Trends In The Periodic Table

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1 Trends In Atomic Radii

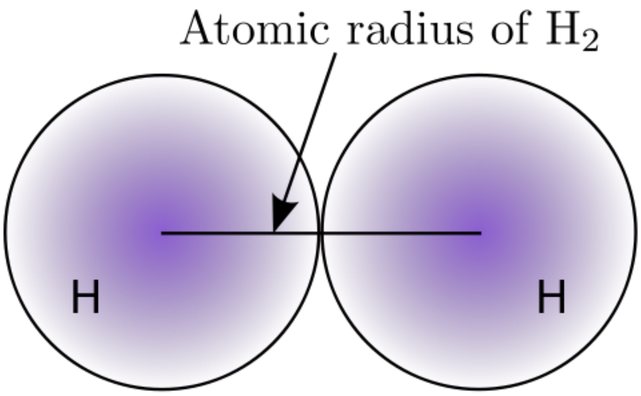

Figure 1: A visual representation of the atomic radius of a hydrogen atom. The measurement would be taken as one-half the distance between the nuclei of the hydrogen atoms in a diatomic hydrogen molecule.

DEFINITION

Atomic Radii.

Half the distance between the nuclei of two atoms of the same element that are joined together by a single covalent bond.

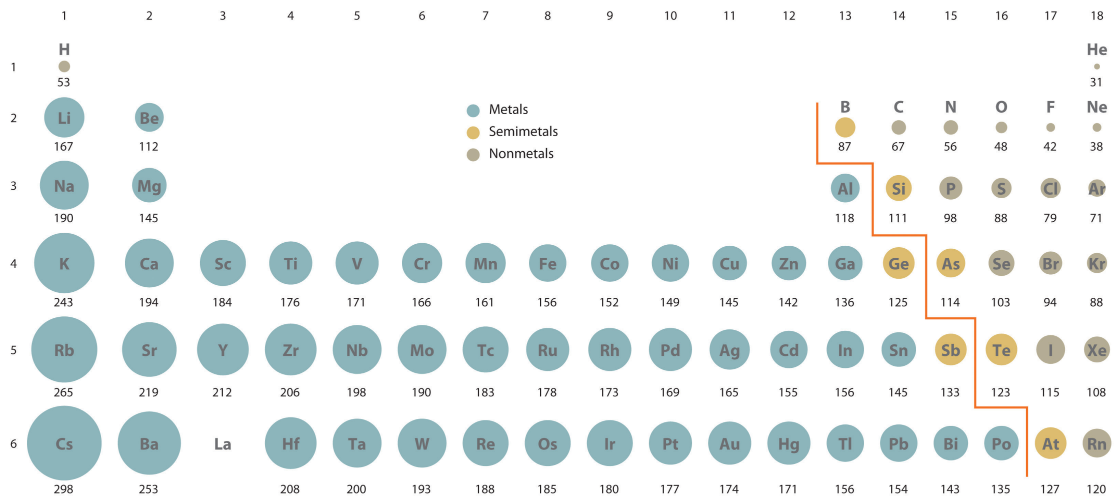

Figure 2: Calculated Atomic Radii (pm)

- The atomic radii **decrease across** a group for two reasons:

  - The increased nuclear charge (number of protons) has a greater attractive force on the electrons
  - There is very little screening affect from other electrons

- The atomic radii **increase down** a group for two reasons:
  - The increasing number of shells, this means that even though there is added protons their influence is lessened on the electrons.
  - There is a greater screening affect on the electrons as shells are added.

1.1 Nuclear Charge

Nuclear charge talks about how attracted the electrons in the orbitals are to the positive charge in the electrons.

- The smaller the atom (in terms of orbitals), the larger the nuclear charge
- Larger atoms have more orbitals, and smaller nuclear charge

1.2 Screening Effect

- Inner electrons will insulate the outer electrons
- As you move across the row, there is now extra orbitals, so no screening effect.

TODO: Put In

2 Ionisation Energies

NOTE: This definition comes up almost every year.

DEFINITION **First Ionisation Energy.**

The minimum energy required to completely remove the most loosely bound electron from a neutral gaseous atom in its ground state.

DEFINITION **Second Ionisation Energy.**

The energy required to remove an electron from an ion with one positive charge in its gaseous state.

