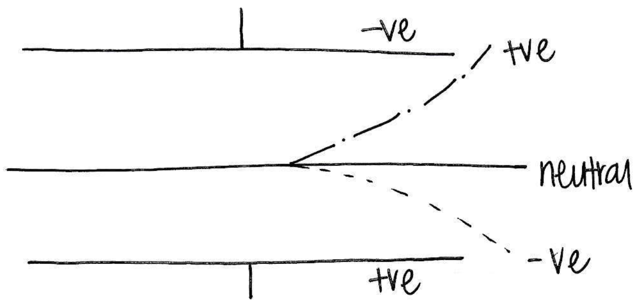
Chapter 3: Atomic Structure

Angle of deflection

angle of deflection $\propto \frac{\text{charge}}{\text{mass}}$



Isotopes

Isotopes are atoms of the same element with the same number of protons but a different number of neutrons.

- same chemical properties
  ↳ same no. of e^-
- different physical properties
  ↳ different masses

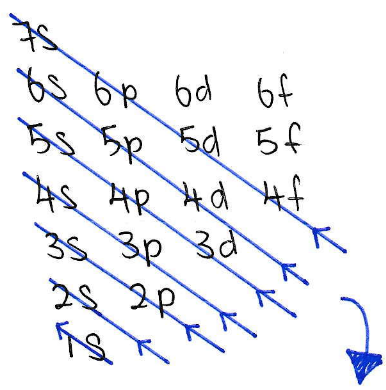
Electron shells

Subshells: (1) s
(2) p
(3) d
(4) f

— same subshell, same energy level → degenerate orbitals

each orbital can hold up to 2 electrons

subshell	no. of orbitals	no. of e^-
s	1	2
p	3	6
d	5	10
f	7	14



energy level

1s < 2s < 2p < 3s < 3p < 4s < 3d < 4p < 5s < 4d < 5p < 6s < 4f < 5d < 6p < 7s

Rules of electron arrangement

Aufbau Principle: electrons always fill orbitals of lower energy first before proceeding to fill orbitals of higher energy

Pauli Exclusion Principle: each orbital can only hold 2 electrons and they must have opposite spins

Hund's Rule: when a number of degenerate orbitals are available, electrons occupy them singly first before pairing occurs

example : V (atomic no. 23)

electron-in-box notation : [↑↓] 1s [↑↓] 2s [↑↓][↑↓][↑↓] 2p [↑↓] 3s [↑↓][↑↓][↑↓] 3p [↑][↑][↑][ ][ ] 3d [↑↓] 4s

★ simplified notation : $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3 4s^2$

abbreviated notation : $[Ar]\ 3d^3 4s^2$

↳ this electronic configuration must have appeared in the question previously

* put electrons into 4s before 3d
remove electrons from 4s before 3d

Exceptions must memorise!

Cr : $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$
Cu : $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$

} fully-filled and half-filled 3d orbitals have higher stability

Periodic Table

1s		1s
2s		2p
3s		3p
4s	3d	4p
5s	4d	5p
6s	5d	6p
7s	6d	7p

Group 1 → ns^1
Group 2 → ns^2
Group 13 → ns^2np^1
Group 14 → ns^2np^2
Group 15 → ns^2np^3
Group 16 → ns^2np^4
Group 17 → ns^2np^5
Group 18 → ns^2np^6

Ionisation Energies

First ionisation energy of an element is the amount of energy required to remove one mole of electrons from one mole of gaseous atoms, producing one mole of gaseous ions with a single positive charge.

$X(g) \rightarrow X^+(g) + e^-$

1st IE < 2nd IE < 3rd IE

electrostatic forces of attraction
- Effective nuclear charge
  - shielding effect
  - nuclear charge
- Distance
  - number of electron shells

between different elements

Across a Period

General increase in 1st IE
- increase in nuclear charge due to higher number of protons
- relatively constant shielding effect due to same number of inner shell electrons
- effective nuclear charge increases

Down a Group

General decrease in 1st IE
- greater distance between valence electrons and nucleus due to an increase in number of electron shells

Successive IE for the same element

General increase

Becomes more endothermic
- extra energy needed to overcome the electrostatic attraction between the leaving electron and ions of increasing positive charge

Much larger than usual increase

When successive electrons are removed from different quantum shells. A much larger amount of energy is required to remove electrons in an inner shell as it is closer to the nucleus and hence experiences greater electronic forces of attraction.

Slightly larger than usual increase

When successive electrons are removed from a different subshell within the same quantum shell for example ns and np subshell

Since the ns subshell is lower in energy than the np subshell, a slightly larger amount of energy is required to remove the successive electron.