states and hence they can act as both oxidising and reducing agents at the same time.

ii. Scandium (Z = 21) does not exhibit variable oxidation states and yet it is regarded as a transition element because it has partially filled d-orbitals, in the ground state ($3d^14s^2$).

12. i. The order of reactivity of alcohols towards Lucas reagent follows the sequence:

$3^\circ > 2^\circ > 1^\circ$

Thus, the correct sequence of reactivity is:

2-methyl-2-propanol (3^o) > 2-butanol (2^o) > 1-butanol (1^o).

ii. Ethanol undergoes intermolecular H -bonding due to the presence of a hydrogen attached to the electronegative oxygen atom. As a result, ethanol exists as associated molecules.
Consequently, a large amount of energy is required to break these hydrogen bonds. Therefore, the boiling point of ethanol is higher than that of methoxymethane which does not form H -bonds.

13. i. Aldehydes such as benzaldehyde, lacks in alpha hydrogens and cannot form an enolate and thus, do not give a positive test with Fehling solution.

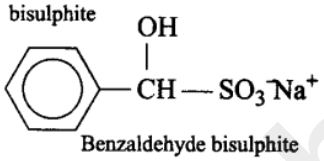
ii. Benzaldehyde is less reactive to electrophilic substitution reactions than benzene because the aldehyde group is an electron withdrawing group and destabilises the intermediate carbocation formed in electrophilic substitution reactions.

Section C

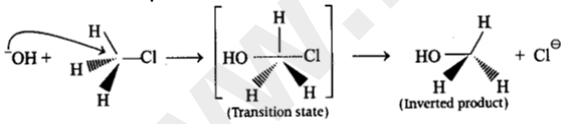
14. i. $CH_3CHO + 4HI \xrightarrow[423\ K]{\text{Red P}} CH_3—CH_3 + H_2O$
Acetaldehyde → Ethane

ii. $(CH_3COO)_2Ca \xrightarrow{\text{Dry distillation}} (CH_3)_2C=O + CaCO_3$
Calcium acetate → Acetone

iii. Benzaldehyde + $NaHSO_3$ (Sodium bisulphite) → Benzaldehyde bisulphite

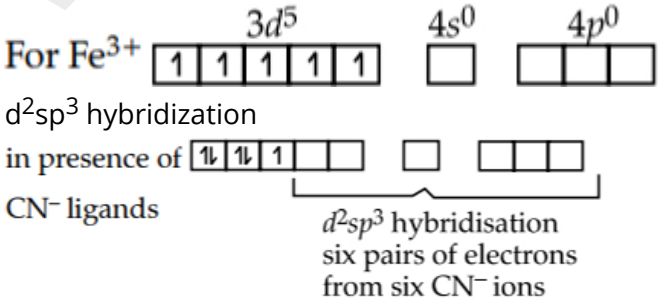


15. In S_N1 mechanism of substitution reaction, the rate of reaction depends upon the concentration of only one reactant, e.g. in the reaction between tert-butyl bromide and hydroxide ion to form tert-butyl alcohol, rate of reaction depends only on the concentration of tert-butyl bromide.
$(CH_3)_3C - Br + OH^- \longrightarrow (CH_3)_3C - OH + Br^-$
It involves the formation of carbocation intermediate and racemisation.
In S_N2 mechanism of substitution reaction, the rate of reaction depends upon the concentration of both the reactants. e.g. In the reaction between methyl chloride and hydroxide ion to form methanol, rate of reaction depends on the concentration of both the reactants.



It involves the formation of transition state and inversion (Walden inversion) of configuration.

16. i. In $[Fe(CN)_6]^{3-}$
Oxidation state of Fe is +3.
Electronic configuration $Fe = [Ar]3d^6 4s^2$



ii. It is an inner orbital complex as inner d-orbitals take part in hybridization.

iii. It is paramagnetic due to the presence of unpaired electrons.

