

Name: _____

Hour: _____ Date: _____

Chemistry: *Density of Gases*

Solve each of the following problems, being sure to show your work and include all proper units.

1. A sample of gas has a density of 0.53 g/L at 225 K and under a pressure of 108.8 kPa. Find the density of the gas at 345 K under a pressure of 68.3 kPa.

2. A sample of gas with a mass of 26 g occupies a volume of 392 L at 32°C and at a pressure of 0.95 atm. Find the density of the gas at STP.

3. A gas sample has a density of 1.77×10^{-4} g/L when the temperature is 15°C and the pressure is 780 mm Hg. Find the density of the gas at STP.

4. What is the mass of a 3.00 L sample of a gas if this volume was measured at 40°C and 99.2 kPa? Assume that the density of the gas at 20°C and 101.3 kPa is 1.43 g/L.

5. A sample of gas has a volume of 2.68 L when the temperature is -54°C and the pressure is 195.0 kPa. If the density of the gas is 0.322 g/L at STP, find the mass of the sample.

Answers: 1. 0.217 g/L 2. 0.078 g/L 3. 1.82×10^{-4} g/L 4. 3.93 g 5. 2.07 g

Chemistry: Density of Gases

Solve each of the following problems, being sure to show your work and include all proper units.

1. A sample of gas has a density of 0.53 g/L at 225 K and under a pressure of 108.8 kPa. Find the density of the gas at 345 K under a pressure of 68.3 kPa.

$$\begin{array}{ll}
 P_1 = 108.8 \text{ kPa} & P_2 = 68.3 \text{ kPa} \\
 V_1 = ? & V_2 = ? \\
 T_1 = 225 \text{ K} & T_2 = 345 \text{ K} \\
 D_1 = 0.53 \text{ g/L} & D_2 = ? \text{ g/L}
 \end{array}
 \quad \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \Rightarrow \frac{P_1 \left(\frac{1}{D_1} \right)}{T_1} = \frac{P_2 \left(\frac{1}{D_2} \right)}{T_2} \Rightarrow \frac{P_1}{D_1 T_1} = \frac{P_2}{D_2 T_2}$$

Assume mass = 1 g.

$$\therefore \frac{1}{D} = V \quad \text{or} \quad D = \frac{1}{V}$$

$$\frac{108.8 \text{ kPa}}{0.53 \text{ g/L} \cdot 225 \text{ K}} = \frac{68.3 \text{ kPa}}{D_2 \cdot 345 \text{ K}}$$

$$D_2 = 0.217 \text{ g/L}$$

2. A sample of gas with a mass of 26 g occupies a volume of 392 L at 32°C and at a pressure of 0.95 atm. Find the density of the gas at STP.

$$\begin{array}{ll}
 P_1 = 0.95 \text{ atm} & P_2 = 1 \text{ atm} \\
 V_1 = 392 \text{ L} & V_2 = ? \text{ L} \\
 T_1 = 32^\circ \text{C} + 273 = 305 \text{ K} & T_2 = 273 \text{ K} \\
 m = 26 \text{ g} & m = 26 \text{ g}
 \end{array}
 \quad \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \Rightarrow \frac{0.95 \text{ atm} \cdot 392 \text{ L}}{305 \text{ K}} = \frac{1 \text{ atm} \cdot V_2}{273 \text{ K}}$$

$$V_2 = 333 \text{ L} \quad \therefore D = \frac{m}{V} \Rightarrow \frac{26 \text{ g}}{333 \text{ L}}$$

$$D = 0.078 \text{ g/L}$$

3. A gas sample has a density of 1.77×10^{-4} g/L when the temperature is 15°C and the pressure is 780 mm Hg. Find the density of the gas at STP.

$$\begin{array}{ll}
 P_1 = 780 \text{ mm Hg} & P_2 = 760 \text{ mm Hg} \\
 V_1 = ? & V_2 = ? \\
 T_1 = 15^\circ \text{C} + 273 = 288 \text{ K} & T_2 = 273 \text{ K} \\
 D_1 = 1.77 \times 10^{-4} \text{ g/L} & D_2 = ? \text{ g/L}
 \end{array}
 \quad \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \Rightarrow \frac{P_1}{D_1 T_1} = \frac{P_2}{D_2 T_2}$$

$$\frac{780 \text{ mm Hg}}{1.77 \times 10^{-4} \text{ g/L} \cdot 288 \text{ K}} = \frac{760 \text{ mm Hg}}{D_2 \cdot 273 \text{ K}}$$

$$D_2 = 1.82 \times 10^{-4} \text{ g/L}$$

Chemistry: Density of Gases

4. What is the mass of a 3.00 L sample of a gas if this volume was measured at 40°C and 99.2 kPa? Assume that the density of the gas at 20°C and 101.3 kPa is 1.43 g/L.

$$P_1 = 99.2 \text{ kPa}$$

$$P_2 = 101.3 \text{ kPa}$$

$$V_1 = 3.0 \text{ L}$$

$$V_2 = ?$$

$$T_1 = 40^\circ\text{C} + 273 = 313 \text{ K}$$

$$T_2 = 20^\circ\text{C} + 273 = 293 \text{ K}$$

$$D_1 = 1.31 \text{ g/L}$$

$$D_2 = 1.43 \text{ g/L}$$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \Rightarrow \frac{P_1}{D_1 T_1} = \frac{P_2}{D_2 T_2}$$

$$\frac{99.2 \text{ kPa}}{1.31 \text{ g/L} \cdot 313 \text{ K}} = \frac{101.3 \text{ kPa}}{1.43 \text{ g/L} \cdot 293 \text{ K}}$$

Finally, calculate the mass of the gas

$$D_1 = 3.31 \text{ g/L}$$

$$x \text{ g} = 3.0 \text{ L} \left(\frac{1.31 \text{ g}}{1 \text{ L}} \right) = 3.93 \text{ g}$$

5. A sample of gas has a volume of 2.68 L when the temperature is -54°C and the pressure is 195.0 kPa. If the density of the gas is 0.322 g/L at STP, find the mass of the sample.

$$P_1 = 195 \text{ kPa}$$

$$P_2 = 101.3 \text{ kPa}$$

$$V_1 = 2.68 \text{ L}$$

$$V_2 = ?$$

$$T_1 = -54^\circ\text{C} + 273 = 219 \text{ K}$$

$$T_2 = 273 \text{ K}$$

$$D_1 = ? \text{ g/L}$$

$$D_2 = 0.322 \text{ g/L}$$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \Rightarrow \frac{P_1}{D_1 T_1} = \frac{P_2}{D_2 T_2}$$

$$\frac{195 \text{ kPa}}{D_1 \cdot 219 \text{ K}} = \frac{101.3 \text{ kPa}}{0.322 \text{ g/L} \cdot 273 \text{ K}}$$

Finally, calculate the mass of the gas

$$D_1 = 0.773 \text{ g/L}$$

$$x \text{ g} = 2.68 \text{ L} \left(\frac{0.773 \text{ g}}{1 \text{ L}} \right) = 2.07 \text{ g}$$

Answers:

1. 0.217 g/L

2. 0.078 g/L

3. 1.82×10^{-4} g/L

4. 3.93 g

5. 2.07 g