Revision Guide

AQA GSCE Triple Chemistry Paper 1 Foundation

Name: Class:

@SinclairEducation

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.

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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.

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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 an mass number of 7. This means that lithium has 4 neutrons in its nucleus also.

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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.

Radius of an Atom	0.1nm or 1×10^{-10}m
Radius of an Atoms Nucleus	1/10,000 of the size of the atom or 1×10^{-14}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.

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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:

RAM of chlorine = (35 x 75) + (37 x 25) / (75 + 25)
= 2625 + 925 / 100 = 3550 / 100
= 35.5

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%.	RAM of Cl = (35 x 75)+ (37x 25)/(75 + 25) = 2625+925 /100 = 3550 / 100 = 35.5
2	Calculate the atomic mass of copper when the abundance of copper-63 is 70% and the abundance of copper-65 is 30%.	RAM of Cu = (63 x 70)+ (65x 30)/(70 + 30) = 4410+ 1950/100 = 6360 / 100 = 63.6
3	Calculate the atomic mass of magnesium when the abundance of magnesium-24 is 79%, magnesium-25 is 10% and the abundance of magnsium-26 is 11%.	RAM of Mg = (24x79)+(25x10)+ (26 x 11) /(79+10+11) = 1896 + 250 + 286 / 100 = 2432 / 100 = 24.32

10 Minutes on….

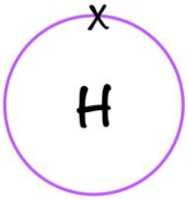
Electronic Structures

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

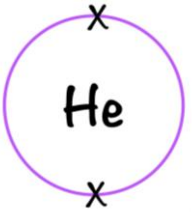
Electron configuration diagrams for the first 20 elements.

