

# CHEM 1 ATOMS & ATOMIC STRUCTURE

Use of the Periodic Table to summarise and systematise chemical and physical properties.

## Chemical symbols, the Periodic table

**Matter** : Elements are the building blocks of all Matter. Matter contains Elements in their pure form, or in combinations in compounds or mixtures, and Matter may exist as a Solid, Liquid or Gas.

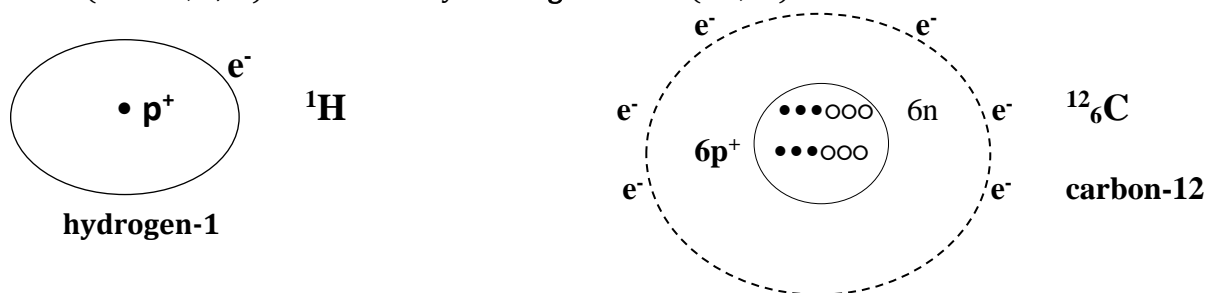
**Atoms** of elements are the fundamental particles from which matter is constructed.

**Atoms and Molecules are uncharged species**, eg., He H<sub>2</sub> O<sub>2</sub> CO<sub>2</sub> C<sub>8</sub>H<sub>18</sub>, CH<sub>3</sub>COOH, C<sub>2</sub>H<sub>5</sub>OH

**Ions are charged particles**, eg., Na<sup>+</sup> Ca<sup>2+</sup> NH<sub>4</sub><sup>+</sup> Cl<sup>-</sup> NO<sub>3</sub><sup>-</sup> SO<sub>4</sub><sup>2-</sup>

## Structure of atom

Bohr planetary model (electron treated as a particle): nucleus contains **protons** (+ve, •, p) and **neutrons** (neutral, o, n) surrounded by **orbiting electrons** (-ve, e<sup>-</sup>)



**Atomic number (Z), Mass number (A):** e.g.  ${}^A_Z\text{H}$

Isotopes eg., hydrogen  ${}^1_1\text{H}$  deuterium (D)  ${}^2_1\text{H}$  tritium (T)  ${}^3_1\text{H}$

${}^{12}_6\text{C}$  ( stable, 99% abundance)  ${}^{13}_6\text{C}$  (Stable, 1% abundance)  ${}^{14}_6\text{C}$  (Radioactive)

${}^{19}_9\text{F}$  (stable, 100 %)  ${}^{35}_{17}\text{Cl}$  (stable, 76% )  ${}^{37}_{17}\text{Cl}$  (stable 24 % )

**Electronegativity (EN), the power of an atom to attract electrons.**

Atoms at top right of Periodic Table have *largest EN* and so attract electrons strongly to *form anions*, whilst those at bottom left have *smallest EN* and readily give up electrons to *form cations*.

Group	1	2	Transition metals	3	4	5	6	7	8
	<b>LOW EN</b>  Lose e <sup>-</sup> s <b>Form cations</b> $M^{n+}$		Usually +1, +2 or +3 Cations $M^{n+}$ Also oxo-anions eg $MnO_4^-$ $Cr_2O_7^{2-}$	<b>HIGH EN</b>  Gain e <sup>-</sup> s <b>Form anions</b> $X^{a-}$					

### SIZE of atoms and ions:

INCREASES down a Group (vertical column) due to electrons entering a new shell,  
 but DECREASES across a Period (horizontal row) due to increasing nuclear charge.

