

Unit 1: Atomic Structure and the Periodic Table

Definitions

Element: a substance made from one type of atom.

There are about 100 different elements.

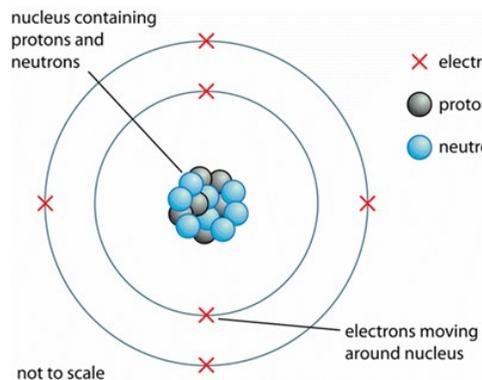
Compound: a substance made from at least two different elements, chemically combined (or **bonded**).

Compounds are made from elements by chemical reactions.

Atomic structure

An atom is the smallest part of an element that can exist.

Atoms are very small (around 0.1 nm (1×10^{-10} m)).



The atom has a small dense **nucleus** containing **protons** and **neutrons**.

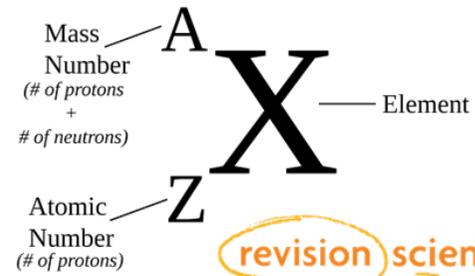
Around the outside of the atom the **electrons** fly in **shells**.

Most of the atom is **empty space**.
The nucleus only takes up 1/10 000 of the total atom.

Particle	Location	Relative mass	Relative Charge
Proton	Nucleus	1	+1
Electron	Shell	1/1840	-1
Neutron	Nucleus	1	0

Calculating the number of sub-atomic particles

Atomic Symbol

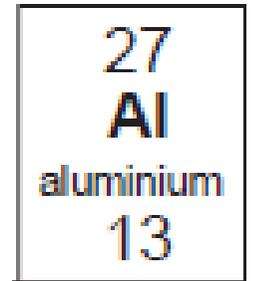


Example: Aluminium

Protons = (atomic number) 13

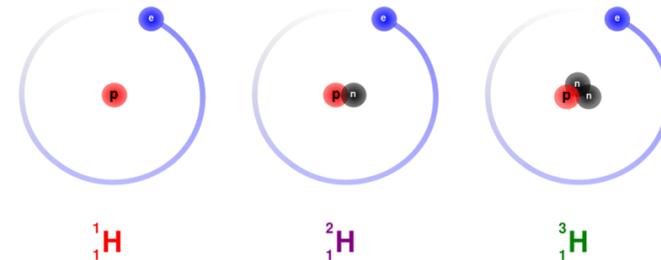
Electrons = (same as protons) 13

Neutrons = (Mass – atomic number) $27 - 13 = 14$



Isotopes

- Atoms of the same element can have different numbers of **neutrons**.
- These different versions of the atom are called **isotopes**.



- Isotopes still have the same number of **protons** and **electrons**.
- Isotopes are referred to by their **relative atomic mass** e.g. Carbon-12, or ^{12}C is the most common isotope of carbon.

Unit 1: Atomic Structure and the Periodic Table

Periodic Table

Groups are columns
↓

Periods are rows →

Metals, Nonmetals, and Metalloids

H																	He																												
Li	Be											B	C	N	O	F	Ne																												
Na	Mg											Al	Si	P	S	Cl	Ar																												
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr																												
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe																												
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn																												
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Uub	Uuq	—	—	—	—	—																												
<table border="1"> <tr> <td>Ce</td><td>Pr</td><td>Nd</td><td>Pm</td><td>Sm</td><td>Eu</td><td>Gd</td><td>Tb</td><td>Dy</td><td>Ho</td><td>Er</td><td>Tm</td><td>Yb</td><td>Lu</td> </tr> <tr> <td>Th</td><td>Pa</td><td>U</td><td>Np</td><td>Pu</td><td>Am</td><td>Cm</td><td>Bk</td><td>Cf</td><td>Es</td><td>Fm</td><td>Md</td><td>No</td><td>Lr</td> </tr> </table>																		Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu																																
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr																																

metals

metalloids

nonmetals

The **Periodic Table** is a list of elements arranged according to their **atomic number**.

Elements in the same Group have the same number of electrons in their outer shell (e.g. Group 1 all have 1 electron in their outer shell) and similar **properties** (e.g. the Noble Gases are all very unreactive gases)

Group 7 (The Halogens)

The **Halogens** get less reactive as you go down the group. This is because as you go down there are more shells and less pull from the nucleus to gain electrons.

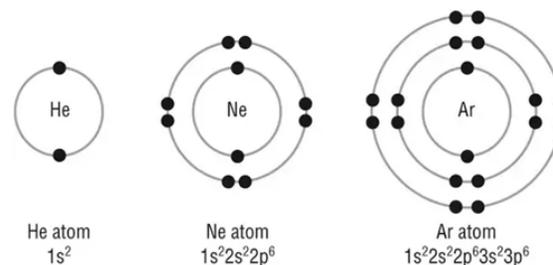
Halogens exist as pairs of atoms: F_2 , Cl_2 , Br_2 , I_2 .

A more reactive halogen can **displace** a less reactive halogen.

E.g. Potassium bromide + chlorine → Potassium chloride + bromine.

Group 0 (The Noble Gases)

Group 0 are called the Noble Gases. They are unreactive because they have a full outer electron shell.



