Step by Step: Stoichiometry Problems

Steps:

1) Write the balanced chemical reaction.
2) Write a conversion equation.
   a) Find the mols of the compound with known mass.
   b) Use the mol ratio (in the balanced reaction) between the 2 compounds you are interested in.
   c) Find the grams of the compound you are looking for.

**The only time you look at the balanced reaction is for step 2b.!!**

Ex. 1) How many grams of HCl will react with 44.7 g $Ca(OH)_2$?

We are given 44.7 g $Ca(OH)_2$, so this is what we start the conversion with. Also check and make sure the reaction is balanced.

$$2\ HCl + Ca(OH)_2 \rightarrow CaCl_2 + 2\ H_2O$$

$$\frac{44.7\ g\ Ca(OH)_2}{\ }$$

We need to change grams to mols, so find the molar mass of $Ca(OH)_2$. Add up 1 Calcium, 2 Oxygen and 2 Hydrogen. The molar mass grams go on the bottom so that the grams cancel.

$$2\ HCl + Ca(OH)_2 \rightarrow CaCl_2 + 2\ H_2O$$

$$\frac{44.7\ g\ Ca(OH)_2}{\ } \left| \frac{1\ mol\ Ca(OH)_2}{74.094\ g\ Ca(OH)_2} \right.$$

Next we use the mol ratio. In the question we started with 44.7 g $Ca(OH)_2$ and we are asked to find the grams of HCl. These are the only two compounds we are concerned with in the balanced reaction.

$$2\ HCl + Ca(OH)_2 \rightarrow CaCl_2 + 2\ H_2O$$

Write a conversion factor with these two compounds (the mol ratio):

2 mols HCl = 1 mol $Ca(OH)_2$ {There is 1 mol $Ca(OH)_2$, since there is only 1 of it in the reaction.}

** Now we must put in this conversion factor, so that the mols of $Ca(OH)_2$ will cancel.**

$$44.7 \text{ g } Ca(OH)_2 \left| \frac{1 \text{ mol } Ca(OH)_2}{74.094 \text{ g } Ca(OH)_2} \right.$$

2 mols HCl = 1 mol $Ca(OH)_2$ The mol $Ca(OH)_2$ in the conversion factor must go on the bottom to cancel the mol $Ca(OH)_2$ on top.

$$44.7 \text{ g } Ca(OH)_2 \left| \frac{1 \text{ mol } Ca(OH)_2}{74.094 \text{ g } Ca(OH)_2} \right| \frac{2 \text{ mol HCl}}{1 \text{ mol } Ca(OH)_2} \Bigg|$$

The last step is to change the mols HCl back to grams. Find the molar mass. Add up 1 Hydrogen and 1 Chlorine. Put the mols on the bottom so that it cancels, leaving grams on top.

****Do not use the 2 in front of the HCl in the reaction for this last step! The only time you use the numbers from the balanced reaction is for the mol ratio conversion (the middle conversion). The gram : mol conversion always has 1 mol and only 1 of the compound added up!****

$2 \text{ HCl} + Ca(OH)_2 \rightarrow CaCl_2 + 2 H_2O$

$$44.7 \text{ g } Ca(OH)_2 \left| \frac{1 \text{ mol } Ca(OH)_2}{74.094 \text{ g } Ca(OH)_2} \right| \frac{2 \text{ mol HCl}}{1 \text{ mol } Ca(OH)_2} \Bigg| \frac{36.461 \text{ g HCl}}{1 \text{ mol HCl}} = \mathbf{44.0 \text{ g HCl}}$$

Multiply across the top to get a number. Then multiply across the bottom to get a number. Then divide the two numbers to get the answer.
Or 44.7 divided by 74.094, multiplied by 2, multiplied by 36.461

Ex. 2) What would be the minimum amount of carbon monoxide used, if 80.3 g iron were produced?

We are given 80.3 g iron, which is the Fe, so that is what we start the conversion with. Make sure the reaction is balanced.

$$Fe_2O_3 + 3 \text{ CO} \rightarrow 2 \text{ Fe} + 3 CO_2$$

We need to change grams to mols, so find the molar mass of the Fe. Just look at the atomic mass of Fe, which is 55.847 g.

****Do not use the 3 in front of the Fe in the reaction for this step! The only time you use the numbers from the balanced reaction is for the**

**mol ratio conversion (the middle conversion). The gram : mol conversion always has 1 mol and only 1 of the compound added up!****

$$\frac{80.3 \text{ g Fe}}{}$$

The grams need to go on the bottom to cancel the grams of Fe.

$$\frac{80.3 \text{ g Fe}}{} \left| \frac{1 \text{ mol Fe}}{55.847 \text{ g Fe}} \right.$$

Next is the mol ratio. Look at the question. We start with 80.3 grams of Fe and are trying to find the grams of carbon monoxide, CO. These are the only 2 compounds we care about in the balanced reaction.

$Fe_2O_3 + 3\ CO \rightarrow 2\ Fe + 3\ CO_2$

Write a conversion for these:
3 mol CO = 2 mol Fe

$$\frac{80.3 \text{ g Fe}}{} \left| \frac{1 \text{ mol Fe}}{55.847 \text{ g Fe}} \right.$$

We must put in this conversion to cancel the mol Fe in the numerator, so our 2 mol Fe in the conversion factor must go on the bottom.

$$\frac{80.3 \text{ g Fe}}{} \left| \frac{1 \text{ mol Fe}}{55.847 \text{ g Fe}} \right| \frac{3 \text{ mol CO}}{2 \text{ mol Fe}} \left|\right.$$

Next we need to change the mol CO to grams. Add up the molar mass of CO ( 1 Carbon and 1 Oxygen). Put in the conversion so that the mol CO cancels.

****Do not use the 3 in front of the CO in the reaction for this step! The only time you use the numbers from the balanced reaction is for the mol ratio conversion (the middle conversion). The gram : mol conversion always has 1 mol and only 1 of the compound added up!****

$Fe_2O_3 + 3\ CO \rightarrow 2\ Fe + 3\ CO_2$

$$\frac{80.3 \text{ g Fe}}{} \left| \frac{1 \text{ mol Fe}}{55.847 \text{ g Fe}} \right| \frac{3 \text{ mol CO}}{2 \text{ mol Fe}} \left| \frac{28.01015 \text{ g CO}}{1 \text{ mol CO}} \right. = \mathbf{60.4\ g\ CO}$$

Multiply across the top to get a number. Then multiply across the bottom to get a number. Then divide the two numbers to get the answer.
Or 80.3 divided by 55.847, multiplied by 3, divided by 2, multiplied by 28.01015

***End of Notes***