**KEY**

## Chemistry: *Percent Yield*

*Directions*: *Solve each of the following problems. Show your work, including proper units, to earn full credit.*

1. "Slaked lime," $Ca(OH)_2$, is produced when water reacts with "quick lime," CaO. If you start with 2 400 g of quick lime, add excess water, and produce 2 060 g of slaked lime, what is the percent yield of the reaction?

2060 g = actual yield

$$\underset{\text{2400 g}}{CaO} + \underset{\text{excess}}{H_2O} \rightarrow \underset{\text{x g = theoretical yield}}{Ca(OH)_2}$$

$$x\ g\ Ca(OH)_2 = 2400\ g\ CaO\left(\frac{1\ mol\ CaO}{56\ g\ CaO}\right)\left(\frac{1\ mol\ Ca(OH)_2}{1\ mol\ CaO}\right)\left(\frac{74\ g\ Ca(OH)_2}{1\ mol\ Ca(OH)_2}\right) = 3171\ g\ Ca(OH)_2$$

$$\%\ Yield = \frac{actual\ yield}{theoretical\ yield}\times 100 \quad \Rightarrow \quad \%\ Yield = \frac{2060\ g\ Ca(OH)_2}{3171\ g\ Ca(OH)_2}\times 100 \quad \Rightarrow \quad 65\%$$

2. Some underwater welding is done via the thermite reaction, in which rust ($Fe_2O_3$) reacts with aluminum to produce iron and aluminum oxide ($Al_2O_3$). In one such reaction, 258 g of aluminum and excess rust produced 464 g of iron. What was the percent yield of the reaction?

464 g = actual yield

$$\underset{\text{excess}}{Fe_2O_3} + \underset{\text{258 g}}{2\ Al} \rightarrow Al_2O_3 + \underset{\text{x g = theoretical yield}}{2\ Fe}$$

$$x\ g\ Fe = 258\ g\ Al\left(\frac{1\ mol\ Al}{27\ g\ Al}\right)\left(\frac{2\ mol\ Fe}{2\ mol\ Al}\right)\left(\frac{55.8\ g\ Fe}{1\ mol\ Fe}\right) = 533\ g\ Fe$$

$$\%\ Yield = \frac{actual\ yield}{theoretical\ yield}\times 100 \quad \Rightarrow \quad \%\ Yield = \frac{464\ g\ Fe}{533\ g\ Fe}\times 100 \quad \Rightarrow \quad 87\%$$

3. Use the balanced equation to find out how many liters of sulfur dioxide are actually produced at STP if $1.5 \times 10^{27}$ molecules of zinc sulfide are reacted with excess oxygen and the percent yield is 75%.

$$\underset{\text{1.5x10}^{27}\text{ molecules}}{2\ ZnS(s)} + \underset{\text{excess}}{3\ O_2(g)} \rightarrow 2\ ZnO(s) + \underset{\text{x L = theoretical yield}}{2\ SO_2(g)}$$

$$x\ L\ SO_2 = 1.5\times 10^{27}\ m'cules\ ZnS\left(\frac{1\ mol\ ZnS}{6.02\times 10^{23}\ m'cules\ ZnS}\right)\left(\frac{2\ mol\ SO_2}{2\ mol\ ZnS}\right)\left(\frac{22.4\ L\ SO_2}{1\ mol\ SO_2}\right)$$

$$= 5.58\times 10^4\ L\ SO_2 \Leftarrow theoretical\ yield$$

$$\%\ Yield = \frac{actual\ yield}{theoretical\ yield}\times 100 \quad \Rightarrow \quad 0.75 = \frac{X\ L\ SO_2}{5.58\times 10^4\ L\ SO_2} \quad \Rightarrow \quad 4.19\times 10^4\ L\ SO_2$$

4. The Haber process is the conversion of nitrogen and hydrogen at high pressure into ammonia, as follows:

700 g = actual yield

$$\underset{\text{x g}}{N_2(g)} + \underset{\text{excess}}{3\ H_2(g)} \rightarrow \underset{\text{x g = theoretical yield}}{2\ NH_3(g)}$$

If you must produce 700 g of ammonia, what mass of nitrogen should you use in the reaction, assuming that the percent yield of this reaction is 70%?

$$\%\ Yield = \frac{actual\ yield}{theoretical\ yield}\times 100 \quad \Rightarrow \quad 0.70 = \frac{700\ g\ NH_3}{X\ g\ NH_3} \quad \Rightarrow \quad 1000\ g\ NH_3$$

$$x\ g\ N_2 = 1000\ g\ NH_3\left(\frac{1\ mol\ NH_3}{17\ g\ NH_3}\right)\left(\frac{1\ mol\ N_2}{2\ mol\ NH_3}\right)\left(\frac{28\ g\ N_2}{1\ mol\ N_2}\right) = 824\ g\ N_2$$

Answers: 1. 65% 2. 87% 3. $4.19 \times 10^4$ L $SO_2$ 4. 824 g $N_2$

Name: _____
Hour: ____ Date: _____

## Chemistry: *Energy and Stoichiometry*

*Directions*: *Solve each of the following problems. Show your work, including proper units, to earn full credit.*

1. The combustion of propane ($C_3H_8$) produces 248 kJ of energy per mole of propane burned. How much heat energy will be released when 1 000 $dm^3$ of propane are burned at STP?

