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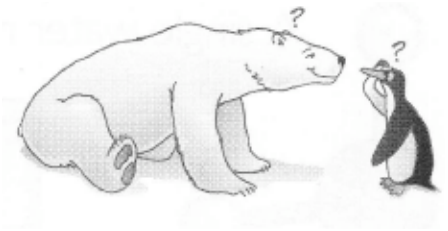
Unit 8 - Topic 3

Polar / Non-Polar Covalent Bonds

Polar Bears & Penguins



Read the comic strip "The Bare Essentials of Polarity," and use it to answer these questions.

1. How does the comic strip define a polar molecule?

   _____
   _____
   _____

2. Define electronegativity as you understand it, after reading the first two pages of the comic strip. _____
   _____
   _____
   _____

3. What is the artist trying to represent by two polar bears arm wrestling or two penguins arm wrestling? _____
   _____
   _____
   _____

4. What three types of bonds are represented on the third page of the comic strip? What happens to the bonding electrons in each type of bond? _____
   _____
   _____
   _____
   _____

5. Explain why there are four scoops of ice cream in the illustration of O_2 on the third page. _____
   _____
   _____
   _____

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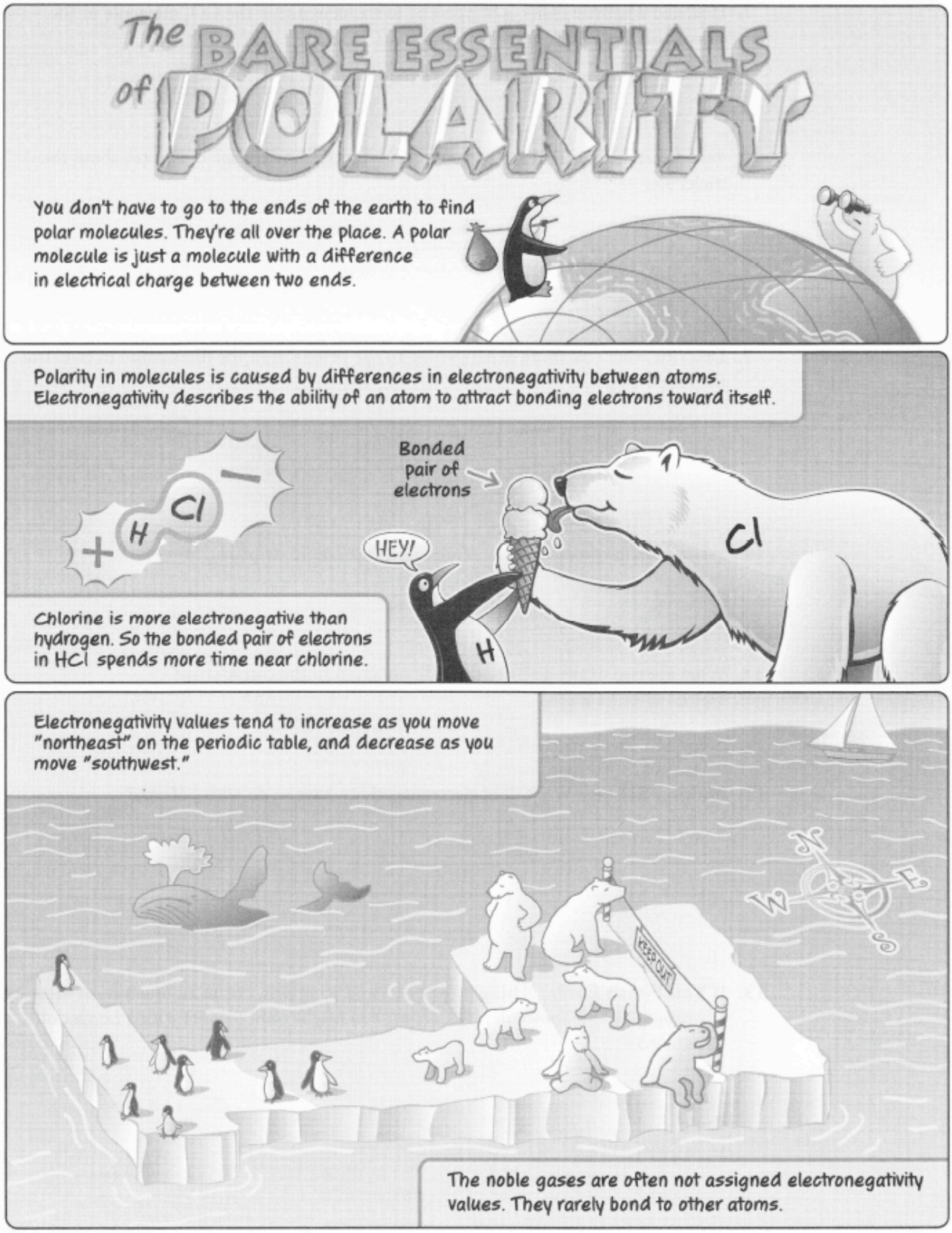
The BARE ESSENTIALS of POLARITY
You don't have to go to the ends of the earth to find polar molecules. They're all over the place. A polar molecule is just a molecule with a difference in electrical charge between two ends.
Polarity in molecules is caused by differences in electronegativity between atoms. Electronegativity describes the ability of an atom to attract bonding electrons toward itself.
+
H
Cl
−
Bonded pair of electrons
HEY!
Cl
H
Chlorine is more electronegative than hydrogen. So the bonded pair of electrons in HCl spends more time near chlorine.
Electronegativity values tend to increase as you move "northeast" on the periodic table, and decrease as you move "southwest."
KEEP OUT
N
W
E
The noble gases are often not assigned electronegativity values. They rarely bond to other atoms.

