AQA Chemistry: Additional content

SAMUEL WARD ACADEMY TRUST

Paper 1 Chemistry topics

- Atoms, molecules and moles
  - Atomic structure
  - The periodic table*
  - Structure and bonding*
  - Chemical calculations*
- Chemical changes and energy changes
  - Chemical changes
  - Electrolysis
  - Energy changes*

Paper 2 Chemistry topics

- Rates, equilibrium and organic chemistry
  - Rates and equilibrium
  - Crude oil and fuels
  - Organic reactions (Chemistry Only Topic)*
  - Polymers (Chemistry Only Topic)*
- Analysis and the Earth's resources
  - Chemical analysis*
  - The Earth's atmosphere
  - The Earth's resources
  - Using our resources (Chemistry Only Topic)*

*** Topics with extra content compared to Trilogy.**

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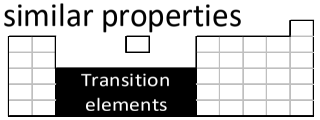
Key points to learn

Topic 2: The Periodic Table

1. Transition elements	Metals with similar properties positioned between groups 2 and 3 in the periodic table 
2. Comparing transition and Group 1 elements	Transition elements have: 1. Higher melting points 2. Higher densities 3. Greater strength 4. Greater hardness 5. Are less reactive with oxygen, water and halogens
3. Ions of transition elements	• Form ions with different charges in compounds that are often coloured • Are very useful as catalysts

Topic 3: Structure and bonding

4. Nano-science	Deals with nanoparticles which are between 1 and 100 nanometres (nm) big i.e. 1 x 10^{-9} and 100 x 10^{-9} metres(m)
5. Nano-particles	Have very different properties to large particles of the same material due to their high surface area to volume ratio. This may mean that less is needed for a specific role
6. Uses of nano-particles	1. Medicine 2. Electronics 3. Cosmetics and sun cream 4. Deodorants 5. Catalysts

Key points to learn

Topic 4: Chemical calculations

7. Theoretical yield	The maximum amount of a product that could be made in a reaction
8. Actual chemical yield	How much product is actually made in a reaction
9. Percentage yield %	How much product is actually made compared to the maximum amount that could have been made in a reaction as a %
10. Reasons for a low % Yield	1. The reaction my not finish because it is reversible 2. Some product lost during separation from reaction mixture 3. Some reactants may react in ways different to expected
11. Atom economy %	The % of a starting material that ends up as useful products It is important for sustainable end economic reasons to use reactions with high atom economy
12. Titration	Measures accurately the volumes of acid and alkali react completely
13. Calculating concentration of solution in mol/dm^3	1. Find mass of solute in volume 2. Calculate mass (g) of solute in 1cm^3 of solution 3. Calculate mass (g) in 1000cm^3 4. Convert mass (g) to mole
14. Volume of gas	• A given volume of gas always has same number of moles if at same temperature and pressure • 1 mole of any gas at room temperature and pressure (20°C and 1 atmosphere) has volume of 24dm^3

Chemistry Additional Content

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Background

Transition metals and nanoscience are exciting areas of Chemistry from which many new and useful substances are being created.
If we want to use chemical reactions, we need to know how much of everything we have or can make. There's a bit more maths in Topic 4 we need to help.

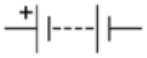
Maths skills

$$\%\ Yield = \frac{mass\ of\ product\ made}{maximum\ theoretical\ mass\ of\ product}$$

$$\%\ Atom\ economy = \frac{Relative\ formula\ mass\ of\ desired\ product\ from\ equation}{Sum\ of\ relative\ formula\ mass\ of\ all\ reactants}$$

Key points to learn

Topic 7: Energy Changes

1. Electrical Cells	Contain chemicals which react to produce electricity
	Provides the potential difference and energy for a circuit  Cell
	Voltage (potential difference) produced depends upon factors including type of electrode and electrolyte
	Can be made by connecting two different metals in contact with an electrolyte
	The bigger the difference between each metals reactivity, the larger the potential difference (voltage)
2. Batteries	Two or more cells connected in series to give bigger voltage (potential difference)  Battery
3. Non-recharge-able cells	Chemical reactions and battery stop when one reactant is used up
	Alkaline batteries are non-rechargeable
4. Recharge-able cells	Chemical reactions can be reversed by applying an electrical current

