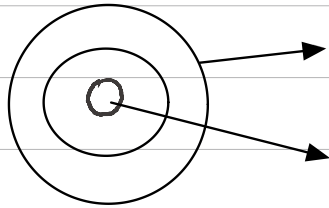
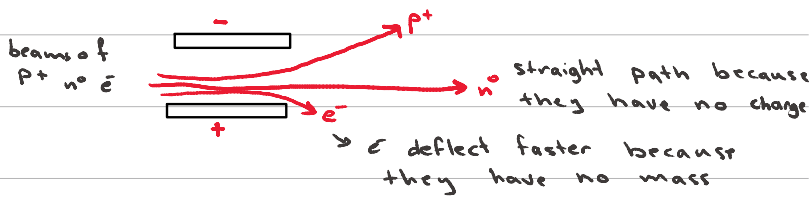
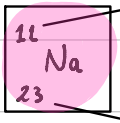
CH 1/2 Atomic Structure



subatomic particles	charge	mass
protons	+	1
neutrons	no charge	1
electrons	-	$\frac{1}{1836} \approx 0$

When p^+, n°, e^- pass through charged plates they **deflect** towards the **opposite plate**





atomic number = number of protons
(number of electrons in natral atom)

mass number = protons + neutrons

Atom: the **smallest part** of an element that contains **protons** and **neutrons** in the nucleus, and **electrons** in shells. Exception: hydrogen isotope $^{1}_{1}H$ has no neutrons.

Isotope: **atoms** of the **same element** with different **mass numbers**

Ions: **charged particles** formed by the loss or gain of electrons

Loss of electrons forms +ve ions

gain of electrons forms -ve ions

	p+	e⁻	n°
$^{40}_{19}K^{+1}$ (losing 1 é)	19	18	40 − 19 = 21
$^{18}_{8}O^{-2}$ (gaining 2 é)	8	10	18 − 8 = 10

Atomic radius : increases down group → more shells → more shielding → valence e^- far from nucleons and less attracted

decreases across the period (going to the right) → more protons → increase of nuclear charge → more attraction for the outer electrons

Ionic radius : Across the period :

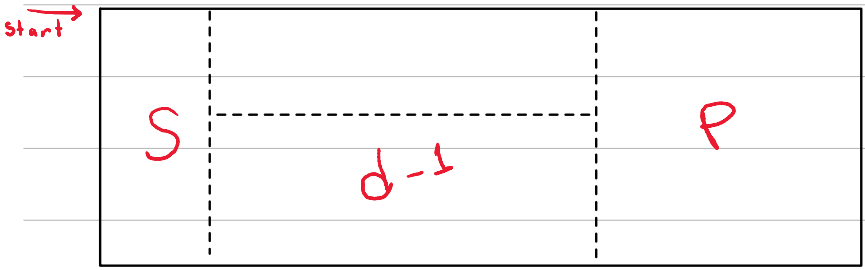
+ve ions ← | −ve ions →

radius decreases | radius increases

Why? more protons than e^- → more attraction | why? less protons than e^- → less attraction

Down the group → increases → more shells.

Electron configuration



electrons are arranged in subshells : s, p, d, f

each subshell has orbitals that contains 2 e^- maximum

s ↑↓ 1 orbital , 2 e^- maximum

p ↑↓ ↑↓ ↑↓ 3 orbitals , 6 e^- maximum

d ↑↓ ↑↓ ↑↓ ↑↓ ↑↓ 5 orbitals , 10 e^- maximum

electrons must added one per each orbital

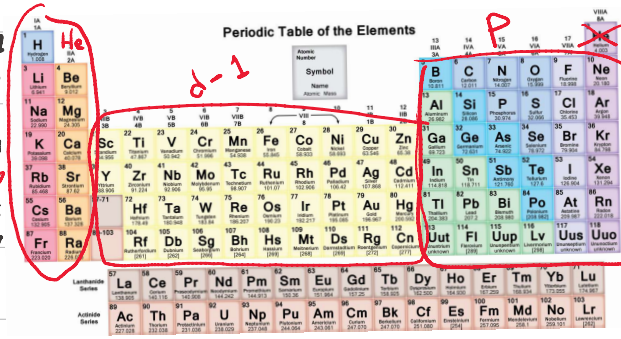
the double each one. → electrons in orbitals spin in different directions to overcome repulsion.

writing electron configuration :

