8. Answer the following questions about carbon monoxide, CO\(_{(g)}\), and carbon dioxide, CO\(_2\)(g). Assume that both gases exhibit ideal behavior.

(a) Draw the complete Lewis structure (electron-dot diagram) for the CO molecule and for the CO\(_2\) molecule.

(b) Identify the shape of the CO\(_2\) molecule.

(c) One of the two gases dissolves readily in water to form a solution with a pH below 7. Identify the gas and account for this observation by writing a chemical equation.

(d) A 1.0 mole sample of CO\(_{(g)}\) is heated at constant pressure. On the graph below, sketch the expected plot of volume versus temperature as the gas is heated.

\[
\frac{V_1}{T_1} = \frac{V_2}{T_2}
\]

(e) Samples of CO\(_{(g)}\) and CO\(_2\)(g) are placed in 1 L containers at the conditions indicated in the diagram below.

![Diagram of CO gas and CO\(_2\) gas at different conditions]

(i) Indicate whether the average kinetic energy of the CO\(_2\)(g) molecules is greater than, equal to, or less than the average kinetic energy of the CO\(_{(g)}\) molecules. Justify your answer.

(ii) Indicate whether the root-mean-square speed of the CO\(_2\)(g) molecules is greater than, equal to, or less than the root-mean-square speed of the CO\(_{(g)}\) molecules. Justify your answer.

(iii) Indicate whether the number of CO\(_2\)(g) molecules is greater than, equal to, or less than the number of CO\(_{(g)}\) molecules. Justify your answer.
ADDITIONAL PAGE FOR ANSWERING QUESTION 8.

a. \[ CO: \quad 4 + 6 = 10 \quad \boxed{5} \quad 1\text{C} = \text{O} \]

\[ \text{C} \quad \text{O} \]

\[ \text{CO}_2: \quad 4 + 6 \cdot 2 = 16 \quad \boxed{8} \quad \text{C} = \text{O} \quad \boxed{1} \]

\[ \text{O} \quad \text{C} \quad \text{O} \]

b. linear

c. \[ \text{CO}_2 + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{CO}_3 \]

d.

e. i. Temperature is a measure of the average kinetic energy. Because the 2 gases are at the same temperature, their average molecular kinetic energies are equal.

\[ u_{\text{rms}} = \sqrt{\frac{3 RT}{M}} \]

All other factors being equal, the molar mass of \( \text{CO}_2 \) is greater than that of \( \text{CO} \). Therefore, according to the above formula, the root-mean-square speed of the \( \text{CO}_2 \) molecules is less than that of \( \text{CO} \) molecules.

ii. \[ PV = nRT \]

\[ n = \frac{PV}{RT} \]

\( V, T, \) and \( R \) being equal, the pressure of \( \text{CO} \) is greater than that of \( \text{CO}_2 \), so there are more \( \text{CO} \) moles than \( \text{CO}_2 \) moles. The number of \( \text{CO}_2 \) molecules is less than the number of \( \text{CO} \) molecules.
8. Answer the following questions about carbon monoxide, CO(g), and carbon dioxide, CO₂(g). Assume that both gases exhibit ideal behavior.

(a) Draw the complete Lewis structure (electron-dot diagram) for the CO molecule and for the CO₂ molecule.

(b) Identify the shape of the CO₂ molecule.

(c) One of the two gases dissolves readily in water to form a solution with a pH below 7. Identify the gas and account for this observation by writing a chemical equation.

(d) A 1.0 mole sample of CO(g) is heated at constant pressure. On the graph below, sketch the expected plot of volume versus temperature as the gas is heated.

(e) Samples of CO(g) and CO₂(g) are placed in 1 L containers at the conditions indicated in the diagram below.

(i) Indicate whether the average kinetic energy of the CO₂(g) molecules is greater than, equal to, or less than the average kinetic energy of the CO(g) molecules. Justify your answer.

(ii) Indicate whether the root-mean-square speed of the CO₂(g) molecules is greater than, equal to, or less than the root-mean-square speed of the CO(g) molecules. Justify your answer.