Hydrogen



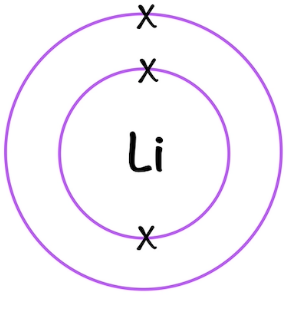
1

Helium



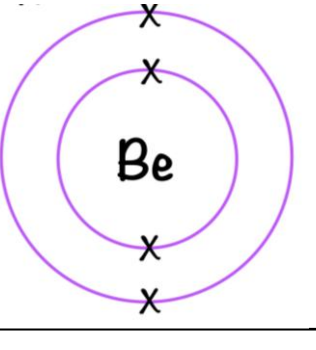
2

Lithium



2,1

Beryllium

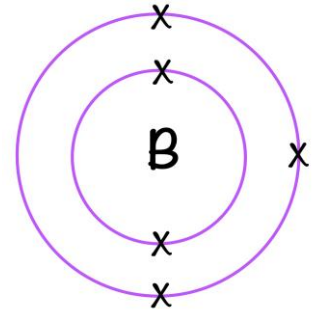


2,2

10 Minutes on….

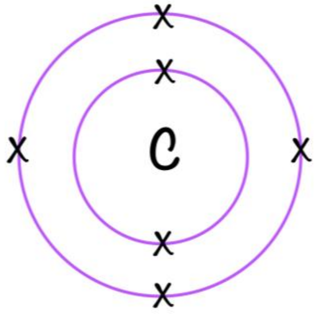
Electronic Structures

Boron



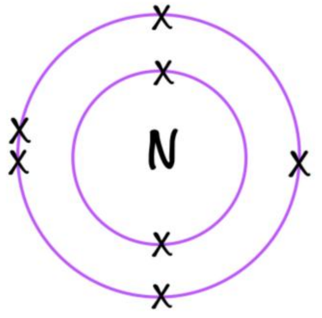
2,3

Carbon



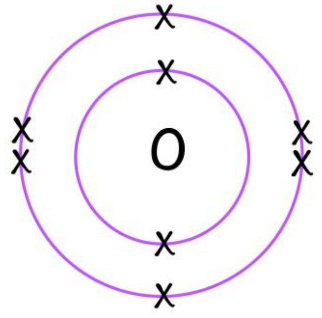
2,4

Nitrogen



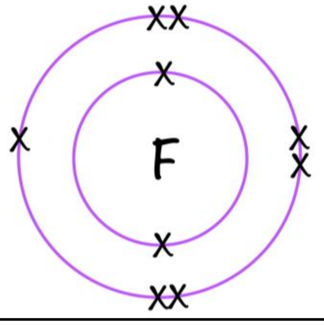
2,5

Oxygen



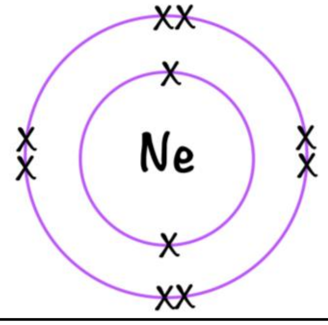
2,6

Fluorine



2,7

Neon

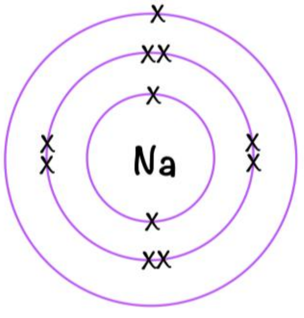


2,8

10 Minutes on....

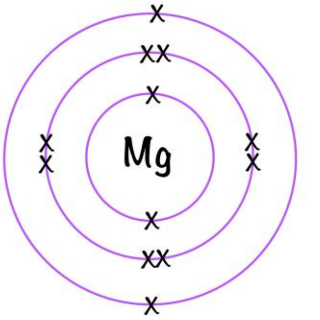
Electronic Structures

Sodium



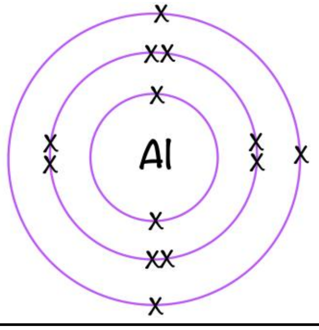
2,8,1

Magnesium



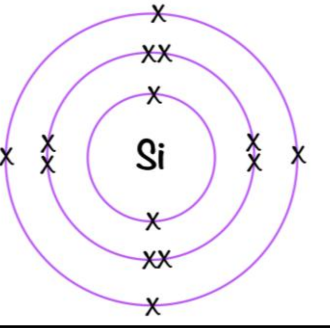
2,8,2

Aluminium



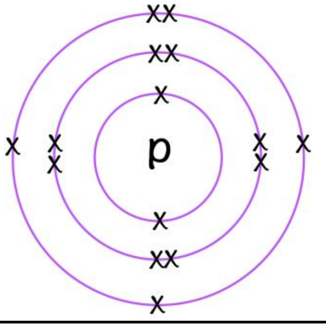
2,8,3

Silicon



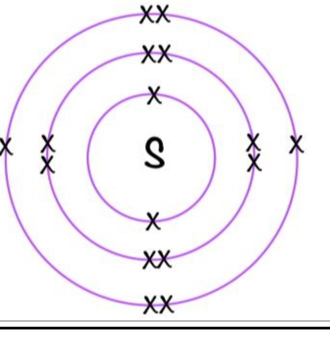
2,8,4

Phosphorus



2,8,5

Sulfur

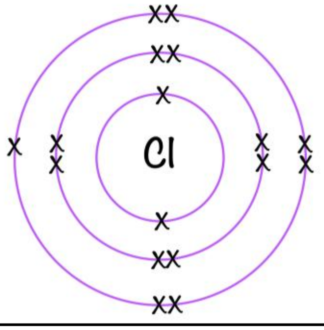


2,8,6

10 Minutes on….

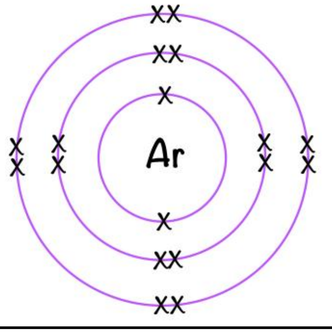
Electronic Structures

Chlorine



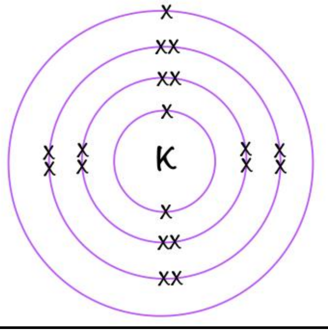
2,8,7

Argon



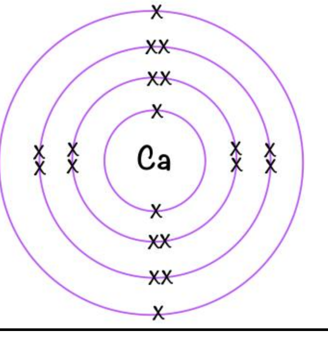
2,8,8

Potassium



2,8,8,1

Calcium



2,8,8,2

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 elements 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	Hoe 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.

Compareing 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.

Lithium + Oxygen → Lithium Oxide $4Li + O_2 \rightarrow 2Li_2O$

Sodium + Oxygen → Sodium Oxide $4Na + O_2 \rightarrow 2Na_2O$

Potassium + Oxygen → Potassium Oxide $4K + O_2 \rightarrow 2K_2O$

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

Lithium + Chlorine → Lithium Chloride $2Li + Cl_2 \rightarrow 2LiCl$

Sodium+ Chlorine → Sodium Chloride $2Na + Cl_2 \rightarrow 2NaCl$

Potassium + Chlorine → Potassium Chloride $2K + Cl_2 \rightarrow 2KCl$

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

Lithium + Water → Lithium Hydroxide + Hydrogen $2Li + 2H_2O \rightarrow 2LiOH + H_2$

Sodium + Water → Sodium Hydroxide + Hydrogen $2Na + 2H_2O \rightarrow 2NaOH + H_2$

Potassium + Water → Potassium Hydroxide + Hydrogen $2K + 2H_2O \rightarrow 2KOH + H_2$

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_2	Pale yellow gas
Chlorine	Cl_2	Green gas
Bromine	Br_2	Orange liquid
Iodine	I_2	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.

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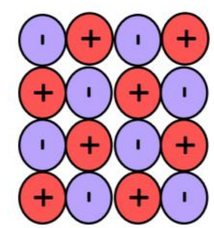
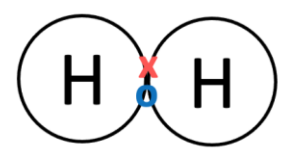
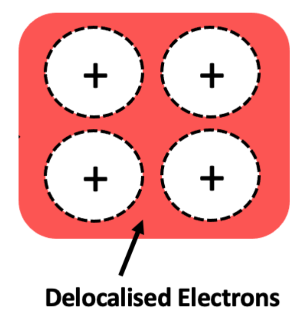
Transition Metals

Property	**Group 1**	**Transition Metals**
Melting Points	Lower Melting Points	Higher Melting Points
Density	Low Density	High Density
Strength	Weaker	Stronger
Hardness	Softer	Harder
Reactivity with Oxygen	Very Reactive With Oxygen	Less Reactive With Oxygen
Reactivity with Water	Very Reactive With Water	Less Reactive With Water
Reactivity with Halogens	Very Reactive With Halogens	Less Reactive With Halogens
Charge of Ions	+1	Form ions with different charges.
Colour of Compounds Formed	Form White Compounds.	Form Colourful Compounds.
Use as a Catalyst	Not Useful as Catalysts.	Used as Catalysts.

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.

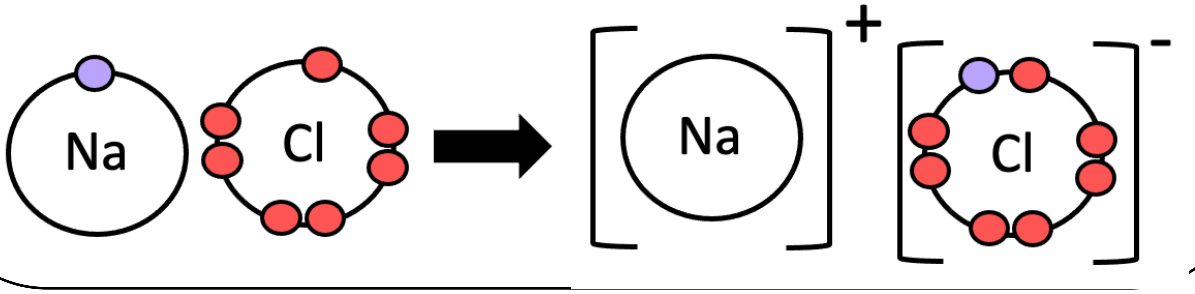
Group	Ion Formed
1	+1
2	+2
6	-2
7	-1

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

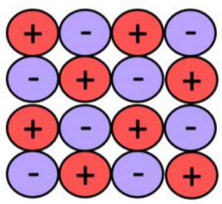
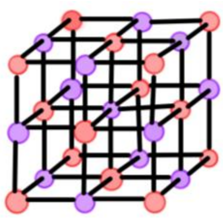
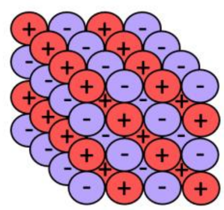
The sodium atom will lose an electron to form a +1 (positive) ion while chlorine will gain one electron to form a -1 (negative) chloride ion. The opposite charges will attract forming an ionic bond between the ions.



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.

