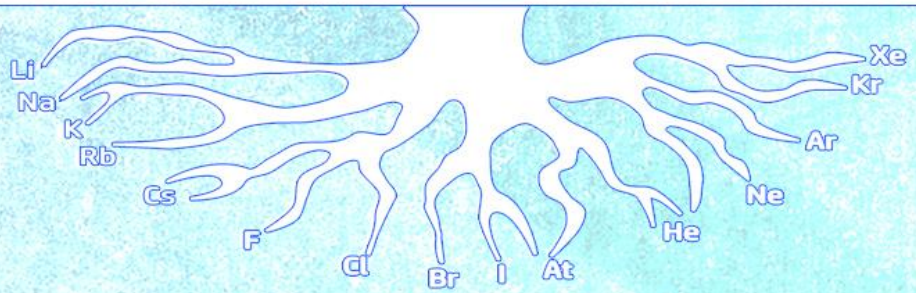
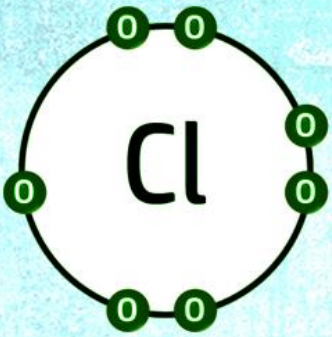
Mr Barnes Teaches Chemistry

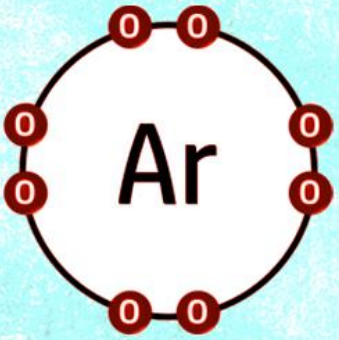
THE CHEMISTREE OF KNOWLEDGE



THE ALKALI METALS

THE HALOGENS





THE NOBLE GASES

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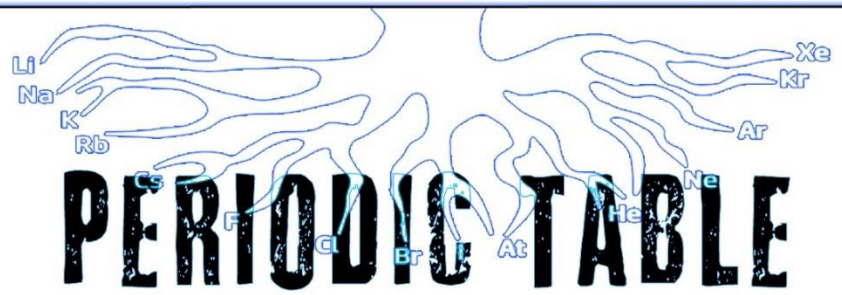
PAPER 2 REVISION GUIDE



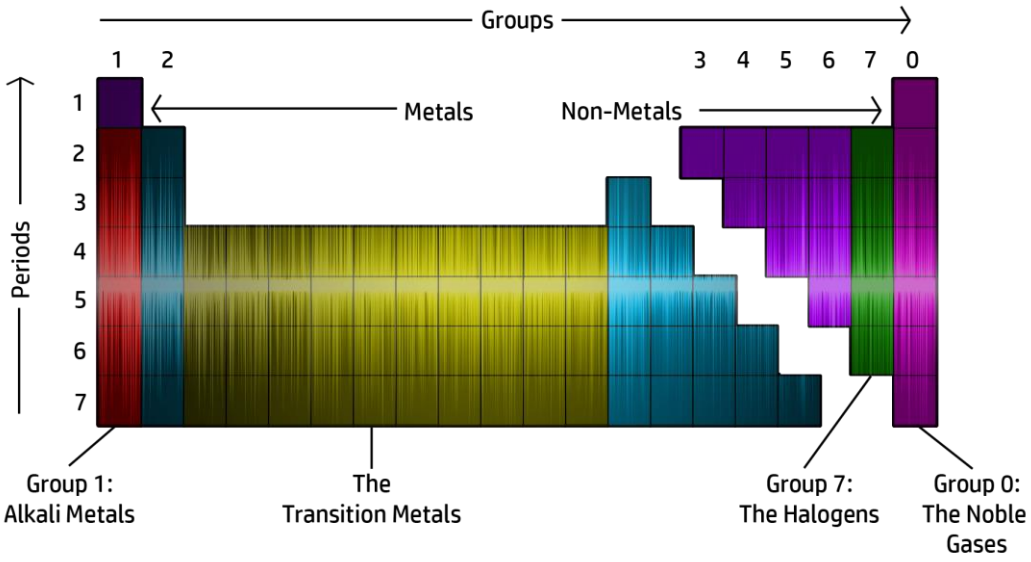
PERIODIC TABLE

1	2										3	4	5	6	7	0
1 **H** hydrogen 1																4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4										11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12										27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111						

Atomic Mass (Large #)

Atomic (proton) Number (Small #)

AfL 15: The Alkali Metals and the Noble Gases:



A. The Alkali Metals

- The Alkali Metals are found in group 1 of the Periodic table and contain lithium, sodium, potassium, rubidium, caesium and francium.
- They all have one electron on the outer shell – this makes them really reactive because they only need to lose one electron to become chemically stable.
- All alkali metals are **soft** (easy to cut) and have **low melting points**

B. Reactions with water:

When the alkali metals are added to water, they react the same way – they have similar chemical properties:

- They produce hydrogen gas – seen as **fizzing/effervescence**
- They **move** around on **top** of the water

When the alkali metals react with water, they produce a hydroxide and hydrogen:

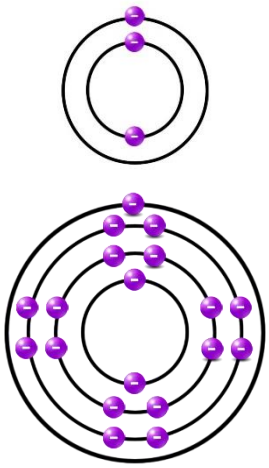
$$\underset{2K}{\text{Potassium}} + \underset{2H_2O}{\text{Water}} \rightarrow \underset{2KOH}{\text{Potassium hydroxide}} + \underset{H_2}{\text{hydrogen}}$$

However, you can see that reactivity increases down the group. This is shown in the following way:

- Lithium moves slowly on the water, producing a small amount of hydrogen
- Sodium does the same, but moves more, gives off more gas and **melts** (remember – low melting point!)
- Potassium gives off a lot of gas, melts and **sets on fire** with a **lilac** flame

C. Why does reactivity INCREASE as you go down group 1?

The reason for this increase in reactivity is down to the electronic configuration:



- As you go down the group, the atom has **more shells of electrons**.
- There is **more electron shielding**.
- The **outer** electron is **further away from the nucleus**.
- The **force of attraction** between the **outer electron** and the **positive nucleus** is weaker.
- It is **easier to lose the outer electron** – therefore more reactive!

D. The Noble Gases

- The **Noble Gases** are found in group 0 of the Periodic table and contain helium, neon, argon, krypton, xenon and radon.
- They all have full outer shells – this makes them **inert** **(unreactive)** because they don't need to lose or gain electrons.
- They are all **monatomic** – which means they go around on their own.
- All noble gases are **gases** and have **low melting points and boiling points.**

E. Uses of the Noble Gases:

Use:	Noble Gases involved:	Reason:
Filament lamps and flash photography filaments	Mainly **argon**, as well as krypton and xenon	Non-flammable – and the noble gas will not react with the filament (oxygen will!)
Welding	Argon and Helium	Provides an inert atmosphere – stops the hot metal from reacting with oxygen.
Airships / part balloons	Helium	Less dense than air. Non-Flammable – won't set on fire like hydrogen will.

F. Properties of the Noble Gases:

The noble gases all seem similar, but the physical properties do change as you go down the group:

- Boiling point and Melting point increases down the group
- Density increases as you go down the group
- You can use the information about these densities to predict the properties of different noble gases.

AfL 16: The Halogens and Displacement Reactions:

A. The colour and state of the halogens:

They are all **diatomic** – meaning they go around in (covalently bonded) pairs – F_2, Cl_2, Br_2, I_2, At_2.

There are only three halogens that you need to know the colour and state for:

Halogen:	Colour:	State: (at room temp)
Chlorine, Cl_2	Green	Gas
Bromine, Br_2	Brown	Liquid
Iodine, I_2	Black	Solid

As you go down group 7, the melting points and boiling points **increase**. You can tell this because the states change from gases to solids as you go down the group.

B. The displacement of the halogens:

As you go down group 7, reactivity decreases. This can be proved using displacement reactions.

If you take a salt containing chlorine, bromine and iodine – for example potassium chloride, potassium bromide and potassium iodide – and react them with their elements (Cl_2, Br_2 and I_2), the following will occur:

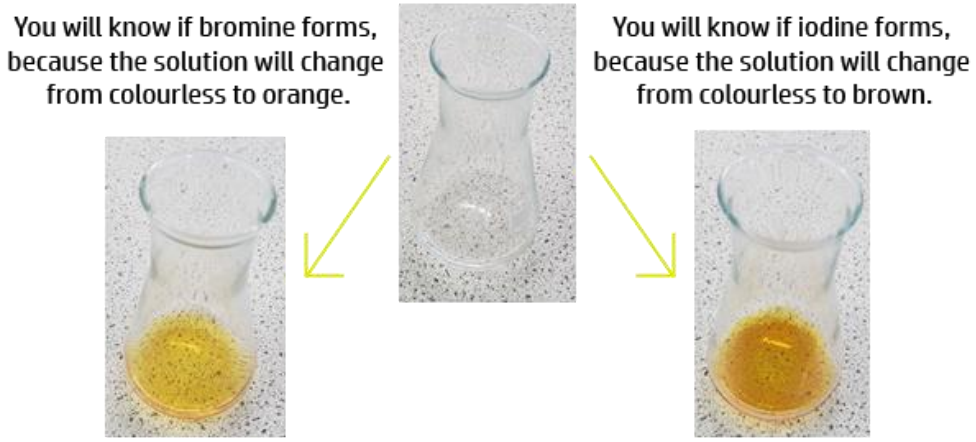
Element:	**Potassium chloride, KCl**	**Potassium bromide, KBr**	**Potassium Iodide, KI**
Chlorine water, Cl_2 (colourless)	No reaction	Reaction (turns orange)	Reaction (turns brown)
Bromine water, Br_2 (orange)	No reaction	No reaction	Reaction (turns brown)
Iodine water, I_2 (brown)	No reaction	No reaction	No reaction

As you can see from the table above:

- Chlorine reacts with potassium bromide and potassium iodide
- This tells us that chlorine is **more reactive** than bromine and iodine.
- Bromine reacts with potassium iodide, but not with potassium chloride.
- This tells us that bromine is **more reactive** than iodine, but **less reactive** than chlorine.
- Iodine reacts with neither, so it is **less reactive than both.**

When a displacement reaction occurs, the more reactive metal displaces (swaps) with the less reactive metal in the compound:

Chlorine **Cl_2** + Potassium Bromide **2KBr** → Potassium Chloride **2KCl** + Bromine **Br_2**



C. Displacement reactions and Redox:

The displacement reactions seen on the previous page are all examples of redox reactions.