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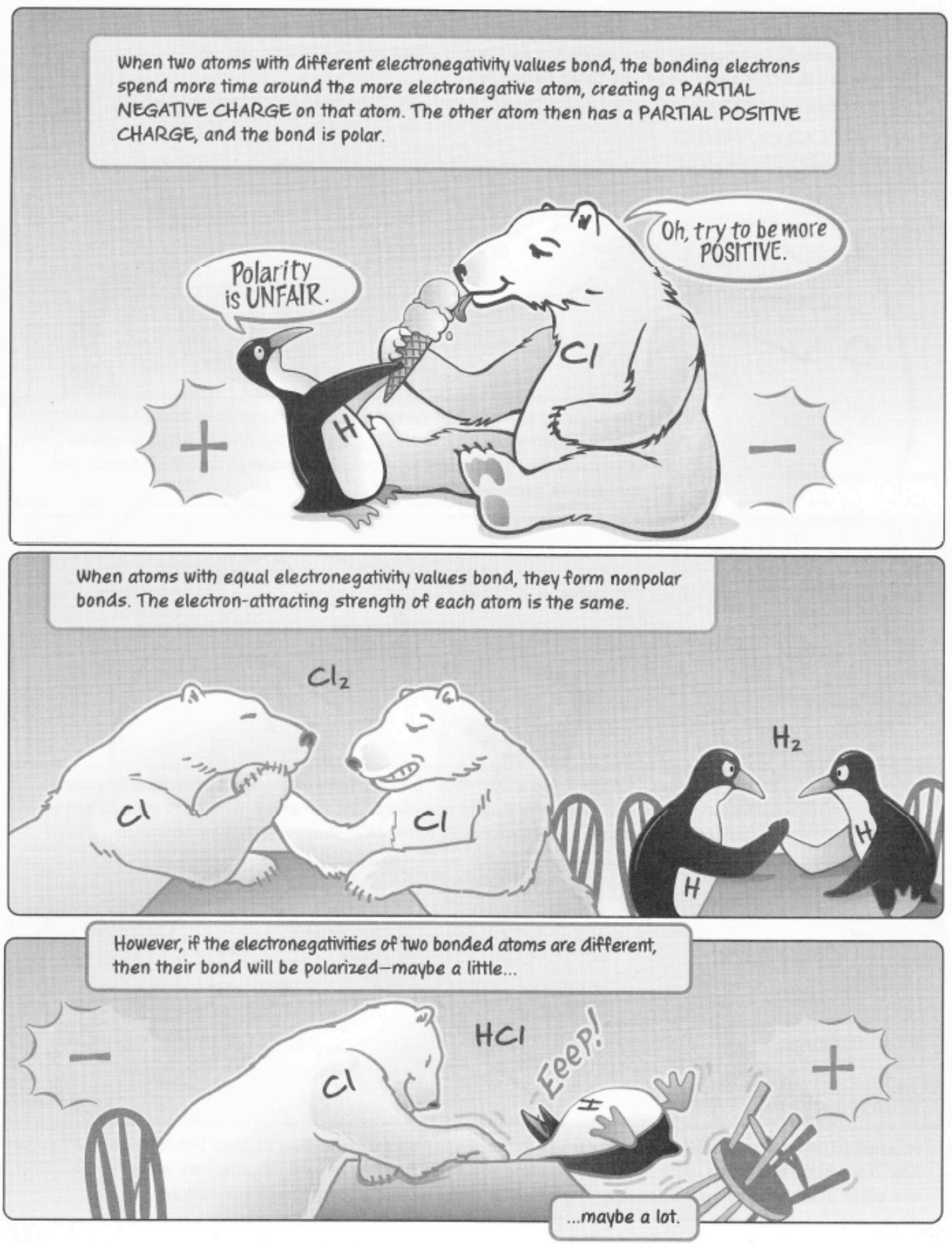
When two atoms with different electronegativity values bond, the bonding electrons spend more time around the more electronegative atom, creating a PARTIAL NEGATIVE CHARGE on that atom. The other atom then has a PARTIAL POSITIVE CHARGE, and the bond is polar.
Polarity is UNFAIR.
Oh, try to be more POSITIVE.
H
Cl
+
−
When atoms with equal electronegativity values bond, they form nonpolar bonds. The electron-attracting strength of each atom is the same.
Cl_2
Cl
Cl
H_2
H
H
However, if the electronegativities of two bonded atoms are different, then their bond will be polarized—maybe a little...
HCl
Cl
H
Eeep!
−
+
...maybe a lot.