17. Given, amount of metal, $w = 0.3605\ g$,

Current, $i = 1.2\ A$, time, $t = 15\ min = 15 \times 60\ s$

$0.3605 = \frac{E}{96500} \times 1.2 \times 15 \times 60$

(where, E is equivalent weight of metal.)

$E = \frac{0.3605 \times 96500}{1.2 \times 15 \times 60} = 32.211$

E = 32.21

$$\text{Equivalent weight} = \frac{\text{Atomic weight}}{\text{Valency}}$$

$$\text{Valency} = \frac{96}{32.21} = 2.98 \cong 3$$

(As atomic weight of metal is 96)

Hence, valency of metal = 3

OR

i. Cell representation is

$$\mathrm{Cd_{(s)} \left| Cd^{2+}{}_{(aq)} \right| \left| Ag^{+}{}_{(aq)} \right| Ag}$$

ii. $E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}}$

$= 0.80 - (-0.40) = 1.2\ V$

$E_{\text{cell}} = E^\circ_{\text{cell}} - \frac{0.0591}{n} \log \frac{[Cd^{2+}][Ag]^2}{[Ag^+]^2[Cd]}$

$= 1.2 - \frac{0.0591}{2} \log \frac{[0.1]}{[0.2]^2}$

= 1.18 V

iii. $\Delta G^\circ = -nFE^\circ$

Since E^o is positive, ΔG will be negative, so the cell will work spontaneously.

18. i. The products obtained on hydrolysis of sucrose are two monosaccharides, glucose and fructose.

ii. Vitamin B and vitamin C are essential for human health because they play important roles in many of our body functions.

$$\mathrm{C_{12}H_{22}O_{11} + H_2O \xrightarrow{H^+} \underset{(Glucose)}{C_6H_{12}O_6} + \underset{(Fructose)}{C_6H_{12}O_6}}$$

Vitamin B is a group of water soluble vitamins that play a key role in energy metabolism, nervous system and the formation of red blood cells. Vitamin C also acts as antioxidant and helps to protect the body against the damaging effects of free radicals.

iii. As the egg gets hotter, the spliced proteins form a mesh with water filling in the spaces within the mesh.

As more protein molecules unfold and connect to each other, the mesh gets stronger and the egg becomes more solid.

19. i. Given, T_1 = 500 K, T_2 = 700 K

$k_1 = 0.02\ s^{-1}$, $k_2 = 0.07\ s^{-1}$

We know that,

$\log \frac{k_2}{k_1} = \frac{E_a}{2.303R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$

$\log\left(\frac{0.07}{0.02}\right) = \frac{E_a}{2303 \times 8314}\left(\frac{1}{500} - \frac{1}{700}\right)$

$\log(3.5) = \frac{E_a}{19.15}\left[\frac{200}{350000}\right]$

$E_a = \frac{0.54 \times 19.15 \times 350000}{200}$

= 18096.75 J mol^{-1} = 18.096 kJ mol^{-1}

ii. Given, Half-life of radioactive substance = 30 hr = 1800 min

We know that, $t_{\frac{1}{2}} = \frac{0.693}{k}$

$\Rightarrow$ k = $\frac{0.693}{t_{\frac{1}{2}}} = \frac{0.693}{1800}$

= 0.000385 min^{-1}

Also for first order reaction,

t = $\frac{2.303}{k}\log\frac{[N_0]}{[N]}$

90 × 60 = $\frac{2303}{0.0003.85}\log\frac{[N_0]}{[N]}$

$\log\left[\frac{N_0}{N}\right] = \frac{90\times60\times0.000385}{2303}$ = 0.9027

$\frac{N_0}{N}$ = Antilog [0.9027]

= 7.9928

20. Let the rate be given by r = $k[A]^x[B]^y$

Where order of the reaction = x + y

Substituting given data

1.10 × 10^{-4} = $k[0.15]^x[0.30]^y$ ...(i)

