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8. Answer the following questions using principles of chemical bonding and molecular structure.

(a) Consider the carbon dioxide molecule, CO₂, and the carbonate ion, CO₃²⁻.

(i) Draw the complete Lewis electron-dot structure for each species.

(ii) Account for the fact that the carbon-oxygen bond length in CO₃²⁻ is greater than the carbon-oxygen bond length in CO₂.

(b) Consider the molecules CF₄ and SF₆.

(i) Draw the complete Lewis electron-dot structure for each molecule.

(ii) In terms of molecular geometry, account for the fact that the CF₄ molecule is nonpolar, whereas the SF₆ molecule is polar.

\[
\text{CO}_2
\]

\[
\begin{array}{c}
\text{O} \\
\text{C} \\
\text{O} \\
\end{array}
\]

\[
\text{CO}_3^{2-}
\]

\[
\begin{array}{c}
\text{O} \\
\text{C} \\
\text{O} \\
\end{array}
\]

(ii) CO₃²⁻ consists of single bonds and double bonds. Since it shows resonance, then the strength of the bonds in CO₃²⁻ is greater than a single bond but smaller than a double bond. CO₂, however, contains only double bonds and therefore its bonds are stronger than those in CO₃²⁻. The stronger the bond, the smaller the length. Therefore, since CO₃²⁻ contains the weaker bonds, the C-O bond is greater in length than the C-O bond in CO₂.
(b) (i) CF₄

C: 4
F: 4 (7)

3₂

(ii) CF₄ is nonpolar because the molecule has a tetrahedral shape. Each Fluorine atom is pulling equally. SF₄ is polar because it has a trigonal bipyramidal shape. Since S has a lone pair electrons, then the molecule has an uneven pull, making the molecule polar.
8. Answer the following questions using principles of chemical bonding and molecular structure.

(a) Consider the carbon dioxide molecule, \( \text{CO}_2 \), and the carbonate ion, \( \text{CO}_3^{2-} \).

(i) Draw the complete Lewis electron-dot structure for each species.

(ii) Account for the fact that the carbon-oxygen bond length in \( \text{CO}_3^{2-} \) is greater than the carbon-oxygen bond length in \( \text{CO}_2 \).

(b) Consider the molecules \( \text{CF}_4 \) and \( \text{SF}_4 \).

(i) Draw the complete Lewis electron-dot structure for each molecule.

(ii) In terms of molecular geometry, account for the fact that the \( \text{CF}_4 \) molecule is nonpolar, whereas the \( \text{SF}_4 \) molecule is polar.
ii) $\text{CF}_4$ is tetrahedral so there are no electron clouds, making it non-polar.

$\text{SF}_4$ is see-saw shaped so the electron cloud is unbalanced, making it polar.
8. Answer the following questions using principles of chemical bonding and molecular structure.

(a) Consider the carbon dioxide molecule, \( \text{CO}_2 \), and the carbonate ion, \( \text{CO}_3^{2-} \).

(i) Draw the complete Lewis electron-dot structure for each species.

(ii) Account for the fact that the carbon-oxygen bond length in \( \text{CO}_3^{2-} \) is greater than the carbon-oxygen bond length in \( \text{CO}_2 \).

(b) Consider the molecules \( \text{CF}_4 \) and \( \text{SF}_4 \).

(i) Draw the complete Lewis electron-dot structure for each molecule.

(ii) In terms of molecular geometry, account for the fact that the \( \text{CF}_4 \) molecule is nonpolar, whereas the \( \text{SF}_4 \) molecule is polar.

\[
a.) (i) \text{CO}_2: \quad \text{O} \quad \text{C} \quad \text{O}^{2-} \\
\quad \begin{array}{c}
\text{O} \\quad \text{O} \\
\text{C} \\
\end{array}
\]

\[
\text{(ii)} \quad \text{In CO}_2 \text{ all of the carbon-oxygen bonds are double bonds, which are stronger and therefore shorter bonds.}
\]

\[
b.) (i) \text{CF}_4: \quad \begin{array}{c}
\text{F} \\
\text{C} \\
\text{F} \\
\end{array} \\
\quad \text{SF}_4: \quad \begin{array}{c}
\text{F} \\
\text{S} \\
\text{F} \\
\text{F} \\
\end{array}
\]

\[
\text{(ii)} \quad \text{The CF}_4 \text{ molecule is in the tetrahedral shape, which means that all of the F molecules are spaced evenly from each other (109° apart). This results in a molecule of uniform charge. In the SF}_4 \text{ molecule, the S atom is capable of holding 10 valence electrons, and hence one pair of free electrons. This deflects the F molecules away, and the result is a square pyramidal molecule, with the free pair of electrons creating a highly negative region, and a highly polar molecule.}
\]