C1A Physical Properties:

\[ \begin{align*}
\text{It has high dipole moment} \\
\text{Boiling point are lower than alcohols due to their inability to form intermolecular H-bonding.} \\
\text{B.Pt. are higher than corresponding alkanes due to dipole-dipole interaction.} \\
\text{Carbonyl group can form H-bond with H}_2\text{O hence they are soluble in water to varying extent.}
\end{align*} \]

C1B Method of Preparation:

1. Oxidation:

(a) \[ \text{RCH}_2\text{OH} \xrightarrow{\text{Cu, } \Delta \text{ 300}^\circ\text{C}} \text{RCHO} \]

(b) \[ \text{RCH}_2\text{OH} \xrightarrow{\text{MnO}_7/\text{CrO}_2/\text{Cr}_2\text{O}_7} \text{RCH} = \text{O} \]

(c) \[ \text{RCHO} + [(\text{CH}_3)_2\text{CO}]_2\text{Al} \xrightarrow{\text{Cu, } \Delta} \text{CO} \]

This oxidation is called as oppenauer oxidation.

2. Rossenmund Reduction:

\[ \text{R} - \text{C} - \text{Cl} + \text{H}_2 \xrightarrow{\text{Pd/ BaSO}_4} \text{R} - \text{C} - \text{H} + \text{HCl} \]

3. \[ \text{R} - \text{C} - \text{Cl} \xrightarrow{\text{LiAlH(OBu-t)}} \text{RCHO} \ [\text{LiAlH (O-t-C}_4\text{H}_3) \text{ or Lithium tri-t-butoxy Aluminium hydride}] \]

4. \[ \text{R} - \text{C} - \text{Cl} \xrightarrow{\text{Sn(C}_6\text{H}_5)\text{H}} \text{RCHO} \]

5. Hydrolysis of Gem-Dihalide

(a) \[ \text{CH}_3\text{CH}_2 - \text{CHCl} + \text{aq. NaOH} \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{OH} \rightarrow \text{CH}_3\text{CH}_2\text{CHO} \]

(b) \[ \text{CH}_3\text{C} - \text{CH}_3 + \text{aq. NaOH} \rightarrow \text{CH}_3\text{C} - \text{CH}_2\text{OH} \rightarrow \text{CH}_3\text{C} - \text{CH}_3 \]
6. **Hydration of Alkynes**: Hydration of alkynes gives ketones (except CH≡CH which gives CH₃CHO)

(a) \[ \text{CH}≡\text{CH} \xrightarrow{\text{H}_2\text{O},\text{H}^+} \text{CH}_3\text{CHO} \]

(b) \[ \text{CH}_2\text{C}≡\text{CH} \xrightarrow{\text{H}_2\text{O},\text{H}^+} \text{CH}_3\text{COCH}_3 \]

7. **Hydroboration Oxidation**: Hydroboration of a non-terminal alkyne followed by oxidation of the intermediate yields a ketone but terminal alkyne yield aldehyde.

\[ \text{CH}_3\text{C}≡\text{CH} \xrightarrow{\text{BH}_3, \text{THF}} \{\text{CH}_3\text{C} = \text{CH}_2\} \xrightarrow{\text{H}_2\text{O}, \text{OH}^-} \text{CH}_3\text{C} = \text{CHO} \xrightarrow{\text{H}} \text{CH}_3\text{C} = \text{CHO} \xrightarrow{\text{enol}} \text{CH}_3\text{CH} = \text{CHO} \]

8. **Use of Grignard Reagent**

(a) With HCN aldehyde is formed.

\[ \text{HCN} \xrightarrow{\text{RMgX}} \text{H} - \text{C} = \text{NMeX} \xrightarrow{\text{H}_2\text{O}} \text{H} - \text{C} = \text{O} \]

(b) With RCN a ketone is formed.

\[ \text{R} - \text{C} = \text{N} \xrightarrow{\text{R'MgX}} \text{R} - \text{C} = \text{NMeX} \xrightarrow{\text{H}_2\text{O}} \text{R} - \text{C} = \text{O} \]

9. **With Esters**

(a) \[ \text{H} - \text{C} - \text{OC}_2\text{H}_5 + \text{RMgX} \xrightarrow{\text{H}} \text{H} - \text{C} - \text{OC}_2\text{H}_5 \xrightarrow{\text{H}^+} \text{R} - \text{C} - \text{H} + \text{C}_2\text{H}_5\text{OH} \]

(b) \[ \text{CH}_3\text{C} - \text{OC}_2\text{H}_5 + \text{RMgX} \xrightarrow{\text{H}} \text{CH}_3\text{C} - \text{OC}_2\text{H}_5 \xrightarrow{\text{H}^+} \text{CH}_3\text{C} - \text{R} + \text{C}_2\text{H}_5\text{OH} \]

10. **Decarboxylation of calcium salts of carboxylic acids**

\[ (\text{R}_1\text{COO})_2\text{Ca} + (\text{R}_2\text{COO})_2\text{Ca} \xrightarrow{\Delta} \text{R}_1\text{C} - \text{R}_2 + 2\text{CaCO}_3 \]

11. **Oxo Process**

\[ \text{C} = \text{C} - + \text{CO} + \text{H}_2 \xrightarrow{100^\circ\text{C, Pr.}} \text{C} = \text{C} - \text{CHO} \]

\[ 2\text{CH}_2\text{CH} = \text{CH}_2 + \text{CO} + \text{H}_2 \xrightarrow{100^\circ\text{C, Pr.}} \text{CH}_3\text{CH}_2\text{CH}_2\text{CHO} + \text{CH}_3\text{CHO} \]
12. **Reduction of acid chloride with organocopper compounds:**

\[
R' \xrightarrow{\text{CuX}} R' - \text{Li} \xrightarrow{\text{RCOCU}} R - \text{C} - R' \text{ or } \text{Ar} - \text{C} - R'
\]

13. **Friedel-Crafts Acylation:**

(a) \[
\begin{align*}
\text{RCOCl} + \text{AlCl}_3 \xrightarrow{\text{HCl or other Lewis acid}} & \text{RCOR'} + \text{RCdCl} \\
& \text{Benzophenone}
\end{align*}
\]

(b) \[
\begin{align*}
\text{R} - \text{Cd} - \text{R} + \text{Ar} - \text{H} \xrightarrow{\text{AlCl}_3} & \text{R} - \text{C} - \text{Ar} + \text{HCl}
\end{align*}
\]

14. **From Cadmium and Lithium Salts:**

1. \[
2\text{RMgX} + \text{CdCl}_2 \rightarrow \text{R} - \text{Cd} - \text{R} + \text{MgCl}_2 + \text{MgX}_2
\]

   \[
\text{R} - \text{Cd} - \text{R} + \text{R'}\text{COCl} \rightarrow \text{RCOR'} + \text{RCdCl}
\]

   \[
\text{R} \xrightarrow{\text{should be 1}^\text{st} \text{alkyl or aryl}} \text{C}_6\text{H}_5
\]

15. **Ozonolysis of Alkene (Zn/H^\prime) \rightarrow Aldehyde/Ketone**

**C2 Chemical Properties:**

1. **Nucleophilic Addition to the Carbon-Oxygen Double bond:**

   The most characteristic reaction of aldehyde and ketone is nucleophilic addition to the carbon-oxygen double bond.

