Name:

Organic Chemistry	**Objectives**
22. Some Families of Organic Compounds	-define tetrahedral carbon -describe the alcohols as a homologous series of organic compounds -name the alcohols (primary and secondary alcohols only) up to C4 -draw the structural formulas of alcohols (primary and secondary alcohols only) up to C4 -account for the physical properties [physical state, solubility (qualitative only) in water and in non-polar solvents]of the alkanes alcohols up to C4 -relate the physical properties of alcohols and water through comparison of their structures -account for the solubility of (a) methanol (methyl alcohol) and (b) butan-1-ol in (i) cyclohexane and (ii) water. -discuss the use of ethanol (ethyl alcohol) as a solvent -outline the use of methanol (methyl alcohol) as a denaturing agent -recall that fermentation is a source of ethanol (ethyl alcohol) -discuss the use of fermentation in the brewing and distilling industries -define planar carbon -define carbonyl compound -describe the bonding in the carbonyl group -describe aldehydes as a homologous series of compounds -construct models to illustrate the structure of aldehydes -name the aldehydes to C4 -draw the structural formulas of the aldehydes up to C4 -account for the physical properties [physical state, solubility (qualitative only) in water and in non-polar solvents]of the aldehydes up to C4 -account for the solubility of ethanal (acetaldehyde)in (i) cyclohexane and in (ii) water -describe carboxylic acids as a homologous series of compounds -construct models to illustrate the structure of carboxylic acids -name the carboxylic acids to C4 -draw the structural formulas of the carboxylic acids to C4 -describe the bonding in the carbonyl group of carboxylic acids -account for the solubility of ethanoic (acetic) acid in (i) cyclohexane and in (ii) water -account for the physical properties [physical state, solubility (qualitative only) in water and in non-polar solvents] of the carboxylic acids up to C4 -give examples of carboxylic acids in everyday life e.g. methanoic acid (formic acid) in - nettles and ants, ethanoic acid (acetic acid) in vinegar -explain what is meant by an aromatic compound -explain in simple terms the use of the circle to represent the identical bonds in benzene, intermediate between double and single -account for the solubility of methylbenzene in (i) cyclohexane and in (ii) water -discuss the use of methylbenzene as an industrial solvent -give an indication of the range and scope of aromatic chemistry (Structures not required) -identify the benzene ring in the structural formulas of a range of consumer products -give one example in each case of: aromatic compounds as the basis of dyestuffs, detergents, herbicides and many pharmaceutical compounds (structures not required) -aromatic acid-base indicators: phenolphthalein, methyl orange (structures not required)

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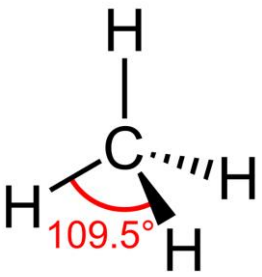
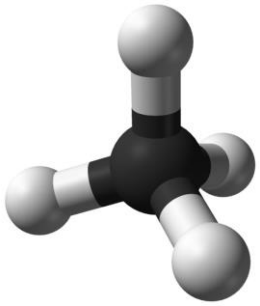
	-recognise the carcinogenic nature of some aromatic compounds e.g. benzene -recognise that not all aromatic compounds are carcinogenic, e.g. aspirin (structure of aspirin not required)

IMPORTANT: YOU NEED TO BE ABLE TO NAME AND DRAW THE STRUCTURAL FORMULAE OF EACH TYPE OF COMPOUND COVERED IN THIS SECTION

Tetrahedral Carbons:

A tetrahedral carbon is a carbon atom which has tetrahedral geometry. This geometry happens only when the carbon atom has 4 single bonds (saturated).





We will look at 1 type of compounds which contain only tetrahedral carbons:

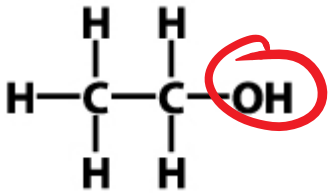
1. Alcohols

1. Alcohols

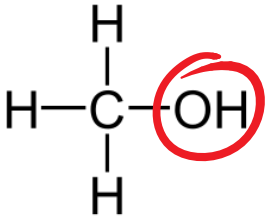
Def^{n}*:* A **functional group** is an atom or a group of atoms which are responsible for the characteristic properties of an organic compound or a series of organic compounds.

