Atomic Structure-1

Structure of an atom

Particle	Location	Relative mass	Relative charge
Proton	Nucleus	1	+1
Neutron	Nucleus	1	0
Electron	Shells	$\left(\frac{1}{1840}\right)$	-1

Mass number & Atomic number

$^{M}_{P}\mathbf{X}$

X: symbol of the element
M: mass number or nucleon number
M=number of neutrons + number of protons
P: atomic number
P = number of protons

Relative molecular mass (M_r) & relative formula mass

The relative formula mass is the term used to denote ionic compounds that do not exist as individual molecules.

$$(M_r) = \frac{Average\ mass\ of\ one\ molecule}{one - twelfth\ of\ the\ mass\ of\ one\ carbon - 12\ atom}$$

Applications of mass spectroscopy

Mass spectrometer: Separates the atoms of a sample according to their masses. Used for finding the composition of each isotope in a sample. This data is used to calculate A_r.

Time of Flight (TOF) Mass spectrometer: Sample is dissolved in polar, volatile solvent and is injected via a narrow capillary tube. Steps:

- Electron spray ionisation
- Acceleration (K.E=1/2mv^2)
- Ion drift (t=d/v): Lighter particles travel faster.
- Ion detection
- Data analysis (relative abundance vs. m/z)

Isotopes & Relative Atomic Mass (A_r)

Isotopes: Different forms of the same element having different masses. Same number of protons but a different number of neutrons.

$$(A_r) = \frac{Average\ mass\ of\ one\ atom\ of\ an\ element}{one - twelfth\ of\ the\ mass\ of\ one\ carbon - 12\ atom}$$

$$A_r = \frac{sum(isotopic\ mass \times relative\ abundance)}{total\ relative\ abundance}$$

Ions

Neutral Atom

Loss of electron(s) → Cation (+)

Gain of electron(s) → Anion (-)

Atomic Structure-2

Electronic configuration

Quantum shell	Maximum number of electrons
n=1	2
n=2	8
n=3	18
n=4	32

The electrons around the nucleus are arranged in principal quantum shells (symbol n).

Ionisation energy

First ionisation energy of an element is the state to form gaseous 1+ ions. energy required to remove one electron from each atom in one mole of atoms of the element in its gaseous state.

The successive ionisation energies are always greater than the first ionisation energy.

Positive ions are formed when atoms lose electrons. Electrons are lost from the outermost shell.

Negative ions are formed when atoms gain electrons.

Quantum sub-shells

The principal quantum shells (except for n=1) are split into sub-shells. The sub-shells are named as s (sharp), p (principal) and d (diffuse).

Sub-shell	Number of electrons	Number of atomic orbitals
s	2	1
p	6	3
d	10	5

Electron configurations and the periodic table

The periodic table can be divided into four blocks:

s-block: outermost electrons in s sub-shell
p-block: outermost electrons in p sub-shell
d-block: outermost electrons in d sub-shell
f-block: outermost electrons in f sub-shell

Electron configurations

The electron configurations of an element denotes the number of electrons in each sub-shell in order.

Filling of orbitals

The shells are filled in the increasing order of energy levels.

Order:

1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, ...

Atomic orbitals

An atomic orbital is the region of space around the nucleus that can be occupied by one or two electrons