   General Reaction:

   \[
   \text{R} - \text{Cd} - \text{R} + \text{O} - \text{H} \xrightarrow{\text{Nu}} \text{R} - \text{C} - \text{OH}
   \]

2. **Relative reactivity of Aldehydes versus Ketones:**

   Aldehydes are more reactive than Ketones. There are two reasons for this, they are as follows:

   1. **Steric Factor**
   2. **Electronic factor**

   1. **Steric Factor:** With one group being the small hydrogen atom, the central carbon of the tetrahedral product formed from the aldehyde is less crowded and the product is more stable.

   With ketones two alkyl groups at the carbonyl carbon causes greater steric crowding in the tetrahedral product and make it less stable. Therefore small concentration is present at equilibrium.

   2. **Electronic Factor:** Because alkyl group are electron releasing therefore aldehydes are more reactive on electronic grounds as well. Aldehyde have one electron releasing alkyl group to stabilise the partial positive charge on the carbon atom of the carbonyl group. Whereas ketones have two alkyl groups.
(a) Addition of cyanide:

\[
\text{CH}_3 - C - \text{CH}_3 + \text{NaCN} \xrightarrow{\text{H}_2\text{O}^+} \text{CH}_3 - C - \text{CN} \xrightarrow{\text{H}_2\text{O/H}_2\text{SO}_4} \text{CH}_3 - C - \text{COOH}
\]

(b) Addition derivatives of ammonia:

(i) \[ \text{HCHO} + \text{NH}_3 \xrightarrow{\text{H}^+} \text{C} - \text{NH} \] \[ \xrightarrow{\text{OH}} \text{C} + \text{N} + \text{G} + \text{H}_2\text{O} \]

(ii) HCHO reacts with NH\(_3\) differently forming UROTROPINE [hexamethylene tetraamine].

\[
6\text{HCHO} + 4\text{NH}_3 \rightarrow (\text{CH}_2)\text{N}_4 + 4\text{H}_2\text{O}
\]

\[
\text{Hydroxylamine} \quad \text{C} = \text{N} - \text{OH} \quad \text{oxime}
\]

\[
\text{Hydrazine} \quad \text{C} = \text{N} - \text{NH}_2 \quad \text{Hydrazone}
\]

\[
\text{Phenylhydrazine} \quad \text{C} = \text{N} - \text{NHC}_6\text{H}_5 \quad \text{Phenylhydrazone}
\]

\[
\text{Semicarbazine} \quad \text{C} = \text{NNHOCH}_2 \quad \text{Semicarbazone}
\]

(c) Addition of Alcohols: Acetal Formation

(i) \[ \text{R - C - OH} \xrightarrow{\text{H}^+} \text{R - C - OR} + \text{H}_2\text{O} \]
Important:

\[ R' - C - OR + H_2O \xrightarrow{H^+ \text{ fast}} R' - C = O + 2ROH \]

OR (Acetal)

(d) Addition of Grignard reagents:

\[ C = O + R - MgX \rightarrow - C - OMgX \xrightarrow{H_2O} - C - OH + Mg^{2+} + X^- \]

Formaldehyde with Grignard Reagent gives 1° alcohol, all higher aldehydes with grignard reagent give 2° alcohol and ketones with grignard reagent gives the 3° alcohol.

C3 Other Reactions of Aldehyde and Ketones:

(a) Oxidation:

(i) \[ RCHO \text{ or ArCHO} \xrightarrow{K\text{MnO}_4, \text{ K}_2\text{Cr}_2\text{O}_7} RCOOH \text{ or ArCOOH} \]

Aldehydes (except benzaldehyde) reduce “Fehling’s Solution” (Cu^{2+} reduced to Cu^{+}) which is an alkaline solution of Cu^{2+} ion complexed with tetrarate ion.

(ii) Example: Tollen’s test:

\[ \text{CH}_3\text{CHO} + 2\text{Ag(NH}_3\text{)}_2^{2+} + 3\text{OH}^- \rightarrow \text{CH}_3\text{COO}^- + 2\text{Ag} + 4\text{NH}_3 + 2\text{H}_2\text{O} \]

\[ \text{Fehling Solution CH}_3\text{CHO} + 2\text{Cu}^{2+} + 3\text{OH}^- \rightarrow \text{CH}_3\text{COO}^- + 2\text{Cu}^+ \downarrow + 2\text{H}_2\text{O} \]

Tollen’s test is chiefly given by aldehydes. Tollen’s reagent does not attack carbon-carbon double bond. Aldehyde also reduce benedict’s solution (Cu^{2+} complexed with citrate ion) to Cu^{+}

(b) Ketones with strong oxidants and at high temperature undergo cleavage of C-C bond on either side of carbonyl group.

\[ RCH_2 \xrightarrow{\text{Oxidant drastic}} RCH_2\text{COOH} + R'\text{COOH} \]

From cleavage of bond

Carbonyl Group after bond cleavage goes with that alkyl group which is of smaller size.

(ii) Ketones are also oxidised from cleavage of bond by caro’s acid (H_2SO_3) or peroxybenzoic acid (C_6H_5CO_3H) to esters.

\[ \text{RCOR}' \xrightarrow{\text{H}_2\text{SO}_3} \text{RCOOR}' \] [Bayer’s Villiger Oxidation]
Haloform Test:

(i) Methylketones:

\[ R - C - CH_3 \quad \text{or} \quad Ar - C - CH_3 \xrightarrow{\text{NaOIsnO}_2} \text{RCOO}^- \quad \text{or} \quad \text{ArCOO}^- + \text{CH}_3 \text{I} \quad \text{(Iodoform)} \]

(ii) Hypohalite NaOX (NaOH + X_2) cannot only halogenate can also oxidise alcohols

\[ R - C - CH_3 + \text{NaOIsnO}_2 \xrightarrow{} R - C - CH_3 + \text{NaI} + \text{H}_2\text{O} \]

Reduction:

(a) Reduction to alcohol

\[ \xrightarrow{\text{H}_2\text{Ni, Pt or Pd}} \quad \text{C} = \text{O} \quad \xrightarrow{\text{LiAIH}_4 \text{or NaBH}_4} \quad \text{C} - \text{OH} \]

(b) Reduction to hydrocarbons

\[ \xrightarrow{\text{Zn(Hg)amine, HCl}} \quad \text{C} = \text{O} \quad \xrightarrow{\text{NH}_2\text{NH}_2 \text{base}} \quad \text{C} - \text{H} \quad \text{(Clemmenson's reduction)} \]

\[ \xrightarrow{\text{NH}_2\text{NH}_2 \text{base}} \quad \text{C} - \text{H} \quad \text{(Wolff-kishner reduction)} \]

(f) Reductive Amination (Discussed under Amines)

(g) Cannizzaro reaction: In the presence of an concentrated base i.e. alkali, aldehydes containing no \( \alpha \)-hydrogens undergo self oxidation and reduction to yield a mixture of an alcohol.

