Limiting Reagent Walk-Through – Example #2

$Al(OH)_3 + 3NaCl \rightarrow AlCl_3 + 3NaOH$
You start with 28.50 g of $Al(OH)_3$ and 45.00g of NaCl

How many grams of NaOH can you make, and how many moles 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:

$$\frac{28.50\text{ g } Al(OH)_3}{78.00\text{ g } Al(OH)_3} \times \frac{1\text{ mol } Al(OH)_3}{} = 0.365\text{ moles } Al(OH)_3$$

$$\frac{75.00\text{ g NaCl}}{58.44\text{ g NaCl}} \times \frac{1\text{ mol NaCl}}{} = 1.283\text{ moles } Al(OH)_3$$

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.

	$Al(OH)_3$ + 3NaCl →	$AlCl_3$+3NaOH
HAVE:	0.365 mol	1.283 mol
NEED:		1.095 mol

$$\frac{0.365\text{ mol } Al(OH)_3}{1\text{ mol } Al(OH)_3} \times \frac{3\text{ mol NaCl}}{} = 1.095\text{ moles } H_2 \text{ would be needed to use up all the } N_2$$

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.

	$Al(OH)_3$ + 3NaCl →	$AlCl_3$+3NaOH
HAVE:	**0.365 mol**	1.283 mol
NEED:		1.095 mol

You can see here that you have 1.283 mol of NaCl, but you would only need 1.095 mol to use up all the $Al(OH)_3$ you have. So you have more than enough NaCl, you will have extra left over. That means NaCl is the excess reagent, and that $Al(OH)_3$ is the limiting reagent.

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

	LR	XS		
	$Al(OH)_3$ +	3NaCl	→	$AlCl_3$ + 3NaOH
HAVE:	**0.365 mol**	1.283 mol		
NEED:		1.095 mol		

0.365 mol $Al(OH)_3$	3 mol NaOH	40.00 g NaOH
	1 mol $Al(OH)_3$	1 mol NaOH

= 43.8 g NaOH made during the rxn

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.

	LR	XS		
	$Al(OH)_3$ +	3NaCl	→	$AlCl_3$ + 3NaOH
HAVE:	**0.365 mol**	1.283 mol		
NEED:		1.095 mol		

This time you already know the moles of XS you have and the moles of XS needed to use up all the limiting reagent! So you can skip straight to subtracting.

LEFT: 1.283 mol
- 1.095 mol
= 0.188 mol of NaCl left as excess

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

It only asked for moles, so there is no need to convert our answer to grams! You are done!