Polarity & Electronegativity Notes Outline

When atoms \_\_\_\_\_\_\_\_\_ valence electrons they do not always share them \_\_\_\_\_\_\_\_\_\_\_\_. Frequently one atom has a \_\_\_\_\_\_\_\_\_\_\_ attraction for the electrons than the other atom does. This \_\_\_\_\_\_\_\_\_\_\_\_\_attraction causes the electrons to be held closer to one end of the bond than the other; we say this makes one end of the bond slightly \_\_\_\_\_\_\_\_\_\_\_\_ and the other end of the bond slightly \_\_\_\_\_\_\_\_\_\_\_\_. **A covalent bond with \_\_\_\_\_\_\_\_\_\_\_ sharing of the electrons is called a \_\_\_\_\_\_\_\_\_\_\_ covalent bond. A bond in which the electrons are shared \_\_\_\_\_\_\_\_\_\_\_ is called a \_\_\_\_\_\_\_\_\_\_\_\_ covalent bond.**

1. Define the following terms:

a. polar covalent

b. nonpolar covalent

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is a measure of the ability of an atom of an element to attract electrons to itself**. Put another way, electronegativity is a measure of the force of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that exists between an atom and a \_\_\_\_\_\_\_\_\_\_\_\_ pair of electrons in a covalent bond. Linus Pauling developed a scale of electronegativities that run from a low of 0.7 for several metals in Group I to a high of 4.0 for fluorine.

The table below gives **Pauling Values for Electronegativity**:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| H  2.1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | He  …. |
| Li  1.0 | Be  1.5 |  |  |  |  |  |  |  |  |  |  | B  2.0 | C  2.5 | N  3.0 | O  3.5 | F  4.0 | Ne  …. |
| Na  0.9 | Mg  1.2 |  |  |  |  |  |  |  |  |  |  | Al  1.5 | Si  1.8 | P  2.1 | S  2.5 | Cl  3.0 | Ar  …. |
| K  0.8 | Ca  1.0 | Sc  1.3 | Ti  1.5 | V  1.6 | Cr  1.6 | Mn  1.5 | Fe  1.8 | Co  1.8 | Ni  1.8 | Cu  1.9 | Zn  1.6 | Ga  1.6 | Ge  1.8 | As  2.0 | Se  2.4 | Br  2.8 | Kr  …. |
| Rb  0.8 | Sr  1.0 | Y  1.2 | Zr  1.4 | Nb  1.6 | Mo  1.8 | Tc  1.9 | Ru  2.2 | Rh  2.2 | Pd  2.2 | Ag  1.9 | Cd  1.7 | In  1.7 | Sn  1.8 | Sb  1.9 | Te  2.1 | I  2.5 | Xe  …. |
| Cs  0.7 | Ba  0.9 | La-Lu  1.1-1.2 | Hf  1.3 | Ta  1.5 | W  1.7 | Re  1.9 | Os  2.2 | Ir  2.2 | Pt  2.2 | Au  2.4 | Hg  1.9 | Tl  1.8 | Pb  1.8 | Bi  1.9 | Po  2.0 | At  2.2 | Rn  …. |
| Fr  0.7 | Ra  0.9 | Ac-Lr  1.1- |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

We use electronegativity values when we discuss bond polarity. **If two atoms sharing a pair of electrons have \_\_\_\_\_\_\_\_\_\_ values for electronegativity the bond is clearly \_\_\_\_\_\_\_\_\_\_\_\_\_.** **As the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in electronegativity increases the \_\_\_\_\_\_\_\_\_\_\_ of the bond increases, and if the difference in electronegativity is very \_\_\_\_\_\_\_\_\_\_ the bond is \_\_\_\_\_\_\_\_\_\_\_\_.**

1. What is electronegativity?
2. Sodium chloride (NaCl) is an example of an ionic bond. What is the difference in electronegativity between sodium and chlorine?
3. Nitrogen dioxide (NO2) is an example of a covalent bond. What is the difference in electronegativity between nitrogen and oxygen?

It is difficult to decide exactly what we consider nonpolar, polar or ionic since bonds may have some covalent character and some ionic character. For convenience for beginning students we have established some arbitrary guidelines:

ELECTRONEGATIVITY VALUES OF THE ELEMENTS, ACCORDING TO THE PERIODIC TABLE

|  |
| --- |
| **Difference in electronegativity Intramolecular Bond Type** |
| 0------.49 nonpolar covalent |
| .5------1.69 polar covalent |
| 1.7 or greater ionic |

Use the table and chart from this worksheet to label the following compounds as nonpolar, polar or ionic:

a. NH3

b. MgO

c. Cl2

d. HCl

e.H2O

f. NaCl

g. CH4

h. NO2

Polarity & Electronegativity Notes Outline - KEY

When atoms share valence electrons they do not always share them equally. Frequently one atom has a stronger attraction for the electrons than the other atom does. This uneven attraction causes the electrons to be held closer to one end of the bond than the other; we say this makes one end of the bond slightly positive and the other end of the bond slightly negative. **A covalent bond with uneven sharing of the electrons is called a polar covalent bond. A bond in which the electrons are shared equally is called a nonpolar covalent bond.**

