

# Revision Guide

## **AQA GSCE Trilogy Chemistry Paper 1 Higher**

Name:

Class:

# 10 Minutes on....

## Atoms, Elements And Compounds

Key Term	Definition
Atom	The smallest part of an atom that can exist.
Element	A substance that is made up of just one type of atom.
Compound	A substance that is made up of two or more different type of atoms chemically bonded together.
Periodic Table	A table of the chemical elements arranged in order of atomic number.

### Comparing elements and compounds.

Elements are made up of just one type of atom while compounds contain two or more elements chemically combined in fixed proportions and can be represented by formulae using the symbols of the atoms from which they were formed. Compounds can only be separated into elements by chemical reactions.

### The first 10 elements and their symbols.

H Hydrogen  
He Helium  
Li Lithium  
Be Beryllium  
B Boron  
C Carbon  
N Nitrogen  
O Oxygen  
F Fluorine  
Ne Neon

# 10 Minutes on....

## Mixtures

Key Term	Definition
Mixture	A substance that is made up of two or more elements or compounds not chemically joined together.

Separation Technique	Description	Example of Use
Filtration	A technique used to separate an insoluble solid from a liquid by using filter paper.	Separating sand from water.
Crystallisation	This separates a soluble solid from its solution. It involves evaporating the solution to a smaller volume and then leaving to cool.	Separating sodium chloride from sea water.
Simple Distillation	This process separates a liquid from solution. It involves evaporating the liquid and then cooling it so that it condenses.	Obtaining water from salty water.
Fractional Distillation	The separation of a mixture into fractions. It involves heating and cooling the vapour.	Separating fractions of crude oil.
Chromatography	Can be used to separate mixtures of coloured compounds. It involves a mobile and stationary phase.	Separating inks and dyes.

# 10 Minutes on....

## Development of the Model of the Atom

### **Comparing the plum pudding and nuclear model of the atom.**

The plum pudding model suggested that the atom is a ball of positive charge with negative electrons embedded in it. The nuclear model also had a positively charged nucleus, however the negative electrons orbit the nucleus within the nuclear model. In the plum pudding model the nucleus is very large and the atom is one solid ball of mass, however in the nuclear model the nucleus is very small and most of the atom is empty space. Neutrons are not present in either model.

### **How the scattering experiment led to a change in the atomic model.**

In the experiment alpha particles were fired at a thin sheet of gold. Most of the alpha particles passed straight through which led to the conclusion that most of the atom was empty space. A very small amount of particles were reflected back which led to the conclusion that the mass of the atom must be concentrated at the centre. Some of the positive alpha particles were also deflected which led to the conclusion that the nucleus must also be positive.

# 10 Minutes on....

## Relative Electrical Charges

Key Term	Definition
Atomic Number	The number of protons in an atom.

Particle	Relative Charge
Proton	+1
Neutron	0
Electron	-1

**What determines the element an atom is.**

The proton number determines the element that an atom is.

**Why atoms are neutral.**

Atoms are neutral because the number of positive protons is equal to the number of negative electrons the atom has.

**Structure of a lithium atom.**

Lithium has an atomic number of 3. This means that lithium has 3 protons in its nucleus and 3 electrons orbiting around the outside. Lithium also has a mass number of 7. This means that lithium has 4 neutrons in its nucleus also.

# 10 Minutes on....

## Size and Mass of Atoms

Key Term	Definition
Mass Number	The total number of protons and neutrons in an atom.
Isotope	Atoms with the same atomic number but different mass number due to having a different number of neutrons.

Particle	Relative Mass
Proton	1
Neutron	1
Electron	Tiny

**Where most of an atom's mass is located.**

Almost all of the mass of an atom is in the nucleus.

<b>Radius of an Atom</b>	0.1nm or $1 \times 10^{-10} \text{m}$
<b>Radius of an Atoms Nucleus</b>	1/10,000 of the size of the atom or $1 \times 10^{-14} \text{m}$

**How to calculate the numbers of protons neutrons and electrons when given the atomic number and mass number.**

To determine the number of protons an element has identify the atomic number. The atomic number will also tell you how many electrons the atom has. To calculate the number of neutrons an atom has deduct the atomic number away from the mass number.

# 10 Minutes on....

## Relative Atomic Mass

Key Term	Definition
Relative Atomic Mass	The average mass of an element's atoms compared to 1/12th the mass of a carbon-12 atom.
Isotope	Atoms with the same atomic number but different mass number due to having a different number of neutrons.

### How to calculate relative atomic mass of an element if you know the mass and abundance of its isotopes.

To calculate the relative atomic mass of an element you add together the total mass of the atoms and divide this by the total number of atoms. For example, chlorine-35 is 75% and chlorine-37 is 25%. So to calculate:

$$\begin{aligned}\text{RAM of chlorine} &= (35 \times 75) + (37 \times 25) / (75 + 25) \\ &= 2625 + 925 / 100 = 3550 / 100 \\ &= 35.5\end{aligned}$$

Question	Answer
1 Calculate the atomic mass of chlorine when the abundance of chlorine-35 is 75% and the abundance of chlorine-37 is 25%.	$\begin{aligned}\text{RAM of Cl} &= (35 \times 75) + (37 \times 25) / (75 + 25) \\ &= 2625 + 925 / 100 \\ &= 3550 / 100 \\ &= 35.5\end{aligned}$
2 Calculate the atomic mass of copper when the abundance of copper-63 is 70% and the abundance of copper-65 is 30%.	$\begin{aligned}\text{RAM of Cu} &= (63 \times 70) + (65 \times 30) / (70 + 30) \\ &= 4410 + 1950 / 100 \\ &= 6360 / 100 \\ &= 63.6\end{aligned}$
3 Calculate the atomic mass of magnesium when the abundance of magnesium-24 is 79%, magnesium-25 is 10% and the abundance of magnesium-26 is 11%.	$\begin{aligned}\text{RAM of Mg} &= (24 \times 79) + (25 \times 10) + (26 \times 11) / (79 + 10 + 11) \\ &= 1896 + 250 + 286 / 100 \\ &= 2432 / 100 \\ &= 24.32\end{aligned}$

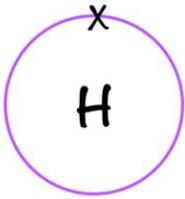
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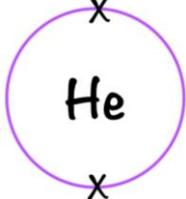
## Electronic Structures

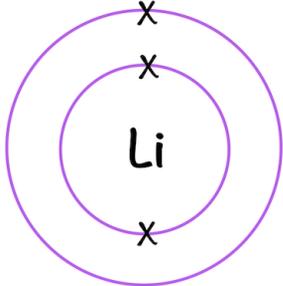
Key Term	Definition
Electron Configurations	The way in which electrons are arranged in an atom.

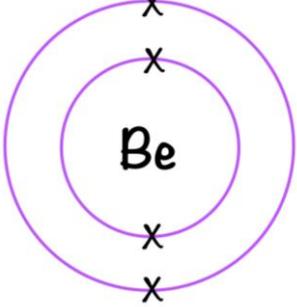
Energy Level	Max No. of Electrons
1	2
2	8
3	8

**Electron configuration diagrams for the first 20 elements.**

Hydrogen

1

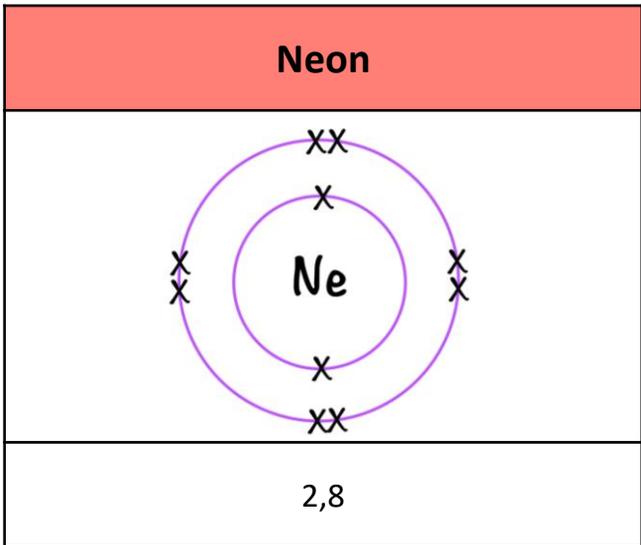
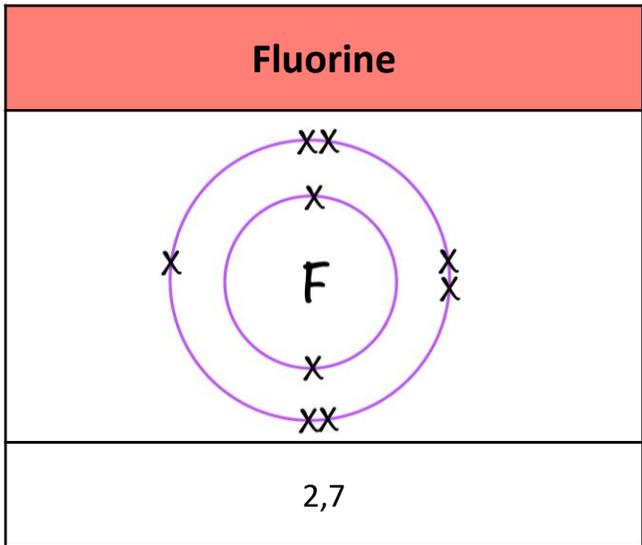
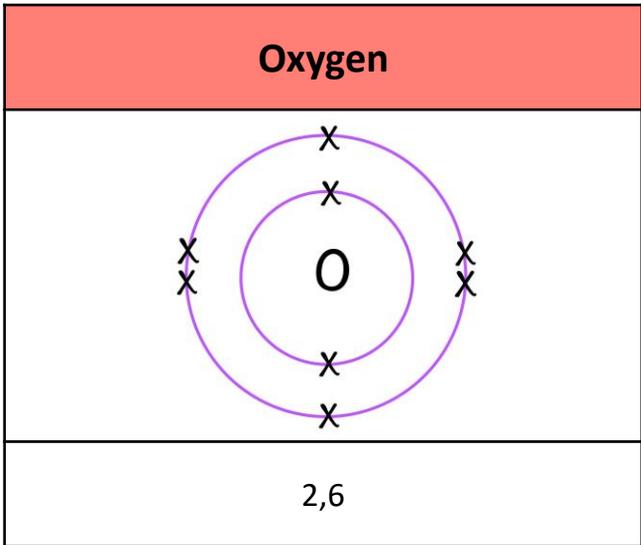
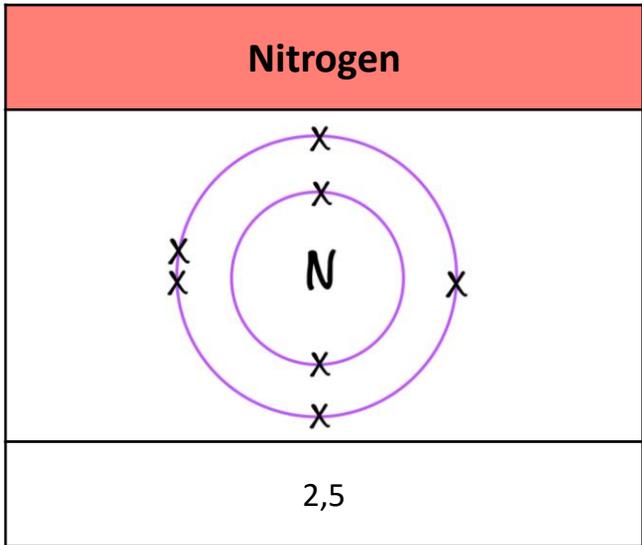
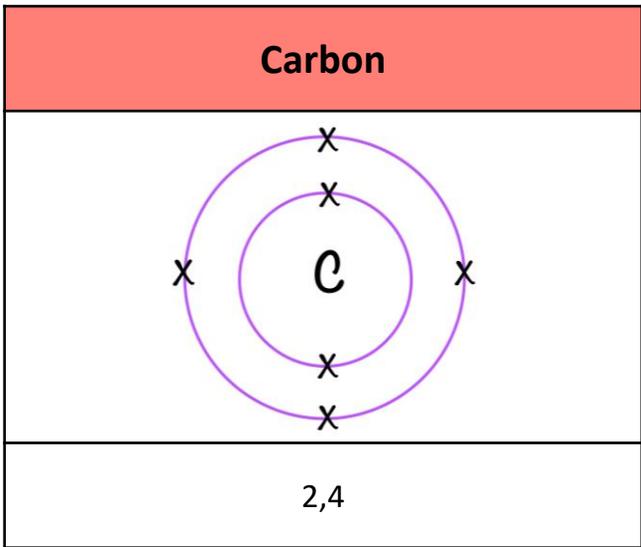
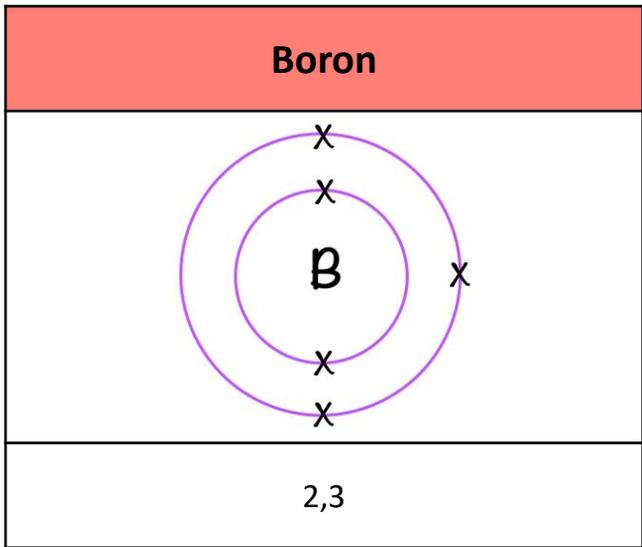
Helium

