NS 9.5 (pg 1 of 2) Limiting Reactants – in grams

Again let me reemphasize that there is no substitute for reading the problem carefully. There will be several numbers in each problem, (some of which may not even be necessary) and you must be sure and use the appropriate numbers at the appropriate times. Each number in all of these problems should have three labels associated with it.

1 the units (g, mole, etc)
2 the Identity label – who the substance is (H_2O , carbon dioxide, Al, lead, etc)
3 the Descriptor label: descriptive words to tell you more about the material – (started with, produced, needed, mass theoretically produced, experimental mass, left over, etc)

For you to have success you need to keep track of the labels on every number both at the start of the problem and throughout the problem. If you lose track of who's who, you are likely to use the wrong number at the wrong time.

As before there is a basic pattern to all stoichiometry problems, with variations depending on what information is given and what questions must be answered. For limiting reactant problems, the problem will give you information about two reactants (as opposed to the one given in the earlier type problems).

A. You must always start with a balanced equation. (If you need more help with that go back to chap 8)
B. You should first determine which reactant will run out – in other words, which reactant is the limiting reactant.
   FIRST – You must change all starting masses into moles.
   NEXT - The mathematical trick to determine which reactant limits is to divide the moles of each reactant by the coefficient (from the balanced equation) associated with that reactant. The number that comes out the smallest indicates which reactant is the limiting one. The limiting reactant is the one that you must base all your other calculations on because it is the substance that limits how much of everything else can be made or is needed.
C. Use any necessary stoichiometric LINKS to convert the moles of the known limiting substance to the moles of one of the desired information.
   Note that the LINK is set up with the known substance on the bottom (so it will cancel out) and with the desired substance on the top.
D. Of course, the other reactant (if there's only two) will be the excess reactant, and some of it will be left over.
E. Knowing which reactant limits and which is excess, use the limiting reactant to set up a stoichiometric LINK to determine the moles of the excess reactant that is actually needed to do the reaction, then convert back to grams
E. Subtract the mass of reactant needed from the amount of excess reactant started with to determine the mass of excess reactant that is left over.

Sample Problems – Study these carefully, and model your work after these.

1 Lithium hydroxide is reacted with carbon dioxide to produce solid lithium carbonate and liquid water. If you started with 250.0 g of carbon dioxide and 120.0 g of lithium hydroxide, what mass of water could be made? Which reactant is left over, and what mass of it are left over?

A. Balanced equation: $2\ LiOH + CO_2 \rightarrow Li_2CO_3 + H_2O$

B. FIRST – Convert masses into moles 250.0 g CO_2 * 1mole/44 g = 5.68 moles
   120.0 g LiOH * 1mole/24 g = 5.00 moles
   NEXT – use the "trick" to determine which reactant limits
   5.00 moles CO_2 / 1 = 5.00
   5.00 moles LiOH / 2 = 2.5 moles since 2.5 is the smaller, it is the LiOH that limits this reaction.

C. Determine the mass of product that can be produced (be sure and base you calculations on the limiting reactant).
   120.0 g LiOH * 1mole/24 g * 1 H_2O / 2 LiOH * 18 g/1mole = 45.0 g <u>of H_2O can be produced.</u>

D. because the LiOH limits, CO_2 must be the excess reactant.

E. 120.0 g LiOH * 1mole/24 g * 1 CO_2 / 2 LiOH * 44 g/1mole = 110 g <u>CO_2 are needed to react with all the LiOH</u>.

F. 250 g CO_2 started with – 110 g CO_2 needed = 140 g <u>CO_2 left over</u>

one more sample on the next page →→

2. Write the reaction that represents the formation of carbon disulfide and carbon monoxide by reacting carbon with sulfur dioxide. If 80.0 g of carbon are reacted with 224.0 g of sulfur dioxide, what mass of carbon monoxide can be produced? What mass of the excess reactant is left over?

   A. Balanced equation: $5\ C + 2\ SO_2 \rightarrow CS_2 + 4\ CO$

   B. FIRST – Convert masses into moles 80.0 g *C* * 1mole/12 g = 6.67 moles *C*
   224.0 g SO_2 * 1mole/64.0 g = 3.50 moles SO_2
   NEXT – use the "trick" to determine which reactant limits
   6.67 moles *C* / 5 = 1.33 since 1.33 is smaller than 1.75 the carbon must limit the reaction
   3.50 moles SO_2 / 2 = 1.75

   C. Determine the mass of product that can be produced (be sure and base you calculations on the limiting reactant).
   80.0 g *C* * 1mole/12 g * 4 *CO* / 5 *C* * 28 g/1mole = 149 g *CO* can be produced.

   D. because the *C* limits, SO_2 must be the excess reactant.

   E. 80.0 g *C* * 1mole/12 g * 2 SO_2 / 5 *C* * 64 g/1mole = 171 g SO_2 are needed to react with all the carbon.

   F. 224 g SO_2 started with - 171 g SO_2 needed = 54 g SO_2 left over