(i) An aldehyde with no \( \alpha \)-hydrogens

\[ 2\text{H} - \text{C} = \text{O} \xrightarrow{\text{strong base}} \text{HCOO}^- + \text{CH}_3\text{OH} \]

(ii) 2

\[ \begin{align*}
\text{CHO} & \xrightarrow{50\% \text{ KOH}} \text{COOK} \\
\text{Cl} & \text{Cl}\\
\text{m-chlorobenzaldehyde} & \text{m-chlorobenzoic acid} & \text{m-chlorobenzy alcohol}
\end{align*} \]
(h) Crossed Cannizzaro reaction:

\[ \text{CHO} + \text{HCHO} \xrightarrow{50\% \text{ KOH}} \xrightarrow{65^\circ} \text{CH}_2\text{OH} + \text{HCOO}^- \]

Veratraldehyde (3, 4-Dimethoxy benzaldehyde)

(i) Tischenko Reaction:

All aldehyde in presence of aluminium ethoxide, \( \text{Al(OCH}_3\text{H}_2\text{)} \), can be simultaneously oxidised (to acid) and reduced (to alcohols) to form ester. This is called Tischenko reaction and is thus like cannizaro reaction.

\[ \text{RCHO} \xrightarrow{\text{Al(OCH}_3\text{H}_2\text{)}} \text{RCH}_2\text{OH} \quad \text{RCHO} \xrightarrow{\text{Al(OCH}_3\text{H}_2\text{)}} \text{RCOOH} \]

\[ 2\text{CH}_3\text{CHO} \xrightarrow{\text{Al(OCH}_3\text{H}_2\text{)}} \text{CH}_3\text{COOC}_2\text{H}_4 \]

(j) Distinction

**Aldehyde and Ketones**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Test</th>
<th>RCHO</th>
<th>RCOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Schiff's reagent</td>
<td>magenta colour</td>
<td>no. reaction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>restored by</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>RCHO</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Tollen's reagent</td>
<td>is reduced by</td>
<td>is not reduced</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RCHO</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Fehling's solution</td>
<td>is reduced by</td>
<td>is not reduced</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RCHO (except ( \text{C}_6\text{H}_5\text{CHO} ))</td>
<td>( \alpha )-hydroxy, ketones reudce Tollen’s reagent and Fehling’s solution ( - \text{CH} - \text{CO} - ) \text{OH}</td>
</tr>
</tbody>
</table>

Practice Problems:

1. Identify (Z) in the reaction series, \( \text{CH}_2 = \text{CH}_2 \xrightarrow{\text{HBr}} \chi (X) \xrightarrow{\text{Hydrolysis}} (Y) \xrightarrow{\text{NaOH}} (Z) \)
   
   \( (a) \ \text{C}_2\text{H}_5\text{I} \quad (b) \ \text{C}_2\text{H}_5\text{OH} \quad (c) \ \text{CH}_3\text{I} \quad (d) \ \text{CH}_3\text{CHO} \)

2. A compound (X) of the formula \( \text{C}_3\text{H}_8\text{O} \) yields a compound \( \text{C}_3\text{H}_6\text{O} \) on oxidation. To which of the following class of compounds could (X) belong
   
   \( (a) \ \text{aldehyde} \quad (b) \ \text{secondard alcohol} \quad (c) \ \text{alkene} \quad (d) \ \text{tert. alcohol} \)

3. Which statement is incorrect in the case of acetaldehyde and acetone
   
   \( (a) \ \text{both react with hydroxylamine} \quad (b) \ \text{both react with NaHSO}_3 \)
4. Which of the following undergoes Cannizzaro’s reaction
   (a) CH₂CHO  (b) CH₂CH₂CHO  (c) (CH₃)₂CHCHO  (d) HCHO

5. Acetaldehyde is formed by the action of ammonia on
   (a) formaldehyde  (b) acetaldehyde  (c) acetone  (d) phenol

6. Hydrocarbons are formed when aldehydes and ketones are reacted with amalgamated zinc and conc. HCl. The reaction is called
   (a) Cannizzaro’s reaction  (b) Clemmenson’s reduction  (c) Rosenmund’s reaction  (d) Tischenko reaction

7. When acetaldehyde is treated with aluminium ethoxide, it forms
   (a) ethyl acetate  (b) ethyl alcohol  (c) acetic acid  (d) methyl propionate

8. Chloretone is formed when chloroform reacts with
   (a) formaldehyde  (b) acetaldehyde  (c) acetone  (d) benzaldehyde

9. Which of the following reagent reacts differently with HCHO, CH₂CHO and CH₂COCH₃?
   (a) HCN  (b) NH₂OH  (c) C₆H₅NHNH₂  (d) NH₃

10. In the following sequence of reactions, the end product is
    \[ \text{CaC}_2 \xrightarrow{\text{H}_2\text{O}} \text{A} \xrightarrow{\text{Hg}^{2+}/\text{H}_2\text{SO}_4} \text{B} \xrightarrow{[\text{O}]} \text{C} \xrightarrow{\text{Ca(OH)}_2} \text{D} \xrightarrow{\text{heat}} \text{E} \]
    (a) acetaldehyde  (b) formaldehyde  (c) acetic acid  (d) acetone

11. In the following sequence of reactions, the end product is
    \[ \text{HC} \equiv \text{CH} \xrightarrow{\text{Hg}^{2+}/\text{H}_2\text{SO}_4} \text{A} \xrightarrow{\text{CH}_3\text{MgX} \ [\text{H}_2\text{O}]} \text{B} \xrightarrow{[\text{O}]} \text{C} \]
    (a) acetaldehyde  (b) isopropyl alcohol  (c) acetone  (d) ethyl alcohol

12. In the following sequence of reactions, the end product is
    \[ \text{CH}_3\text{CHO} \xrightarrow{\text{HCN}} \text{A} \xrightarrow{\text{H}_2\text{O}} \text{B} \]
    (a) CH₃COOH  (b) CH₃CHOHCOOH  (c) CH₃CH₆N₂H₂  (d) CH₃CONH₂

13. A compound, C₃H₆O, forms a phenyl hydrazone and gives negative Tollen’s and iodoform tests. The compound on reduction gives n-pentane. The compound A is
    (a) pentanal  (b) pentanone-2  (c) pentanone-3  (d) amyl alcohol

