AP CHEMISTRY

TOPIC 3: GASES, PART B-I

Day 37:

- Gas Density
- Gas Molar Mass

---

1) What is the density of carbon tetrachloride vapor at 714 torr and 125 ^{0}C?

Answers:

$PV=nRT$

$CCl_4 = 153.823\ g\ mol^{-1}$

$$PV = \frac{mass}{molar\ \ mass}RT \quad \textbf{OR} \quad PV = \frac{m}{M}RT$$

$$\frac{m}{V} = \frac{PM}{RT}$$

RECALL THAT: $density = \frac{m}{V}$

$$\frac{m}{V} = \frac{PM}{RT} = \frac{(0.939\ \ atm)\left(mol \cdot K\right)(153.823\ \ g)}{(0.0821\ \ atm \cdot L)(398\ \ K)\left(mol\right)} = 4.42\ \ g\ \ L^{-1}$$

2) The average molar mass of the atmosphere at the surface of Titan (Saturn's largest moon) is 28.6 g mol^{-1}. The surface temperature is 95.0 K, and the pressure is 1.60 atm (in Earth atm). Assuming ideal behavior, calculate the density of Titan's atmosphere.

Answers:

$$\frac{m}{V} = \frac{PM}{RT}$$

$$\frac{m}{V} = \frac{PM}{RT} = \frac{(1.60\ \ atm)\left(mol \cdot K\right)(28.6\ \ g)}{(0.0821\ \ atm \cdot L)\left(mol\right)(95.0\ \ K)} = 5.87\ \ g\ \ L^{-1}$$

3) Calculate the density of SO_3 gas at 0.96 atm and 35 ^{0}C

Answers:

$SO_3 = 80.06\ g\ mol^{-1}$

$$\frac{m}{V} = \frac{PM}{RT}$$

$$\frac{m}{V} = \frac{PM}{RT} = \frac{(0.96\ \ atm)\left(mol \cdot K\right)(80.06\ \ g)}{(0.0821\ \ atm \cdot L)(308\ \ K)\left(mol\right)} = 3.0\ \ g\ \ L^{-1}$$

4) Calculate the molar mass of a gas if 4.40 grams occupies 3.50 L at 560 torr and 41.0 ^{0}C.

Answers:

$$\boldsymbol{PV=nRT}$$

$$PV = \frac{mass}{molar\ \ mass}RT \quad \textbf{\textit{OR}} \quad PV = \frac{m}{M}RT$$

$$M = \frac{mRT}{PV}$$

$$M = \frac{(4.40\ \ g)(0.0821\ \ atm \cdot L)(314\ \ K)}{(3.50\ \ L)\left(mol \cdot K\right)(0.737\ \ atm)} = 44.0\ \ g\ \ mol^{-1}$$

5) Calculate the molar mass of a gas if it has a density of 3.67 g L^{-1} at 15.0 ^{0}C and 825 torr.

Answers:

$$\boldsymbol{PV=nRT}$$

$$PV = \frac{mass}{molar\ \ mass}RT \quad \textbf{\textit{OR}} \quad PV = \frac{m}{M}RT$$

$$M = \frac{m}{V} \times \frac{RT}{P}$$

$$\boxed{\textbf{\textit{RECALL THAT}}: \quad density = \frac{m}{V}}$$

$$M = \left(\frac{3.67\ \ g}{L}\right) \times \frac{(0.0821\ \ atm \cdot L)(288\ \ K)}{\left(mol \cdot K\right)(1.08553\ \ atm)} = 80.0\ \ g\ \ mol^{-1}$$