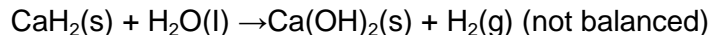


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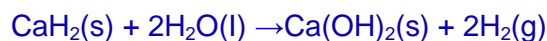
### Stoichiometry Problems

You may work these problems individually, or with one partner. If you work with a partner, both people will get the same score on the assignment.

1. The reaction of calcium hydride with water can be used to prepare small quantities of hydrogen gas, as is done to fill weather-observation balloons.



- (a) How many grams of water are consumed in the reaction of 56.2 g  $\text{CaH}_2$ ?

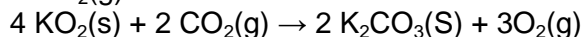


$$56.2\text{g CaH}_2 \times \frac{1 \text{ mol CaH}_2}{42.10 \text{ g CaH}_2} \times \frac{2 \text{ mol H}_2\text{O}}{1 \text{ mol CaH}_2} \times \frac{18.02 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = \mathbf{48.1 \text{ g H}_2\text{O}}$$

- (b) What mass of  $\text{CaH}_2(\text{s})$  must react with an excess of water to produce  $8.12 \times 10^{24}$  molecules of  $\text{H}_2$ ?

$$8.12 \times 10^{24} \text{ molec. H}_2 \times \frac{1 \text{ mol H}_2}{6.02 \times 10^{23} \text{ molec.}} \times \frac{1 \text{ mol CaH}_2}{2 \text{ mol H}_2} \times \frac{42.10 \text{ g CaH}_2}{1 \text{ mol CaH}_2} = \mathbf{284 \text{ g CaH}_2}$$

2. The reaction of potassium superoxide,  $\text{KO}_2$ , is used in life-support systems to replace  $\text{CO}_2(\text{g})$  in expired air with  $\text{O}_2(\text{g})$ .



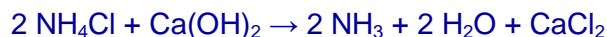
- (a) How many moles of  $\text{O}_2(\text{g})$  are produced by the reaction of 156 g  $\text{CO}_2$  with excess  $\text{KO}_2$ ?

$$156\text{g CO}_2 \times \frac{1 \text{ mol CO}_2}{44.01 \text{ g CO}_2} \times \frac{3 \text{ mol O}_2}{2 \text{ mol CO}_2} = \mathbf{5.32 \text{ mol O}_2}$$

- (b) How many grams of  $\text{KO}_2$  are consumed per 100.0 g  $\text{CO}_2$  removed from expired air?

$$100\text{g CO}_2 \times \frac{1 \text{ mol CO}_2}{44.01 \text{ g CO}_2} \times \frac{4 \text{ mol KO}_2}{2 \text{ mol CO}_2} \times \frac{71.10 \text{ g KO}_2}{1 \text{ mol KO}_2} = \mathbf{323 \text{ g KO}_2}$$

3. Ammonia can be generated by heating together the solids  $\text{NH}_4\text{Cl}$  and  $\text{Ca}(\text{OH})_2$  with  $\text{CaCl}_2$  and  $\text{H}_2\text{O}$  also being formed.  
 (a) If a mixture containing 33.0 g each of  $\text{NH}_4\text{Cl}$  and  $\text{Ca}(\text{OH})_2$  is heated, how many grams of  $\text{NH}_3$  will form?



