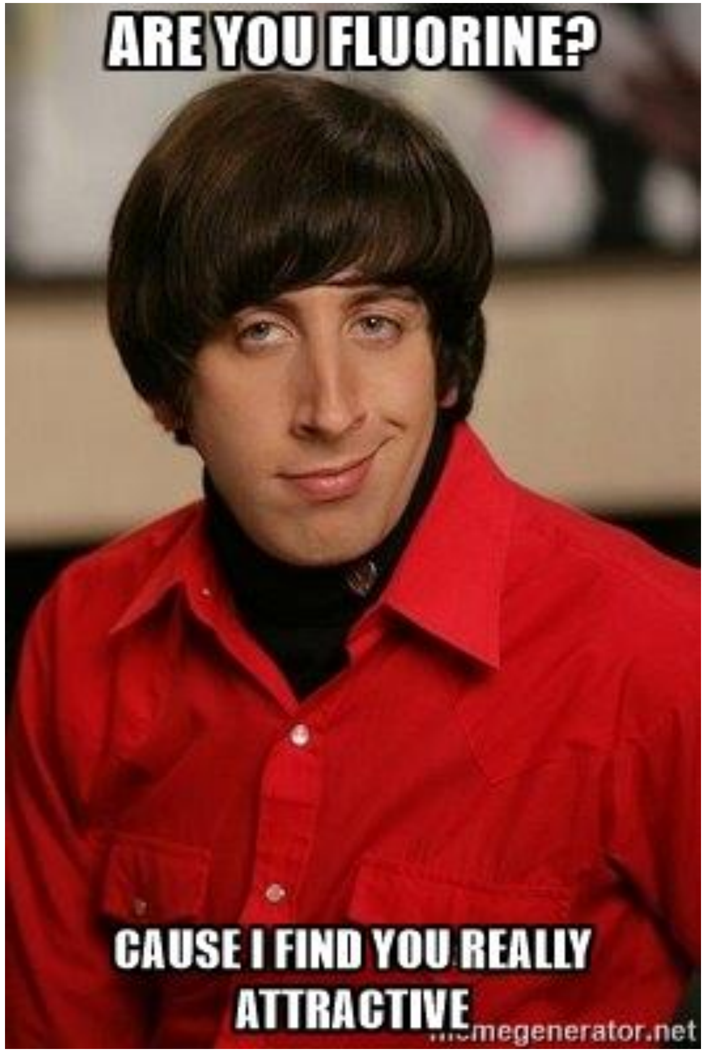
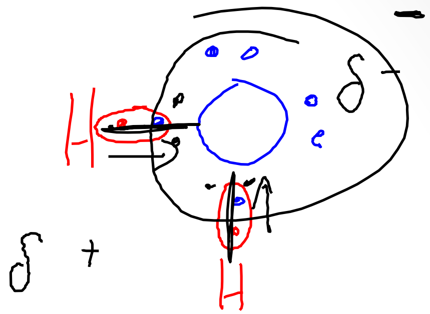
Periodic Trends in Electronegativity



Outcome:

Identify and account for periodic trends among the properties of elements, and relate to electron configuration. *Include: atomic radii, ionic radii, ionization energy, electronegativity*

Electronegativity



In CH30S you learned about electronegativity…

- An atom's **ABILITY** to **ATTRACT** electrons in a chemical **BOND**.
- Remember that:
    - **IONIC** bonds result from a **TRANSFER** of electrons
    - **COVALENT** bonds are from a "**SHARING**" of electrons.

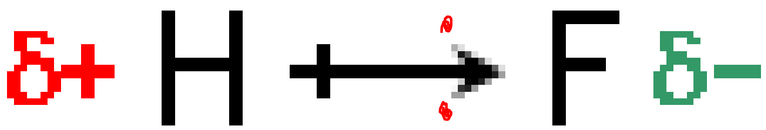
- Recall that most **NON**-**METALS** are highly **ELECTRONEGATIVE**, and **METALS** have **LOW** electronegativities.

