B. Limiting and Excess Reagents (XLR)

Limiting Species - the reactant species that runs out first in a chemical reaction
Excess Species - the reactant species that doesn't run out

If you look at combustion of gasoline:

$2C_8H_{18}$ (l) + 25 O_2 (g) → 16CO_2 (g) + 8H_2O (g)

Since the oxygen gas comes from the air, it is pretty obvious that the limiting species is the gasoline, and the excess species is the oxygen, but sometimes it's not easy to tell. Take a look at the next example:

5.0 mol of aluminum reacts with 7.0 mol of bromine. How many grams of aluminum bromide would be produced?

Step One: Write and balance the chemical equation. Write your given information underneath.

2 Al (s)	+	3 Br_2 (l)	→	2 $AlBr_3$ (s)
5.0 mol		7.0 mol		m = ?

Step Two : The problem is that you have two "givens". You need to find out which is the limiting species. Calculate the amount of one species that is required to completely use up the given amount of the other species. Do this for <u>each</u> reactant.

$$\text{n of Al required} = \text{n of } Br_2 \times \frac{2 \text{ mol of Al}}{3 \text{ mol of } Br_2}$$

$$= 7.0 \text{ mol} \times 2/3$$
$$= 4.67 \text{ mol}$$

$$\text{n of } Br_2 \text{ required} = \text{n of Al} \times \frac{3 \text{ mol of } Br_2}{2 \text{ mol of Al}}$$

$$= 5.0 \text{ mol} \times 3/2$$
$$= 7.50 \text{ mol}$$

Step Three: Interpret the results

Since the amount of Al required (4.67 mol) is less than the amount available to react (5.0 mol) then the Al is in **excess**. Since the amount of bromine needed to completely react with all the aluminum is 7.50 mol, but we only have 7.0 mol available, then the bromine is the **limiting reagent**.

Step Four : Continue on with the stoichiometry problem, using the **limiting species as your given**. Totally ignore the 5.0 mol of Al, <u>work with only the 7.0 mol of Br_2.</u> The rest is just regular stoichiometry.
Your given is already in moles, so proceed to your mole ratio equation:

n of $AlBr_3$ = n of Br_2 x W/G
= 7.0 mol x 2/3
= 4.67 mol

Then convert your wanted to the desired units, grams:

m of $AlBr_3$ = nM
=266.68g/mol
= 4.67 mol x 266.68 g/mol
= 1200 g

M of $AlBr_3$ = 26.98 + (3 x 79.90)

Now, you try this one:
Propane (C_3H_8) burns in air. How much carbon dioxide would be produced if 12.6 mol of propane reacted with 84.3 mol of oxygen gas?