1. How would a gas differ from a liquid with respect to each of the following properties: (a) density; (b) compressibility; (c) ability to mix with other substances of the same phase to form homogeneous mixtures?

2. Container A has twice the volume but holds twice as many gas molecules as container B at the same temperature. Use kinetic-molecular theory to compare the pressures in the two containers.

3. Perform the following conversions: (a) 0.860 atm to kilopascals; (b) 457 torr to atmospheres; (c) 802 mm Hg to atm; (d) 0.897 atm to torr

4. The volume of a gas is 5.80 L measured at 1.00 atm. What is the pressure of the gas in mm Hg if the volume is changed to 9.65 L? (The temperature remains constant.)

5. Under constant-pressure conditions a sample of hydrogen gas initially at 88°C and 9.6 L is cooled until its final volume is 3.4 L. What is its final temperature?

6. A gas evolved during the fermentation of glucose (wine making) has a volume of 780 mL at 20.1°C and 1.00 atm. What was the volume of this gas at the fermentation temperature of 36.5°C and 1.00 atm pressure?

7. Dry ice is solid carbon dioxide. A 0.050 g sample of dry ice is placed in an evacuated 4.6 L vessel at 30°C. Calculate the pressure inside the vessel after all the dry ice has been converted to CO₂ gas.

8. Ozone molecules in the stratosphere absorb much of the harmful radiation from the sun. Typically, the temperature and pressure of ozone in the stratosphere are 250 K and 1.0 x 10⁻³ atm, respectively. How many ozone molecules are present in 1.0 L of air under these conditions?

9. Some commercial drain cleaners contain a mixture of sodium hydroxide and aluminum powder. When the mixture is poured down a clogged drain, the following reaction occurs:

   \[ 2 \text{NaOH(aq)} + 2 \text{Al(s)} + 6 \text{H}_2\text{O(l)} \rightarrow 2 \text{NaAl(OH)}_4(\text{aq}) + 3 \text{H}_2(\text{g}) \]

   The heat generated in this reaction melts away obstructions such as grease, and the hydrogen gas released stirs up the solids clogging the drain. Calculate the volume of H₂ formed at STP (1 atm pressure, 0°C) if 3.12 g of Al are treated with an excess of NaOH.

10. Do problem 38 on page 172 of your textbook.
#1. How would a gas differ from a liquid with respect to each of the following properties:

(a) Density: The density of a gas will be much less than a liquid because the molecules in a gas are spaced much farther apart than those in liquids.

(b) Compressibility: Gases are very compressible because of the large spaces between molecules.

(c) Ability to mix with other substances of the same phase to form homogeneous mixtures.

Gases are able to form homogeneous mixtures very readily because of the ease with which gases can diffuse.

#2. Container A has twice the volume but holds twice as many gas molecules as container B at the same temperature. Use kinetic-molecular theory to compare the pressures in the two containers.

- Pressure is related to the # of collisions the molecules have with the container. If the size of the container doubles, the # of collisions will decrease, and so the pressure will decrease. If the volume doubles, but the # of particles also doubles, then there will be no change in the pressure.

#3. Perform the following conversions:

(a) 0.860 atm to kilopascals

\[
(0.860 \text{ atm}) \left( \frac{101.325 \text{ kPa}}{1 \text{ atm}} \right) = 87.1 \text{ kPa}
\]

(b) 457 torr to atmosphere

\[
(457 \text{ torr}) \left( \frac{1 \text{ atm}}{760 \text{ torr}} \right) = 0.601 \text{ atm}
\]

(c) 802 mm Hg to atm

\[
(802 \text{ mm Hg}) \left( \frac{1 \text{ atm}}{760 \text{ mm Hg}} \right) = 1.06 \text{ atm}
\]

(d) 0.897 atm to torr

\[
(0.897 \text{ atm}) \left( \frac{760 \text{ torr}}{1 \text{ atm}} \right) = 682 \text{ torr}
\]
4. The volume of a gas is 5.80 L measured at 1.00 atm. What is the pressure of the gas in mm Hg if the volume is changed to 9.65 L? (Temp. remains const.)

\[ P_1V_1 = P_2V_2 \]
\[ P_2 = \frac{P_1V_1}{V_2} = \frac{(1.00 \text{ atm})(5.80 \text{ L})}{9.65 \text{ L}} = 0.601 \text{ atm.} \]

\[ V_1 = 5.80 \text{ L} \]
\[ P_1 = 1.00 \text{ atm} \]
\[ V_2 = 9.65 \text{ L} \]

\[ (0.601 \text{ atm}) \left( \frac{760 \text{ mm Hg}}{1 \text{ atm}} \right) = 457 \text{ mm Hg} \]

5. Under constant-pressure conditions, a sample of hydrogen gas initially at 88°C and 9.6 L is cooled until its final volume is 3.4 L. What is its final temp?

