The content on this sheet is assessed on paper 2 only.

# Topic 9d—Alcohols and carboxylic acids

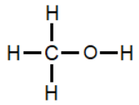
* Indicates that these are some examples only: you could be asked about any substance / reaction.

## 9.26—Formulae and structures of the alcohols

Methanol:

Formula = $CH_3OH$

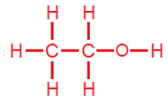
Structure =



Ethanol:

Formula = $C_2H_5OH$

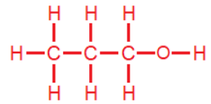
Structure =



Propanol:

Formula = $C_3H_7OH$

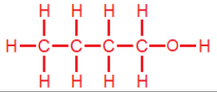
Structure =



Butanol:

Formula = $C_4H_9OH$

Structure =



## 9.27—Functional group & reaction of alcohols

The functional group of the alcohols is the OH group. All of the alcohols can undergo dehydration reactions (where a water molecule is lost) to form an alkene.

The word equation, for this reaction with ethanol, is:

Ethanol —> ethene + water

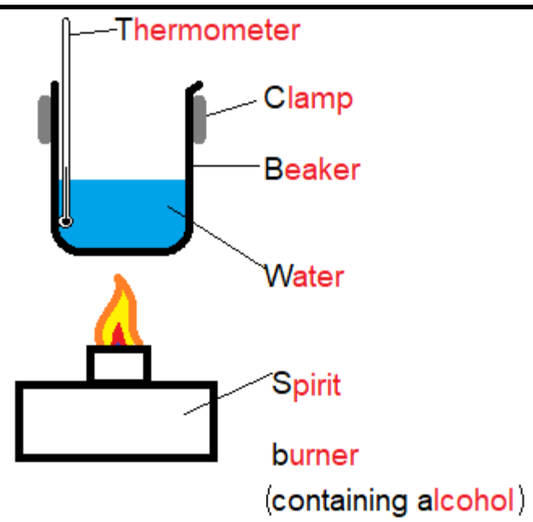
## 9.28—CP8—Temperature rise when alcohols burn

Method: measure out a known volume of water and add to a beaker. Record the mass of the spirit burner and place it beneath the beaker. Record the starting temperature of the water. Light the fuel and heat the water up for a set amount of time *or* temperature increase. Extinguish the flame. Record the final temperature of the water and mass of the spirit burner.

The values will not be close to the actual values, due to a large amount of heat/energy loss. This can be reduced by either insulating the beaker, or adding a lid/draught shield, to reduce the amount of energy lost to the surroundings.

Suggest & explain a safety precaution that should be taken in this practical.

Allow objects to cool before handling; keep alcohols away from uncontrolled flames.

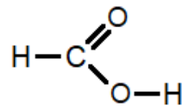



## 9.29—Formulae and structures of the carboxylic acids

Methanoic acid:

Formula = $CH_3OH$

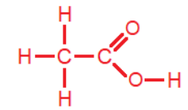
Structure =



Ethanoic acid:

Formula = $CH_3COOH$

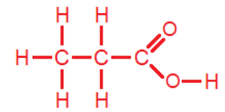
Structure =



Propanoic acid:

Formula = $C_2H_5COOH$

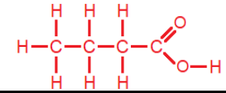
Structure =



Butanoic acid:

Formula = $C_3H_7COOH$

Structure =



## 9.30—Functional group & reaction of carboxylic acids

The functional group of the carboxylic acids is the COOH group. All of the carboxylic acids undergo reactions typical of acids—for example, they could neutralise a base to form a salt + water, and can react with metals to form a salt + hydrogen. As weak acids, they tend to turn universal indicator orange.

## 9.31—Oxidising alcohols*

Alcohols, such as ethanol, can be oxidised (by reacting with oxygen from the air) to form the corresponding carboxylic acid. In the case of ethanol, this would be ethanoic acid. When this happens, a molecule of water is also produced.

The word equation for this oxidation reaction is:

Ethanol + oxygen —> ethanoic acid + water

## 9.32—Homologous series*

All members of the same homologous series undergo similar reactions, due to the fact that they all have the same functional group.

We can use this to predict the reactions of other members of the alcohol and carboxylic acid homologous series.

homologous series.

The word equation for the oxidation of propanol is:

Propanol + oxygen —> propanoic acid + water

The word equation for the production of methanoic acid by oxidation is:

Methanol + oxygen —> methanoic acid + water

## 9.33—Fermentation

Ethanol can be produced in two ways: *the first way is by reacting ethene with steam at raised temperatures, over a catalyst, to produce ethanol (this is the opposite of the dehydration reaction described in section 9.27).*

Ethanol can be produced by the fermentation of sugars in aqueous solution. There are two products in this reaction, with the other being carbon dioxide.

However, this reaction requires a catalyst. These catalysts are provided from yeast in the form of different enzymes.

## 9.34—Purifying the product of fermentation

Once the sugar solution has been fermented, the ethanol produced needs to be separated from the mixture. Ethanol boils at around 78 °C, and water boils at 100 °C. These temperatures are quite similar, and so the mixture is separated by fractional distillation (see section 2.7 for further guidance).