The element (e.g. Cl_2) is always gain electrons and are **reduced** and the compounds halogen (e.g. K**Br**) is always oxidised, as the lose electrons.

Watch the video on the right for more information and written half equations.

D. The test for chlorine:

- If you wanted to prove that a gas was chlorine, add **damp blue litmus paper to it**.
- Damp **blue** litmus paper turns **red**, then **bleaches**.

E. Metal Halides:

When the halogens react with metals, they form metal halides. The reactions are all similar, depending on what group you are reacting with:

- Group 1 metals give the general formula of MH – one metal and one halogen
- Group 2 metals give the general formula of MH_2 – one metal and two halogens
- Group 3 metals give the general formula of MH_3 – one metal and three halogens

Examples:

Group 1:	Sodium **2Na**	+	Iodine **I_2**	→	Sodium Iodide **2NaI**
Group 2:	Magnesium **Mg**	+	Bromine **Br_2**	→	Magnesium Bromide **$MgBr_2$**
Group 3:	Aluminium **2Al**	+	Chlorine **$3Cl_2$**	→	Aluminium Chloride **$2AlCl_3$**

F. Hydrogen Halides:

When the halogens react with hydrogen, the same reaction occurs - hydrogen halides are formed.

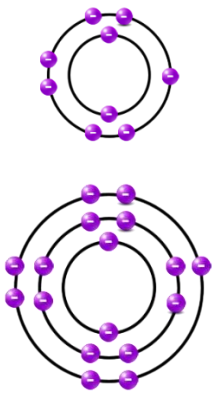
Hydrogen **H_2 (g)** + Chlorine **Cl_2 (g)** → Hydrogen Chloride **2HCl (g)**

All the hydrogen halides are gases, and when they dissolve into water, they form an aqueous solution which is acidic.

- Hydrogen chloride, HCl (g), dissolves to form hydrochloric acid, HCl (aq).
- The hydrogen ion, H^+, is what makes the solution acidic.

G. Why does reactivity DECREASE as you go down group 7?

The reason for this decrease in reactivity is down to the electronic configuration:



- As you go down the group, the atom has **more shells of electrons**.
- There is **more electron shielding**.
- The **outer** electron is **further away from the nucleus**.
- The **force of attraction** between the **outer electron** and the **positive nucleus** is weaker.
- It is **harder to gain the outer electron** – therefore less reactive!

AfL 17: Rates of Reaction & Collision Theory:

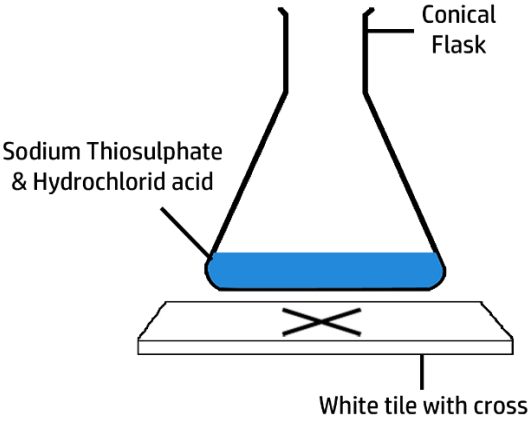
A. Rates of Reaction: The Core Practicals

The rate of reaction is how fast a reaction can happen. There are two practicals you need to know to investigate rates of reaction:

1. The Disappearing Cross

Sodium thiosulfate + hydrochloric acid → sodium chloride + water + sulfur dioxide + sulfur

$Na_2S_2O_{3\,(aq)} + 2HCl_{(aq)} \rightarrow 2NaCl_{(aq)} + H_2O_{(l)} + SO_{2\,(g)} + S_{(s)}$



Method:

- Measure out 50cm³ of sodium thiosulfate
- Measure out 5cm³ of hydrochloric acid.
- Place a conical flask on a white tile with a cross on it.
- Add the sodium thiosulfate to the hydrochloric acid and start the timer.
- Once the cross is no longer visible, stop the timer.

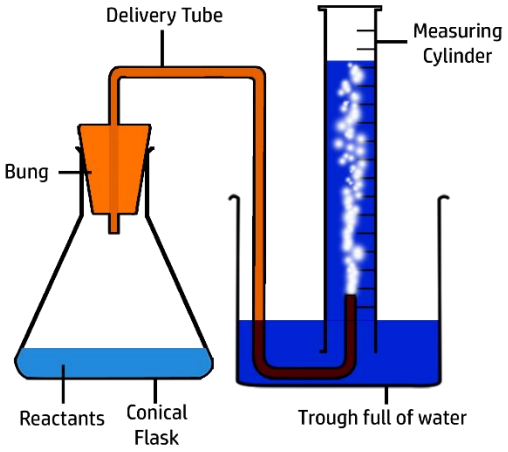
Variables:

- Independent Variable: Concentration OR Temperature
- Dependent Variable: Time for cross to disappear
- Control Variable: Volume of acid/thiosulfate

2. Gas collection – Acid and Marble chips

Calcium carbonate + hydrochloric acid → calcium chloride + carbon dioxide + water

$CaCO_{3\,(s)} + 2HCl_{(aq)} \rightarrow CaCl_{2\,(aq)} + CO_{2\,(g)} + H_2O_{(l)}$



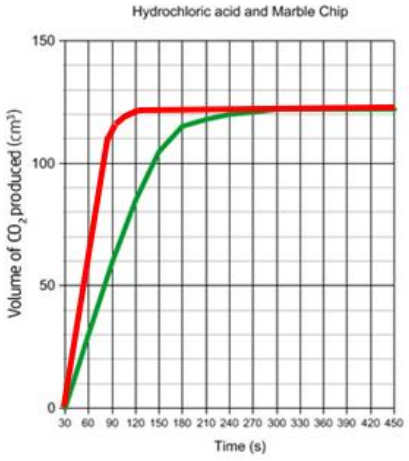
Method:

- Measure out 50cm³ of hydrochloric acid
- Measure out 5g of marble chip
- Add the hydrochloric and marble chip to a conical flask and add the bung.
- Start the timer.
- Stop the timer when 50cm³ of carbon dioxide gas has been produced.

Variables:

- Independent Variable: Concentration, surface area OR Temperature
- Dependent Variable: Time to produce 50cm³ of gas
- Control Variable: Volume of acid/mass of marble chip

B. Rates and graphs:



Rate Graphs:

- If you **increase** the temperature / concentration / surface area, the reaction will be quicker, and the rate graph will be **steeper as shown in red on the left**
- If you **decrease** the temperature / concentration / surface area, the reaction will be slower, and the rate graph will be **shallower as shown in green on the left**
- Note that in both situations, the total volume at the end **is always the same – the flat bit should always be at the same level.**

Rate calculations:

- To calculate the rate of a reaction, take the volume of gas produced in cm³ and divide it by the time (s).
- Unit: cm³/s

C: What is needed for a reaction to occur?

For a reaction to occur, two things must happen:

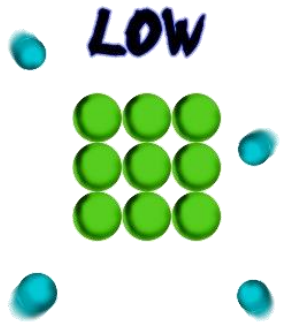
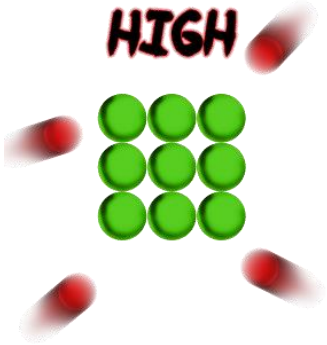
1. A collision between two reactants
2. The collision must have enough energy to break the bonds of the reactants (Called the activation energy)

D. Increasing the rate of reaction:

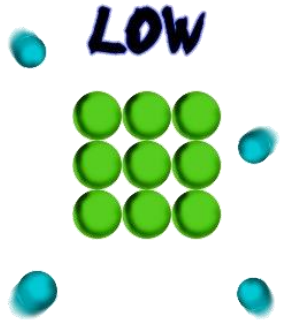
To make a reaction go faster, there are 5 things you can do:

1. Increase the **temperature**
2. Increase the **concentration**
3. Increase the **pressure**
4. Increase the **surface area**
5. Use a **catalyst**

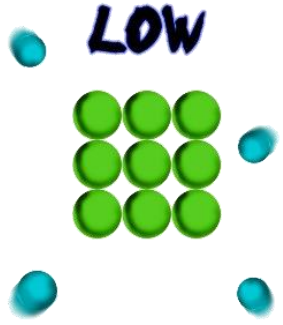
E. Collision Theory: Temperature

Low Temperature	Explanation:	High Temperature
	❋ If you increase the temperature, the particles have more **kinetic energy**, meaning they are moving faster and with more energy. ❋ This means that when the particles **collide**, there is enough energy for a successful reaction to occur. ❋ The **more successful collisions**, the faster the rate of reaction.	

F. Collision Theory: Concentration / Pressure

Low Concentration	Explanation:	High Concentration
	❋ If you increase the concentration, there are **more particles in the same volume**. This means there are **more frequent collisions** – increasing the rate of reaction. ❋ If you increase the pressure, the particles are pushed closer together – this also means **more frequent collisions**.	