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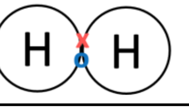
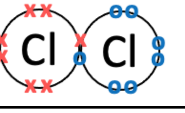
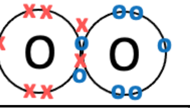
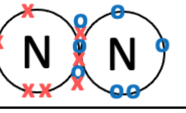
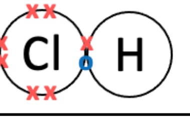
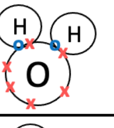
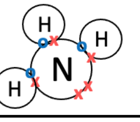
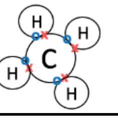
Covalent Bonding

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_2	
Chlorine	Cl_2	
Oxygen	O_2	
Nitrogen	N_2	
Hydrogen Chloride	HCl	
Water	H_2O	
Ammonia	NH_3	
Methane	CH_4	

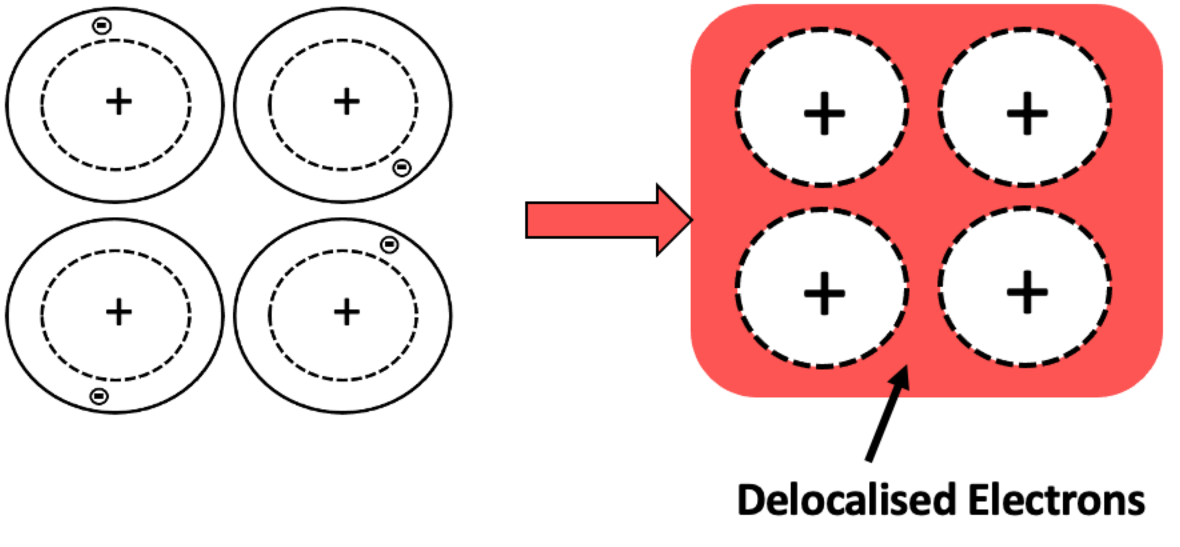
10 Minutes on…. Metallic Bonding

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.

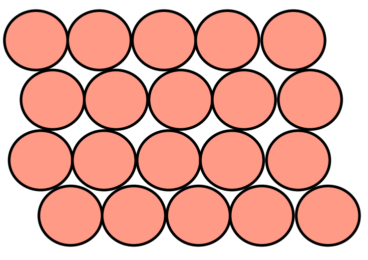
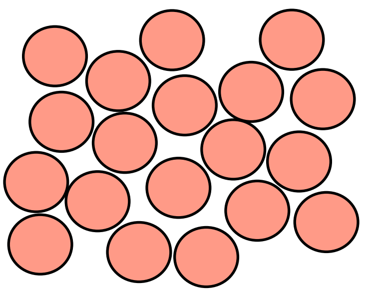
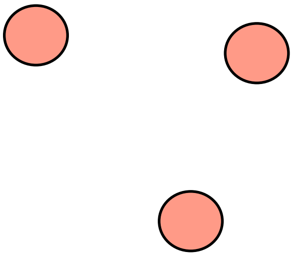
Modelling the formation of metallic bonds.



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.

Particle Models	Solid	Liquid	Gas
			

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

What the amount of energy needed to change state depends on.

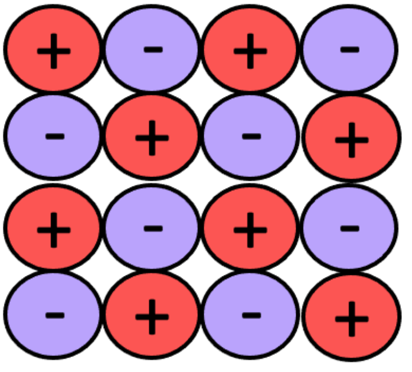
The amount of energy needed to change state from solid to liquid and from liquid to gas depends on the strength of the forces between the particles of the substance. The nature of the particles involved depends on the type of bonding and the structure of the substance. The stronger the forces between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

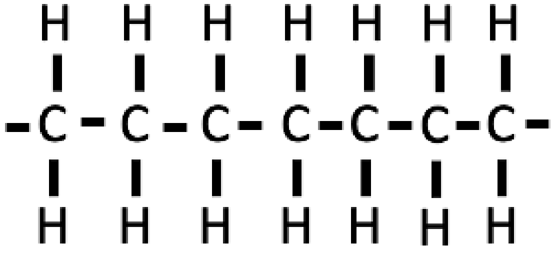
Polymers

Key Term	Definition
Polymers	Lage 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.



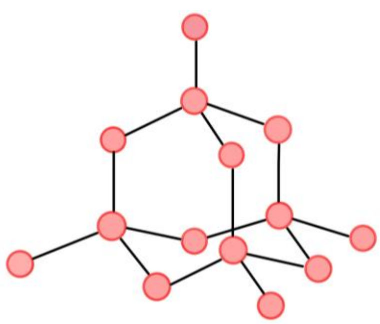
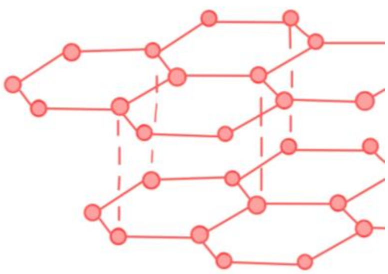
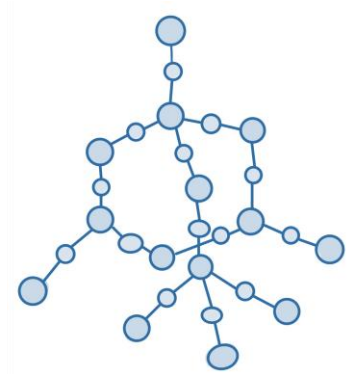
Why polymers are solids at room temperature.

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.

Diagrams	Diamond	Graphite	Silicon Dioxide
			

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.

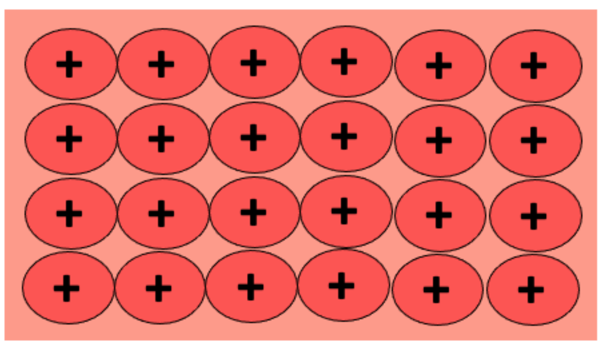
10 Minutes on....