14. The product Z in the series is
    \[ \text{CH}_2 = \text{CH}_2 \xrightarrow{\text{HBr}} \text{X} \xrightarrow{\text{Hydrolysis}} \text{Y} \xrightarrow{\text{Na}_2\text{CO}_3}{\text{I}_2(\text{excess})} \text{Z} \]
    (a) C₂H₅I  (b) C₂H₅OH  (c) CH₃I  (d) CH₃CHO

15. If formaldehyde and KOH are treated together, we get
    (a) methane  (b) methanol  (c) ethyl acetate  (d) acetylene

16. The correct order of reactivity in nucleophilic addition reaction CH₃CHO, CH₃COC₂H₅ and CH₂COCH₃ is
    (a) CH₃CHO > CH₃COCH₃ > CH₃CO₂H₅  (b) C₂H₅COCH₃ > CH₃COCH₃ > CH₃CHO  (c) CH₂COCH₃ > CH₃CHO > C₂H₅COCH₃  (d) CH₃COCH₃ > C₂H₅COCH₃ > CH₃CHO
17. To distinguish between 2-pentanone and 3-pentanone which reagent can be used
   (a) NaOH/I₂ (b) Tollen’s reagent
   (c) K₂Cr₂O₇/H⁺ (d) Zn–Hg, HCl

18. CH₃CH = CHCHO is oxidised to CH₃ – CH = CHCOOH, using oxidising agent as
   (a) alkaline KMnO₄ (b) K₂Cr₂O₇/conc. H₂SO₄
   (c) ammonical AgNO₃ (d) dilute HNO₃

19. m-chloro benzaldehyde on reaction with conc. KOH at room temperature gives
   (a) potassium m-chloro benzoate and m-hydroxy benzaldehyde
   (b) m-chloro benzyl alcohol and m-hydroxy benzaldehyde
   (c) m-chloro benzyl alcohol and m-hydroxy benzyl alcohol
   (d) m-chloro benzyl alcohol and potassium m-chloro benzoate

20. The reagent which can be used to distinguish acetophenone from benzophenone is :
   (a) 2, 4-dinitrophenyl hydrazine (b) benedict reagent
   (c) I₂ and Na₂CO₃ (d) aqueous solution of NaHSO₃

21. Best starting material to synthesize 2-methyl-2-butenoic acid is

   \[
   \begin{align*}
   \text{(a)} & \quad \text{CH}_3 \\
   \text{(b)} & \quad \text{CH}_3 - \text{C} - \text{CH}_3 \\
   \text{(c)} & \quad \text{CH}_3 - \text{CH} - \text{CHO} \\
   \text{(d)} & \quad \text{CH}_3\text{CH}_2 - \text{C} - \text{CH}_3
   \end{align*}
   \]

22. 1-pentyne

   X and Y can be distinguished by :

   (a) silver-mirror test (b) iodoform test (c) both (d) none

23. Which of the following will give haloform test

   (a) \( \text{CH}_3 - \text{C} - \text{CCl}_3 \) (b) \( \text{CH}_3 - \text{C} - \text{CH}_2\text{I} \)
   (c) \( \text{CH}_3 - \text{C} - \text{CH}_2\text{Cl} \) (d) all

   [Answers : (1) c (2) b (3) d (4) d (5) b (6) b (7) a (8) c (9) d (10) d (11) c (12) b (13) c (14) c (15) b (16) a (17) a (18) a (19) d (20) c (21) c (22) c (23) d]
1. Which of the following reagent reacts differently with HCHO, CH₃CHO and CH₃COCH₃
   (a) HCN  (b) NH₂OH  (c) C₆H₅NHNH₂  (d) NH₃

2. In the following sequence of reactions, the end product is
   CH₃CHO [Condensation] → (A) [Dehydrating agent] → (B)
   (a) aldol
   (b) crotonaldehyde
   (c) paraldehyde
   (d) metaldehyde

3. Which of the following reaction is a condensation reaction
   (a) HCHO → Paraformaldehyde
   (b) CH₃CHO → Paraldehyde
   (c) CH₃COCH₃ → Mesityl oxide
   (d) CH₂ = CH₂ → Polyethylene

4. A compound A has molecular formula C₆Cl₃OH. It reduces Fehling's solution and on oxidation gives a monocarboxylic acid. A is obtained by the action of Cl₂ on ethyl alcohol. The compound A is
   (a) chloroform
   (b) chloral
   (c) trichloro ethanol
   (d) trichloro acetic acid

5. The product Z in the series is
   CH₂ = CH₂ \xrightarrow{IBr} X \xrightarrow{Hydrolysis} Y
   Na₂CO₃ \xrightarrow{I₂(excess)} Z
   (a) C₆H₁₁  (b) C₆H₅OH
   (c) CH₃I  (d) CH₃CHO

6. Cyanohydrin of which of the following gives lactic acid on hydrolysis
   (a) acetone  (b) acetaldehyde
   (c) propanal  (d) HCHO

7. In the reaction CH₃CHO + HCN → CH₃CHOHCN, a chiral centre is produced. The product is
   (a) meso compound
   (b) laevorotatory
   (c) dextrorotatory
   (d) racemic mixture

8. Formic acid and formaldehyde can be distinguished by treating with
   (a) Benedict's solution
   (b) Tollen's reagent
   (c) Fehling's solution
   (d) NaHCO₃

9. 2CH₃CHO \xrightarrow{Al(OC₂H₅)₃, heat} CH₃COOCH₂CH₃. This reaction is called
   (a) Cannizzaro’s reaction
   (b) Aldol condensation
   (c) Claisen’s reaction
   (d) Tischenko reaction

10. The reaction involving condensation of acetic anhydride with an aromatic aldehyde by a carboxylate ion is an example of
    (a) aldon condensation
    (b) benzon condensation
    (c) Perkin reaction
    (d) Wurtz reaction

11. Benzaldehyde when refluxed with aqueous alcoholic KCN forms
    (a) benzoin
    (b) benzene
    (c) phenyl cyanide
    (d) phenyl isocyanide

12. Benzyl alcohol is obtained from benzaldehyde by
    (a) Wurtz reaction
    (b) Cannizzaro’s reaction
    (c) Perkin reaction
    (d) Claisen reaction

13. C₆H₆ + CO + HCl \xrightarrow{Anhyd.AlCl₃} (X) + HCl
    The compound (X) is
    (a) C₆H₅CHO  (b) C₆H₅COOH
    (c) C₆H₅CH₂Cl  (d) C₆H₅CH₃

