Polarity Reading Assignment
Chemistry

Name: ________________________

Date: ____________ Hour: ________

§10.4: Electronegativity and Polarity

(from *Basic Chemistry*, 2^{nd} edition, pp. 303-308, Pearson Prentice Hall, 2008)

The ability of an atom to attract bonding electrons to itself is called its electronegativity. The electronegativity values assigned to the representative elements are shown in Figure 10.1. Nonmetals have high electronegativity values compared to metals because nonmetals have a greater attraction for electrons than metals. The nonmetals with the highest electronegativity values are fluorine (4.0) at the top of Group 17 and oxygen (3.5) at the top of Group 16. The metals cesium and francium at the bottom of Group 1 have the lowest electronegativity values because their valence electrons are farther from their nuclei. Thus, the values of electronegativity generally increase going from left to right across each period of the periodic table and increase going up within each group. The values of electronegativity for the transition metals are also low, but we will not include them in our discussion. Note that there are no electronegativity values for the noble gases because they do not typically form bonds.

Why is electronegativity higher for nonmetals? ____

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Figure 10.1:

Electronegativity increases –>

	1	2	13	14	15	16	17	18
1	H 2.1							
2	Li 1.0	Be 1.5	B 2.0	C 2.5	N 3.0	O 3.5	F 4.0	
3	Na 0.9	Mg 1.2	Al 1.5	Si 1.8	P 2.1	S 2.5	Cl 3.0	
4	K 0.8	Ca 1.0	Ga 1.6	Ge 1.8	As 2.0	Se 2.4	Br 2.8	
5	Rb 0.8	Sr 1.0	In 1.7	Sn 1.8	Sb 1.9	Te 2.1	I 2.5	
6	Cs 0.7	Ba 0.9	Tl 1.8	Pb 1.9	Bi 1.9	Po 2.0	At 2.1	

Looking at Figure 10.1,

(a) Which element in Group 14 has the highest electronegativity? ________________________

(b) Which element in Period 2 has the lowest electronegativity? ________________________

(c) Do values increase or decrease down a column? ____________________________________

(d) Why are there no values for the noble gases? _____________________________________

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Earlier we discussed bonding as either ionic, in which electrons are transferred, or covalent, in which electrons are equally shared. The difference in the electronegativity values of two atoms gives an indication of the type of bond that forms. In H–H, the electronegativity difference is zero (2.1 - 2.1 = 0), which means the bonding electrons are shared equally beteween the two hydrogen atoms. A bond between atoms with identical or very similar electronegativities is a nonpolar covalent bond. However, most covalent bonds are between different atoms with different electronegativity values. For example, in H–Cl, there is an electronegativity difference of 3.0 - 2.1 = 0.9. Where the electrons are shared unequally in a covalent bond, it is called a polar covalent bond.

How is a covalent bond different from an ionic bond? ____

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What are the two types of covalent bonds? ____

In a polar covalent bond, the shared electrons are attracted to the more electronegative atom, which makes it partially negative. At the other end of the polar bond, the atom with the lower electronegativity becomes partially positive. Because a polar covalent bond has a separation of positive and negative charges, or two poles, it is called a dipole. The positive and negative ends of a polar covalent bond are indicated by the lowercase Greek letter delta with a positive or negative sign, δ^+ or δ^-. An arrow pointing from the positive charge to the negative charge (→) may be used to indicate the dipole.

What is a dipole? ____

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If an atom has a δ^- near it, what does that mean? ____

As the electronegativity difference increases, the shared electrons are attracted more strongly to the more electronegative atom. The polarity, which depends on the separation of charges, also increases. Eventually, the difference in electronegativity is great enough that the electrons are transferred from one atom to another, which results in an ionic bond. For example, the electronegativity difference for the ionic compound Na Cl is 3.0 - 0.9 = 2.1. Thus for large differences in electronegativity, we would predict an ionic bond.

What happens to the electrons in a bond when the difference in electronegativity is great? ____________

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The variations in bonding are continuous; there is no definite point at which one type of bond stops and the next starts. However, for purposes of discussion, we can use some general ranges to predict the type of bond between atoms. When electronegativity differences are between 0.0 and 0.4, the electrons are shared about equally in a nonpolar covalent bond. For example, H–H (2.1 - 2.1 = 0) and C–H (2.5 - 2.1 = 0.4) are classified as nonpolar covalent bonds. As electronegativity differences increase, there is also an increase in the polarity of the covalent bond. For example, an O–H bond with a difference of 1.4 is much more polar than an O–F bond with a difference of only 0.5. Differences in electronegativity of 1.8 or greater generally indicate a bond that is mostly ionic. For example, we would classify K–Cl with an electronegativity difference of 3.0 - 0.8 = 2.2 as an ionic bond resulting from a transfer of electrons.

What type of bond would be present if the difference in electronegativity was

(a) 0.2? __________________ (b) 0.9? __________________ (c) 1.9? __________________

Use Figure 10.1 to determine the type of bond between these pairs of atoms:

(a) Cl–Cl ____________________ (c) H–Br ____________________

(b) Mg–O ____________________ (d) O–H ____________________