Key points to learn

Topic 7: Energy Changes

5. Fuel cells	Supplied by external fuel (eg hydrogen) and oxygen
	Fuel is oxidised to produce a potential difference (voltage)
6. Hydrogen fuel cells	Produce potential difference by oxidising hydrogen to produce water
	Hydrogen + Oxygen → Water $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$
	1. H_2 supplied to negative electrode provides excess of electrons $2H_2(g) + 4OH^-(aq) \rightarrow 4H_2O(l) + 4e^-$ 2. O2 reacts at positive electrode with Water and takes electrons $O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$ 3. The movement of the electrons is the electrical current
	Potential alternative to rechargeable cells
7. Advantages of hydrogen fuel cells	1. Do not need to be electrically recharged 2. No pollutants 3. Can be a range of sizes
8. Dis-advantages of hydrogen fuel cells	1. Hydrogen is highly flammable 2. Hydrogen is sometimes produced using non-renewable sources 3. Hydrogen is difficult to store

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  - C7: Energy changes*

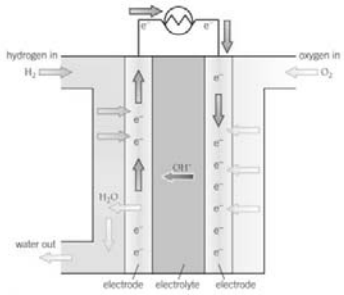
*** Topics with extra content compared to Trilogy.**

Background

Having portable sources of electrical energy have allowed us to develop everything from mobile phones to pace makers.
The demand for more efficient, effective and more sustainable energy sources is driving us to develop new technologies.

Additional information

A typical hydrogen fuel cell



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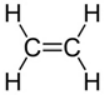
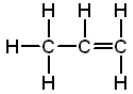
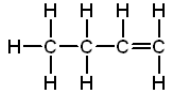
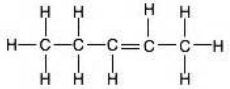
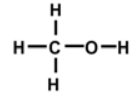
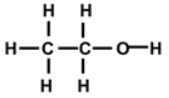
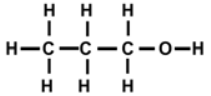
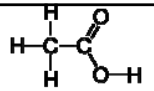
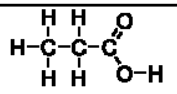
Key points to learn

1. Alk**ene**s	Hydrocarbon with a double covalent bonds eg C=C
	Belong to C=C functional group
	Known as unsaturated hydrocarbons
	Ethene (C_2H_4) 
	Propene (C_3H_6) 
	Butene (C_4H_8) 
	Pentene (C_5H_{10}) 
2. Functional group	Determines reactions of organic compounds
3. Alkene reactions	With oxygen: • combustion reactions • React same way as alkanes • Tend to have smoky flames because of incomplete combustion
	With hydrogen, water (steam) and halogens: • Atoms are added across the C=C bond so that it becomes C–C
4. Uses of alcohols	Used as solvents and fuels. Ethanol is in alcoholic drinks
5. Fermentation	A process where yeast consumes sugar in absence of oxygen to produce aqueous solutions of ethanol

Key points to learn

6. Alcohols	Contain functional group –OH
	Methanol (CH_3OH) 
	Ethanol (CH_3CH_2OH) 
	Propanol ($CH_3CH_2CH_2OH$) 
	Butanol ($CH_3CH_2CH_2CH_2OH$)
7. Reactions of alcohol	With sodium to give strong alkaline solution and hydrogen gas
	Burn in air with clean blue flame. Produces CO_2 and H_2O
	React with oxidising agent to make a carboxylic acid and water
8. Carboxylic acids	Have functional group –COOH
	Weak acids but have higher pH than strong acids. Due to most of their molecules not ionising in solution
	Methanoic acid (HCOOH)
	Ethanoic acid (CH_3COOH) 
	Propanoic acid (C_2H_5COOH) 
	Butanoic acid (C_3H_7COOH)
9. Reactions of carboxylic acids	With carbonates gently fizz releasing carbon dioxide
	Reversible reaction with alcohols to make esters and water Need strong catalyst eg sulfuric acid