- If two atoms of **DIFFERENT** electronegativities form a bond, electrons are **NOT** shared **EVENLY**, resulting in a **POLAR** bond.
    - One atom has a **PARTIAL NEGATIVE** (**δ-**) charge, the other a **PARTIAL POSITIVE** (**δ+**) charge

Electronegativity

Example: *Hydrogen Fluoride*

Fluorine is the **MOST ELECTRONEGATIVE** atom. When bonded to hydrogen, the fluorine **DRAWS** the **ELECTRONS** towards itself.



The **ARROW** between the H and F indicates the **DIRECTION** the **ELECTRONS** are drawn, resulting in a more **POSITIVE** end.

→ The **FLUORINE** end of the bond has a **PARTIAL NEGATIVE** charge (**δ–**) and

→ The **HYDROGEN** end has a **PARTIAL POSITIVE** charge (**δ+**).

Electronegativity

Values for Electronegativities

- Many chemists have come up with various methods of assigning a **VALUE** for the electronegativity of an atom.
- The values we will use are based on the **FORCE** of **ATTRACTION** between the **NUCLEUS** and the **VALENCE** electrons.

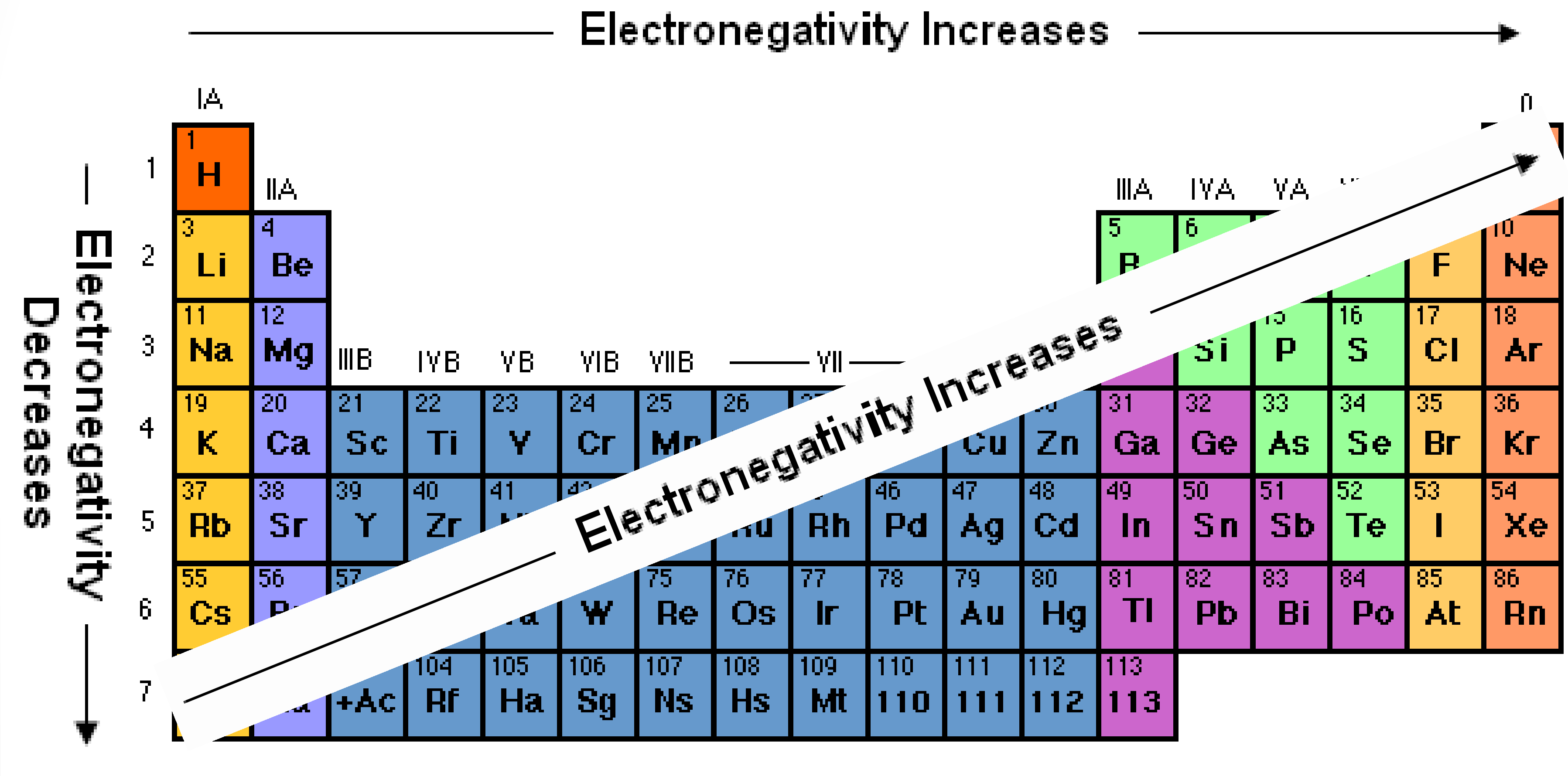
See Table of Electronegativities

Do you notice any trends in the table?

Electronegativity

Trends in Electronegativity

label the trends on the table below.



Bond Character

The **DIFFERENCE** in electronegativities of two atoms determines the **TYPE** of **BOND** formed – **IONIC**, **COVALENT**, **POLAR COVALENT**.

- The **LARGER** the difference, the **MORE IONIC**.
- The **SMALLER** the difference, the **MORE COVALENT**

We can use the table below to determine bond type:

Electronegativity Difference and Bond Character		
Electronegativity Difference	**Predicted Bond Type**	**Examples**