14. Which of the following is the weakest acid
    (a) benzene sulphonlic acid
    (b) benzoic acid
    (c) benzyl alcohol
    (d) phenol
15. In the Cannizzaro’s reaction given below

\[2\text{PhCHO} + \text{OH}^- \rightarrow \text{PhCH}_2\text{OH} + \text{PhCO}_2^-\]

the slowest step is
(a) attack of OH\(^-\) at the carbonyl group
(b) the transfer of hydride to the carbonyl group
(c) the abstraction of proton from the carboxylic acid
(d) the deprotonation of Ph–CH\(_2\)OH

16. The reagent(s) which can be used to distinguish acetophenone from benzophenone is (are) :
(a) 2, 4-dinitrophenyl hydrazine
(b) benedict reagent
(c) I\(_2\) and Na\(_2\)CO\(_3\)
(d) aqueous solution of NaHSO\(_3\)

17. m-chloro benzaldehyde on reaction with conc. KOH at room temperature gives
(a) potassium m-chloro benzoate and m-hydroxy benzaldehyde
(b) m-chloro benzyl alcohol and m-hydroxy benzaldehyde
(c) m-chloro benzyl alcohol and m-hydroxy benzy alcohol
(d) m-chloro benzyl alcohol and potassium m-chloro benzoate

18. A natural compound (X), C\(_4\)H\(_8\)O\(_2\), reduces Fehling’s solution, liberates hydrogen when treated with sodium metal and gives a positive iodoform test. The structure of (X) is
(a) CH\(_3\)CHOHCH\(_2\)CHO
(b) HOCH\(_2\)CH\(_2\)CHO
(c) CH\(_3\)COCH\(_2\)CHO
(d) CH\(_2\)COCH\(_2\)CH\(_2\)OH

19. 1-pentene

\[\text{BH}_3, \text{THF} / \text{H}_2\text{O}_2, \text{OH}^- \rightarrow Y\]

X and Y can be distinguished by :
(a) silver-mirror test
(b) iodoform test
(c) both
(d) none

20. Which of the following will give haloform test

(a) CH\(_3\) – C – CCl\(_3\)
(b) CH\(_3\) – C – CH\(_2\)I
(c) CH\(_3\) – C – CH\(_2\)Cl
(d) all

21. \(\text{2D} – \text{C} = \text{O} + \text{OH}^- \rightarrow \text{cannizzaro} \rightarrow \text{X and Y}\) (Y is alcohol, D is deuterium)

X and Y will have structure :
(a) \(\text{D} \quad \text{O} \quad \text{D}\)
(b) \(\text{D} \quad \text{C} \quad \text{O}^- , \quad \text{D} \quad \text{C} \quad \text{OH} \quad \text{D}\)
(c) \(\text{H} \quad \text{C} \quad \text{O}^- , \quad \text{D} \quad \text{C} \quad \text{OH} \quad \text{D}\)
(d) none is correct

22. \(\text{2} \quad \text{O} \quad \text{NaOH} \quad \Delta \rightarrow \text{A}\)

A is :
(a) 
(b) 
(c) none is correct
(d) 

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23. A carbonyl compound with molecular weight 86, does not reduce Fehling’s solution but forms crystalline bisulphite derivatives and gives iodoform test. The possible compounds can be
(a) 2-pentanone and 3-pentanone
(b) 2-pentanone and 3-methyl-2-butanone
(c) 2-pentanone and pentanal
(d) 3-pentanone and 3-methyl-2-butanone

24. In the Cannizzaro’s reaction given below,

\[ 2\text{PhCHO} + \text{OH}^- \rightarrow \text{PhCH}_2\text{OH} + \text{PhCOO}^- \]

the slowest step is
(a) the attack of OH$^-$ at the carbonyl group
(b) the transfer of hydride to the carbonyl group
(c) the abstraction of proton from the carboxylic acid
(d) the deprotonation of Ph–CH$_2$OH

**ANSWERS (SINGLE CORRECT CHOICE TYPE)**

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COMPREHENSION TYPE

Comprehension-1

Cyclohexanol $\xrightarrow{\text{H$_2$CrO$_4$, acetone}}$ A(C$_6$H$_{10}$O)

$\xrightarrow{(1)\text{CH}_2\text{Mgl}}$ B(C$_7$H$_{14}$O) $\xrightarrow{\text{heat}}$ C(C$_7$H$_{12}$)

$\xrightarrow{(1)\text{O}_3, (2)\text{Zn, HOAc}}$ D(C$_7$H$_{12}$O$_2$) $\xrightarrow{(1)\text{Ag$_2$O, OH$^-$}, (2)\text{H}_2\text{O}^+}$ E(C$_7$H$_{12}$O$_3$)

1. The structure of compound B formed is

(a) \[
\begin{array}{c}
\text{CH}_3 \\
\text{O} \\
\text{CH}_3
\end{array}
\]

(b) \[
\begin{array}{c}
\text{CH}_3 \\
\text{OH} \\
\text{CH}_3
\end{array}
\]

(c) \[
\begin{array}{c}
\text{CH}_2\text{OH} \\
\text{O}
\end{array}
\]

(d) \[
\begin{array}{c}
\text{CH}_3 \\
\text{C}_\text{H}(\text{CH}_3)_2\text{OH} \\
\text{O}
\end{array}
\]

2. The D formed in the above sequence is

(a) \[
\begin{array}{c}
\text{CH}_3\text{C}(\text{CH}_3)_2\text{COOH}
\end{array}
\]

(b) \[
\begin{array}{c}
\text{CH}_3\text{C}(\text{CH}_3)_2\text{CHO}
\end{array}
\]

(c) \[
\begin{array}{c}
\text{CHO}(\text{CH}_3)_2\text{CHO}
\end{array}
\]

(d) \[
\begin{array}{c}
\text{HOOC}(\text{CH}_3)_2\text{COOH}
\end{array}
\]

3. D on treatment with Ag$_2$O, OH$^-$ and upon acidification forms

(a) \[
\begin{array}{c}
\text{CH}_3\text{C}(\text{CH}_3)_2\text{COOH}
\end{array}
\]

(b) \[
\begin{array}{c}
\text{CH}_3\text{C}(\text{CH}_3)_2\text{CHO}
\end{array}
\]

(c) \[
\begin{array}{c}
\text{CHO}(\text{CH}_3)_2\text{CHO}
\end{array}
\]

(d) \[
\begin{array}{c}
\text{HOOC}(\text{CH}_3)_2\text{COOH}
\end{array}
\]

Comprehension-2

The following reaction sequence shows how the carbon chain of an aldehyde may be lengthened by two carbon atoms.