Start from period 1 n=1 then → Subshell

then → number of groups in the subshell

e.g. Na : $1s^2$ $2s^2$ $2p^6$ $3s^1$ → valence e^-



noble gas configuration: use noble gas that comes directly before the element, then continue adding up shells

e.g. Ge: $[Ar]\ 4s^2\ 3d^{10}\ 4p^2$; Ge is in group 4

4 e^- in the valence shell

full e^- configuration

n-1 for d subshell

First Ionisation Energy: energy required to remove 1 mole of electrons from 1 mole of gaseous atom to form 1 mole of gaseous +1 ions.

equation: $Na_{(g)} \rightarrow Na^{+1}_{(g)} + 1e^-$

e.g. third ionisation energy for Aluminum:

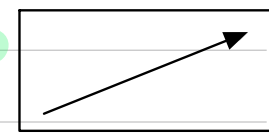
$$Al^{+2}_{(g)} \rightarrow Al^{+3}_{(g)} + 1e^-$$

we must remove 1 e^- only

Factors affecting ionisation energy

1. **Nuclear charge**: more p^+ → greater nuclear charge attraction to the outer e^- → greater IE
2. **Atomic radius**: larger radius → weaker attraction between positive nucleus and negative e^- → lower IE
3. **Shielding**: more shells → more shielding → weaker attraction between e^- and nucleus → lower IE
4. **Spin pair repulsion**: electrons in the same orbital repel each other → lower IE

General trend: IE increases up and right periodic table



Why? less shells and more protons → more nuclear charge effect → more IE needed to remove e^-

exceptions: between groups 2 and 3

more IE ↑ ↖ less IE

s^2 p^1 → easy to remove e^-, farther from nucleus

between groups 15 and 16

e.g. N and O

configuration: $2p^3$ $2p^4$

↑ ↑ ↑ ↑↓ ↑ ↑

half shell more stable more IE

↓ spin pair repulsion less IE

same exception in d subshell groups 7 and 8

e.g. Mn and Fe

$3d^5$ $3d^6$

↑ ↑ ↑ ↑ ↑ ↑↓ ↑ ↑ ↑ ↑

half shell more stable more IE

spin pair repulsion less IE

Successive ionisation energy: removing one mole of e^- from 1 mole of gaseous ion.

* increases because radius decreases across period → greater attraction between outer e^- and nucleus.

$Al_{(g)} \rightarrow Al^{+}_{(g)} + 1e^-$ IE_1 577 $kJ\ mol^{-1}$

$Al^{+1}_{(g)} \rightarrow Al^{+2}_{(g)} + 1e^-$ IE_2 1800 $kJ\ mol^{-1}$

$Al^{+2}_{(g)} \rightarrow Al^{+3}_{(g)} + 1e^-$ IE_3 2700 $kJ\ mol^{-1}$

$Al^{+3}_{(g)} \rightarrow Al^{+4}_{(g)} + 1e^-$ IE_4 25000 $kJ\ mol^{-1}$

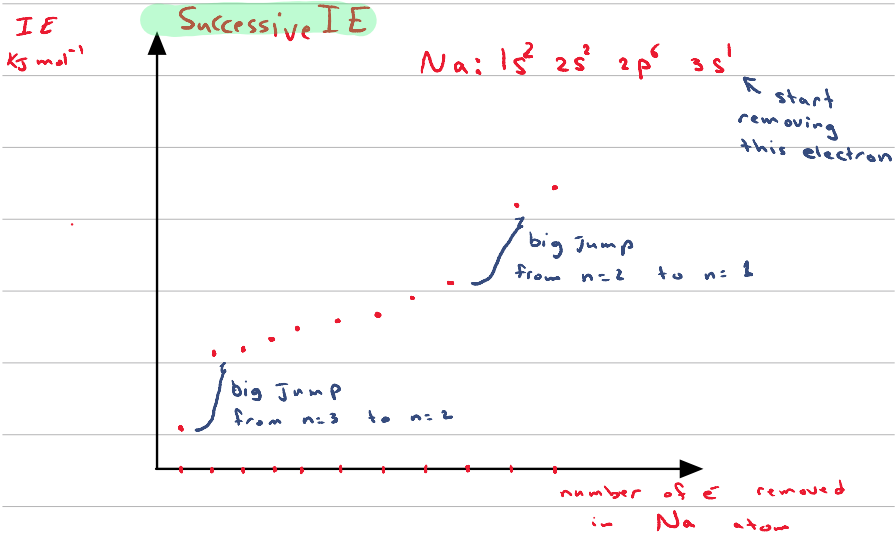
A large jump

indicates that 3 e^- removed from valence shell but the fourth e^- removed from inner shell

* number of IE values before the jump indicates number of e^- in the outer shell therefore group number

two important graphs

Successive IE



General trend: IE increases across the period →