ChemQuest 30

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

Formal Charge

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

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

**Information**: More than one possible Lewis Structure.

Sometimes when you draw a Lewis structure you discover that there is more than one possible way to draw it. For example, consider the following Lewis Structures for sand, which is silicon dioxide:

Diagram #1:

Si

O

O

Si

O

O

Structure A Structure B

**Critical Thinking Questions**

1. What is the total number of electrons allowed in the Lewis structure for SiO­2? Do both of the above Lewis structures have the correct number of electrons pictured?
2. Is each of the proposed structures above a legitimate Lewis structure for CO2? (In other words, in each of the proposed structures are all of the “rules” that you know followed?) Explain.
3. According to a large number of experiments, both of the silicon-oxygen bonds in SiO2 are identical. Given this information, which Lewis structure, A or B, is a better description of the bonding in SiO2. Explain.

**Information**: Formal Charges

When there are two structures that are possible for a compound, then scientists in a lab can determine which one is the correct one. Other than laboratory work, there is another way to determine which Lewis structure is correct—using “formal charges”.

Let’s examine Structure B for SiO2. In the structure that was drawn, each atom has the eight electrons that they need. Let’s look at how many **formal electrons** each atom has. To understand “formal electrons” study the diagram of Structure B below:

Diagram #2:

Of the six electrons being shared, three are formal electrons for oxygen and three are formal electrons for silicon.

Of the two electrons being shared, one is a formal electron for oxygen and one is a formal electron for silicon.

Electrons that aren’t shared belong to the atom that they are around, so these six electrons are six of oxygen’s formal electrons.

Electrons that aren’t shared belong to the atom that they are around, so these two electrons are two of oxygen’s formal electrons.

Si

O

O

Oxygen Atom #2

Oxygen Atom #1

You should see from the above diagram that the silicon atom has a total of four formal electrons, oxygen atom #1 has 7 formal electrons, and oxygen atom #2 has 5 formal electrons. Now we can calculate the **formal charge** of each atom.

Found from the column of the periodic table that the atom is in

Formal charge = (# of valence electrons) – (# of formal electrons)

Here are the formal charges for each of the atoms in structure B for SiO2.

Si = 4 – 4 = 0 Oxygen atom #1: 6 – 7 = -1 Oxygen atom #2: 6 – 5 = 1

**Critical Thinking Questions**

1. Verify that the formal charge for each of the atoms is zero in Structure A from Diagram #1.
2. Consider questions 3 and 4. If two different structures are possible, does the best structure have the fewest or the most formal charges?
3. Draw a Lewis structure for the carbonate ion, CO32-. On your drawing label the formal charge of each atom.
4. Add up all of the formal charges for all the atoms from question 6.
5. Draw the Lewis structure for the ammonium ion, NH4+ and label the formal charge of each atom.
6. Add up all of the formal charges for the atoms from question 8.
7. Draw the Lewis structure for SO3 and label the formal charge of each atom.
8. Add up all of the formal charges for the atoms from question 10.
9. Consider questions 6-11 and then fill in the blanks: The SUM of the formal charges for all the

atoms in a structure always equals the \_\_\_\_\_\_\_\_\_ of the molecule or ion. For example, the

charge on CO32- is \_\_\_\_\_\_\_\_ and the sum of the formal charges (question 6) is \_\_\_\_\_\_\_\_.

1. Which of the following is the best structure for CH2O2? Explain your reasoning.

H

C

O

H

O

O

O

H

C

H

Structure #1 Structure #2