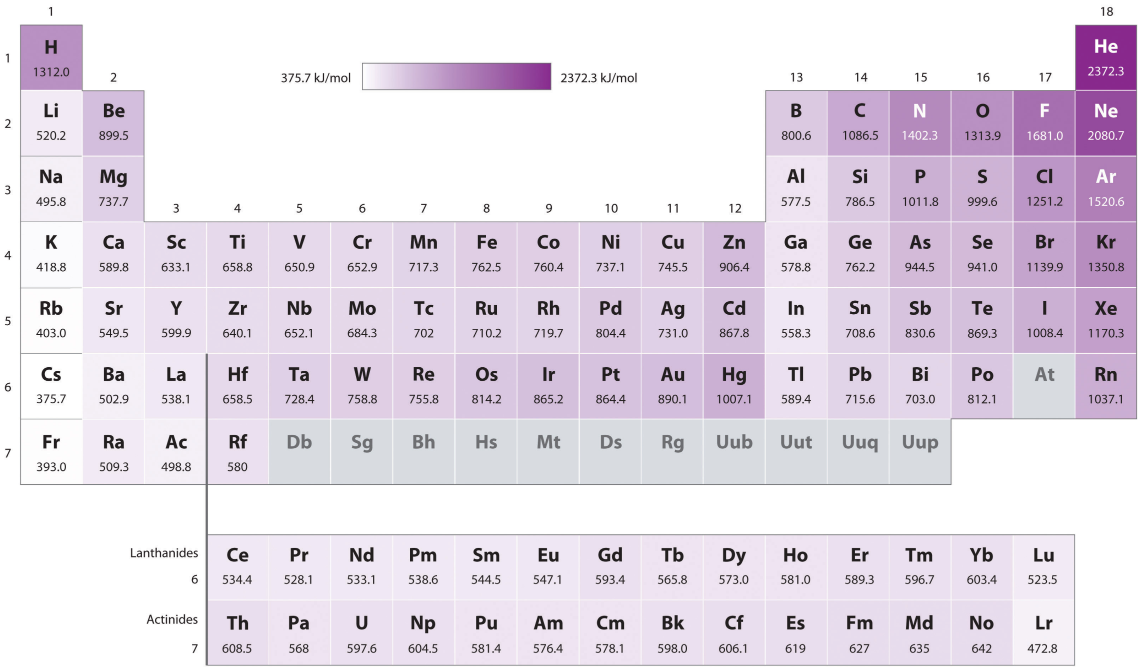

Figure 3: Table Of Ionisation Energies

- They **increase across** a period for two reasons:
  - The increased nuclear charge (no. of protons) has a greater attractive force on the electrons.
  - Decreased atomic radius means the electrons in the outermost shell are closer to the nucleus.

- They **decrease down** a group for two reasons:
  - Increasing atomic radii means the outermost electrons are further from the nucleus.
  - The increased screening effect means the outermost electrons are loosely held but the nucleus therefore easier to remove.
  - There are exceptions to the rules.

2.1 Exceptions

Look at the SPD Configuration for the following:

- Be: 1s2 2s2
- N: 1s2 2s2 2px1 2py1 2pz1
- Mg: 1s2 2s2 2p6 3s2
- P: 1s2 2s2 2p6 3s2 3px1 3py1 3pz1

Elements with full outer shell (or even half filled outer shell) will have higher ionization energies.
Note that the ionization energies are evidence of atomic sublevels.

- These exceptions to the rule further explain the existence of energy levels.
- Once the first electron is moved an ion is formed.
- When an atom looses an electron it becomes positively charged.
- The second ionisation energy is always higher than the first.
- This continues to happen as more and more electrons are removed from the atom, especially when moving to another shell.

3 Electronegative

DEFINITION

Electronegative.

The electrostatic force of attraction an atom has for a shared pair of electrons in a covalent bond.

- Electronegativity **increases across** the period because:
  - Increasing nuclear charge therefore the electrons involved in bonding are closer to the nucleus.
  - Decreasing atomic radii this causes the electrons to be more attracted to the nucleus therefore increased electronegativity
- The electronegativity **decreases down** a group because:
  - Increasing atomic radii
  - Screening effect of other electrons.

3.1 Trends in the Alkali Metals

- The alkali metals are **very reactive** and none of them appear free in nature.
- They have **low ionisation energies** and **low electronegativity** energies therefore they have a tendency to loose electrons and form ionic compounds
- The more easily the outer electron is lost the more reactive the metal.

3.1.1 Reactions with Oxygen

- All metals react with oxygen to form oxides
- $2\,K + \frac{1}{2}\,O_2 \longrightarrow K_2O$
- For this reason the alkali metals must be stored under oil

3.1.2 Reactions with Water

- The alkali metals react with water to form hydroxides and hydrogen gas is given off.
- This hydrogen gas ignites causing flames to be released
- $Na + H_2O \longrightarrow NaOH + \frac{1}{2}\,H_2$

3.2 Trends in the Halogen

- The Halogens are the **most electronegative** elements.
- Fluorine is the most electronegative of the halogens and the most electronegative in the periodic table.
- The halogens do not exist free in nature
- They are quite reactive as they have a **great attraction for electrons**.
- Halogens get more reactive as you go up the column, the opposite of alkalis.
- A substance that **removes electrons** from other substances is an **oxidising agent**.
- If chlorine gas is bubbled through bromine the chlorine takes electrons from the bromine ions and coverts them into bromide.
- $Cl_2 + 2\,Br^- \longrightarrow 2\,Cl^- + Br_2$