Find limiting reactant

$$33.0\text{g NH}_4\text{Cl} \times \frac{1 \text{ mol NH}_4\text{Cl}}{53.50 \text{ g NH}_4\text{Cl}} \times \frac{2 \text{ mol NH}_3}{2 \text{ mol NH}_4\text{Cl}} \times \frac{17.04 \text{ g NH}_3}{1 \text{ mol NH}_3} = 10.5 \text{ g NH}_3$$

$$33.0\text{g Ca}(\text{OH})_2 \times \frac{1 \text{ mol Ca}(\text{OH})_2}{74.10 \text{ g Ca}(\text{OH})_2} \times \frac{2 \text{ mol NH}_3}{1 \text{ mol Ca}(\text{OH})_2} \times \frac{17.04 \text{ g NH}_3}{1 \text{ mol NH}_3} = 15.2 \text{ g NH}_3$$

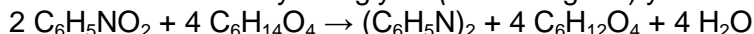
**Therefore  $\text{NH}_4\text{Cl}$  is the limiting reactant and 10.5 g  $\text{NH}_3$  can be made.**

- (b) Which reactant remains in excess, and in what mass?

$$10.5 \text{ g NH}_3 \times \frac{1 \text{ mol NH}_3}{17.04 \text{ g NH}_3} \times \frac{1 \text{ mol Ca}(\text{OH})_2}{2 \text{ mol NH}_3} \times \frac{74.01 \text{ g Ca}(\text{OH})_2}{1 \text{ mol Ca}(\text{OH})_2} = 22.8 \text{ g Ca}(\text{OH})_2$$

**Therefore 22.8 g  $\text{Ca}(\text{OH})_2$  will be consumed and  $(33.0 - 22.8)\text{g} = 10.2 \text{ g Ca}(\text{OH})_2$  will remain.**

4. Azobenzene ( $(\text{C}_6\text{H}_5\text{N})_2$ ), an intermediate in the manufacture of dyes, can be prepared from nitrobenzene ( $\text{C}_6\text{H}_5\text{NO}_2$ ) by reaction with triethylene glycol ( $\text{C}_6\text{H}_{14}\text{O}_4$ ). In one reaction, 120 g of nitrobenzene and 310 mL of triethylene glycol ( $d = 1.12 \text{ g/mL}$ ) yields 55 g azobenzene.



- (a) What is the theoretical yield?

$$120 \text{ g C}_6\text{H}_5\text{NO}_2 \times \frac{1 \text{ mol C}_6\text{H}_5\text{NO}_2}{123.1 \text{ g C}_6\text{H}_5\text{NO}_2} \times \frac{1 \text{ mol } (\text{C}_6\text{H}_5\text{N})_2}{2 \text{ mol C}_6\text{H}_5\text{NO}_2} = 0.487 \text{ mol } (\text{C}_6\text{H}_5\text{N})_2$$

$$300 \text{ mL C}_6\text{H}_{14}\text{O}_4 \times \frac{1.12 \text{ g C}_6\text{H}_{14}\text{O}_4}{1 \text{ mL C}_6\text{H}_{14}\text{O}_4} \times \frac{1 \text{ mol C}_6\text{H}_{14}\text{O}_4}{150.2 \text{ g C}_6\text{H}_{14}\text{O}_4} \times \frac{1 \text{ mol } (\text{C}_6\text{H}_5\text{N})_2}{4 \text{ mol C}_6\text{H}_{14}\text{O}_4} = 0.559 \text{ mol } (\text{C}_6\text{H}_5\text{N})_2$$

So,  $\text{C}_6\text{H}_5\text{NO}_2$  is our limiting reactant and our theoretical yield is:

$$0.487 \text{ mol } (\text{C}_6\text{H}_5\text{N})_2 \times \frac{182.26 \text{ g } (\text{C}_6\text{H}_5\text{N})_2}{1 \text{ mol } (\text{C}_6\text{H}_5\text{N})_2} = \mathbf{88.8 \text{ g } (\text{C}_6\text{H}_5\text{N})_2}$$

- (b) What is the actual yield?

The actual yield is **55 g**

- (c) What is the percent yield of this reaction?

$$\% \text{ yield} = \frac{55 \text{ g}}{89 \text{ g}} \times 100\% = \mathbf{62 \% \text{ yield}}$$