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^{o}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 x 10^{-4} g/L when the temperature is 15^{o}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^{o}C and 99.2 kPa? Assume that the density of the gas at 20^{o}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^{o}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 x 10^{-4} g/L 4. 3.93 g 5. 2.07 g

KEY

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.

$P_1 = 108.8\,\text{kPa}$ $\quad P_2 = 68.3\,\text{kPa}$
$V_1 = ?$ $\quad V_2 = ?$
$T_1 = 225\,\text{K}$ $\quad T_2 = 345\,\text{K}$
$D_1 = 0.53\,\text{g/L}$ $\quad D_2 = ?\,\text{g/L}$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \Rightarrow \frac{P_1\left(\frac{1}{D_1}\right)}{T_1} = \frac{P_2\left(\frac{1}{D_2}\right)}{T_2} \Rightarrow \frac{P_1}{D_1T_1} = \frac{P_2}{D_2T_2}$$

Assume mass $= 1\,\text{g}$.

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

$$\frac{108.8\,\text{kPa}}{(0.53\,\text{g/L})(225\,\text{K})} = \frac{68.3\,\text{kPa}}{(225\,\text{K})(D_2)}$$

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

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.

$P_1 = 0.95\,\text{atm}$ $\quad P_2 = 1\,\text{atm}$
$V_1 = 392\,\text{L}$ $\quad V_2 = ?\,\text{L}$
$T_1 = 32^\circ\text{C} + 273 = 305\,\text{K}$ $\quad T_2 = 273\,\text{K}$
$m = 26\,\text{g}$ $\quad m = 26\,\text{g}$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \Rightarrow \frac{(0.95\,\text{atm})(392\,\text{L})}{305\,\text{K}} = \frac{(1\,\text{atm})(V_2)}{273\,\text{K}}$$

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

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

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.

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

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \Rightarrow \frac{P_1}{D_1T_1} = \frac{P_2}{D_2T_2}$$

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

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

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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.

$P_1 = 99.2\,\text{kPa}$ $\quad P_2 = 101.3\,\text{kPa}$

$V_1 = 3.0\,\text{L}$ $\quad V_2 = \,?$

$T_1 = 40^\circ\text{C} + 273 = 313\,\text{K}$ $\quad T_2 = 20^\circ\text{C} + 273 = 293\,\text{K}$

$D_1 = 1.31\,\text{g/L}$ $\quad D_2 = 1.43\,\text{g/L}$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \quad \Rightarrow \quad \frac{P_1}{D_1T_1} = \frac{P_2}{D_2T_2}$$

$$\frac{99.2\,\text{kPa}}{(D_1)(313\,\text{K})} = \frac{101.3\,\text{kPa}}{(1.43\,\text{g/L})(293\,\text{K})}$$

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.

$P_1 = 195\,\text{kPa}$ $\quad P_2 = 101.3\,\text{kPa}$

$V_1 = 2.68\,\text{L}$ $\quad V_2 = \,?$

$T_1 = -54^\circ\text{C} + 273 = 219\,\text{K}$ $\quad T_2 = 273\,\text{K}$

$D_1 = ?\ \text{g/L}$ $\quad D_2 = 0.322\,\text{g/L}$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \quad \Rightarrow \quad \frac{P_1}{D_1T_1} = \frac{P_2}{D_2T_2}$$

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

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