ALEVEL ORGANIC CHEMISTRY

ORGANIC QUALITATIVE ANALYSIS

1. **Appearance of the substance.**

Observation	**Deduction**
Solid compound	Aromatic compound or aliphatic compound with a high molecular mass.
A colourless liquid	Aliphatic compound with a low molecular mass.
Pink crystals dissolves to form a pink solution on exposure to the atmosphere.	Phenol probably present.

BURNING FLAME:

Test	**Observation**	**Deduction**
Burn a small amount of the organic compound on a spatula end or crucible.	Burns readily with yellow non-sooty flame.	Aliphatic saturated compound with a low carbon content.
	Burns with great difficulty with a smell of burnt sugar.	Carbohydrate inform of sugar present.
	Burns readily with a yellow sooty flame.	Aromatic, unsaturated compound with a high carbon content/ long chain aliphatic unsaturated compound with high carbon content.
		Alkyl halide, nitrogen containing compound or salt of carboxylic acid.

SOLUBILITY:

Test	Observation	Deduction
To 1cm^3 of organic compound, add 2cm^3 of water.	Soluble in water with water to form a colourless solution.	Polar aliphatic compound such as alcohol, carbonyl, carboxylic acid, ester or amine with a high molecular mass.
	Partially miscible with water to form a colourless solution.	Polar aliphatic compound such as alcohol, carbonyl, carboxylic acid, ester or amine with a high molecular mass.
	Immiscible with water	Non-polar aliphatic compound.
Shake a spatula endful of the organic compound with 4cm^3 of water.	Sparingly soluble in water to form a colourless solution.	Polar aromatic compound such as aromatic carbonyl compound, carboxylic acid, ester or phenol.
	Insoluble in water	Non-polar aromatic compound.

INDICATOR USED:

Litmus paper	Litmus solution	Universal indicator solution	Deduction
No effect on both blue and red litmus paper.	No effect on both blue and red litmus solution.	Solution remains green.	Neutral compound such as alcohol, carbonyl/ ester
Blue litmus paper turns red.	Blue litmus solution turns red.	Solution turns red/ orange/ pink.	Acidic compound such as carboxyli.
Red litmus paper turns blue.	Red litmus solution turns blue.	Solution turns blue, purple, or violet.	Basic compound such as amine/ salt of a carboxylic acid.

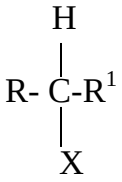
SMELL OF AN ORGANIC COMPOUND:

Observation	**Deduction**
Odourless	Ionic organic compound.
Fishy smell	Amines
Smell of petrol	Liquid alkanes
Pungent	Lower carboxylic acid and acid chlorides.
Carbolic smell	Phenol
Antiseptic smell	Triiodomsthane
Sweet, fruity smell	Ester
Sweet smell (but not fruity)	Ketones, aromatic aldehyde or lower alkythalides.

REAGENT:

Sodium hydroxide solution and silver nitrate solution.

It is used to test for aliphatic halide from aromatic halide. Aliphatic halide is of :



Phenol	**Test**	**Observation**	**Deduction**
	Add $2cm^3$ of dilute sodium hydroxide solution to about $5cm^3$ of a test solution, shake well and heat the mixture, then cool and add silver nitrate solution.	White precipitate is formed on addition of silver nitrate solution.	$AgCl_{(s)}$ formed Cl^-released iron compound.
		Cream precipitate is formed on addition of silver nitrate solution.	$AgBr_{(s)}$ formed. Br^- released from compound.
		Pale yellow precipitate is formed on addition of silver nitrate solution.	$AgI_{(s)}$ formed I^- released from compound.

Iron (III) chloride solution:

Test	Observation	Deduction
To 1cm^3 of the solution, add iron(III) chloride solution, .	Purple colouration formed.	Phenol present
	No observable change	Phenol absent
To 1cm^3 of the solution, add neutral (III) chloride solution and heat	Brown precipitate is formed on heating.	Salt of aliphatic carboxylic acid present.
	No observable change even on heating,	Salt of aliphatic carboxylic acid absent.
	Red colouration which turns to reddish brown precipitate on heating.	Aliphatic carboxylic acid present.

SODIUM HYDROXIDE SOLUTION:

Test	Observation	Deduction
To 1cm^3 of the organic compound, add 4cm^3 of sodium hydroxide solution.	Dissolves to form a colourless solution without evolution of a gas.	Neutralization reaction, aliphatic carboxylic acid or phenol present.
To 1cm^3 of the organic compound, add 4cm^3 of sodium hydroxide solution and boil.	Dissolves to form a colorless solution without evolution of a gas and on boiling the sweet fruity smell is lost.	Ester hydrolysis to form alcohol and sodium salt of a carboxylic acid. Ester present.
To a spatula endful of the solid, add 4cm^3 of sodium hydroxide solution and warm.	Dissolves to form a colourless solution without evolution of a gas.	Neutralization Aromatic carboxylic acid or phenol present.
To 1cm^3 of the organic compound, add 4cm^3 of sodium hydroxide solution.	Dissolves with evolution of a colourless gas that turns moist red litmus paper blue.	Aliphatic amine present
To 1cm^3 of the organic compound, add 4cm^3 of sodium hydroxide solution and warm.	Dissolves on warming with evolution of a colourless gas that turns moist red litmus paper blue.	Aliphatic amide present.

