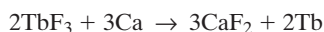


- a. What mass of  $\text{Hg}(\text{NH}_2)\text{Cl}$  could be produced from 0.91 g of  $\text{HgCl}_2$  assuming plenty of ammonia is available?
- b. What mass of  $\text{Hg}(\text{NH}_2)\text{Cl}$  could be produced from 0.91 g of  $\text{HgCl}_2$  and 0.15 g of  $\text{NH}_3$  in solution?
- 211.** Aluminum chips are sometimes added to sodium hydroxide-based drain cleaners because they react to generate hydrogen gas which bubbles and helps loosen material in the drain. The equation follows:
- $$\text{Al}(s) + \text{NaOH}(aq) + \text{H}_2\text{O}(l) \rightarrow \text{NaAlO}_2(aq) + \text{H}_2(g)$$
- a. Balance the equation.
- b. How many moles of  $\text{H}_2$  can be generated from 0.57 mol Al and 0.37 mol NaOH in excess water?
- c. Which reactant should be limiting in order for the mixture to be most effective as a drain cleaner? Explain your choice.
- 212.** Copper is changed to copper(II) ions by nitric acid according to the following equation:
- $$4\text{HNO}_3 + \text{Cu} \rightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{NO}_2 + 2\text{H}_2\text{O}$$
- a. How many moles each of  $\text{HNO}_3$  and Cu must react in order to produce 0.0845 mol of  $\text{NO}_2$ ?
- b. If 5.94 g of Cu and 23.23 g of  $\text{HNO}_3$  are combined, which reactant is in excess?
- 213.** One industrial process for producing nitric acid begins with the following reaction:
- $$4\text{NH}_3 + 5\text{O}_2 \rightarrow 4\text{NO} + 6\text{H}_2\text{O}$$
- a. If 2.90 mol  $\text{NH}_3$  and 3.75 mol  $\text{O}_2$  are available, how many moles of each product are formed?
- b. Which reactant is limiting if  $4.20 \times 10^4$  g of  $\text{NH}_3$  and  $1.31 \times 10^5$  g of  $\text{O}_2$  are available?
- c. What mass of NO is formed in the reaction of 869 kg of  $\text{NH}_3$  and 2480 kg  $\text{O}_2$ ?
- 214.** Acetaldehyde,  $\text{CH}_3\text{CHO}$ , is manufactured by the reaction of ethanol with copper(II) oxide according to the following equation:
- $$\text{CH}_3\text{CH}_2\text{OH} + \text{CuO} \rightarrow \text{CH}_3\text{CHO} + \text{H}_2\text{O} + \text{Cu}$$
- What mass of acetaldehyde can be produced by the reaction between 620 g of ethanol and 1020 g of CuO? What mass of which reactant will be left over?
- 215.** Hydrogen bromide can be produced by a reaction among bromine, sulfur dioxide, and water as follows:
- $$\text{SO}_2 + \text{Br}_2 + \text{H}_2\text{O} \rightarrow 2\text{HBr} + \text{H}_2\text{SO}_4$$
- If 250 g of  $\text{SO}_2$  and 650 g of  $\text{Br}_2$  react in the presence of excess water, what mass of HBr will be formed?
- 216.** Sulfur dioxide can be produced in the laboratory by the reaction of hydrochloric acid and a sulfite salt such as sodium sulfite:
- $$\text{Na}_2\text{SO}_3 + 2\text{HCl} \rightarrow 2\text{NaCl} + \text{SO}_2 + \text{H}_2\text{O}$$
- What mass of  $\text{SO}_2$  can be made from 25.0 g of  $\text{Na}_2\text{SO}_3$  and 22.0 g of HCl?
- 217.** The rare-earth metal terbium is produced from terbium(III) fluoride and calcium metal by the following single-displacement reaction:



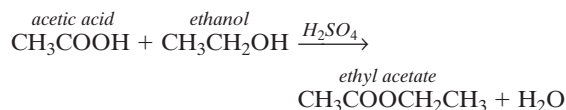
- a. Given 27.5 g of  $\text{TbF}_3$  and 6.96 g of Ca, how many grams of terbium could be produced?
- b. How many grams of the excess reactant is left over?

## Percentage Yield: Chap. 9, Sec. 3

- 218.** Calculate the percentage yield in each of the following cases.
- a. theoretical yield is 50.0 g of product; actual yield is 41.9 g
- b. theoretical yield is 290 kg of product; actual yield is 270 kg
- c. theoretical yield is  $6.05 \times 10^4$  kg of product; actual yield is  $4.18 \times 10^4$  kg
- d. theoretical yield is 0.00192 g of product; actual yield is 0.00089 g
- 219.** In the commercial production of the element arsenic, arsenic(III) oxide is heated with carbon, which reduces the oxide to the metal according to the following equation:
- $$2\text{As}_2\text{O}_3 + 3\text{C} \rightarrow 3\text{CO}_2 + 4\text{As}$$
- a. If 8.87 g of  $\text{As}_2\text{O}_3$  is used in the reaction and 5.33 g of As is produced, what is the percentage yield?
- b. If 67 g of carbon is used up in a different reaction and 425 g of As is produced, calculate the percentage yield of this reaction.

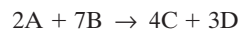
## Mixed Review

- 220.** Ethyl acetate is a sweet-smelling solvent used in varnishes and fingernail-polish remover. It is produced industrially by heating acetic acid and ethanol together in the presence of sulfuric acid, which is added to speed up the reaction. The ethyl acetate is distilled off as it is formed. The equation for the process is as follows:



Determine the percentage yield in the following cases.

- a. 68.3 g of ethyl acetate should be produced but only 43.9 g is recovered.
- b. 0.0419 mol of ethyl acetate is produced but 0.0722 mol is expected. (Hint: Percentage yield can also be calculated by dividing the actual yield in moles by the theoretical yield in moles.)
- c. 4.29 mol of ethanol is reacted with excess acetic acid, but only 2.98 mol of ethyl acetate is produced.
- d. A mixture of 0.58 mol ethanol and 0.82 mol acetic acid is reacted and 0.46 mol ethyl acetate is produced. (Hint: What is the limiting reactant?)
- 221.** Assume the following hypothetical reaction takes place:



Calculate the percentage yield in each of the following cases.

- a. The reaction of 0.0251 mol of A produces 0.0349 mol of C.