Topic: Year 10 States of Matter and Mixtures Review

Duration: 1 lesson

Composite:

Key vocabulary:

State
Physical
Predict
Describe
Explain
Connective
Element
Compound
Mixture
Pure/Impure
Solvent
Solute
Solution
Soluble
Insoluble
Condensation
Condenser
Hazard
Risk
Chromatography
R_f value
Chromatogram
Mobile phase
Stationary phase
Solvent front
Sedimentation
Filtration
Chlorination
Potable
Precipitate
Vapour
Crystallisation
Evaporation
Concentration
Fractional
Distillation
Aquifer
Relative
Residue
Spattering

Core Knowledge in this unit: All matter is made of particles which are attracted to one another. Their movement is due to kinetic energy which increases with temperature.

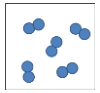
There are weak attractions between small molecules called intermolecular forces which can be broken if heated sufficiently.

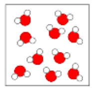
An element contains one type of atom and is found on the Periodic Table.

A compound contains two or more different elements chemically bonded together in fixed amount shown in a formula.

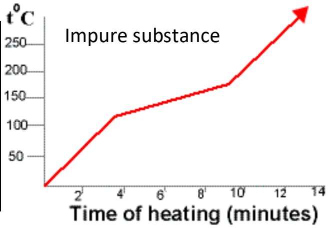
A mixture contains two or more different substances not chemically bonded together and therefore it can be easily separated. It has no chemical formula.

A pure substance has a specific melting point but impure substances melt over a range of temperatures.


A pure element


A pure compound

s	Solid
l	Liquid
g	Gas
aq	aqueous



Solvent	the liquid in which a solute dissolves
Solute	the substance that dissolves in a liquid to form a solution
Solution	is the mixture formed when a solute has dissolved in a solvent
Soluble	describes a substance that will dissolve
Insoluble	describes a substance that will not dissolve

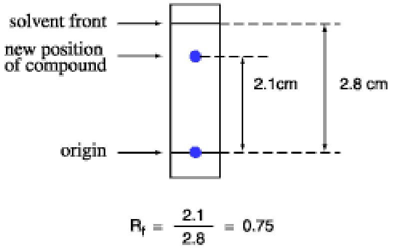
Crystallisation is used to separate a soluble substance from a solvent.

Filtration is used to separate an insoluble substance from a liquid.

Simple distillation separates a liquid from a mixture by evaporation and condensation.

Fractional distillation separates a mixture of more than two liquids.

Paper chromatography is used to separate and identify coloured substances.



$$R_f = \frac{2.1}{2.8} = 0.75$$

The ratio of the distance moved by a compound (centre of spot from origin) can be expressed as its R_f value:

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

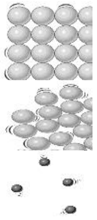
When calculating the R_f value, remember the **solvent will always travel further than the substance** so the **R_f value can never be greater than 1.**

Chromatography can be used to separate **mixtures of soluble substances** by running a solvent (**mobile phase**) through the mixture on the paper (**stationary phase**) causing the substances to **move at different rates.**

Filtration cannot be used to purify seawater as the dissolved salts would pass through the small holes in the filter paper.

Distilled water is used for chemical tests as it is pure and does not contain dissolved substances which could give false test results.

Powerful Knowledge components critical to commit to long term memory:

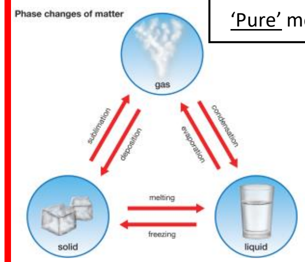


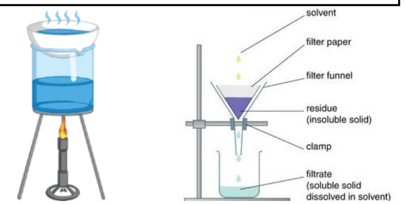
Solid Particles are arranged in a repeating regular pattern with no spaces between them and can only vibrate about a fixed position

Liquid Particles are touching, not in a pattern and can move past one another

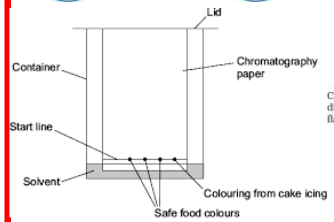
Gas Particles have empty spaces between them, they are not in a pattern and can move past one another

'Pure' means made of one type of substance in Chemistry.

