Chemistry Key Knowledge Paper 1

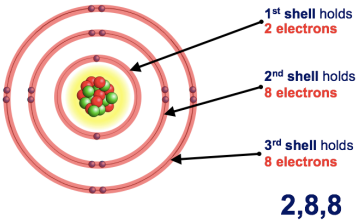
Elements, compounds and mixtures

- Element – are shown in the periodic table
- Compound – two or more elements chemically bonded
- Mixture – two or more elements or compounds not chemically bonded
- Mixtures can be separated by physical processes – filtration, crystallization, distillation, chromatography

Atomic models

- Plum pudding model – negative electrons embedded throughout the atom, rest of atom is positive
- Nuclear model – most of the mass of an atom in the nucleus, most of the atom is empty space

Structure of the atom



Subatomic particle	Mass	Charge	Position in the atom
Proton	1	+1	Nucleus
Neutron	1	0	Nucleus
Electron	Very small	-1	Electron shells

- Atomic number – number of protons in an atom
- Atomic mass – number of protons + neutrons added together
- Electrons fill the shells 2,8,8
- Isotopes are atoms of the same element with a different number of neutrons

Periodic table

- Mendeleev left gaps and predicted existence of new elements

Group 1 – Alkali metals

- More reactive going down the group
- Single outer electron feels less electrostatic attraction from the nucleus as we go down the group
- Alkali metal + water → metal hydroxide + hydrogen
- All have 1 electron in the outer shell

Group 7 – The halogens

- More reactive at the top of the group
- Further down the group the outer electron shell feels less attractive force from the nucleus due to electron shielding
- All have 7 electrons in the outer shell

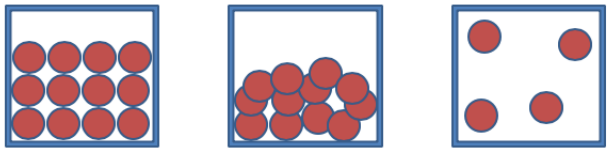
Group 0 – Noble gases

- Full outer shell
- Don't react with anything

Topic 1
Atomic structure and the periodic table

Chemistry Key Knowledge Paper 1

States of matter and state symbols

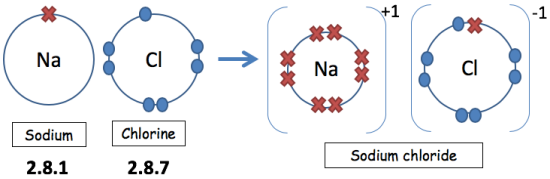


- Solid (s)
- Liquid (l)
- Gas (g)
- Aqueous (aq)

Ions

- Atoms or groups of atoms that have lost or gained one or more electrons
- Metal atoms form positive ions
- Non-metal atoms form negative ions

Ionic bonding



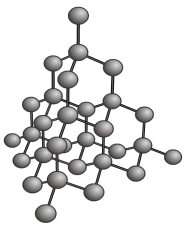
- Between metal and non-metal
- The metal atom transfers electrons to the non-metal atom
- Positive and negative ions attract
- Strong electrostatic force holds the ions together

Ionic compounds

- Ions arranged in layers in a giant lattice structure
- Requires a lot of energy to break the bond so ionic compounds have a high melting and boiling point
- Cannot conduct electricity when solid as the ions cannot move
- Can conduct electricity when molten or dissolved as the ions can move

Covalent bonding

- Between non-metals
- The atoms share a pair of electrons to get a full outer shell



Simple covalent molecules

- Made of only a few atoms
- Weak forces between molecules means low boiling and melting points
- Examples – H_2O, CO_2, O_2, CH_4

Giant covalent structures

- Made of billions of atoms
- Diamond, graphite, silica
- Strong covalent bonds between atoms means they have a high melting and boiling point
- Graphite has free electrons that can move so can conduct electricity

Metallic bonding

- Metals
- Atoms arranged in layers
- Delocalised electrons can move so metals can conduct electricity and heat
- Atoms in a pure metal arranged in layers so the metal can be bent and shaped
- Alloys are stronger – atoms not in layers

Topic 2 Bonding

Law of conservation of mass

- Mass of products = mass of reactants

Relative formula mass

- The sum of the relative atomic masses of the atoms shown in the formula
- Example – H_2O H = 1 H = 1 O = 16 Add them up = 18

Moles (Higher only)

- Mass of one mole of a substance in grams is equal to its relative formula mass

$$\text{number of moles of substance} = \frac{\text{mass of substance (g)}}{A_r \text{ or } M_r}$$