2. Carbon monoxide burns in air to produce carbon dioxide according to the following balanced equation:

$$2\ CO(g) + O_2(g) \rightarrow 2\ CO_2(g) + 566\ kJ$$

How many grams of carbon monoxide are needed to yield 185 kJ of energy?

3. Nitrogen gas combines with oxygen gas according to the following balanced equation:

$$N_2(g) + 2\ O_2(g) + 67.8\ kJ \rightarrow 2\ NO_2(g)$$

Assuming that you have excess nitrogen, how much heat energy must be added to 540 g of oxygen in order to use up all of that oxygen?

4. Ethyl alcohol burns according to the following balanced equation:

$$C_2H_5OH(l) + 3\ O_2(g) \rightarrow 2\ CO_2(g) + 3\ H_2O(g) + 1\ 364\ kJ$$

How many molecules of water are produced if 5 000 kJ of heat energy are released?

Answers: 1. 11 071 kJ 2. 18.3 g CO 3. 572 kJ 4. $6.62 \times 10^{24}$ molecules $H_2O$

**KEY**

## Chemistry: *Energy and Stoichiometry*

*Directions*: *Solve each of the following problems. Show your work, including proper units, to earn full credit.*

1. The combustion of propane ($C_3H_8$) produces 248 kJ of energy per mole of propane burned. How much heat energy will be released when 1 000 $dm^3$ of propane are burned at STP?

$$\underset{1000\ dm^3}{\mathbf{C_3H_8}} + \underset{excess}{\mathbf{5\ O_2}} \rightarrow \mathbf{3\ CO_2} + \mathbf{4\ H_2O} + \underset{x\ kJ}{\mathbf{heat}}$$

$$x\ kJ = 1000\ dm^3\ C_3H_8 \left(\frac{1 mol\ C_3H_8}{22.4\ L\ C_3H_8}\right)\left(\frac{248\ kJ}{1 mol\ C_3H_8}\right) = 11{,}071\ kJ$$

2. Carbon monoxide burns in air to produce carbon dioxide according to the following balanced equation:

$$2\ CO(g) + O_2(g) \rightarrow 2\ CO_2(g) + 566\ kJ$$

How many grams of carbon monoxide are needed to yield 185 kJ of energy?

$$\underset{x\ g}{\mathbf{2\ CO}} + \mathbf{O_2} \rightarrow \mathbf{2CO_2} + \underset{185\ kJ}{\mathbf{566\ kJ}}$$

$$x\ g\ Co = 185\ kJ\left(\frac{2 mol\ CO}{566\ kJ}\right)\left(\frac{28\ g\ CO}{1 mol\ CO}\right) = 18.3\ g\ CO$$

3. Nitrogen gas combines with oxygen gas according to the following balanced equation:

$$N_2(g) + 2\ O_2(g) + 67.8\ kJ \rightarrow 2\ NO_2(g)$$

Assuming that you have excess nitrogen, how much heat energy must be added to 540 g of oxygen in order to use up all of that oxygen?

$$\mathbf{N_2} + \underset{540\ g}{2\ O_2} + \underset{x\ kJ}{67.8\ kJ} \rightarrow \mathbf{2\ NO_2}$$

$$x\ kJ = 540\ g\ O_2\left(\frac{1 mol\ O_2}{32\ g\ O_2}\right)\left(\frac{67.8\ kJ}{2 mol\ O_2}\right) = 572\ kJ$$

4. Ethyl alcohol burns according to the following balanced equation:

$$C_2H_5OH(l) + 3\ O_2(g) \rightarrow 2\ CO_2(g) + 3\ H_2O(g) + 1364\ kJ$$

How many molecules of water are produced if 5 000 kJ of heat energy are released?

$$C_2H_5OH(l) + 3\ O_2(g) \rightarrow 2\ CO_2(g) + \underset{x\ molecules}{3\ H_2O(g)} + \underset{5000\ kJ}{1364\ kJ}$$

$$x\ molecules\ H_2O = 5000\ kJ\left(\frac{3 mol\ H_2O}{1364\ kJ}\right)\left(\frac{6.02\times10^{23}\ molecules\ H_2O}{1 mol\ H_2O}\right) = 6.62\times10^{24}\ molecules\ H_2O$$

Answers: 1. 11 071 kJ 2. 18.3 g CO 3. 572 kJ 4. 6.62 x $10^{24}$ molecules $H_2O$