0.0 → 0.4	Non-polar covalent	O_2 (0.0)
0.5 → 1.9	Polar covalent	SCl_2 (3.26 – 2.58)
≥ 2.0	Ionic	KCl (3.16 – 0.82)

Bond Character

Predicting Bond Character Examples:

1. What type of bond forms between sodium and chlorine in NaCl?

Solution:

Find the electronegativity (EN) values for Na and Cl on the table.

Na = 0.9 ***Cl = 3.0***

Find the EN difference

3.0 - 0.9 = 2.1

The difference is greater than 1.9 so the bond is ionic.

Bond Character

Predicting Bond Character Examples:

2. What type of bond forms between sulphur and oxygen in SO_3?

Solution:

Find the electronegativity values for S and O on the table.

S = 2.5 ***0 = 3.5***

Find the EN difference

3.5 - 2.5 = 1.0

The difference is between 0.4 and 1.9 so the bond is <u>polar covalent</u>.

Bond Character

Predicting Bond Character Examples:

3. What type of bond forms between aluminum and chlorine in $AlCl_3$?

Solution:

Find the electronegativity values for Al and Cl on the table.

Al = 1.5 ***Cl = 3.0***

Find the EN difference

3.0 - 1.5 = 1.5

The difference is between 0.4 and 1.9 so the bond is polar covalent.

Bond Character

Note:

- According to our **METAL + NON-METAL = IONIC** rule, $AlCl_3$ should be an **IONIC BOND**.
- But according to electronegativities, it is actually **MORE** ~~**COVALENT**~~ Polar than ionic!

We will still use metal + non-metal to predict an ionic bond, but use electronegativity values to **CONFIRM** our prediction.

Bond Character

Try these ones…

Determine the bond character for the following:

H_2O 3.5 − 2.1 = 1.4 polar.

CCl_4 3.0 − 2.5 = 0.5 polar

N_2O_5 3.5 − 3.0 = 0.5 polar

CuS 2.5 − 1.9 = 0.6 polar

Cl_2 3.0 − 3.0 = ∅ non polar.