Concentration

$$\text{Concentration of solution} = \frac{\text{mass of solute (g)}}{\text{volume of solution (dm}^3\text{)}}$$

- To convert cm^3 into dm^3 you divide by 1000

Topic 3
Quantitative chemistry

Chemistry Key Knowledge Paper 1

Extraction of metals
- Unreactive metals like gold are found unreacted in the ground
- Metals less reactive than carbon can be extracted from their oxides by reduction with carbon
- Metals more reactive than carbon can be extracted by electrolysis
- OILRIG – oxidation is the loss of electrons, reduction is the gain of electrons

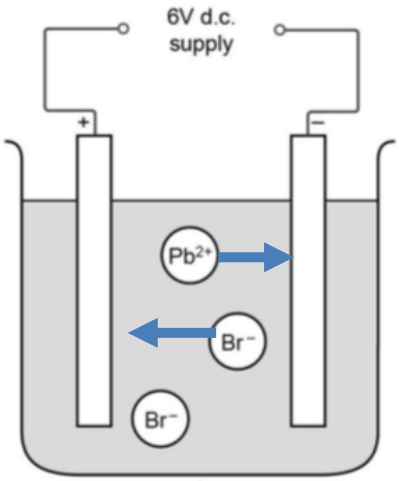
Neutralisation
- Acid + alkali → salt + water
- Bases are insoluble metal hydroxides and metal oxides
- Alkalis are soluble metal hydroxides
- All acids contain H^+ ions
- All alkalis contain hydroxide ions OH^-
- $H^+ + OH^- \rightarrow H_2O$

Strong and weak acids (Higher only)
- A strong acid is completely ionized in aqueous solution
- A weak acid is only partially ionized in aqueous solution
- As pH decreases by one, the H^+ concentration in solution increases by a factor of 10

Acid + metal
- Acid + metal → salt + hydrogen
- Hydrogen gas test – lit splint makes a squeaky pop

Acid + carbonates
- Acid + metal carbonate → salt + carbon dioxide + water
- Carbon dioxide test – limewater turns cloudy

Making soluble salts
- Mix excess base with acid
- Add excess base to neutralize all of the acid
- Heat the solution to speed up the reaction
- Filter off the excess oxide
- Evaporate the water to leave crystals of salt



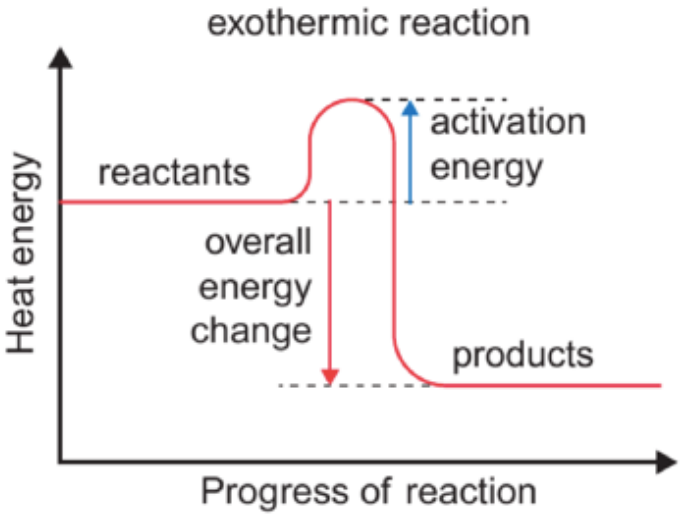
Electrolysis
- Splitting a compound using electricity
- Solid ionic compounds cannot conduct electricity as there are no free ions
- Ionic compounds can conduct electricity when molten or dissolved as the ions can move
- Positive ions move to negative electrode (cathode)
- Negative ions move to positive electrode (anode)
- $Cu^{2+} + 2e \rightarrow Cu$
- $2Cl^- \rightarrow Cl_2 + 2e$