G. Collision Theory: Surface Area

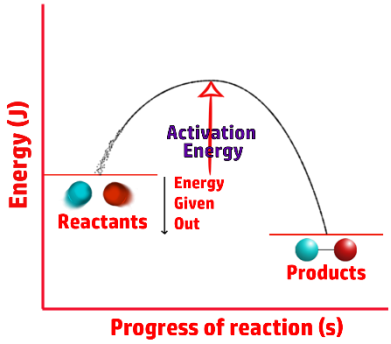
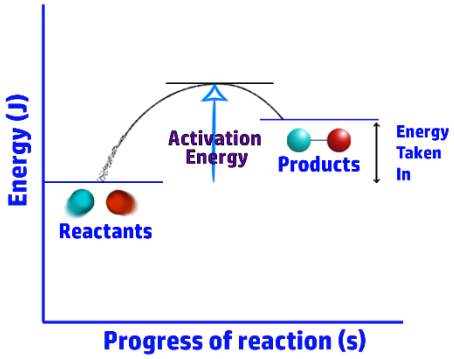
Low Surface Area	Explanation:	High Surface Area
	❋ If you increase the surface area of a solid, you break it up into **smaller pieces**. This means that there is **a larger surface area to volume ratio** – more solid is exposed to the acid. ❋ This will mean that the higher the surface area to volume ratios, there are **more frequent collisions** and a faster rate of reaction.	

AfL 18: Energy in Reactions:

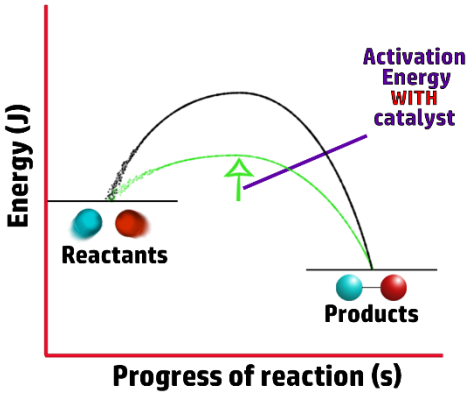
A. Exothermic and Endothermic:

The activation energy is the energy required to start a reaction. If there is not enough energy, a collision will not be successful.

- To start a reaction there must be enough energy to make **collisions successful**.
- This can be drawn on Reaction Profiles, like the ones seen below.
- A reaction profile is a graph that shows the energy of the reactants and products, as well as the changes in energy.

Factor:	Reaction Profile:	Explanation
Exothermic:		❋ In an **exothermic** reaction, heat is given out to the surroundings. ❋ This means that: ⚗ The temperature **increases**. ⚗ **Heat** energy is given **out**. ⚗ The products have **less** energy than the reactants. ❋ This is shown on the energy reaction profile on the left
Endothermic:		❋ In an **endothermic** reaction, heat is taken in from the surroundings. ❋ This means that: ⚗ The temperature **decreases**. ⚗ **Heat** energy is taken **in**. ⚗ The products have **more** energy than the reactants. ❋ This is shown on the energy reaction profile on the left

B. Catalysts:

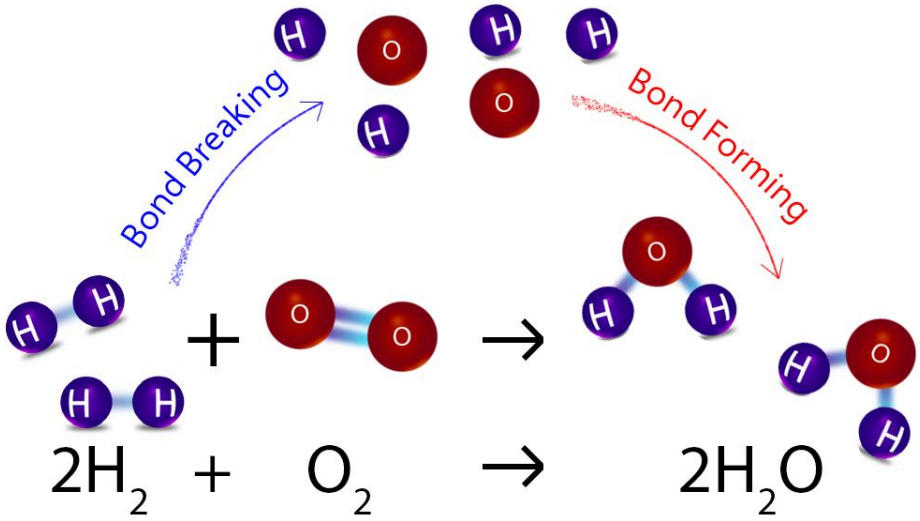


- Catalysts are chemicals that **speed up a chemical reaction** but **remain unchanged** at the end of the reaction.
- The mass will stay the same, and the chemical composition will also stay the same.
- This means that catalysts can be **reused**.
- Catalysts work by **lowering the activation energy** (by providing a different route for a reaction), so that **more collisions are successful**.
- **Catalytic converters** in car exhausts contain a **platinum** catalyst which converts harmful gases (nitrous oxides) into safer ones.

Enzymes:

- **Enzymes**, which are **biological catalysts**, are used to speed up reactions such as **alcoholic** drink production, **respiration**, **photosynthesis** and **protein synthesis**.
- Enzymes contain an **active site**, where the reactant molecule (the **substrate**) bonds in a *lock and key* type mechanism.
- Enzymes can be **denatured** if the pH or temperature changes.

C. Bond Breaking and Bond Forming:



There are two key things to remember that occur in **every chemical reaction**:

- Bond breaking is **endothermic** – you put **in** heat energy to break the bonds.
- Bond forming is **exothermic** – heat energy is given **out** to the surroundings.

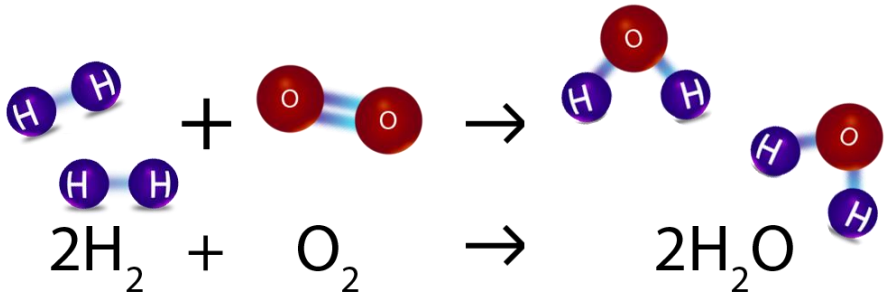
For a reaction to be **exothermic** over all, more energy must be given out (when bonds form) than taken in (when bonds are broken). This can be seen on the reaction profile on P8. The products have less energy because energy has been **given out** to the surroundings.

For a reaction to be **endothermic** over all, more energy must be **taken in** (when bonds are broken) than given out (when new bonds are formed). This can be seen on the endothermic reaction profile on P8. The products have more energy because energy has been **taken in** from the surroundings.

D. Bond Energy Calculations

You can calculate the energy given in/out in a reaction and use it to work out if a reaction is exothermic or endothermic:

To work out the bond energy, you will be given a table in the exam – this will show the energy needed to break a bond – in $kJmol^{-1}$.



Covalent bond:	Bond Energy ($kJmol^{-1}$)
H-H	436
O=O	498
O-H	464

In the above diagram, you are breaking two H-H bonds ($436kJmol^{-1}$) and one O=O bond ($498kJmol^{-1}$). Therefore, the total energy to break bonds is: $436 + 436 + 498 = 1370kJmol^{-1}$.

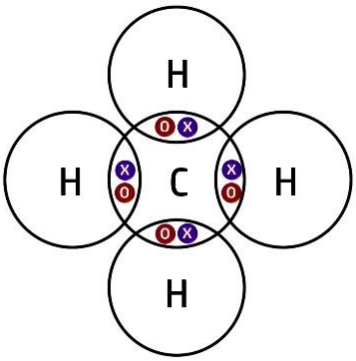
When new bonds are being formed – you are breaking two H-O bonds for every H_2O molecule, so the total energy given out forming new bonds is: $464 + 464 + 464 + 464 = 1856kJmol^{-1}$

- The total energy change is the energy to break bonds ($1370kJmol^{-1}$) minus the total energy given out ($1856kJmol^{-1}$)
- Total energy change = 1370 – 1856 = **$-486kJmol^{-1}$**.
- If the energy change is **negative**, it is **exothermic**. If **positive**, it is **endothermic**.

AfL 19: Fuels and Hydrocarbons:

A. Hydrocarbons:

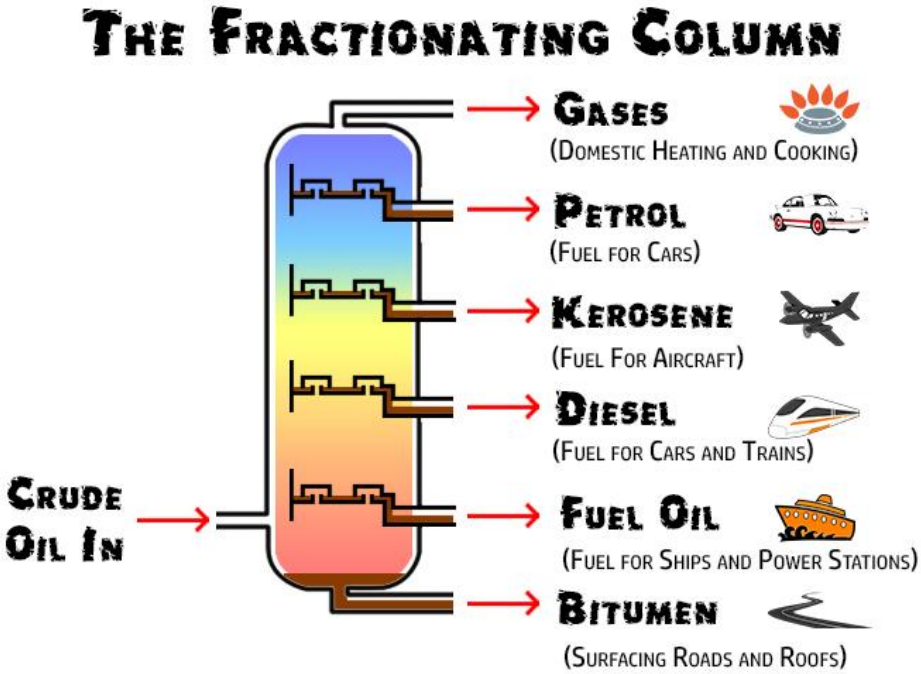
Crude oil is a mixture of hydrocarbons, formed from the remains of dead plants and animals over millions of years.



- A **hydrocarbon** is a compound containing hydrogen and carbon atoms **only**.
- Carbon atoms have a valence of 4, meaning they can make **4 covalent bonds**.
- This high valency leads to many hydrocarbons being formed, ranging from 1 carbon to hundreds of them.
- This can also lead to the hydrocarbons forming chains and rings.