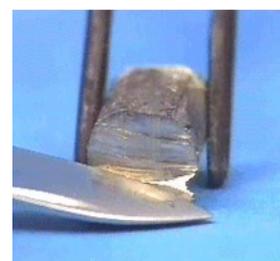
Their boiling points are very low and they are always gases at room temperature.

Group 1 (The Alkali Metals)

The Alkali Metals get more reactive as you go down the group. This is because the outer electrons are further from the nucleus and more easily lost.

They all react with water to make a hydroxide and hydrogen gas.

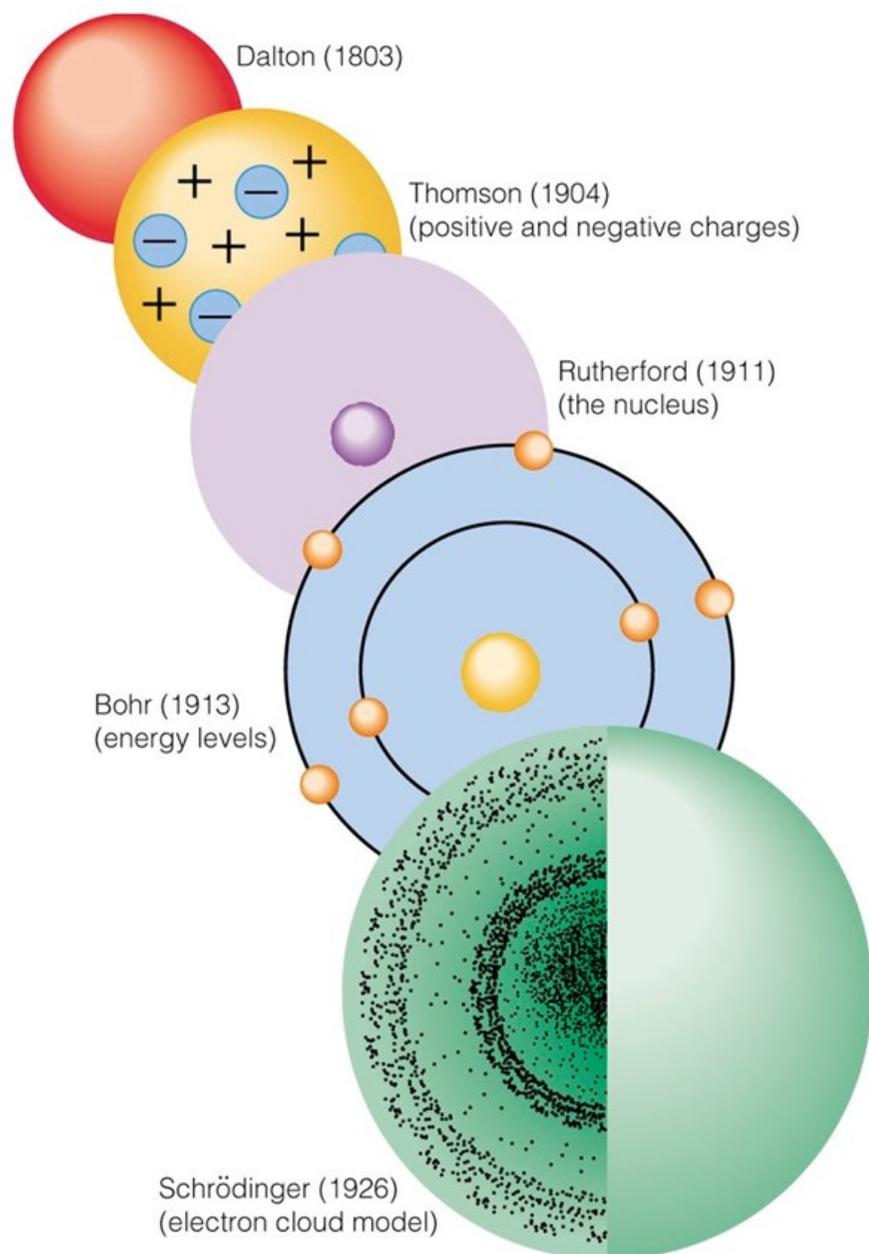
Sodium + water → sodium hydroxide + hydrogen



Li	↓	least reactive
Na		hard to lose 1 electron
K		
Rb		
Cs		most reactive
		loses 1 electron easily

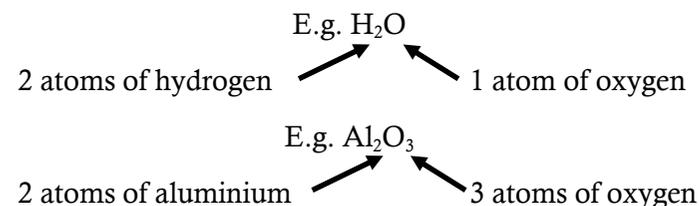
Unit 1: Atomic Structure and the Periodic Table

Changing ideas about atoms



Formulae

Chemical formulae show you the number of atoms of each type in a compound



Early Periodic Table

- An early version of the Periodic Table was developed by Russian chemist, **Mendeleev**
- He, and others before him like Newlands, arranged the elements according to their **atomic weight** (as protons had not yet been discovered)
- This meant some elements were placed in inappropriate looks (e.g. look at potassium and argon).
- Mendeleev new his table was imperfect. He left gaps to allow him to place elements with similar **chemical properties together**.
- Later, as more elements were discovered, these gaps were filled.

Metals and Non-Metals

- Metals are found on the **left** of the Periodic Table. Non-metals are found on the **right** of the table.
- They react to form **positive ions**.
- They are strong, hard, usually solid (because they have **high melting points**), **malleable** (they can be hammered into shape) and shiny.