Keywords; *atom, element, compound, mixtures, filtration, crystallisation, chromatography, simple distillation, fractional distillation, proton, neutron, electron, nucleus, orbital/shell, plum pudding model, Niels Bohr, alpha particle, positive, negative, models*

5.1 Atomic structure (Chemistry) Foundation

The first 20 elements you need to know

The Periodic Table

H 1 Hydrogen $A_r = 1$							He 2 Helium $A_r = 4$
Li 3 Lithium $A_r = 7$	Be 4 Beryllium $A_r = 9$	B 5 Boron $A_r = 11$	C 6 Carbon $A_r = 12$	N 7 Nitrogen $A_r = 14$	O 8 Oxygen $A_r = 16$	F 9 Fluorine $A_r = 19$	Ne 10 Neon $A_r = 20$
Na 11 Sodium $A_r = 23$	Mg 12 Magnesium $A_r = 24$	Al 13 Aluminium $A_r = 27$	Si 14 Silicon $A_r = 28$	P 15 Phosphorus $A_r = 31$	S 16 Sulphur $A_r = 32$	Cl 17 Chlorine $A_r = 35$	Ar 18 Argon $A_r = 40$
K 19 Potassium $A_r = 39$	Ca 20 Calcium $A_r = 40$						

groups, Mendeleev, metals, non-metals, ions, physical properties, reactivity, halogens, noble gases

Atoms, elements & compounds

Compounds;

- Are formed by elements in chemical reactions
- Are 2 or more elements that are chemically combined

Atomic number;

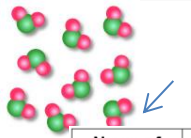
The proton number, it is different for every element

Atoms;

Everything is made of atoms, it is the smallest part of an element

Elements;

There are about 100 different elements, each with a symbol



Name of particle	Relative mass
Proton	1
Neutron	1
Electron	Very small

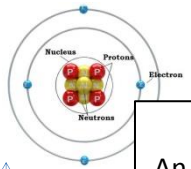
Size and mass;

- Very small, radius is 0.1nm ($1x10^{-10}$m)
- Mass is mainly in the nucleus

Mass Number;

The number of protons & neutrons in the nucleus

(Mass number) 23
(Atomic number) 11 Na

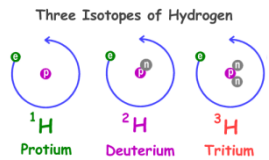


Atoms;

An atom has no overall charge, the number of protons = the number of electrons

Isotopes;

- Atoms that have the same number of protons (element), but different numbers of neutrons



COMPOUNDS/FORMULAE TABLE

You need to know the names and formulae of the following chemical compounds:

Compound	Formula	Compound	Formula
Ammonia	NH_3	Barium chloride	$BaCl_2$
Carbon dioxide	CO_2	Sodium chloride	NaCl
Methane	CH_4	Calcium carbonate	$CaCO_3$
Water	H_2O	Copper carbonate	$CuCO_3$
Hydrochloric acid	HCl	Sodium carbonate	Na_2CO_3
Sulphuric acid	H_2SO_4	Potassium nitrate	KNO_3
Calcium oxide	CaO	Silver nitrate	$AgNO_3$
Iron oxide	Fe_2O_3	Barium sulphate	$BaSO_4$
Lead oxide	PbO	Copper sulphate	$CuSO_4$
Sodium hydroxide	NaOH	Sodium sulphate	Na_2SO_4

Balancing chemical equations

Step 1: Write reactants and products

$C_3H_8 + O_2 \rightarrow CO_2 + H_2O$

Step 2: Find one atom that occurs only in one substance on both sides

$C_3H_8 + O_2 \rightarrow CO_2 + H_2O$

Step 3: Find coefficients to balance this atom

$1C_3H_8 + O_2 \rightarrow 3CO_2 + H_2O$

Step 4: Find another unbalanced atom which occurs in only one substance

$1C_3H_8 + O_2 \rightarrow 3CO_2 + H_2O$

Ionic Equations – Metal Carbonate + Acid

sodium carbonate + hydrochloric acid → sodium chloride + water + carbon dioxide

$Na_2CO_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$

dissolves

$2Na^+(aq) + CO_3^{2-}(aq) + 2H^+(aq) + 2Cl^-(aq) \rightarrow 2Na^+(aq) + 2Cl^-(aq) + H_2O(l) + CO_2(g)$

- The chloride and sodium ions do not change during the reaction (they are spectator ions).
- The chloride and sodium ions can be left out of the equation.
- The resulting equation is called a net ionic equation

$CO_3^{2-}(aq) + 2H^+(aq) \rightarrow H_2O(l) + CO_2(g)$

You try:
Write a net ionic equation for the following reaction:
$CaCO_3(aq) + H_2SO_4(aq) \rightarrow CaSO_4(aq) + CO_2(g) + H_2O(l)$

Relative charges;

Name of particle	Relative charge
Proton	+1
Neutron	0
Electron	–1

James Chadwick, relative mass, relative charge, isotope, atomic number, mass number, electronic configuration, percentage abundance, periodic table,

Word equations

A **word equation** is used as a quick, shorthand way of writing a chemical reaction.

reactants ⇨ products

There are always three parts to a word equation:

1. **The names of the reactants.**
2. **An arrow.**
3. **The names of the products.**

