ChemQuest 43

Limiting Reactants

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Hour: \_\_\_\_\_

**Information**: Limiting Reactant

Again consider the combustion of propane: C3H8 + 5 O2 🡪 3 CO2 + 4 H2O. If you had 10 moles of propane to burn, you would need 50 moles of oxygen according to the ratio in the balanced equation. If you only had 20 moles of oxygen you could not combust all 10 moles of propane. The reaction has been **limited** by the amount of oxygen you have—you don’t have enough oxygen to burn all of the propane. In this case, oxygen is called the “limiting reactant” because it limits how much propane can react. Notice that the limiting reactant isn’t always the substance that is present in the fewest number of moles. In this example, propane (C3H8) is the “excess reactant” because after the reaction there will be some of it left over. It is important to remember that everything in a chemical equation is related by mole ratios. If you only know the mass (grams) of the substances, you need to convert to moles.

**Critical Thinking Questions**

1. a) In the above discussion, it was evident that 20 moles of oxygen was not sufficient to combust 10 moles of propane. How many moles of the propane can be combusted with 20 moles of oxygen?

b) How many moles of carbon dioxide will be produced? (Base the answer to this question on the number of moles of propane that actually get combusted—which is your answer to part a.)

1. Verify that if 12.5 moles of propane and 63.2 moles of oxygen were present, then propane is the “limiting reactant” and oxygen is the excess reactant.

2. Consider the following chemical reaction: 3 MgCl2 + 2 Na3PO4 🡪 6 NaCl + Mg3(PO4)2. Assume that 0.75 mol of MgCl2 and 0.65 mol of Na3PO4 are placed in a reaction vessel.

1. Verify that Na3PO4 is the excess reactant and MgCl2 is the limiting reactant.
2. How many moles of the excess reactant are left over after the reaction stops?
3. How many moles of NaCl will be produced in this reaction? (Remember—you must base this answer on how many moles of the limiting reactant that reacted.)
4. Consider the double replacement reaction between calcium sulfate (CaSO4) and sodium iodide (NaI). If 34.7 g of calcium sulfate and 58.3 g of sodium iodide are placed in a reaction vessel, how many grams of each product are produced? (Hint: Do this problem in the steps outlined below.)
5. Write the balanced chemical equation for the reaction.
6. Find the limiting reactant. First, convert 34.7g and 58.3g from grams to moles using the molar masses from the periodic table. Next, compare the number of moles of each reactant. Ask yourself: Do I have enough NaI to use up all of the CaSO4? Do I have enough CaSO4 to use up all of the NaI? Whichever one will get used up is the limiting reactant.
7. Use the number of moles of the limiting reactant to calculate the number of moles of each product produced using the coefficients from the balanced chemical equation in part a.
8. In part c you found the moles of each product produced. Now convert moles to grams using the molar mass from the periodic table. You have now answered the question.
9. If 181.1g of Al(NO3)3 react with 102.1g of CaO in a double replacement reaction, how many grams of each product will be produced? (Note: this is just like the last question, but parts a-d are not spelled out for you.)