# Station 1

The balanced equation for the combustion of benzoic acid is as follows:

$$2\ C_7H_6O_2 + 15\ O_2 \rightarrow 14\ CO_2 + 6\ H_2O$$

A 305.0 g sample of $C_7H_6O_2$ is combined with 512.0 grams of $O_2$.

a. Determine which reactant is in excess.

$$305.0\,g_{C_7H_6O_2} \times \frac{1\,mol_{C_7H_6O_2}}{122.13\,g_{C_7H_6O_2}} \times \frac{14\,mol\ CO_2}{2\,mol\ C_7H_6O_2} = 17.\cancel{48}\,mol_{CO_2}$$

← excess reaction

∴ excess reactant = $\boxed{C_7H_6O_2}$

$$512.0\,g_{O_2} \times \frac{1\,mol_{O_2}}{32.00\,g_{O_2}} \times \frac{14\,mol_{CO_2}}{15\,mol_{O_2}} = 14.93\,mol_{CO_2}$$

← limiting reaction

b. When this reaction is carried out, what mass of $CO_2$ will be produced?

$$14.93\,mol_{CO_2} \times \frac{44.01\,g_{CO_2}}{1\,mol_{CO_2}} = \boxed{657.1\,g_{CO_2}}$$

c. Determine the mass of the excess reactant left over.

$$512.0\,g_{O_2} \times \frac{1\,mol_{O_2}}{32.00\,g_{O_2}} \times \frac{2\,mol\ C_7H_6O_2}{15\,mol\ O_2} \times \frac{122.13\,g_{C_7H_6O_2}}{1\,mol_{C_7H_6O_2}} = 260.5\,g_{C_7H_6O_2}$$

Used

Have − Used = Excess

$$305.0\,g - 260.5\,g = \boxed{44.5\,g_{C_7H_6O_2}}$$

*subtraction sig figs

## Station 2

The iron present in a sample of iron ore is converted to $Fe^{2+}$ and reacted with dichromate ion:

$$\underset{\substack{0.0176\,L \\ 0.125\,M}}{Cr_2O_7^{\;2-}} + \underset{0.0250\,L}{6\,Fe^{2+}} + 14H^+ \rightarrow 2\,Cr^{3+} + 6\,Fe^{3+} + 7\,H_2O$$

17.6 mL of 0.125 M dichromate is required to react with 25.0 mL sample of $Fe^{2+}$ solution.

a. What is the molarity of $Fe^{2+}$?

$$0.0176\,L\ Cr_2O_7^{2-} \times \frac{0.125\,mol\ Cr_2O_7^{2-}}{1\,L\ Cr_2O_7^{2-}} \times \frac{6\,mol\ Fe^{2+}}{1\,mol\ Cr_2O_7^{2-}} \times \frac{1}{0.0250\,L\ Fe^{2+}} = \boxed{0.528\,M\ Fe^{2+}}$$

b. What mass of iron is present in the 25.0 mL sample?

$$0.0250\,L\ Fe^{2+} \times \frac{0.528\,mol\ Fe^{2+}}{1\,L\ Fe^{2+}} \times \frac{55.85\,g\ Fe^{2+}}{1\,mol\ Fe^{2+}} = \boxed{0.737\,g\ Fe^{2+}}$$

## Station 3

The reaction between nitrogen and hydrogen produces $NH_3$.

a. What is the balanced equation?

$$N_2 + 3H_2 \rightarrow 2NH_3$$

b. At STP, calculate the volume of $NH_3$ that is produced when 145 L of $N_2$ reacts with excess hydrogen gas.

$$145\,L_{N_2} \times \frac{1\,mol_{N_2}}{22.4\,L_{N_2}} \times \frac{2\,mol_{NH_3}}{1\,mol_{N_2}} \times \frac{22.4\,L_{NH_3}}{1\,mol_{NH_3}} = \boxed{290.\,L_{NH_3}}$$

!

c. How many litres of nitrogen react with 581 L of hydrogen at STP?

$$581\,L_{H_2} \times \frac{1\,mol_{H_2}}{22.4\,L_{H_2}} \times \frac{1\,mol_{N_2}}{3\,mol_{H_2}} \times \frac{22.4\,L_{N_2}}{1\,mol_{N_2}} = \boxed{194\,L_{N_2}}$$

# Station 4

Consider the following reaction:

$$Mg + HNO_3 \rightarrow Mg(NO_3)_2 + H_2$$

a. What is the balanced equation?

$$Mg + 2\,HNO_3 \rightarrow Mg(NO_3)_2 + H_2$$

b. If 6.01 g of Mg metal reacts with 8.45 g of $HNO_3$ at STP, what volume of $H_2$ gas is produced?

$$6.01\,g_{Mg} \times \frac{1\,mol_{Mg}}{24.31\,g_{Mg}} \times \frac{1\,mol_{H_2}}{1\,mol_{Mg}} \times \frac{22.4\,L_{H_2}}{1\,mol_{H_2}} = \cancel{5.54}\,L_{H_2}$$

$$8.45\,g_{HNO_3} \times \frac{1\,mol_{HNO_3}}{63.02\,g_{HNO_3}} \times \frac{1\,mol_{H_2}}{2\,mol_{HNO_3}} \times \frac{22.4\,L_{H_2}}{1\,mol_{H_2}} = \boxed{1.50\,L_{H_2}}$$

c. How much excess reactant is left over?

Used

$$8.45\,g_{HNO_3} \times \frac{1\,mol_{HNO_3}}{63.02\,g_{HNO_3}} \times \frac{1\,mol_{Mg}}{2\,mol_{HNO_3}} \times \frac{24.31\,g_{Mg}}{1\,mol_{Mg}} = 1.63\,g_{Mg}$$

Have − Used = Excess

$$6.01\,g - 1.63\,g = \boxed{4.38\,g_{Mg}}$$