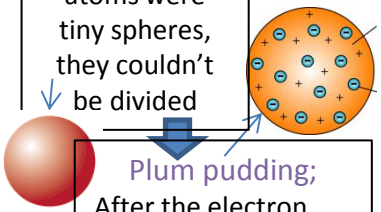
What is the word equation for hydrogen reacting with oxygen to form water?

hydrogen + oxygen ➡ water

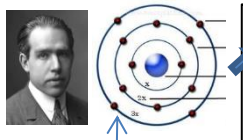
15 of 30 © Boardworks Ltd 2005

Development of the model of the atom;
New experimental evidence may lead to the model being changed or replaced

Early ideas;
Before the discovery of the electron atoms were tiny spheres, they couldn't be divided



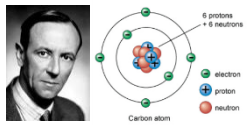
Plum pudding;
After the electron was discovered the atom became a ball of positive charge with negative electrons scattered in it



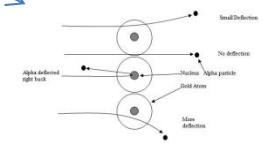
Niels Bohr;
Adapted the nuclear model suggesting electrons in orbitals at set distance

Nucleus development;
Experiments now show nucleus is made of smaller particles of positive charge

James Chadwick;
Evidence to show the existence of neutrons in the nucleus



Alpha particle scattering;
Showed that the mas of an atom was concentrated in the centre, it was charged too



Nuclide notation – how many protons, neutrons, and electrons in ions?

Mass number (protons + neutrons) → 23
Atomic number (number of protons) → 11
number of neutrons → 12

$^{23}_{11}Na^{+}$

1+ charge means 1 electron less than the number of protons. This atom has 10 electrons.

$^{27}_{13}Al$

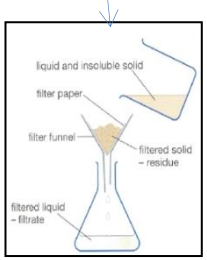
n = 27 − 13 = 14

p = 13

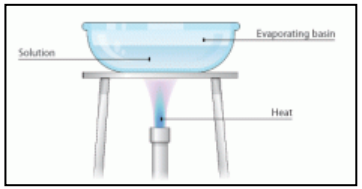
e = 13

Mixtures;
Are elements not chemically combined and can be separated by the following methods

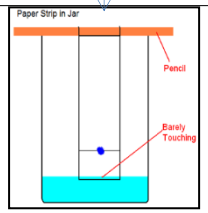
Filtration;
Separating soluble and insoluble substances



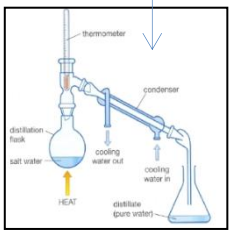
Crystallisation;
Removing a liquid leaving a solid behind



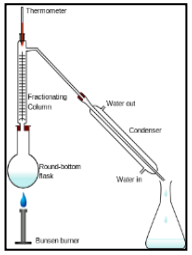
Chromatography;
Separating solutions dissolved in the same solvent

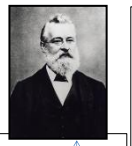


Simple distillation;
Separating a liquid from its solvent



Fractional distillation;
Separating 2 different liquids based on different boiling points



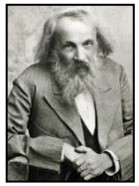
Early tables:

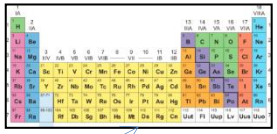
- First attempts to classify elements were made before subatomic particles were discovered
- Based on atomic weight
- Wrong groups used

Mendeleev;

Overcome the problems of atomic weight. He did this by;

- Leaving gaps
- Changing the order of the elements
- Predicted elements were discovered
- Differences were accounted for by isotopes





Non-metals;

- Form negative ions
- Found on right hand side and top of table

Modern periodic table;

The arrangement of elements in a table based on proton number, properties and outer electron number

Today;

- Elements with similar properties arranged in groups
- Based on properties
- All have the same number of electrons in the outer shell

Development of the periodic table;

As more elements were discovered scientist tried to classify them

Metals & non-metals;

Group 1;

- Alkali metals
- 1 outer electron
- Reactivity increases going down the group

Group 7;

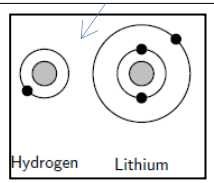
- Halogens
- 7 outer electrons
- Non-metals
- Molecules made of pairs of atoms

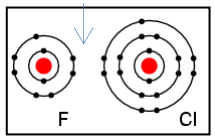
Group 0;

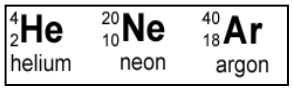
- Noble gases
- Unreactive/ stable – full outer shell of electrons
- Don't form molecules easily
- boiling point increases going down group

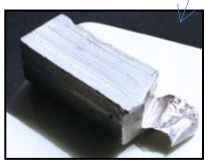
Metals;

- Majority of elements are metals
- Form positive ions
- Found on left hand side, middle and bottom of table









Comparison with alkali metals

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How do the properties of transition metals compare with those of alkali metals?

Transition metals:

- are more dense – this means that, in a fixed volume of metal (e.g. 1 cm^3), there are more atoms of a transition metal than of an alkali metal;
- have higher melting and boiling points – except mercury;
- are harder and stronger – they are not brittle and cannot be cut with a knife.