St Ninian's High School

Chemistry Department

National 5 Chemistry

Unit 2: Nature's Chemistry

Topic 2

Consumer Products

Summary Notes

Name _____

Learning Outcomes

After completing this topic you should be able to :

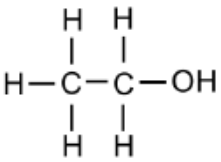
1	identify an alcohol from the hydroxyl group and the '-ol' name ending
2	name straight-chain alcohols, incorporating the position of the hydroxyl group, from shortened and full structural formulae (C_1 - C_8)
3	write molecular formulae and draw shortened and full structural formulae given the names of straight-chain alcohols (C_1 - C_8)
4	state that the alcohols are an example of a homologous series
5	state that ethanol is the alcohol present in alcoholic drinks
6	relate the properties of the alcohols to their uses
7	identify a carboxylic acid from the carboxyl group and the '-oic' name ending
8	name straight-chain carboxylic acids from shortened and full structural formulae (C_1 - C_8)
9	write molecular formulae and draw shortened and full structural formulae given the names of carboxylic acids (C_1 - C_8)
10	state that vinegar is a dilute solution of ethanoic acid
11	give examples of the use of vinegar (household cleaning products and food preservative)
12	state that esters are produced from an carboxylic acid and an alcohol
13	state that esters are used in food flavourings, industrial solvents and fragrances.

Alcohols

The Alcohols

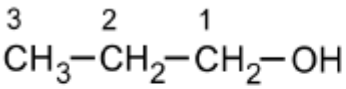
Alcoholic drinks have been known of for thousands of years. Many people use alcoholic drinks to celebrate social occasions whilst other people do not drink alcoholic beverages. There are many different alcohols but the alcohol present in alcoholic drinks is ethanol.

All alcohols contain a hydroxyl functional group (OH). The atoms in the hydroxyl group are attached by a covalent bond to form part of the molecule.

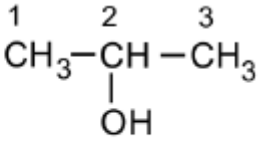


ethanol

Alcohols are named in a similar way to the alkanes. The general formula for the alcohols is $C_nH_{2n+1}OH$.



propan-1-ol



propan-2-ol

Alcohols

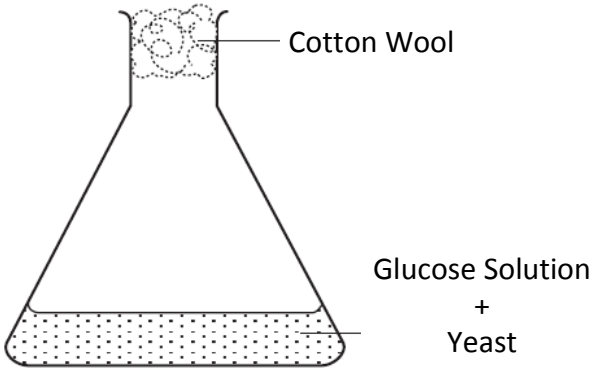
Making Ethanol

Ethanol is produced by the fermentation of glucose (sugar $C_6H_{12}O_6$). This requires an enzyme found in yeast to catalyse the reaction, carbon dioxide is also produced.

Fermentation:

Glucose	$\xrightarrow{\text{Yeast}}$	Ethanol	+	Carbon Dioxide
$C_6H_{12}O_6$		C_2H_5OH	+	CO_2

Fermentation can be carried out in the lab as shown below.



Once the ethanol has been formed you should be able to identify it by smell. The maximum concentration of ethanol produced by fermentation is about 15% since the ethanol destroys the enzymes in the yeast and prevents further fermentation. To produce drinks like vodka and whisky the alcohol has to be distilled. Ethanol can be distilled since the boiling point of ethanol is lower than water at 78°C . Ethanol can also be produced by the hydration of ethene as seen in Unit 2 Topic 1. Ethanol produced by the hydration of ethene cannot be used to make alcoholic drinks.

The alcohols are a homologous series, so show gradual changes in physical properties.

Boiling Points

The boiling points of alcohols increase with increasing length of carbon chain. Larger molecules have stronger forces between the molecules and therefore increased boiling points.

Flammability

All alcohol molecules will burn easily. Flammability decreases with increasing length of alcohol molecule. When an alcohol molecule burns in a plentiful supply of air carbon dioxide and water are produced.

Solubility

Alcohols are soluble in water and therefore dissolve to form solutions. The solubility decreases with increasing size of molecule. Methanol and ethanol will dissolve easily in water.

Alcohols

Uses of Alcohols

We have already seen that ethanol is the alcohol found in alcoholic drinks. Alcohols have a variety of other uses in everyday life.

Alcohols as Solvents

Short chain alcohols, such as methanol, ethanol, propanol and butanol are able to dissolve a variety of compounds and therefore are used as solvent in numerous applications. They are frequently used to dissolve compounds required to make perfumes, deodorants, paints and dyes. As the alcohols evaporate easily, once they have been applied to the surface (e.g. paint to a wall), the alcohol evaporates and leaves behind the solute.