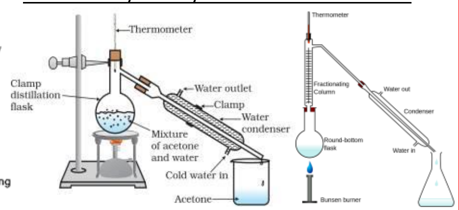




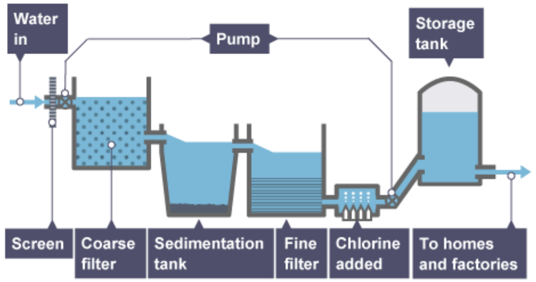
How to carry out crystallisation and filtration



Paper chromatography



Simple and fractional distillation



Seawater is not safe to drink as it contains a high concentration of salts but it can be turned into potable water by using

Potable water is water that is safe to drink but it is not pure as it contains dissolved substances such as salts. It also contains added chlorine, which destroys microorganisms.

Links to previous and future topics

KS2 Materials

KS3 Elements, compounds and reactivity (Yr7)

KS3 Separations & Mixtures (Yr7)

KS3 Particles & Solutions (Yr7)

KS3 Solutions & Mixtures (Yr8)

KS4 States of Matter & Mixtures (Chem)

KS4 Particle Model (Physics)

KS5 Chromatography (Chem)

Impressive reading	Impressive speaking	Impressive writing	Resilience	Employability via:
CULTURAL CAPITAL:				
SEND				

Topic: Atomic Structure

Duration: 4 lessons

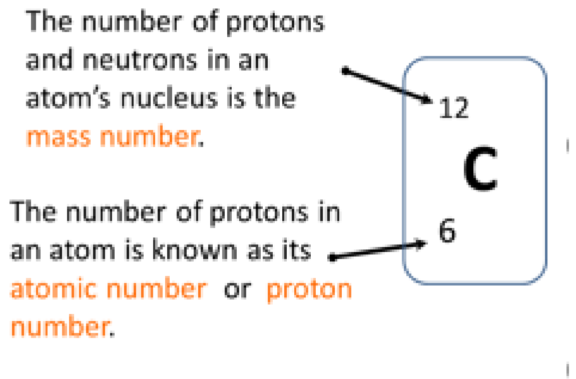
Composite:

Key vocabulary:
Atom
Proton
Electron
Neutron
subatomic
Nucleus
Electron shell
Electron configuration
Atomic number
Mass number
Isotope
abundance

Core Knowledge in this unit:

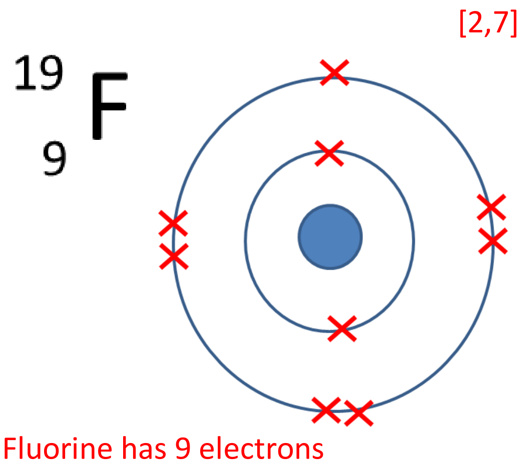
Atomic number and mass number

Different atoms have different numbers of protons, neutrons and electrons.
The periodic table is arranged in order of increasing number of protons.
Information about the number of protons, neutrons and electrons can be found from the periodic table
Every element has a different proton number
If the proton number changes, the type of element changes!
Atoms are overall neutral charge
The number of protons = number of electrons in a neutral atom