2

Lithium

2,1

Beryllium

2,2

# 10 Minutes on....

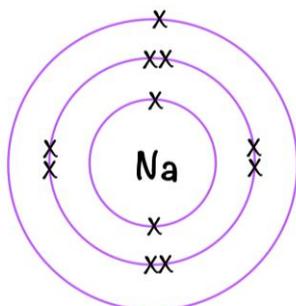
## Electronic Structures



# 10 Minutes on....

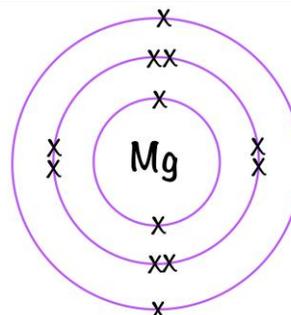
## Electronic Structures

**Sodium**



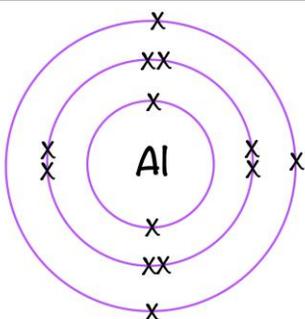
2,8,1

**Magnesium**



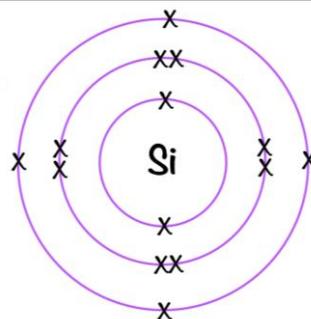
2,8,2

**Aluminium**



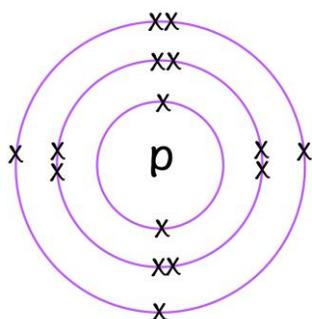
2,8,3

**Silicon**



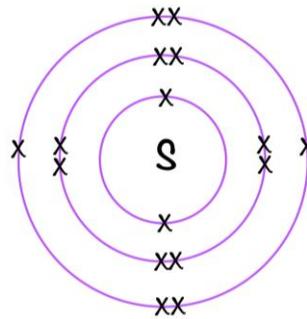
2,8,4

**Phosphorus**



2,8,5

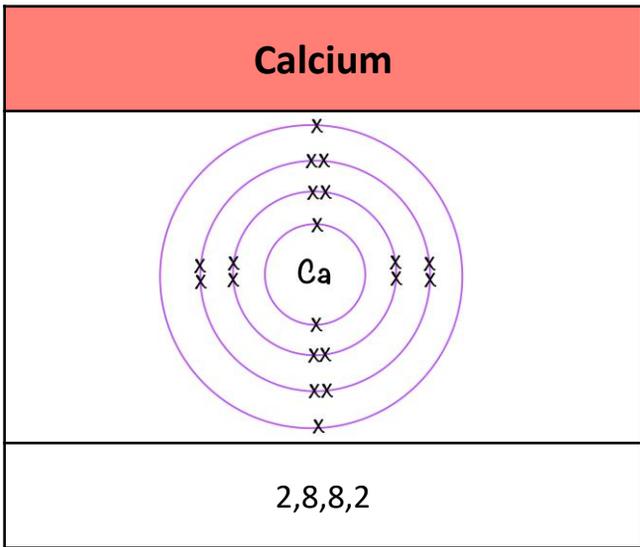
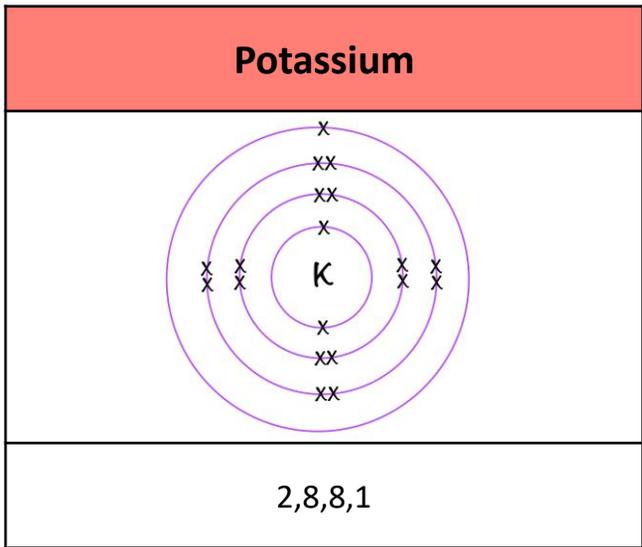
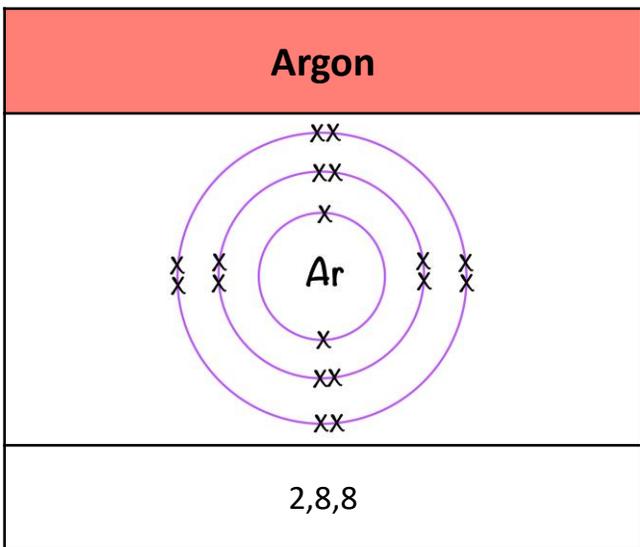
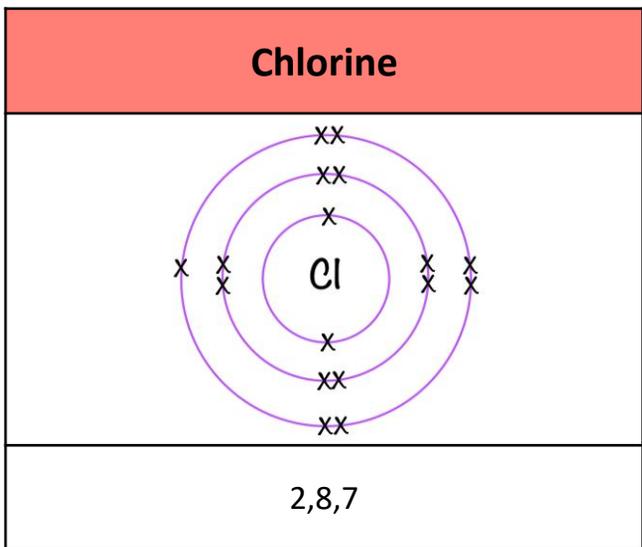
**Sulfur**



2,8,6

# 10 Minutes on....

## Electronic Structures



# 10 Minutes on....

## Periodic Table

Key Term	Definition
Periodic Table	A table of the chemical elements arranged in order of atomic number.

### **How elements in the periodic table are arranged.**

The elements in the periodic table are arranged in order of atomic (proton) number in rows known as periods. Elements with similar properties are in columns, known as groups. The table is called a periodic table because similar properties occur at regular intervals.

### **Why elements in the same group have similar chemical properties.**

Elements in the same group in the periodic table have the same number of electrons in their outer shell and this gives them similar chemical properties.

### **What the position of an element in the periodic table tells you about its electron configuration.**

An element's position in the periodic table tells you a lot about its electronic structure. The period it is in (row) tells you how many shells the atom has. For example, lithium is in period 2, this means Lithium must have 2 shells. The group that the element is in tells you how many electrons are in its outer shell. For example, lithium is in group 1, this means it has 1 electron in its outermost shell while chlorine is in group 7, this means it has 7 electrons in its outer shell.

# 10 Minutes on....

## Development of the Periodic Table

### How elements were arranged before the periodic table.

Before the discovery of protons, neutrons and electrons, scientists attempted to classify the elements by arranging them in order of their atomic weights.

Problems in The Early Periodic Table	How Mendeleev Overcame This Problem
Incomplete	He left gaps for undiscovered elements.
Some elements were in inappropriate groups and did not have properties that were like other chemicals in the same group.	He changed the order of some of the elements when arranging them based on atomic weight.

### Why over time Mendeleev's periodic table was accepted.

Eventually Mendeleev's table was accepted. This is because elements with properties predicted by Mendeleev were discovered and filled the gaps. Knowledge of isotopes made it possible to explain why the order based on atomic weights was not always correct.

### How elements are now ordered in the periodic table.

Elements are now arranged in order of atomic number in the modern periodic table.

# 10 Minutes on....

## Metals and Non-Metals

Type of Element	Description	Where Found on the Periodic Table
Metal	An element that reacts to form a positive ion.	To the right and towards the top of the periodic table.
Non-Metal	An element that reacts and forms a negative ion.	To the left and bottom of the periodic table.

### Comparing the properties of metals and non-metals.

Metals are good conductors of electricity and heat while non-metals tend to be poor conductors. The reactivity of metals increases down the group while the properties of non-metals decreases down the group.

### How the atomic structure of metals and non-metals relates to their position on the periodic table.

Metals are found in groups 1,2 and 3 of the periodic table. This means that they tend to have 1,2 or 3 electrons in their outermost shell and so their outer shell is less than half full. This means that metals lose electrons to obtain a full outer shell and so form positive ions. Non-metals are found in groups 5,6,7 and 0 and so non-metals will have outermost shells with 5,6,7 electrons (or in group 0 the outermost shell will be full). This means non-metals have electron shells that are more than half full and so to obtain a full outer shell they will gain electrons. This means that they will form negative ions.

