CHURCH STRETTON SCHOOL

Triple Science - Chemistry

SC22-24 Knowledge Organiser

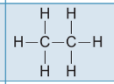
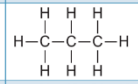
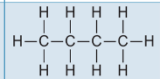
SC22-24: Organic Chemistry

Sequence

1. Alkanes and alkenes
2. Reactions of alkanes and alkenes
3. Ethanol production
4. Alcohols
5. Core practical – Combustion of alcohol
6. Carboxylic acids
7. Addition polymerisation
8. Polymer properties and uses
9. Condensation polymers
10. Problems with polymers

1. Alkanes and alkenes

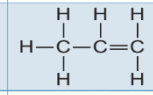
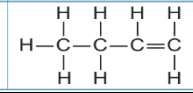
Hydrocarbon	A compound that contains hydrogen and carbon atoms **only**.
Alkanes	A hydrocarbon in which all of the bonds between the carbon atoms are single bonds. They have the general formula C_nH_{2n+2}.
General formula	The formula showing the proportions of different atoms in molecules of a homologous series.
Homologous series	A family of compounds that have the same general formula and similar properties, but have different numbers of carbon atoms.
Saturated	A molecule that contains only single bonds between the carbon atoms in a chain.
Alkenes	A hydrocarbon in which there are one or more double bonds between carbon atoms. They have the general formula C_nH_{2n}.
Unsaturated	A molecule that contains one or more double bonds between the carbon atoms in a chain.
Functional group	An atom or group of atoms in a molecule that is mainly responsible for the molecule's chemical reactions and properties.
Isomers	Molecules with the same molecular formula but different arrangements of atoms.

Number of carbons in the chain	Prefix	Alkane	Molecular formula	Structural formula
1	meth-	methane	CH_4	
2	eth-	ethane	C_2H_6	
3	prop-	propane	C_3H_8	
4	but-	butane	C_4H_{10}	

2. Reactions of alkanes and alkenes

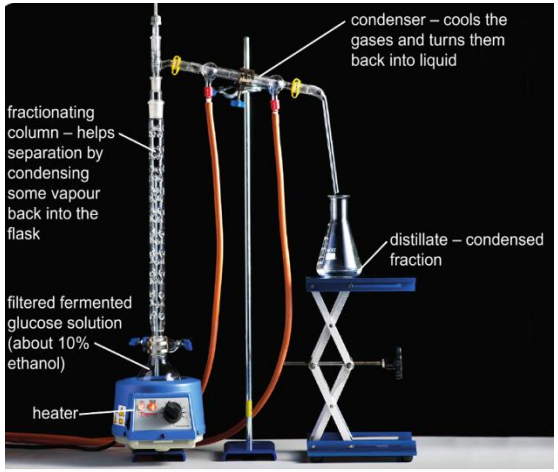
Combustion	When a compound reacts with oxygen producing a flame.
Oxidation	Gaining oxygen or losing electrons
Complete combustion	Combustion that produces only water and carbon dioxide and releases the most possible energy.
Incomplete combustion	Combustion that produces a mixture of carbon dioxide, carbon monoxide, carbon and water and produces less energy.
The bromine water test	When bromine water is added to an alkane and shaken the product retains the colour of the bromine water, orange. When bromine water is added to an alkene and shaken the colour of the bromine water is lost and the product is colourless. The test works because the C=C double bond reacts with bromine to form a colourless bromo-alkane.
Addition reaction	A reaction in which reactants combine to form one larger product molecule.

ethene + bromine ⟶ 1,2-dibromoethane

Name	Molecular formula	Structural formula
ethene	C_2H_4	
propene	C_3H_6	
butene	C_4H_8	

