AP Chem - unit 3 - Gases

Wkst: FR Problems

(1) (A) Given:

$V_{sample} = 90.0\,mL = 0.0900\,L$

$Temp = 25° = 298\,K$

$P_{atm} = 745\,mm\,Hg$

$P_{vapor} = 23.8\,mmHg$

Moles H_2 in 90.0 mL?

Soln:

$PV = nRT$

$n = \frac{PV}{RT}$

$P = P_{atm} - P_{vapor}$

$= 745\,mm - 23.8\,mm$

$P = 721\,mm$

$$n = \frac{(721\,mm)(0.0900\,L)}{(62.36\,\frac{L\,Torr}{K\,mol})(298\,K)}$$

$$\boxed{n = 0.00349 \text{ moles } H_2}$$

(B) ? H_2O molecules in 90.00 mL

$P_{vapor} = 23.8\,mmHg$

$$n = \frac{PV}{RT} = \frac{(23.8\,mm)(0.0900\,L)}{(62.36\,\frac{L\,Torr}{K\,mol})(298\,K)}$$

$n = 1.15 \times 10^{-4}$ moles $H_2O_{(g)}$

$$\left(\frac{1.15 \times 10^{-4} \text{ moles } H_2O}{1}\right)\left(\frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mole } H_2O}\right)$$

$$\boxed{= 6.92 \times 10^{19} \text{ molecules } H_2O}$$

(C) Avg KE are equal

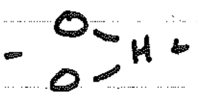
$$\tfrac{1}{2} m V_{H_2}^2 = \tfrac{1}{2} m V_{H_2O}^2$$

$$\frac{V_{H_2}^2}{V_{H_2O}^2} = \frac{m_{H_2O}}{m_{H_2}}$$

$$\frac{V_{H_2}}{V_{H_2O}} = \sqrt{\frac{m_{H_2O}}{H_2}} = \sqrt{\frac{18.02}{2.016}} = 3$$

(D) H_2 Vs H_2O ? which deviates more from Ideal Gas Behavior

The intermolecular forces among the H_2O molecules are stronger than those among H_2 molecules

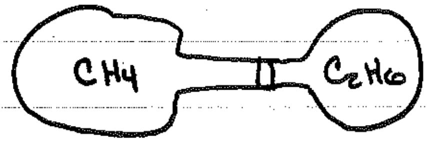
 Vs H - H

polar nonpolar

∴ H_2O deviates more from Ideal Gas Law

(2) cont.

(C)



5.0L 3.0Atm | 1.0L 0.55Atm

Assume
T = constant

Total Pressure?

when stopcock opened

$P_T = P_{CH_4} + P_{C_2H_6}$ ← when Total volume is 6.0 L
$V_T = 6.0L$

CH_4: $PV = nRT$

$P_1V_1 = P_2V_T$

$P_2 = \frac{P_1V_1}{V_T} = \frac{(3.0 Atm)(5.0L)}{(6.0L)} = 2.5 Atm$

C_2H_6: $P_2 = \frac{P_1V_1}{V_T} = \frac{(0.55 Atm)(1.0L)}{(6.0L)} = 0.092 Atm$

$P_T = 2.5 Atm + 0.092 Atm$

$P_T = 2.6 Atm$

(D) $2 C_8H_{18(l)} + 25 O_{2(g)} \rightarrow 16 CO_{2(g)} + 18 H_2O_{(g)}$

D = 0.703 g/ml | Excess | ? moles gas **products**

V = 255 ml

T = 20°C

16 moles + 18 moles

$\left(\frac{.703 \text{ g } C_8H_{18}}{ml}\right)\left(\frac{255 \text{ ml}}{1}\right)\left(\frac{1 \text{ mole } C_8H_{18}}{114.22 \text{ g } C_8H_{18}}\right)\left(\frac{34 \text{ mole Products}}{2 \text{ mole } C_8H_{18}}\right)$

= 26.7 moles gas Products

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Note:

(2) (A) Empirical formula? 85.7 % Carbon ∴ 14.3 % Hydrogen

Δ % to g

$$\left(\frac{85.7g\ C}{1}\right)\left(\frac{1\ mole\ C}{12.01g\ C}\right) = 7.14\ mole\ C\ /7.14 = 1$$

÷ By smallest

$$\left(\frac{14.3g\ H}{1}\right)\left(\frac{1\ mole\ H}{1.008g\ H}\right) = 14.2\ mole\ H\ /7.14 \approx 2$$

CH_2

(B) CH_2

D = 2.0 g/L

P = 0.948 Atm

T = 50°C + 273 = 320°K

i) molar mass?