# 10 Minutes on....

Group 0

Key Term	Definition
Noble Gas	Elements in group 0 of the periodic table.

## Properties of the noble gases.

The noble gases have a low boiling point which increases with increasing relative atomic mass. So, as you go down the group the boiling point increases. This is because as you go down the group the atoms become larger and the forces between the atoms become stronger and so more energy is needed to overcome these forces. Noble gases are not flammable because of how unreactive they are. The particles in a noble gas are also quite far apart and so they have low densities.

## Why noble gases are not reactive.

All of the noble gases have stable arrangements of electrons because they all have a full outer shell. Helium has 2 electrons in its outer shell, while the rest of the noble gases have 8 in their outer shell. The noble gases having a full outer shell means that they are all very unreactive, this is because they are unable to lose or gain electrons. Unreactive noble gases are otherwise known as inert. Noble gases do not form molecules easily and so they are usually monatomic. Monatomic means that they are made up of just one atom.

## Identify what happens to boiling point of the noble gases going down the group.

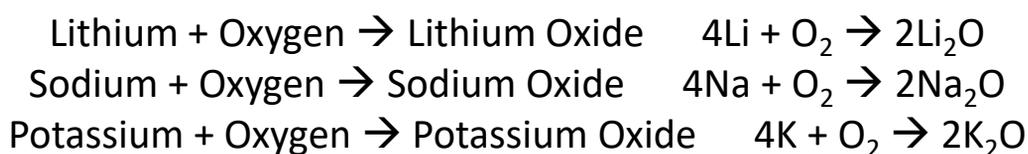
The boiling point of noble gases increases as you go down the group.

# 10 Minutes on....

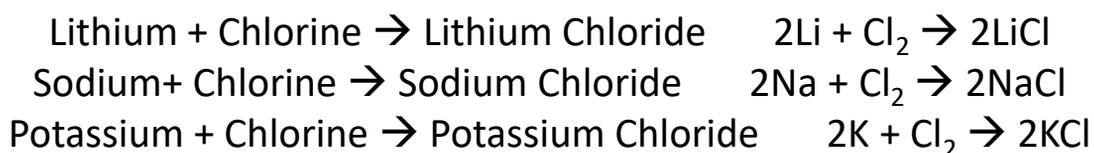
Group 1

Key Term	Definition
Alkali Metals	Metals found in group 1 of the periodic table.

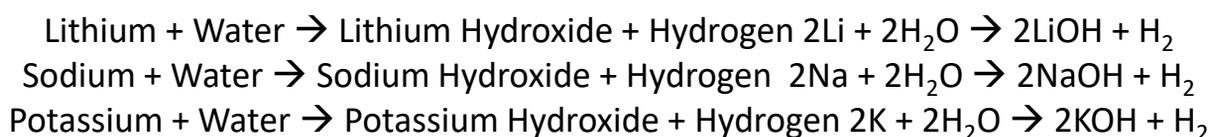
**Word and symbol equations to model the reaction between the first three alkali metals and oxygen.**



**Word and symbol equations to model the reaction between the first three alkali metals and chlorine.**



**Word and symbol equations to model the reaction between the first three alkali metals and water.**



# 10 Minutes on....

Group 7

Key Term	Definition
Halogens	An element found in group 7 of the periodic table.
Displacement	A chemical reaction in which a more reactive element displaces a less reactive element from a compound and takes its place.

Halogen	Formula	Appearance at Room Temperature
Fluorine	F <sub>2</sub>	Pale yellow gas
Chlorine	Cl <sub>2</sub>	Green gas
Bromine	Br <sub>2</sub>	Orange liquid
Iodine	I <sub>2</sub>	Grey solid forms a purple vapour when warmed. It is brown when a liquid

**What happens to melting and boiling point of the halogens as you go down the group.**

Melting point and boiling point increases as you go down the group.

**What determines the properties of elements in Group 7.**

The properties of elements in group 7 are due to the 7 electrons in their outermost shell. This explains why elements in group 7 all have similar properties.

# 10 Minutes on....

## Group 1 and 7 Reactivity

**What happens to the reactivity of group 1 elements as you go down the group.**

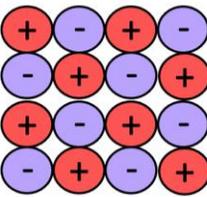
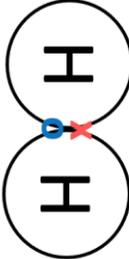
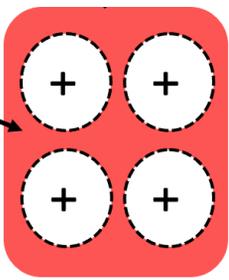
1. As you go down the group the atom becomes bigger
2. The atoms have more shells
3. The outermost electrons are further away from the nucleus
4. There is a weaker attraction between the outmost electrons and the nucleus.
5. The electrons in the outer shell are more easily lost.

**What happens to the reactivity of group 7 elements as you go down the group.**

1. As you go down the group the atom becomes bigger
2. The atoms have more shells
3. The outermost electrons are further away from the nucleus
4. There is a weaker attraction between the outmost electrons and the nucleus.
5. The electrons in the outer shell are harder to gain.

# 10 Minutes on....

## Chemical Bond

Type of Bond	What Happens to Electrons	When Bond Occurs	Diagram	Example
Ionic	Electrons are exchange.	Between metals and non-metals		Sodium Chloride, Magnesium Oxide
Covalent	Pairs of electrons are shared.	Between non-metals.		Diamond, Graphite, Oxygen, Hydrogen
Metallic	Delocalised electrons are shared.	Between metals		Aluminium, Gold, Silver



# 10 Minutes on....

## Ionic Bonding

Key Term	Definition
Ionic Bond	An electrostatic force of attraction between oppositely charged ions.
Ion	A charged particle formed when an atom gains or loses electrons.

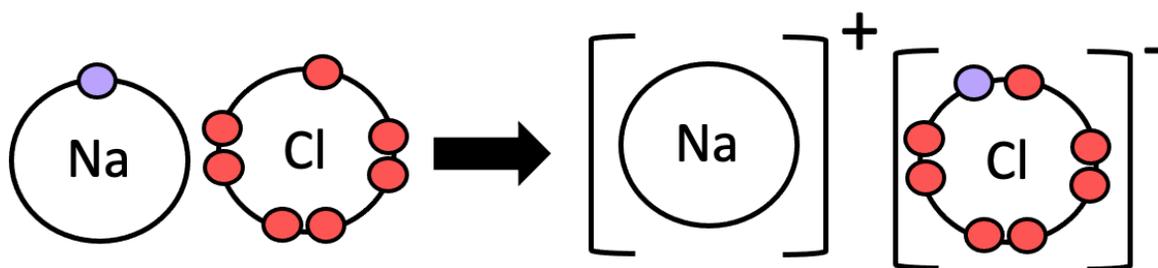
Group	Ion Formed
1	+1
2	+2
6	-2
7	-1

### How to determine the charge an ion will form.

The charge on the ions produced by metals in Groups 1 and 2 and by non-metals in Groups 6 and 7 relates to the group number of the element in the periodic table.

### Modelling the formation of ionic compounds

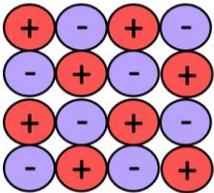
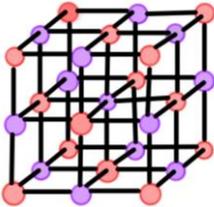
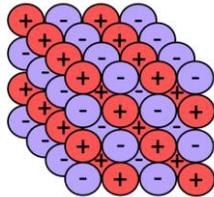
The sodium atom will lose an electron to form a +1 (positive) ion while chlorine will gain one electron to form a -1 (negative) chloride ion. The opposite charges will attract forming an ionic bond between the ions.



# 10 Minutes on....

## Ionic Compounds

Key Term	Definition
Ionic Compound	A giant structure of ions held together by electrostatic forces.

Model of An Ionic Compound	Diagram	Limitations of Model
2D Diagram		Does not show how each of the ions is arranged within the 3D structure.
Ball and Stick		Using sticks for bonds is misleading as the forces of attraction act in all directions. It shows lots of free space between the ions which there isn't.
3D Diagram		It does not show the forces of attraction between the ions.

### Structure and bonding of an ionic compound.

An ionic compound is a giant structure of ions. Ionic compounds are held together by strong electrostatic forces of attraction between oppositely charged ions. These forces act in all directions in the lattice.

# 10 Minutes on....

## Covalent Bonding

Key Term	Definition
Covalent Bond	When atoms share pairs of electrons.

Small Covalent Molecules	Giant Covalent Structures
Ammonia, Oxygen, Water, Carbon Dioxide, Hydrogen, Nitrogen, Hydrogen Chloride, Methane.	Diamond, Graphite, Silicon Dioxide

Molecule	Formula	Dot Cross Diagram
Hydrogen	H <sub>2</sub>	
Chlorine	Cl <sub>2</sub>	
Oxygen	O <sub>2</sub>	
Nitrogen	N <sub>2</sub>	
Hydrogen Chloride	HCl	
Water	H <sub>2</sub> O	
Ammonia	NH <sub>3</sub>	
Methane	CH <sub>4</sub>	

# 10 Minutes on....

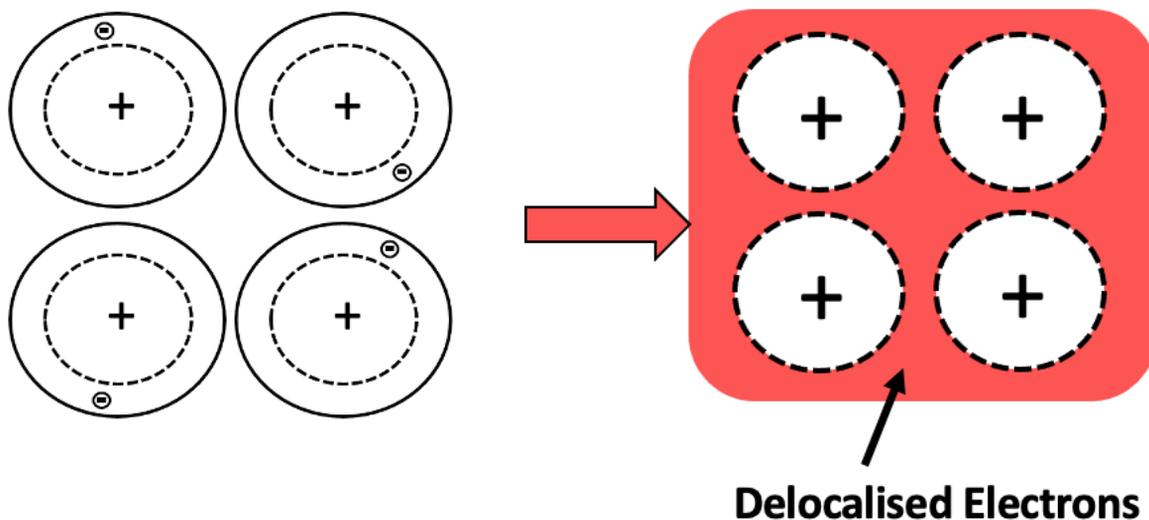
## Metallic Bonding

Key Term	Definition
Metallic Bond	The sharing of delocalised electrons.

### How metallic bonds form.

The electrons in the outer shell of metal atoms are delocalised and so are free to move through the whole structure. The sharing of delocalised electrons gives rise to strong metallic bonds.