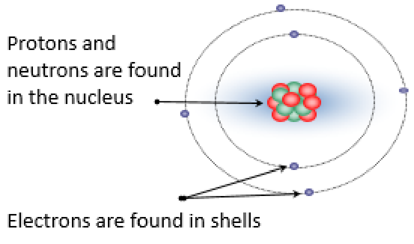
Electron configuration

Electrons are found in 'shells' around the nucleus
Each shells can only fit a certain number of electrons.
Shells are filled with the inside (lowest energy) ones first.
The first 3 shells can fit 2, 8, 18 electrons (best remembered 2,8,8)



Powerful Knowledge components critical to commit to long term memory:

- Everything in the world is made up of tiny particles called atoms.
- There are 92 different types of atom and different combinations of these atoms make all of the things that you see around you.
- Scientists originally thought that atoms were tiny hard spheres that could not be broken down further (Daltons atomic theory).
- We now know they are made of sub-atomic particles: Protons, Neutrons and Electrons
- Atoms are made of 3 types of subatomic particles: protons, electrons and neutrons
- The nucleus is in the middle of the atom and this contains the protons and the neutrons
- Compared to the overall size of an atom, the nucleus is tiny
- Almost all the mass of an atom is concentrated in the nucleus
- The electrons move around the nucleus in shells.



Protons neutrons and electrons have different mass and charge

Particle	Mass	Charge
proton	1	+1
neutron	1	0
electron	almost 0	-1

Links to previous and future topics

KS2 Materials

KS3 Elements, compounds and reactivity (Yr7)

KS3 Separations & Mixtures (Yr7)

KS3 Particles & Solutions (Yr7)

KS3 Solutions & Mixtures (Yr8)

KS4 States of Matter & Mixtures (Chem)

KS4 Particle Model (Physics)

	Isotopes An isotope is the same element that has a different mass Atoms of isotopes have the same number of protons and electrons but different numbers of neutrons giving them different mass. The Relative Atomic Mass (RAM) is the mass of an atom of an element relative to a Carbon-12 atom and taking into account the naturally occurring isotopes and their natural abundances e.g. Chlorine has two isotopes ^{35}Cl and ^{37}Cl $^{35}_{17}Cl$ $^{37}_{17}Cl$ If naturally occurring chlorine is 75% chlorine-35 and 25% chlorine 37 then the RAM can be calculated: $\frac{(75 \times 35) + (25 \times 37)}{100} = 35.5$	

Impressive reading	Impressive speaking	Impressive writing	Resilience	Employability via:
Following written practical instructions correctly	Presentation		Public speaking -	Chemist, recycling technologies, product planning, Hazardous waste chemist. Environmental scientist.

CULTURAL CAPITAL:

SEND

- Opening activity/theme is Knowledge Recall slide to ensure learner buy in
- Opportunities for retrieval practice and building on prior knowledge – opening slide @the, now, next' and during lesson.
- Multi-sensory approach using: listening, reading, talking, watching, practical, paired works…
-
- Repetition of key vocabulary in every lesson
- Curriculum time allocated for the explicit teaching of key vocabulary
- Skills ordered logically and sequenced with an increase in complexity
- Links to prior learning explicitly highlighted to support non-verbal reasoning
- Activities are scaffolded with over-learning of previous content to encourage independence
-

Bonding		Duration:	Composite
Key vocabulary:	**Core Knowledge in this unit:**	**Powerful Knowledge components critical to commit to long term memory:**	**Links to previous and future topics**

Key vocabulary:

Bond
Electron
Outer shell
Dot and cross
Ionic
Covalent
Simple
Giant
Allotrope
Metal
Non-metal
Shared pair
Diamond
Graphite
Electrostatic
Positive
negative

Core Knowledge in this unit:

Ionic compounds have specific properties related to their structure:

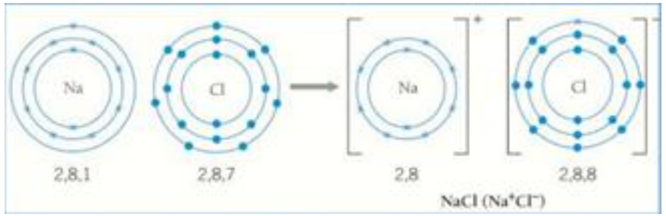
- **Melting points are high as ionic compounds form giant ionic lattices (crystals). To melt the compound, many of the strong ionic bonds will need to be broken. This requires a lot of energy.**
- **Solid ionic compounds do not conduct electricity as the ions are fixed and unable to move.**
- **Molten and dissolved ionic compounds do conduct electricity as the ions are free to move and can carry a charge**
- **Ionic compounds are electrically neutral substances. We can find the formula of an ion by using the ion charges to work out how many of each ion are needed to create a neutral compound.**
- **We can use the 'cross-over' method to work out the formulae**