The short chain alcohols are also used in cleaning since they have the ability to dissolve a variety of compounds and evaporate easily. For example, screen wipes, baby wipes, alcohol hand gels and disinfectant wipes.

Alcohols as Fuels

Alcohols are highly flammable. They react with oxygen (combust) to produce carbon dioxide and water.

Example: Methanol $CH_3OH + O_2 \longrightarrow CO_2 + H_2O$

When alcohols burn they release a significant amount of energy, this means they are able to be used as fuels. A **fuel** is substance which burns to give out energy.

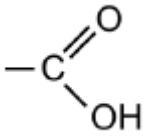
Ethanol can be produced by the fermentation of sugar cane. This means it can be regarded as a renewable source of energy, as the sugar cane can easily be regrown. The ethanol produced can be used as a fuel, or mixed with petrol or diesel to produce a fuel blend. Methanol is used as a fuel in racing cars.

Methylated Spirits is a mixture of ethanol and methanol and is commonly used as a fuel in camping stoves.

Carboxylic Acids

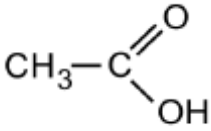
The Carboxylic Acids

The carboxylic acids are another example of a homologous series. All carboxylic acids have a name which ends in "anoic" and contain the **carboxyl** group:



Carboxyl Group

The carboxylic acids take a similar name as the other families we have met so far where a prefix indicates the number of carbon atoms. The first member of this homologous series is called methanoic acid, the second member is called ethanoic acid. In fact vinegar is a solution which contains ethanoic acid and this is what gives vinegar a sour taste.



Ethanoic Acid

The general formula for the carboxylic acids is $C_nH_{2n+1}COOH$.

Uses of Carboxylic Acids

Food Preservation

Vinegar (a solution of ethanoic acid) is used as a preservative in the food industry as the low pH of vinegar prevents bacteria and fungi growing which would spoil the food. Using vinegar is an example of pickling. Vinegar is used to pickle eggs and various vegetables such as cucumbers and gherkins.

Pickled Eggs

Pickled Gherkins

Carboxylic Acids

Cleaning

Acidic solutions will react with bases in neutralisation reactions. Many cleaning chemicals contain acidic solutions since cleaning often involves removing metal carbonates. Metal carbonate deposits can build up in kettles, showerheads and taps. Some cleaning chemicals contain vinegar (ethanoic acid) which can react with metal carbonates to produce soluble salts which are washed away easily and therefore "cleaned away".

Example: The reaction between ethanoic acid and sodium carbonate.

ethanoic acid + sodium carbonate ⟶ sodium ethanoate + water + carbon dioxide

Acid **Base** **Salt**

Food

The food industry uses other carboxylic acids such as benzoic acid. This occurs naturally in cherry bark, raspberries and tea, but is also synthesized (produced) for use as the food additive, E210. It acts as a preservative and is often used in fruit products and soft drinks.

Citric acid, another common carboxylic acid, is found in citrus fruits, such as lemons, and is responsible for the bitter taste. Citric acid is also found in soft drinks and is widely used in cooking for example fruit salads are covered in orange juice to stop the enzymes in fruit turning the fruit brown.

The concentration of ethanoic acid in vinegar can be determined by titration with sodium carbonate solution with a suitable indicator.

Esters

Esters are a type of compound which are used in consumer products particularly for flavourings. Esters are made when an alcohol and carboxylic acid react.

Alcohol + Carboxylic Acid ⟶ Ester + Water

Forming an ester is an example of a condensation reaction since two molecules are reacted together to produce a larger molecule plus water. A wide variety of fruity smelling esters can be made from various alcohols and carboxylic acids.

Uses of Esters

Esters have several uses:

i) as food flavourings e.g. sweets

ii) as perfumes, aftershaves and deodorants

iii) as solvents e.g. nail varnish removers.

Topic 2 Summary Statements

- ☐ An alcohol can be identified from the hydroxyl group and the '-ol' name ending.
- ☐ Straight-chain alcohols, incorporating the position of the hydroxyl group, from shortened and full structural formulae (C_1 - C_8) can be named.
- ☐ The molecular formulae can be written and the shortened and full structural formulae given the names of straight-chain alcohols (C_1 - C_8).
- ☐ The alcohols are an example of a homologous series.
- ☐ Ethanol is the alcohol present in alcoholic drinks.
- ☐ The physical properties of the alcohols relate to the their uses such as flammability, boiling points and solubility.
- ☐ A carboxylic acid can be identified from the carboxyl group and the '-oic' name ending.
- ☐ Straight-chain carboxylic acids can be named from shortened and full structural formulae (C_1 - C_8).
- ☐ The molecular formulae can be written and shortened and full structural formulae drawn given the names of carboxylic acids (C_1 - C_8).
- ☐ Vinegar is a dilute solution of ethanoic acid.
- ☐ Vinegar is often used in household cleaning products and as a food preservative.
- ☐ Esters are produced from an carboxylic acid and an alcohol.
- ☐ Esters are used in food flavourings, industrial solvents and fragrances.