



CHM301 Carbonyl Compound – Reactions OF Aldehydes AND Ketones

Cell and metabolism (Universiti Teknologi MARA)



CHM301

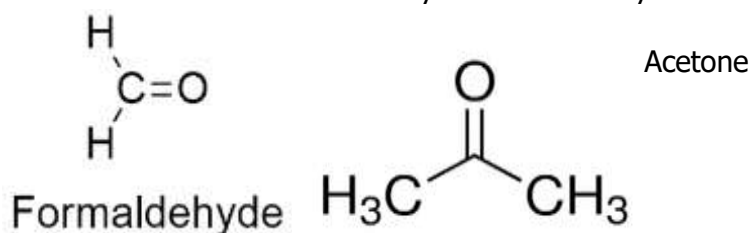
CARBONYL COMPOUND – REACTIONS OF ALDEHYDES AND KETONES

EXPERIMENT 2

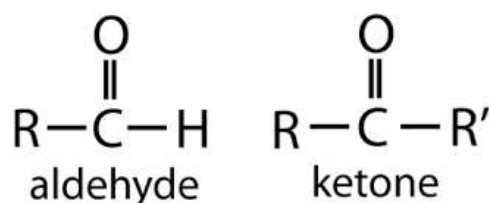
GROUP MEMBERS	
LECTURER	
DATE OF EXPERIMENT	
DATE OF SUBMISSION	

PRE LAB ASSIGNMENT

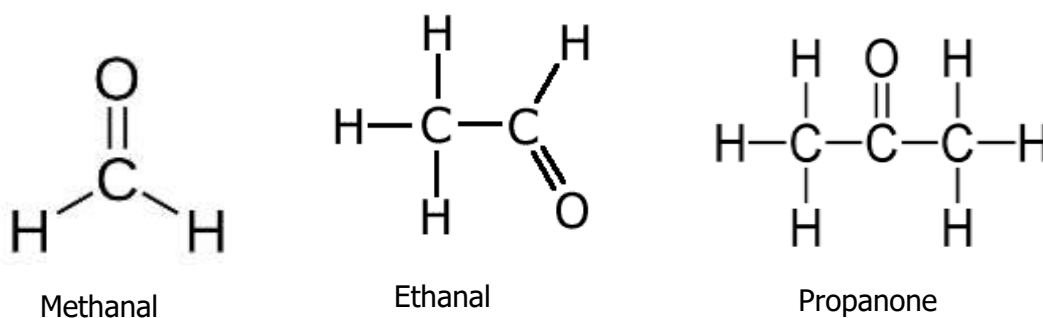
- a) Give a common structure for aldehyde and ketones.
- The common structure for aldehyde is formaldehyde and for ketones is acetone.



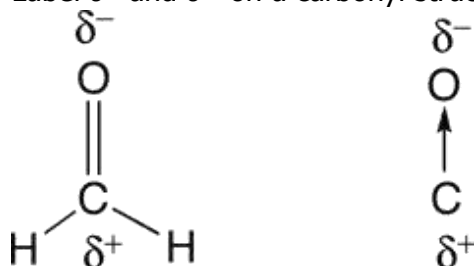
- b) What is the different structure in of aldehyde compare to ketones
- The difference is aldehyde have the form of R-CHO. Meanwhile ketones have the form of R-CO-R'.



- c) Draw the structures for methanal, ethanal and propanone.



- d) Label δ^+ and δ^- on a carbonyl structure.



- e) Draw the mesomeric(resonance) effect on the carbonyl structure.
- f) Give an example for each of the following.
- Nucleophile - Cl^-
 - Electrophile - H^+

INTRODUCTION

The typical structural formula of aldehyde and ketone are $R-COH$ and $R-COR$ respectively. Both classes consist of the carbonyl group $C=O$. The carbon and oxygen atom are bonded with a double bond. Due to higher electronegativity of oxygen, the carbonyl group are polarized with carbon atom having a slightly positive charge and oxygen atom toward negative charge. The polarization of the carbonyl group has a strong influence towards its physical properties and chemical properties.

Due to this factor, aldehyde and ketone are easily attacked by nucleophile at carbon atom and electrophile at oxygen atom.

Aldehyde and ketone will not form hydrogen bond, which give them lower boiling point than alcohol. Aldehyde easily oxidized to produce carboxylic acid which makes it strong reducing agent, where as ketone difficult to oxidised. It can be oxidised by prolong heating with a very strong oxidizing agent.

OBJECTIVE

To investigate the reaction of aldehydes and ketones with certain reagents.