+ Ion	- Ion	What to do
Ca^{2+}	Cl^{-}	
2+	1-	Note down charge
1	2	Cross numbers over
	$CaCl_2$	Write formulae

Powerful Knowledge components critical to commit to long term memory:

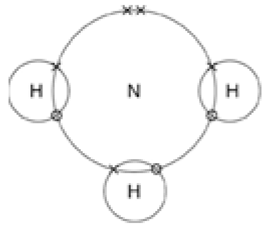
Ionic Bonding:

- Metals react with non-metals
- Metals lose the electron(s) on the outer shell
- These electrons are transferred to a non-metal
- This way, both electrons achieve a full outer shell
- Metals form positive ions
- Non-metals form negative ions
- An ionic bond is the strong electrostatic attraction between two oppositely charged ions



Covalent Bonding:

- Non-metals share pair of electrons in order to fill their outer shells
- A shared pair of electrons is a covalent bond
- We draw dot and cross diagrams to represent the covalent bonds



-

Metallic Bonding

- Metallic bonds form between metal atoms and metals from giant metallic structures
- The structure of a metal consists of a regular arrangement of metal **ions** surrounded by a sea of **delocalised electrons**

Links to previous and future topics

KS2 Materials

KS3 Elements, compounds and reactivity (Yr7)

KS3 Separations & Mixtures (Yr7)

KS3 Particles & Solutions (Yr7)

KS3 Solutions & Mixtures (Yr8)

KS4 States of Matter & Mixtures (Chem)

KS4 Particle Model (Physics)

COMMON IONS

CATIONS

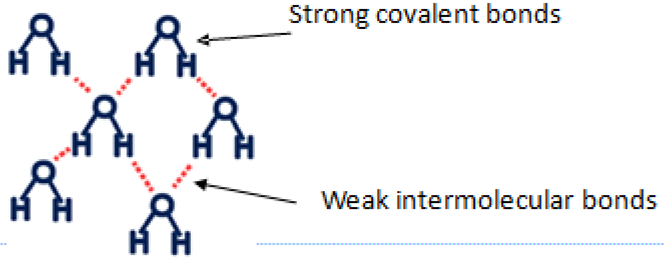
Name	Formula
Hydrogen	H^+
Sodium	Na^+
Silver	Ag^+
Potassium	K^+
Lithium	Li^+
Copper (II)	Cu^{2+}
Iron (II)	Fe^{2+}
Iron (III)	Fe^{3+}
Calcium	Ca^{2+}
Barium	Ba^{2+}
Lead	Pb^{2+}
Aluminium	Al^{3+}
Ammonium	NH_4^+
Zinc	Zn^{2+}

ANIONS

Name	Formula
Chloride	Cl^-
Fluoride	F^-
Bromide	Br^-
Iodide	I^-
Oxide	O^{2-}
Nitrate	NO_3^-
Carbonate	CO_3^-
Sulphate	SO_4^{2-}
Sulphide	S^{2-}
Hydroxide	OH^-
Hydrogen carbonate	HCO_3^-
Nitrite	NO_2^-

Covalent Bonding:
Simple Covalent Molecules:

- Simple molecular substances consist of molecules when atoms are joined by *strong covalent bonds*
- But…the molecules are held together by *weak intermolecular forces* – this causes the property of **low melting and boiling points**
- When we boil or melt a simple molecule, the weak intermolecular forces break
- They do not conduct electricity as there are no free electrons, nor an overall electric charge