Chemistry Additional Content

Knowledge Organiser

Big picture (Chemistry Paper 2)

- Rates, equilibrium and organic chemistry
  - Rates and equilibrium
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  - **Organic reactions (Chemistry Only)***
  - Polymers (Chemistry Only)*
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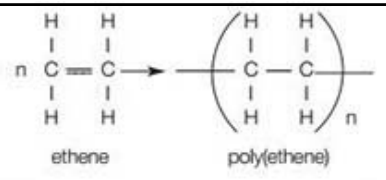
Background

Ever wondered why wine smells like vinegar if its left out for too long? This topic will explore the wonderful wold of organic compounds (containing carbon) . Look back at your notes from the Crude Oil and Fuels topic. Be careful naming of compounds!

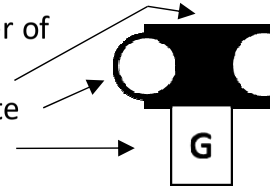
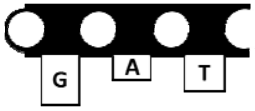
Carbons in molecule	Name likely to contain
1	Meth
2	Eth
3	Pro
4	But
5	Pent

10. Esters	Volatile, fragrant compound used in flavourings an perfume
	Ethyl ethanoate is an ester

Key points to learn

1. Polymers	Large molecules made from repeating patterns of small molecules (monomers)
2. Addition polymerisation	Reaction where many (n) monomers join together to make a polymer
	eg •  ethene poly(ethene) • Propene monomers → polypropene • Butene monomers → polybutene • Styrene monomers → polystyrene
3. Condensation polymerisation	Involves monomers with two functional groups
	Simple condensation polymers have two different monomers with two of the same functional groups on each monomer
	When monomers react and join they usually lose small molecules such as water
	Eg making polyesters • ethane diol HO–[CH_2–CH_2]–OH • combines with hexandioic acid HOOC–[CH_2–CH_2–CH_2–CH_2]–COOH • to produce a polyester $\left(\square\text{–OOC–}\square\text{–COO}\right)_n + 2nH_2O$

Key points to learn

4. Amino acids	Have an acidic and basic functional group in the same molecule
	React together during condensation polymerisation to make these natural polymers: • Polypeptides • Proteins
5. Starch and cellulose	Naturally occurring polymers made from carbohydrate
6. Protein	Naturally occurring polymers made from amino acids
7. Nucleotides	A monomer of a sugar, a phosphate and a base → 
8. DNA	Is a polymer of repeating nucleotide monomers 
	Large molecule that encodes genetic information essential for life
9. Double helix	Most DNA molecules are two polymer chains that link and twist around each other in this pattern 

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Background

When we think of polymers, most people think of plastics. But they are so much more… this topic looks more closely.

The term *mono* means *one* and *poly* means *many*.

Additional

Lots of links to other topics within Chemistry and Biology in this topic. Look at Reproduction in Biology for more on nucleotides and DNA. Organic Reactions has more on functional groups and alkenes.

Key points to learn

1. Flame tests	Can be used to identify some metals cations
	• Lithium compounds - crimson • Sodium compounds – yellow • Potassium compounds – lilac • Calcium compounds – orange-red • Copper compounds - green
2. Metal hydroxide tests	Sodium hydroxide can be used to identify some metal cations
	These solutions form white precipitates when sodium hydroxide added: • Aluminum • Calcium • Magnesium
	These solutions form coloured precipitates when sodium hydroxide added: • Copper (II) – Blue precipitate • Iron (II) – green precipitate • Iron (III) – brown precipitate
3. Testing for carbonates	React with acid to form carbon dioxide gas which can be identified with limewater
4. Testing for halides	Produce different coloured precipitates with silver nitrate solution • Silver chloride – white • Silver bromide – cream • Silver iodide – yellow