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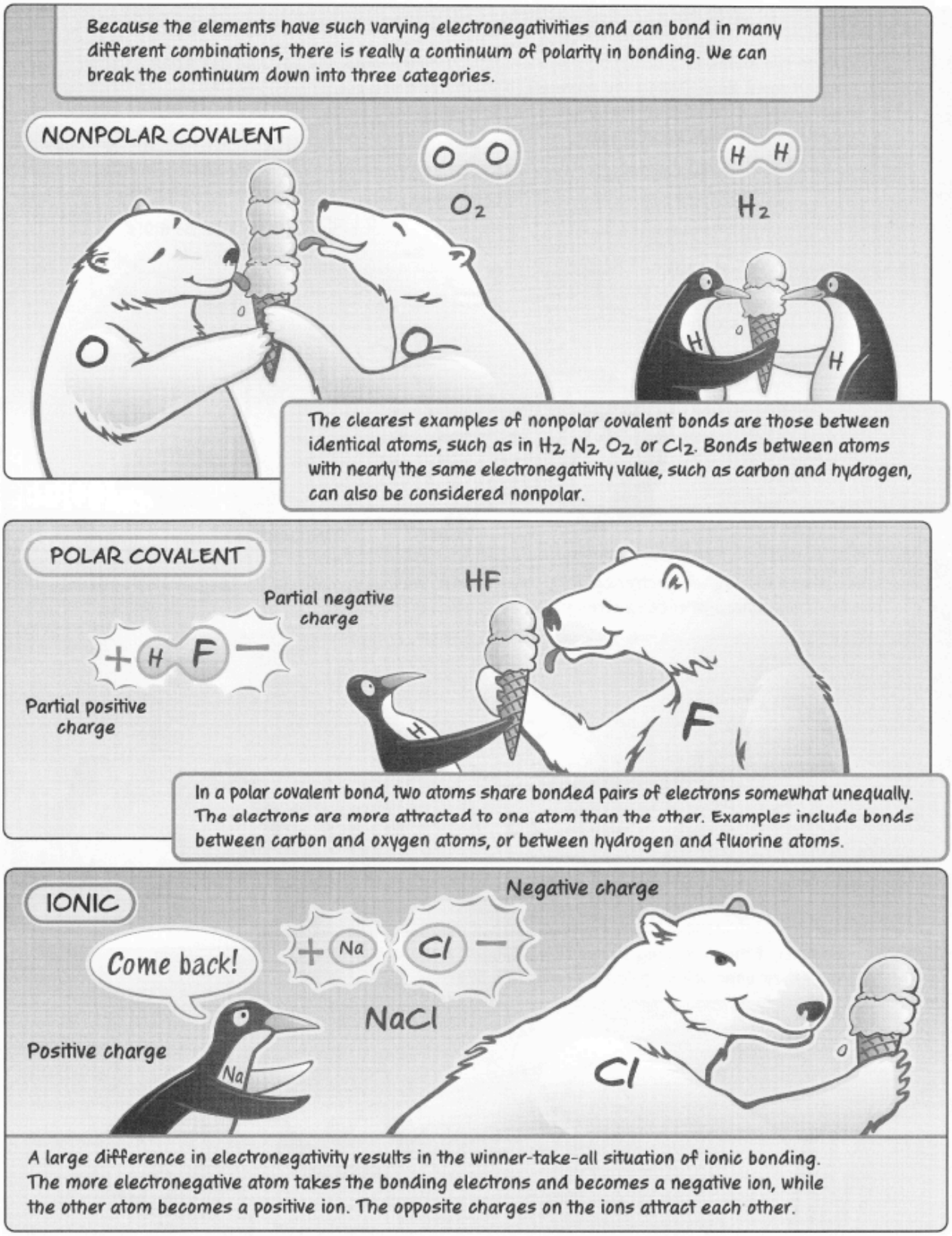
Because the elements have such varying electronegativities and can bond in many different combinations, there is really a continuum of polarity in bonding. We can break the continuum down into three categories.
NONPOLAR COVALENT
O O
O_2
H H
H_2
O
O
H
H
The clearest examples of nonpolar covalent bonds are those between identical atoms, such as in H_2, N_2, O_2, or Cl_2. Bonds between atoms with nearly the same electronegativity value, such as carbon and hydrogen, can also be considered nonpolar.
POLAR COVALENT
Partial negative charge
+ H F −
Partial positive charge
HF
H
F
In a polar covalent bond, two atoms share bonded pairs of electrons somewhat unequally. The electrons are more attracted to one atom than the other. Examples include bonds between carbon and oxygen atoms, or between hydrogen and fluorine atoms.
IONIC
Negative charge
Come back!
+ Na Cl −
NaCl
Positive charge
Na
Cl
A large difference in electronegativity results in the winner-take-all situation of ionic bonding. The more electronegative atom takes the bonding electrons and becomes a negative ion, while the other atom becomes a positive ion. The opposite charges on the ions attract each other.