(iii) Indicate whether the number of CO₂(g) molecules is greater than, equal to, or less than the number of CO(g) molecules. Justify your answer.

\[ \text{8. a) } \text{ :C::O:: } \quad \text{ :O::C::O:: } \]

b) linear

c) (acid) \( H_2O + CO_2 \rightarrow H_2CO_3 \)

d) on graph
e) (i) The more pressure put on a molecule, the higher its kinetic energy will be. So CO gas has a higher kinetic energy because it has 2 atm of pressure.

(ii) Because CO has a higher molar mass, its root-mean-square speed is less. \( \text{urms} = \sqrt{\frac{3kT}{m}} \) is the more you divide by the smaller your answer.

(iii) Pressure + Volume is constant so more CO
8. Answer the following questions about carbon monoxide, \( \text{CO}(g) \), and carbon dioxide, \( \text{CO}_2(g) \). Assume that both gases exhibit ideal behavior.

(a) Draw the complete Lewis structure (electron-dot diagram) for the \( \text{CO} \) molecule and for the \( \text{CO}_2 \) molecule.

(b) Identify the shape of the \( \text{CO}_2 \) molecule.

(c) One of the two gases dissolves readily in water to form a solution with a \( \text{pH} \) below 7. Identify the gas and account for this observation by writing a chemical equation.

(d) A 1.0 mole sample of \( \text{CO}(g) \) is heated at constant pressure. On the graph below, sketch the expected plot of volume versus temperature as the gas is heated.

\[
\begin{align*}
\frac{PV}{T} &= \frac{PV}{T} \\
\frac{\text{V}}{\text{T}} &= \frac{\text{V}}{\text{T}} \\
\frac{3}{1} &= \frac{\text{V}}{\text{T}} \\
\frac{4}{1} &= \frac{\text{V}}{\text{T}}
\end{align*}
\]

(e) Samples of \( \text{CO}(g) \) and \( \text{CO}_2(g) \) are placed in 1 L containers at the conditions indicated in the diagram below.

(i) Indicate whether the average kinetic energy of the \( \text{CO}_2(g) \) molecules is greater than, equal to, or less than the average kinetic energy of the \( \text{CO}(g) \) molecules. Justify your answer.

(ii) Indicate whether the root-mean-square speed of the \( \text{CO}_2(g) \) molecules is greater than, equal to, or less than the root-mean-square speed of the \( \text{CO}(g) \) molecules. Justify your answer.

(iii) Indicate whether the number of \( \text{CO}_2(g) \) molecules is greater than, equal to, or less than the number of \( \text{CO}(g) \) molecules. Justify your answer.
a) $\text{CO} \rightarrow \text{CO}_2$

\[ \cdot\text{C} = \cdot\text{O} \quad \cdot\text{O} = \cdot\text{C} = \cdot\text{O} \]

b) The $\text{CO}_2$ molecule is linear.

c) $\text{CO}$ dissolves in water

\[ 2 \text{H}_2\text{O}(l) + 2\text{CO}(g) \rightarrow \text{CH}_3\text{COOH}(aq) + \text{O}_2(g) \]

d) The relationship is $\dfrac{V_1}{V_2} = \dfrac{T_1}{T_2}$, thus they vary such that as temp increases, so does volume.

e) $i)\; T = \dfrac{1}{2}mv^2$

The KE of the $\text{CO}_2(g)$ would be greater than that of the $\text{CO}$ as the mass is greater in $\text{CO}_2$.

This increases collisions.

ii) The root mean square speed would be greater in the $\text{CO}$. This is because by increasing the molar mass, the speed is slowed as shown in the equation $v = \sqrt{\dfrac{3RT}{M}}$. By dividing by a small molar mass, the speed is increased assuming the conditions are the same.

iii) There would be more molecules of $\text{CO}$ in order to have the same pressure within the two containers. As the individual molecules of $\text{CO}$ are smaller, more of them are required to attain the same pressure.