Key points to learn

5. Testing for sulfates	Sulfate ions produce a white precipitate with barium chloride solution in the presence of dilute hydrochloric acid
6. Instrumental methods for identifying chemicals	Advantages over older methods: • Accurate • Sensitive • Quicker Disadvantages: • Expensive • Need special training • Results can often only be interpreted by comparing against known substances
7. Flame emission spectroscopy	An instrumental method used to analyse metal ions in a solution
	1. Sample is put into a flame 2. Light given out is passed through a spectroscope 3. Output is a line spectrum that can be analysed 4. Allows us to identify metals and measure their concentration

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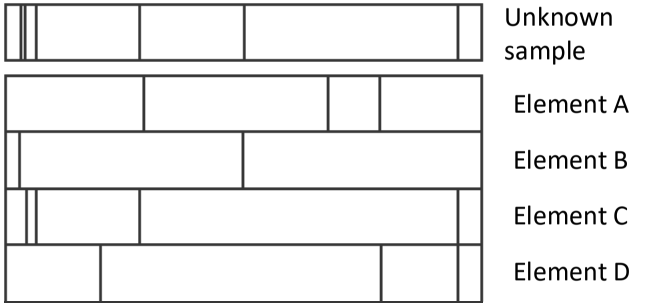
Background

The desire to find out what things are made of, was of most peoples first scientific adventures. We've come a long way from using just our human senses of taste, touch, smell, sight and hearing!

Additional

Using flame emission spectroscopy you an tell that the unknown sample below is made up of Element B and Element C.



Key points to learn

1. Corrosion	Destruction of materials by chemical reactions with substances in the environment
2. Rusting	• The corrosion of iron • Requires both water and air
3. Preventing corrosion	Using a barrier: • Grease, Paint, Electroplate • Aluminium has a oxide coating which prevents further corrosion
	Sacrificial protection uses a more reactive metal to protect eg zinc galvanising iron
4. Alloys	A mixture of metals
	Most metals in use are alloys
5. Bronze	Alloy of copper and tin. Used in statues and ship propellers
6. Brass	Alloy of copper and zinc. Used in musical instruments and taps
7. Gold alloys	Used in jewellery. Contains silver, copper and zinc
	Proportion of gold is measured in carats. 24 carats is pure gold, 18 carats is 75% gold
8. Aluminium alloys	Low density. Used to build aeroplanes
9. Steel	Alloy of iron, carbon and other metals
	High carbon steel: strong but brittle
	Low carbon steel: softer and more easily shaped

Key points to learn

10. Stainless steel	Contains chromium and nickel. Are hard and resistant to corrosion. Used for cutlery and saucepans
11. Soda-lime glass	Made by heating a mixture of sand, sodium carbonate and limestone
12. Borosilicate glass	Made from sand and boron trioxide Melting point above soda-lime glass
13 Clay ceramics	Shaped wet clay heated in a furnace
14 Properties of polymers	Depends on the monomers used and the production conditions
LD poly(ethene)	Made at high pressure with oxygen
16. HD poly(ethene)	Made with catalyst at 50°C at slightly raised pressure
17 Thermosoft-ening polymers	Melt when heated as intermolecular forces are relatively weak
18 Thermoset-ting polymers	Char rather than melt when heated. Have 'cross-linking' polymer chains
19. Composites	Made of two materials with one acting as a binder for the other e.g. Plywood, MDF and concrete
20. Haber process	Manufactures ammonia which is used in nitrogen fertilisers
	Raw materials are nitrogen from air and hydrogen from natural gas
	H_2 and N_2 are passed over iron catalyst at high temperature (≈450°C) and a high pressure (≈ 200atm)
	Nitrogen + Hydrogen $\rightleftharpoons$ Ammonia
	On cooling, ammonia liquifies and is removed remaining H_2 and N_2 are recycled back into Haber process

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Background

There is barely a single resource on our planet that we are not able to use to better our lives in some way. This topics considers a few of them in more detail.

21. NPK fertilizers	Contain Nitrogen, Phosphorus and Potassium salts for high crop yield
22. Ammonia	Can be used to produce ammonium salts and nitric acid
23. Obtaining Potassium salts	Potassium chloride and potassium sulfate are mined directly
	Potassium rock is mined but treated with: • nitric acid to make ammonium phosphate • sulfuric acid to make *single superphosphate* • phosphoric acid to make *triple superphosphate*