\[ \frac{V_1}{T_1} = \frac{V_2}{T_2} \]
\[ T_2 = \frac{V_2}{V_1} \cdot T_1 = \frac{(3.4 \text{ L})(361 \text{ K})}{9.6 \text{ L}} = 128 \text{ K} \]

\[ T_1 = 88^\circ C + 273 = 361 \text{ K} \]
\[ V_1 = 9.6 \text{ L} \]
\[ V_2 = 3.4 \text{ L} \]

6. A gas evolved during the fermentation of glucose has a volume of 780 mL at 20.1°C and 1.00 atm. What was the volume of this gas at the fermentation temperature of 36.5°C and 1.00 atm pressure?

\[ \frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \]
\[ V_2 = \frac{P_1V_1T_2}{P_2T_1} = \frac{(1 \text{ atm})(780 \text{ mL})(309 \text{ K})}{(1 \text{ atm})(293 \text{ K})} = 823 \text{ mL} \]

\[ P_1 = 1.00 \text{ atm} \]
\[ T_1 = 20.1^\circ C + 273 = 293 \text{ K} \]
\[ V_1 = 780 \text{ mL} \]
\[ P_2 = 1.00 \text{ atm} \]
\[ T_2 = 36.5^\circ C + 273 = 309 \text{ K} \]
\[ V_2 = ? \]

7. Dry ice is solid carbon dioxide. A 0.050 g sample of dry ice is placed in an evacuated 4.6 L vessel at 30°C. Calculate the pressure inside the vessel after all the dry ice has been converted to CO₂ gas.

\[ PV = nRT \]
\[ P = \frac{nRT}{V} = \frac{(1.14 \times 10^{-3} \text{ mol CO}_2) \cdot (0.0821 \text{ L atm/mol K}) \cdot (303 \text{ K})}{4.6 \text{ L}} \]

\[ 4.6 \text{ L} \]

\[ P = 6.14 \times 10^{-3} \text{ atm} \]

\[ n = \frac{(0.050 \text{ g} \text{ CO}_2)}{(44.014 \text{ g/mol})} = 1.14 \times 10^{-3} \text{ mol CO}_2 \]
8. Ozone molecules in the stratosphere absorb much of the harmful radiation from the Sun. Typically, the temp. and pressure of ozone in the stratosphere are 250K and 1.0 x 10^3 atm, respectively. How many ozone molecules are present in 1.0L of air under these conditions?

\[ PV = nRT \]
\[ P = 1.0 \times 10^{-3} \text{ atm} \]
\[ T = 250 \text{ K} \]
\[ V = 1.0 \text{ L} \]
\[ n = \frac{PV}{RT} = \frac{(1.0 \times 10^3 \text{ atm})(1.0 \text{ L})}{(0.0821 \frac{\text{L atm}}{\text{mol K}})(250 \text{ K})} = 4.87 \times 10^{-5} \text{ mol O}_3 \]

molecules O\textsubscript{3} = \left(4.87 \times 10^{-5} \text{ mol O}_3\right) \left(6.022 \times 10^{23} \text{ molecules O}_3\right) = 2.9 \times 10^{19}

= 2.9 \times 10^{19} \text{ molecules O}_3

9. Some commercial drain cleaners contain a mixture of sodium hydroxide and aluminium powder. When the mixture is poured down a clogged drain, the following reaction occurs:

\[ 2 \text{NaOH(aq)} + 2 \text{Al(s)} + 6 \text{H}_2\text{O(l)} \rightarrow 2 \text{NaAl(OH)}_4\text{(aq)} + 3 \text{H}_2\text{(g)} \]

The heat generated in this reaction melts away obstructions such as grease, and the hydrogen gas released stirs up the solids clogging the drain. Calculate the volume of H\textsubscript{2} formed at STP if 3.12g of Al are treated with an excess of NaOH.

\[ 9 \text{ Al} \rightarrow \text{mol Al} \rightarrow \text{mol H}_2 \rightarrow \text{L H}_2 \]

\[ (3.12 \text{ g Al}) \left(\frac{1 \text{ mol Al}}{26.98 \text{ g}}\right) \left(\frac{3 \text{ mol H}_2}{2 \text{ mol Al}}\right) = 0.173 \text{ mol H}_2 \]

\[ PV = nRT \quad V = \frac{nRT}{P} = \frac{(0.173 \text{ mol H}_2)(0.0821 \frac{\text{L atm}}{\text{mol K}})(273 \text{ K})}{1 \text{ atm}} = 3.9 \text{ L H}_2 \]

10. The pressure of the atmosphere on the surface of Venus is about 100 atm. Carbon dioxide makes up about 97% by volume of the atmospheric gases. What is the partial pressure of carbon dioxide in the atmosphere of Venus?

\[ P_T = P_{\text{CO}_2} + \text{other} \]

\[ (100 \text{ atm})(0.97) = (97 \text{ atm} = P_{\text{CO}_2}) \]