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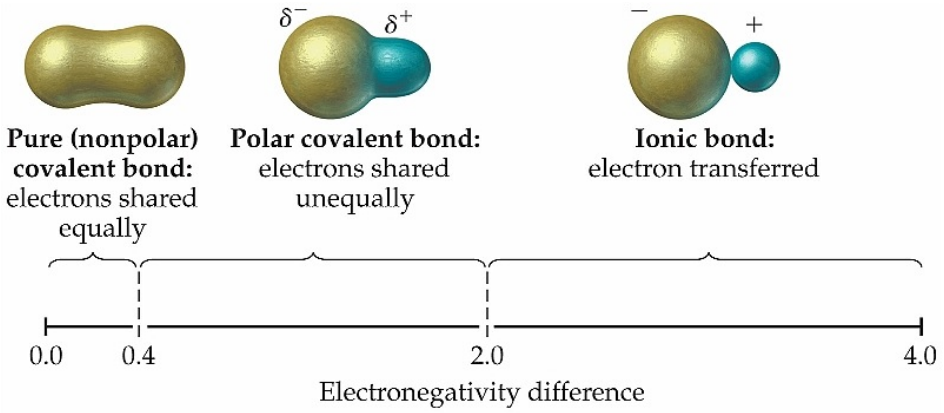
Bond Type

