

Limiting Reagent Walk-Through – Example #1



You start with 115.0g of N_2 and 15.00g of H_2

How many grams of product can you make, and how many grams of the excess (XS) reagent do you have left when done?

STEP #1 - Grams to Moles

Use molar masses to convert from grams to moles:

$$\frac{115.0 \text{ g N}_2}{28.01 \text{ g N}_2} \times 1 \text{ mol N}_2 = 4.106 \text{ moles N}_2 \quad \frac{15.00 \text{ g H}_2}{2.02 \text{ g H}_2} \times 1 \text{ mol H}_2 = 7.426 \text{ moles H}_2$$

STEP #2 – Have versus Need

Make a little chart showing how many moles of each chemical you have versus how many moles of each chemical you would need. Pick one of your starting values (doesn't matter which one – I like to just pick the first one so I'm consistent), do dimensional analysis to figure out how many moles of the other chemical you would need to have in order to complete the reaction.

	N_2	3H_2	2NH_3
HAVE:	4.106 mol	7.426 mol	
NEED:		12.318 mol	

$$\frac{4.106 \text{ mol N}_2}{1 \text{ mol N}_2} \times 3 \text{ mol H}_2 = 12.318 \text{ moles H}_2 \text{ would be needed to use up all the N}_2$$

STEP #3 – Identify Limiting

Compare the amount you have with the amount you need to see which chemical you don't have enough of, and which chemical you will have extra left over of.

	N_2	3H_2	2NH_3
HAVE:	4.106 mol	7.426 mol	
NEED:		12.318 mol	

You can see here that you only have 7.426 mol of H_2 , but you would need 12.318 mol to use up all the N_2 you have. So you do not have enough. That means the H_2 is the Limiting Reagent, and N_2 is the excess reagent.

If you had more than you needed that would mean it was the excess reagent and the other was the limiting. That means that you only need to do one calculation to determine which is limiting and which is excess because you can use the answer to one calculation to conceptually explain either result!

STEP #4 – Do Stoich with Limiting

Convert from moles of limiting reactant to desired unit of unknown substance asked for in the problem – use mole highway to determine where to start and end. It is now just a normal stoichiometry problem once you know which number to use!

Example pathway: moles of A → moles of B → grams of B

	XS	LR
	N_2	$3\text{H}_2 \rightarrow 2\text{NH}_3$
HAVE:	4.106 mol	7.426 mol
NEED:		12.318 mol

7.426 mol H_2	2 mol NH_3	17.03 g NH_3	= 84.31 g NH_3 made during the rxn
	3 mol H_2	1 mol NH_3	

STEP #5 – Find XS left

Use moles of Limiting Reagent and mole ratio to calculate how many moles of Excess Reagent are needed to use up all the limiting reagent during the reaction. Add this value to the little chart that you already made. Then, just subtract to find how many moles of XS are left over.

	XS	LR
	N_2	$3\text{H}_2 \rightarrow 2\text{NH}_3$
HAVE:	4.106 mol	7.426 mol
NEED:	2.475 mol	12.318 mol

$$\frac{7.426 \text{ mol H}_2}{3 \text{ mol H}_2} \left| \frac{1 \text{ mol N}_2}{1 \text{ mol N}_2} \right. = 2.475 \text{ moles of N}_2 \text{ will be needed during the rxn to use up all the LR}$$

$$\begin{array}{l} \text{LEFT: } 4.106 \text{ mol} \\ \quad - 2.475 \text{ mol} \\ \hline = 1.631 \text{ mol of N}_2 \text{ left as excess} \end{array}$$

Convert your answer into whatever unit is asked for – if it doesn't specify then it is ok to leave it in moles.

$$\frac{1.631 \text{ mol N}_2 \text{ left over}}{1 \text{ mol N}_2} \left| \frac{28.01 \text{ g N}_2}{1 \text{ mol N}_2} \right. = 45.68 \text{ g of N}_2 \text{ left over}$$