Ch 9, supplementary problems.

Problems #1 & 4 for Ch 9, taken together, are a wonderful stoichiometry exercise. At the simplest, the parts show that the balanced equation tells you the mole ratios for all the chemicals involved. When you want something other than moles, either as input or result, you simply do the appropriate conversion between the moles that are inherent in the equation and the unit you want -- most commonly grams (mass). Here is another set of such problems.

Be sure to show clear work, with clear dimensional analysis set-ups for each part. Get in the habit of showing complete set-ups even for the simple problems; then you will have little trouble going on to do more complex problems, which require more complex set-ups. Show proper significant figures in all problems.

> For simplicity, all of these questions use only 1-2 significant figures (SF). You can use integer molar masses. But do show your answers with proper SF.

All of these problems refer to the following balanced equation, which reflects the process used to make ammonia, either industrially or biologically:
$N_2(g) + 3\ H_2(g) \rightarrow 2\ NH_3(g)$

> Answers are on the back, with complete or partial set-ups for some problems.

a. If 6 moles of hydrogen react, how many moles of ammonia can be made?

b. How many moles of nitrogen do you need to make 3.6 moles of ammonia?

c. If you use 4.7 moles of nitrogen, how many moles of hydrogen would you need?

d. If you use 4.7 moles of hydrogen, how many moles of nitrogen would you need?

e. If 8.0 moles of nitrogen react, how many grams of ammonia can be made?

f. How many moles of nitrogen do you need to make 78 g of ammonia?

g. How many grams of nitrogen do you need to make 78 moles of ammonia?

h. If you use 45 grams of hydrogen, how many moles of ammonia can you make?

i. How many grams of ammonia can you make from 12 g of hydrogen?

j. If you wanted to make 88 g of ammonia, how many grams of nitrogen would you need?

k. In the previous part, how many grams of hydrogen would you need?

l. If you make ammonia from 45 g of nitrogen, what mass of hydrogen would be needed?

m. (The above parts are all calculations involving the equation given above. Try to answer this part later, as you finish studying this chapter.) Consider part i, above, as an example. Would you expect the actual amount of ammonia you get to be what you calculated, or more, or less? Explain.

Answers

a. Given: mol of one chemical.
Wanted: mol of another chemical.
Path: mol → mol, using coefficients from the balanced equation.

$$6\ \cancel{\text{mol H}_2} \times \frac{2\ \text{mol NH}_3}{3\ \cancel{\text{mol H}_2}} = 4\ \text{mol NH}_3$$

b. 1.8 mol N_2

c. 14 mol H_2

d. 1.6 mol N_2

e. Path: mol N_2 (given) → mol NH_3 (from the equation) → g NH_3 (from the molar mass)

$$8.0\ \cancel{\text{mol N}_2} \times \frac{2\ \cancel{\text{mol NH}_3}}{1\ \cancel{\text{mol N}_2}} \times \frac{17\ \text{g NH}_3}{1\ \cancel{\text{mol NH}_3}} = 2.7\text{x}10^2\ \text{g NH}_3$$

f. 2.3 mol N_2

g. $1.1\text{x}10^3$ g N_2

h. 15 mol NH_3

i. Path: The question asks g H_2 → g NH_3. But the equation is in moles.
Therefore: g H_2 → mol H_2 → mol NH_3 → g NH_3.

$$12\ \cancel{\text{g H}_2} \times \frac{1\ \cancel{\text{mol H}_2}}{2\ \cancel{\text{g H}_2}} \times \frac{2\ \cancel{\text{mol NH}_3}}{3\ \cancel{\text{mol H}_2}} \times \frac{17\ \text{g NH}_3}{1\ \cancel{\text{mol NH}_3}} = 68\ \text{g NH}_3$$

j. $88\ \text{g NH}_3$
$\text{x} \ldots = 72\ \text{g N}_2$

k. 16 g H_2

l. 9.6 g H_2

Please let me know of any other topics for which it would be useful to have supplemental problem sets.