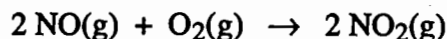


Exercises

1. Given the balanced chemical equation:



calculate the mass of nitrogen dioxide that can be made from 30.0 grams of NO and 30.0 grams of O₂.

2. Zinc, Zn, and iodine, I₂, react to form zinc iodide, ZnI₂ (the reactants and the product are all solids at room temperature).

- Write a balanced chemical equation for this reaction.
- Suppose that 50.0 g of zinc and 50.0 g of iodine are used to form zinc(II) iodide.
 - Assuming that the reaction goes to completion, which element will be totally consumed in the formation of the zinc(II) iodide?
 - What is the limiting reagent?
 - How many grams of zinc(II) iodide can be produced?
 - How many grams of the excess element remain unreacted?

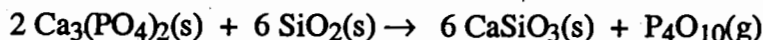
3. Acetylene gas, HCCH, is commonly used in high temperature torches.

- Write a balanced chemical equation for the reaction of acetylene with hydrogen gas (H₂) to form ethane (C₂H₆).
- How many grams of ethane can be produced from a mixture of 30.3 grams of HCCH and 4.14 grams of H₂?

4. Titanium (Ti) is a strong, lightweight metal that is used in the construction of rockets, jet engines, and bicycles. It can be prepared by reacting TiCl₄ with Mg metal at very high temperatures. The products are Ti(s) and MgCl₂.

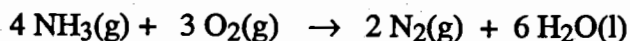
- Provide a balanced chemical reaction for the reaction described above.
- How many grams of Ti metal can be produced from a reaction involving 3.54×10^4 g of TiCl₄ and 6.53×10^3 g of Mg?

5. The first step in the manufacturing process of phosphorous is the reaction below:

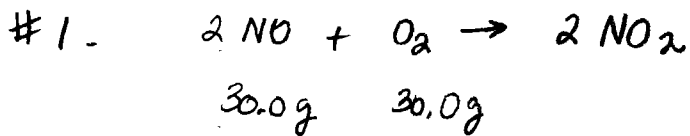


The MW of Ca₃(PO₄)₂(s) is 310.2 g/mole and the MW of SiO₂(s) is 60.1 g/mole. If 20.0 g of Ca₃(PO₄)₂(s) and 20.0 g of SiO₂(s) are reacted, how many grams of P₄O₁₀(g) can be produced?

6. How many grams of N₂ (28.01 g/mole) can be obtained by reacting 24.5 g of NH₃ (17.03 g/mole) with 30.8 g of O₂ (MW = 32.00 g/mole)?



Answer key to Limiting reagent Exercises



$$\frac{30.0\text{g NO} \left| \begin{array}{l} 1 \text{ mol NO} \\ 30.01 \text{ g NO} \end{array} \right| \begin{array}{l} 2 \text{ mol NO}_2 \\ 2 \text{ mol NO} \end{array}}{=} = 0.9996 \rightarrow 1.00 \text{ mol NO}_2$$

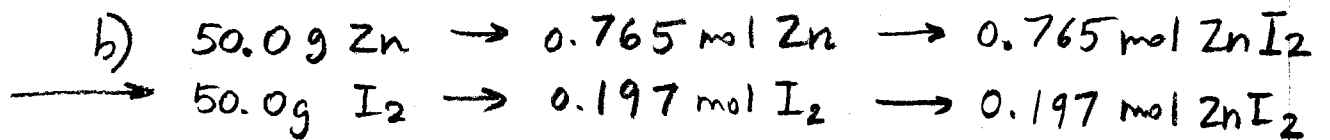
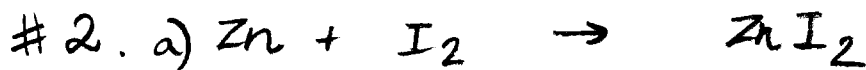
$$\frac{30.0\text{g O}_2 \left| \begin{array}{l} 1 \text{ mol O}_2 \\ 32.00 \text{ g O}_2 \end{array} \right| \begin{array}{l} 2 \text{ mol NO}_2 \\ 1 \text{ mol O}_2 \end{array}}{=} = 1.875 \rightarrow 1.88 \text{ mol NO}_2$$

If all NO is used, 1.00 mol NO₂ formed
 If all O₂ is used, 1.88 mol NO₂ is formed.

less, so NO is limiting reagent.