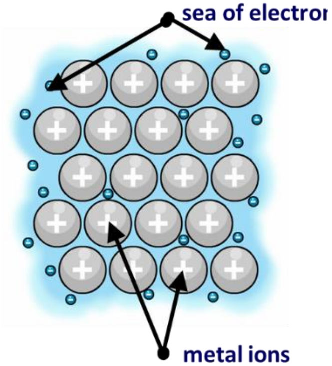
Giant Covalent Substances

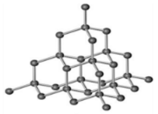
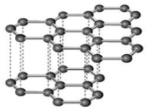
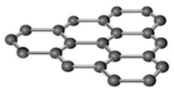
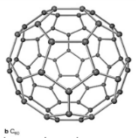
- Have huge numbers of atoms, and form giant lattices
- There are strong covalent bonds between all of the atoms, which require lots of energy to break, therefore they have high melting and boiling points

Allotropes of Carbon

Metallic Bonding

- Metallic bonds form between metal atoms and metals from giant metallic structures
- The structure of a metal consists of a regular arrangement of metal **ions** surrounded by a sea of **delocalised electrons**



Material	Structure	Bonding	Properties	Uses
Diamond	 diamond Giant covalent	Every carbon atom bonded to 4 other carbon atoms with strong covalent bonds. Carbon atoms form tetrahedral shapes	Hard, strong High melting point Does not conduct electricity Does not dissolve	Cutting equipment
Graphite	 graphite Giant covalent	Every carbon bonded to 3 other carbon atoms to form hexagons which form layers. Strong covalent bonds in the layers Weak forces of attraction between layers	Forms layers which slide over each other High melting point Conducts electricity along layers Does not dissolve	Pencil lead Electrodes Lubricant
Graphene	 graphene Giant covalent	Every carbon bonded to 3 other carbon atoms to form hexagons in a single layer. A single layer of graphite	Strong but flexible High melting point Conducts electricity along sheet	
C_{60}	 Simple molecular	Large molecule with 60 atoms. In the molecule every carbon bonded to 3 other carbons with strong covalent bonds. Weak intermolecular forces between molecules	Molecules are strong Low melting points	

Impressive reading	Impressive speaking	Impressive writing	Resilience	Employability via:
Following written practical instructions correctly	Presentation			

CULTURAL CAPITAL:

SEND

- Opening activity/theme is Knowledge Recall slide to ensure learner buy in
- Opportunities for retrieval practice and building on prior knowledge – opening slide @the, now, next' and during lesson.
- Multi-sensory approach using: listening, reading, talking, watching, practical, paired works…
- Repetition of key vocabulary in every lesson
- Curriculum time allocated for the explicit teaching of key vocabulary
- Skills ordered logically and sequenced with an increase in complexity
- Links to prior learning explicitly highlighted to support non-verbal reasoning
- Activities are scaffolded with over-learning of previous content to encourage independence
-

The Periodic Table		Duration:	Composite
Key vocabulary:	**Core Knowledge in this unit:**	**Powerful Knowledge components critical to commit to long term memory:**	

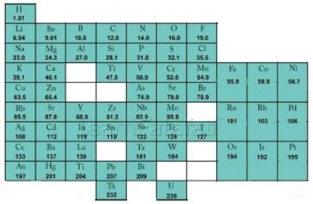
Key vocabulary:

Periodic Table
Group
Period
Atomic mass
Atomic number
Isotope
Abundance
Electron configuration
Mendeleev
Properties
Patterns

Core Knowledge in this unit:

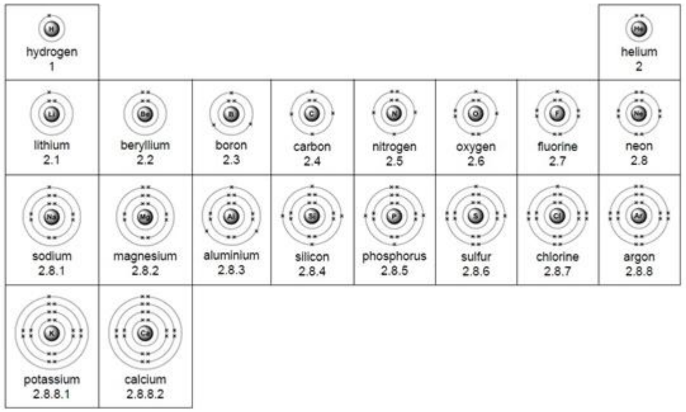
<u>Mendeleev's periodic Table</u>

The earliest version of the Periodic able was created by Dimitri Mendeleev. He arranged the elements in order of increasing atomic mass. Mendeleev also looked at the chemical and physical properties of the elements and created groups in which to put them. Mendeleev noticed that when he combined these two methods, he needed to leave gaps (if the properties were to match up). Mendeleev predicted that these gaps meant that there were elements that were yet to be discovered and added to the periodic table. He left gaps for them and predicted their properties based on other elements in the group.



