Phone: +442081445350

www.chemistryonlinetuition.com

Email:asherrana@chemistryonlinetuition.com

CHEMISTRY

ORGANIC CHEMISTRY

Level & Board	AQA (A-LEVEL)
TOPIC:	ORGANIC ANALYSIS
PAPER TYPE:	SOLUTION - 3
TOTAL QUESTIONS	10
TOTAL MARKS	55

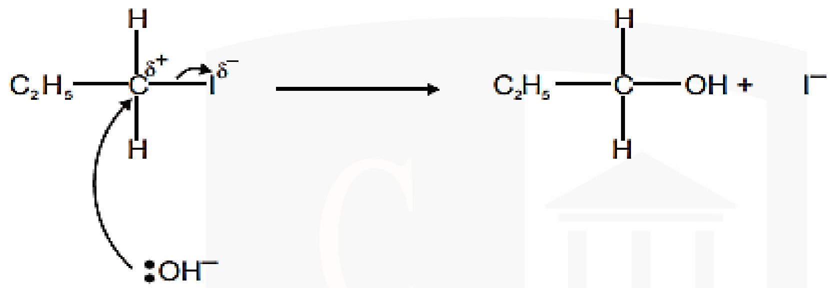
Organic Analysis - 3

1.

(a)

Name of mechanism: nucleophilic substitution

Mechanism:



(4)

(b)

1-iodopropane hydrolyzes faster than 1-bromopropane because C-I bonds are broken more easily.
This is due to the weaker nature of C-I bonds, which have less bond enthalpy or are longer compared to C-Br bonds.

(2)

2.

(a)

Fragment Ion	Formula	m/z Value
M^+ (Molecular Ion)	$C_4 H_{10} O$	74
$M-CH_3$	$C_3 H_7 O$	59
$CH_3{}^+$	CH_3	15
$C_2 H_5{}^+$	$C_2 H_5$	29
$C_3 H_7{}^+$	$C_3 H_7$	43
$C_4 H_9{}^+$	$C_4 H_9$	57
OH^+	OH	17

(3)

(b)

Mass spectrometry has practical applications outside the laboratory, such as in breathalyzers for alcohol testing, monitoring air pollution, and conducting emission tests during MOT inspections.

(2)

3.

Mole Ratio Calculation:

- *Given the percentage composition by mass: C, 88.89%; H, 11.1%.*
- *The percentages to moles: C = 88.89/12, H = 11.1/1.*
- *The mole ratio is: C = 7.41, H = 11.1.*
  = 7.41 : 11.1
- *This gives the empirical formula:* $C_2 H_3$.

Empirical Formula Mass Calculation:

- *The relative mass of* $C_2 H_3$: $(2 \times 12) + (3 \times 1) = 27$.
- *The molecular ion peak at m/z = 54, the empirical formula mass is a factor of 54/2 = 27.*
- *Confirming the empirical formula as* $C_2 H_3$.

Determination of Molecular Formula:

- *The empirical formula mass (27) is less than the molecular ion peak mass (54).*
- *The factor by which the empirical formula mass must be multiplied to match the molecular ion peak mass: 54/27 = 2.*
- *Multiply* $C_2 H_3$ *by 2 to get the molecular formula:* $C_4 H_6$.

Reaction with H_2 :

- *X reacts with 2 mol H_2 so there are 2 double bonds.*
- *Possible structure = 1,3-butadiene*

(5)

4.

(a)

Reagents:

Acidified Potassium Dichromate ($K_2Cr_2O_7$ / H_2SO_4):
The acid provides the acidic medium needed for the reaction.

Procedure:

Add acidified potassium dichromate to each alcohol separately.

Observations:

Butan-2-ol:
The orange color of the dichromate solution changes to green.
This indicates the oxidation of the alcohol to a corresponding aldehyde or ketone. The butan-2-ol would be oxidized to butan-2-one (a ketone).

2-Methylpropan-2-ol:
No immediate change is observed, and the solution remains orange. Tertiary alcohols, such as 2-methylpropan-2-ol, do not readily undergo oxidation with acidified potassium dichromate under the conditions provided.

(3)

(b)

Reagent:

Bromine (Br_2) or Bromine water (Br_2/H_2O)

Procedure:

Shake with bromine or add bromine water to each hydrocarbon separately.

Observations:

Propane:
The bromine color (orange or red or yellow or brown) remains the same, or there is no observed change.
No reaction occurs, and the bromine does not react with propane.

Propene:
The bromine color (orange) goes colorless, or the solution loses its color.
This shows that propene reacts with bromine, causing decolorization due to the addition of bromine across the carbon-carbon double bond.

(3)

5.

(a)

Reagent: Hydrochloric acid (HCl)
Observations:
Aqueous Silver Nitrate ($AgNO_3$):

- Add hydrochloric acid (HCl) to $AgNO_3$.
- **Observation:** A white precipitate of silver chloride (AgCl) will form.
- **Equation:** $AgNO_3 + HCl \rightarrow AgCl \downarrow + HNO_3$

Aqueous Sodium Nitrate ($NaNO_3$):

- Add hydrochloric acid (HCl) to $NaNO_3$.
- **Observation**: No precipitate is formed.

(3)

(b)

Reagent: soluble sulfate /dilute sulfuric acid
Observations:
Aqueous Magnesium Chloride ($MgCl_2$):

- Add any soluble sulfate or dilute sulfuric acid to MgCl2.
- **Observation:** Remains clear or no observed change.
- **Equation:**
  $MgCl_2 + H_2SO_4 \rightarrow MgSO_4 + 2NaCl$

Aqueous Barium Chloride ($BaCl_2$):

- Add any soluble sulfate or dilute sulfuric acid to $BaCl_2$.
- **Observation:** White precipitate or white suspension forms.
- **Equation:**
  $BaCl_2 + H_2SO_4 \rightarrow BaSO_4 \downarrow + 2NaCl$

(3)

6.