B. What is Fractional Distillation?

- Crude oil contains many different fuels, with different uses. We cannot just put crude oil into our cars, for example – it needs to be separated into the different **fractions**.
- This is done using **fractional distillation** – which means separating into their fractions using their *boiling points*.



C. How Fractional Distillation Works:

- The crude oil is vapourised and added to the column
- The fractionating column is hottest at the bottom and coolest at the top.
- The vapours rise throughout the column until they fall **below** their boiling point – they then **condense**.
- The liquid falls into the tray and is collected.
- The rest of the hydrocarbons will move up the column, and the process continues until you are left with just the gases at the top.

D. Properties of the fractions of crude oil:

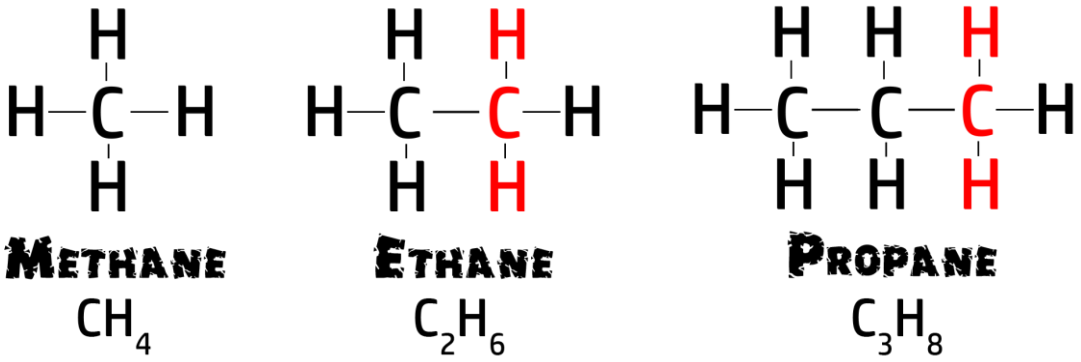
- The **gases** at the **top** of the column are the **easiest to ignite**, have the **lowest boiling points**, have the **smallest chain lengths** (less carbon atoms) and are the **least viscous** (flow more easily).
- The **bitumen** at the **bottom** of the column is the **hardest to ignite**, has the **highest boiling points**, has the **largest chain lengths** (more carbon atoms) and are the **most viscous** (thick and doesn't flow easily).

E. Homologous Series

A homologous series is any group of chemicals that have:

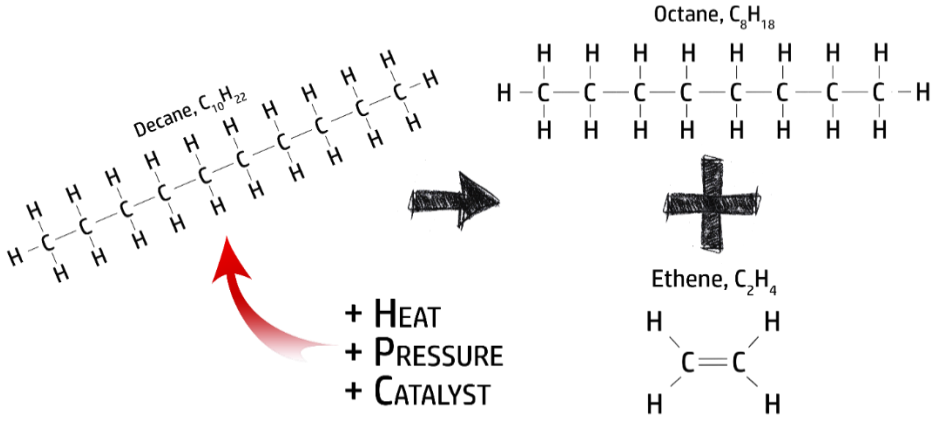
- **similar chemical properties**,
- a **gradual change** in **physical properties** (boiling points and melting points),
- the same **general formula**,
- and extra CH_2 in their molecular formulae each time a carbon is added.

For example: Alkanes:



- These are called homologues series because the general formula is C_nH_{2n+2}.
- For example, when n=2, the molecule is $C_2H_{(2x2)+2} = C_2H_6$.
- This formula works by adding in a Carbon and 2 Hydrogens (CH_2) each time.

F. Cracking



When a large chained alkane is put under **heat and pressure** with a **catalyst**, they are broken down into short chained alkanes and alkenes.

In the above reaction, Decane, $C_{10}H_{22}$, is broken down into Octane, C_8H_{18}, and Ethene, C_2H_4:

$$C_{10}H_{22} \rightarrow C_8H_{18} + C_2H_4$$

You will notice that the amount of carbon and hydrogen atoms above are the same for both the reactants and products. This is called the **conservation of mass**.

The reason we need to do this is to meet the demand of the shorter chained alkanes and alkenes.

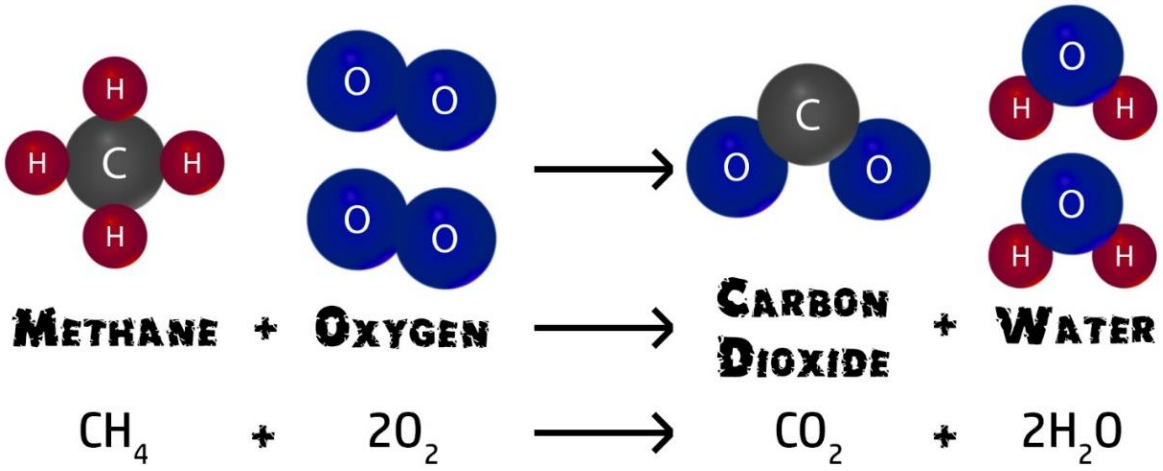
- In general, long chained alkanes - like bitumen - are available in large amounts and we don't need as much of them. **They have a larger supply than demand**.
- In general, short chained alkanes – like petrol – are in demand. **There is more demand than supply**, so we break down larger alkanes to meet the demand.
- Alkenes, such as ethene, are used to make **polymers** and are extremely useful.

AfL 20: Human Impact on the Earth:

A. Complete and incomplete Combustion

Combustion is the reaction of any fuel with oxygen to form heat and light energy. There are two types of combustion – **complete** and **incomplete** combustion.

1. Complete Combustion:



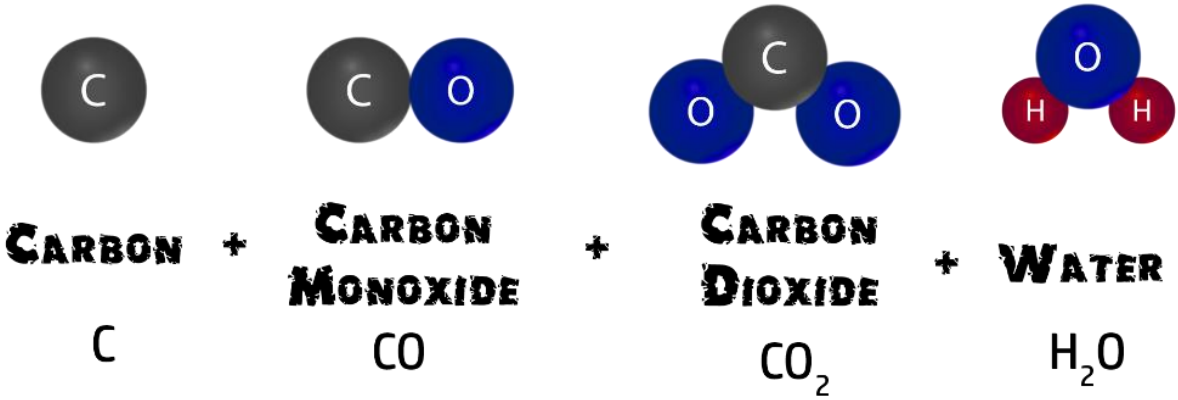
Complete combustion is where a fuel reacts with **lots of oxygen**, giving out **lots of energy** as well as producing *carbon dioxide* and *water*.

Writing balanced equations for this is easy – as long as you know the formula for the fuel (which will usually be given) – the rest of the equation is always the same. Then it just needs balancing!

Example: Propane, C_3H_8

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

2. Incomplete Combustion:



Incomplete combustion occurs when there is **not enough oxygen**. Water is still formed, but instead of just carbon dioxide, carbon monoxide and carbon (soot) are produced as well.

B. The Dangers of Incomplete Combustion

The problem with soot:

- Soot blocks pipes carrying away waste gases from a boiler.
- It blackens buildings.
- It can cause breathing problems if it collects in the lungs.

The problem with carbon monoxide:

- Carbon monoxide is a toxic gas – which means it is poisonous.
- It binds to the **haemoglobin** in the red blood cells, taking up space needed by the oxygen.
- This reduces the amount of oxygen reaching the cells and lowers the amount of **respiration** occurring.
- This makes people **sleepy** and can cause them to become **unconscious** – and can lead to **death**.

C. The Formation of Acid Rain

Rainwater is naturally acidic – the carbon dioxide in the atmosphere dissolves in the rain water and forms a very weak acid.

When **impurities** in fossil fuels – **sulfur** – are heated, they react with the oxygen to form sulfur dioxide:

$$S + O_2 \rightarrow SO_2$$

The sulfur dioxide gas then dissolves into the water in the clouds to form sulfurous acid, H_2SO_3, which then **oxidises** (reacts with oxygen) to form sulfuric acid, H_2SO_4 – Acid Rain!

Step 1: Water + sulfur dioxide → sulfurous acid

$$\mathbf{H_2O + SO_2 \rightarrow H_2SO_{3\,(aq)}}$$

Step 2: Sulfurous acid + oxygen → sulfuric acid

$$\mathbf{2H_2SO_3 + O_2 \rightarrow 2H_2SO_{4\,(aq)}}$$

D. The Effect of Acid Rain

Acid rain has the following effects:

- It makes the soil **acidic** – which stops some plants from growing.
- It **acidifies** the rivers and lakes – killing fish and insects and stopping eggs from hatching.
- It **weathers** statues made from sedimentary rock.
- It **corrodes** metallic structures.