4.40 × 10^{-4} = k$[0.30]^x$ $[0.30]^y$ ...(ii)

8.80 × 10^{-4} = k$[0.60]^x$ $[0.15]^y$ ...(iii)

From Eqs. (i) and (ii)

$\frac{1.1\times10^{-4}}{4.4\times10^{-4}} = \left[\frac{0.15}{0.30}\right]^x \Rightarrow \frac{1}{4} = \left(\frac{1}{2}\right)^x$

⇒ x = 2

From Eqs. (ii) and (iii)

$\frac{4.40\times10^{-4}}{8.80\times10^{-4}} = \left[\frac{0.30}{0.60}\right]^x\left[\frac{0.30}{0.15}\right]^y$

$\Rightarrow \frac{1}{2} = \left(\frac{1}{2}\right)^2[2]^y$

$\Rightarrow \frac{2^2}{2} = 2^y$

⇒ y = 1

From Eq. (ii),

4.40 × 10^{-4} = k$[0.30]^2$ $[0.30]^1$

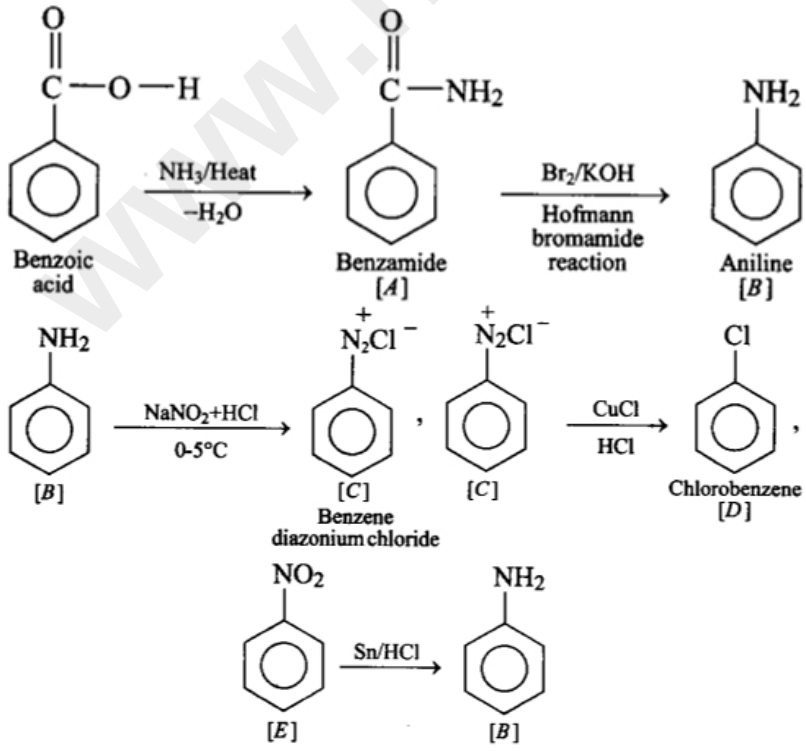
$\Rightarrow$ k = $\frac{4.40\times10^{-4}}{0.027}$

= 162.96 × 10^{-4} = 1.63 × 10^{-2}

$\therefore$ R = 1.63 × 10^{-2} $[A]^2$ $[B]^1$

Section D

21.



Since, E on reduction, gives aniline, hence it must be nitrobenzene, i.e. $C_6H_5NO_2$.