Sodium Carbonate Or Sodium Hydrogen Carbonate Solution:

Test	Observation	Deduction
To 1cm^3 of the solution, add little sodium carbonate /sodium hydrogen carbonate, Or to 1cm^3 of the solution add sodium carbonate/ sodium hydrogen carbonate solution.	Effervescence of a colourless gas which turns moist blue litmus paper red and forms white precipitate with calcium hydroxide solution.	$CO_{2\ (g)}$ evolved Carboxylic acid present.
	No observable change	Carboxylic acid absent

Action of 2, 4-dinitrophenythydrazine solution (Brady's solution):

Test	Observation	Deduction
To 1cm^3 of a solution, add 2-3 drops of Brady's Reagent	Yellow/ orange precipitate	Carbonyl compound present
	No observable change	Carbonyl compound absent

Saturated sodium hydrogen sulphite solution:

Test	Observation	Deduction
To 1cm^3 of the solution, add saturated sodium hydrogen sulphite solution.	White precipitate	Carbonyl compound present
	No observable change	Carbonyl compound absent

Ammoniacal silver nitrate solution (Tollen's Reagent confirms aidehydes and ethanoic acid:

Test	Observation	Deduction
To 1cm^3 of the solution, add 2cm^3 of Tollen's Reagent and warm, then allow to stand.	Silver mirror formed on the walls of the test tube.	Reducing agent present such as aldehydes, methanoic acid.

Ammonial silver nitrate is prepared by,

N.B. To 1cm^3 of silver nitrate solution, add 1cm^3 of sodium hydroxide solution followed by dilute ammonia drop wise until the precipitate just dissolves, then add 2cm^3 of the test solution and warm, then allow to stand.

Bromine water:

Test	Observation	Deduction
To $1cm^3$ of the solution or to half a spatula endful of the solid, add bromine water, little at a time, shaking after each addition..	Reddish-brown solution turns colourless, with no white fumes, and formation of a second liquid layer.	Unsaturated compound with multiple carbon to carbon bonds e.g alkene or alkyne.
	Reddish-brown solution turns colourless, with formation of a white fume and a product that is completely miscible with water.	Aliphatic amine or aromatic amine whose amino group is not directly attached to the Bonzene ring.
	Reddish – brown solution turns colourless, with formation of white fumes and a product that is immiscible with water, white precipitate formed on addition of excess Bromine water. Reddish-brown solution turns colourless with no fumes and a product that is immiscible with water, white precipitate formed on addition of excess Bromine water..	Aromatic amine with amino group directly attached to the Benzene ring present. Phenol present

Fchling's solution:

Test for aliphatic aldehyles (aldose sugars/ reducing sugars) but does not apply to aromatic aldehydes where the aldehyde group is directly attached to the Benzene ring.

Test	Observation	Deduction
To $1cm^3$ of the solution, add $2cm^3$ of fehling's solution and boil.	Reddish brown precipitate	Reducing agent present such as aliphatic aldehydes or aldose sugar.

Acidified potassium permanganate solution:

- Detects, by oxidizing primary and secondary alcohol to aldehyde, then to carboxylic and ketones respectively.
- Also detects unsaturation, methanoic acid and oxalic acid.

Test	Observation	Deduction
To $1cm^3$ of solution, add 1-2 drops of acidified potassium permanganate solution.	Purple solution turns caolourless in the cold and the product immiscible with water.	Unsaturated compound with multiple carbon-sarbon bonds e.g alkene/ alkyne.
To $1cm^3$ of the solution, add 1-2 drops of acidified potassium permanganate solution and warm.	Purple solution turns colourless on warming and the product is miscible with water.	Primary alcohol, secondary alcohol, aldehydes, methanoic acid, aldose sugar, oxalic acid or salt of oxalic acid present.

Acidified potassium dichromate solution:

- It's a weaker oxidizing agent compared to potassium permanganate.
- It oxidizes primary alcohol to aldehydes and other reaction similar to those of acidified potassium permanganate.
- And changes from orange to green.

Ehanoic acid and Concentrated sulphuric acid:

Test	Observation	Deduction
To $1cm^3$ of the solution of the organic compound, add $1cm^3$ of Ethanoic acid followed by about drops of concentrated sulphuric acid and warm. Pour the product in a beaker containing cold water.	Sweet, fruity smell	Esterification reaction Primary, secondary or tertiary alcohol present.

Ethanol/ methanol and concentrated sulphuric acid:

Test	Observation	Deduction
To 1cm^3 of the solution of the organic compound, add 1cm^3 of ethanol/ methanol followed by about 5 drops of concentrated sulphuric acid and warm. Pour the product in a beaker containing cold water.	Sweet, fruity smell	Esterification reaction Carboxylic acid confirmed present.

