

**SAMPLE PROBLEM D**

For more help, go to the **Math Tutor** at the end of this chapter.

The first step in the industrial manufacture of nitric acid is the catalytic oxidation of ammonia.



The reaction is run using 824 g  $\text{NH}_3$  and excess oxygen.

- How many moles of  $\text{NO}$  are formed?
- How many moles of  $\text{H}_2\text{O}$  are formed?

**SOLUTION****1 ANALYZE**

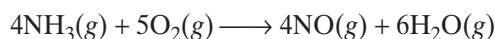
**Given:** mass of  $\text{NH}_3 = 824 \text{ g}$

**Unknown:** a. amount of  $\text{NO}$  produced (mol)

b. amount of  $\text{H}_2\text{O}$  produced (mol)

**2 PLAN**

First, write the balanced chemical equation.



Two conversion factors are needed to solve part (a)—the molar mass factor for  $\text{NH}_3$  and the mole ratio of  $\text{NO}$  to  $\text{NH}_3$ . Part (b) starts with the same conversion factor as part (a), but then the mole ratio of  $\text{H}_2\text{O}$  to  $\text{NH}_3$  is used to convert to the amount in moles of  $\text{H}_2\text{O}$ . The first conversion factor in each part is the molar mass factor of  $\text{NH}_3$ .

$$\text{a. } \text{g NH}_3 \times \frac{\overset{\text{molar mass factor}}{1 \text{ mol NH}_3}}{\underset{\text{g NH}_3}{17.04}} \times \frac{\overset{\text{mol ratio}}{\text{mol NO}}}{\underset{\text{mol NH}_3}{4}} = \text{mol NO}$$

$$\text{b. } \text{g NH}_3 \times \frac{\overset{\text{molar mass factor}}{1 \text{ mol NH}_3}}{\underset{\text{g NH}_3}{17.04}} \times \frac{\overset{\text{mol ratio}}{\text{mol H}_2\text{O}}}{\underset{\text{mol NH}_3}{6}} = \text{mol H}_2\text{O}$$

**3 COMPUTE**

Use the periodic table to compute the molar mass of  $\text{NH}_3$ .

$$1 \text{ mol NH}_3 = 17.04 \text{ g/mol}$$

$$\text{a. } 824 \text{ g NH}_3 \times \frac{1 \text{ mol NH}_3}{17.04 \text{ g NH}_3} \times \frac{4 \text{ mol NO}}{4 \text{ mol NH}_3} = 48.4 \text{ mol NO}$$

$$\text{b. } 824 \text{ g NH}_3 \times \frac{1 \text{ mol NH}_3}{17.04 \text{ g NH}_3} \times \frac{6 \text{ mol H}_2\text{O}}{4 \text{ mol NH}_3} = 72.5 \text{ mol H}_2\text{O}$$

**4 EVALUATE**

The answers are correctly given to three significant figures. The units cancel in the two problems to leave mol  $\text{NO}$  and mol  $\text{H}_2\text{O}$ , respectively, which are the unknowns.

**PRACTICE**

Answers in Appendix E

Oxygen was discovered by Joseph Priestley in 1774 when he heated mercury(II) oxide to decompose it to form its constituent elements.

- How many moles of mercury(II) oxide,  $\text{HgO}$ , are needed to produce 125 g of oxygen,  $\text{O}_2$ ?
- How many moles of mercury are produced?

**extension**

Go to **go.hrw.com** for more practice problems that ask you to calculate unknown quantities by using mole ratios.



Keyword: HC6STCX