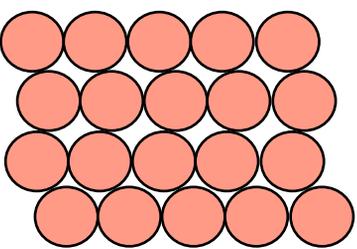
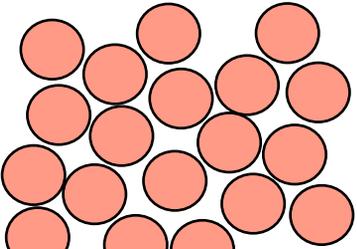
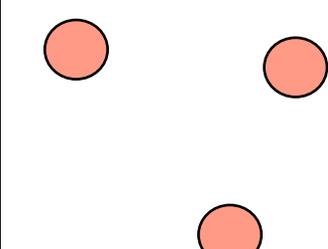
### Modelling the formation of metallic bonds.



# 10 Minutes on....

## 3 States of Matter

Key Term	Definition
Melting Point	The temperature at which a solid becomes a liquid and liquids become solids.
Boiling Point	The temperature at which a liquid becomes a gas and gases become a liquid.

	Solid	Liquid	Gas
Particle Models			

State of Matter	Symbol
Solid	(s)
Liquid	(l)
Gas	(g)
Aqueous Solution	(aq)

**Limitations of the particle models above.**  
Limitations of the models include that in the model there are no forces, that all particles are represented as spheres and that the spheres are solid.

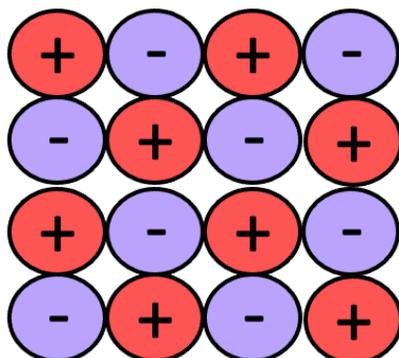
**What the amount of energy needed to change state depends on.**  
The amount of energy needed to change state from solid to liquid and from liquid to gas depends on the strength of the forces between the particles of the substance. The nature of the particles involved depends on the type of bonding and the structure of the substance. The stronger the forces between the particles the higher the melting point and boiling point of the substance.

# 10 Minutes on....

## Properties of Ionic Compounds

### Structure and bonding of ionic compounds.

Ionic compounds have regular structures (giant ionic lattices) in which there are strong electrostatic forces of attraction in all directions between oppositely charged ions.



Property	Explanation
High Melting and Boiling Point	Ionic compounds contain lots of strong ionic bonds. It takes lots of energy to overcome these bonds and so ionic compounds have high melting and boiling points.
Do Not Conduct Electricity When Solid	When solid the ions are vibrating in fixed positions. They are unable to move freely and so as a solid ionic compounds cannot conduct electricity.
Conducts Electricity When Melted or Dissolved	When dissolved or molten the ions are able to move freely and so able to conduct electricity.

# 10 Minutes on....

## Properties of Small Molecules

### What happens when small molecules change state.

When small molecules change state the intermolecular forces between the molecules are overcome.

### What happens to boiling point when the size of the molecule increases.

The intermolecular forces increase with the size of the molecules, so larger molecules have higher melting and boiling points.

Property	Explanation
Low Melting and Boiling Point	The intermolecular bonds between the particles are weak. It does not take much energy to overcome these weak bonds and so small molecules with covalent bonds have low melting and boiling points.
Do Not Conduct Electricity	Small molecules do not have an overall charge or charged particles that can separate and so are unable to conduct electricity.

# 10 Minutes on....

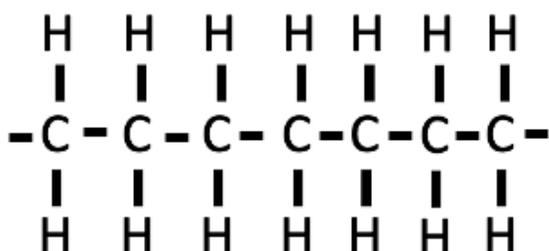
## Polymers

Key Term	Definition
Polymers	Large molecules in which the atoms are linked by other strong bonds.

### How atoms in a polymer are bonded together.

Polymers have very large molecules. The atoms in the polymer molecules are linked to other atoms by strong covalent bonds.

### Modeling a polymer.



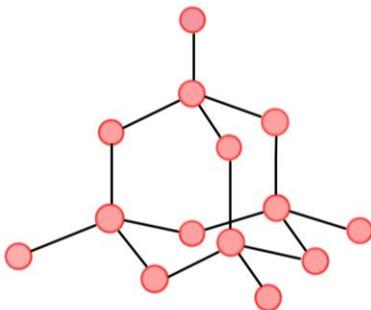
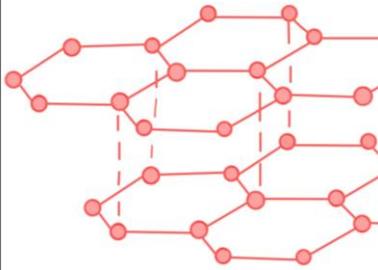
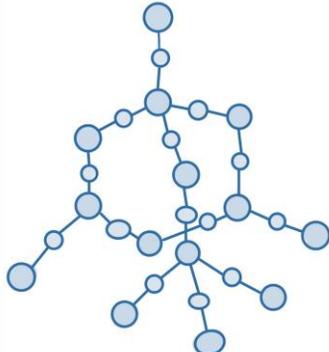
### Why polymers are solids at room temperature.

The intermolecular forces between polymer molecules are relatively strong and so these substances are solids at room temperature.

# 10 Minutes on....

## Giant Covalent Structures

Key Term	Definition
Giant Covalent Structure	Large structures in which the atoms are linked together by covalent bonds. They are all solids with very high melting points.

	Diamond	Graphite	Silicon Dioxide
Diagrams			

### Why giant covalent structures have high melting and boiling points.

Substances that consist of giant covalent structures are solids with very high melting points. All of the atoms in these structures are linked to other atoms by strong covalent bonds. These bonds must be overcome to melt or boil these substances. As the bonds are so strong it will take a lot of energy to overcome and break these bonds. As a result, giant covalent structures have high melting and boiling points.

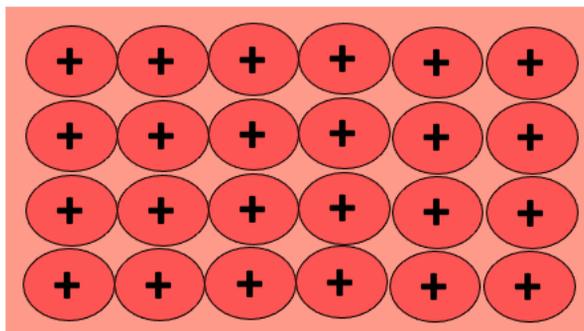
# 10 Minutes on....

## Properties of Metals And Alloys

Key Term	Definition
Metallic Bond	The sharing of delocalised electrons.

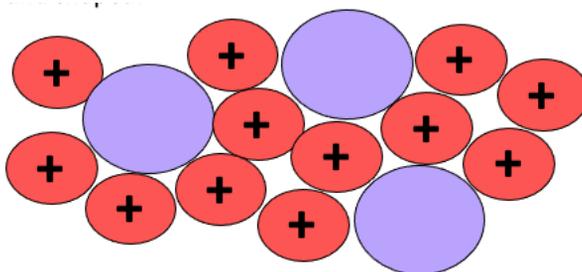
### Why metals can be bent and shaped.

In pure metals, atoms are arranged in layers, which allows metals to be bent and shaped.



### Why alloys are harder than pure metals.

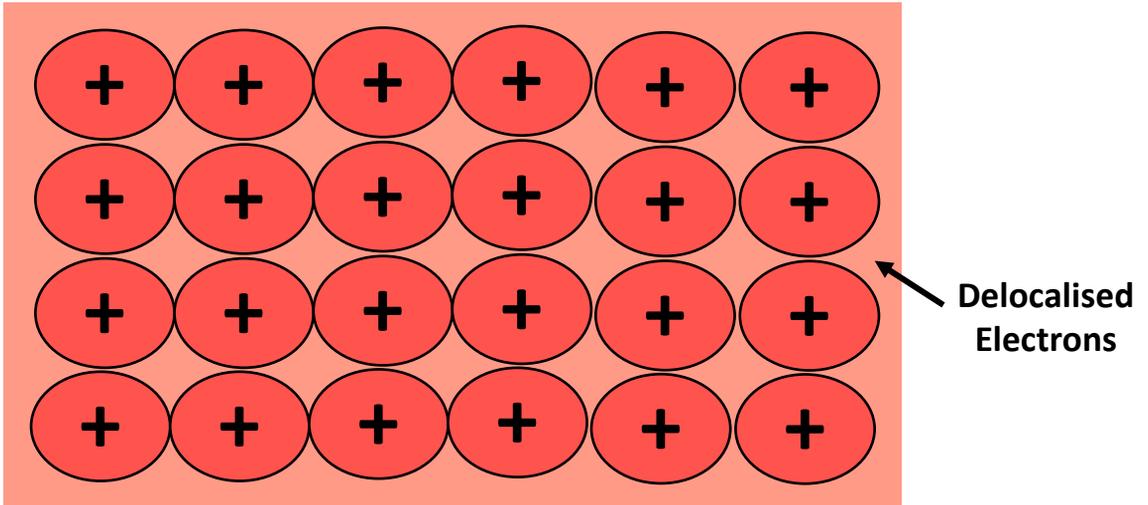
Pure metals are too soft for many uses and so are mixed with other metals to make alloys which are harder. Alloys are harder because the introduction of another element to the metal distorts the regular layers of atoms.



# 10 Minutes on....

## Metals as Conductors

### Modeling electronic bonding.



### Why metals are good conductors of electricity.

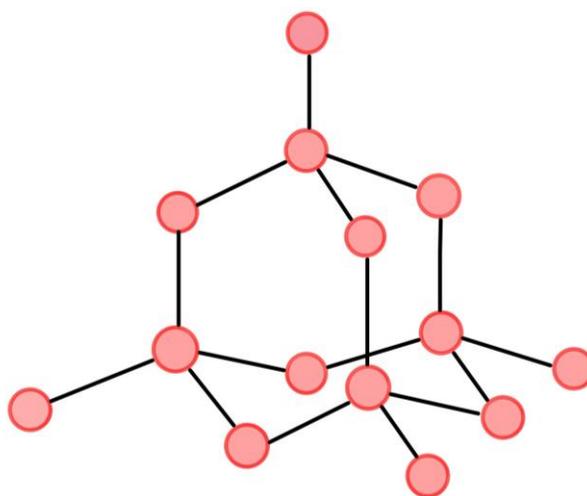
Metals are good conductors of electricity because the delocalised electrons in the metal carry electrical charge through the metal.

### Why metals are good conductors of thermal energy.

Metals are good conductors of thermal energy because energy is transferred by the delocalised electrons.

### Structure and bonding of diamond.

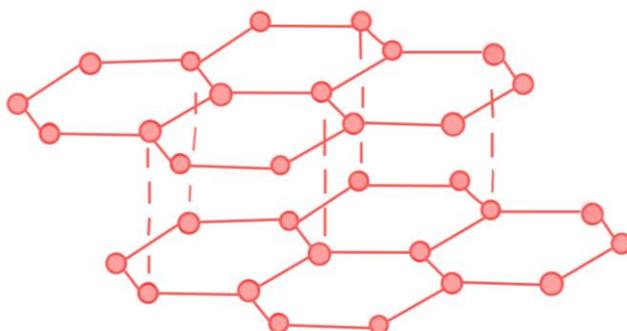
In diamond, each carbon atom forms four covalent bonds with other carbon atoms in a giant covalent structure.