APPARATUS

Test tube, test tube rack, dropper, Bunsen burner, water bath, evaporating dish

CHEMICALS

Methanal (formaldehyde), Ethanal (acetaldehyde), Propanone (acetone)

REAGENTS

Silver nitrate solution with ammonia (Tollen's reagent), Potassium permanganate solution ($KMnO_4$), Schiff reagent, Fehling reagent, KOH solution, 2,4-dinitrophenylhydrazine (2,4-DNPH), H_2SO_4 solution

PROCEDURE

Method A:

- 5 mL of Tollen's reagent was added into a clean test tube and about 2 mL of methanal solution was added. The observation was recorded.
- A few drops of dilute H_2SO_4 was added into a 5 mL of $KMnO_4$ (acidifying the solution) and then about 2 mL of methanal solution was added.

Method B:

- 1mL of Schiff's reagent was added into a test tube, then a few drops of ethanal solution added. The observation was recorded.
- 5 mL of Tollen's reagent was added into test tube then 5 drops of ethanal was added. The solution was shake well (to ensure they mix well) and it was heated in a water bath. The test tube was immediately took out when there was a change on the wall of the test tube. The test tube was rinsed(outer side) underneath a tap to observed the product clearly. The observation was recorded.

- c. A few drops of concentrated KOH was added into a test tube, then a few drops of ethanal added and heated in a water bath. The observation and smell of the product were recorded.
- d. 3mL of Fehling A solution and 3 mL of Fehling B were added into a test tube then, a few drops of ethanal was added. The mixture was heated in a beaker of boiling water. Any colour change and precipitation(solid at the bottom of the test tube) formed.
- e. A few drops of dilute H₂SO₄ was added into a 5 mL OF KMnO₄(acidifying the solution) then about 2 mL of ethanal solution. The observation was recorded.
- f. 3-5 drops of ethanal was added in a test tube. After that, 3mL of 2,4-DNPH reagent was added. The mixture was heat using the direct flame slowly by moving in and out of the flame. (Do it carefully). Let it cool down and the observation was recorded.

Method C:

- a. 5mL of Tollen's reagent was added into test tube, then 5 drops of propanone was added. The solution was shake well(to ensure they mixes properly). The mixture was heated in a water bath. The observation was recorded.
- b. 2mL of Fehling A solution and 2mL of Fehling B solution was added in a test tube and then added with a few drops of propanone. The mixture was heated in a water bath. Any colour change and precipitation formed was recorded.
- c. A few drops of dilute H₂SO₄ was added into a 5mL of KMnO₄(acidifying the solution) then a few drops of propanone was added. Any immediate change and any change after a few minutes were recorded.
- d. 3-5 drops of propanone and 3mL of 2,4-DNP reagent were added into a test tube. It was leave for few minutes and the observation was recorded.

RESULTS

Method A: Reaction of methanal with the following reagents.

Experiment	Observation
a) Tollen's reagent	<ul style="list-style-type: none"> Formation of silver mirror Clear solution turns cloudy $2[\text{Ag}(\text{NH}_3)_2] + \text{H-CHO} + \text{H}_2\text{O} \rightarrow 2\text{Ag} + 4\text{NH}_3 + \text{H-COOH} + 2\text{H}^+$
b) Oxidation with Kmno ₄	<ul style="list-style-type: none"> Purple colour changed to colourless $3\text{HCHO} + \text{KMnO}_4 \rightarrow 3\text{HCOOH} + 2\text{MnO}_2 + 2\text{OH}^-$

Method B: Reaction of ethanal with the following reagents.

Experiment	Observation
a) Schiff's reagent	<ul style="list-style-type: none"> Formation of magenta-pink colour $\text{CH}_3\text{CHO} + \text{NH}_3 \rightarrow \text{CH}_3\text{CH}=\text{NH} + \text{NH}_2$
b) Tollen's reagent	<ul style="list-style-type: none"> Formation of silver mirror $2[\text{Ag}(\text{NH}_3)_2] + \text{CH}_3\text{CHO} + \text{H}_2\text{O} \rightarrow 2\text{Ag} + 4\text{NH}_3 + \text{CH}_3\text{COOH} + 2\text{H}^+$
c) Concentrated KOH + ethanal solution	<ul style="list-style-type: none"> colourless change to yellow Have a sweet, fruity smells $2\text{CH}_3\text{COH} \xrightarrow{\text{KOH}} \text{CH}_3\text{CHOHCH}_2\text{C}=\text{OH}$
d) Fehling's test	<ul style="list-style-type: none"> Blue colour of Fehling's colour disappears brick-precipitate is obtained $\text{CH}_3\text{COH} + 2\text{Cu} + 5\text{OH}^- \rightarrow \text{Cu}_2\text{O} + \text{CH}_3\text{COO}^- + 3\text{H}_2\text{O}$
e) Oxidation with KMnO_4	<ul style="list-style-type: none"> Purple colour changed to colourless $\text{CH}_3\text{COH} + [\text{O}] \xrightarrow{\text{KMnO}_4} \text{CH}_3\text{-COOH}$
f) Brady's test	<ul style="list-style-type: none"> Formation of orange precipitate $\begin{array}{c} \text{H} \\ \diagdown \\ \text{C}=\text{O} \\ \diagup \\ \text{H} \end{array} + \text{HN}_2-\text{N}(\text{NO}_2)-\text{C}_6\text{H}_4-\text{NO}_2 \rightarrow \begin{array}{c} \text{H} \\ \diagdown \\ \text{C}=\text{N}-\text{N}(\text{NO}_2)-\text{C}_6\text{H}_4-\text{NO}_2 \\ \diagup \\ \text{H} \end{array} + \text{H}_2\text{O}$