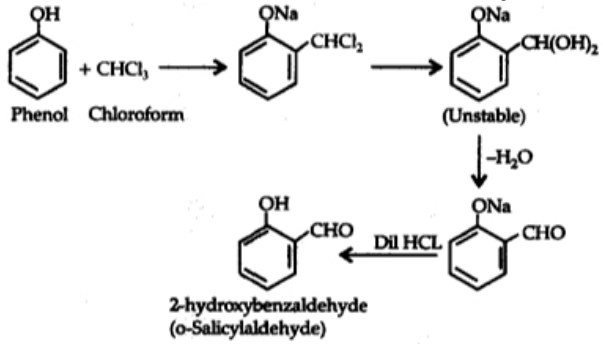
22. i. a. **Williamson's synthesis:** It is the best laboratory method for the preparation of simple and mixed ethers.

$$\underset{\text{Ethyl Bromide}}{C_2H_5Br} + \underset{\text{Sodium ethoxide}}{C_2H_5ONa} \rightarrow \underset{\text{Diethyl ether}}{C_2H_5 - O - C_2H_5} + NaBr$$

b. **Esterification reaction:** An acid reacts with an alcohol to produce ester, is called esterification.

$$\underset{\text{acetic acid}}{CH_3COOH} + \underset{\text{ethyl alcohol}}{C_2H_5OH} \rightarrow \underset{\text{ethyl acetate}}{CH_3COOCH_2CH_3} + H_2O$$

c. **Reimer-Tiemann reaction:** In this reaction phenol is heated with chloroform along with aqueous KOH/NaOH to about 340 K, followed by acidification,aldehyde is form.



$$C_2H_5OH \xrightarrow[573\ K]{Cu} CH_3CHO \xrightarrow{\text{Dil. NaOH}}$$

ii.

$$CH_3CH(OH)-CH_2-CHO$$

Aldol (3-hydroxybutanal)

(B)

23. For the decomposition of SO_2Cl_2

	$SO_2Cl_2(g) \longrightarrow$	$SO_2(g)$ +	$Cl_2(g)$
At $t = 0$	p_0 atm	0	0
At time t	$(p_0 - x)$ atm	x	x

p(t) = P_0 - x + x + x = P_0 + x

or x = P_1 = P_0

Now at time t, p($SOCl_2$) = $p_0 - x = p_0 - (p_t - p_0)$

= $2P_0$ - P

$\therefore k = \frac{2.303}{t} \log \frac{p_0}{2p_0 - p_t}$

when t = 100 s

$k = \frac{2.303}{100} \log \frac{0.5}{2 \times 0.5 - 0.6}$

$= \frac{2.303}{100} \log 1.25$

$= 2.2316 \times 10^{-3}\ s^{-1}$

When P_t = 0.65 atm, i.e., P_0 + P = 0.65 atm

P = 0.65 - P_0 = 0.65 - 0.50 = 0.15 atm

$\therefore$ Pressure of SO_2Cl_2 at time t = 0.50 - 0.15

= 0.35 atm

Rate = $2.2316 \times 10^{-3} \times 0.35$

$= 7.8 \times 10^{-5}\ atm\ s^{-1}$

OR

The reaction will be of first order, if it obeys the equation,

$k = \frac{-2.303}{t} \log \frac{a}{a-x}$

In this reaction, oxygen is liberated and collected at different times. The total volume of oxygen collected

at the end of reaction (after infinite time, t = ∞) gives a measure of the total concentration of nitrogen peroxide taken initially, i.e., a. If Vt is the volume collected after time t and V_∞ is the total volume collected at the end of the reaction, then the concentration of nitrogen peroxide at any time t, i.e., (a - x) is V_∞ - V_t

Thus, the above equation becomes

$k = \frac{2.303}{t} \log \frac{V_\infty}{V_i - V_t}$

Substituting the values,

t = 300 s, V_∞ = 34.75, V_t = 3.42

$\therefore k = \frac{2.303}{300} \log \frac{34.75}{34.75 - 3.42}$

= 0.000345

$t = 600\ s, V_\infty = 34.75, V_t = 6.30$

$k = \frac{2.303}{600} \log \frac{34.75}{34.75 - 6.30} = 0.000333$

$t = 900\ s, V_\infty = 34.75, V_t = 8.95$

$k = \frac{2.303}{900} \log \frac{34.75}{34.75 - 8.95} = 0.000332$

Since the value of k is almost constant, the reaction is of first order. The average value of rate constant is 0.000336.