Atomic Structure | Topic Notes

Law of Conservation of Mass

- matter is neither created nor destroyed though it may change forms in the course of a chemical reaction

History of Atomic Structure

Dalton's Atomic Theory

- very small indivisible particles
- atoms of a given element are identical - same mass & chemical properties
- compound = 2+ elements combined in fixed proportions
- accounts for experimentally based laws - conservation of mass

Crookes' Vacuum Tubes, Cathode Rays

- discharge tube - long glass tube, electrode at each end, gas at low pressure
- rays from cathode to anode = cathode rays
- straight lines - maltese cross - sharp shadow in glow at end of tube

Stoney's Name

- named the particles of electricity electrons - adopted & replaced cathode rays

Thomson's Charge, e/m Ratio

- showed cathode rays were attracted to positive plate - ∴ negative
- measured e/m ratio using the fact that they are deflected by magnetic fields
- same e/m no matter what gas/electrode materials - ∴ in all matter

Millikan's Oil Drop Experiment

- voltage applied to fine mist of electrically charged oil drops - causes upward force
- adjusted until it balances gravity
- charge on electron measured accurately

Thomson's Plum Pudding Model

- knew majority of mass was positively charged
- positive spheres in which negatively charged electrons are embedded

Rutherford's Gold Foil

- Geiger & Marsden
- fire α-particles at thin gold foil
- large no. not deflected - essentially empty space
- many deflected at small angles
- some deflected at large angles - passed close to positive charge
- few rebounded - collided directly with a small, dense nucleus of positive charge
- model: mostly empty space, small dense nucleus at centre, electrons moving around to balance charge

Bohr's Model

- electrons arranged in a series of concentric circular orbits of increasing distance from the nucleus
- orbits had characteristic energy - ∴ called energy levels

Rutherford's Protons

- bombarded elements with α-particles
- same particle was given out
- identical to hydrogen nucleus
- concluded these are the positive charge in the nucleus of an atom

Chadwick's Neutron

- bombarded beryllium with α-particles
- the α-particles displaced the beryllium neutrons
- the beryllium neutrons hit and displaced paraffin wax protons
- protons detected

Properties of Electrons, Protons, Neutrons

Particle	Relative Mass	Relative Charge	Location
Electron	1/1836	-1	Outside nucleus
Proton	1	+1	In nucleus
Neutron	1	0	In nucleus

-

Atomic Number (Z)

- number of protons in the nucleus of an atom of that element
- gives: no. of protons, no. of electrons, position in the periodic table

Mass Number (A)

- sum of the no. of protons and neutrons in the nucleus of an atom of the element

Isotopes (hydrogen and carbon)

- same no. of protons but different no. of neutrons
- Hydrogen: ^{1}H / protium, deuterium, tritium
- Carbon: ^{12}C, ^{13}C, ^{14}C
- chemical properties depend on no. and arrangement of electrons
- same chemical properties
- physical properties are slightly different due to difference in mass

Relative Atomic Mass (A_r)

- The relative atomic mass of an element is the average mass of the isotopes of that element, as they occur naturally, taking abundances into account and expressed on a scale relative to $^{1}/_{12}$ of the mass of an atom of ^{12}C.

Calculations: Relative Atomic Masses

Silicon has the isotopic composition:
silicon-28 = 92.2%
silicon-29 = 4.7%
silicon-30 = 3.1%

- Ar = (0.922 x 28) + (0.047 x 29) + (0.031 x 30) = 28.11 amu

Spectrometer (use and processes)

Processes

Vaporisation - non-gaseous samples are vaporised

- Ionisation - high-energy electrons bombard atoms to form positive ions
- Acceleration - by an electric field
- Separation - ions are deflected sideways as they move through a magnetic field (lighter ions are deflected more than heavier ions)
- Detection - electric current is produced on striking & detected - current $\propto$ no. of ions of that particular type

Principle

- positively charged ions are deflected in circular paths according to their mass/charge ratio and are therefore separated

Uses

- carbon dating
- organic pollutants in water
- identifying unknown samples