

ChemQuest 26

Electronegativity

Name: _____

Date: _____

Hour: _____

Information: Definition of Electronegativity

Electronegativity is a measure of how much an atom attracts an electron. The higher the electronegativity, the greater the atom's attraction for electrons. Atoms that become negative ions have a much greater electronegativity than atoms that become positive ions. Below is a table of the electronegativities of many elements from the periodic table.

1 H 2.20						2 He —	
3 Li 0.97	4 Be 1.47	5 B 2.01	6 C 2.50	7 N 3.07	8 O 3.50	9 F 4.10	10 Ne —
11 Na 1.01	12 Mg 1.23	13 Al 1.47	14 Si 1.74	15 P 2.06	16 S 2.44	17 Cl 2.83	18 Ar —
19 K 0.91	20 Ca 1.04	31 Ga 1.82	32 Ge 2.02	33 As 2.20	34 Se 2.48	35 Br 2.74	36 Kr —

Critical Thinking Questions

- Why do you think there are no values for the noble gases?
Noble gases are so stable that they do not attract electrons.
- In terms of electrons, what is the difference between a covalent bond and an ionic bond?
Electrons are shared in a covalent bond, but atoms lose or gain them in ionic bonds.
- What type of bond (covalent or ionic) would you expect to form between an atom with a high electronegativity and an atom of low electronegativity. Explain and give an example.
Ionic bond because the atom with high electronegativity will attract an electron away from the atom with low electronegativity. Example: NaF (between a metal and a nonmetal)
- What type of bond (covalent or ionic) would you expect to form between two atoms of somewhat high electronegativity? Explain and give an example.
Covalent bond because both atoms will be trying to attract an electron and so they will end up sharing it. Example: CO₂ (both atoms have high electronegativity compared to the metals)
- Consider the ionic compound, sodium chloride (NaCl). Which atom has a greater attraction for electrons—sodium or chlorine? Which atom forms the negative ion?
Chlorine has the highest electronegativity and therefore the strongest attraction. It also forms the negative ion and sodium forms a positive ion.

6. In an ionic bond, the atom with the highest electronegativity will always form a

_____ negative _____ ion.
(positive or negative)

7. Consider the covalent compound, carbon monoxide (CO).

- a) Draw the Lewis dot structure for carbon monoxide.



- b) In the Lewis structure you drew, you should see that there is a triple bond between carbon and oxygen. The carbon and oxygen share 6 electrons. All 6 electrons are not shared equally, however, because carbon and oxygen don't have equal attraction for electrons. The 6 electrons spend a little more time near one of the atoms—predict which one and explain.

The electrons will spend more time near the oxygen because oxygen has a greater electronegativity than carbon and therefore attracts the electrons more.

8. Why are the electrons in a nitrogen-phosphorus covalent bond NOT shared equally? Which atom do the electrons spend more time around? Explain.

They are not shared equally because nitrogen and phosphorus do not have the same electronegativity. The atoms spend more time around the most electronegative atom—nitrogen.

9. True or false: In an ionic bond, the difference in electronegativities between the two bonding atoms is greater than the difference in a covalent bond.

True; there is a greater difference between a metal and nonmetal than between 2 nonmetals.

10. In terms of electronegativity, explain why this statement is true: “Carbon monoxide is more ‘ionic’ than carbon monosulfide”.

The electronegativity difference is greater between carbon and oxygen (like in carbon monoxide) than between carbon and sulfur (like in carbon monosulfide)

11. Which bond is more like an ionic bond—a nitrogen-oxygen bond or a carbon-oxygen bond? Explain.

A carbon oxygen bond is more like an ionic bond because there is a greater difference in electronegativity between carbon and oxygen than between nitrogen and oxygen.

12. Which compound is more like an ionic compound—NH₃ or PH₃? Explain.

NH₃, because of the greater electronegativity difference between N and H than between P and H.

Information: “Polar” Bonds

In critical thinking questions 10, 11, and 12 we used the term “ionic” when describing covalent bonds. This can get confusing and so instead of the term “ionic” we will use the term “**polar**”. A **polar covalent bond** then is a covalent bond in which the electrons are not shared equally by the two atoms involved in the bond. For example, in carbon monoxide the electrons spend more time near oxygen than carbon because oxygen has a greater electronegativity. Because of oxygen's greater electronegativity, it attracts the electrons more than carbon.

Critical Thinking Questions

13. Which bond is more polar—a phosphorus-chlorine bond or a phosphorus-fluorine bond? Explain why.

P—F bond is more polar than the P—Cl bond because there is a greater electronegativity difference between P and F than between P and Cl.

14. Consider a carbon-fluorine bond. One atom in the bond is “partially negative” and the other atom is “partially positive”. Which atom is which? Explain how you know.

The fluorine is “partially negative” because it has a higher electronegativity than carbon and therefore the electrons that are shared between carbon and fluorine spend more time near fluorine.

15. In your own words explain what you think the term “partially negative” means and explain why an atom might be partially negative when it bonds covalently. (I.e. What makes it partially negative?)

If an atom is “partially negative” it means that the electrons are more attracted to that atom than to the other atom covalently bonded to it.

16. In your own words explain what you think the term “partially positive” means and explain why an atom might be partially positive when it bonds covalently. (What makes it partially positive?)

If an atom is partially positive, then the electrons it shares with another atom will spend more time around that other atom.

Information: Polar vs. Nonpolar

Not all covalent compounds are categorized as polar. For example, a carbon-hydrogen bond is made up of two atoms that have very similar electronegativities. Because of this, carbon and hydrogen share the electrons just about equally and we say that a carbon-hydrogen bond is “nonpolar”. As a general measure, if the difference in electronegativity between two bonding atoms is less than about 0.5, then the bond is nonpolar.

Critical Thinking Questions

17. For the following bonds, indicate whether they are ionic (I), polar covalent (P), or nonpolar covalent (NP).

NP a) C—P P b) S—O I c) Fe—O P d) N—H

18. What are the three most electronegative atoms on the periodic table?

Nitrogen, oxygen, and fluorine