### Common Ions

Cations	Transition metals	Anions
H <sup>+</sup> Li <sup>+</sup>	Cr <sup>2+</sup> Cr <sup>3+</sup> Mn <sup>2+</sup> Fe <sup>2+</sup> Fe <sup>3+</sup> Co <sup>2+</sup> Co <sup>3+</sup>	F <sup>-</sup> Cl <sup>-</sup> Br <sup>-</sup> I <sup>-</sup> (halide) OH <sup>-</sup> (hydroxide) O <sup>2-</sup> (oxide) S <sup>2-</sup> (sulphide) CO <sub>3</sub> <sup>2-</sup> (carbonate) HCO <sub>3</sub> <sup>-</sup> (bicarbonate) SiO <sub>4</sub> <sup>4-</sup> (silicate) PO <sub>4</sub> <sup>3-</sup> (phosphate) NO <sub>2</sub> <sup>-</sup> (nitrite) NO <sub>3</sub> <sup>-</sup> (nitrate) SO <sub>3</sub> <sup>2-</sup> (sulphite) SO <sub>4</sub> <sup>2-</sup> (sulphate) <b>MnO<sub>4</sub><sup>1-</sup> (permanganate, purple)</b> <b>CrO<sub>4</sub><sup>2-</sup> (chromate, yellow) Cr<sub>2</sub>O<sub>7</sub><sup>2-</sup> (dichromate, orange)</b> OCl <sup>-</sup> (hypochlorite) ClO <sub>2</sub> <sup>-</sup> (chlorite) ClO <sub>3</sub> <sup>-</sup> (chlorate) ClO <sub>4</sub> <sup>-</sup> (perchlorate) IO <sub>3</sub> <sup>-</sup> (iodate)
Na <sup>+</sup> K <sup>+</sup>	Ni <sup>2+</sup>	
Cs <sup>+</sup>	Cu <sup>+</sup> Cu <sup>2+</sup>	
Mg <sup>2+</sup> Ca <sup>2+</sup>	Zn <sup>2+</sup> Ag <sup>+</sup>	
Ba <sup>2+</sup>		
NH <sub>4</sub> <sup>+</sup> (ammonium)		

### COMMON COMPOUNDS

Sodium hydroxide	Na <sup>+</sup> OH <sup>-</sup>	caustic soda (a strong base)
Potassium hydroxide	K <sup>+</sup> OH <sup>-</sup>	caustic potash (a strong base)
Sodium chloride	Na <sup>+</sup> Cl <sup>-</sup>	table salt
Magnesium sulphate	Mg <sup>2+</sup> SO <sub>4</sub> <sup>2-</sup>	Epsom salts
Calcium sulphate	Ca <sup>2+</sup> SO <sub>4</sub> <sup>2-</sup>	gypsum, plaster of Paris
Calcium phosphate	Ca <sup>2+</sup> <sub>3</sub> (PO <sub>4</sub> <sup>3-</sup> ) <sub>2</sub>	bones/teeth
Ammonium nitrate	NH <sub>4</sub> <sup>+</sup> NO <sub>3</sub> <sup>-</sup>	fertilizer
Ammonium sulphate	(NH <sub>4</sub> <sup>+</sup> ) <sub>2</sub> SO <sub>4</sub> <sup>2-</sup>	fertilizer
Sodium carbonate	(Na <sup>+</sup> ) <sub>2</sub> CO <sub>3</sub> <sup>2-</sup>	washing soda
Sodium bicarbonate	Na <sup>+</sup> HCO <sub>3</sub> <sup>-</sup>	cooking soda, bicarb soda
Potassium iodate	K <sup>+</sup> IO <sub>3</sub> <sup>-</sup>	an oxidant
Potassium permanganate	K <sup>+</sup> MnO <sub>4</sub> <sup>-</sup>	'condy's crystals' an oxidant
Potassium dichromate	(K <sup>+</sup> ) <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> <sup>2-</sup>	an oxidant
Sodium hypochlorite	Na <sup>+</sup> OCl <sup>-</sup>	'pool chlorine'
Iron(III)oxide	(Fe <sup>3+</sup> ) <sub>2</sub> (O <sup>2-</sup> ) <sub>3</sub>	'rust'
Hydrochloric acid	HCl	pool acid
Nitric acid	HNO <sub>3</sub>	powerful oxidizing acid
Sulphuric acid	H <sub>2</sub> SO <sub>4</sub>	battery acid
Phosphoric acid	H <sub>3</sub> PO <sub>4</sub>	rust protector
Methane	CH <sub>4</sub>	natural gas
Octane	C <sub>8</sub> H <sub>18</sub>	gasoline

Benzene	$C_6H_6$	gasoline
Ethylene (ethene)	$C_2H_4$	Fruit ripening agent/cling wrap
Acetylene ( ethyne)	$C_2H_2$	Welding gas
Methanol	$CH_3OH$	'wood alcohol'
Ethanol	$C_2H_5OH$	'alcohol' ethyl alcohol
Acetic acid	$CH_3COOH$	vinegar
Di-ethyl Ether	$(C_2H_5)_2O$	'ether', an anaesthetic
Chloroform	$CHCl_3$	solvent, anaesthetic
Ammonia	$NH_3$	cleaning products, refrigerant
Hydrogen sulphide	$H_2S$	"Rotten egg gas"
Phosphine	$PH_3$	Grain silo fumigant/insecticide