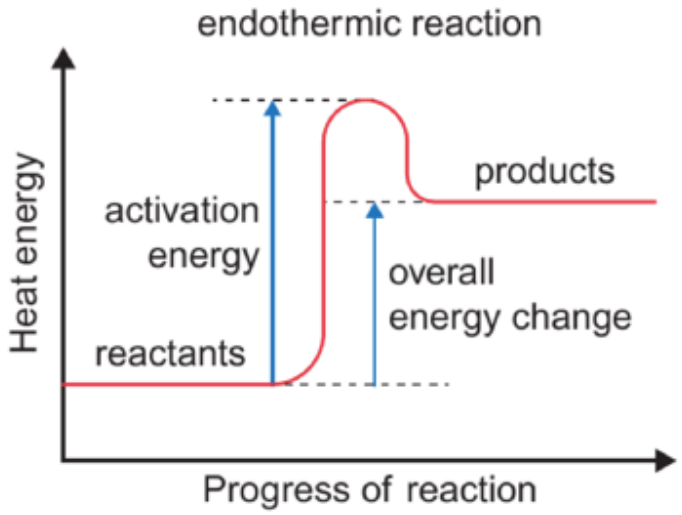
Topic 4
Chemical changes

Activation energy
- The energy needed for a reaction to occur

Exothermic reactions
- Transfers energy to the surroundings
- Temperature of the surroundings goes up
- Combustion and neutralization reactions are exothermic

Endothermic reactions
- Takes in energy from the surroundings
- Temperature of the surroundings decreases
- Thermal decompositions and photosynthesis are endothermic





Topic 5
Energy changes

Chemistry Key Knowledge Paper 2

Collision theory

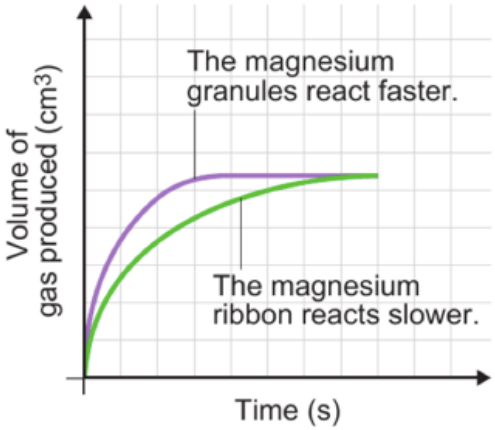
- Chemical reactions only occur when particles collide
- Particles have to collide with enough energy
- Minimum amount of energy needed for particles to react is the activation energy

Factors affecting rate of reaction

- Increasing surface area increases rate of reaction – more collisions between particles
- Increasing temperature increases rate of reaction – particles move faster and collide more often
- Increasing concentration increases rate of reaction – there are more particles so more collisions

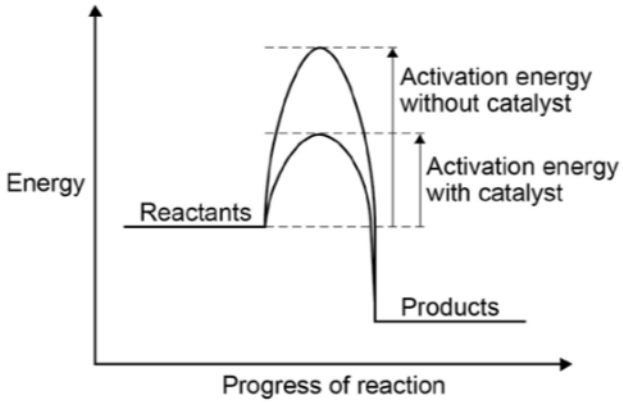
Rate of reaction

- A steeper line shows a faster rate of reaction
- On this graph the blue line shows a faster rate



Catalysts

- Catalysts speed up the rate of reaction but are not used up
- Catalysts increase the rate of reaction by lowering the activation energy
- A reaction profile for a catalyst is:



Reversible reactions

- In some reactions, the products of the reaction can react to produce the original reactants
- Symbol for a reversible reaction: ⇌

Equilibrium

- Equilibrium is reached when the forward and reverse reactions occur at exactly the same rate