Ethanal $\xrightarrow{(1)\text{BrCH}_2\text{CO}_2\text{Et, Zn, }\text{H}_2\text{O}^+}$ K(C$_6$H$_{12}$O$_3$) $\xrightarrow{\text{HA, heat}}$ L(C$_6$H$_{18}$O$_2$) $\xrightarrow{\text{H}_2\text{Pt, DIBAL--H}}$ M(C$_6$H$_{12}$O$_2$) $\xrightarrow{(1)\text{DIBAL--H}, (2)\text{H}_2\text{O}}$ butanal

4. Structure of K formed is

(a) \[
\begin{array}{c}
\text{O}
\end{array}
\]

(b) \[
\begin{array}{c}
\text{CH}_3\text{C}_\text{H}(\text{CH}_3)_2\text{CO}_2\text{Et}
\end{array}
\]

(c) \[
\begin{array}{c}
\text{CH}_3\text{CCHCH}_2\text{CO}_2\text{Et}
\end{array}
\]

(d) \[
\begin{array}{c}
\text{CH}_3\text{CHCHCH}_2\text{CO}_2\text{Et}
\end{array}
\]

5. Thus L is

(a) \[
\begin{array}{c}
\text{OH} - \text{CH}_3 - \text{CH}_2\text{CO}_2\text{Et}
\end{array}
\]

(b) \[
\begin{array}{c}
\text{CH}_3\text{CCHCH}_2\text{CO}_2\text{Et}
\end{array}
\]

(c) \[
\begin{array}{c}
\text{CH}_3\text{CHCHCH}_2\text{CO}_2\text{Et}
\end{array}
\]

(d) \[
\begin{array}{c}
\text{CH}_3\text{CCHCH}_2\text{CO}_2\text{Et}
\end{array}
\]

6. Thus M is

(a) \[
\begin{array}{c}
\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{Et}
\end{array}
\]

(b) \[
\begin{array}{c}
\text{OH} - \text{CH}_3 - \text{CH}_2\text{CO}_2\text{Et}
\end{array}
\]

(c) \[
\begin{array}{c}
\text{CH}_3\text{CHCHCH}_2\text{CO}_2\text{Et}
\end{array}
\]

(d) \[
\begin{array}{c}
\text{CH}_3\text{CHCHCH}_2\text{CO}_2\text{Et}
\end{array}
\]

Comprehension-3

\[
\begin{array}{c}
\text{CH}_3 \\
\text{A} \\
\text{B}
\end{array}
\]

The missing reagent A is

(a) OsO$_4$, NaHSO$_3$ (b) dilute KMnO$_4$ (c) any one of these (d) O$_3$/H$_2$O$_2$

7. The missing reagent B is

(a) HIO$_4$ (b) NaIO$_4$ (c) any one of these (d) None
9. The product(s) formed is/are
(a) \[\text{CH}_3\text{CO}\] 
(b) \[\text{CH}_2\text{CHO}\]
(c) both of these
(d) none

MULTIPLE CORRECT CHOICE TYPE

1. A new carbon-carbon bond formation is possible in
(a) Cannizaro reaction
(b) Friedel-craft reaction
(c) Clemensen reduction
(d) Reimen-Tiemann reaction

2. Which of the following undergoes \textit{Aldol Condensation}?
(a) Acetaldehyde
(b) propionaldehyde
(c) Benzaldehyde
(d) Trideuteracetalddehyde

3. Which of the following on reduction with Li\text{AlH}_4 with give ethyl alcohol?
(a) \((\text{CH}_3\text{CO})_2\text{O}\)
(b) CH\text{COCl}
(c) CH\text{CO NH}_2
(d) CH\text{COOC}_2\text{H}_5

4. Acetophenone is obtained when
(a) Benzoylchloride treated with dimethyl cadmium
(b) Acetyl chloride is treated with dimethyl cadmium
(c) Acetyl chloride is treated with benzene in presence of anhydrous AlCl₃
(d) Benzoyl chloride is reduced with H₂ in presence of Lindar’s catalyst

5. Which of the following on oxidation with alk. KMnO₄ followed by acidification with HCl gives benzoic acid?
(a) Methyl benzene
(b) Ethyl benzene
(c) O-xylene
(d) \(p\)-xylene

6. Which of the following statements about Benzaldehyde is/are true?
(a) Reduces Tollen’s reagent
(b) Undergoes \textit{Aldol condensation}
(c) Undergoes cannizaro’s reaction
(d) Does not form an addition compound with NaHSO₃

7. Base-catalysed \textit{Aldol condensation} occurs with
(a) propionaldehyde
(b) Benzaldehyde

8. On heating which of the following get decarboxylated?
(a) Methylmalonic acid
(b) succinic acid
(c) 2, 2-Dimethyl acetoacetic acid
(d) Malie acid

9. Cannizaro reaction will be given by
(a) \[\text{CHO} \]
(b) \[\text{CHO} \]
(c) \[\text{CHO} \]
(d) CCl₃ CHO

10. Which of the following is/are correct about an acetal?
(a) it is a condensation product of two molecules of aldehyde
(b) it is the condensation product of two molecules of ketones
(c) it is the condensation product of one molecular of aldehyde two molecules of Alcohols
(d) it is a diether

\textbf{Assertion-Reason Type}

Each question contains \textbf{STATEMENT-1 (Assertion)} and \textbf{STATEMENT-2 (Reason)}. Each question has 4 choices (A), (B), (C) and (D) out of which ONLY ONE is correct.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True

\begin{enumerate}
\item \textbf{STATEMENT-1 :} H₂CO is a planar molecule.
\textbf{STATEMENT-2 :} In H₂CO, C is sp² hybridised above reaction is correct.
\item \textbf{STATEMENT-1 :} \(H_2 + \text{PhCH}_2\text{CH}_2\text{COCl}\) \(\xrightarrow{\text{Pd/C, \text{Sorquinoline}}} \text{Ph CH}_2\text{CH}_2\text{CHO}\)
\end{enumerate}
3. **STATEMENT-1**: ![Chemical structure](image)

The above reaction is pinacol-pinacolone rearrangement.

**STATEMENT-2**: In pinacol-pinacolone rearrangement formation of the cyclopropyl C⁺ is unlikely because the ring strain decreases.

4. **STATEMENT-1**: When \( \text{C}_6\text{H}_6 \) react with \( \text{CO} + \text{HCl} \) in the presence of \( \text{CuCl}/\text{AlCl}_3 \), it form \( \text{C}_6\text{H}_5\text{CHO} \).

**STATEMENT-2**: The electrophilic aromatic substitution take place in above reaction.

5. **STATEMENT-1**: Under wollf-kishner reduction RCHO reduce to \( \text{CH}_2 \).

**STATEMENT-2**: Under clemmenson reduction pHCH\(_2\)CHO reduce to pHCH\(_2\)CH\(_3\).

6. **STATEMENT-1**: H\(_2\)CO is always oxidised in the crossed cannizzaro reaction.

**STATEMENT-2**: H\(_2\)CO is the most reactive aldehyde, it exists in aqueous OH\(^-\) solution mainly as the conjugate base of its hydrate, H\(_2\)C(OH)O\(^-\).