Property	Explanation
High Melting and Boiling Point	The covalent bonds between the carbon atoms are very strong. This means that it takes a lot of energy to overcome these bonds and so diamond has a high melting and boiling point.
Hard	Each carbon atom is covalently bonded to 4 other carbon atoms. The strong covalent bonds and rigid structure mean that diamond is very hard.
Doesn't Conduct Electricity	Diamond does not have any delocalised electrons and so it is unable to conduct.

### Structure and bonding of graphite.

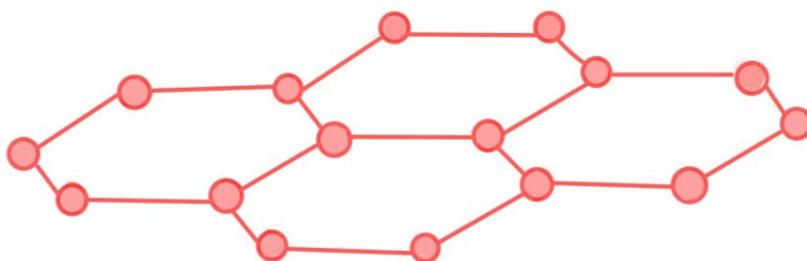
In graphite, each carbon atom forms three covalent bonds with three other carbon atoms, forming layers of hexagonal rings which have no covalent bonds between the layers. Graphite has one electron from each carbon atom is delocalised.



Property	Explanation
High Melting and Boiling Point	The covalent bonds between the carbon atoms are very strong. This means that it takes a lot of energy to overcome these bonds and so graphite has a high melting and boiling point.
Soft	The intermolecular bonds between the graphite layers are weak. This means that the layers can slide over each other easily making the material soft.
Conducts Electricity	It has delocalised electrons which can move freely.

### Structure and bonding of graphene.

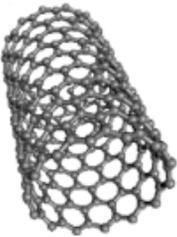
Graphene is a single layer of graphite and so it is made up of carbon atoms that form three covalent bonds with three other carbon atoms, forming a layer of hexagonal rings.



Property	Explanation
High Melting and Boiling Point	The bonds between the carbon atoms are very strong which takes a lot of energy to overcome.
Very Strong	It has a large regular arrangement of carbon atoms joined together covalently which gives graphene its strong structure.
Conducts Electricity	It has delocalised electrons which can move freely.

# 10 Minutes on....

## Graphene and Fullerenes

Material	Structure and Bonding	Properties	Diagram	Uses
Graphene	Single layer of graphite with strong covalent bonds between the C atoms.	High melting and boiling points. Good electrical conductivity. Very strong Lightweight Transparent		Solar Cells, Electronics and Composites
Fullerenes	Hexagonal rings of carbon atoms joined together with covalent bonds. It is in a spherical hollow shape.	Conduct Electricity Slippery		Electronics
Carbon Nanotubes	Cylindrical fullerenes.	High tensile strength Conduct electricity		Nanotechnology and Electronics.

# 10 Minutes on....

## Conservation of Mass

Key Term	Definition
Law of Conservation of Mass	A law that states that no atoms are lost or made during a chemical reaction and so the mass of the products equals the mass of the reactants.

### Why chemical equations must be balanced.

The law of conservation of mass states that no atoms are lost or made during a chemical reaction and so the mass of the products equals the mass of the reactants. This means that chemical reactions can be represented by symbol equations which are balanced in terms of the numbers of atoms of each element involved on both sides of the equation.

**Explaining why when balancing the equation:  $\text{CH}_4 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$  the following would be incorrect:  $\text{CH}_4 + \text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}_2$**

Within the equation a subscript 2 has been added to the water molecule changing it from  $\text{H}_2\text{O}$  (water) to  $\text{H}_2\text{O}_2$  (hydrogen peroxide). When balancing equations, you cannot change the formula itself and so can't add subscript numbers. You can only add multipliers. The correct balanced equation would be:



# 10 Minutes on....

## RFM

Key Term	Definition
Relative Formula Mass	The sum of the relative atomic masses of the atoms in the numbers shown in the formula.

Substance	Formula	RFM
Water	H <sub>2</sub> O	$(2 \times 1) + 16 = 18$
Carbon Dioxide	CO <sub>2</sub>	$12 + (2 \times 16) = 44$
Methane	CH <sub>4</sub>	$12 + (4 \times 1) = 16$

Task	Mass of Substance	RFM of molecule	(Mass of Substance / RFM) x 100	Answer
Determine the % mass of C in CO <sub>2</sub>	C = 12	44	$(12/44) \times 100$	27.3%
Determine the % mass of O in CO <sub>2</sub>	O = $(16 \times 2) = 32$	44	$(32/44) \times 100$	72.7%
Determine the % mass of H in H <sub>2</sub> O	H = $(2 \times 1) = 2$	18	$(2/18) \times 100$	11.1%
Determine the % mass of O in H <sub>2</sub> O	O = 16	18	$(16/18) \times 100$	88.9%
Determine the % mass of H in CH <sub>4</sub>	H = $(4 \times 1) = 4$	16	$(4/16) \times 100$	25%

# 10 Minutes on....

## Mass Changes

Key Term	Definition
Law of Conservation of Mass	A law that states that no atoms are lost or made during a chemical reaction and so the mass of the products equals the mass of the reactants.

### **Why mass may appear to increase during a chemical reaction.**

Mass may appear to increase when one of the reactants in a non enclosed system is a gas and its mass has not been taken into account. For example, when magnesium reacts with oxygen to form magnesium oxide mass may appear to increase.

### **Why mass may appear to decrease during a chemical reaction.**

Mass may appear to decrease when one of the products in a non enclosed system is a gas and it escapes into the atmosphere. For example, during the thermal decompositions of metal carbonates carbon dioxide is produced and escapes into the atmosphere leaving the metal oxide as the only solid product.

# 10 Minutes on....

## Chemical Measurements

Key Term	Definition
Uncertainty	The interval within which the true value of a quantity is.
Resolution	The smallest change in a quantity that gives a change in the reading of a measuring instrument.

### How to calculate uncertainty from repeat measurements.

1. Find the range of the results
2. Divide by 2

<b>Calculate uncertainty for the following data:</b>	15cm, 17cm, 14cm, 18cm, 13cm	31°C, 28°C, 33°C, 31°C, 27°C	231m, 233m, 245m, 244m, 244m	4.2N, 4.3N, 4.2N, 4.6N, 4.3N
Determine the range.	$18-13 = 5$	$33-27 = 6$	$244-231 = 13$	$4.6-4.2 = 0.4$
Divide by 2	$5 / 2 = 2.5$	$6 / 2 = 3$	$13 / 2 = 6.5$	$0.4 / 2 = 0.2$
State answer with units.	$\pm 2.5\text{cm}$	$\pm 3^\circ\text{C}$	$\pm 6.5\text{m}$	$\pm 0.2\text{N}$

### How to determine the uncertainty of measuring instruments.

1. Identify the resolution of the apparatus.
2. Divide by 2

<b>Determine uncertainty for the following apparatus:</b>	Thermometer with a resolution of $1^\circ\text{C}$	Ruler with a resolution of 1mm	Balance with a resolution of 0.01g	Beaker with a resolution of $20\text{cm}^3$
Divide resolution by 2.	$1 / 2 = \pm 0.5^\circ\text{C}$	$1 / 2 = \pm 0.5\text{mm}$	$0.01 / 2 = \pm 0.005\text{g}$	$20 / 2 = \pm 10\text{cm}^3$

# 10 Minutes on....

## Moles

Key Term	Definition
Mole	The unit for chemical amounts.
Avogadro Constant	The number of atoms, molecules or ions in a mole of substance. The value is $6.02 \times 10^{23}$ per mole.

Question	Calculate the mass of 0.25mol of $\text{CO}_2$ .	Calculate the mass of 2 mol of $\text{H}_2\text{O}$ .	Calculate the mass of 2.8 mol of $\text{NaCl}$ .	Calculate the mass of 0.2 mol of $\text{H}_2$ .
Calculate the RFM of the molecule	44	18	58.5	2
Multiply the RFM by the number of moles	$44 \times 0.25$	$18 \times 2$	$58.5 \times 2.8$	$2 \times 0.2$
State answer with units.	11g	36g	163.8g	0.4g

Question	Calculate the number of moles in 22g of $\text{CO}_2$	Calculate the number of moles in 14g of $\text{H}_2\text{O}$	Calculate the number of moles in 64mg of $\text{MgCO}_3$	Calculate the number of moles in 12mg of $\text{NaCl}$
Check for unit conversions.	-	-	$64\text{mg} = 0.064\text{g}$	$12\text{mg} = 0.012\text{g}$
Calculate the RFM	44	18	84	58.4
Divide the mass by the RFM	$22/44$	$14/18$	$0.064/84$	$0.012 / 58.4$
Round	0.5moles	0.78moles	$7.6 \times 10^{-4}$	$2.1 \times 10^{-4}$

# 10 Minutes on....

## Amounts of Substances in Equations



Within this reaction there is 1 mole of magnesium reacting with 2 moles of hydrochloric acid. 1 mole of magnesium chloride and 1 mole of hydrogen is made.

For the equation above...

Question	Calculate the mass of H <sub>2</sub> produced if an excess of acid is added to 100g of Mg.	Calculate the mass of Mg that will be needed to produce 250g of magnesium chloride.	Calculate the mass of MgCl <sub>2</sub> produced if an excess of acid is added to 1.5kg of Mg.
Check for unit conversions.	-	-	1.5kg = 1500g
Calculate the RFM of the chemicals in the question.	H <sub>2</sub> = 2 Mg = 24	Mg = 24 MgCl <sub>2</sub> = 95	Mg = 24 MgCl <sub>2</sub> = 95
Divide the known mass by the RFM of that substance.	100/24	250/95	1500 / 24
Multiply by the RFM of the other substance.	(100 / 24) x 2	(250 / 95) x 24	(1500 / 24) x 95
State answer to correct number of sig fig.	8.33333 = 8.3g	63.1578947368 = 63.1g	5,937.5g

# 10 Minutes on....

## Using Moles To Balance Equations

### How the balancing number in a symbol equation can be calculated.

The balancing numbers in a symbol equation can be calculated from the masses of reactants and products by converting the masses in grams to amounts in moles and converting the numbers of moles to simple whole number ratios.

Reactants	Products	Mole Calculations	Ratio	Balanced Symbol Equation
Mg = 24g O <sub>2</sub> = 16g	MgO = 40g	Mg = 1 mole O <sub>2</sub> = 0.5 mole MgO = 1 mole	1:0.5:1 2:1:2	2Mg + O <sub>2</sub> → 2MgO
BeCl <sub>2</sub> = 40g K = 39g	KCl = 74.5g Be = 4.5g	BeCl <sub>2</sub> = 0.5mol K = 1 mol KCl = 1mol Be = 0.5mol	0.5:1:1:0.5 1:2:2:1	BeCl <sub>2</sub> + 2K → 2KCl + Be
P <sub>4</sub> = 124g O <sub>2</sub> = 160g	P <sub>4</sub> O <sub>10</sub> = 284g	P <sub>4</sub> = 1mol O <sub>2</sub> = 5mol P <sub>4</sub> O <sub>10</sub> = 1 mol	1:5:1	P <sub>4</sub> + 5O <sub>2</sub> → P <sub>4</sub> O <sub>10</sub>
H <sub>2</sub> = 12g O <sub>2</sub> = 96g	H <sub>2</sub> O = 108g	H <sub>2</sub> = 6 mol O <sub>2</sub> = 3 mol H <sub>2</sub> O = 6 mol	6:3:6 2:1:2	2H <sub>2</sub> + O <sub>2</sub> → 2H <sub>2</sub> O
Al = 27g O <sub>2</sub> = 12g	Al <sub>2</sub> O <sub>3</sub> = 51g	Al = 1 mol O <sub>2</sub> = 0.75 mol Al <sub>2</sub> O <sub>3</sub> = 0.5 mol	1:0.75:0.5 4:3:2	4Al + 3O <sub>2</sub> → 2Al <sub>2</sub> O <sub>3</sub>

# 10 Minutes on....

## Limiting Reactants

Key Term	Definition
Limiting Reactant	The reacting substance that is completely used up in a chemical reaction and which determines how much product is made.