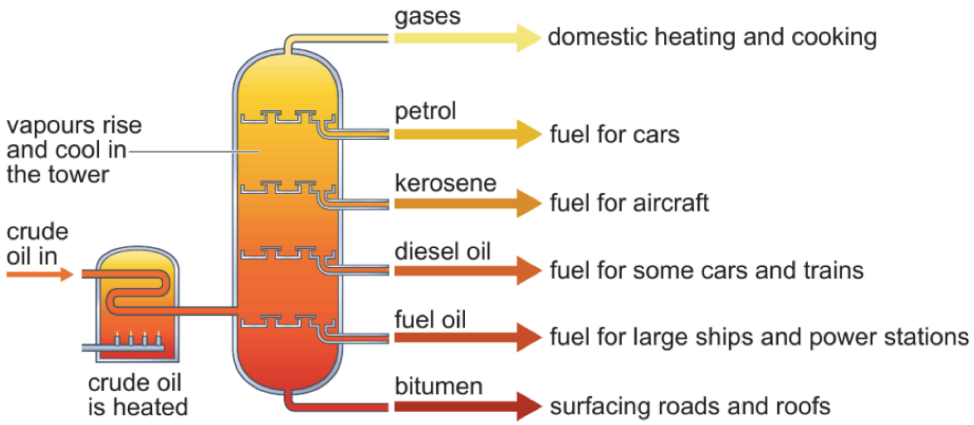
Topic 6
Rates of reaction

Chemistry Key Knowledge Paper 2

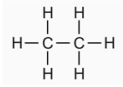
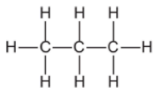
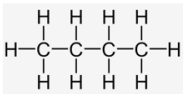
Crude oil
- Remains of plankton buried in mud under the sea
- A mixture of hydrocarbons

Hydrocarbons
- Molecules made of hydrogen and carbon only

Fractional distillation
- Crude oil is heated and evaporates
- Gases rise up a fractionating column and cool down and condense
- They condense at different points depending on the boiling point
- Most viscous at the bottom of the column
- Highest boiling point at the bottom of the column



Alkanes
- Methane, ethane, propane, butane
- General formula C_nH_{2n+2}
- React with oxygen to produce carbon dioxide and water

Name	Structural formula	Chemical formula
Methane		CH_4
Ethane		C_2H_6
Propane		C_3H_8
Butane		C_4H_{10}

Cracking
- Cracking is breaking down longer hydrocarbons into smaller, more useful molecules
- A product of cracking is an alkene
- Test for alkenes: bromine water turns from orange to colourless

Topic 7
Organic chemistry

Chemistry Key Knowledge Paper 2

Pure substances
- A single element or compound not mixed with any other substance
- Will melt at specific temperatures

Formulations
- A mixture that has been designed as a useful product
- Formulations include fuels, cleaning agents, paints, medicines, alloys, fertilisers and foods

Chromatography
- Used to separate mixtures
- Stationary phase – the chromatography paper
- Mobile phase – the solvent moving
- More soluble dyes move further up
- A pure compound will produce a single spot in all solvents

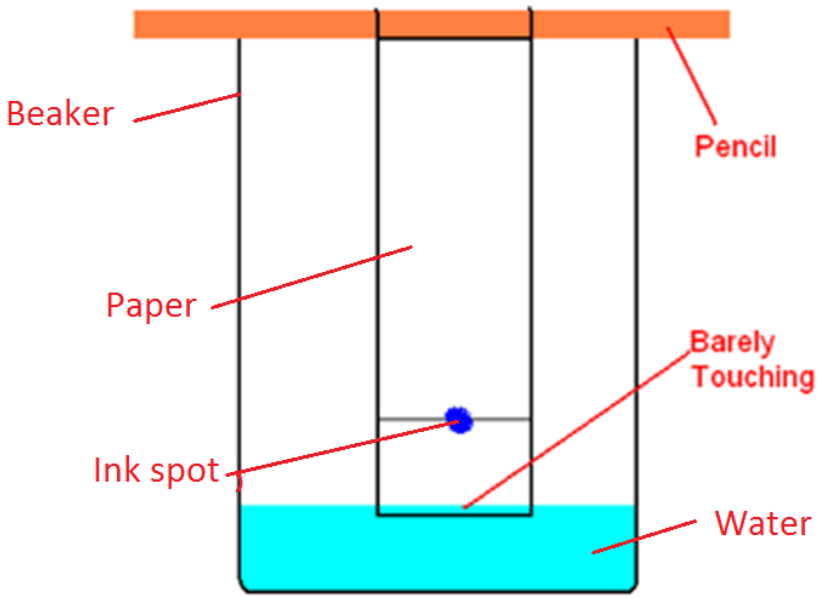
$$R_f = \frac{\text{distance moved by substance}}{\text{distance moved by solvent}}$$

Test for hydrogen
- Lit splint
- Squeaky pop

Test for oxygen
- Re-lights a glowing splint

Test for carbon dioxide
- Bubble the gas through limewater
- Limewater turns cloudy

Test for chlorine
- Damp litmus paper turns white



Topic 8
Chemical analysis

Chemistry Key Knowledge Paper 2

The atmosphere today
- About 80% nitrogen
- About 20% oxygen
- Small proportions of carbon dioxide, water vapour and noble gases