Properties of Metals And Alloys

Key Term	Definition
Metallic Bond	The sharing of delocalised electrons.

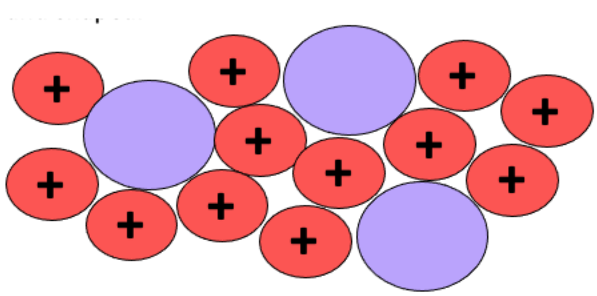
Why metals can be bent and shaped.

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



Why alloys are harder than pure metals.

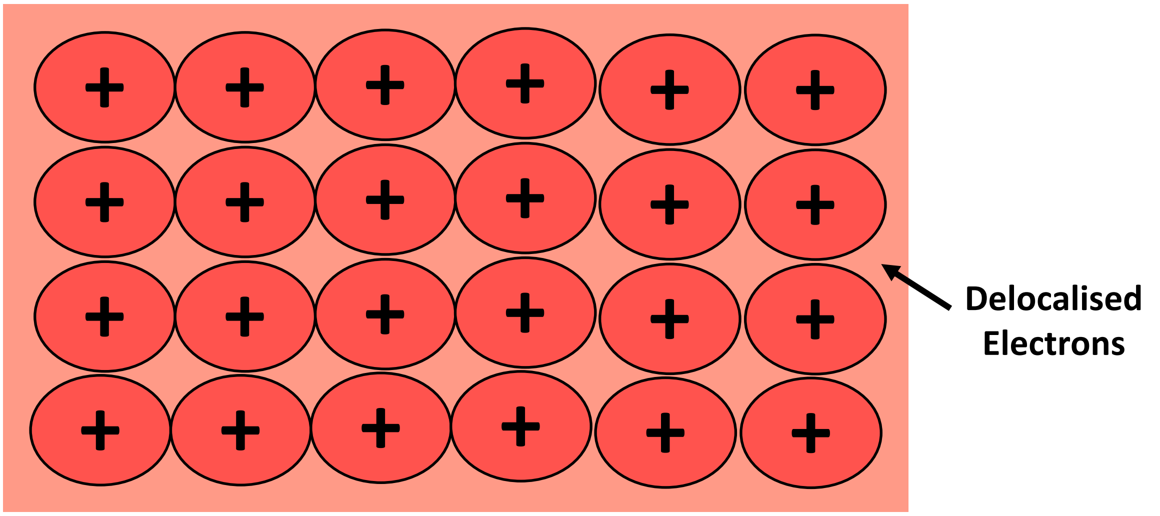
Pure metals are too soft for many uses and so are mixed with other metals to make alloys which are harder. Alloys are harder because the introduction of another element to the metal distorts the regular layers of atoms.



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.

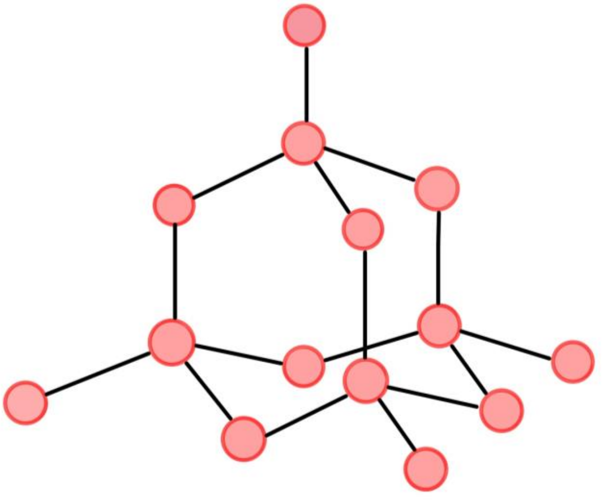
Why metals are good conductors of thermal energy.

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

10 Minutes on.... Diamond

Structure and bonding of diamond.

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

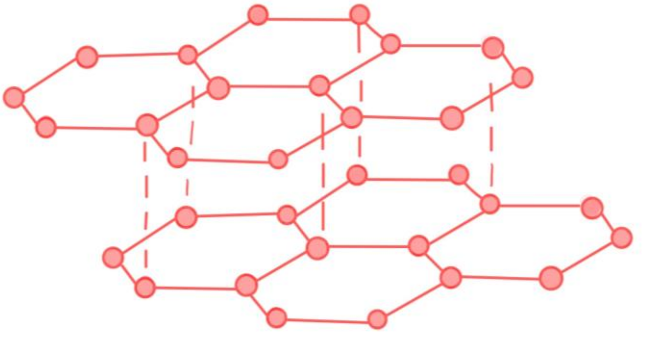


Property	Explanation
High Melting and Boiling Point	The covalent bonds between the carbon atoms are very strong. This means that it takes a lot of energy to overcome these bonds and so diamond has a high melting and boiling point.
Hard	Each carbon atom is covalently bonded to 4 other carbon atoms. The 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.

10 Minutes on.... Graphite

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.



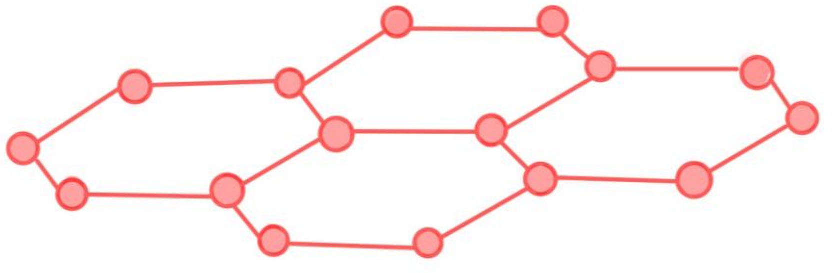
Property	Explanation
High Melting and Boiling Point	The covalent bonds between the carbon atoms are very strong. This means that it takes a lot of energy to overcome these bonds and so graphite has a high melting and boiling point.
Soft	The intermolecular bonds between the graphite layers are weak. This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

10 Minutes on….

Graphene

Structure and bonding of graphene.