Phosphorus pentachloride:

Observation	Deduction
Misty fumes which form dense white fumes with concentrated ammonia solution.	Compound with OH-group such as an alcohol, phenol or carboxylic acid.
Dense white fumes	Basic compound present such as amine

Sodium metal:

Test	Observation	Deduction
To test solution in a test tube add a spatula of sodium metal	Effervescence of a colourless gas that burns with a pop sound.	Compound with OH group such as alcohol, phenol or carboxylic acid.

Anhydrous zincchloride in concentrated hydrochloric acid (Luca's Reagent)

Observation	Deduction
No observable change at room temperature	Primary alcohol present
Cloudy solution formed with 5 to 10 minutes.	Secondary alcohol present
Cloudy solution formed immediately	Tertiary alcohol present

Iodine solution and sodium hydroxide solution:

Tests compounds with a methyl group on carbon carrying an hydroxyl groups.

N.B All tertiary alcohol do not give positive iodoform tests.

- It is also called iodo form.

Tests compound of formula $CH_3-\underset{OH}{\overset{H}{\underset{|}{\overset{|}{C}}}}-R$, where R is an alkyl group of hydrogen.

Test	Observation	Deduction
To $1cm^3$ of the solution, add $2cm^3$ of iodine solution followed by dilute sodium hydroxide solution drop wise until the solution turns pale yellow. Warm it gently and then cool under running tap water.	Pale yellow precipitate with an antiseptic smell	$CHI_{3(s)}$ formed Alcohol with structure $CH_3-\underset{OH}{\overset{H}{\underset{|}{\overset{|}{C}}}}$ Or Carbonyl with structure $CH_3-\overset{O}{\overset{\|}{C}}-$

Concentrated hydrochloric acid and sodium nitrite solution:

Test	Observation	Deduction
To $1cm^3$ of the organic compound, add 4 drops of concentrated hydrochloric acid followed by $1cm^3$ of sodium nitrite solution and temperature maintained at ℃.	Effervescence of a colourless gas neutral to litmus paper.	$N_{2(g)}$ evolved Primary aliphatic amine present.
	No observable change on warming	Tertiary aliphatic amine
	Yellow oily liquid is formed without effervescence of a colourless gas.	Nitrosoamine formed, secondary aliphatic amine present.
	No observable change in the cold, but on warming , effervescence occurs, of a colourless gas neutral to litmus paper	Primary aromatic amine present.

Copper(II) sulphate solution:

Test	Observation	Deduction
To $3cm^3$ of organic compound, add $1cm^3$ of cooper (II) sulphate solution.	Deep blue solution is formed	Aliphatic amine present

Concentrated hydrochloric acid, followed by sodium nitrite solution, sodium hydroxide solution and then 2-naphthol:

Test	Observation	Deduction
To about $2cm^3$ of organic compound, add 4 drops of concentrated hydrochloric acid, followed by 3/4 drops of sodium nitrite solution, then $1cm^3$ of sodium hydroxide solution, and 3 drops of 2-naphthat	Bright yellow precipitate is formed on addition of dilute sodium hydroxide solution.	Azone dye is formed. Amino benzene present.

Soda lime (mixture of sodium hydroxide and calcium oxide):

Test	Observation	Deduction
To $1cm^3$ of the organic compound or to half a spatula endful of the organic compound, add 2 spatula endful of soda lime and warm the mixture, first gently and more strongly	Colourless vapour with a smell of petrol or paraffin that burns with a non-sooty flame.	Alkane evolved. Aromatic carboxylic acid present.
	Colourless vapour with a carbolic smell which burns with a sooty flame.	Benzene vapour evolved . Aromatic carboxylic acid e.g benzoic acid.
	Colourless vapour with a carbolic smell which burns with a sooty flame.	Phenol evolved Hydroxyl aromatic carboxylic acid present.
	Colourless vapour with a characteristic fishy smell which turns moist red litmus vapor blue and burns with a non-sooty flame.	Lower aliphatic amine evolved . Lower aliphatic amide or substitute amide present.

Hot concentrated sulphuric acid:

Test	Observation	Deduction
To $1cm^3$ of the organic compound, add 5 drops of concentrated sulphuric acid and heat pass the vapour formed through acidified potassium manganate(VII) solution.	White fumes which turn acidified potassium manganate (VII) solution from purple to colourless.	Alcohol dehydrated to form alkene.

Dilute sulphuric acid:

Test	Observation	Deduction
To $1cm^3$ of the solution, add 2-3 drops of dilute sulphuric acid.	White precipitate	Phenolic compound Aromatic carbonyl acid/ salt of aromatic carboxylic acid.
To a spatula endful of the solid, add $4cm^3$ of dilute sulphuric acid and shake well to dissolve.	The solid dissolves in the acid in the cold without effervescence.	Basic compound present e.g Amine

NB. Salt of aromatic carboxylic acid can be formed when aromatic carboxylic acid is reacted with sodium hydroxide solution.