CHM136 General Chemistry II

Gas Laws Worksheet 2

Fundamentals

1. Arrange the following gases in order of increasing density:
   CO_2, CH_4, N_2 lowest CH_4 ($M = 16$), N_2 (28), CO_2 (44) highest density

2. Arrange the following gases in order of increasing rates of effusion:
   Ar, Ne, CH_4 lowest Ar ($M = 40$), Ne (20), CH_4 (16) highest rate of effusion

3. Convert the following:
   a. -35°C = 238 K b. 890 torr = 1.17 atm c. STP = 273 K, 1 atm

Problems

4. A sample of CO_2 gas was collected over water at 21°C in a gas buret. The water inside the buret was leveled with the water in the container. The volume of the gas was 35.3 mL and the barometric pressure was 752 torr. How many moles of CO_2 were collected?
($P_{water\ vapor}$ = 18 torr at 21°C)

$P_{CO_2} = 752\ torr - 18\ torr = 734\ torr$

$$n_{CO_2} = \frac{PV}{RT} = \frac{\left(\frac{734}{760}\ atm\right)(0.0353\ L)}{\left(0.0821\ \frac{L\,atm}{mol\,K}\right)(294\ K)} = 0.00141\ mol$$

5. How many grams of phosphine (PH_3) can form by the reaction of 15.5 g phosphorus with 42.0 L hydrogen gas at STP?
   $P_4(s) + H_2(g) \rightarrow PH_3(g)$ [unbalanced]

$P_4 + 6H_2 \rightarrow 4PH_3$

limiting reactant

$$42.0\ L\ H_2 \times \frac{1\ mol\ H_2}{22.4\ L\ H_2} \times \frac{1\ mol\ P_4}{6\ mol\ H_2} \times \frac{124\ g\ P_4}{1\ mol\ P_4} = 38.8\ g\ P_4 \quad (\therefore P_4 \text{ is limiting})$$

$$15.5\ g\ P_4 \times \frac{1\ mol\ P_4}{124\ g\ P_4} \times \frac{4\ mol\ PH_3}{1\ mol\ P_4} \times \frac{34.0\ g\ PH_3}{1\ mol\ PH_3} = 17.0\ g\ PH_3$$

6. Compare the rates of effusion of the SF_6(g) and CH_4(g). Clearly note which gas effuses faster.

$$\frac{Rate\ CH_4}{Rate\ SF_6} = \frac{\sqrt{146}}{\sqrt{16.0}} = 3.02$$

Rate CH_4 : SF_6
3.02 : 1.00