For the questions below use the equation:  $2\text{Al} + \text{Fe}_2\text{O}_3 \rightarrow 2\text{Fe} + \text{Al}_2\text{O}_3$

<b>Determine the limiting factor when....</b>	1.00kg of aluminium is mixed with 3.00kg of iron oxide.	1.50kg of aluminium is mixed with 3.00kg of iron oxide.	1.58kg of aluminium is mixed with 8.54kg of iron oxide.
Convert units.	1.00kg = 1000g 3.00kg = 3000g	1.50kg = 1500g 3.00kg = 3000g	1.58kg = 1580g 8.54kg = 8540g
Calculate RFM's	$\text{Fe}_2\text{O}_3 = (56 \times 2) + (16 \times 3) = \underline{160}$	$\text{Fe}_2\text{O}_3 = (56 \times 2) + (16 \times 3) = \underline{160}$	$\text{Fe}_2\text{O}_3 = (56 \times 2) + (16 \times 3) = \underline{160}$
Calculate No of Moles of Reactant 1	$1000/27 = 37.0$ moles	$1500/27 = 55.6$ moles	$1580 / 27 = 58.5$ moles
Calculate No of Moles of Reactant 2	$3000/160 = 18.75$ moles	$3000/160 = 18.75$ moles	$8540 / 160 = 53.3$ moles
Determine the No of Moles Needed	18.75 moles of iron oxide needs $(18.75 \times 2)$ 37.5 moles of aluminium	18.75 moles of iron oxide needs $(18.75 \times 2)$ 37.5 moles of aluminium	53.3 moles of iron oxide needs $(53.3 \times 2)$ 106.6 moles of aluminium
Identify Limiting Reactant	Aluminium is the limiting reactant.	Iron oxide is the limiting reactant.	Aluminium is the limiting reactant.

# 10 Minutes on....

## Concentration of Solutions

Key Term	Definition
Concentration	The mass of a solute in a given volume of solution.

Quantity	Unit
Concentration	$\text{g/dm}^3$
Mass	g
Volume	$\text{dm}^3$

Equation that should be used to calculate concentration.

$$\text{Conc} = \text{Mass of Solute} / \text{Volume of Solution}$$

Calculate the conc. of...	300g of $\text{CuCl}_2$ dissolved in $1\text{dm}^3$ of water.	A solution of hydrochloric acid that contains 3.2g of hydrogen chloride in $50\text{cm}^3$	1g of copper sulfate dissolved in water to make $25\text{cm}^3$ of copper sulfate solution.
Convert Units	-	$50\text{cm}^3 = 0.05\text{dm}^3$	$25\text{cm}^3 = 0.025\text{dm}^3$
Divide Mass by Volume	$300/1$	$3.2/0.05$	$1/0.025$
State answer	300	64	40
Round and add units.	$300\text{g/dm}^3$	$64\text{g/dm}^3$	$40\text{g/dm}^3$

# 10 Minutes on....

## Metal Oxides

Key Term	Definition
Reduction	The loss of oxygen or gain of electrons.
Oxidation	The gain of oxygen or the loss of electrons.
Oxidation Reaction	A reaction in which a substance gains oxygen.

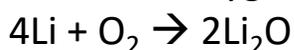
### Reaction between metals and oxygen.

Metals react with oxygen to produce metal oxides. The reactions are oxidation reactions because the metals gain oxygen.

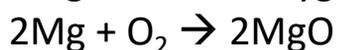
### Word and symbol equations for the reactions between the following metals and oxygen: Lithium, Magnesium, Aluminium

Ions each forms,  $\text{Li}^+$ ,  $\text{Mg}^{2+}$ ,  $\text{Al}^{3+}$ ,  $\text{O}^{2-}$

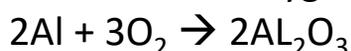
Lithium + Oxygen  $\rightarrow$  Lithium Oxide



Magnesium + Oxygen  $\rightarrow$  Magnesium Oxide



Aluminium + Oxygen  $\rightarrow$  Aluminium Oxide



# 10 Minutes on....

## Reactivity Series

Key Term	Definition
Reactivity	The tendency of an atom to form an ion.

### **Non-metals often included in the reactivity series.**

Hydrogen and carbon are the 2 non-metals included in the reactivity series.

### **What determines the reactivity of a metal.**

The reactivity of a metal is related to its tendency to form positive ions.

### **A method to deduce the order of reactivity of metals.**

The metals potassium, sodium, lithium, calcium, magnesium, zinc, iron and copper can be put in order of their reactivity from their reactions with water and dilute acids. You would add each to fixed volumes of water and dilute acid and record your observations. You could for example look for bubbles. The metals that produce lots of bubbles when added to water are the most reactive while the metals that produce very few bubbles when added to acid would be the least reactive.

# 10 Minutes on....

## Extraction of Metals

Key Term	Definition
Reduction	The loss of oxygen or gain of electrons.

### Unreactive metal found native on Earth.

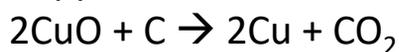
Gold is an unreactive metal found in its native state on Earth.

**How metals less reactive than carbon can be extracted from their oxides.** Metals less reactive than carbon can be extracted from their ores through reduction reactions.

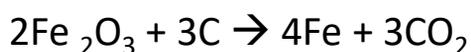
**Word equations and symbol equations to model the reactions between the following oxides and carbon:: Copper Oxide, Iron Oxide, Lead Oxide**

**Ions involved are  $\text{Cu}^{2+}$ ,  $\text{Pb}^{2+}$ ,  $\text{Fe}^{3+}$ ,  $\text{O}^{2-}$**

Copper Oxide + Carbon  $\rightarrow$  Copper + Carbon Dioxide



Iron Oxide + Carbon  $\rightarrow$  Iron + Carbon Dioxide



Lead Oxide + Carbon  $\rightarrow$  Lead + Carbon Dioxide



# 10 Minutes on....

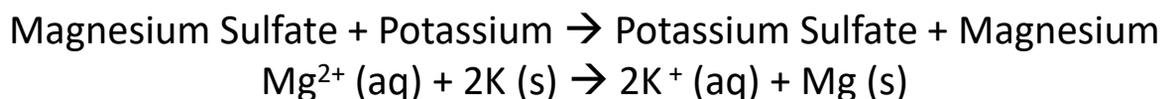
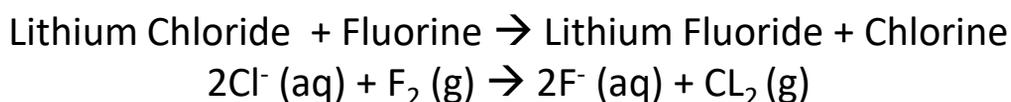
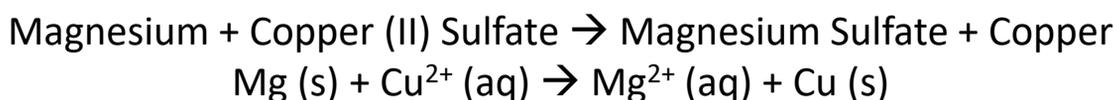
## Oxidation and Reduction

Key Term	Definition
Oxidation	The gain of oxygen or the loss of electrons.
Reduction	The loss of oxygen or gain of electrons.

**How to determine in a symbol equation which species are oxidised, and which are reduced.**

From the symbol equation identify the atoms that are losing electrons, this atom is being oxidised. To identify the atom being reduced identify the atoms that are gaining electrons.

**Ionic equations for the following displacement reactions:**



# 10 Minutes on....

## Reactions of Acids With Metals

**General word equation to show what happens when metals react with acids.**



Ions:  $\text{Mg}^{2+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Fe}^{3+}$ ,  $\text{SO}_4^{2-}$ ,  $\text{Cl}^-$

Metal	Acid	Word and Symbol Equations
Magnesium	Hydrochloric	Magnesium + Hydrochloric Acid $\rightarrow$ Magnesium Chloride + Hydrogen $\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$
Zinc	Hydrochloric	Zinc + Hydrochloric Acid $\rightarrow$ Zinc Chloride + Hydrogen $\text{Zn} + 2\text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2$
Iron	Hydrochloric	Iron + Hydrochloric Acid $\rightarrow$ Iron Chloride + Hydrogen $\text{Fe} + 6\text{HCl} \rightarrow 2\text{FeCl}_3 + 3\text{H}_2$
Magnesium	Sulfuric	Magnesium + Sulfuric Acid $\rightarrow$ Magnesium Sulfate + Hydrogen $\text{Mg} + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + \text{H}_2$
Zinc	Sulfuric	Zinc + Sulfuric Acid $\rightarrow$ Zinc Sulfate + Hydrogen $\text{Zn} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2$
Iron	Sulfuric	Iron + Sulfuric Acid $\rightarrow$ Iron Sulfate + Hydrogen $2\text{Fe} + 3\text{H}_2\text{SO}_4 \rightarrow \text{Fe}_2(\text{SO}_4)_3 + 3\text{H}_2$

# 10 Minutes on....

## Neutralisation of Acids

Key Term	Definition
Alkali	A base than can dissolve in water such as a soluble metal hydroxide.
Bases	A substance that can react with acids and neutralise them . Examples include insoluble metal hydroxides and metal oxides.
Neutralisation	A chemical reaction that occurs when an acid and base are mixed together.

**General word equation to show what happens when an acid reacts with a metal hydroxide.**



**General word equation to show what happens when an acid reacts with a metal oxide.**



**General word equation to show what happens when an acid reacts with a metal carbonate.**



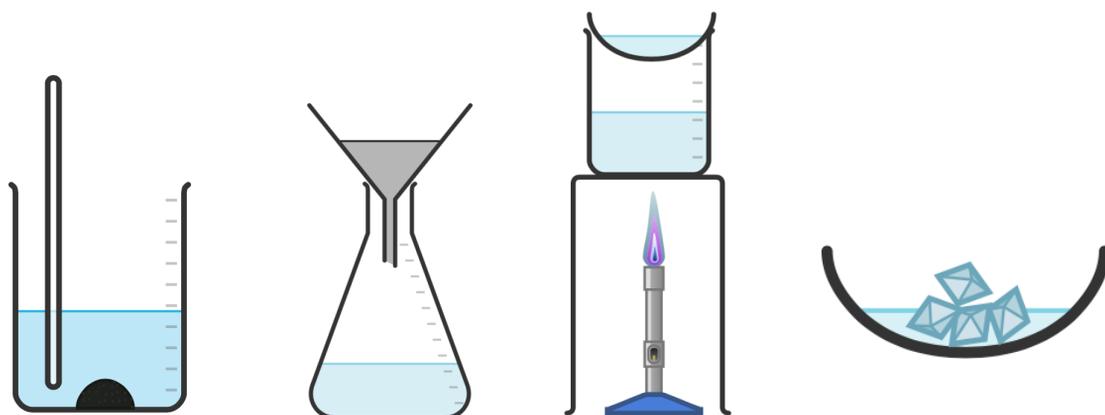
Acid	Type of Salt Formed
Hydrochloric	Chloride
Nitric	Nitrate
Sulfuric	Sulfate

# 10 Minutes on....

## Soluble Salts

### How to make a soluble salt.

*To make a salt you would add a base such as magnesium oxide in excess to warmed acid, for example, sulfuric acid. This would be stirred until no more magnesium oxide will react. To remove the excess magnesium oxide the solution should be filtered using a funnel and filter paper. The solution will then be warmed in an evaporating dish using a water bath to evaporate the water. As soon as crystals start to form the solution will be removed from the heat so that crystallisation can occur.*



### Why the solid should be added in excess.

The solid should be added in excess to ensure that all of the acid has reacted.