The early atmosphere
- Volcanoes released gases – water vapour, nitrogen, methane, ammonia, carbon dioxide
- No oxygen
- Water vapour condensed to form the oceans
- Carbon dioxide dissolved in the oceans

How carbon dioxide decreased
- Dissolved in the oceans
- Formation of sedimentary rocks and fossil fuels
- Algae and plants used CO_2 for photosynthesis

How oxygen increased
- Algae and plants produced O_2 by photosynthesis

Greenhouse gases
- Maintain temperature on Earth to support life
- Water vapour, carbon dioxide and methane

How human activities increase greenhouse gases
- Carbon dioxide – deforestation, burning fossil fuels
- Methane – farming

Effects of climate change
- Sea levels rise
- More extreme weather
- Extinction of wildlife

Carbon footprint
- The total amount of carbon dioxide and other greenhouses gases over the full life cycle of a product
- Can be reduced by reducing emissions of carbon dioxide and methane

Atmospheric pollutants
- Combustion of fuels produces pollutants
- Carbon monoxide is a toxic gas
- Sulfur dioxide and oxides of nitrogen cause respiratory problems in humans and acid rain
- Soot particles cause health problems and global dimming

Topic 9
Chemistry of the atmosphere

Potable water
- Water that is safe to drink

Desalination
- Making sea water or salty water safe to drink
- Can be done by distillation
- Requires large amounts of energy

Waste water treatment
- Screening and grit removal
- Sedimentation
- Anaerobic digestion of sewage sludge
- Aerobic biological treatment of effluent

Methods of extracting metals (Higher only)
- Phytomining – uses plants to absorb metal compounds from the ground. Plants then burnt to produce ash that contains metal compounds
- Bioleaching – uses bacteria to produce solutions with metal compounds

Life cycle assessment stages
- Extracting and processing raw materials
- Manufacturing and packaging
- Use and operation
- Disposal

Reusing and recycling
- Obtaining raw materials from the Earth by quarrying and mining causes environmental impacts
- Glass bottles can be crushed and melted to make different glass products
- Metals can be recycled by melting

Advantages of recycling	Disadvantages of recycling
• Conserves finite oil resources • Saves energy • Reduces need for mining • Reduces waste disposed of in landfill • Less pollution • Cheaper to recycle than mine new ores	• Costs of collecting, sorting and melting metals • Some metals more expensive to recycle

Chemistry Key Knowledge Paper 1

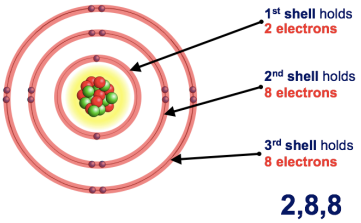
Elements, compounds and mixtures

- Element – _____
- Compound – _____
- Mixture – _____
- Mixtures can be separated by _____

Atomic models

- Plum pudding model – _____
- Nuclear model – _____

Structure of the atom



Subatomic particle	Mass	Charge	Position in the atom
Proton			
Neutron			
Electron			

- Atomic number – _____
- Atomic mass – _____
- Electrons fill the shells _____
- Isotopes are _____

Periodic table

- Mendeleev left _____ and predicted _____

Group 1 – Alkali metals

- More reactive going _____
- Single outer electron feels less _____
- Alkali metal + water → _____ + _____
- All have 1 _____

Group 7 – The halogens

- More reactive _____
- Further down the group the outer electron shell feels less _____ _____
- All have 7 _____

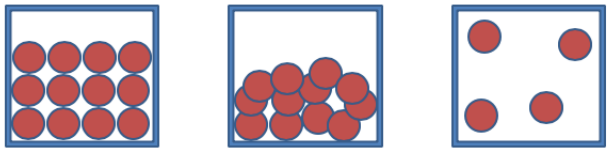
Group 0 – Noble gases

- Full _____
- Don't _____

Topic 1
Atomic structure and the periodic table

Chemistry Key Knowledge Paper 1

States of matter and state symbols

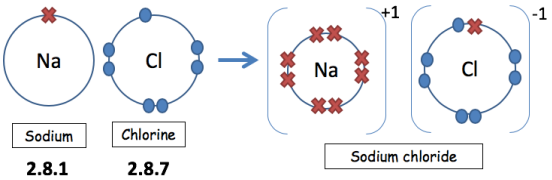


- _____ (___)
- _____ (___)
- _____ (___)
- _____ (___)

Ions

- Atoms or groups of atoms that have _____
- Metal atoms form _____
- Non-metal atoms form _____

Ionic bonding



- Between _____ and _____
- The metal atom transfers _____
- Positive and negative ions _____
- Strong _____