E. Oxides of Nitrogen:

Car engines can get extremely hot. When this happens, they react with the nitrogen in air and produce nitrogen oxides – such as nitrogen oxide, NO, or nitrogen dioxide, NO_2.

- These gases are pollutants and can cause acid rain by forming nitric acid, HNO_3, when dissolved in the rain water.
- Nitrogen dioxide, a red/brown gas, is toxic and can cause respiratory diseases such as bronchitis.
- Catalytic converters can be used to convert this back into nitrogen – a harmless gas.

F. Hydrogen as a fuel:

Hydrogen can be used as a fuel, instead of fossil fuels.

- **Advantage:** It only produces water and a lot of energy: $2H_2 + O_2 \rightarrow 2H_2O$ – no CO_2!
- **Disadvantage:** The engine is expensive, and so is making the hydrogen gas. It is also hard to store.

AfL 21: The Earth's Sea and Atmosphere:

A. How did the Earth's Early Atmosphere form?

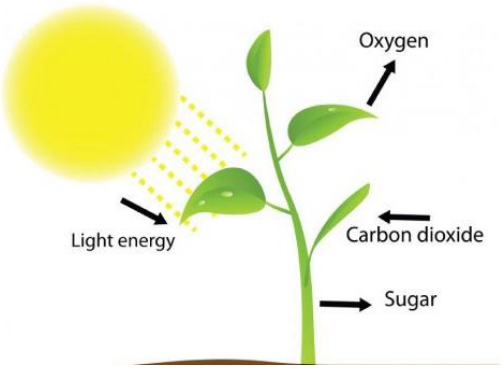
- Volcanoes produced the gases in the early atmosphere.
- We are sure of this because Venus has lots of volcanoes and an atmosphere full of carbon dioxide.
- The volcanoes give out carbon dioxide and water vapour (as well as small amounts of methane, nitrogen and ammonia)

B. What happened to the water vapour?

- Eventually, the Earth started to cool.
- When the Earth cooled, the water vapour **condensed** into a liquid – water.
- This liquid eventually formed the oceans.

C. How did Carbon Dioxide levels decrease?

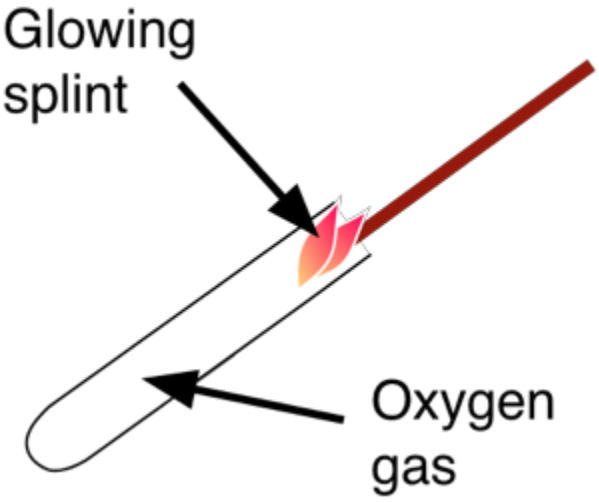
- There are three main ways that CO_2 levels decreased:
  1. The carbon dioxide started to **dissolve** into the newly formed oceans.
  2. The carbon dioxide in the oceans was absorbed by small creatures and ended up as **animal shells** or **sedimentary rock**.
  3. Once **primitive plants** formed, they absorbed carbon dioxide and produced oxygen in a process called **photosynthesis**.



- We know there was **no oxygen** in the Early Atmosphere because there is lots of **iron pyrite** in ancient rock – a chemical that only forms when there is **no oxygen**.

D. The test for oxygen:

- Simple! Oxygen **relights** a **glowing** splint!
- Take a splint, light it and then blow it out – make sure it is still **glowing**.
- Put the glowing splint into your oxygen and, if oxygen is present, the splint will **relight**!
- Why? The oxygen accelerates combustion, so even the tiniest bit of energy can set the splint on fire again!

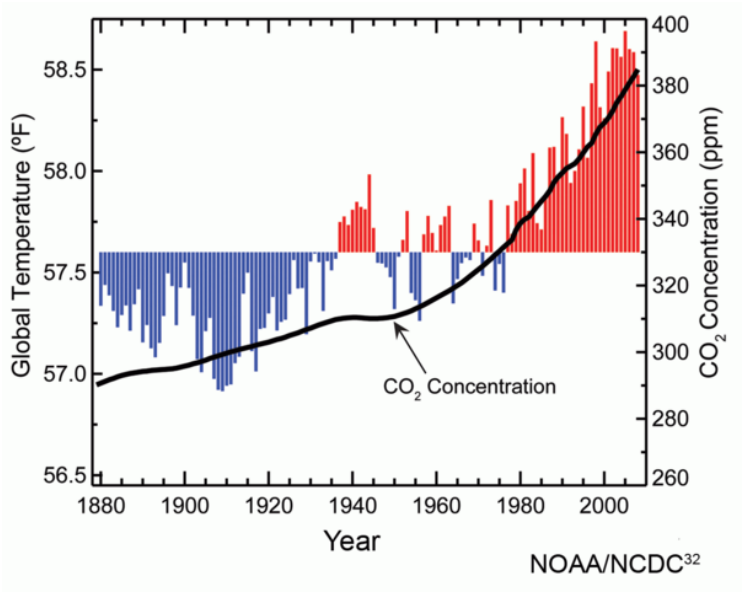


E. Today's Atmosphere

- When the sun emits heat and light rays, some is absorbed by the Earth's surface, warming it up.
- The Earth will then emit heat rays which travel through the atmosphere.
- The more greenhouse gases there are, the more heat gets trapped in the atmosphere.
- This helps to keep the Earth warm, but as carbon dioxide levels continue to increase, this can lead to global warming.

F. The link between carbon dioxide and climate change:

- Since 1850 there has been an increase in fossil fuel usage (from the industrial revolution).
- This increase in carbon dioxide in the atmosphere has happened at the same time as the increase in temperature of the Earth.
- There is a **strong correlation** between increasing CO_2 levels and increasing temperature levels.
- Correlation does not mean a **causal link**.
- Scientists must collect data and use it to explain the evidence for there to be a causal link (where one thing **causes** another).



G. The effects of climate change:

- We add greenhouse gases to the atmosphere in the following ways:
  - **Drilling for oil**: When we drill for oil, it can release stores of methane – a powerful greenhouse gas.
  - **Farming**: Cows have bacteria in their gut to digest grass. This also produces methane.
  - **Combustion**: Burning fossil fuels produces lots of carbon dioxide and water vapour.
  - **Deforestation**: Cutting down trees reduces the amount of photosynthesis, meaning carbon dioxide levels increase
- The increase of carbon dioxide levels results in:
  - **The ice caps melting**: This means animals cannot survive and either must migrate or become extinct.
  - **Sea levels rising**: Increased flooding
  - **Extreme weather**: Heavy rainfall, powerful storms, droughts, heat waves, etc...

Apply Task 1: The Alkali Metals and the Noble Gases

Question:		Marks:
1:	i. Group 1 in the periodic table contains (1) ☒ **A** transition metals ☒ **B** noble gases ☒ **C** halogens ☒ **D** alkali metals ii. Describe what you would **see** when a small piece of sodium is added to water. (2) iii. Describe **the difference** you would **see** when small pieces of lithium and potassium are added to water. (3)	**6**
2:	i. Write the **word equation** for the reaction of sodium with water to form sodium hydroxide and hydrogen. (1) ii. Write the **balanced equation** for the reaction of sodium with water to form sodium hydroxide, NaOH, and hydrogen. (2) iii. Explain, in terms of their electronic configurations, why potassium is more reactive than sodium. (3)	**6**
3:	Helium and argon are noble gases. i. Choose the correct word from this box to complete the sentence below. (1) non- flammable odourless reactive Argon can be used to put out fires because it is ..... ii. Choose the correct phrase from this box to complete the sentence below. (1) has a high density has a low density is colourless Helium is used in airships because it ..... iii. Some light bulbs contain a metal filament. These light bulbs are filled with argon. Explain why argon, instead of air, is used inside these light bulbs. (2)	**4**
4:	i. Fill in the three spaces in the table. (3)	**3**

gas	atomic symbol	density / g dm^{-3}	reaction with metals
helium	He	0.12	no reaction
neon	Ne	1.44	no reaction
argon	Ar		no reaction
krypton		3.00	no reaction
xenon	Xe	3.56	

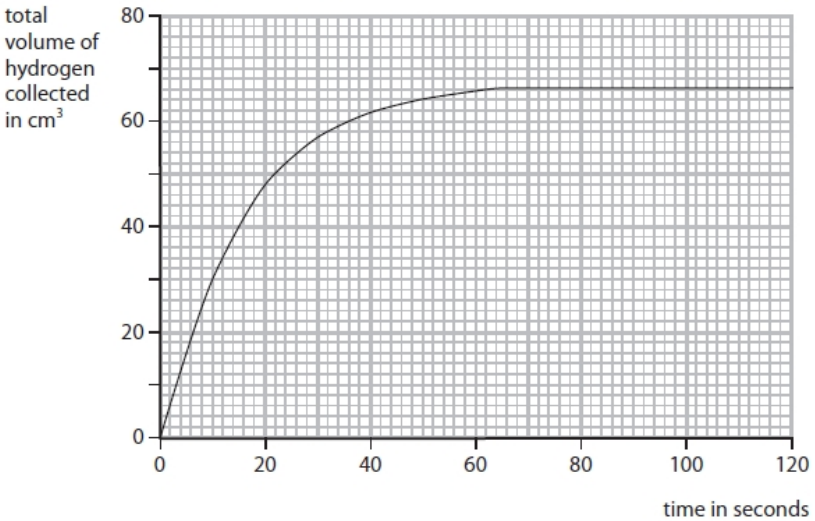
Red:	Amber:	Green:	Blue:
1-5	6-12	13-17	18-19