7. **STATEMENT-1**: PCC oxidises 1\(^{\text{th}}\) alcohol to aldehyde and 2\(^{\text{nd}}\) alcohol to ketone.

**STATEMENT-2**: Cu dehydrates 3\(^{\text{rd}}\) alcohol to alkene.

8. **STATEMENT-1**: Aldehydes are more reactive than carboxyl group.

**STATEMENT-2**: Carboxyl compounds cannot form hydrogen bonding with H\(_2\)O.

9. **STATEMENT-1**: Boiling points of carbonyl compounds are higher than those of alkanes.

**STATEMENT-2**: Boiling points of carbonyl compound are higher because of hydrogen-bonding.

10. **STATEMENT-1**: The reaction of aldehydes and ketones with LiAlH\(_4\) and NaBH\(_4\) is nucleophilic addition reaction.

**STATEMENT-2**: Aldol condensation reaction is not given by \( \text{C}_6\text{H}_5\text{CHO} \).

(Answers) EXCERCISE BASED ON NEW PATTERN

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<th>COMPREHENSION TYPE</th>
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<th>2. b</th>
<th>3. a</th>
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<td>MULTIPLE CORRECT CHOICE TYPE</td>
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<td>8. a, c</td>
<td>9. b, c, d</td>
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</table>
1. Complete the following equations and write down the names of the products:

(i) \[ \text{CH}_3\text{CH}_2\text{C} = \text{O} \xrightarrow{1\text{KCN}/\text{H}_2\text{SO}_4} \text{?} \]
(ii) \[ \text{CH}_3\text{CH}_2\text{C} \equiv \text{CH} \xrightarrow{(i)\text{BD}_2/\text{THF}} \xrightarrow{(ii)\text{H}_2\text{O}{}_{2}/\text{OH}^-} \text{?} \]

2. Identify the (A), (B), (C) and (D) in the following reactions sequence:

(i) \[ \text{CH}_3 - \text{CH} = \text{CH} - \text{CHO} \xrightarrow{\text{HCl}} \xrightarrow{\text{ZnCl}_2} \text{(A)} \xrightarrow{\text{KCN}} \xrightarrow{\text{H}^+} \text{(B)} \xrightarrow{\text{KOH(alc.)}} \text{(C)} \xrightarrow{\text{Br}_2} \text{(D)} \]

(ii) \[ \text{CH}_3\text{CH}_2\text{CH}_2\text{Br} \xrightarrow{\text{KOH(alc.)}} \text{(A)} \xrightarrow{\text{Br}_2} \text{(B)} \xrightarrow{\text{KOH(alc.)}} \xrightarrow{\text{NaNH}_2} \xrightarrow{\text{H}_2\text{SO}_4(\text{dil.})} \text{(C)} \xrightarrow{\text{Hg}^{2+}} \text{(D)} \]

(iii) \[ \text{CH}_2\text{CHO} \xrightarrow{\text{Ag}_2\text{O}} \xrightarrow{\text{PCl}_3} \text{(A)} \xrightarrow{\text{H}_2} \xrightarrow{\text{Pd}/\text{BaSO}_4} \xrightarrow{\text{CH}_3\text{MgBr}} \text{(C)} \xrightarrow{\text{H}_2\text{O}{}_{2}/\text{H}^-} \text{(D)} \]

3. What happens when (Give equation only) Chloral is heated with aqueous sodium hydroxide.

4. How will you differentiate between
   (i) Acetaldehyde and Acetone.

5. How would you bring the following conversions:
   (a) Acetone from acetaldehyde.
   (b) Methanal to ethanal (not more than 3 steps).
   (c) Acetone from methane.
   (d) 2-Butanone from ethyl alcohol.
   (e) 3-Hexanone from n-propyl alcohol.

6. Arrange the following:
   (i) \( \text{CH}_3\text{CHO}, \text{CH}_3\text{COCH}_3, \text{HCHO}, \text{C}_3\text{H}_5\text{COCH}_3 \) in decreasing order of nucleophilic addition.
   (ii) \( \text{CH}_3\text{COCH}_3, \text{CHO}, \text{CH}_3\text{CH}_2\text{CO}, \text{CH}_3\text{COCH}_3, \text{CH}_3\text{CHO}, \text{CH}_3\text{COCH}_3, \text{COCH}_3 \) in increasing order of expected enol content.

7. A ketone (A) which undergoes haloform reaction gives compound (B) on reduction. (B) on heating with sulphuric acid gives compound (C), which forms monozonide (D). (D) on hydrolysis in presence of zinc dust gives only acetaldehyde. Identify (A), (B) and (C). Write down the reactions involved.

8. Show, by equations, how acetaldehyde may be converted into:
   (i) \( \text{EtOH} \);
   (ii) \( \text{CH}_3\text{COCl} \);
   (iii) \( \text{CH}_3 \text{I} \);
   (iv) \( \text{MeCOEt} \);
   (v) \( \text{CH}_3\text{CO}_2\text{Et} \);
   (vi) \( \text{CH}_3\text{CHOHCO}_2\text{H} \);
   (vii) \( \text{EtNH}_2 \);
   (viii) \( \text{CH}_3\text{CHBrCHBrCO}_2\text{H} \).

9. Convert \( \text{CICH}_2\text{CH}_3\text{CHO} \) into \( \text{HOCH}_2\text{CHOHCHO} \).

10. Compound (A) and (B) on reaction in ether medium and subsequent acidification and oxidation gives 2, 5-dimethyl 3-hexanone. What are (A) and (B)?

11. Identify (A) to (E) as reactant, reagent, product or name of the reaction in following:
   (i) \( 3(\text{CH}_3)_2\text{C} = \text{O} \xrightarrow{(\text{A})} \text{(B)} \) Aldol condensation
   (ii) \( \text{CH}_3\text{COCl} + \text{H}_2 \xrightarrow{(\text{C})} \text{(D)} \) Rosenmund’s reaction
   (iii) \( \text{E} \xrightarrow{\text{NH}_2\text{NH}_2} \xrightarrow{\text{C}_2\text{H}_5\text{ONa}} \text{CH}_3\text{CH}_2\text{CH}_3 \) (F)

12. Write the structural formula of the main organic product formed when the hydration of ethyne is treated with dilute alkali.

13. How can we convert \( \text{PhCH} = \text{CHOCH}_3 \) to
   (a) \( \text{PhCH} = \text{CHCOOH} \)
   (b) \( \text{PhCH} = \text{CHCOHCH}_3 \)
   (c) \( \text{PhCH}_2\text{CH}_2\text{COCH}_3 \)
   (d) \( \text{PhCH} = \text{CHCH}_2\text{CH}_3 \)
   (e) \( \text{Ph(CH}_2)_2\text{CH}_3 \)

14. An organic compound (A) contains 40% carbon and 6.7% hydrogen. Its V.D. is 15. On reaction with a conc. solution of KOH, it gives two compounds (B) and (C). When (B) is oxidised, the original compound (A) is obtained. (C) give effervescence with NaHCO_3. Write the structures of A, B, C and D and explain the reactions.