PV = Rnt

Note: sub in

$$n = \frac{mass}{molar\ mass}$$

$$PV = \frac{mass}{molar\ mass} RT$$

$$molar\ mass = \frac{mass \cdot R \cdot T}{PV}$$

$$D = \frac{m}{V}$$

sub in

$$= \frac{DRT}{P}$$

$$= \frac{(2.0g/L)(0.08206\ \frac{L\,Atm}{mole\,K})(320K)}{0.948\ Atm}$$

molar mass = 55g

ii) molecular Formula?

CH_2 = 14.03 g/mole

$$\left(\frac{55g}{1}\right)\left(\frac{1\ mole}{14.03g}\right) = 3.9\ mole \approx 4\ mole$$

∴ **C_4H_8**

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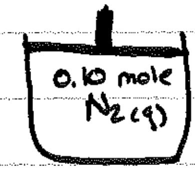
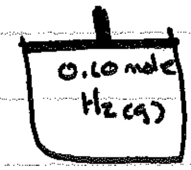
(3) Given:



1.0 L
298 K
KE = 6.2×10^{-21} J



1.0 L
298 K

Assume
ideal gas
Behavior

A) $H_{2(g)}$ Pressure >, <, or = to $N_{2(g)}$? Justify Answer

The pressure in the container holding the $H_{2(g)}$ is equal to the pressure in the container holding the $N_{2(g)}$.

Because there is an equal # of moles of Both gases at the same Temp & volume

$PV = nRT$

$\therefore \; P = n\frac{RT}{V}$ n, T, V are all the same in Both Containers

(B) Avg KE of $H_{2(g)}$ molecules?

The avg KE of the $H_{2(g)}$ molecules is 6.2×10^{-21} J, Because Both gases are at the same Temperature

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(3) cont.

(C) N_2 vs H_2 molecules which has greater Avg Speed? Justify

H_2 gas molecules will have the greater Avg speed. Both gases have the same KE, But H_2 has smaller molar mass. (H_2 2.016 g/mole vs N_2 28.02 g/mole)

if $KE = \frac{1}{2}mv^2$ & $KE_{H_2} = KE_{N_2}$ @ constant T

$$\therefore \frac{1}{2} m_{H_2} V_{H_2}^2 = \frac{1}{2} m_{N_2} V_{N_2}^2 \qquad V_{N_2} = V_{H_2}$$

$$V^2 = \frac{m_{H_2}}{m_{N_2}} \Rightarrow V = \sqrt{\frac{m_{H_2}}{m_{N_2}}} \quad \therefore \text{Dependant on mass}$$

Note: Also could use $u_{rms} = \sqrt{3RT} \frac{1}{\sqrt{m}}$

(D) What Δ could be made that would ↓ the Avg KE of the molecules in container?

The Avg KE of a gas particle depends on the temp of the gas sample. To lower the Avg KE of gas sample <u>lower</u> the <u>temperature</u> of gas sample.

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(3) cont:

(c) H_2

$V_1 = 1.0L \Rightarrow V_2 = 0.50L$ T = constant

i) Δ in Pressure? V_2 is ½

$PV = nRT$ T constant, n = constant

$P_1V_1 = P_2 \frac{V_2}{2}$ $V_2 = ½$

$P_2 = \frac{2P_1V_1}{V_2}$

$\therefore P_2 = 2P_1$

ii) with Δ in V, affect on Avg speed of H_2 molecules

Avg speed depends on changes in temp, not changes in volume.

∴ the Avg speed of H_2 molecules is unchanged.