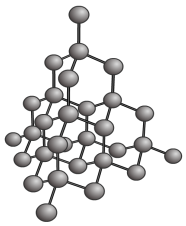
Ionic compounds

- Ions arranged in _____
- Requires a lot of _____ so ionic compounds have a high _____
- Cannot conduct _____ when solid as the ions _____
- Can conduct electricity when _____as the ions can move

Covalent bonding

- Between _____
- The atoms share a _____

Simple covalent molecules



- Made of _____
- Weak _____ between molecules means _____
- Examples – _____

Giant covalent structures

- Made of _____
- Examples - _____
- Strong covalent _____ between atoms means they have a _____
- Graphite has _____that can _____ so can _____

Metallic bonding

- Metals
- Atoms arranged in _____
- _____ can move so metals can _____
- Atoms in a pure metal arranged in _____ so the metal can be _____
- Alloys are _____

Topic 2 Bonding

Law of conservation of mass

- Mass of products = mass of reactants

Relative formula mass

- The sum of the relative atomic masses of the atoms shown in the formula
- Example – H_2O H = 1 H = 1 O = 16 Add them up = 18

Moles (Higher only)

- Mass of one mole of a substance in grams is equal to its relative formula mass

$$\text{number of moles of substance} = \frac{\text{mass of substance (g)}}{A_r \text{ or } M_r}$$

Concentration

$$\text{Concentration of solution} = \frac{\text{mass of solute (g)}}{\text{volume of solution (dm}^3\text{)}}$$

- To convert cm^3 into dm^3 you divide by 1000

Topic 3
Quantitative chemistry

Chemistry Key Knowledge Paper 1

Extraction of metals

- Unreactive metals like _____ are found _____
- Metals less reactive than _____ can be extracted from their oxides by _____
- Metals more reactive than _____ can be extracted by _____
- OILRIG – _____

Neutralisation

- Acid + alkali → _____ + _____
- Bases are _____
- Alkalis are _____
- All acids contain _____
- All alkalis contain _____
- $H^+ + OH^-$ → _____

Strong and weak acids (Higher only)

- A strong acid is completely _____
- A weak acid is only partially _____
- As pH decreases by one, the H^+ concentration in solution increases by _____

Acid + metal

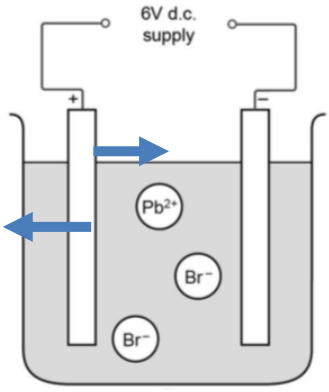
- Acid + metal → _____ + _____
- Hydrogen gas test – _____

Acid + carbonates

- Acid + metal carbonate → _____ + _____ + _____
- Carbon dioxide test – _____

Making soluble salts

- Mix excess base with _____
- Add excess base to _____
- Heat the solution to _____
- _____
- _____



Electrolysis

- Splitting _____
- Solid ionic compounds cannot conduct _____ as there are no _____
- Ionic compounds can conduct _____ when _____ or _____ as the ions can _____
- Positive ions move to _____ (cathode)
- Negative ions move to _____(anode)
- Cu^{2+} + _____ → _____
- $2Cl^-$ → _____ + _____

