

### I. Mole ↔ Mole Calculations

1) Given the balanced equation,  $6 \text{ AgI (aq)} + \text{Fe}_2(\text{CO}_3)_3 \text{ (aq)} \rightarrow 2 \text{ FeI}_3 \text{ (aq)} + 3 \text{ Ag}_2\text{CO}_3 \text{ (s)}$ :

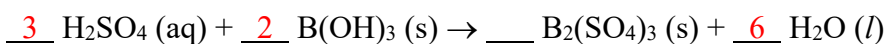
a. How many moles of AgI would be required to form 10. moles of  $\text{FeI}_3$ ?

$$? \text{ mol Ag I} = 10. \text{ mol FeI}_3 \times \frac{6 \text{ moles AgI}}{2 \text{ moles FeI}_3} = \boxed{30. \text{ mol AgI}}$$

b. How many moles of  $\text{Ag}_2\text{CO}_3$  would be formed from the reaction of 4.0 moles of  $\text{Fe}_2(\text{CO}_3)_3$  with enough AgI?

$$? \text{ mol Ag}_2\text{CO}_3 = 4.0 \text{ mol Fe}_2(\text{CO}_3)_3 \times \frac{3 \text{ mol Ag}_2\text{CO}_3}{1 \text{ mol Fe}_2(\text{CO}_3)_3} = \boxed{12 \text{ mol Ag}_2\text{CO}_3}$$

2) Given the chemical equation,



a. Balance the equation

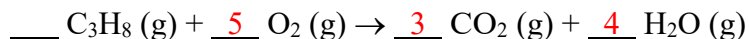
b. How many moles of  $\text{B(OH)}_3$  would be required to completely react with 4.65 moles of  $\text{H}_2\text{SO}_4$ ?

$$? \text{ mol B(OH)}_3 = 4.65 \text{ mol H}_2\text{SO}_4 \times \frac{2 \text{ mol B(OH)}_3}{3 \text{ mol H}_2\text{SO}_4} = \boxed{3.10 \text{ mol B(OH)}_3}$$

c. How many moles of  $\text{H}_2\text{SO}_4$  would be needed, given enough  $\text{B(OH)}_3$ , to produce 11.8 moles of  $\text{B}_2(\text{SO}_4)_3$ ?

$$? \text{ mol H}_2\text{SO}_4 = 11.8 \text{ mol B}_2(\text{SO}_4)_3 \times \frac{3 \text{ mol H}_2\text{SO}_4}{1 \text{ mol B}_2(\text{SO}_4)_3} = \boxed{35.4 \text{ mol H}_2\text{SO}_4}$$

3) When propane ( $\text{C}_3\text{H}_8$ ) gas burns in oxygen gas, it forms carbon dioxide gas and water vapor:



a. Write and balance the equation

b. How many moles of water would be formed in the reaction where 3.19 mol of carbon dioxide are formed?

$$? \text{ mol H}_2\text{O} = 3.19 \text{ mol CO}_2 \times \frac{4 \text{ mol H}_2\text{O}}{3 \text{ mol CO}_2} = \boxed{4.25 \text{ mol H}_2\text{O}}$$

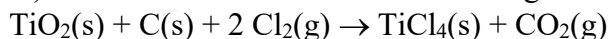
c. How many moles of carbon dioxide would be produced by the reaction of 23.4 moles of oxygen, with sufficient propane?

$$? \text{ mol CO}_2 = 23.4 \text{ mol O}_2 \times \frac{3 \text{ mol CO}_2}{5 \text{ mol O}_2} = \boxed{14.0 \text{ mol CO}_2}$$

### II. Mass ↔ Mole and Mass ↔ Mass Calculations

For the following problems, use the flowchart **Mass** → **Mole** → **Mole** → **Mass**

4) Titanium is a transition metal used in many alloys because it is extremely strong and lightweight. Titanium(IV) chloride ( $\text{TiCl}_4$ ) is extracted from titanium oxide using chlorine and coke (carbon):



a. If you begin with 1.25 mol  $\text{TiO}_2$ , what mass of  $\text{Cl}_2$  gas is needed?

$$\text{MM (Cl}_2) = 2 \times 35.45 \text{ g} = 70.90 \text{ g/mol}$$

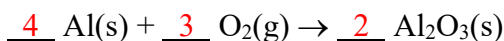
$$? \text{ g Cl}_2 = 1.25 \cancel{\text{ mol TiO}_2} \times \frac{2 \cancel{\text{ mol Cl}_2}}{1 \cancel{\text{ mol TiO}_2}} \times \frac{70.90 \text{ g Cl}_2}{1 \cancel{\text{ mol Cl}_2}} = \boxed{177 \text{ g Cl}_2}$$

b. How many moles of C must be used in the formation of 82.5 g of  $\text{TiCl}_4$ ?