Reagent:

Bromine water (Br_2) or iodine (I_2).

Observations:

Bromine water:

Orange/red-brown to colorless.

Iodine:

Purple to colorless.

(2)

7.

(a)

Reagent: Bromine water ($Br_{2\ (aq)}$)

Observations:

Cyclohexane:

- *When bromine water is added to cyclohexane, there is no reaction because saturated hydrocarbons do not readily react with bromine water.*
- *Bromine water remains its characteristic orange-brown color, indicating no change.*
- *Cyclohexane is a saturated hydrocarbon with only single bonds.*

Cyclohexene:

- *When bromine water is added to cyclohexene, the double bond reacts with bromine (Br_2) causing it to add across the double bond, resulting in the formation of a colorless product.*
- *The bromine water changes from its initial orange-brown color to colorless or significantly fades, indicating the presence of unsaturation.*
- *Cyclohexene is an unsaturated hydrocarbon with a carbon-carbon double bond (C=C).*

(3)

(b)

Reagent:

Acidified potassium dichromate ($K_2Cr_2O_7/H_2SO_4$)

Butanal (Butyraldehyde):

Observation:

- The orange solution of acidified potassium dichromate ($K_2Cr_2O_7/H^+$) will change Orange to green.
- This indicates the oxidation of butanal to butanoic acid.

Butanone (Methyl Ethyl Ketone):

Observation:

- No change or no reaction will occur.

(3)

8.

(a)

As the resulting chromium species is green. Therefore, the color of the chromium species after the reaction is green.

(1)

(b)

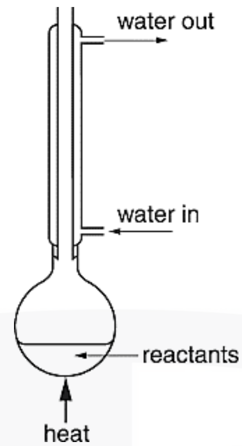
Reagents:

- Propan-1-ol
- Excess acidified potassium dichromate(VI) solution (commonly with sulfuric acid)

Procedure:

- Mix propan-1-ol and excess acidified potassium dichromate(VI) in a round-bottom flask.
- Set up a reflux apparatus with a vertical condenser attached to the round-bottom flask.
- Reflux the mixture for some time.

Diagram of the Assembled Apparatus:



(4)

(c)

Experimental Conditions:

Distillation:

- *A distillation setup to separate propanal as it forms.*
- *The distillation process helps isolate propanal from the reaction mixture, promoting a higher yield of the aldehyde.*

Immediate Distillation:

- *Start distillation immediately after mixing the reagents.*
- *This distillation prevents prolonged exposure to oxidizing conditions, favoring the retention of propanal over further oxidation to propanoic acid.*

(2)

9.

(a)

Oleic acid:
Molecular formula: $C_{18}H_{34}O_2$
Empirical formula: $C_9H_{17}O$

(2)

(b)

An unsaturated compound contains at least one double bond, represented by the C=C.

Examples of unsaturated compounds are alkenes, which are hydrocarbons with one or more carbon-carbon double bonds. E.g. $H_2C=CH_2$
This double bond gives a degree of reactivity and flexibility in the molecular structure.

(1)

(c)
Bromine water is a simple chemical test shows that oleic acid is unsaturated.

Reagent:

Bromine water $Br_{2\,(aq)}$

Observation:

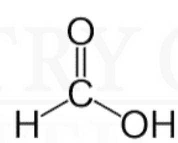
The bromine water gets decolourised or becomes colourless.

(3)

10.
(a)
Silver-containing complex: $[Ag(NH_3)_2]$
Shape: Linear

(1)

(b)

Structure of methanoic acid: 

Methanoic acid contains an aldehyde group, which is the formyl group (-CHO). When methanoic acid reacts with Tollens' reagent, the aldehyde group undergoes oxidation, reducing silver ions (Ag^+) to silver metal (Ag). This results in the formation of a silver mirror on the inner surface of the reaction container, providing visual evidence of the presence of the aldehyde functional group.

(2)

(c)

When methanoic acid ($HCOOH$) reacts with Tollens' reagent, it undergoes oxidation, and the aldehyde group is converted into a carboxylate ion.
The overall reaction is as follows:

$$HCOOH + 2Ag(NH_3)_2 + OH^- \rightarrow CO_2 + 2Ag + 4NH_3 + 2H_2O$$

The carbon-containing species formed in this reaction is carbon dioxide (CO_2).

(3)

DR. ASHAR RANA

M.B.B.S / MS. CHEMISTRY

CHEMISTRY ONLINE
TUITION

Phone: +442081445350
www.chemistryonlinetuition.com
Email: asherrana@chemistryonlinetuition.com

- Founder & CEO of Chemistry Online Tuition Ltd.
- Completed Medicine (M.B.B.S) in 2007
- Tutoring students in UK and worldwide since 2008
- CIE & EDEXCEL Examiner since 2015
- Chemistry, Physics, Math's and Biology Tutor

CONTACT INFORMATION FOR **CHEMISTRY ONLINE TUITION**

- UK Contact: 02081445350
- International Phone/WhatsApp: 00442081445350
- Website: www.chemistryonlinetuition.com
- Email: asherrana@chemistryonlinetuition.com

Address: 210-Old Brompton Road, London SW5 OBS, UK