Functional Group: **-OH** Name ends in "-ol"

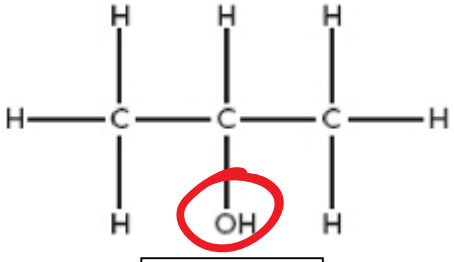
Examples:



ethanol



methanol



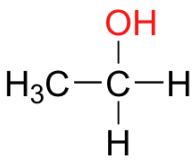
propan-2-ol

Types of Alcohols:

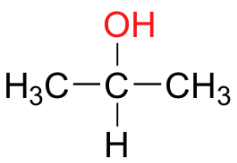
Primary Alcohols: An alcohol where the carbon atom bonded to the OH group is bonded to only 1 other carbon.

Secondary Alcohol: An alcohol where the carbon atom bonded to the OH group is bonded to 2 other carbons.

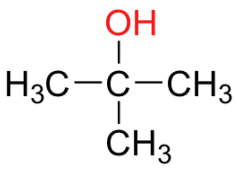
Tertiary Alcohol: An alcohol where the carbon atom bonded to the OH group is bonded to 3 other carbons.



a primary alcohol



a secondary alcohol



a tertiary alcohol

Ethanol:

Ethanol (C_2H_5OH) is the most common and best known alcohol. It is found in alcoholic drinks.

It is made by fermenting glucose using yeast: $\mathbf{C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2}$

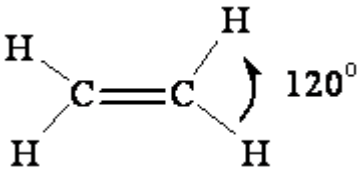
To prevent people from drinking industrial ethanol, methanol is added, as it is particularly toxic. This ethanol is now denatured and is called methylated spirits.

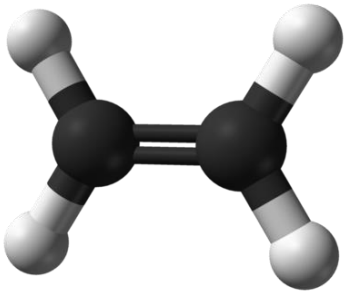
Physical Properties:

1) Alcohols have higher boiling points than their corresponding alkanes. This is due to hydrogen bonding between the alcohol molecules.
2) Small alcohol molecules are soluble in water due to the hydrogen bonding between the molecules. Larger alcohol molecules (e.g. butanol) are not soluble in water as the effect of the hydrogen bonding decreases as the molecule gets bigger. These larger alcohols are soluble in non-polar solvents like cyclohexane.

Planar Carbons:

A planar carbon is a carbon atom which has planar geometry. This geometry happens only when the carbon atom is unsaturated (contains a double- or triple-bond)





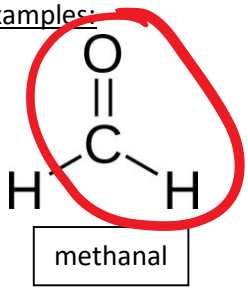
We will look at 5 types of planar compounds:

1. Aldehydes
2. Carboxylic Acids
3. Benzene and Natural Compounds Containing Benzene Rings

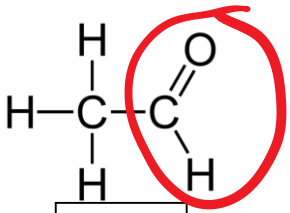
1. Aldehydes:

Functional Group: **-CHO** Name ends in "-al".

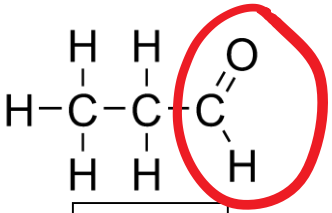
Examples:



methanal



ethanal



propanal

Carbonyl Group: The highly polar **C=O** carbonyl group is always located at the end of the carbon chain in an aldehyde.