Apply Task 2: The Halogens and Displacement Reactions

Question:		Marks:
1:	Chlorine, bromine and iodine are halogens. Draw **one** straight line from each solid to properties of that solid. **solid** → **properties of solid** iodine → a soft metal that reacts vigorously with water potassium → a grey solid that forms a purple vapour when heated a yellow solid that does not conduct electricity	**2**
2:	Chlorine reacts with hydrogen to form hydrogen chloride. i. Write the word equation for this reaction. (1) ii. Write the balanced equation for this reaction. (2) Some metals react with halogens. Iron reacts with bromine, Br_2, to form iron(III) bromide, $FeBr_3$. iii. Write the word equation for this reaction (1) iv. Write the balanced equation for this reaction.(2)	**6**
3:	When a halogen is added to a solution containing halide ions a displacement reaction may occur. In the table ✓ shows a displacement reaction occurs × shows a displacement reaction does not occur **halogen added** / **halide ion in solution**: **chloride ion**, **bromide ion**, **iodide ion** chlorine: ✓, ✓ bromine: ×, ✓ iodine: ×, × Use the information in the table to explain the order of reactivity of the three halogens.	**3**
4:	Chlorine is a halogen. Chlorine reacts with potassium iodide solution to form potassium chloride solution and iodine. $Cl_2 + 2KI \rightarrow 2KCl + I_2$ i. State what would be **seen** when this reaction occurs.(1) ii. Explain, in terms of their electronic configurations, why chlorine is more reactive than iodine. (2) (H) iii. Explain why this reaction is an example of a redox reaction. (4)	**7**

Red:	Amber:	Green:	Blue:
1-5	6-12	13-17	18-19

Apply Task 3: Rates of Reaction and Collision Theory

<table>
<tr><th colspan="2">Question:</th><th>Marks:</th></tr>
<tr><td>1:</td><td>Marble chips react with dilute hydrochloric acid to produce carbon dioxide gas. The rate of this reaction can be changed by changing the size of the marble chips.
Describe experiments to investigate what effect using smaller marble chips has on the rate of this reaction. Explain the results you should see. (6)</td><td>6</td></tr>
<tr><td>2:</td><td>The student carried out two experiments. The same mass of zinc and the same sized pieces of zinc were used in each experiment. The results are shown in the table.
<table>
<tr><th></th><th>experiment 1</th><th>experiment 2</th></tr>
<tr><td>concentration of sulfuric acid / mol dm^{-3}</td><td>0.5</td><td>1.5</td></tr>
<tr><td>temperature / °C</td><td>20</td><td>40</td></tr>
<tr><td>rate of reaction</td><td>slow</td><td>fast</td></tr>
</table>
Evaluate these results, explaining the reasons why the rate of reaction in experiment 2 is faster than the rate of reaction in experiment 1.
In your answer you should refer to the frequency and energy of collisions between particles. (6)</td><td>6</td></tr>
<tr><td>3:</td><td>A student investigated the rate of reaction between magnesium ribbon and excess dilute hydrochloric acid.
The word equation for the reaction is
magnesium + hydrochloric acid → magnesium chloride + hydrogen
The total volume of hydrogen evolved was measured every 10 seconds for 120 seconds.
The graph in Figure 8 shows the results obtained by the student.


i. Using the graph, give the time in seconds at which the reaction stopped. (1)
ii. Give the reason why the reaction stopped. (1)
iii. Use the graph to calculate the average rate of reaction during the first 20 seconds, in cm^3 of hydrogen produced per second. (2)
(iv) The experiment was repeated at a higher temperature, keeping all other conditions exactly the same. Sketch a line on the graph to show the results you would expect in this experiment. (2)</td><td>6</td></tr>
</table>

Red:	Amber:	Green:	Blue:
1-5	6-10	11-15	16-18

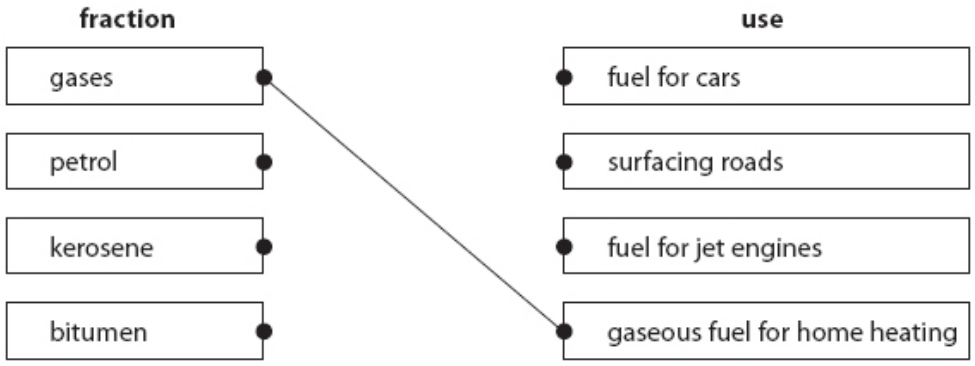
Apply Task 4: Energy in Reactions

Question:		Marks:
1:	An experiment was carried out to measure the temperature change when zinc powder reacts with copper sulfate solution. initial temperature of copper sulfate solution = 20 °C final temperature of mixture after the reaction = 46 °C i. Explain what the temperature readings show about the type of heat change that occurs during this reaction. (3) ii. Explain, in terms of the energy involved in the breaking of bonds and in the making of bonds, why some reactions are exothermic. (3)	**6**
2:	i. Draw a reaction profile for an endothermic reaction (2) ii. Add the activation energy to the reaction profile (1) iii. Explain what makes a reaction endothermic overall. (4)	**7**
3:	i. A catalyst is added to some reactions. Explain the meaning of **catalyst.** (2) ii. Draw a reaction profile for an exothermic reaction (2) iii. Draw the activation energy for a normal reaction **and** for a reaction using a catalyst. (2)	**6**
4:	When hydrogen reacts with chlorine it forms hydrogen chloride: hydrogen + chlorine → hydrogen chloride. $H_{2(g)}$ + $Cl_{2(g)}$ → $2HCl_{(g)}$ Using the bond energies below, work out the energy change for the reaction and state whether the reaction is exothermic or endothermic overall. (4)	**4**

Bond	Bond Energy ($kJmol^{-1}$)
H—H	436
Cl—Cl	242
H—Cl	431

Red:	Amber:	Green:	Blue:
1-5	6-12	13-17	18-23

Apply Task 5: Fuels and Hydrocarbons

Question:		Marks:
1:	i. Which of these is the formula of a hydrocarbon? (1) ☒ **A** CH_3COOCH_3 ☒ **B** CH_3CH_2Cl ☒ **C** CH_3CH_3 ☒ **D** CH_3COOH ii. Methane is a hydrocarbon. The formula of a molecule of methane is CH_4. Explain what is meant by a **hydrocarbon**. (2)	**3**
2:	Useful products can be obtained by the fractional distillation of crude oil. i. The table shows some crude oil fractions and some uses. Draw one straight line from each fraction to its correct use. One has been completed for you. (3)  ii. Explain how the fractions of crude oil are separated (3) iii. Petrol is obtained from near the top of the column and bitumen is obtained from the bottom. Explain how the petrol and bitumen fractions differ in their properties and uses. (3)	**9**
3:	Alkenes can be obtained by cracking some fractions obtained from crude oil. i. Explain what is meant by **cracking**. (2) ii. The equation for a reaction that occurs during cracking is $C_{12}H_{26} \rightarrow C_2H_6 + C_6H_{12} + X$ In the balanced equation, X is (1) ☒ **A** C_3H_8 ☒ **B** C_4H_8 ☒ **C** C_4H_{10} ☒ **D** C_6H_{14} iii. Explain why the process of cracking is important (2)	**5**
4:	Ethane is a member of the homologous series, the alkanes. Describe what is meant by an **homologous series**. (2)	**2**

Red:	Amber:	Green:	Blue:
1-4	5-10	11-15	16-19

Apply Task 6: Human Impact on the Earth

Question:		Marks:
1:	Methane burns in oxygen to form carbon dioxide and water. i. Methane is useful because, when it burns, it produces (1) ☒ **A** carbon dioxide ☒ **B** carbon monoxide ☒ **C** heat energy ☒ **D** a yellow flame ii. Write the word equation for this reaction. (2) iii. Write the balanced equation for this reaction. (2)	**5**
2:	When hydrocarbon fuels burn in a plentiful supply of air, they undergo complete combustion, forming carbon dioxide and water vapour. If the air supply is limited incomplete combustion occurs and carbon monoxide and carbon may be formed. Describe the problems that can be caused by these products of complete and incomplete combustion.	**6**
3:	Sulfur impurity can be present in the coal used in coal-fired power stations. As a result of the presence of the sulfur impurity, the gases from the chimneys of these power stations can produce acid rain. Explain how acid rain is formed and the environmental problems caused by acid rain. (6)	**6**
4:	Hydrogen is an alternative fuel to petrol. Use your knowledge of hydrogen and petrol to explain the advantages and disadvantages of using hydrogen rather than petrol as the fuel in cars. (4)	**4**

Red:	Amber:	Green:	Blue:
1-5	6-12	13-17	18-21

Apply Task 7: The Earth's Sea and Atmosphere

Question:		Marks:
1:	The Earth's earliest atmosphere is thought to have been formed by (1) ☐ **A** animal breathing ☐ **B** photosynthesis in plants ☐ **C** the oceans cooling ☐ **D** gases from volcanoes ii. The Earth's early atmosphere contained a larger percentage of water vapour than the Earth's atmosphere today. Explain what happened to cause the percentage of water vapour in the Earth's atmosphere to decrease. (2)	**3**
2:	The percentage of carbon dioxide in the atmosphere has decreased since the Earth's earliest atmosphere. Explain what has caused the amount of carbon dioxide in the atmosphere to decrease. (4)	**4**
3:	Carbon dioxide and other gases in the atmosphere help to keep the Earth warm. Explain, using knowledge of these greenhouse gases, how the increase in greenhouse gases can affect the Earth. You should include: i. How these greenhouse gases help to keep the Earth warm (2) ii. How we are adding greenhouse gases to the atmosphere (3) iii. The effect of climate change (3)	**8**
4:	Describe the test to show that a gas is oxygen. (2)	**2**

Red:	Amber:	Green:	Blue:
1-4	5-10	11-14	15-17

Check Task 1: The Alkali Metals and the Noble Gases

Question:

1:

i. Group 1 in the periodic table contains (1)

☒ **D alkali metals**

ii. Describe what you would **see** when a small piece of sodium is added to water. (2)

- Floating (1)
- Moving (1)
- Fizzing / bubbles / effervescence (1)
- Turns into a molten ball (1)
- Becomes smaller / disappears (1)

iii. Describe **the difference** you would **see** when small pieces of lithium and potassium are added to water. (3)

