PERIODICITY

Periodic Table

- consists of **rows**, or ....
- **columns**, or ....
- is split into several blocks
- in each block the elements are filling, or have just filled, particular types of orbital

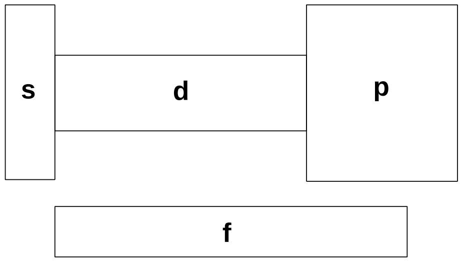
Group(s)

s block ....

p block ....

d block ....

f block ....



The outer electron configuration is a periodic function ***i.e. it repeats every so often***

Because many physical and chemical properties are influenced by the outer shell configuration of an atom, it isn't surprising that such properties also exhibit periodicity...

ionisation energy, electron affinity, atomic radius, ionic radius, electronegativity, melting points and boiling points

Periods

Introduction

- the first two periods in the periodic table are not typical
- the first contains only two elements (H, He)
- the second (Li - Ne) contains the top elements of each group; these have small sizes and relatively high ionisation energies
- Period 3 is best for studying periodic trends.

Period 3

Elements As you move from left to right the elements go from highly electropositive metals through metalloids with giant structures to the simple molecular structure of non-metals.

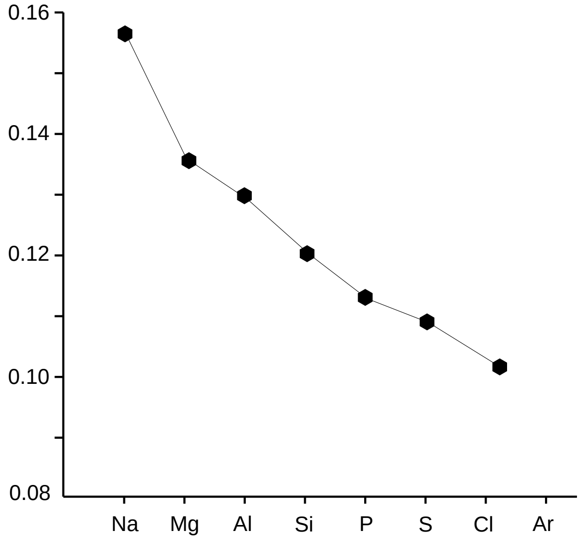
Na	**Mg**	**Al**	**Si**	**P_4**	**S_8**	**Cl_2**	**Ar**
< - - - -	*metals* -	- - - >	*metalloid*	< - *non metals*	*(simple*	*molecules)*	- >

Initially one is filling the 3s orbital then the 3p orbitals

The nuclear charge increases by one each time giving an increased pull on the electrons.

Atomic Radius

A problem with measuring atomic radius is that one is not measuring the true radius of an atom. In metals one measures the metallic radius (half the distance between the inter-nuclear distance of what are effectively ions). Covalent radius is half the distance between the nuclei of atoms joined by a covalent bond. The values are measured by X-ray or electron diffraction.



UNITS:- nanometres

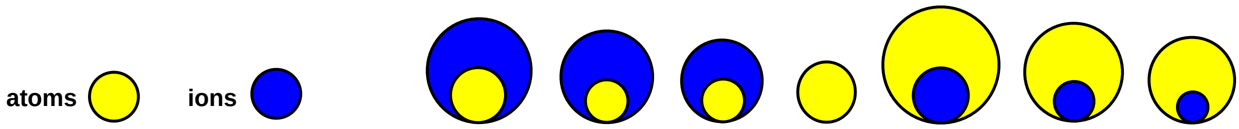
Decreases across a given period

due to ...

increased nuclear charge attracting the electrons
(which are going into the same shell) more strongly.

Argon's value cannot be measured as it doesn't form compounds.

Q.1 *Explain the variation in atomic and ionic size for the following isoelectronic species.*

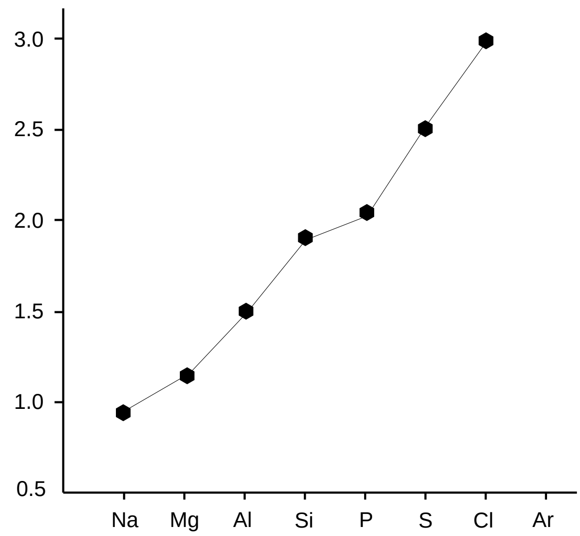


	N^{3-}	O^{2-}	F^-	Ne	Na^+	Mg^{2+}	Al^{3+}
Protons	7	8	9	10	11	12	13
Electrons	10	10	10	10	10	10	10

Electronegativity

A measure of the attraction an atom has for the electron pair in a covalent bond.
Do not confuse with electron affinity.

