









## Solutions:

1. Reaction for this problem is:



a. This is a moles to moles problem, so only one step is required:

Moles  $\text{Na}_2\text{SiO}_3 \rightarrow$  Moles HF

$$0.300 \text{ moles Na}_2\text{SiO}_3 \times \frac{8 \text{ moles HF}}{1 \text{ mole Na}_2\text{SiO}_3} = 2.40 \text{ moles HF}$$

b. This is a moles to grams problem, so two steps are required:

Moles HF  $\rightarrow$  Moles NaF  $\rightarrow$  Grams NaF

$$\text{Molar mass of NaF} = 1(22.99) + 1(18.998) = 41.998 \text{ g/mol}$$

$$0.500 \text{ moles HF} \times \frac{2 \text{ moles NaF}}{8 \text{ mole HF}} \times \frac{41.988 \text{g NaF}}{1 \text{ mole NaF}} = 5.25 \text{g NaF}$$

c. This is a grams to grams problem, so three steps are required

Grams HF  $\rightarrow$  Moles HF  $\rightarrow$  Moles  $\text{Na}_2\text{SiO}_3 \rightarrow$  Grams  $\text{Na}_2\text{SiO}_3$

$$\text{Molar mass of HF} = 1(1.008) + 1(18.998) = 20.006 \text{ g/mol}$$

$$\text{Molar mass of Na}_2\text{SiO}_3 = 2(22.99) + 1(28.086) + 3(15.999) = 122.063 \text{ g/mol}$$

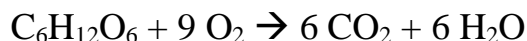
$$80.4 \text{g HF} \times \frac{1 \text{ mole HF}}{20.006 \text{g HF}} \times \frac{1 \text{ mole Na}_2\text{SiO}_3}{8 \text{ moles HF}} \times \frac{122.063 \text{g Na}_2\text{SiO}_3}{1 \text{ mole Na}_2\text{SiO}_3} = 61.3 \text{g Na}_2\text{SiO}_3$$

d. This is a moles to volume problem, so two steps are required:

Moles HF  $\rightarrow$  Moles  $\text{H}_2\text{O} \rightarrow$  Volume  $\text{H}_2\text{O}$

$$5.77 \text{ moles HF} \times \frac{3 \text{ moles H}_2\text{O}}{8 \text{ moles HF}} \times \frac{22.4 \text{L H}_2\text{O}}{1 \text{ mole H}_2\text{O}} = 48.5 \text{L H}_2\text{O}$$

2. Reaction for this problem is:



a. This is a moles to moles problem, so only one step is required:

Moles  $\text{C}_6\text{H}_{12}\text{O}_6 \rightarrow$  Moles  $\text{H}_2\text{O}$

$$0.450 \text{ moles } \text{C}_6\text{H}_{12}\text{O}_6 \times \frac{6 \text{ moles } \text{H}_2\text{O}}{1 \text{ mole } \text{C}_6\text{H}_{12}\text{O}_6} = 2.70 \text{ moles } \text{H}_2\text{O}$$

b. This is a grams to moles problem, so two steps are required:

Grams  $\text{C}_6\text{H}_{12}\text{O}_6 \rightarrow$  Moles  $\text{C}_6\text{H}_{12}\text{O}_6 \rightarrow$  Moles  $\text{CO}_2$

Molar mass of  $\text{C}_6\text{H}_{12}\text{O}_6 = 6(12.011) + 12(1.008) + 6(15.999) = 180.156 \text{ g/mol}$

$$284.7 \text{ g } \text{C}_6\text{H}_{12}\text{O}_6 \times \frac{1 \text{ moles } \text{C}_6\text{H}_{12}\text{O}_6}{180.156 \text{ g } \text{C}_6\text{H}_{12}\text{O}_6} \times \frac{6 \text{ moles } \text{CO}_2}{1 \text{ mole } \text{C}_6\text{H}_{12}\text{O}_6} = 9.482 \text{ moles } \text{CO}_2$$

c. This is a grams to grams problem, so three steps are required

Grams  $\text{O}_2 \rightarrow$  Moles  $\text{O}_2 \rightarrow$  Moles  $\text{C}_6\text{H}_{12}\text{O}_6 \rightarrow$  Grams  $\text{C}_6\text{H}_{12}\text{O}_6$