- Potassium moves faster / Lithium moves slower (1)
- Potassium fizzes more / lithium fizzes less (1)
- Potassium produces a **lilac** flame / Lithium doesn't produce a flame, but potassium does (1)

6

2:

i. Write the **word equation** for the reaction of sodium with water to form sodium hydroxide and hydrogen. (1)

- Sodium + water → sodium hydroxide + hydrogen (1)

ii. Write the **balanced equation** for the reaction of sodium with water to form sodium hydroxide, NaOH, and hydrogen. (2)

- $2Na + 2H_2O \rightarrow 2NaOH + H_2$ (1)
- Equation correct (1); Balancing correct (1)

iii. Explain, in terms of their electronic configurations, why potassium is more reactive than sodium. (3)

- Sodium and potassium both want to lose one electron (1)
- Potassium has more shells / a larger atomic radius / more electron shielding (1) ORA
- The attraction between the nucleus and the **outer** electron is weaker (1) ORA
- It is easier for potassium to lose its **outer** electron (1) ORA

6

3:

Helium and argon are noble gases.

i. Choose the correct word from this box to complete the sentence below. (1)

- Argon can be used to put out fires because it is **non-flammable (1)**

ii. Choose the correct phrase from this box to complete the sentence below. (1)

- Helium is used in airships because it **has a low density (1)**

iii. Some light bulbs contain a metal filament. These light bulbs are filled with argon. Explain why argon, instead of air, is used inside these light bulbs. (2)

- argon is inert / unreactive (1)
- argon does not react with metal/filament/metal/ filament would react with air or oxygen (1)
- atom has eight electrons in outer shell / full (outer) shell (1)

4

4:

i. Fill in the three spaces in the table. (3)

gas	atomic symbol	density / g dm^{-3}	reaction with metals
helium	He	0.12	no reaction
neon	Ne	1.44	no reaction
argon	Ar		no reaction
krypton		3.00	no reaction
xenon	Xe	3.56	

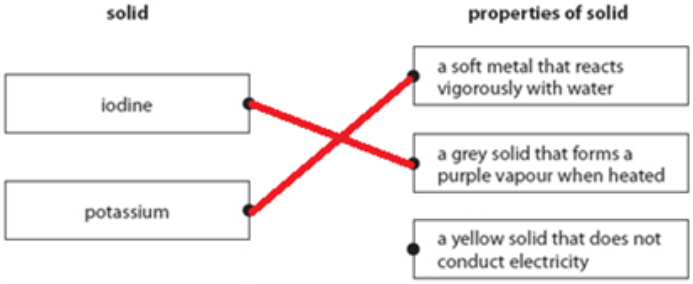
- Atomic Symbol: Kr (1)
- Density: Anything between 1.45 to 2.99 (1)
- Reaction with metals: no reaction (1)

3

Check Task 2: The Halogens and Displacement Reactions

Question:

1: Chlorine, bromine and iodine are halogens. Draw **one** straight line from each solid to properties of that solid.



2

2: Chlorine reacts with hydrogen to form hydrogen chloride.

i. Write the word equation for this reaction. (1)

- Chlorine + hydrogen → hydrogen chloride (1)

ii. Write the balanced equation for this reaction. (2)

- $Cl_2 + H_2 \rightarrow 2HCl$
- Equation correct (1); Balancing correct (1)

Some metals react with halogens. Iron reacts with bromine, Br_2, to form iron(III) bromide, $FeBr_3$.

iii. Write the word equation for this reaction (1)

- Iron + Bromine → Iron Bromide (1)

iv. Write the balanced equation for this reaction.(2)

- $2Fe + 3Br_2 \rightarrow 2FeBr_3$
- Equation correct (1); Balancing correct (1)

6

3: When a halogen is added to a solution containing halide ions a displacement reaction may occur.

In the table ✓ shows a displacement reaction occurs × shows a displacement reaction does not occur

halogen added	halide ion in solution		
	chloride ion	bromide ion	iodide ion
chlorine		✓	✓
bromine	×		✓
iodine	×	×	

Use the information in the table to explain the order of reactivity of the three halogens.

- Correct order of reactivity chlorine > bromine > iodine (1)
- chlorine displaces bromine (from bromide) AND chlorine displaces iodine (from iodide) (1)
- bromine displaces iodine (from iodide) AND bromine does not displace chlorine (from chloride) (1)
- iodine does not displace chlorine(from chloride) AND iodine does not displace bromine (from bromide) (1)

3

4: Chlorine is a halogen. Chlorine reacts with potassium iodide solution to form potassium chloride solution and iodine.

$$Cl_2 + 2KI \rightarrow 2KCl + I_2$$

i. State what would be **seen** when this reaction occurs.(2)

- From colourless (1) to {orange/yellow/brown} (1)

ii. Explain, in terms of their electronic configurations, why chlorine is more reactive than iodine. (2)

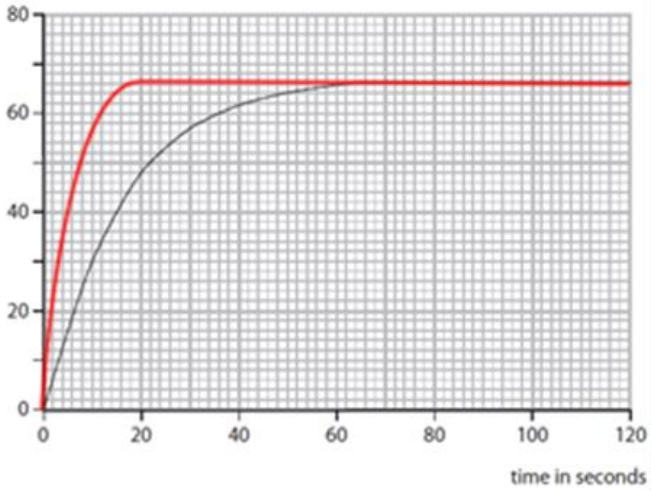
- Chlorine and Bromine both want to gain one electron (1)
- Bromine has more shells / a larger atomic radius / more electron shielding (1) ORA
- The attraction between the nucleus and the **outer** shell is weaker (1) ORA
- It is harder for bromine to gain an electron (1) ORA

(H) iii. Explain why this reaction is an example of a redox reaction. (4)

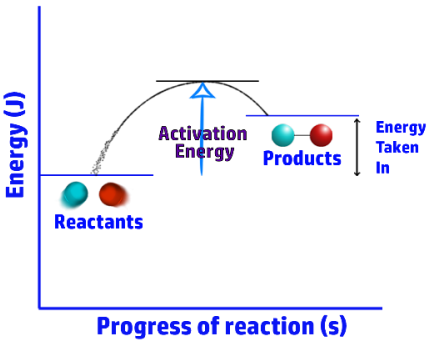
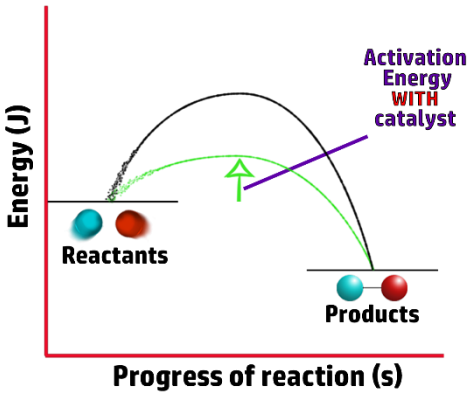
- The iodide ion loses an electron (1)
- Oxidation is loss of electrons / iodide ion is oxidised (1)
- The chlorine atom gains an electron (1)
- Reduction is the gain of electrons / chlorine is reduced (1)

8

Check Task 3: Rates of Reaction and Collision Theory

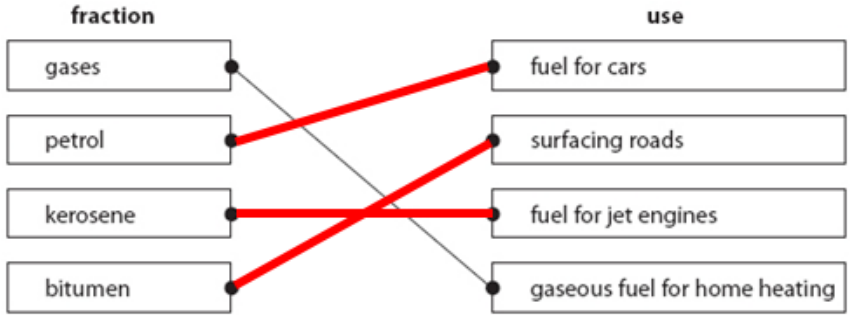
Question:		
1:	Marble chips react with dilute hydrochloric acid to produce carbon dioxide gas. The rate of this reaction can be changed by changing the size of the marble chips. Describe experiments to investigate what effect using smaller marble chips has on the rate of this reaction. Explain the results you should see. (6) **Method: Any 4 from:** ❄ Measure the volume of acid / stated volume (1) ❄ Measure the mass of marble chip / stated mass (1) ❄ Add the acid to the marble chip in a conical flask (1) ❄ Collect the gas in a {gas syringe / measuring cylinder over water} (1) ❄ Measure 50cm^3 of gas and stop the stop watch (1) ❄ Repeat for different {sized marble chips / surface areas} (1) **Results: Any 2 from:** ❄ The larger the surface area the quicker it is to produce the gas (1) ❄ Larger {surface area-to-volume ratio / area for collision to occur} (1) ❄ More frequent collisions (1)	**6**
2:	The student carried out two experiments. The same mass of zinc and the same sized pieces of zinc were used in each experiment. The results are shown in the table. Evaluate these results, explaining the reasons why the rate of reaction in experiment 2 is faster than the rate of reaction in experiment 1. In your answer you should refer to the frequency and energy of collisions between particles. (6) ❄ For a reaction to occur collisions are needed (1) ❄ The collisions need to have enough energy to react (1) ❄ experiment 2 higher/triple concentration of acid (1) ❄ more particles **in the same volume** (1) ❄ more frequent collisions between particles (1) ❄ experiment 2 higher temperature (1) ❄ particles move faster (1) ❄ particles have more **kinetic** energy (1) ❄ more successful collisions **per second** (1) ❄ more particles have enough energy to react (activation energy) when they collide (1)	**6**
3:	A student investigated the rate of reaction between magnesium ribbon and excess dilute hydrochloric acid. The word equation for the reaction is magnesium + hydrochloric acid → magnesium chloride + hydrogen The total volume of hydrogen evolved was measured every 10 seconds for 120 seconds. i. Using the graph, give the time in seconds at which the reaction stopped. (1) ❄ 60s (1) ii. Give the reason why the reaction stopped. (1) ❄ One reactant used up (1) iii. Use the graph to calculate the average rate of reaction during the first 20 seconds, in cm^3 of hydrogen produced per second. (2) ❄ Correct reading: 48cm^3 (±2cm^3) (1) ❄ Calculation: 48/20 = 2.4cm^3/s (1) (iv) The experiment was repeated at a higher temperature, keeping all other conditions exactly the same. Sketch a line on the graph to show the results you would expect in this experiment. (2) ❄ MP1: Graph steeper (1) ❄ MP2: Finishes at the same volume. (1)  	**6**