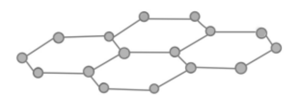
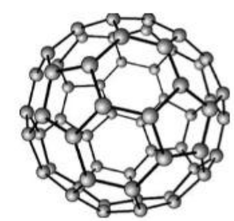
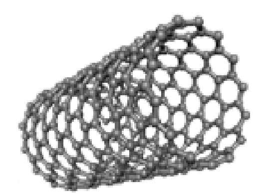
Graphene is a single layer of graphite and so it is made up of carbon atom that forms three covalent bonds with three other carbon atoms, forming a layer of hexagonal rings.



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….

Nanoparticles

Key Term	Definition
Nanoscience	The study of structures that are 1-100nm in size.
Nanoparticle	A particle that is between 1-100nm in size.
Course Particle	A particle with a diameter between 1x10 $^{-5}$ and 2.5 x 10 ^{6} m.
Fine Particle	A particle with a diameter between 100 and 2500nm. (1 x 10^{-7}m and 2.5 x 10^{-6}m)

What happens to the surface area to volume ratio when the side of a cube decreases by a factor of 10.

As the side of cube decreases by a factor of 10 the surface area to volume ratio increases by a factor of 10.

Why nanoparticles have different properties to the same material in bulk.

Nanoparticles may have properties different from those for the same materials in bulk because of their high surface area to volume ratio. It may also mean that smaller quantities are needed to be effective than for materials with normal particle sizes.

10 Minutes on....

Uses of Nanoparticles

Use of Nanoparticle	Advantage	Disadvantage
Medicine	Could be used to treat cancer.	Could cause toxicity to cells.
Electronics	Power consumption decreased. Electronic displays improved. Reduced weight	Expensive
Cosmetics	Could improve the hydration of skin.	The nanoparticles may penetrate deeper into the skin causing harm to cells.
Sun creams	The nanoparticles of zinc oxide are invisible on the skin preventing white streaks.	Can be difficult to apply. Can be difficult to tell where the sunscreen has been applied.
Deodorants	Antibacterial properties	Nanoparticles could be accidently inhaled and become embedded in the lung walls causing potential harm.
Catalysts	Catalyse reactions more efficiently	-

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: $CH_4 + O_2 \rightarrow CO_2 + H_2O$ the following would be incorrect: $CH_4 + O_2 \rightarrow CO_2 + 2H_2O_2$

Within the equation a subscript 2 has been added to the water molecule changing it from H_2O (water) to H_2O_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:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

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_2O	(2 x 1) + 16 = 18
Carbon Dioxide	CO_2	12 + (2 x 16) = 44
Methane	CH_4	12 + (4 x 1) = 16

Task	Mass of Substance	RFM of molecule	(Mass of Substance / RFM) x 100	Answer
Determine the % mass of C in CO_2	C = 12	44	(12/44) x 100	27.3%
Determine the % mass of C in CO_2	O = (16 x 2) = 32	44	(32/44) x 100	72.7%
Determine the % mass of H in H_2O	H = (2 x 1) = 2	18	(2/18) x 100	11.1%
Determine the % mass of O in H_2O	O = 16	18	(16/18) x 100	88.9%
Determine the % mass of H in CH_4	H = (4 x 1) = 4	16	(4/16) x 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

Calculate uncertainty for the following data:	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.	±2.5cm	±3°C	±6.5m	±0.2N

How to determine the uncertainty of measuring instruments.

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

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

10 Minutes on....

Concentration of Solutions

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

Quantity	Unit
Concentration	g/dm^3
Mass	g
Volume	dm^3

Equation that should be used to calculate concentration.

Conc = Mass of Solute / Volume of Solution

Calculate the conc. of...	300g of $CuCl_2$ dissolved in $1dm^3$ of water.	A solution of hydrochloric acid that contains 3.2g of hydrogen chloride in $50cm^3$	1g of copper sulfate dissolved in water to make $25cm^3$ of copper sulfate solution.
Convert Units	-	$50cm^3 = 0.05dm^3$	$25cm^3 = 0.025dm^3$
Divide Mass by Volume	300/1	3.2/0.05	1/0.025
State answer	300	64	40
Round and add units.	$300g/dm^3$	$64g/dm^3$	$40g/dm^3$

10 Minutes on....

Percentage Yield

Key Term	Definition
Yield	The amount of product obtained.
Percentage Yield	The amount of product obtained when compared to the maximum theoretical amount as a percentage.

Why it is not always possible to obtain the maximum theoretical mass of a product from a reaction.

Reasons for this include that the reaction may be reversible and so not go to completed. Some of the reactants may react in wats different to the expected reaction or some of the products may be lost when it is separated from the mixture.

Equation to calculate percentage yield of a reaction.

% Yield = (Mass of product made / maximum theoretical mass of product) x 100

Calculate the % yield when…	Theoretical yield is 2.8g and the actual yield is 1.4g	Theoretical yield is 12.3g and the actual yield is 3.2g	Theoretical yield is 1.2kg and the actual yield is 525g
State formula used.	% Yield = (Mass of product made / max theoretical mass of product) x 100	% Yield = (Mass of product made / max theoretical mass of product) x 100	% Yield = (Mass of product made / max theoretical mass of product) x 100
Substitute values	1.4 / 2.8 x 100 = 50	3.2 / 12.3 x 100 = 26.0162601626	525 / 1200 x 100 = 43.75
State final answer	50%	26.0%	43.8%

10 Minutes on….

Atom Economy

Key Term	Definition
Atom Economy	A measure of the amount of starting materials that end up as useful products.

Why it is important that we use reactions with high atom economy.

High atom economy is important for sustainable development, and it is more economical.

Equation to calculate percentage atom economy of a reaction.

(RFM of Desired Product / Sum of RFM or all Reactants) x 100

Calculate the % atom economy for…	$CH_4 + H_2O \rightarrow 3H_2 + CO$ …the production of hydrogen.	$2CuO + C \rightarrow 2Cu + CO$ …the production of copper.	$CuCl_2 \rightarrow Cu + Cl_2$ …the production of copper.
Calculate the RFM of desired product	RFM $3H_2$ = H x 6 = 1 x 6 = 6	RFM 2Cu = Cu x 2 = 63.5 x 2 = 127	RFM Cu = Cu x 1 = 63.5 x 1 = 63.5
Calculate RFM of all reactants	= (Cx1)+(Hx6)+ O = (12x1) + (1x6) + 16 = 12 + 6 + 16 = 34	= (Cux2)+(Ox2)+ C =(63.5x2)+ (16x2)+ 12 = 127 + 32 + 12 = 171	= Cu + (Cl x 2) = 63.5 + (35.5 x2) = 63.5 + 71 = 134.5
Calculate Atom % Economy	(6 / 34) x 100 = 17.6470588235	(127 / 171) x 100 = 74.269005848	(63.5 / 134.5) x 100 = 47.2118959108
State final answer to 3 sig fig.	17.6%	74.3%	47.2%

10 Minutes on....

Metal Oxides

Key Term	Definition
Reduction	The loss of oxygen or gain of electrons.
Oxidation	The gain or 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, Li^{+}, Mg^{2+}, Al^{3+}, O^{2-}

