ChemQuest 31

Molecular

Geometry

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Hour: \_\_\_\_\_

**Information**: Shapes of Molecules

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Methane, CH4** | **Ammonia, NH3** | **Water, H2O** |
| **Lewis**  **Structure** |  |  |  |
| Bond angle =106.5o  Bond angle =109.5o  Bond angle =104.5o  **3-D**  **Shape** | Tetrahedral shape | Trigonal pyramidal shape | Bent shape |
| **Total # of electron regions** | 4 | 4 | 4 |
| **# of Bonding electron regions** | 4 | 3 | 2 |
| **# of lone pair electron regions** | 0 | 1 | 2 |

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Carbonate, CO32-** | **Ozone, O3** | **Carbon dioxide, CO2** |
| **Lewis**  **Structure** |  |  |  |
| Bond angle =118.6o  Bond angle =120o  Bond angle =180o  **3-D**  **Shape** | Trigonal planar shape  CO3 | Bent shape  ozone | Linear shape  carbondioxide |
| **Total # of electron regions** | 3 | 3 | 2 |
| **# of bonding electron regions** | 3 | 2 | 2 |
| **# of lone pair electron regions** | 0 | 1 | 0 |

**Critical Thinking Questions**

* + - 1. What is an electron region?
      2. What is a "lone pair electron region"?
      3. What is a "bonding electron region"?
      4. *The number of electron regions determines the bond angle.* With this in mind, complete the following sentence: "Any molecule that has bond angles of approximately 105-109o will have

\_\_\_\_\_\_\_\_\_\_\_\_ total electron regions; any molecule that has bond angles of approximately 120o

how many?

will have \_\_\_\_\_\_\_\_\_\_\_ total electron regions; and any molecule with bond angles of

how many?

approximately 180o will have \_\_\_\_\_\_\_\_\_\_\_ total electron regions."

how many?

* + - 1. The molecules in the above table are representative of many other molecules. Therefore, it can be said that any molecule with 3 bonding electron regions and 1 lone pair electron region has a geometrical shape called "trigonal pyramidal". Draw Lewis dot structures for the following structures and name the geometrical shape.

A) NO3- B) NF3 C) CF4

* + - 1. A certain molecule has a bent shape with bond angles of about 119o. Is the molecule SO2 or SH2? Explain. (Hint: draw the Lewis structures for SO2 and SH2.)

**Information**: VSEPR

The geometry of molecules is based on a theory called "**V**alence **S**hell **E**lectron **P**air **R**epulsion" (VSEPR) theory. The word "repulsion" is the key word because this theory states that all the electron pairs repel each other and so they want to get as far away from each other as possible. The atoms in a tetrahedral molecule are as far apart as geometrically possible at bond angles of 109.5o. There is no way that the atoms can get farther apart.

**Critical Thinking Questions**

* + - 1. In the tables above, there are 3 molecules that have a total of 4 electron regions. The bond angles are slightly different because of lone pair electrons. What takes up more room--a lone pair of electrons or a bonding pair of electrons? Offer proof from the table above.
      2. If you know how many bonding regions and lone pair regions surround an atom you can predict the bond angles around the atom, even in complex situations. Examine the following "big" molecules. By each arrow that points to an atom, write the bond angle for that atom; you should write 109.5o, 120o, or 180o to represent the *approximate* bond angle. One of them is done for you.

120o because of 3 bonding regions and no lone pair regions