3. Ethanol production

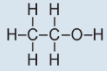
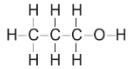
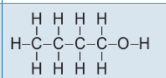
Ethanol	The alcohol found in alcoholic drinks, its formula is C_2H_5OH. It can also be used as a fuel for vehicles and the raw material for the chemical industry.
Sugar	Sugars are small, soluble substances that belong to a group called carbohydrates.
Carbohydrates	Carbohydrates are compounds made of carbon hydrogen and oxygen.
Starch	Starch is a long polymer made up of sugar monomers.
Enzymes	Enzymes are biological catalysts, which speed up chemical reactions within living things.
Fermentation	The process carried out by enzymes in yeast that turns sugars into ethanol and carbon dioxide. The temperature and pH of the fermentation vessel must be carefully controlled to avoid denaturing the enzymes.
Anaerobic respiration	A type of respiration that only occurs in the absence of oxygen. Yeast respire anaerobically during the fermentation process.
Fractional distillation	A method of separating a mixture of liquids with different boiling points into individual fractions.
Distillate	The liquid produced by condensing gases during distillation.



fractional distillation of an ethanol solution

4. Alcohols

Alcohol	A homologous series of compounds that contain the –OH functional group and the general formula $C_nH_{2n+1}OH$
Organic compound	A compound that has the central framework of carbon atoms onto which hydrogen atoms and other elements are attached. Methane is organic (CH_4) but carbon dioxide is not (CO_2) as it does not contain any hydrogen atoms.
Methanol	The simplest alcohol, its formula is CH_3OH.
Propanol	The third member of the alcohol series, its formula is C_3H_7OH.

Name	Molecular formula	Structural formula
methanol	CH_3OH	
ethanol	C_2H_5OH	
propanol	C_3H_7OH	
butanol	C_4H_9OH	

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5. Core practical – The combustion of alcohol

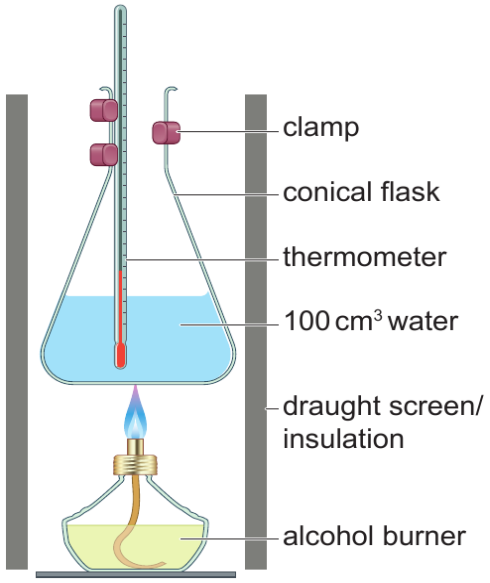
Aim	Investigate the temperature rise produced in a known mass of water by the combustion of the alcohols ethanol, propanol, butanol and pentanol.
Your task	You will investigate and compare the energy given out by the combustion of different alcohols. To do this, you will measure the temperature rise of a known mass of water caused by the combustion of ethanol, propanol, butanol and pentanol.

Method

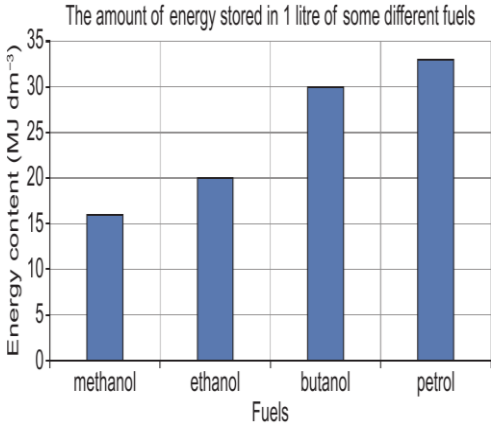
Wear eye protection. Do not fill the alcohol burner if there are any naked flames nearby.

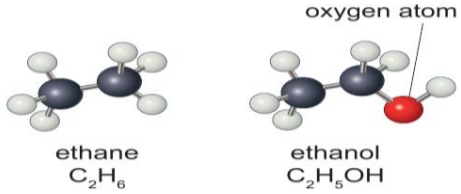
a. Measure the mass of an alcohol burner and cap. Record the mass and the name of the alcohol.
b. Place the alcohol burner in the centre of a heat-resistant mat.
c. Use a measuring cylinder to add 100cm^3 of cold water to a conical flask,
d. Measure and record the initial temperature of the water and clamp the flask above the alcohol burner.
e. Light the wick of the burner and allow the water to heat up by 40°C.
f. Replace the cap on the burner and measure and record the final temperature of the water.
g. Measure the mass of the alcohol burner and cap again and record the mass.
h. Calculate the mass of the alcohol burned to produce a 1°C rise in temperature.
i. Repeat steps a-h using fresh, cold water and a different alcohol.

