PRACTICE #2 LIMITING REAGENT/% COMPOSITION PROBLEMS

1. Solutions of sodium sulfate and lead(II)chloride are combined to produce solid lead(II)sulfate and sodium chloride solution.

   a. Write a balanced equation, using the proper phase symbols to represent all species.
   b. If the solutions contained 7.50 grams of sodium sulfate and 11.30 grams of lead(II)chloride, what is the limiting reagent?
   c. What amount, in grams, of the excess reagent is left over?
   d. If the reaction described above was performed experimentally and the % yield of lead(II)sulfate was 87.3%, what mass, in grams, of the solid was recovered?

2. Solutions of tin(IV)chloride and potassium dichromate are combined to produce solid tin(IV)dichromate and potassium chloride solution.

   a. Write a balanced equation, using the proper phase symbols to represent all species.
   b. If the solutions contained 9.13 grams of potassium dichromate and 12.73 grams of tin(IV)chloride, what is the limiting reagent?
   c. What amount, in grams, of the excess reagent is left over?
   d. If the reaction described above was performed experimentally and the % yield of tin(IV)dichromate was 93.1%, what mass, in grams, of the solid was recovered?

ANSWERS TO PROBLEMS:

1(A).
7.50g Na_2SO_4 (aq) + $PbCl_2$ (aq) → $PbSO_4$ (s) + 2NaCl (aq)

1(B).
We must test which reagent would make the least product. Since we are asked later about the mass of the solid produced, we will choose the solid as our product. The reagent making the most solid will identify the reagent that is in excess.

Test #1: 7.50 g Na_2SO_4 X 1mol Na_2SO_4/142.05 g X 1mol $PbSO_4$/1mol Na_2SO_4 X

303.3 g $PbSO_4$/mol $PbSO_4$ = 16.0 g of $PbSO_4$

Test #2: 11.30 g $PbCl_2$ X 1 mol $PbCl_2$/278.1 g X 1 mol $PbSO_4$/1 mol $PbCl_2$ X

303.3 g $PbSO_4$/mol $PbSO_4$ = 12.32 g of $PbSO_4$

We can see that 12.32 g is less than 16.0 so *$PbCl_2$ must be the limiting reagent*, while Na_2SO_4 is the reagent in excess.

1(C).
The excess reagent is Na_2SO_4. We started with 7.50 g of Na_2SO_4 and since it is in excess there must be some of it left after the reaction ceases. We take the original amount and subtract from it from the amount which reacted. The remainder is the excess portion. We can determine the amount reacted by relating it to the amount of solid product ($PbSO_4$) produced in Test 2. Remember: this is the test which identified the limiting reagent.

12.32 g $PbSO_4$ X 1 mol $PbSO_4$/303.0 g X 1 mol Na_2SO_4/1 mol $PbSO_4$ X 142.05 g/1 mol Na_2SO_4

= 5.770 grams of Na_2SO_4 used.

So, 7.50 g – 5.770 g = 1.73 g Na_2SO_4 is in excess.

1(D).
Experimental/Theoretical X 100 = % yield

The theoretical amount of $PbSO_4$ that could be produced was 12.32 grams.

So x g/12.32 g X 100 = 87.3% OR x g/12.32 g = .873% 12.32 X .873 = x = 10.8 grams

2(A).

$SnCl_4$ (aq) + $2K_2Cr_2O_7$ (aq) → $Sn(Cr_2O_7)_2$ (s) + 4KCl (aq)

2(B).

We must test which reagent would make the least product. Since we are asked later about the mass of the solid produced, we will choose the solid as our product. The reagent making the most solid will identify the reagent that is in excess.

Test #1: 9.13 g $K_2Cr_2O_7$ X 1mol $K_2Cr_2O_7$/294.20 g X 1mol $Sn(Cr_2O_7)_2$/2 mol $K_2Cr_2O_7$ X

550.71 g /mol $Sn(Cr_2O_7)_2$ = 8.55 g of $Sn(Cr_2O_7)_2$

Test #2: 12.73 g $SnCl_4$ X 1 mol $SnCl_4$/260.51 g X 1 mol $Sn(Cr_2O_7)_2$/1 mol $SnCl_4$ X

550.71 g /mol $Sn(Cr_2O_7)_2$ = 26.91 g of $Sn(Cr_2O_7)_2$

We can see that 8.55 g is less than 26.91 *so $K_2Cr_2O_7$ must be the limiting reagent*, while $SnCl_4$ is the reagent in excess.

2(C).

The excess reagent is $SnCl_4$. We started with 12.73 g of $SnCl_4$ and since it is in excess there must be some of it left after the reaction ceases. We take the original amount and subtract from it from the amount which reacted. The remainder is the excess portion. We can determine the amount reacted by relating it to the amount of solid product ($Sn(Cr_2O_7)_2$) produced in Test 2. Remember: this is the test which identified the limiting reagent.

8.55 g $Sn(Cr_2O_7)_2$ X 1 mol $Sn(Cr_2O_7)_2$/550.71 g X 1 mol $SnCl_4$/1 mol $Sn(Cr_2O_7)_2$ X

260.51 g/1 mol $SnCl_4$ = 4.04 grams of $SnCl_4$ used.

So, 12.73 g – 4.04 g = 8.69 g $SnCl_4$ is in excess.

2(D).

Experimental/Theoretical X 100 = % yield

The theoretical amount of $Sn(Cr_2O_7)_2$ that could be produced was 8.55 grams.

So x g/8.55 g X 100 = 93.1% OR x g/8.55 g = .931% 8.55 g X .931 = x = 7.96 grams