Topic 4
Chemical changes

Activation energy

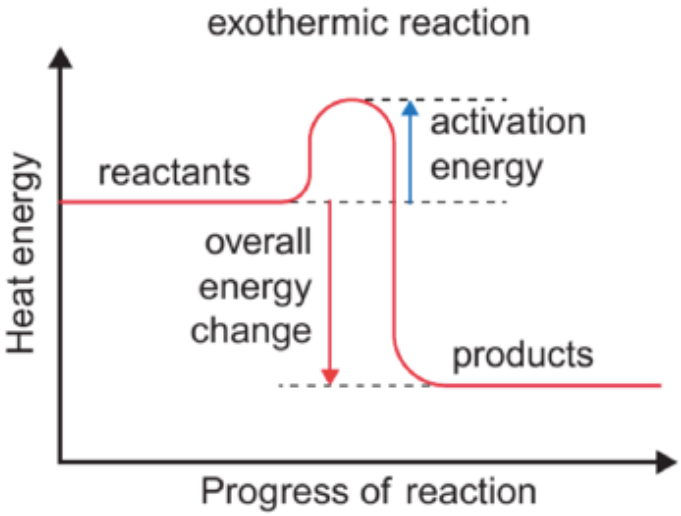
- The energy needed for _____

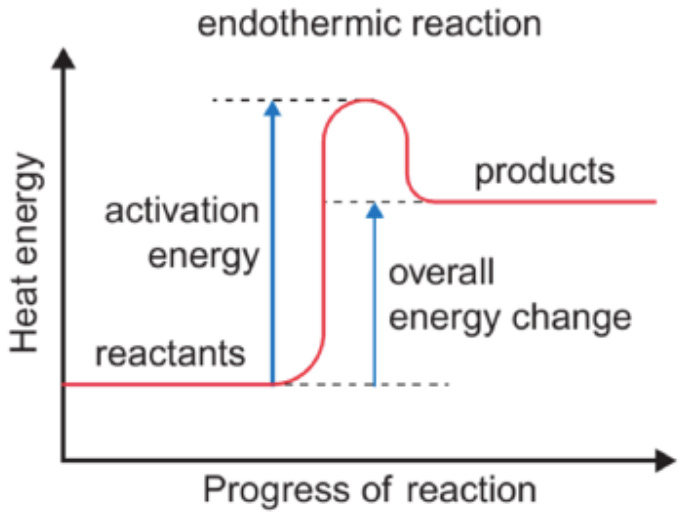
Exothermic reactions

- Transfers _____
- Temperature of the surroundings _____
- _____ and _____ reactions are exothermic

Endothermic reactions

- Takes in energy from _____
- Temperature of the surroundings _____
- Thermal decompositions and _____ are endothermic





Topic 5
Energy changes

Chemistry Key Knowledge Paper 2

Collision theory

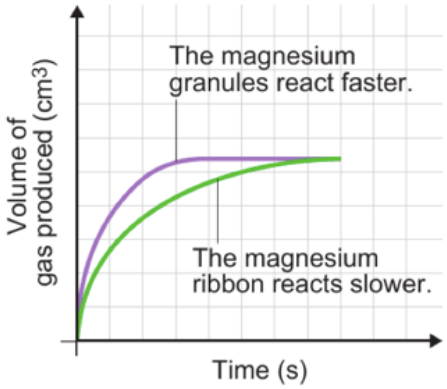
- Chemical reactions only occur when _____
- Particles have to _____
- Minimum amount of energy needed for particles to react is the _____

Factors affecting rate of reaction

- _____
- _____
- _____

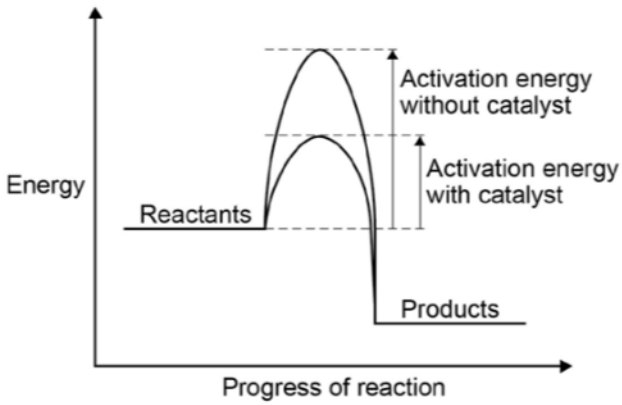
Rate of reaction

- A steeper line shows _____
- On this graph the _____ line shows a faster rate



Catalysts

- Catalysts _____
- Catalysts increase the rate of reaction by _____
- A reaction profile for a catalyst is:



Reversible reactions

- In some reactions, the _____ of the reaction can react to produce the original _____
- Symbol for a reversible reaction:

Equilibrium

- Equilibrium is reached when the _____-
  _____

Topic 6
Rates of reaction

Chemistry Key Knowledge Paper 2

Crude oil

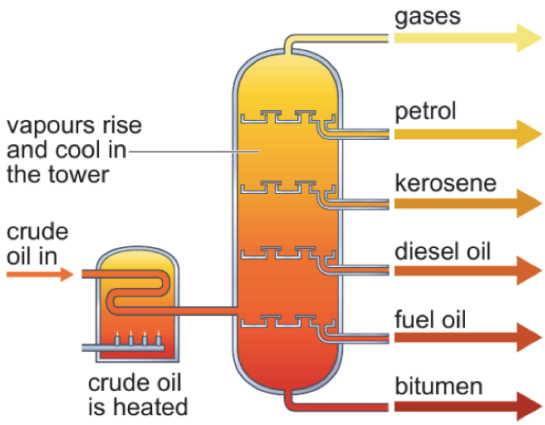
- Remains of _____
- A mixture of _____

Hydrocarbons

- Molecules made of _____

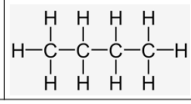
Fractional distillation

- Crude oil is _____
- Gases _____
- They condense at _____
- Most viscous at _____
- Highest boiling point at _____