Considering your results	To calculate the mass of the alcohol burned to produce a 1°C rise in temperature you need to divide the mass of alcohol burned by 40. $\frac{\text{Mass of alcohol burned}}{40}$ = mass required to produce a 1°C rise



B investigating energy in fuels

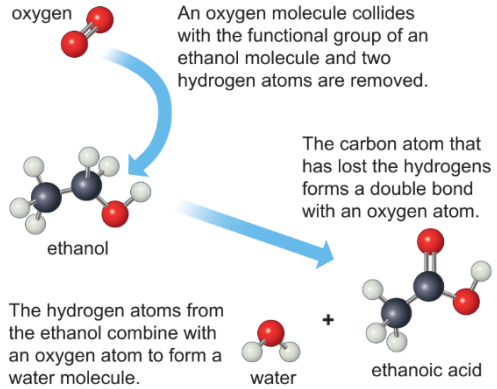




A Ethane and ethanol are both organic compounds but are in different homologous series.

6. Carboxylic acids

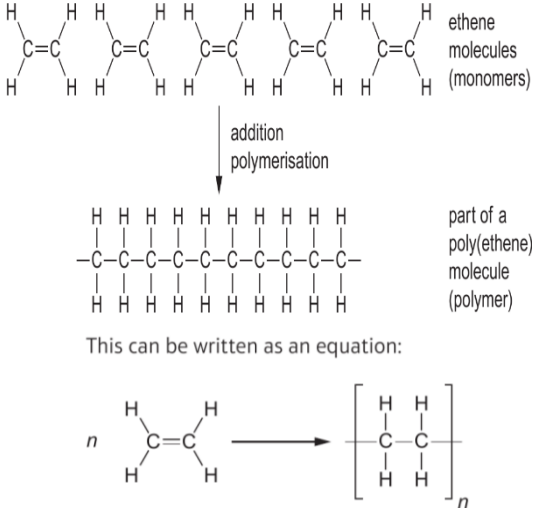
Carboxylic acid	A homologous series of compounds that contain the –COOH functional group and the general formula $C_nH_{2n+1}COOH$. They all form solutions with a pH of less than 7, react with metals to form a salt and hydrogen, reacts with bases to form a salt and water and reacts with carbonates to form a salt, water and carbon dioxide.
Methanoic acid	The simplest carboxylic acid, its formula is HCOOH.
Ethanoic acid	The carboxylic acid found in vinegar, its formula is CH_3COOH. It can be made by oxidising ethanol.
Propanoic acid	The third member of the carboxylic acid series, its formula is C_2H_5COOH.
Oxidising agents	A substance that causes another substance to be oxidised in an oxidation reaction.



Name	Molecular formula	Structural formula
methanoic acid	HCOOH	
ethanoic acid	CH_3COOH	
propanoic acid	C_2H_5COOH	
butanoic acid	C_3H_7COOH	

7. Addition polymerisation

Polymers	A large molecule made of a small unit repeated many times.
Monomers	A small molecule that can be joined together many times to form a polymer.
Polymerisation	A reaction in which a large number of small molecules (monomers) join together to form a long chain molecule (polymer).
Addition polymerisation	A type of polymerisation in which the monomers add on to each other and no small molecules are eliminated.
Repeating unit	The part of a polymer that can be repeated many times to form the polymer chain.
Synthetic polymer	A polymer that is manufactured in a laboratory or factory.
Natural polymers	A substance that exists naturally as a polymer in plants, animals etc., such as DNA, starch and proteins.
DNA	Deoxyribonucleic acid is made from four different monomers called nucleotides.
Proteins	Proteins are polymers made from amino acids.
Starch	Starch is a polymer made from a sugar called glucose.