Lithium + Oxygen → Lithium Oxide
$4Li + O_2 \rightarrow 2Li_2O$

Magnesium + Oxygen → Magnesium Oxide
$2Mg + O_2 \rightarrow 2MgO$

Aluminium + Oxygen → Aluminium Oxide
$2Al + 3O_2 \rightarrow 2AL_2O_3$

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 Cu^{2+}, Pb^{2+}, Fe^{3+}, O^{2-}

Copper Oxide + Carbon → Copper + Carbon Dioxide
$2CuO + C \rightarrow 2Cu + CO_2$

Iron Oxide + Carbon → Iron + Carbon Dioxide
$2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$

Lead Oxide + Carbon → Lead + Carbon Dioxide
$2PbO + C \rightarrow 2Pb + CO_2$

10 Minutes on….

Reactions of Acids With Metals

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

Metal + Acid → Salt + Hydrogen

Ions: Mg^{2+}, Zn^{2+}, Fe^{3+}, SO_4^{2-}, Cl^-

Metal	Acid	Word and Symbol Equations
Magnesium	Hydrochloric	Magnesium + Hydrochloric Acid → Magnesium Chloride + Hydrogen $Mg + 2HCl \rightarrow MgCl_2 + H_2$
Zinc	Hydrochloric	Zinc + Hydrochloric Acid → Zinc Chloride + Hydrogen $Zn + 2HCl \rightarrow ZnCl_2 + H_2$
Iron	Hydrochloric	Iron + Hydrochloric Acid → Iron Chloride + Hydrogen $Fe + 6HCl \rightarrow 2FeCl_3 + 3H_2$
Magnesium	Sulfuric	Magnesium + Sulfuric Acid → Magnesium Sulfate + Hydrogen $Mg + H_2SO_4\ MgSO_4 + H_2$
Zinc	Sulfuric	Zinc + Sulfuric Acid → Zinc Sulfate + Hydrogen $Zn + H_2SO_4\ ZnSO_4 + H_2$
Iron	Sulfuric	Iron + Sulfuric Acid → Iron Sulfate + Hydrogen $2Fe + 3H_2SO_4 \rightarrow Fe_2(SO_4)_3 + 3H_2$

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.

Acid + Metal Hydroxide → Salt + Water

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

Acid + Metal Oxide → Salt + Water

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

Acid + Metal Carbonate → Salt + Water + Carbon Dioxide

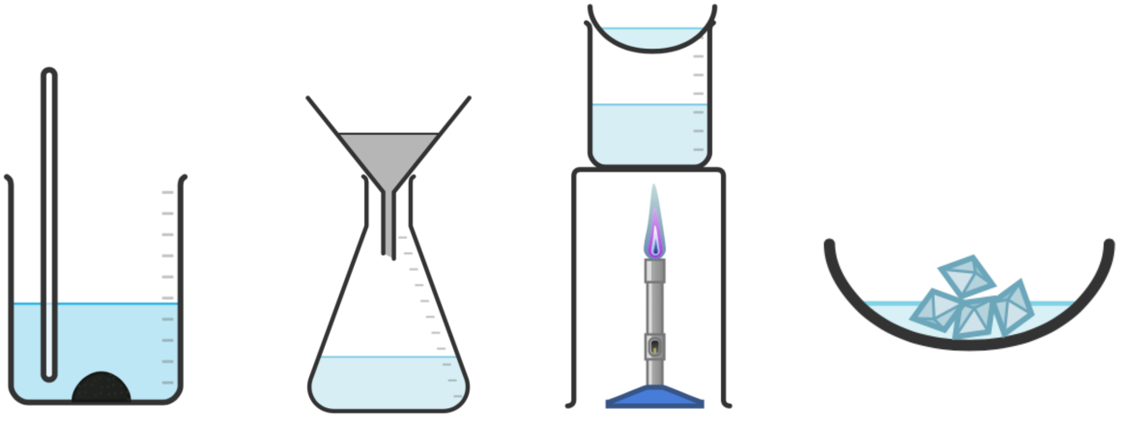
Acid	Type of Salt Formed
Hydrochloric	Chloride
Nitric	Nitrate
Sulfuric	Sulfate

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 a 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.

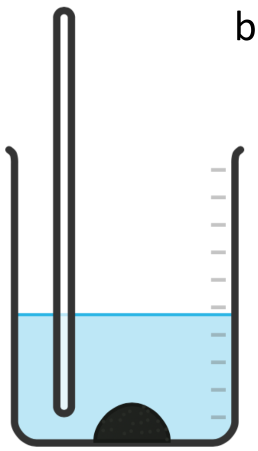
The solution should be filtered to remove the insoluble unreacted base.

10 Minutes on….

Making Salts RP

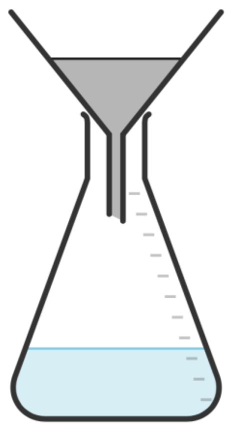
A method to prepare a pure, dry sample of a soluble salt.

1
Add the insoluble base in excess to warmed acid.

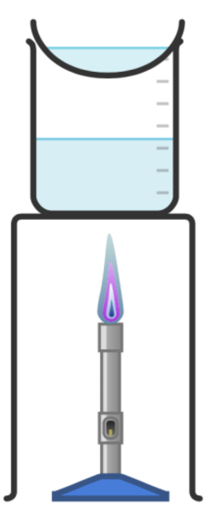


2
Stir the solution until no more base will react.

3
Filter the contents to remove the excess base.

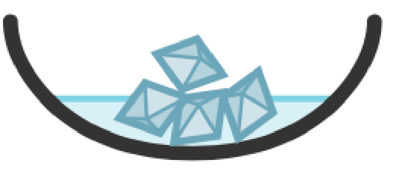


4
Pour the filtered solution into an evaporating basin and evaporate the water using a water bath.



5
Stop heating when crystals start to appear.

6
Leave the remaining solution to crystallise over time.



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.

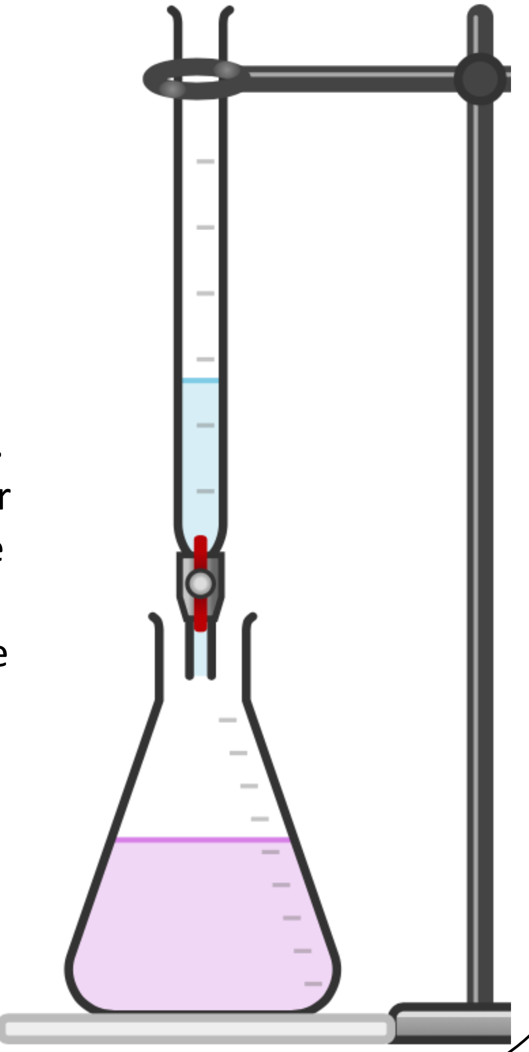
10 Minutes on....