$$\text{MM}(\text{TiCl}_4) = 47.87 \text{ g} + 4(35.45 \text{ g}) = 189.7 \text{ g/mol}$$

$$? \text{ mol C} = 82.5 \text{ g TiCl}_4 \times \frac{1 \text{ mol TiCl}_4}{189.7 \text{ g TiCl}_4} \times \frac{1 \text{ mol C}}{1 \text{ mol TiCl}_4} = \boxed{0.435 \text{ mol C}}$$

5) Aluminum oxidizes according the following unbalanced equation:



a. Balance the equation

b. How many grams of  $\text{Al}_2\text{O}_3$  would be formed by the reaction of 29.75 grams of Al with enough  $\text{O}_2$ ?

$$\text{MM}(\text{Al}_2\text{O}_3) = 2(26.98 \text{ g}) + 3(16.00 \text{ g}) = 101.96 \text{ g/mol}$$

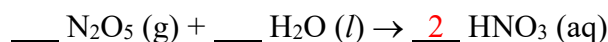
$$? \text{ g Al}_2\text{O}_3 = 29.75 \text{ g Al} \times \frac{1 \text{ mol Al}}{26.98 \text{ g Al}} \times \frac{2 \text{ mol Al}_2\text{O}_3}{4 \text{ mol Al}} \times \frac{101.96 \text{ g Al}_2\text{O}_3}{1 \text{ mol Al}_2\text{O}_3} = \boxed{56.18 \text{ g Al}_2\text{O}_3}$$

c. How many grams of  $\text{O}_2$  would be required to form 65.32 grams of  $\text{Al}_2\text{O}_3$ ?

$$\text{MM}(\text{Al}_2\text{O}_3) \text{ above; } \text{MM}(\text{O}_2) = 2(16.00 \text{ g}) = 32.00 \text{ g/mol}$$

$$? \text{ g O}_2 = 65.32 \text{ g Al}_2\text{O}_3 \times \frac{1 \text{ mol Al}_2\text{O}_3}{101.96 \text{ g Al}_2\text{O}_3} \times \frac{3 \text{ mol O}_2}{2 \text{ mol Al}_2\text{O}_3} \times \frac{32.00 \text{ g O}_2}{1 \text{ mol O}_2} = \boxed{30.75 \text{ g O}_2}$$

6) Dinitrogen pentoxide,  $\text{N}_2\text{O}_5$ , is an acidic gas that reacts with water to forms aqueous nitric acid:



a. Balance the chemical equation.

b. How many grams of dinitrogen pentoxide would be required to completely react with 13.44 grams of water?

$$\text{MM}(\text{H}_2\text{O}) = 2(1.008 \text{ g}) + 16.00 \text{ g} = 18.02 \text{ g/mol; } \text{MM}(\text{N}_2\text{O}_5) = 2(14.01 \text{ g}) + 5(16.00 \text{ g}) = 108.02 \text{ g/mol}$$

$$? \text{ g N}_2\text{O}_5 = 13.44 \text{ g H}_2\text{O} \times \frac{1 \text{ mol H}_2\text{O}}{18.02 \text{ g H}_2\text{O}} \times \frac{1 \text{ mol N}_2\text{O}_5}{1 \text{ mol H}_2\text{O}} \times \frac{108.02 \text{ g N}_2\text{O}_5}{1 \text{ mol N}_2\text{O}_5} = \boxed{80.56 \text{ g N}_2\text{O}_5}$$

c. How many grams of dinitrogen pentoxide would be needed, given enough water, to produce 105.65 grams of nitric acid?

$$\text{MM}(\text{HNO}_3) = 1.008 \text{ g} + 14.007 \text{ g} + 3(15.999 \text{ g}) = 63.012 \text{ g/mol; } \text{MM}(\text{N}_2\text{O}_5) \text{ above}$$

$$? \text{ g N}_2\text{O}_5 = 105.65 \text{ g HNO}_3 \times \frac{1 \text{ mol HNO}_3}{63.012 \text{ g HNO}_3} \times \frac{1 \text{ mol N}_2\text{O}_5}{2 \text{ mol HNO}_3} \times \frac{108.02 \text{ g N}_2\text{O}_5}{1 \text{ mol N}_2\text{O}_5} = \boxed{90.557 \text{ g N}_2\text{O}_5}$$

Note use of 5 SF in MM due to 5 SF in given amount.