Physical Properties:

The polar carbonyl group in aldehydes mean that aldehyde molecules have dipole-dipole intermolecular forces.

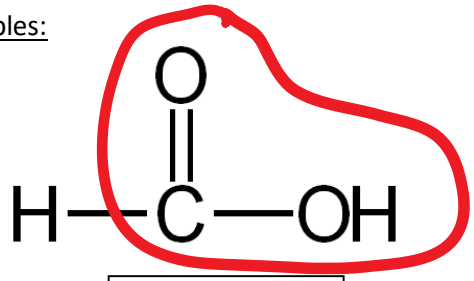
1. Boiling points of aldehydes are higher than their respective alkanes due to the dipole-dipole forces between the aldehyde molecules being stronger than the weak Van-der-Waals forces between the alkane molecules.
2. The boiling points of aldehydes are lower than their corresponding alcohols due to the dipole-dipole forces between aldehyde molecules being weaker than the hydrogen bonding that occurs between alcohol molecules.

3. Small aldehyde molecules are soluble in water due to the polar carbonyl group. The larger the aldehyde molecule becomes, the less soluble the aldehyde is in water, as the effect of the polar carbonyl group decreases.

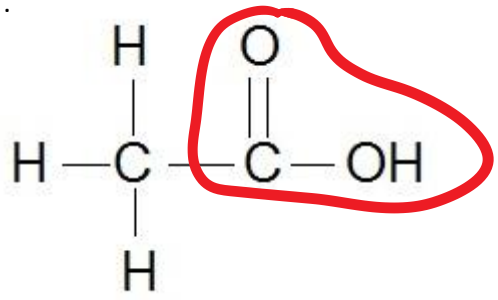
2. Carboxylic Acids:

Functional Group: **-COOH** Name ends in "-oic acid".

Examples:



Methanoic acid



Ethanoic acid

Uses: Methanoic acid is found in ant and nettle stings.

Ethanoic acid is used as a flavouring agent in vinegar.

Carbonyl Group: The highly polar **C=O** carbonyl group is always located at the end of the carbon chain in a carboxylic acid.

Physical Properties:

The polar O-H bond located off the carbonyl group in carboxylic acids means that carboxylic acid molecules have Hydrogen Bonding intermolecular forces.

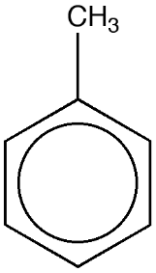
1. Boiling points of carboxylic acids are higher than their respective alkanes, aldehydes, alcohols and ketones due to the relatively strong hydrogen bonds between the carboxylic acid molecules being stronger than the weaker Van-der-Waals and Dipole-Dipole forces between the other respective molecules.

Small carboxylic acid molecules are soluble in water due to the Hydrogen Bonding. The longer the carbon chain becomes, the less soluble the carboxylic acid is in water, as the effect of the polar **-OH** group decreases.

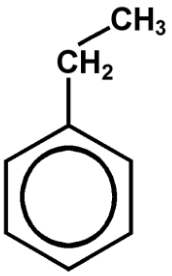
3. Aromatic Compounds:

Structure: Contains a **Benzene Ring**.

Examples:



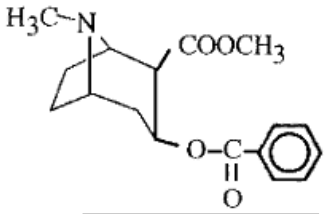
Methylbenzene



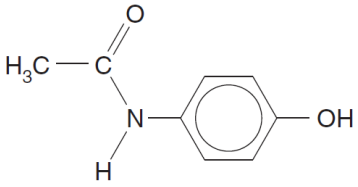
Ethylbenzene

Structure/Bonding in Benzene: The bond lengths between all carbon atoms in benzene is identical – it is somewhere between a single bond and a double bond. (Structure is NOT alternating single and double bonds).

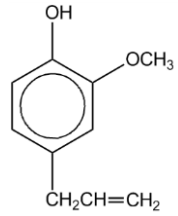
Organic Natural Products: Many compounds made in nature contain benzene rings. Examples are:



Cocaine
(Lab Made)



Paracetamol
(Lab Made)



Eugenol (Clove Oil)
(Natural)

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