Molar mass of  $\text{O}_2 = 2(15.999) = 31.998 \text{ g/mol}$

Molar mass of  $\text{C}_6\text{H}_{12}\text{O}_6 = 6(12.011) + 12(1.008) + 6(15.999) = 180.156 \text{ g/mol}$

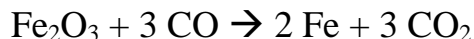
$$43.8 \text{ g } \text{O}_2 \times \frac{1 \text{ mole } \text{O}_2}{31.998 \text{ g } \text{O}_2} \times \frac{1 \text{ mole } \text{C}_6\text{H}_{12}\text{O}_6}{9 \text{ moles } \text{O}_2} \times \frac{180.156 \text{ g } \text{C}_6\text{H}_{12}\text{O}_6}{1 \text{ mole } \text{C}_6\text{H}_{12}\text{O}_6} = 27.4 \text{ g } \text{C}_6\text{H}_{12}\text{O}_6$$

d. This is a volume to moles problem, so two steps are required:

Volume  $\text{CO}_2 \rightarrow$  Moles  $\text{CO}_2 \rightarrow$  Moles  $\text{O}_2$

$$124 \text{ L } \text{CO}_2 \times \frac{1 \text{ mole } \text{CO}_2}{22.4 \text{ L } \text{CO}_2} \times \frac{9 \text{ moles } \text{O}_2}{6 \text{ moles } \text{CO}_2} = 8.30 \text{ moles } \text{O}_2$$

3. Reaction for this problem is:



a. This is a moles to moles problem, so only one step is required:

Moles Fe  $\rightarrow$  Moles CO

$$9.4 \text{ moles Fe} \times \frac{3 \text{ moles CO}}{1 \text{ mole Fe}} = 28 \text{ moles CO}$$

b. This is a moles to grams problem, so two steps are required:

Moles CO  $\rightarrow$  Moles CO<sub>2</sub>  $\rightarrow$  Grams CO<sub>2</sub>

Molar mass of CO<sub>2</sub> = 1(12.011) + 2(15.999) = 44.009 g/mol

$$2.44 \text{ moles CO} \times \frac{3 \text{ moles CO}_2}{3 \text{ moles CO}} \times \frac{44.009 \text{g CO}_2}{1 \text{ mole CO}_2} = 107 \text{g CO}_2$$

c. This is a grams to grams problem, so three steps are required

Grams Fe  $\rightarrow$  Moles Fe  $\rightarrow$  Moles Fe<sub>2</sub>O<sub>3</sub>  $\rightarrow$  Grams Fe<sub>2</sub>O<sub>3</sub>

Molar mass of Fe = 1(55.845) = 55.845 g/mol

Molar mass of Fe<sub>2</sub>O<sub>3</sub> = 2(55.845) + 3(15.999) = 159.687 g/mol

$$72.1 \text{g Fe} \times \frac{1 \text{ mole Fe}}{55.845 \text{g Fe}} \times \frac{1 \text{ mole Fe}_2\text{O}_3}{2 \text{ moles Fe}} \times \frac{159.687 \text{g Fe}_2\text{O}_3}{1 \text{ mole Fe}_2\text{O}_3} = 103 \text{g Fe}_2\text{O}_3$$

d. This is a moles to volume problem, so two steps are required:

Moles Fe<sub>2</sub>O<sub>3</sub>  $\rightarrow$  Moles CO<sub>2</sub>  $\rightarrow$  Volume CO<sub>2</sub>

$$15.22 \text{ moles Fe}_2\text{O}_3 \times \frac{3 \text{ moles CO}_2}{1 \text{ mole Fe}_2\text{O}_3} \times \frac{22.4 \text{L CO}_2}{1 \text{ mole CO}_2} = 1023 \text{L CO}_2$$

e. This is a volume to volume problem, so three steps are required:

Volume CO  $\rightarrow$  Moles CO  $\rightarrow$  Moles CO<sub>2</sub>  $\rightarrow$  Volume CO<sub>2</sub>

$$133 \text{L CO} \times \frac{1 \text{ mole CO}}{22.4 \text{L CO}} \times \frac{3 \text{ moles CO}_2}{3 \text{ mole CO}} \times \frac{22.4 \text{L CO}_2}{1 \text{ mole CO}_2} = 133 \text{L CO}_2$$

4. Reaction for this problem is:



a. This is a moles to moles problem, so only one step is required:

Moles  $\text{C}_6\text{H}_6 \rightarrow$  Moles  $\text{Br}_2$

$$3.11 \text{ moles } \text{C}_6\text{H}_6 \times \frac{1 \text{ mole } \text{Br}_2}{1 \text{ mole } \text{C}_6\text{H}_6} = 3.11 \text{ moles } \text{Br}_2$$

b. This is a grams to moles problem, so two steps are required:

Grams  $\text{C}_6\text{H}_6 \rightarrow$  Moles  $\text{C}_6\text{H}_6 \rightarrow$  Moles  $\text{HBr}$

Molar mass of  $\text{C}_6\text{H}_6 = 6(12.011) + 6(1.008) = 78.114 \text{ g/mol}$

$$61.92\text{g } \text{C}_6\text{H}_6 \times \frac{1 \text{ mole } \text{C}_6\text{H}_6}{78.114\text{g } \text{C}_6\text{H}_6} \times \frac{1 \text{ mole } \text{HBr}}{1 \text{ mole } \text{C}_6\text{H}_6} = 0.7927 \text{ moles } \text{HBr}$$

c. This is a grams to grams problem, so three steps are required

Grams  $\text{C}_6\text{H}_6 \rightarrow$  Moles  $\text{C}_6\text{H}_6 \rightarrow$  Moles  $\text{C}_6\text{H}_5\text{Br} \rightarrow$  Grams  $\text{C}_6\text{H}_5\text{Br}$

Molar mass of  $\text{C}_6\text{H}_6 = 6(12.011) + 6(1.008) = 78.114 \text{ g/mol}$

Molar mass of  $\text{C}_6\text{H}_5\text{Br} = 6(12.011) + 5(1.008) + 1(79.904) = 157.01 \text{ g/mol}$

$$117.83\text{g } \text{C}_6\text{H}_6 \times \frac{1 \text{ mole } \text{C}_6\text{H}_6}{78.114\text{g } \text{C}_6\text{H}_6} \times \frac{1 \text{ mole } \text{C}_6\text{H}_5\text{Br}}{1 \text{ mole } \text{C}_6\text{H}_6} \times \frac{157.01\text{g } \text{C}_6\text{H}_5\text{Br}}{1 \text{ mole } \text{C}_6\text{H}_5\text{Br}} = 236.84$$

d. This is a volume to grams problem, so three steps are required:

Volume  $\text{Br}_2 \rightarrow$  Moles  $\text{Br}_2 \rightarrow$  Moles  $\text{HBr} \rightarrow$  Grams  $\text{HBr}$

$$124\text{L } \text{Br}_2 \times \frac{1 \text{ mole } \text{Br}_2}{22.4\text{L } \text{Br}_2} \times \frac{1 \text{ mole } \text{HBr}}{1 \text{ mole } \text{Br}_2} \times \frac{80.912\text{g } \text{HBr}}{1 \text{ mole } \text{HBr}} = 448 \text{ grams } \text{HBr}$$