Periodic Trends

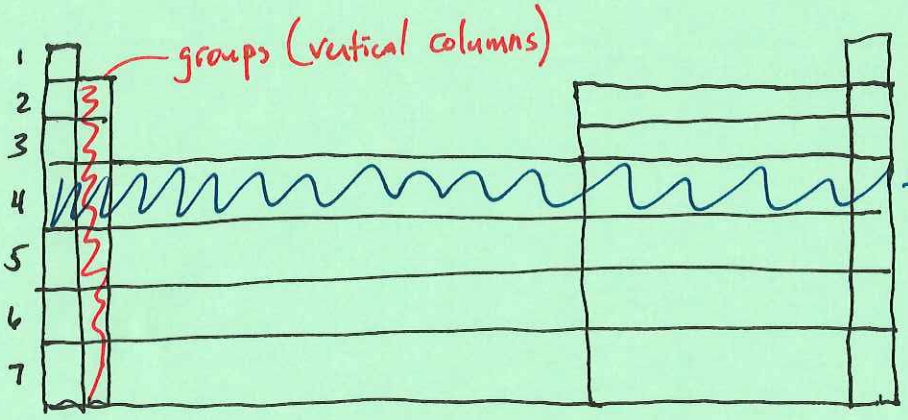
↳ elements display trends in their properties when they are arranged in increasing atomic number

Intro: Periodicity can be explained qualitatively with Coulombs Law, the shell model of the atom, and shielding because of the regular variations that occur in the electronic structure of atoms

Coulombs Law ⟹ Force of attraction/repulsion are proportional to the charges present and inversely proportional to the square of the distance between them

$$F \propto \frac{Q_1 Q_2}{r^2}$$

(*) r^2 ➡ (energy shells) matters more so than charges (*)



Period (side to side)

Across Period →

- VE added in same shell
- shielding is constant
- nuclear charge increases

down group

- VE added to higher energy shells
- shielding increases
- nuclear charge increases BUT... offset by increased distance and shielding ∴ it is a non factor

(*)(*)(*) 3 Bits of Evidence to provide when arguing trends

1. Location (energy shell) of VE
2. Shielding (# of core electrons)
3. Nuclear charge (# of protons)

Atomic Radius – size of an Atom, measure of the distance from nucleus to outermost VE

Across period – All VE in same energy level, shielding is constant, nuclear charge increases

↳ ∴ Decreases across period because VE pulled in towards nucleus because of increased nuclear charge

Down group – VE put into higher energy shells (increased distance from nucleus), shielding increases as core e^- increase

notice no mention of nuclear charge! ⟹

↳ ∴ Increases down a group because VE put into higher shells which are farther from nucleus

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Electronegativity – measure of attraction between the nucleus and adjacent atoms outermost e^-

Across period – All VE in same energy level, shielding is constant, nuclear charge increases

↳ ∴ Increases across period because of increase in nuclear charge with constant shielding (# of core e^-)

Down group – VE put into higher energy shells, shielding increases as core e^- increase

↳ decreases down a group because as VE energy shell increases it is farther from nucleus which will cause a decrease in Coulombic forces

Small note: notice we are discussing attraction at VE energy shell NOT attraction felt by VE themselves !!! ⟹

Ionic Radius - charge of an ion compared to a neutral species

Positive Ions - have lost VE electrons and therefore lost outer energy shell
↳ ∴ Removing e^- from outer energy shell will cause radius to decrease

Negative Ions - have additional e^- placed in VE energy shell
↳ ∴ additional e^- increases electron/electron repulsion and causes VE to spread out thereby increasing radius

Isoelectric Species - Have same electronic structure, so only difference between the two elements is nuclear charge
↳ ∴ the species with the larger nuclear charge will experience larger coulombic forces and will be smaller

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Chemical Reactivity - elements w/ same group have similar properties

Metals - metals lose e^-; so more likely to lose e^- = Higher metallic Reactivity
↳ tend to have larger radius, low IE, Low Elect

metal oxides form Basic solutions: $Na_2O + H_2O \rightarrow 2NaOH$

NonMetals - nonmetals gain e^-; so more likely to gain e^- = Higher nonmetal Reactivity
↳ tend to have smaller radius, high IE, high Elect

non-metal oxides form acidic solutions: $CO_2 + H_2O \rightarrow H_2CO_3$

(#) Groups have similar electronic structures (# of VE) so they have similar chemical properties

SiO_2 → Can be ceramic
SnO_2 → might also be ceramic