Sheet #3: Volume → Amount → Amount → Volume

1. $CaCO_3 \rightarrow CaO + CO_2$
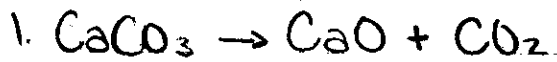
a) $1 Kg CaCO_3 \times \dfrac{1000 g CaCO_3}{1 Kg CaCO_3} \times \dfrac{1 mol CaCO_3}{100.086 g CaCO_3} \times \dfrac{1 mol CaO}{1 mol CaCO_3} \times \dfrac{56.077 g CaO}{1 mol CaO}$

$$= 560.288 g CaO$$

b) $1 Kg CaCO_3 \times \dfrac{1000 g CaCO_3}{1 Kg CaCO_3} \times \dfrac{1 mol CaCO_3}{100.086 g CaCO_3} \times \dfrac{1 mol CO_2}{1 mol CaCO_3} \times \dfrac{22.414 L CO_2}{1 mol CO_2}$

$$= 223.947 L CO_2$$

2. $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$

a) $454 g C_6H_{12}O_6 \times \dfrac{1 mol C_6H_{12}O_6}{180.18 g C_6H_{12}O_6} \times \dfrac{2 mol C_2H_5OH}{1 mol C_6H_{12}O_6} \times \dfrac{46.08 g C_2H_5OH}{1 mol C_2H_5OH}$

$$= 232.21 g C_2H_5OH$$

b) $454 g C_6H_{12}O_6 \times \dfrac{1 mol C_6H_{12}O_6}{180.18 g C_6H_{12}O_6} \times \dfrac{2 mol CO_2}{1 mol C_6H_{12}O_6} = 5.0394 mol CO_2$

$P = 101.325 Kpa$

$V = ?$

$n = 5.0394 mol$

$R = 8.314 \frac{Kpa \cdot L}{mol \cdot K}$

$T = 300.15 K$

$\dfrac{PV}{P} = \dfrac{nRT}{P}$

$V = \dfrac{nRT}{P}$

$V = \dfrac{(5.0394 mol CO_2)(8.314 \frac{Kpa \cdot L}{mol \cdot K})(300.15 K)}{101.325 Kpa}$

$V = 124.1 L$

3. $4NH_3 + 5O_2 \rightarrow 6H_2O + 4NO$

a) $2500 g NH_3 \times \dfrac{1 mol NH_3}{17.03 g NH_3} \times \dfrac{5 mol O_2}{4 mol NH_3} \times \dfrac{22.414 L O_2}{1 mol O_2} = 4112.96 L O_2$

b) $2500 g NH_3 \times \dfrac{1 mol NH_3}{17.03 g NH_3} \times \dfrac{4 mol NO}{4 mol NH_3} \times \dfrac{30 g NO}{1 mol NO} = 4403.99 g NO$

4. $3Zn + 2MoO_3 \rightarrow Mo_2O_3 + 3ZnO$
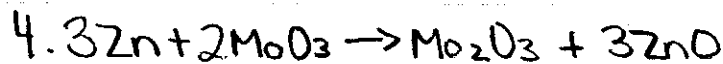
$20 g MoO_3 \times \dfrac{1 mol MoO_3}{143.94 MoO_3} \times \dfrac{1 mol Mo_2O_3}{2 mol MoO_3} \times \dfrac{239.88 Mo_2O_3}{1 mol Mo_2O_3} = 16.66 g Mo_2O_3$

$20 g MoO_3 \times \dfrac{1 mol MoO_3}{143.94 MoO_3} \times \dfrac{3 mol ZnO}{2 mol MoO_3} \times \dfrac{81.409 g ZnO}{1 mol ZnO} = 16.967 g ZnO$

5. $CaCO_3 + 2HCl \rightarrow CO_2 + H_2O + CaCl_2$
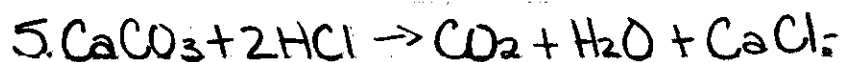
$15gHCl \times \dfrac{1mol\,HCl}{36.463g\,HCl} \times \dfrac{1mol\,CaCO_3}{2mol\,HCl} \times \dfrac{100.088g\,CaCO_3}{1mol\,CaCO_3} = 20.587g\,CaCO_3$

$15gHCl \times \dfrac{1mol\,HCl}{36.463g\,HCl} \times \dfrac{1mol\,CO_2}{2mol\,HCl} \times \dfrac{44.01g\,CO_2}{1mol\,CO_2} = 9.0524g\,CO_2$.

6. $2KNO_3 + 3C + S \rightarrow N_2 + 3CO_2 + K_2S$
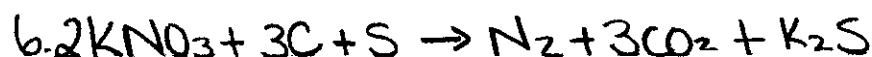
$50gKNO_3 \times \dfrac{1mol\,KNO_3}{101.105g\,KNO_3} \times \dfrac{1mol\,N_2}{2mol\,KNO_3} \times \dfrac{22.414L\,N_2}{1mol\,N_2} = 5.542L\,N_2$

$50gKNO_3 \times \dfrac{1mol\,KNO_3}{101.105g\,KNO_3} \times \dfrac{3mol\,CO_2}{2mol\,KNO_3} \times \dfrac{22.414L\,CO_2}{1mol\,CO_2} = 16.626L\,CO_2$

$5.542L\,N_2 + 16.626L\,CO_2 = 22.168L\,gas$

Gas volumes are additive

7. $2NH_3 + 3Ca \rightarrow 3CaH_2 + N_2$

$30L\,N_2 \times \dfrac{1mol\,N_2}{22.414L\,N_2} \times \dfrac{3mol\,Ca}{1mol\,N_2} \times \dfrac{40.078g\,Ca}{1mol\,Ca} = 160.927g\,Ca$

8. $C_3H_8 + 5O_2 \rightarrow 4H_2O + 3CO_2$
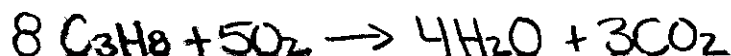
$1L\,C_3H_8 \times \dfrac{1mol\,C_3H_8}{22.414L\,C_3H_8} \times \dfrac{5mol\,O_2}{1mol\,C_3H_8} \times \dfrac{22.414L\,O_2}{1mol\,O_2} = 5L\,O_2$

$\dfrac{100L\,air}{21L\,O_2} = \dfrac{23.80952L\,air}{5L\,O_2}$ ∴ the optimum ratio is 23.8095 L of air.

Let the volume of propane be 1 L. (you could use any volume, but using 1 L makes the problem easier - this statement should be made at the top (beginning) of the problem)