Titrations

Key Term	Definition
Titration	A quantitative procedure in which two solutions react in a known ratio, so if the concentration of one solution is known and the volumes of both are measured, the concentration of the other solution can be determined.

How to carry out titrations using strong acids and strong alkalis to find reacting volumes accurately.

1. Add your acid or base with a known volume to the conical flask.
2. Add indicator solution to the conical flask and swirl to mix them.
3. Stand the flask on a white tile.
4. Fill the burette with the acid or base that you need to find the volume for.
5. Add chemical from the burette to the conical flask.
6. Swirl and add dropwise when you reach near the end point. Stop when colour changes.
7. Measure volume used from burette.
8. Repeat.

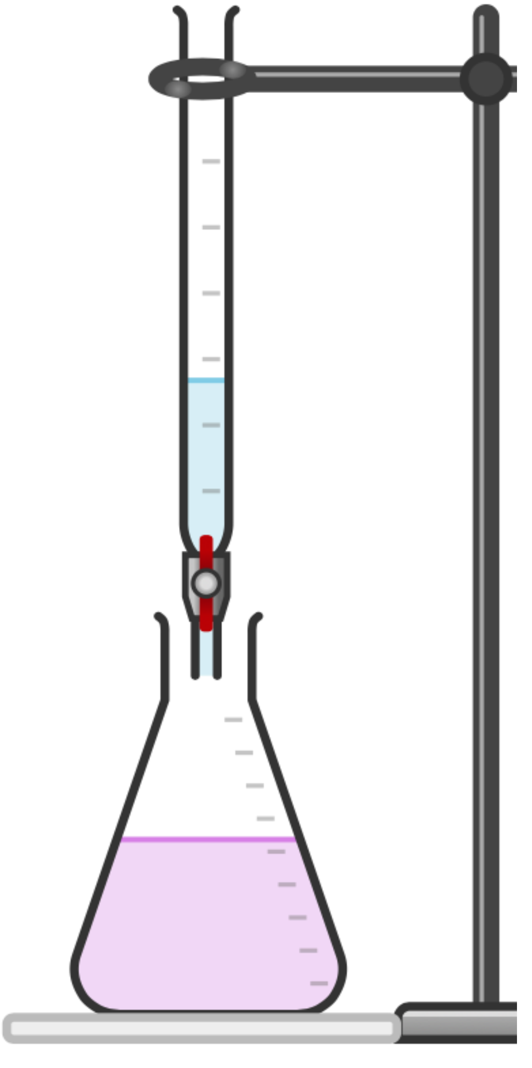


10 Minutes on….

Titrations 1 RP

A method to determine the reacting volumes of solutions of a strong acid and strong alkali by titration.

1. Add your acid or base with a known volume to the conical flask.
2. Add indicator solution to the conical flask and swirl to mix them.
3. Stand the flask on a white tile.
4. Fill the burette with the acid or base that you need to find the volume for.
5. Add chemical from the burette to the conical flask.
6. Swirl and add dropwise when you reach near the end point. Stop when colour changes.
7. Measure volume used from burette.
8. Repeat.



10 Minutes on….

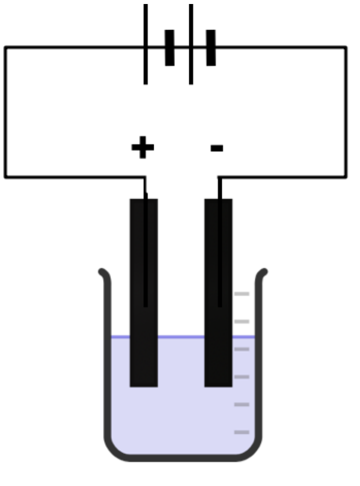
Process of Electrolysis

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 bromide 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

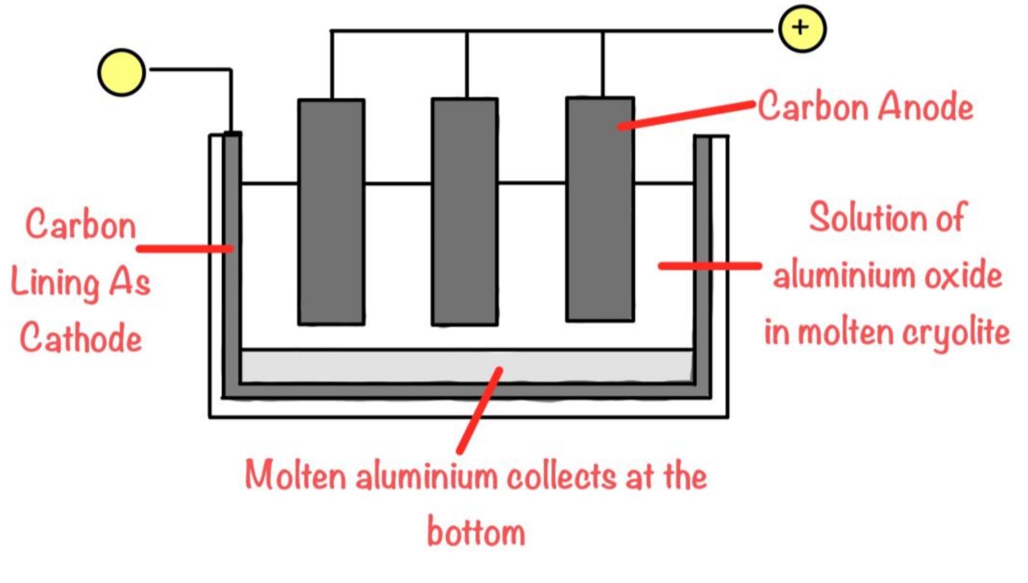
When metals are extracted using electrolysis.

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.