* The limiting reagent determines amount of product:

$$\frac{1.00 \text{ mol NO}_2 \left| \begin{array}{l} 46.01 \text{ g NO}_2 \\ 1 \text{ mol NO}_2 \end{array} \right|}{=} = 46.01 \text{ g NO}_2 \text{ is formed}$$



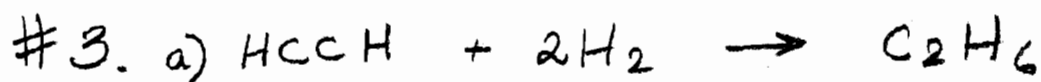
1) I₂ will be completely consumed (it's limiting)

2) I₂

3) $0.197 \text{ mol ZnI}_2 \rightarrow 62.9 \text{ g ZnI}_2$

4) $0.765 \text{ mol Zn} - 0.197 \text{ mol Zn used} = 0.568 \text{ mol Zn left}$
 \downarrow
37.1 g Zn

similar to lab exp 9 on limiting reactant.



b)
$$\begin{array}{c|c|c} 30.3 \text{ g HCCH} & 1 \text{ mol HCCH} & 1 \text{ mol C}_2\text{H}_6 \\ \hline & 26.04 \text{ g HCCH} & 1 \text{ mol HCCH} \end{array}$$

= 1.16 mol C_2H_6 if all HCCH is used

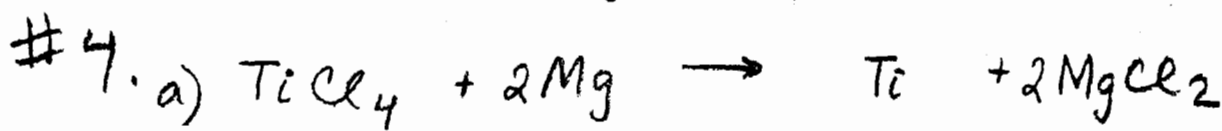
$$\begin{array}{c|c|c} 4.14 \text{ g H}_2 & 1 \text{ mol H}_2 & 1 \text{ mol C}_2\text{H}_6 \\ \hline & 2.02 \text{ g H}_2 & 2 \text{ mol H}_2 \end{array}$$

= 1.02 mol C_2H_6 if all H_2 is used.



30.68 g C_2H_6

H₂ is limiting



b)
$$\begin{array}{l} 3.54 \times 10^4 \text{ g TiCl}_4 \rightarrow 187 \text{ moles Ti} \\ 6.53 \times 10^3 \text{ g Mg} \rightarrow 134 \text{ moles Ti} \end{array} \rightarrow \text{Mg is limiting}$$



6430 g Ti

#5. MW = molecular weight (molar mass)

$20.0 \text{ g Ca}_3(\text{PO}_4)_2 \rightarrow 0.0322 \text{ moles P}_4\text{O}_{10} \rightarrow 9.14 \text{ g P}_4\text{O}_{10}$

$20.0 \text{ g SiO}_2 \rightarrow 0.0554 \text{ moles P}_4\text{O}_{10}$

$\text{Ca}_3(\text{PO}_4)_2$ is limiting!

#6. $24.5 \text{ g NH}_3 \rightarrow 0.719 \text{ mol N}_2$

$30.8 \text{ g O}_2 \rightarrow 0.642 \text{ mol N}_2 \rightarrow 17.973 \rightarrow 18.0 \text{ g N}_2$