10/24/18

$$d = \frac{\mathcal{M} \cdot P}{RT} \qquad d \propto \mathcal{M} \text{ (molar mass)}$$

Let's calculate the molar mass of a gas!

- can just rearrange last eq!

$$d = \frac{\mathcal{M} \cdot P}{R \cdot T} \Rightarrow \frac{dRT}{P} = \frac{\mathcal{M} \cdot P}{P}$$

$$\Rightarrow \boxed{\mathcal{M} = \frac{d \cdot R \cdot T}{P}}$$

ex: A sample of gas has a mass of 0.311g. Its volume is 0.225 L @ 55°C and a pressure of 886 mm Hg. Q: What is $\mathcal{M}$?

$R = 0.08206 \frac{atm \cdot L}{mol \cdot K}$ $\qquad$ 760 mm Hg = 1 atm.

$$886 \text{ mm Hg} \times \frac{1 \text{ atm}}{760 \text{ mm Hg}} = 1.1658 \text{ atm}$$

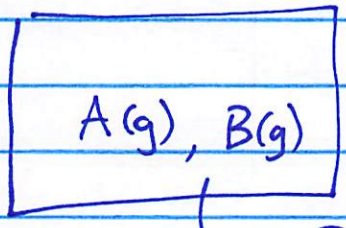
$$d = m/V = \frac{0.311 g}{0.225 L} = 1.3829 g/L$$

$$T = 55 + 273.15 = 328.15 K$$

$$\mathcal{M} = \frac{dRT}{P} = \frac{1.3829 g/L \times 0.08206 \frac{atm \cdot L}{mol \cdot K} \times 328.15 K}{1.1658 atm}$$

$$= 31.9 \ g/mol$$

Mixtures of gases + partial pressures



partial pressures

$P_{TOT} = P_A + P_B + \ldots$

$pV = nRT$

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

total pressure.

#mol A

$P_B = \frac{n_B \cdot RT}{V}$

$P_A = \frac{n_A \cdot RT}{V}$

(pressure assuming only A present)

(press. ass. only B present.)

can show $P_{TOT} = \frac{n_A RT}{V} + \frac{n_B RT}{V} + \ldots$

$= (n_A + n_B + \ldots)\frac{RT}{V}$

$= n_{TOT} \cdot \frac{RT}{V}$

note: $\frac{P_A}{P_{TOT}} = \frac{n_A \cdot \cancel{RT/V}}{n_{TOT} \cdot \cancel{RT/V}} = \frac{n_A}{n_{TOT}}$

x_A, mol fraction of A

$P_A / P_{TOT} = x_A$

OR: $\boxed{P_A = x_A \cdot P_{TOT}}$

if $P_{TOT} = 760 mmHg$

AIR

$P_A = x_A \cdot P_{TOT}$

air: 78% N_2

21% O_2

1% Ar

$P_{N_2} = 0.78 \times 760 mmHg = 592.8 mmHg$

$P_{O_2} = 0.21 \times 760 mmHg = 159.6 mmHg$

$P_{Ar} = 0.01 \times 760 mmHg = 7.60 mmHg$

} partial pressures

$\oplus$ ——————

760 mmHg

} tot. press.

Dalton's law of partial pressures: $P_{TOT} = P_A + P_B + \dots$

- Exercise in chapter: 5-9
- read over: gases collected over H_2O.

Gases in chem. rxns ~ STOICHIOMETRY revisited!

- can use ideal gas eq (pV=nRT) to calculate:

n_{gas}, P_{gas}, V_{gas} } for gases used-up of produced in a chem rxn!

ex: Synthesis of methanol: CH_3OH

$$CO(g) + 2H_2(g) \longrightarrow CH_3OH(g)$$

Q: What vol. of $H_2(g)$ in liters @ 355K and a pressure of 738 mmHg is needed to make 35.7g CH_3OH?