When atoms combine, there is a 'tug of war' over their valence electrons. The type of bond that forms depends on the outcome of the tug of war and is determined by the relative strengths of the forces exerted by the atoms. The electronegativity provides a measure of those forces. when the electronegativity differences is great than or equal to 2.0, the atoms with the greater electronegativity gains the electron, and an **ionic bond** is formed. Electronegativity differences below 2.0 result in covalent bonds or sharing. If the electronegativity differences is close to zero (<0.4), the atoms share equally and a **non-polar bond** forms. Higher electronegativity differences (still below 1.7) result in unequal sharing or **polar bonds**.



Fill in the table below by looking up the electronegativities of the elements in each compound. Determine the electronegativity difference and the bond type.

Compound	Electronegativity		Electronegativity Difference	Bond Type (Ionic, Polar covalent, Non-polar covalent)
	Metal (low)	Non-metal (high)		
NaBr	*0.9*	*3.0*	*2.1*	*ionic*
HCl				
KI				
SO_2				
H_2O				
CS_2				
MgO				

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1. Which of the following compounds does NOT contain covalent bonds?
   (1) H_2O
   (2) NH_3
   (3) NaF
   (4) CS_2

2. Which of these formulas contains the ***most*** polar bond?
   (1) H-Br
   (2) H-Cl
   (3) H-F
   (4) H-I

3. Two atoms with a small electronegativity difference form a bond that is
   (1) ionic, because electrons are shared
   (2) ionic, because electrons are transferred
   (3) covalent, because electrons are shared
   (4) covalent, because electrons are transferred

4. The electrons in a bond between two iodine atoms (I_2) are shared
   (1) equally, and the resulting bond is polar
   (2) equally, and the resulting bond is non-polar
   (3) unequally, and the resulting bond is polar
   (4) unequally, and the resulting bond is non-polar

5. In a non-polar covalent bond, electrons are
   (1) located in a mobile 'sea' shared by many ions
   (2) transferred from one atom to another
   (3) shared equally by two atoms
   (4) shared unequally by two atoms

6. Which of the following substances is composed of molecules that contain multiple (double or triple) covalent bonds? (Remember: Use Tables P & Q)
   (1) methane
   (2) ethane
   (3) propene
   (4) butane

7. In non-polar covalent bonds, electrons are:
   (1) shared equally between 2 bonding atoms
   (2) shared unequally between 2 bonding atoms
   (3) exchanged from one atom to another atom

8. In ionic bonds, electrons are:
   (1) shared equally between 2 bonding atoms
   (2) shared unequally between 2 bonding atoms
   (3) exchanged from one atom to another atom

9. In polar covalent bonds, electrons are:
   (1) shared equally between 2 bonding atoms
   (2) shared unequally between 2 bonding atoms
   (3) exchanged from one atom to another atom

10. How many valence electrons are there in:
    (1) H? _____
    (2) C? _____
    (3) O? _____
    (4) N? _____
    (5) Cl? _____

11. How many bonds will each type of atom in #10 form when bonding covalently with other atoms?
    (1) H _____
    (2) C _____
    (3) O _____
    (4) N _____
    (5) Cl _____