15. An organic compound (A), \( \text{C}_3\text{H}_5\text{Cl} \) on reacting with aqueous KOH gives (B) and on reaction alc. KOH gives (C) which is also formed on passing the vapours of (B) over heated copper. The compound
C.

(C) readily decolourizes bromine water. Ozonolysis of (C) gives two compounds (D) and (E). Compound (D) reacts with NH₂OH to give (F) and the compound (E) reacts with NaOH to give an alcohol (G) and sod. salt (H) of an acid. (D) can also be prepared from propyne on treatment with water in presence of Hg²⁺ and H₂SO₄. Identify (A) to (H) with proper reasoning.

16. How would you convert:

\[
\text{CH}_3\text{CHO} \xrightarrow{\text{OH}} (\text{CH}_3)\text{C} - \text{Ph}
\]

17. An organic compound A, C₄H₆, on treatment with dilute H₂SO₄ containing HgSO₄ gives a compound B which can also be obtained from the reaction of benzene with an acid chloride in the presence of anhydrous AlCl₃. The compound B when treated with iodine and aq. KOH, yields C and a yellow compound D. Identify A, B, C and D with justification. Show how C and D is formed.

18. A certain hydrocarbon A was found to contain 85.7% C and 14.3% H. This compound consumes 1 molar equivalent of hydrogen to give a saturated hydrocarbon B. 1.0 g of hydrocarbon A just decolourised 38.05 of a 5 percent solution (by weight) of Br₂ in CCl₄. Compound A on oxidation with concentrated KMnO₄ gave compound C (molecular formulae C₄H₈O) and acetic acid. Compound C could easily be prepared by action of acidic aqueous HgSO₄ on 2-Butyne. Determine the molecular formula of A and deduce the structure of A, B and C.

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(Einstein Classes)

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7. A neutral organic compound (A) on analysis gave C = 52.17%; H = 13.04%. On mild oxidation (A) gave (B) which on treatment with dilute NaOH gave another neutral compound (C) with double the molecular mass. Compound (C) readily loses water on heating to form (D) which on oxidation gave \( CH_3CH=CHCOOH \) (crotonic acid). Identify (A), (B), (C) and (D) and explain the reactions.

8. (a) Identify A, B, in the following set up

\[
\begin{align*}
A & \xrightarrow{O_3} B & \xrightarrow{OH_2^+} C
\end{align*}
\]

(b) An alkyne with 5 carbon atoms per molecule when passed through dilute sulphuric acid containing mercuric sulphate gives a compound which forms an oxime, but has no effect on Fehling’s solution. The compound on oxidation gives dimethyl acetic acid. It reacts with sodamide to forms a hydrocarbon. What is the structure of the alkyne?

9. When 0.0088 g of compound (A) was dissolved in 0.50 g of camphor, the melting point of camphor was lowered by 8°C. Analysis of (A) gave 68.18% C and 13.16% H. Compound (A) showed the following reactions: (i) It reacted with acetyli chloride and evolved hydrogen with sodium, (ii) When reacted with \( HCl + ZnCl_2 \), a dense oily layer separated out immediately. Compound (A) was passed over \( Al_2O_3 \) at 350°C to give compound (B). (B) on ozonolysis followed by hydrolysis gave two neutral compounds (C) and (D) which gave positive tests with carboyl reagents but only (C) gave a positive test with Fehling solution. Identify (A), (B), (C) and (D) with proper reasoning. \( K_f \) for camphor = 40 mol⁻¹ kg⁻¹.

10. Suggest the appropriate structures for the missing compound. (The number of carbon atoms remain the same throughout the reactions)

\[
\begin{align*}
&\text{CH}_3 \\
&\text{CH}_3 \\
dil. K\text{MnO}_4 & \rightarrow A & \xrightarrow{HIO_4} B & \xrightarrow{HO^-} C
\end{align*}
\]

11. A \( \xrightarrow{\text{conc. NaOH}} \) B + C

\[
\text{F} \xrightarrow{\text{H/NI}} \text{E} \xrightarrow{\text{KCN/H}_2\text{O}^+} \text{Adipic Acid}
\]

\[
\begin{align*}
B & + \xrightarrow{\text{(Acid)}} \xrightarrow{\text{NaOH}} \text{Salt} & \xrightarrow{\text{H}_2\text{O}}
\end{align*}
\]

\[
\begin{align*}
\text{O} & \xrightarrow{\text{dil. NaOH}} \text{D} \xrightarrow{\text{CH}_3 - \text{C - CH}_3 + A} \xrightarrow{\text{C}_2\text{H}_4\text{O}_3}
\end{align*}
\]

Identify A to G.

12. Wolff-Kishner reduction of the compound shown gave compound A. Treatment of compound A with m-chloroperoxy benzoic acid gave B which on reduction with \( \text{LiAlH}_4 \) gave C. Oxidation of compound C with chromic acid gave compound D \( \text{(C}_9\text{H}_8\text{O}_4) \). Identify A, B, C and D.

13. An optically active alkyne A contains 89.52% C and 10.48% H. After hydrogenation over a Pd catalyst it is converted to \( 1\text{-Methyl-4-propyl cyclohexane} \). When compound A reacts with \( \text{CH}_3\text{MgBr} \) no gas is liberated. Hydrogenation of A over Lindlar catalyst, followed by ozonolysis and reaction with \( \text{KMnO}_4 \) gives product B. Product B reacts with \( I_2/\text{NaOH} \) and gives a yellow precipitate, which is filtered off. Acidification of the filtrate gives an optically active product C. Give the structures of A, B and C and account for all observations.

14. Give the structure for compounds A – F:

\[
\begin{align*}
\text{C}_6\text{H}_4\text{O}_6 & \xrightarrow{\text{H}_2\text{CrO}_4} \text{B} & \xrightarrow{1,\text{CH}_3\text{Mgl}} \text{C} & \xrightarrow{\text{HA}}
\end{align*}
\]

\[
\begin{align*}
\text{D} & \xrightarrow{1,\text{O}_2} \xrightarrow{2,\text{Zn}/\text{CH}_3\text{COOH}} \text{E} & \xrightarrow{\text{Ag}_2\text{O}/\text{OH}^-} \text{F}
\end{align*}
\]

15. \( \text{C}_6\text{H}_{12}\text{O}_6 \) can be glucose or fructose. To decide nature, one can carry out following steps:

\[
\begin{align*}
\text{C}_6\text{H}_{12}\text{O}_6 & \xrightarrow{\text{HCN}} \text{H}_2\text{O}^+ & \xrightarrow{\text{P/\text{III}}}?
\end{align*}
\]

What can be the end product starting with glucose and fructose?