The Ideal Gas Law

PV = nRT

1. A 65.62 g sample of N_2 occupies a volume of 12.0 L at a temperature of 145.0 °C. What is the pressure of the gas?

PV = nRT $\quad P = \frac{nRT}{V} \quad n = 65.62\ g \times \frac{1\ mol}{28.0\ g} = 2.34\ mol \quad$ V = 12.0 L

R = 0.0821 $\frac{L \cdot atm}{mol \cdot K}$ $\quad$ T = 145.0 °C + 273.15 = 418.15 K

$$P = \frac{2.34\ mol \times 418.15\ K \times 0.0821 \frac{L \cdot atm}{mol \cdot K}}{12.0\ L} = \mathbf{6.69\ atm}$$

2. How many molecules of oxygen, O_2, are in a 45.0 L container under 1.25 atm of pressure at 135°C?

PV = nRT $\quad n = \frac{PV}{RT} \quad$ P = 1.25 atm, V = 45.0 L, T = 408 K

$$n = \frac{1.25\ atm \times 45.0\ L}{408\ K \times 0.0821 \frac{L \cdot atm}{mol \cdot K}} = 1.68\ mol\ O_2$$

$$1.68\ mol \times \frac{6.02 \times 10^{23}\ molecules}{1\ mol} = \mathbf{1.01 \times 10^{24}\ molecules}$$

3. Calculate the molar mass of a gas if a 28.54 g sample is under a pressure of 755 mmHg at 27.6°C. The volume of gas is 28.6 L.

$M_m = \frac{mRT}{PV}$ $\quad$ m = 28.54 g, P = 0.993 atm, T = 300.75 K, V = 28.6 L

$$M_m = \frac{28.54\ g \times 300.75\ K \times 0.0821 \frac{L \cdot atm}{mol \cdot K}}{0.993\ atm \times 28.6\ L} = \mathbf{24.8\ g/mol}$$

4. What is the density of CO_2 gas at 1.65 atm and 32.6 °C?

$$d = \frac{M_m P}{RT} = \frac{44.0 \frac{g}{mol} \times\ 1.65\ atm}{305.75\ K\ \times\ 0.0821 \frac{L \cdot atm}{mol \cdot K}} = \mathbf{2.89\ g/L}$$

5. Calculate the density of ethane, C_2H_6, at 0.82 atm and 120 °C.

$$d = \frac{M_m P}{RT} = \frac{30.07 \frac{g}{mol} \times\ 0.82\ atm}{393\ K\ \times\ 0.0821 \frac{L \cdot atm}{mol \cdot K}} = \mathbf{0.76\ g/L}$$