1. The reaction of methane and water is one way to prepare hydrogen:

\[ \text{CH}_4(\text{g}) + \text{H}_2\text{O}(\text{g}) \rightarrow \text{CO}(\text{g}) + 3 \text{H}_2(\text{g}) \]

If you begin with 995 g of CH\(_4\) and 2510 g of water, what is the maximum possible yield of H\(_2\)?

2. Disulfur dichloride, S\(_2\)Cl\(_2\), is used to vulcanize rubber. It can be made by treating molten sulfur with gaseous chlorine: \( \text{S}_8(\ell) + 4 \text{Cl}_2(\text{g}) \rightarrow 4 \text{S}_2\text{Cl}_2(\ell) \)

Starting with a mixture of 32.0 g of sulfur and 71.0 g of Cl\(_2\), which is the limiting reactant? What mass of S\(_2\)Cl\(_2\) (in grams) can be produced? What mass of the excess reactant remains when the limiting reactant is consumed?

3. Aspirin (C\(_9\)H\(_8\)O\(_4\)) is produced by the reaction of salicylic acid (C\(_7\)H\(_6\)O\(_3\)) and acetic anhydride (C\(_4\)H\(_6\)O\(_3\)).

\[ \text{C}_7\text{H}_6\text{O}_3(\text{s}) + \text{C}_4\text{H}_6\text{O}_3(\ell) \rightarrow \text{C}_9\text{H}_8\text{O}_4(\text{s}) + \text{CH}_3\text{CO}_2\text{H}(\text{aq}) \]

If you mix 100. g of each of the reactants, what is the maximum mass of aspirin that can be obtained?

4. Diborane, B\(_2\)H\(_6\), is a valuable compound in the synthesis of new organic compounds. Use the following reaction:

\[ 2 \text{NaBH}_4(\text{s}) + \text{I}_2(\text{s}) \rightarrow \text{B}_2\text{H}_6(\text{g}) + 2 \text{NaI}(\text{s}) + \text{H}_2(\text{g}) \]

Suppose you use 1.203 g of NaBH\(_4\) with an excess of iodine and obtain 0.295 g of B\(_2\)H\(_6\). What is the percent yield of B\(_2\)H\(_6\)?

5. Disulfur dichloride, which has a revolting smell, can be prepared by directly combining S\(_8\) and Cl\(_2\), but it can also be made by the following reaction:

\[ 3 \text{SCl}_2(\ell) + 4 \text{NaF}(\text{s}) \rightarrow \text{SF}_4(\text{g}) + \text{S}_2\text{Cl}_2(\ell) + 4 \text{NaCl}(\text{s}) \]

Assume you begin with 5.23 g of SCl\(_2\) and excess NaF. What is the theoretical yield of S\(_2\)Cl\(_2\)? If only 1.19 g of S\(_2\)Cl\(_2\) is obtained, what is the percent yield of the compound?