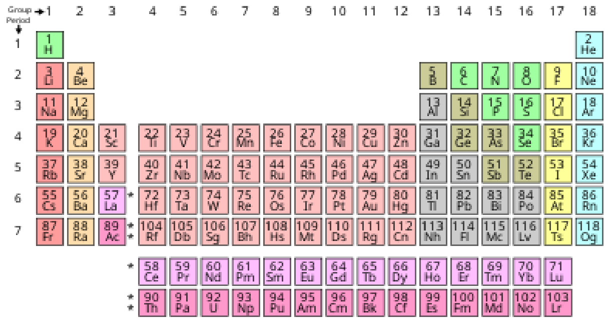
<u>Electron Configuration</u>

We can work out the number of electrons in the neutral atoms of an element by looking at the atomic number. These electrons are arranged in electron shells around the nucleus. Different shells can hold different numbers of electrons. The first shell, can hold up to 2 electrons, the second shell can hold up to 8 and the third shell also up to 8.

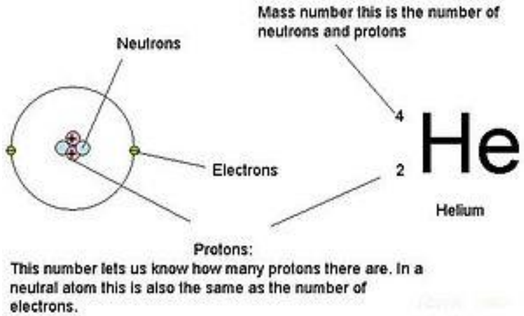


Powerful Knowledge components critical to commit to long term memory:

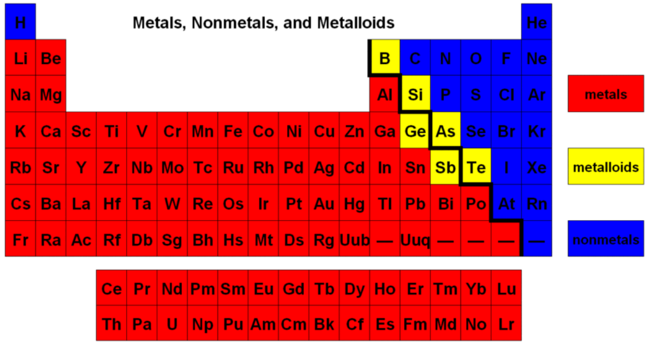
The periodic table is a list of all the known elements arranged in order of atomic number in rows. These rows are called periods.



The atomic number of an element tells us the number of protons (and electrons) in an atom.



Metals are on the left of the periodic table, and non-metals are on the right.



Impressive reading	Impressive speaking	Impressive writing	Resilience	Employability via:
https://www.pbs.org/wgbh/nova/article/make-an-element/ or https://www.nhm.ac.uk/discover/are-we-really-made-of-stardust.html	Share cultural capital findings	Report on how elements are made naturally and by scientists. Are there more to come?	Drawing and writing electron configurations	Logical processing, reading for information, problem solving, numeracy.

CULTURAL CAPITAL: Why are there only 118 (ish) elements? How are elements made? https://www.pbs.org/wgbh/nova/article/make-an-element/ Is it possible that there may be more elements to be discovered?

SEND

- Opening activity/theme is Knowledge Recall slide to ensure learner buy in
- Opportunities for retrieval practice and building on prior knowledge – opening slide @the, now, next' and during lesson.
- Multi-sensory approach using: listening, reading, talking, watching, practical, paired works…
- Repetition of key vocabulary in every lesson
- Curriculum time allocated for the explicit teaching of key vocabulary

- Skills ordered logically and sequenced with an increase in complexity
- Links to prior learning explicitly highlighted to support non-verbal reasoning
- Activities are scaffolded with over-learning of previous content to encourage independence

Topic: Calculations involving masses

Duration: 6 lessons

Composite:

Key vocabulary:
Moles
Avogadro's Number
Concentration
Relative atomic Mass
Relative formula mass
Mass Conservation

Conservation of Mass

Mass is always conserved in a chemical reaction, i.e. the number of atoms going in the reactants will be the same as the number of atoms in the products.