Alkanes

- _____
- General formula _____
- React with oxygen to produce _____and _____

Name	Structural formula	Chemical formula
Methane		
Ethane		
		
		

Cracking

- Cracking is _____
- A product of cracking is an _____
- Test for alkenes: _____

Topic 7
Organic chemistry

Chemistry Key Knowledge Paper 2

Pure substances

- A single _____
- Will melt at _____

Formulations

- _____

  Formulations include _____

Chromatography

- Used to _____
- Stationary phase – _____
- Mobile phase – _____
- More soluble dyes move _____
- A pure compound will produce a _____

$$R_f = \frac{\text{distance moved by substance}}{\text{distance moved by solvent}}$$

Test for hydrogen

- _____
- _____

Test for oxygen

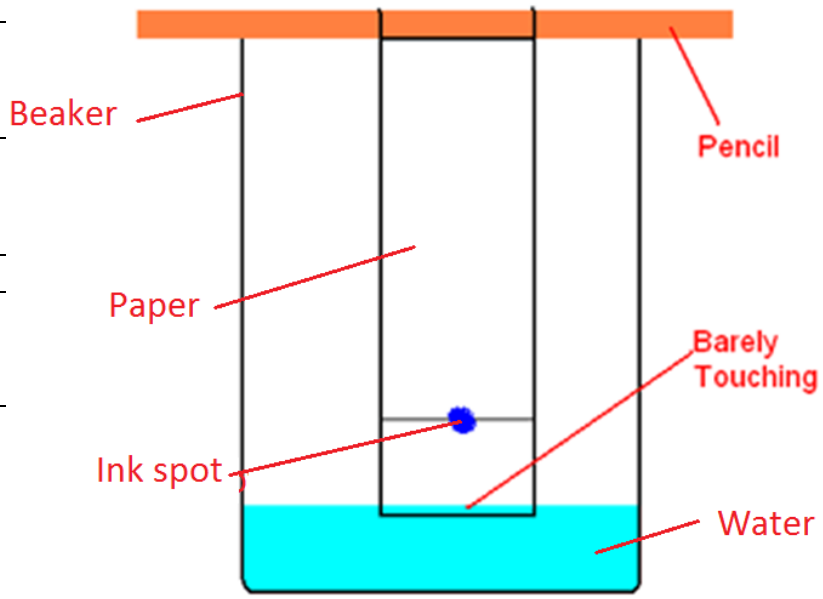
- _____

Test for carbon dioxide

- _____
- _____

Test for chlorine

- _____



Topic 8
Chemical analysis

Chemistry Key Knowledge Paper 2

The atmosphere today
- About 80% _____
- About 20% _____
- Small proportions of _____

The early atmosphere
- _____ released gases – _____
- No _____
- Water vapour _____
- Carbon dioxide _____

How carbon dioxide decreased
- Dissolved _____
- Formation of _____
- Algae and plants used CO_2 _____

How oxygen increased
- Algae and plants produced O_2 by _____

Greenhouse gases
- Maintain _____
- Examples - _____

How human activities increase greenhouse gases
- Carbon dioxide – _____
- Methane – _____

Effects of climate change
- _____
- _____
- _____

Carbon footprint
- _____
- Can be reduced by _____

Atmospheric pollutants
- Combustion of _____
- Carbon monoxide is a _____ gas
- Sulfur dioxide and oxides of nitrogen cause _____
- Soot particles cause _____

Topic 9
Chemistry of the atmosphere

Chemistry Key Knowledge Paper 2

Potable water

- Water that is _____

Desalination

- _____
- Can be done by _____
- Requires _____

Waste water treatment

- _____
- _____
- _____
- _____

Methods of extracting metals (Higher only)

- Phytomining – _____
- Bioleaching – _____

Life cycle assessment stages

- _____
- _____
- _____
- _____

Reusing and recycling

- Obtaining raw materials from the Earth by _____ and _____ causes environmental impacts
- Glass bottles can be _____
- Metals can be recycled by _____

Advantages of recycling	Disadvantages of recycling

Topic 10
Using resources