1. Define the following terms:

a. polar covalent: **A covalent bond with uneven sharing of the electrons**

b. nonpolar covalent: **A covalent bond in which the electrons are shared equally**

**Electronegativity is a measure of the ability of an atom of an element to attract electrons to itself**. Put another way, electronegativity is a measure of the force of attraction that exists between an atom and a shared pair of electrons in a covalent bond. Linus Pauling developed a scale of electronegativities that run from a low of 0.7 for several metals in Group I to a high of 4.0 for fluorine.

The table below gives **Pauling Values for Electronegativity**:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| H  2.1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | He  …. |
| Li  1.0 | Be  1.5 |  |  |  |  |  |  |  |  |  |  | B  2.0 | C  2.5 | N  3.0 | O  3.5 | F  4.0 | Ne  …. |
| Na  0.9 | Mg  1.2 |  |  |  |  |  |  |  |  |  |  | Al  1.5 | Si  1.8 | P  2.1 | S  2.5 | Cl  3.0 | Ar  …. |
| K  0.8 | Ca  1.0 | Sc  1.3 | Ti  1.5 | V  1.6 | Cr  1.6 | Mn  1.5 | Fe  1.8 | Co  1.8 | Ni  1.8 | Cu  1.9 | Zn  1.6 | Ga  1.6 | Ge  1.8 | As  2.0 | Se  2.4 | Br  2.8 | Kr  …. |
| Rb  0.8 | Sr  1.0 | Y  1.2 | Zr  1.4 | Nb  1.6 | Mo  1.8 | Tc  1.9 | Ru  2.2 | Rh  2.2 | Pd  2.2 | Ag  1.9 | Cd  1.7 | In  1.7 | Sn  1.8 | Sb  1.9 | Te  2.1 | I  2.5 | Xe  …. |
| Cs  0.7 | Ba  0.9 | La-Lu  1.1-1.2 | Hf  1.3 | Ta  1.5 | W  1.7 | Re  1.9 | Os  2.2 | Ir  2.2 | Pt  2.2 | Au  2.4 | Hg  1.9 | Tl  1.8 | Pb  1.8 | Bi  1.9 | Po  2.0 | At  2.2 | Rn  …. |
| Fr  0.7 | Ra  0.9 | Ac-Lr  1.1- |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

We use electronegativity values when we discuss bond polarity. **If two atoms sharing a pair of electrons have equal values for electronegativity the bond is clearly nonpolar.** **As the difference in electronegativity increases the polarity of the bond increases, and if the difference in electronegativity is very large the bond is ionic.**

1. What is electronegativity?

**Electronegativity is a measure of the ability of an atom of an element to attract electrons to itself**.

3.Sodium chloride (NaCl) is an example of an ionic bond. What is the difference in electronegativity between sodium and chlorine?

**Na – 0.9 3.0 – 0.9 = 2.1**

**Cl- 3.0**

1. Nitrogen dioxide (NO2) is an example of a covalent bond. What is the difference in electronegativity between nitrogen and oxygen?

N – 3.0 **3.5 – 3.0 = 0.5**

O – 3.5

It is difficult to decide exactly what we consider nonpolar, polar or ionic since bonds may have some covalent character and some ionic character. For convenience for beginning students we have established some arbitrary guidelines:

ELECTRONEGATIVITY VALUES OF THE ELEMENTS, ACCORDING TO THE PERIODIC TABLE

|  |
| --- |
| **Difference in electronegativity Intramolecular Bond Type** |
| 0------.49 nonpolar covalent |
| .5------1.69 polar covalent |
| 1.7 or greater ionic |

Use the table and chart from this worksheet to label the following compounds as nonpolar, polar or ionic:

a. NH3

**N – 3.0 3.0 – 2.1 = 0.9**

**H - 2.1 Polar Covalent**

b. MgO

**Mg – 1.2 3.5 – 1.2 = 2.3**

**O – 3.5 Ionic**

c. Cl2

**Cl – 3.0 3.0 -3.0 = 0**

**Cl – 3.0 Nonpolar Covalent**

d. HCl

**H – 2.1 3.0 – 2.1 = 0.9**

**Cl – 3.0 Polar Covalent**

e.H2O

**H – 2.1 3.5 – 2.1 = 1.4**

**O – 3.5 Polar Covalent**

f. NaCl

**Na – 0.9 3.0 – 0.9 = 2.1**

**Cl – 3.0 Ionic**

g. CH4

**C – 2.5 2.5 – 2.1 = 0.4**

**H –2.1 Nonpolar Covalent**

h. NO2

**N – 3.0 3.5 – 3.0 = 0.5**

**O – 3.5 Polar Covalent**