Method C: Reaction of propanone with the following reagents

Experiment	Observation
a) Tollen's reagent	<ul style="list-style-type: none"> Stay colourless ,Silver mirror did not formed

b) Fehling's test	<ul style="list-style-type: none"> Blue colour remains
c) Oxidation with KMnO_4	<ul style="list-style-type: none"> Purple colour of KMnO_4 remains
d) Brady's test	<ul style="list-style-type: none"> Orange precipitate did not formed

QUESTIONS

- Write all the equation involved in the experiments.
 - Refers to results
- Discuss the results obtained
 - Refers to discussions

DISCUSSION

The objective of the experiment is to investigate the reaction of aldehydes and ketones with certain reagents. There are total of five reactions for aldehydes which include oxidation, reduction, nucleophilic addition, condensation and haloform reaction meanwhile there are four reactions for ketones such as reduction, nucleophilic reaction, condensation and iodoform reaction.

For method A, methanal was added with Tollen's reagent and formed silver mirror. This reaction is called oxidation reaction. Tollen's reagent also known as ammoniacal silver nitrate is a solution that contain amine complex ion $[\text{Ag}(\text{NH}_3)_2]^+$. Aldehyde reduced the colourless complex ion of Tollen's reagent to grey metallic silver that resulted for the precipitate to form silver mirror on the walls of the test tube. The methanal that reacted with KMnO_4 with few drops of dilute H_2SO_4 , made colour changes of the solution from purple to colourless. The methanal was actually converted to methanoic acid. Tollen's reagent is usually used to distinguish aldehydes from ketones as ketones do not react with Tollen's reagent.

For method B, Schiff's reagent was used to see its reaction with ethanal. Schiff reagent is made with treating sulphurous acid to pararosanilin. Schiff reagent is a colourless reagent that when combined with aldehyde it will produce a bright magenta pink coloured solution due to the disruption of chromophore by the addition of sulphonc acid in the central carbon of pararosanilin. Ethanal also reacted to Tollen's reagent and produced silver mirror. Ethanal was tested with I_2 and alkaline medium, KOH as an oxidising agent. When ethanal was warmed with this solution, an intermediate product of triiodoethanal was formed and reacted with KOH to form yellow precipitate of triiodomethane. Iodoform test is usually used to distinguish ethanal from another aldehydes because ethanal is the only aldehyde that gives of positive iodoform test. Ethanal that reacted with Fehling's solution made the blue colour of Fehling's solution disappeared and formed brick-red precipitate. Fehling's solution contains a copper(II) complex solution and ethanal reduced the complex of copper(II) ion to copper(I) oxide. Ethanal also reacted with KMnO_4 and changed the solution colour from purple to colourless as ethanal converted to ethanoic acid. Ethanal reacted with 2,4-dinitrophenylhydrazine formed an orange precipitate. The double bond of oxygen atom broke and form water with hydrogen from the nitro groups. Ethane then bonded with nitrophenylhydrazine resulting the formation of orange precipitate. For method C, propanone did not react with all of the solution because

ketones do not react well with Tollen's, Fehling's, KMnO_4 and Brady's solution. This is because ketones are not oxidized unless they are alpha-hydroxyketones.

Some precautions should be taken concern before conducting the experiments such as wearing gloves and face mask. Plus, meniscus level must be considered for every measurement of solute for a more accurate result. Avoid direct contact with H_2SO_4 and acidic solution because it is corrosive. Be careful when using the water bath because it is very hot.

CONCLUSION

The objective of the experiment which is to investigate the reactions of aldehydes and ketones with certain reagents is achieved. It is concluded that most of aldehyde react with most of the reagent in the experiments while ketone react with just certain reagent. The aldehyde and ketone can distinguish by the experiments.

REFERENCE