This is ACA # 11. It is OK to use your textbook, but if you can answers the questions without it that is OK too.

I recommend you print out this page and bring it to class. Click here to show a set of five ACA11 student responses, randomly selected from all of the student responses thus far, in a new window.

john , here are your responses to the ACA and the Expert's response.

1. When pentane, C_5H_{12}, is combusted in air, the products are carbon dioxide and water. When an amount of pentane and an amount of oxygen are mixed in a particular experiment 100. grams of carbon dioxide is produced.

a) Write a balanced chemical equation for the combustion of pentane.

C5H12(g) + 8O2(g) ---> 5CO2(g) + 6H2O(l) 70%

$C_5H_{12}(l) + 8O_2(g) \rightarrow 5CO_2(g) + 6H_2O(l)$

5% no O_2
14% wrong O_2 balance

b) How many moles of CO_2 are produced in the reaction?

18% 5 mol 2% use MM = 28 g mol^{-1} for CO_2

2.27 moles 64%

(100. grams CO_2*(1 mol CO_2/44.0 grams CO_2) = 2.27 moles CO_2)

c) How many moles of H_2O are produced in the reaction?

2.72 moles 40%

20% 6 4% 2.27 3% 1 2% 5.56 3% 5.45 2% 12

Initially the ICE table for this problem would look like this,

	REACTANTS	REACTANTS		PRODUCTS	PRODUCTS
Exp.	$C_5H_{125}(l)$ +	$8O_2(g)$	--->	$5CO_2(g)$	+ $6H_2O(s)$
Initial Amount	? mol	? mol		0 mol	0 mol
Change Amount					
Final Amount				2.27 mol	

Since we know the Initial amount of CO_2 and the final amount we can determine what the Change must be for CO_2.

	REACTANTS	REACTANTS		PRODUCTS	PRODUCTS
Exp.	$C_5H_{125}(l)$ +	$8O_2(g)$	--->	$5CO_2(g)$	+ $6H_2O(s)$
Initial Amount	? mol	? mol		0 mol	0 mol
Change Amount				2.27 mol	
Final Amount				2.27 mol	

To determine the amount of H_2O formed we must be sure the the ratio of CO_2 to H_2O in the Change row is the same as the coefficients in the balanced chemical equation. So we will use the conversion from the balanced equation to be sure the ratio in the Change row is upheld.
(2.27 mol CO_2(6 mol H_2O/5 mol CO_2) = 2.72 moles H_2O)

	REACTANTS	REACTANTS		PRODUCTS	PRODUCTS
Exp.	$C_5H_{125}(l)$ +	$8O_2(g)$	--->	$5CO_2(g)$	+ $6H_2O(s)$
Initial Amount	? mol	? mol		0 mol	0 mol
Change Amount				+2.27 mol	+2.72 mol
Final Amount				2.27 mol	+2.72 mol

Knowing the Initial amount and the Change we can determine the Final amount of mol H_2O.

d) Calculate the mass of pentane required to produce 100. grams of carbon dioxide.

32.7 grams 40%

8% 72.1 ~~mol~~ g
2% 164 g

To determine the moles of pentane (and oxygen) we must finish the Change row for the reactants. Again we must be sure that ratio in the Change row is the same as the ratio of the coefficients in the balanced chemical equation.

(2.27 mol CO_2(1 mol C_5H_{12}/5 mol CO_2) = 0.454 mol C_5H_{12})

The Change in the amount of water would be

(2.27 mol CO_2(8 mol O_2/5 mol CO_2) = 3.63 mol O_2)

	REACTANTS	REACTANTS		PRODUCTS	PRODUCTS
Exp.	$C_5H_{125}(l)$ +	$8O_2(g)$	--->	$5CO_2(g)$	+ $6H_2O(s)$
Initial Amount	? mol	? mol		0 mol	0 mol
Change Amount	-0.454 mol	-3.63 mol		+2.27 mol	+2.72 mol
Final Amount				2.27 mol	+2.72 mol

To determine the number of grams of pentane we need to multiply by the molar mass of pentane

(2.27 mol CO_2(1 mol C_5H_{12}/5 mol CO_2)(72.0 g C_5H_{12}/1 mol C_5H_{12}) = 32.7 grams C_5H_{12})

To finish off the ICE table we want to know how much pentane must have reacted to produce the 100 g of CO_2. See the ICe table completed below.

	REACTANTS	REACTANTS		PRODUCTS	PRODUCTS
Exp.	$C_5H_{125}(l)$ +	$8O_2(g)$	--->	$5CO_2(g)$	+ $6H_2O(s)$

Initial Amount	0.454 mol	3.63 mol		0 mol	0 mol
Change Amount	-0.454 mol	-3.63 mol		+2.27 mol	+2.72 mol
Final Amount	0 mol	0 mol		2.27 mol	+2.72 mol

2) Gallium (III) oxide is used in semiconductors, and is formed when elemental gallium reacts with oxygen according to the reaction;

$$4Ga(s) + 3O_2(g) \rightarrow 2Ga_2O_3(s)$$

In a particular experiment 45.0 g gallium are mixed with 15.0 g of oxygen and allowed to form the product. Complete the ICE Table below.

45.0 grams Ga*(1 mol Ga/69.72 grams Ga) = 0.645 moles Ga

15.0 grams O_2*(1 mol O_2/32.0 grams O_2) = 0.469 moles O_2

	REACTANTS	REACTANTS		PRODUCTS
Exp.	$4Ga(s)$	$3O_2(g)$	--->	$2Ga_2O_3(s)$
Initial Amount	0.645 68% 0.645 mole 7% 4 10% 45	5% 3 10% 13 g 0.469 44% 0.469 mole 23% .938		0 0 mol 91%
Change Amount	4% -4 -0.625 -0.625 mol 58%	-0.469 -0.469 mol 38%		+0.313 +0.313 mol 54%
Final Amount	37% 0 0.020 0.020 mol 32%	62% 0 0 mol		18% .326 0.313 +0.313 mol 32%

For the Change Row:

If we assume that the 0.645 mol of Ga completely react, then the moles of O_2 that must react are;

0.645 mole Ga*(3 mol O_2/4 mol Ga) = 0.484 moles O_2

Oops!! we only have 0.469 mol of O_2.....there is not enough, so O_2 is limiting the reaction. So O_2 is the limiting reagent and we must assume that all of the O_2 reacts. Therefore the moles of Ga that must react with 0.469 mol O_2 is;

0.469 mole O_2*(4 mol Ga/3 mol O_2) = 0.625 moles Ga

So now we can complete the Change Row.

a) Which substance is the limiting reagent?

57 wt% O_2 39% Ga

O2

O_2, oxygen

b) Calculate the mass O_2 remaining after the reaction is over

0 grams O_2

0 grams O_2 remain

c) Calculate the mass Ga remaining after the reaction is over.

1.39 grams Ga

0.020 moles Ga*(69.72 grams Ga/1 mol Ga) = 1.39 grams Ga 26% 30% O_2

3. Is there anything about the questions that you feel you do not understand? List your concerns/questions.

nothing

4. If there is one question you would like to have answered in lecture, what would that question be?

nothing