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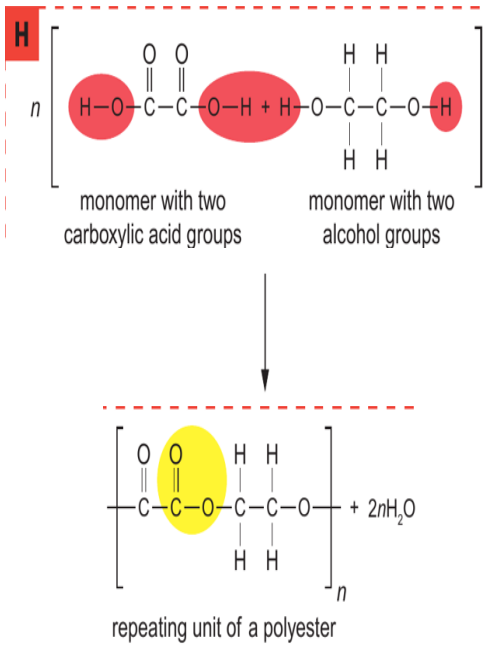
8. Polymer properties and uses

Polythene	A common polymer made of ethene monomers. It is a flexible, cheap and a good insulator. Making it suitable for making plastic bags, plastic bottles, cling film and polytunnels.
Poly(propene)	A common polymer made of propene monomers. It is flexible and does not shatter. Making it useful for making buckets, crates, ropes and carpets.
Poly (chloroethene)	A polymer, also known as PVC, made of dichloroethene monomers. It is tough, a good insulator and can be made hard or flexible. Making it useful for making window frames, gutters and insulation for electrical wires.
Poly (tetra fluoroethene)	A polymer, also known as PTFE or Teflon, made of tetrafluoroethene monomers. It is tough and slippery. Making it useful for non-stick coatings on frying pans and cooking utensils, stain proof clothing and carpets.

A There are many different polymers and their uses depend on their properties.

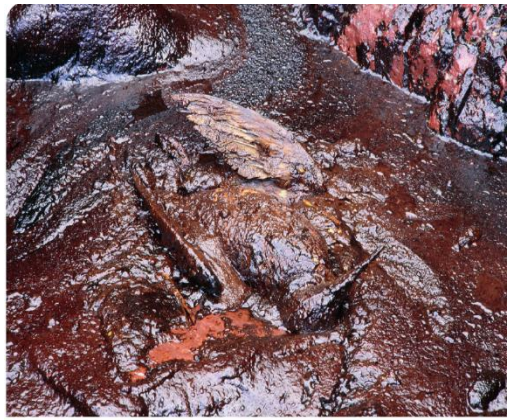
9. Condensation polymers

Polyester	This is a polymer that contains large numbers of ester links.
Condensation polymerisation	When monomers join together and eliminate a small molecule, such as water. The functional group that all polyester molecules contain is -COO-. This functional group is formed when an alcohols functional group -OH and a carboxylic acids functional group -COOH react to form a water molecule and the -COO-. To form a long chain each monomer must have two functional groups, one at each end.
Ester	Esters are organic compounds that contain the functional group -COO-.



10. Problems with polymers

Finite resources	Something useful that is no longer made or which is being made very slowly.
Non-renewable	Any energy resource that will run out because you cannot renew your supply of it, e.g. oil.
Biodegradable	A substance that can be broken down by microorganisms.
Non-biodegradable	A substance that cannot be broken down by microorganisms.
Incinerated	When waste is burnt in order to dispose of it. The heat generated can be used to generate electricity. The waste products are fly ash, carbon dioxide and acid rain forming gases.
Landfill	When waste is buried in a large hole in the ground. The rotting waste generates large amounts of methane and carbon dioxide, which contribute to global warming.
Recycling	Converting waste materials into new products.



A The extraction and transport of crude oil can have disastrous consequences for wildlife.

B These plastic items were found in the stomachs of dead albatrosses in Hawaii. The plastics are non-biodegradable and so they will not rot if they get into the sea. The albatrosses, such as the one in the photo, mistake the items for food.

symbol	polymer	uses
1 PET	poly(ethylene terephthalate)	some bottles, food trays, duvet fillings
2 HDPE	high-density poly(ethene)	some bottles, buckets
3 PVC	poly(chlorothene)	soft toys, window frames
4 LDPE	low-density poly(ethene)	cling film, bags
5 PP	poly(propene)	crisp packets, carpet, rope
6 PS	poly(styrene)	egg boxes, foam packaging
7 OTHER	other polymers	