

10/22/2018

The ideal gas law: $pV = nRT$

$$R = 0.08206 \text{ atm}\cdot\text{L}/\text{mol}\cdot\text{K}$$

ex: What's the vol. of 0.845 mol $\text{N}_2(\text{g})$

@ a pressure of 1.37 atm and a temp of 42°C ?

$$T = 42 + 273.15 = 315.15 \text{ K}$$

$$\frac{pV}{p} = \frac{nRT}{p}$$

$$V = \frac{nRT}{p} = \frac{0.845 \text{ mol} \times 0.08206 \frac{\text{atm}\cdot\text{L}}{\text{mol}\cdot\text{K}} \times 315.15 \text{ K}}{1.37 \text{ atm}}$$

$$= 16.0 \text{ L (3s.f.)}$$

Q: What's pressure of 1.75 mol of helium gas @ -28°C w/ a vol. of 23.8 L?

$$T = -28 + 273.15 = 245.15 \text{ K}$$

$$\frac{pV}{V} = \frac{nRT}{V}$$

$$p = \frac{nRT}{V} = \frac{1.75 \text{ mol} \times 0.08206 \frac{\text{atm}\cdot\text{L}}{\text{mol}\cdot\text{K}} \times 245.15 \text{ K}}{23.8 \text{ L}}$$

$$= 1.48 \text{ atm}$$

Molar Volume

- vol. occupied by 1 mol gas.
- often speak of : Standard Temperature + Pressure (STP)

$$\begin{array}{cc} 0^{\circ}\text{C} & 1\text{ atm} \\ 273.15\text{K} & \end{array}$$

$$PV = nRT, \quad V = \frac{nRT}{P} = \frac{(1\text{ mol})(0.08206 \frac{\text{atm} \cdot \text{L}}{\text{mol} \cdot \text{K}})(273.15\text{K})}{(1\text{ atm})}$$

$$n = 1\text{ mol (exact)}$$

$$T = 273.15\text{K (exact)}$$

$$P = 1\text{ atm (exact)}$$

$$= 22.41\text{ L}$$

$$\approx 22.4\text{ L}$$

\approx vol of 1 mol ideal gas @ STP

Density + Molar-Mass

ch 1: $d = \frac{m}{V}$ extensive
intensive

$$\text{Molar Mass} = M \quad (\text{g/mol}) = \frac{m}{n}$$

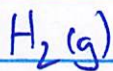
$$\Rightarrow m = M \cdot n$$

$$d = \frac{m}{V}?$$

$$V? \quad pV = nRT \Rightarrow V = \frac{nRT}{p}$$

$$\Rightarrow d = \frac{m}{V} = \frac{M \cdot n}{\frac{nRT}{p}} = M \times \frac{p}{RT}$$

$$\Rightarrow \boxed{d = \frac{M \cdot p}{RT}} \quad d \propto M$$
$$\propto 1/T$$



@ STP - d?

$$T = 273.15 \text{ K}, \quad p = 1 \text{ atm (exact)}$$

$$R = 0.08206 \frac{\text{atm} \cdot \text{L}}{\text{mol} \cdot \text{K}}$$



$$2 \times N = 2 \times 14.01$$

$$\underline{28.02 \text{ g/mol}}$$

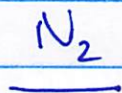
M



$$2 \times H = 2 \times 1.008$$

$$\underline{2.016 \text{ g/mol}}$$

M



$$d = \frac{pM}{RT}$$



$$d = \frac{(1 \text{ atm})(28.02 \text{ g/mol})}{(0.08206 \frac{\text{atm} \cdot \text{L}}{\text{mol} \cdot \text{K}})(273.15 \text{ K})}$$

$$= 1.250 \text{ g/L (4s.f.)}$$

$$d = \frac{(1 \text{ atm})(2.016 \text{ g/mol})}{\dots}$$

$$= 0.08994 \text{ g/L (4s.f.)}$$