Check Task 4: Energy in Reactions

Question:		
1:	An experiment was carried out to measure the temperature change when zinc powder reacts with copper sulfate solution. initial temperature of copper sulfate solution = 20 °C final temperature of mixture after the reaction = 46 °C i. Explain what the temperature readings show about the type of heat change that occurs during this reaction. (3) ❋ Temperature increased/went up (1) ❋ Exothermic (1) ❋ **Heat** energy given out **to surroundings** (1) ii. Explain, in terms of the energy involved in the breaking of bonds and in the making of bonds, why some reactions are exothermic. (3) ❋ Energy is needed to break bonds / bond breaking is endothermic (1) ❋ Energy is released when new bonds form / bond forming is exothermic (1) ❋ More {**heat** / **energy**} is released than {needed/taken in} (1)	**6**
2:	i. Draw a reaction profile for an endothermic reaction (2) ❋ Products on the right, reactants on the left (1) ❋ Product energy line **higher** than reactants (1) ii. Add the activation energy to the reaction profile (1) ❋ Line drawn from same height as reactants **straight up** to the middle of the peak (see right) (1) iii. Explain what makes a reaction endothermic overall. (4) ❋ Energy is needed to break bonds / bond breaking is endothermic (1) ❋ Energy is released when new bonds form / bond forming is exothermic (1) ❋ More {**heat** / **energy**} is needed/taken in than released (1) 	**7**
3:	i. A catalyst is added to some reactions. Explain the meaning of **catalyst.** (2) ❋ increases rate / speeds up reaction (1) ❋ without being {used up / changed itself} (1) ii. Draw a reaction profile for an exothermic reaction (2) ❋ Products on the right, reactants on the left (1) ❋ Product energy line **higher** than reactants (1) iii. Draw the activation energy for a normal reaction **and** for a reaction using a catalyst. (2) ❋ MP1: Line drawn from same height as reactants **straight up** to the middle of the peak (see right) (1) ❋ Catalyst activation energy **lower** than normal (see right) (1) 	**6**
4:	When hydrogen reacts with chlorine it forms hydrogen chloride: hydrogen + chlorine ⟶ hydrogen chloride. $H_{2(g)}$ + $Cl_{2(g)}$ ⟶ $2HCl_{(g)}$ Using the bond energies below, work out the energy change for the reaction and state whether the reaction is exothermic or endothermic overall. (4) ❋ MP1: Bonds broken: H-H = 436; Cl-Cl = 242. 436 + 242 = **647**kJmol^{-1} (1) ❋ MP2: Bonds formed: 2H-Cl = 2x431 = **862**kJmol^{-1} (1) ❋ MP3: Energy change: MP1-MP2 = 647 – 862 = **-215**kJmol^{-1} (Allow ECF if values for MP1 and MP2 are incorrect) (1) ❋ MP4: (Negative sign =) **Exothermic** (1); (If calculation for MP3 ends up positive, allow Endothermic) (1)	**4**

Bond	Bond Energy (kJmol^{-1})
H—H	436
Cl—Cl	242
H—Cl	431

Check Task 5: Fuels and Hydrocarbons

Question:		
1:	i. Which of these is the formula of a hydrocarbon? (1) ☒ **C** CH_3CH_3 ii. Methane is a hydrocarbon. The formula of a molecule of methane is CH_4. Explain what is meant by a **hydrocarbon**. (2) ✱ A {**compound/substance**} made up of **hydrogen and carbon** (1) ✱ **...only** (1)	**3**
2:	Useful products can be obtained by the fractional distillation of crude oil. i. The table shows some crude oil fractions and some uses. Draw one straight line from each fraction to its correct use. One has been completed for you. (3)  ii. Explain how the fractions of crude oil are separated (3) ✱ Crude oil is vapourised (1) ✱ The column is hotter at the bottom (1) ✱ Separated based on boiling point (1) ✱ When fraction falls below boiling point, it condenses (1) iii. Petrol is obtained from near the top of the column and bitumen is obtained from the bottom. Explain how the petrol and bitumen fractions differ in their properties and uses. (3) ✱ Petrol is easier to ignite / Bitumen is harder to ignite (1) ✱ Petrol has a lower boiling point / Bitumen has a higher boiling point (1) ✱ Petrol has a shorter chain length / Bitumen has a larger chain length (1) ✱ Petrol is {less viscous / runny} / Bitumen is {more viscous / thicker} (1)	**9**
3:	Alkenes can be obtained by cracking some fractions obtained from crude oil. i. Explain what is meant by **cracking**. (2) ✱ Breaking down of a large {molecule/hydrocarbon/alkane} (1) ✱ ...into shorter chained {molecules / hydrocarbons / alkanes **and** alkenes} (1) ii. The equation for a reaction that occurs during cracking is $C_{12}H_{26} \rightarrow C_2H_6 + C_6H_{12} + X$ In the balanced equation, X is (1) ☒ **B** C_4H_8 iii. Explain why the process of cracking is important (2) ✱ Not enough supply of shorter chained hydrocarbons / Too much demand for shorter chained hydrocarbons (1) ✱ More supply than demand for larger chained hydrocarbons (1)	**5**
4:	Ethane is a member of the homologous series, the alkanes. (i) Describe what is meant by an **homologous series**. (2) ✱ Same general formula (1) ✱ Formula differ by CH_2 (1) ✱ Trend in physical properties (1) ✱ Same chemical properties (1)	**2**

Check Task 6: Human Impact on the Earth

Question:		
1:	Methane, CH_4, burns in oxygen to form carbon dioxide and water. i. Methane is useful because, when it burns, it produces (1) ☒ **C heat energy** ii. Write the word equation for this reaction. (2) ❄ Methane + oxygen (1) → carbon dioxide + water (1) iii. Write the balanced equation for this reaction. (2) ❄ $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ ❄ Equation correct (1); Balancing correct (1)	**5**
2:	When hydrocarbon fuels burn in a plentiful supply of air, they undergo complete combustion, forming carbon dioxide and water vapour. If the air supply is limited incomplete combustion occurs and carbon monoxide and carbon may be formed. Describe the problems that can be caused by these products of complete and incomplete combustion. CARBON DIOXIDE: ❄ greenhouse gas/ keeps in heat (1) ❄ may contribute to global warming (1) ❄ consequences of global warming e.g. flooding/ drought / crop failure / disease/ melting ice caps / climate change etc (1) CARBON ❄ soot (1) ❄ makes things dirty/ black (1) ❄ can cause breathing problems (1) CARBON MONOXIDE ❄ toxic (1) ❄ odourless **and** colourless (1) ❄ combines with haemoglobin (1) ❄ stops oxygen getting to cells (1) ❄ Less respiration can occur (1) ❄ Can lead to {tiredness / dizziness / death} (1)	**6**
3:	Sulfur impurity can be present in the coal used in coal-fired power stations. As a result of the presence of the sulfur impurity, the gases from the chimneys of these power stations can produce acid rain. Explain how acid rain is formed and the environmental problems caused by acid rain. (6) Formation – any 3 from: ❄ Sulfur reacts with oxygen (1) ❄ Forms sulfur dioxide (1) ❄ Dissolves into rain clouds (1) ❄ Forms sulfurous acid (1) ❄ Sulfurous acid reacts with oxygen to form sulfuric acid / acid rain (1) Effect – any 3 from: ❄ Damage/erosion/weathering of buildings (1) ❄ Acidification of soil (1) ❄ Kills fish (1) ❄ Kills plants / trees (1)	**6**
4:	Hydrogen is an alternative fuel to petrol. Use your knowledge of hydrogen and petrol to explain the advantages and disadvantages of using hydrogen rather than petrol as the fuel in cars. (4) ❄ Only produces water (1) ❄ No carbon dioxide produced (1) ❄ Hydrogen more difficult to store (1) ❄ The engine is expensive / making hydrogen gas is expensive. (1)	**4**

Check Task 7: The Earth's Sea and Atmosphere

Question:		
1:	The Earth's earliest atmosphere is thought to have been formed by (1) ☒ **D gases from volcanoes** ii. The Earth's early atmosphere contained a larger percentage of water vapour than the Earth's atmosphere today. Explain what happened to cause the percentage of water vapour in the Earth's atmosphere to decrease. (2) ❄ the Earth / atmosphere cooled (1) ❄ water vapour condensed (1) ❄ liquid/ water/ rain formed (1) ❄ produced sea/oceans(1)	**3**
2:	The percentage of carbon dioxide in the atmosphere has decreased since the Earth's earliest atmosphere. Explain what has caused the amount of carbon dioxide in the atmosphere to decrease. (4) ❄ dissolves /is absorbed (1) ❄ in the oceans (1) ❄ incorporated into marine organisms (1) ❄ formed carbonate rocks (1) ❄ increase in (green) plants/plants start growing (1) ❄ photosynthesis /plants remove carbon dioxide (1)	**4**
3:	Carbon dioxide and other gases in the atmosphere help to keep the Earth warm. Explain, using knowledge of these greenhouse gases, how the increase in greenhouse gases can affect the Earth. You should include: i. How these greenhouse gases help to keep the Earth warm (2) ❄ Radiation from the sun keeps the earth warm (1) ❄ These gases absorb/trap the heat (1) ii. How we are adding greenhouse gases to the atmosphere (3) Any 3 from: ❄ Burning fossil fuels / combustion (1) ❄ ...increases carbon dioxide levels (1) ❄ Deforestation (1) ❄ ... less trees to absorb carbon dioxide (1) ❄ {Drilling for oil / farming} (1) ❄ ...releases methane (1) iii. The effect of climate change (3) Any 3 from: ❄ Ice caps melt (1) ❄ ...which can kill animals (1) ❄ Sea levels rising (1) ❄ ...which can cause flooding (1) ❄ {Extreme weather / Heavy rainfall / powerful storms / droughts / heat waves} (1)	**8**
4:	Describe the test to show that a gas is oxygen. (2) ❄ Relights (1) ❄ Glowing splint (1)	**2**