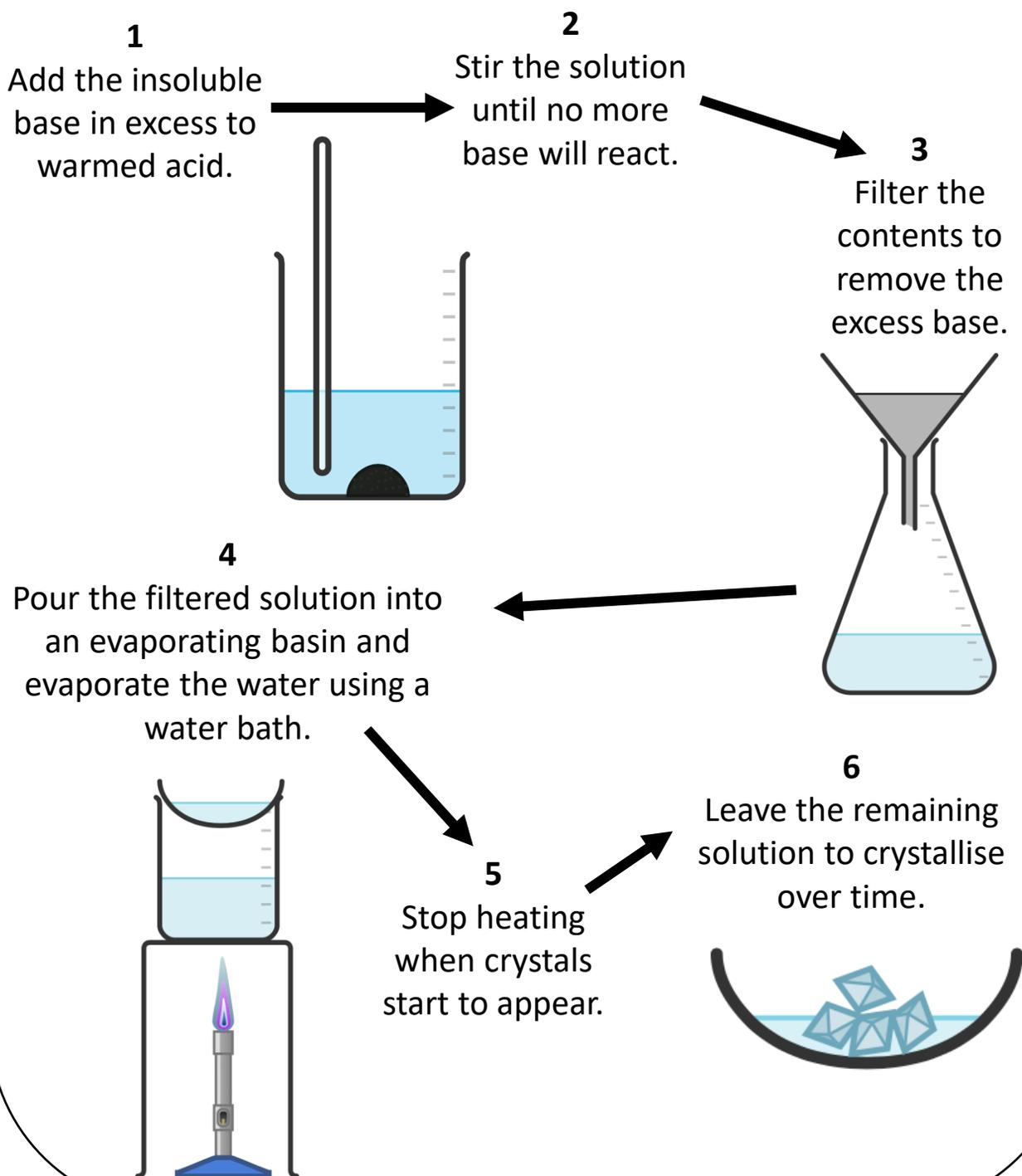
### Why the solution should be filtered.

The solution should be filtered to remove the insoluble unreacted base.

# 10 Minutes on....

## Making Salts RP

A method to prepare a pure, dry sample of a soluble salt.



# 10 Minutes on....

## pH Scale and Neutralisation

Key Term	Definition
pH Scale	A scale from 0-14 that is a measure of the acidity or alkalinity of a solution.
Universal Indicator	A chemical that can be used to determine pH
pH Probe	A device that can be used to measure pH
Hydrogen Ion	An ion that is produced by acids in aqueous solutions.
Hydroxide Ion	An ion that is produced by alkalis in aqueous solutions.

Type of Substance	pH
Acid	Less than 7
Neutral	7
Alkali	More than 7

### What happens during neutralisation in terms of ions.

In neutralisation reactions between an acid and an alkali, hydrogen ions react with hydroxide ions to produce water.

### How to use universal indicator to determine the pH of a substance.

To determine the pH of a solution you could add **universal indicator**. You would observe the colour that the indicator turned and use a chart to identify the pH. Alternatively, you could alternatively use a **pH probe** by dipping this into the solution and recording the value on the digital display.

# 10 Minutes on....

## Strong and Weak Acids

Key Term	Definition
Strong Acid	An acid that is completely ionised in aqueous solutions.
Weak Acid	An acid that is only partially ionised in aqueous solutions.
Dilute Acid	An acid in which the concentration of the water mixed in the acid is higher than the concentration of the acid itself.
Concentrated Acid	An acid in which the concentration of the water mixed in the acid is lower than the concentration of the acid itself.

Examples of Strong Acids	Examples of Weak Acids
Hydrochloric Acid Nitric Acid Sulfuric Acid	Ethanoic Acid Citric Acid Carbonic Acid

### The relationship between the strength of an acid and its pH

For a given concentration of aqueous solutions, the stronger an acid, the lower the pH.

### The relationship between pH and the hydrogen ion concentration.

As the pH decreases by one unit, the hydrogen ion concentration of the solution increases by a factor of 10.

# 10 Minutes on....

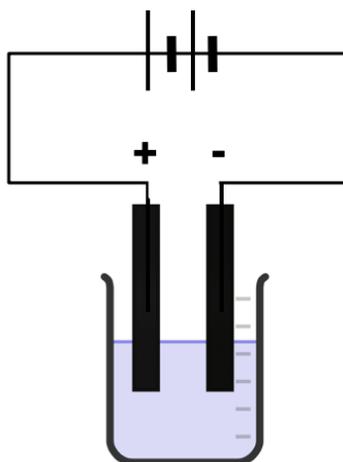
## Process of Electrolysis

Key Term	Definition
Electrolysis	The process by which ionic substances are broken down into simpler substances through the use of an electric current.
Electrolyte	A substance which, when molten or in solution, will conduct an electric current.

### Process of electrolysis.

When an ionic compound is melted or dissolved in water, the ions are free to move about within the liquid or solution. These liquids and solutions are able to conduct electricity and are called electrolytes. Passing an electric current through electrolytes causes the ions to move to the electrodes. Positively charged ions move to the negative electrode (the cathode), and negatively charged ions move to the positive electrode (the anode). Ions are discharged at the electrodes producing elements. This process is called electrolysis.

### A diagram to model the process of electrolysis.



# 10 Minutes on....

## Electrolysis of Molten Ionic Compounds

Key Term	Definition
Electrolysis	The process by which ionic substances are broken down into simpler substances through the use of an electric current.
Ionic Compound	A giant structure of ions held together by electrostatic forces.

### What happens during the electrolysis of lead bromide.

During electrolysis of lead bromide, the positive lead ions would move towards the negative electrode (cathode) At the cathode the lead ions would gain electrons and so lead would form on the cathode. The negative bromide ions would move towards the positive electrode (anode). At the anode, the bromide ions would lose electrons, react with other bromine atoms and form bromine molecules.

Molten Ionic Compound	Product at the Cathode	Product at the Anode
Zinc Chloride	Zinc	Chlorine
Aluminium Oxide	Aluminium	Oxygen
Zinc Bromide	Zinc	Bromine
Calcium Chloride	Calcium	Chlorine

# 10 Minutes on....

## Electrolysis to Extract Metals

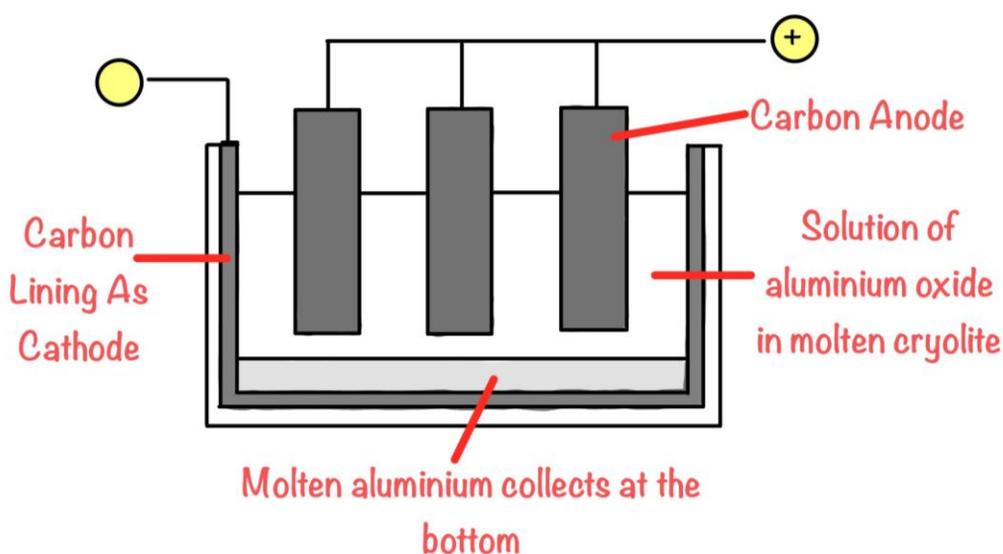
### When metals are extracted using electrolysis.

Metals can be extracted from molten compounds using electrolysis. Electrolysis is used if the metal is too reactive to be extracted by reduction with carbon or if the metal reacts with carbon.

### Wow aluminium is extracted using electrolysis.

The aluminium oxide is melted so that electricity can pass through it. To lower the melting point it is mixed with cryolite. The aluminium ions move towards the negative electrode. At the electrode the aluminium gains electrons forming aluminium atoms. The oxygen ions move towards the positive electrode, lose electrons and form oxygen atoms. The oxygen then reacts with the carbon electrodes forming carbon dioxide.

### Diagram to model the extraction of aluminium using electrolysis.



# 10 Minutes on....

## Electrolysis of Aqueous Solutions

### When hydrogen is produced at the cathode.

Hydrogen is produced at the cathode if the metal ion in the solution is more reactive than hydrogen.

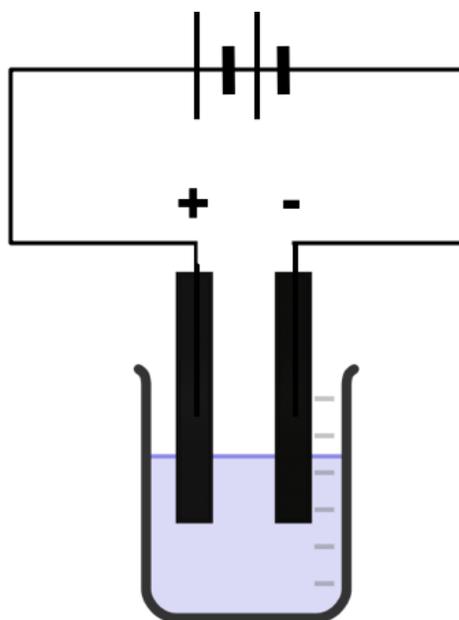
### When oxygen is produced at the anode.

