## Atomic Structure

### Atoms

| Representation | Proton number: no of proton | Nucleon number: no of proton and neutron |
| --- | --- | --- |
| Isotopes | atoms of same element with different no of neutron | i.e. same no of proton, diff no of neutrons |
| | same no of $e^-$ = same chemical properties | diff no of neutron = diff mass = diff physical properties |

### Electronic structure of atom

3 levels

| Principle quantum shell | Energy band of shells separated by large energy gap | Numbered (1,2,3) | specifies energy of $e^-$, size of orbital, avg distance from nucleus |
| --- | --- | --- | --- |
| | Higher no = | further from nucleus = less strongly attracted | higher energy level of $e^-$ |
| Subshell | group of orbitals which share same shape and properties | 4 types: s, p, d, f | Energy: s<p<d<f |
| Orbitals | region of space with high possib­ility (>95%) of finding $e^-$ | each orbital can hold max 2 $e^-$, and must be of opp spin | |
| | s orbital | spherical | |
| | p orbital | dumbbell along axis | px, py, pz |
| | d orbital | 2 dumbbells on plain | d(xy), d(yz), d(xz) |
| | | 2 dumbbells cutting axis | $d(x^2-y^2)$ |
| | | dumbell cutting z-axis, donut at the centre | $d(z^2)$ |
| | f orbital | *NOT IN SYLLABUS* | |

### Effective nuclear charge

Strength of electrostatic forces of attraction felt by valence $e^-$ after accounting for shielding effect of inner electrons

$Z(eff) = Z - S$

| Z: nuclear charge | size of positive charge (no of protons) | larger = stronger EFoA |
| --- | --- | --- |
| S: shielding effect | decrease in EFoA btwn nucleus and $e^-$ due to repelling effect of inner $e^-$ | |
| | no of inner $e^-$ (no of inner PQN/ subshell) | more = weaker EFoA btwn nucleus and $e^-$ |

### Ionisation energy

energy required to remove 1mol of $e^-$ from 1mol of gaseous atoms to form 1mol of singly charged gaseous cations (1st IE)

Breaking EFoA = endothermic = always +ve

| Subsequent IE always greater than previous | stronger EFoA between more +vely charged nucleus and e | Z incr -> Z(eff) incr -> more E to overcome |
| --- | --- | --- |

Trend

| Down group | Z incr, but S incr more significantly => Z(eff) decr | valence $e^-$ to be removed are further from nucleus | |
| --- | --- | --- | --- |
| | | = EFoA decr | = less E req. to remove $e^-$ |
| | **= decr in IE** | | |
| Across period | S almost same as same PQN | Z incr as proton no incr | = Z(eff) incr |
| | | = incr EFoA | = more E req. to remove $e^-$ |
| | **= incr in IE** | | |
| Anomaly: within period | G2 > G13 | p-orbital $e^-$ at higher E than s-orbital $e^-$ | |
| | | = less E req to be ionised | |

## Ionisation energy (cont)

| | | | |
|---|---|---|---|
| | G15>G16 | $e^-$ from G16 is paired | = inter-$e^-$ repulsion in same orbital |
| | | | = less E req to ionise completely |
| When answering | 1. write both electronic config | | |
| | 2. change in Z, S, PQN, Z(eff) | | |
| | 3. change in EFoA and E req. | | |
| | 4. Effect on IE | | |
| Successive IE of an element | singly -> doubly charged | doubly -> triply charged | |
| | Z remains same (for same element), S decr => Z(eff) incr | | |
| | = more E req to overcome | | |
| | | Large incr in IE => change in PQN | |

## Structure of atoms

| Subatomic particles | Symbol | relative mass | relative charge | position in atom | actual mass | mvmt in E-field |
|---|---|---|---|---|---|---|
| Proton | p | 1 | +1 | nucleus | 1.67E-27 | deflect towards -ve plate |
| Neutron | n | 1 | 0 | nucleus | 1.67E-27 | no deflection |
| Electron | e | 1/1840 | -1 | orbitals | 9.11E-31 | deflect to +ve plate |

## Electronic configuration

Arrangement of $e^-$ in their principal quantum shells, subshells and orbitals

| Rules for arrangement | Pauli's exclusion principle | each orbital holds max 2 $e^-$, in opp spin | |
|---|---|---|---|
| | | each $e^-$ is a half arrow | opp spin = 1 point up, other point down |
| | Hund's rule | orbitals must be singly occupied first w/ parallel spin before pairing | to minimise inter-$e^-$ repulsion |
| | Aufbau principle | $e^-$ in ground state goes into empty orbital w/ lowest energy, before filling up next orbital of lowest energy | |
| | | as PQN incr, energy ga between sucessive shell decrease | eventually overlaps/converges |
| | | 3d vs 4s: fill and remove from 4s first | 4s lower E when empty, higher E when filled |

3 representation

| Written | 1s2 2s2 2p6 3s2 3p6 4s2 3d7 | | |
|---|---|---|---|
| | write 3d before 4s as 4s is higher energy | | |
| | Anomaly for Cr and Cu | Expected: [Ar] 4s2 3d4 *or* 3d9 | Actual: Expected: [Ar] 4s1 3d5 *or* 3d10 |
| | | symmetrical 3d cloud more energetically favourable | close E levels allow for rearrangement |

| Electronic configuration (cont) | | |
|---|---|---|
| Drawn config | Draw lines representing orbitals | fill up with e⁻ accordingly |
| Energy level diagram | y axis: E level | . |
| | each subshell occupies the same E level | . |
| | spaces btwn subshell decrease as E incr | . |