UNITS:- Pauling Scale



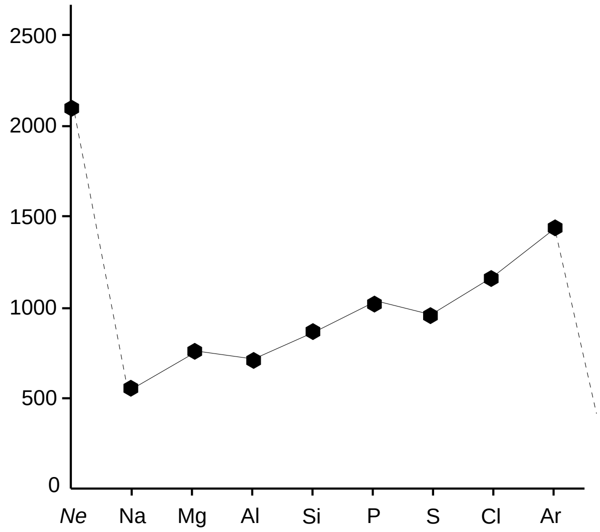
Groups **Decreases down a group.**

Periods **Increases across a period**
As the nuclear charge increases so does the attraction for the shared pair of electrons in a covalent bond.

Ionisation Energy *e.g.* $M_{(g)} \longrightarrow M^{+}_{(g)} + e^{-}$

Groups **Decreases down a group**

Despite the increase in nuclear charge, the increased shielding and the increased distance from the nucleus means the electrons are held less strongly and need less energy for their removal.



Periods **Increases across a period**

Nuclear charge increases by one each time. Each extra electron, however, is going into the same main energy level so is subject to similar shielding and is a similar distance away from the nucleus. The electrons are held increasingly more strongly and are harder to remove.

BUT...

Minor differences occur...

aluminium — 1st Ionisation Energy is lower than that of magnesium because of the **shielding effect** of the newly filled 3s orbital.

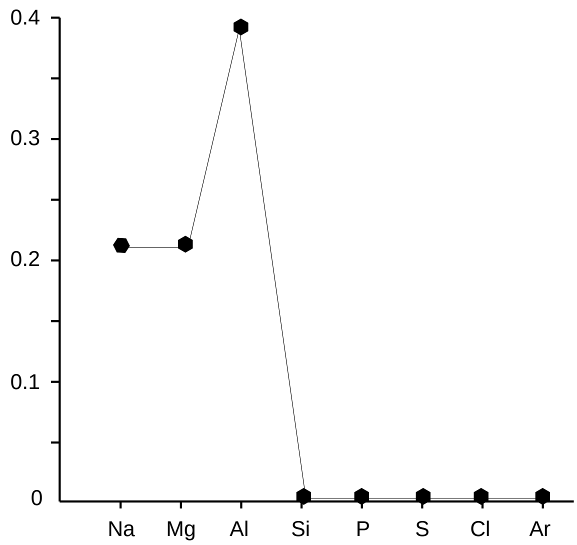
sulphur — 1st Ionisation Energy is less than that of phosphorus due to additional repulsion between the newly **paired up electrons** in one of the p orbitals.

Electrical conductivity

Electrical conductivity takes place when ions or electrons are free to move.

UNITS:- Siemens per metre

Groups Where there is any electrical conductivity, it **Decreases down a group.**



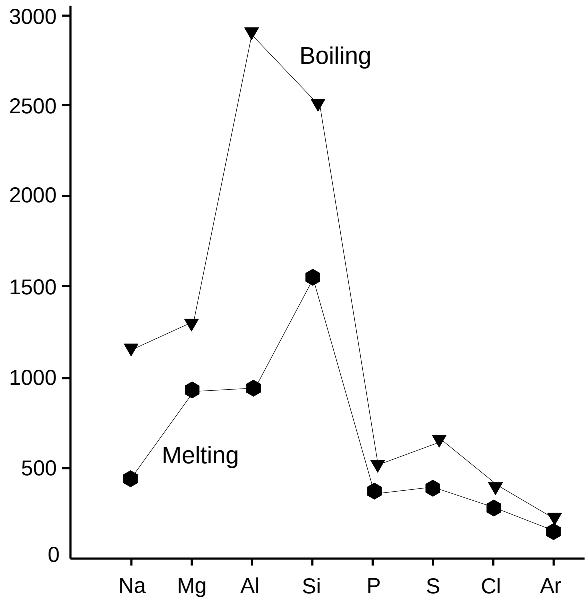
Periods **Decreases across a period**

Na, Mg, Al — metallic bonding with delocalised electrons

Si, P, S, Cl — covalently bonded so no electrons are free to move

Ar — monatomic so electrons are held very tightly

Melting Point & Boiling Point



Boiling and melting points are a measure of the energy required to separate the particles in a substance.

Bond type is significant.

Boiling points tend to be a better measure and show better trends because solids can be affected by the crystal structure as well as the type of bonding.

UNITS:- Kelvin

Periods A general increase then a decrease

Metals

Na-Al Melting point **increases** due to the increasing **metallic bonding** caused by ...

- larger number of electrons contributed to the "cloud"
- larger charge and smaller size of ions gives rise to a larger charge density.

Non-metals

Si Large increase in melting point as it has a **giant molecular structure** like diamond
A lot of energy is required to break the many covalent bonds holding the atoms together.

P, S, Cl Very much lower melting points as they are simple covalent molecules
The melting point depends on the weak intermolecular van der Waals forces.
The larger the molecule the greater the van der Waals' forces

	P_4	**S_8**	**Cl_2**
relative mass	124	256	71
melting point	**44°C**	**119°C**	**-101°C**

Shape of P_4 *Shape of S_8*

Ar Monatomic species with the lowest melting point