Relative Formula Mass (M_r)

The relative formula mass of a compound is the sum of the atomic masses of each of its elements. One mole of a substance will weigh the same as its M_r.

E.g. Find the M_r of H_2O

1. Count the atoms: H x 2, O x 1

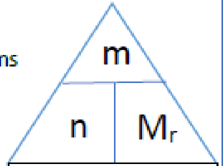
2. Find the atomic masses: H = 1, O = 16

3. Multiply the no. of atoms by masses:

$(2 \times 1) + 16 = \underline{18}$

Moles

One mole is 6.02×10^{23} atoms (Avogadro's number). One mole of <u>any</u> substance will have this same number of atoms.



n = moles (mol)

m = mass (g)

Mr = formula mass

E.g. find the number of moles in 6g of H_2.

1. Calculate the M_r of H_2

2. Divide mass by M_r:

Reacting Masses

A balanced equation tells us the ratio that is reacting. For example:

$$2H_2 + O_2 \rightarrow 2H_2O$$

This tells us that 2 moles of hydrogen react with 1 mole of oxygen to form 2 moles of water. We can use this information to calculate the masses of reactants or products using the moles equation.

E.g. find the mass of hydrogen that reacts with 48g O_2 to form water.

1. Draw a table and write in what you know, outline what you need to know.
1. Calculate the M_r's.
2. Calculate moles O_2 using mass/M_r
3. Use ratios from the equation to find moles H_2 (double in this case)
4. Calculate mass H_2 using mol x M_r

Using Moles to Balance Equations

By calculating the moles of each reactant in an equation we can then use them to prove balancing is correct.

E.g. 3g of carbon (C) reacts with 64g sulfur (S_8) to form 19g carbon disulfide (CS_2). Balance the equation using moles.

1. Write a chemical equation and draw a table.
2. Write in the masses you know.
3. Calculate the M_r's.
4. Find the moles using mass/M_r
5. Divide by the smallest number to get the coefficient.

	C +	S_8 →	CS_2
Mass	2. 3	2. 64	2. 76
Mr	3. 12	3. 256	3. 76
Moles	4. 0.25	4. 0.25	4. 1
Coefficient	5. 1	5. 1	5. 4

2. Write a balanced equation with the coefficients.

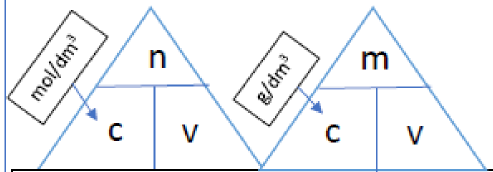
Concentration

M = mol/dm^3

The concentration of a solution is a measure of the number of solute particles dissolved in a solvent.

We can convert concentration from mol/dm^3 to g/dm^3 by multiplying by M_r. You can divide by M_r to go the other way.

$$1000cm^3 = 1dm^3$$



n = moles (mol) v = volume (dm^3) m = mass (g)

Links to previous and future topics

KS2 Materials

KS3 Elements, compounds and reactivity (Yr7)

KS3 Separations & Mixtures (Yr7)

KS3 Atomic model (Yr 9)

KS3 Solutions & Mixtures (Yr8)

KS4 Rates of reaction (Chem)

KS4 Particle Model (Physics)

Impressive reading	Impressive speaking	Impressive writing	Resilience	Employability via:
Following written practical instructions correctly	Presentation		Public speaking -	Chemist, physical chemist, efficiency manager, Materials engineer, Chemical engineer

CULTURAL CAPITAL:
SEND • Opening activity/theme is Knowledge Recall slide to ensure learner buy in • Opportunities for retrieval practice and building on prior knowledge – opening slide @the, now, next' and during lesson. • Multi-sensory approach using: listening, reading, talking, watching, practical, paired works… • • Repetition of key vocabulary in every lesson • Curriculum time allocated for the explicit teaching of key vocabulary • Skills ordered logically and sequenced with an increase in complexity • Links to prior learning explicitly highlighted to support non-verbal reasoning • Activities are scaffolded with over-learning of previous content to encourage independence •