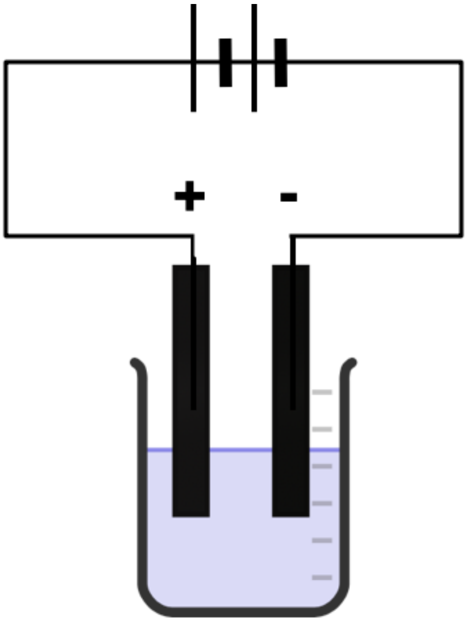
Aqueous Solution	Product at the Cathode	Product at the Anode	Justification
Calcium Chloride	Hydrogen	Chlorine	Calcium is more reactive than hydrogen and the solution contains halide ions.
Copper Bromide	Copper	Bromine	Copper less reactive than hydrogen and the solution contains halide ions.
Copper Sulfate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

10 Minutes on….

Electrolysis RP

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....

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.

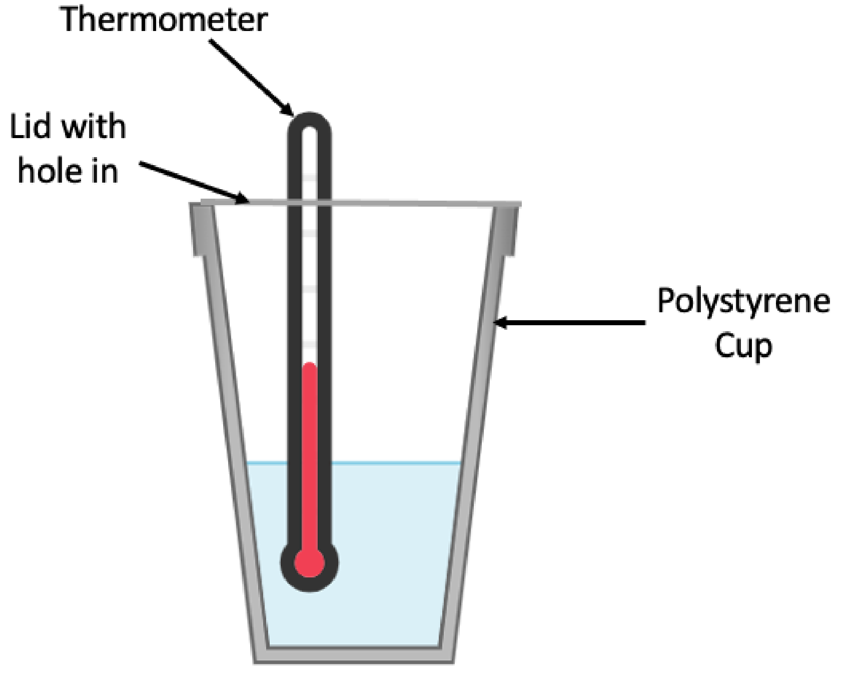
Energy is conserved in chemical reactions. The amount of energy in the universe at the end of a chemical reaction is the same as before the reaction takes place. If a reaction transfers energy to the surroundings the product molecules must have less energy than the reactants, by the amount transferred.

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....

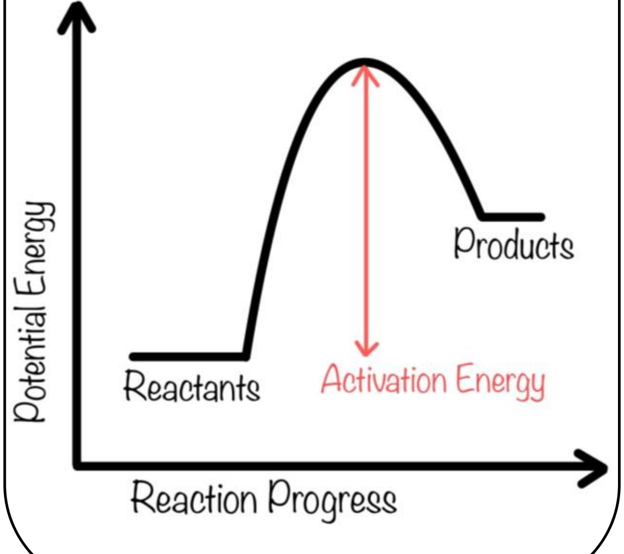
Reaction Profile

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.

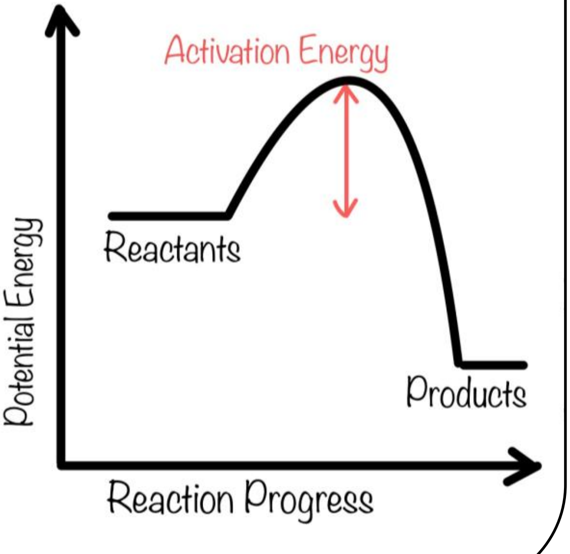
What is required for particles to react.

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....

Cells and Batteries

Key Term	Definition
Simple Cell	A component that contains chemicals which react to make electricity. It is made by connecting two different metals in contact with an electrolyte.
Battery	A component that consists of two or more cells connected together in series to provide a greater voltage.
Non-Rechargeable Battery	Batteries in which the chemical reactions stop when one of the reactants has been used up. Alkaline batteries are non rechargeable.
Rechargeable Battery	Batteries that can be recharged because the chemical reactions are reversed when an external electrical current is supplied.

What the voltage produced by a cell is dependent upon.

The voltage produced by a cell is dependent on:

- The type of electrodes used
- The electrolyte used

10 Minutes on....

Fuel Cells

Key Term	Definition
Fuel Cell	A cell that is supplied by an extremal source of fuel, such as hydrogen , and oxygen or air. The fuel is oxidised electrochemically within the fuel cell to make a potential difference.
Hydrogen Fuel Cell	A fuel cell in which hydrogen is supplied. The hydrogen is oxidised to make water. This fuel cells offers an alternative to rechargeable cells and batteries.

Advantages of Hydrogen Fuel Cells	Disadvantages of Hydrogen Fuel Cells
Easy to maintain Small Only product made is water.	Hydrogen fuel is highly flammable. Expensive to make.

Half equations for what happens at the electrodes in a hydrogen fuel cell.

Hydrogen + Oxygen → Water

At the negative electrode: $2H_2 + 4OH^- \rightarrow 4H_2O + 4e^-$

At the positive electrode: $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$