Oxygen is made at the anode unless the solution contains halide ions. If the solution does contain halide ions, a halogen will form instead.

Aqueous Solution	Product at the Cathode	Product at the Anode	Justification
Calcium Chloride	Hydrogen	Chlorine	Calcium is more reactive than hydrogen and the solution contains halide ions.
Copper Bromide	Copper	Bromine	Copper less reactive than hydrogen and the solution contains halide ions.
Copper Sulfate	Copper	Oxygen	Copper less reactive than hydrogen and the solution didn't contain halide ions.
Potassium Sulfate	Hydrogen	Oxygen	Potassium more reactive than hydrogen and the solution didn't contain halide ions.
Copper Chromate	Copper	Oxygen	Copper less reactive than hydrogen and the solution didn't contain halide ions.
Zinc Chloride	Hydrogen	Chlorine	Zinc is more reactive than hydrogen and the solution contains halide ions.

A method to investigate what happens when aqueous solutions are electrolysed using inert electrodes

1. Set up equipment as shown in the diagram:



2. Add the test solution to the beaker.

3. Dip the electrodes attached to a power supply into the beaker to complete the circuit.

4. Observe and record what happens at the electrodes.

# 10 Minutes on....

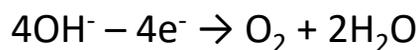
## Half Equations

Electrode	Definition	What Happens There in Terms of Electrons
Cathode	Negative Electrode	Positive ions gain electrons.
Anode	Positive Electrode	Negative ions lose electrons.

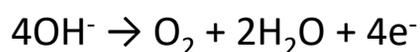
**Half equation to model what happens at the cathode.**



**Half equation to model what happens at the anode.**



Or



# 10 Minutes on....

## Energy Transfer During Reactions

Key Term	Definition	Example
Exothermic Reaction	Reaction in which energy is given out to the surroundings.	Combustion, Oxidation Reactions, Neutralisation
Endothermic Reaction	Reaction in which energy is taken in.	Thermal Decompositions

### Law of conservation of energy.

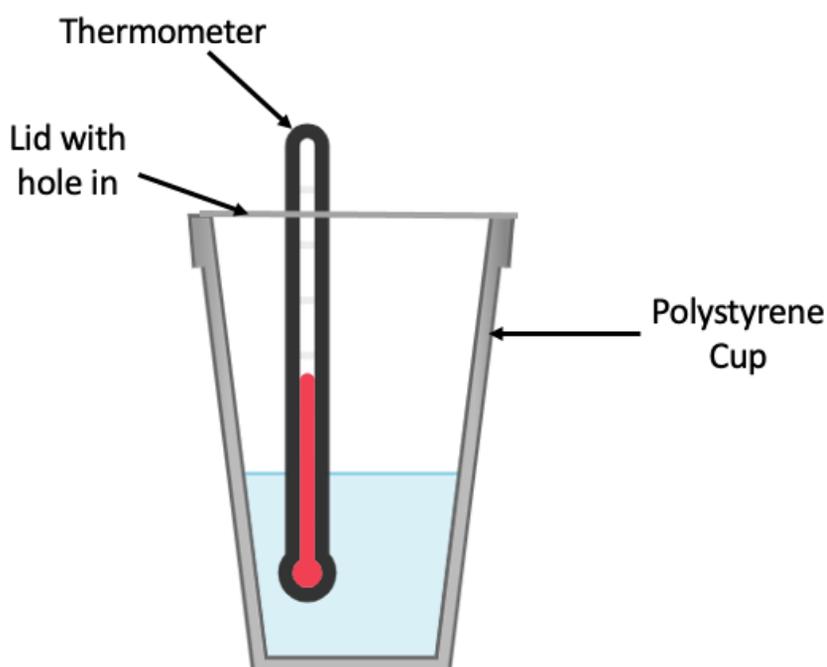
Energy is conserved in chemical reactions. The amount of energy in the universe at the end of a chemical reaction is the same as before the reaction takes place. If a reaction transfers energy to the surroundings the product molecules must have less energy than the reactants, by the amount transferred.

# 10 Minutes on....

## Energy Changes RP

**A method to investigate the variables that affect the temperature changes when a metal reacts with an acid.**

1. Add the acid into a polystyrene cup.
2. Record the start temperature of the solution.
3. Add the other reactant (test solution) to the polystyrene cup.
4. Add the lid and stir the solution
5. Record the highest/lowest temperature that you observe.
6. Calculate the temperature change.
7. Repeat steps 1-6 2 more times to identify outliers and calculate an average.
8. Repeat sets 1-7 with 4 different test solutions.



# 10 Minutes on....

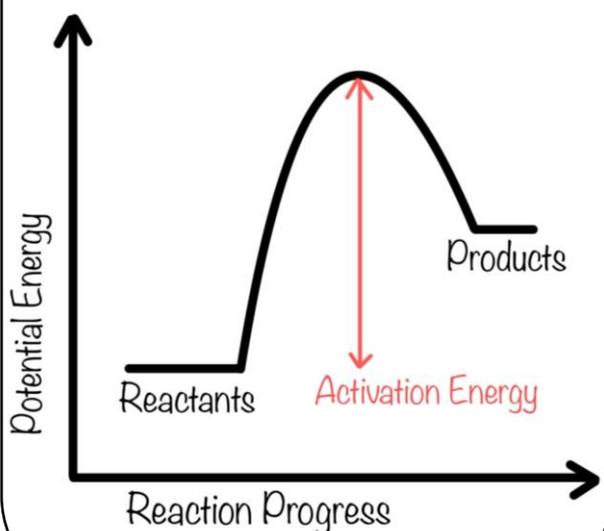
## Reaction Profile

Key Term	Definition
Reaction Profile	A diagram that can show the relative energies of reactions, products, the activation energy and the overall energy change of a reaction.
Activation Energy	The minimum energy required for a reaction to occur.

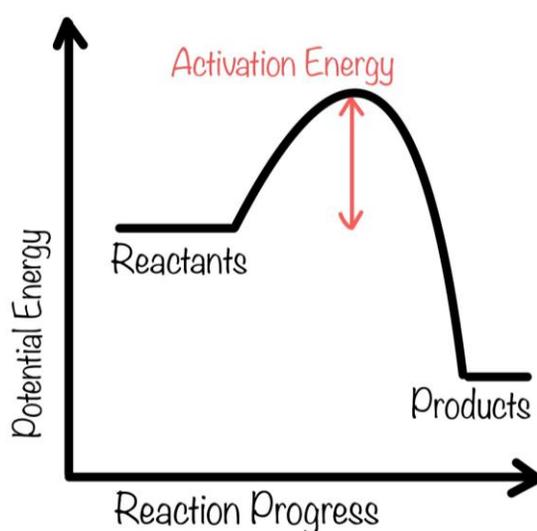
### What is required for particles to react.

Chemical reactions can occur only when reacting particles collide with each other and with sufficient energy. The minimum amount of energy that particles must have to react is called the activation energy.

#### Reaction profile for an endothermic reaction.



#### Reaction profile for an exothermic reaction.



# 10 Minutes on....

## Energy Changes of Reactions

### **What happens in terms of bonds during chemical reactions.**

During a chemical reaction:

- Energy must be supplied to break bonds in the reactants
- Energy is released when bonds in the products are formed.

The energy needed to break bonds and the energy released when bonds are formed can be calculated from bond energies.

### **How to calculate the overall energy change of a reaction.**

The difference between the sum of the energy needed to break bonds in the reactants and the sum of the energy released when bonds in the products are formed is the overall energy change of the reaction. To calculate the change in energy you take you add together the bond energies for all the bonds in the reactants and products. Then take away the energy for making the products bonds away from the energy for breaking the reactants bonds.

### **How to identify an exothermic reaction when calculating bond energies.**

The energy change you would calculate should be a negative number for an exothermic reaction.

### **How to identify an endothermic reaction when calculating bond energies.**

The energy change you would calculate should be a positive number for an endothermic reaction.

# 10 Minutes on....

## Energy Changes of Reactions

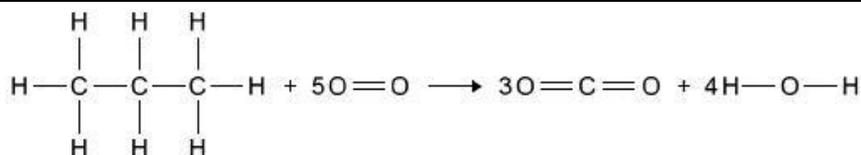
Bond	Bond Dissociation Energy (kJ/mol)	Bond	Bond Dissociation Energy (kJ/mol)
O-O	138	C-Cl	327
O=O	496	Cl-Cl	243
O-H	463	H-Cl	432
C-C	347	C=C	614
C-H	413	Br-Br	193
C=O	799	C-Br	276

### Reaction

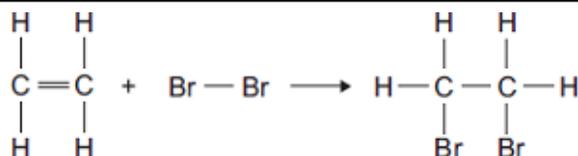
A



B



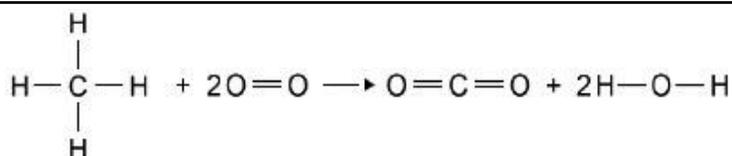
C



D



E



# 10 Minutes on....

Reaction	Bonds Broken	Bonds Made	Bonds Broken – Bonds Made	Answer
A	$(4 \times \text{C-H}) + \text{Cl-Cl}$ $(4 \times 413) + 243$ $1652 + 243 = 1895$	$(3 \times \text{H-C}) \text{H-Cl} + \text{C-Cl}$ $(3 \times 413) + 432 + 327$ $1238 + 432 + 327 = 1998$	$1895 - 1998 =$	-103kJ/mol
B	$(8 \times \text{C-H}) + (5 \times \text{O=O}) + (2 \times \text{C-C})$ $(8 \times 413) + (5 \times 496) + (2 \times 347)$ $3304 + 2480 + 694 = 6478$	$(6 \times \text{C=O}) + (8 \times \text{O-H})$ $(6 \times 799) + (8 \times 463)$ $4794 + 3704 = 8498$	$6478 - 8498 =$	-2020kJ/mol
C	$\text{C=C} + (4 \times \text{C-H}) + \text{Br-Br}$ $614 + (4 \times 413) + 193$ $614 + 1652 + 193 = 2459$	$\text{C-C} + (4 \times \text{C-H}) + (2 \times \text{C-Br})$ $347 + (4 \times 413) + (2 \times 276)$ $347 + 1652 + 552 = 2551$	$2459 - 2551 =$	-92kJ/mol
D	$(4 \times \text{O-H}) + \text{O-O}$ $(4 \times 463) + 138$ $1852 + 138 = 1990$	$(4 \times \text{O-H}) + \text{O=O}$ $(4 \times 463) + 496$ $1852 + 496 = 2348$	$1990 - 2348 =$	-358kJ/mol
E	$(4 \times \text{C-H}) + (2 \times \text{O=O})$ $(4 \times 413) + (2 \times 496)$ $1652 + 992 = 2644$	$(2 \times \text{C=O}) + (4 \times \text{O-H})$ $(2 \times 799) + (4 \times 463)$ $1598 + 1852 = 3450$	$2644 - 3450 =$	-806kJ/mol