Periodic Trends Info Sheet

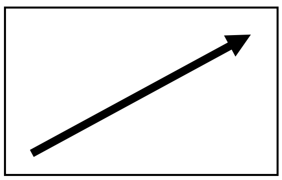
IONIZATION ENERGY

The minimum amount of energy required to *remove* the most loosely bound electron, the valence electron, of an isolated neutral gaseous atom to form a cation. It is quantitatively expressed in symbols as:

$$X + \text{energy} \rightarrow X^{+} + e^{-}$$

In other words…
How much energy does it take to take away an electron from an atom?

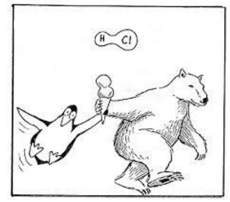
Trend
Increases →
Increases ↑



Highest = Fluorine only higher are Noble Gases (Rn)
Lowest = Francium

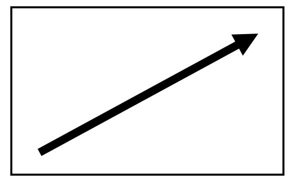
ELECTRONEGATIVITY

The tendency of an atom to attract a shared pair of electrons (or electron density) towards itself.



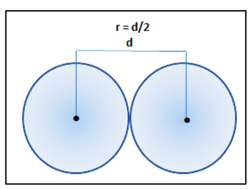
In other words…
How strong is the atom? How hard can it pull on electrons when sharing them with another atom?

Trend
Increases →
Increases ↑



Highest = Fluorine
Lowest = Francium only lower are Noble Gases (He)

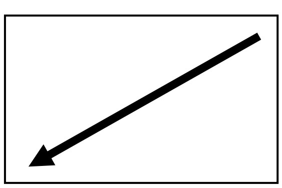
ATOMIC RADIUS



Usually the mean or typical distance from the center of the nucleus to the boundary of the surrounding cloud of electrons. Since the boundary is not a well-defined physical entity, there are various non-equivalent definitions of atomic radius.

In other words…
Half the diameter of an atom. Hard to measure because atoms do not have actual tangible edges. Lots of ways to measure it.

Trend
Increases ←
Increases ↓



Highest = Francium
Lowest = Helium

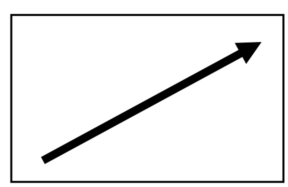
ELECTRON AFFINITY

The amount of energy released* when an electron is *added* to one mole of a neutral atom, or molecule, in the gaseous state to form a negative ion. Usually written as a ΔE value.

$$X + e^{-} \rightarrow X^{-} + \text{energy}$$

In other words…
How happy is the atom to gain that new electron? Really happy – much more stable, releases lots of energy. Not happy – not as much stability, doesn't release lots of energy.

Trend
Increases →
Increases ↑



Highest = Fluorine
Lowest = Francium only lower are Noble Gases (zero)

*Some electron affinities are actually positive ΔE – meaning energy is absorbed. They are not commonly talked about or used though.

Periodic Trends Info Sheet

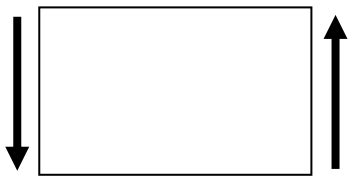
REACTIVITY

The impetus for which a chemical substance undergoes a chemical reaction, either by itself or with other materials, with an overall release of energy.

In other words…
How quickly, violently, readily, does an element undergo certain reactions. More reactivity means faster, more violent, easier reaction with lots of energy released.

Trend

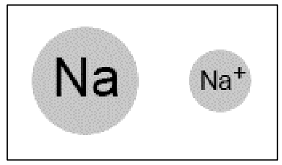
Metals
Increase ↓←
Non-metals
Increases ↑→



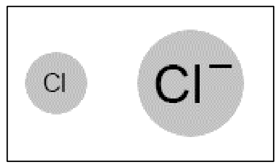
Highest metal = Francium
Highest non-metal = Fluorine
Lowest non-metal = Noble gases (He)

IONIC RADIUS

Cations:
Get smaller when they lose electrons



Anions:
Get larger when they gain electrons



EFFECTIVE NUCLEAR CHARGE - Zeff

The pull that the nucleus has on electrons

$$Zeff = Z - S$$

Z = # of protons
S = Core/Inner electrons (# of electrons in previous noble gas + any d or f electrons)

SUBSEQUENT IONIZATIONS

1st ionization energy
$X \rightarrow X^{+} + e^{-}$
2nd ionization energy
$X^{+} \rightarrow X^{2+} + e^{-}$
3rd ionization energy
$X^{2+} \rightarrow X^{3+} + e^{-}$

Ionization energy increases with each subsequent ionization because there is more attraction between the nucleus and the valence electrons each time you lower the number of valence electrons.

There is a huge leap in ionization energy once an atom loses all it's valence electrons because it now looks like a noble gas and really doesn't want to let go of any more electrons!

SHIELDING

When the inner/core electrons repel the valence electrons and prevents them from seeing the nucleus. Decreases how strongly the electrons are held onto by the nucleus.

BREAKS IN PATTERNS

There are *many* examples of elements that do not appear to follow the general trends typically described. This can be due to a variety of reasons. Here are two of many reasons why this can happen.

- Half-filled orbitals have slightly more stability than expected
  Example: p orbital set: ↑ ↑ ↑
- Unpairing an electron takes slightly more energy than expected
  Example: p orbital set: ↑↓ ↑ ↑