Day 1.9 Warm-Up

1. Consider separate 100.0 gram samples of each of the following: H_2O, N_2O, $C_3H_6O_2$, CO_2. Rank them from greatest to least number of oxygen atoms.

1 mol O = 6.02×10^{23} atoms O

$$\frac{100\text{ g sample}}{} \cdot \frac{1\text{ mol sample}}{\text{MM sample}} \cdot \frac{x\text{ mol O}}{1\text{ mol sample}} \cdot \frac{6.02 \times 10^{23}\text{ atoms O}}{1\text{ mol O}}$$

H_2O: $$\frac{100\text{ g } H_2O}{} \cdot \frac{1\text{ mol } H_2O}{18\text{ g } H_2O} \cdot \frac{1\text{ mol O}}{1\text{ mol } H_2O} = 5.56\text{ mol O}$$

N_2O: $$\frac{100\text{ g } N_2O}{} \cdot \frac{1\text{ mol } N_2O}{44\text{ g } N_2O} \cdot \frac{1\text{ mol O}}{1\text{ mol } N_2O} = 2.27\text{ mol O}$$

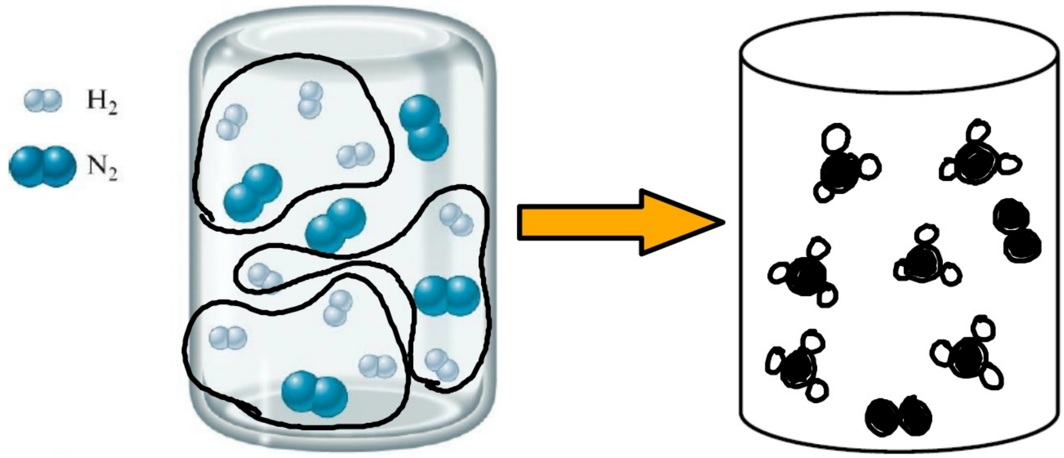
$C_3H_6O_2$: $$\frac{100\text{ g } C_3H_6O_2}{} \cdot \frac{1\text{ mol } C_3H_6O_2}{74\text{ g}} \cdot \frac{2\text{ mol O}}{1\text{ mol } C_3H_6O_2} = 2.7\text{ mol O}$$

CO_2: $$\frac{100\text{ g } CO_2}{} \cdot \frac{1\text{ mol } CO_2}{44\text{ g}} \cdot \frac{2\text{ mol O}}{1\text{ mol } CO_2} = 4.55\text{ mol O}$$

H_2O, CO_2, $C_3H_6O_2$, N_2O

$N_2(g) + 3\,H_2(g) \rightarrow 2\,NH_3(g)$

2. Nitrogen gas reacts with hydrogen gas to produce gaseous ammonia according to the equation above. Nitrogen gas and hydrogen gas were combined in an evacuated container and allowed to react. The initial amounts of each reactant are shown in the container below.



(a) What is the limiting reactant? H_2 is the limiting reactant because it was completely consumed

(b) How many moles of product are formed?
6 mol NH_3

(c) Sketch a particulate drawing to depict the amount of each species present in the container at the completion of the reaction.

$$\frac{9 \text{ mol } H_2 \text{ available} \;|\; 1 \text{ mol } N_2}{\;|\; 3 \text{ mol } H_2} = 3 \text{ mol } N_2$$

required to react w/ 9 mol H_2

5 mol N_2 available

∴ N_2 is in excess and H_2 is limiting

$$\frac{9 \text{ mol } H_2 \;|\; 2 \text{ mol } NH_3}{\;|\; 3 \text{ mol } H_2} = 6 \text{ mol } NH_3 \text{ produced}$$

Excess N_2 = Available N_2 − Used/reacted N_2

= 5 mol N_2 avail − 3 mol N_2 reacted

= 2 mol N_2 in excess