Problem Set #2

CHEM101A: General College Chemistry

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1 Topic A Problem 12

What mass of Fe_2O_3 would react with 20.00 g of Zn? The chemical equation for this reaction is:

$$3\,Zn + Fe_2O_3 \longrightarrow 2\,Fe + 3\,ZnO \tag{1}$$

1.1 Solution

The simple stoichiometry is the way to go here.

$$20.00\text{g} \times \frac{1\,\text{mol}\,Zn}{65.38\text{g}} \times \frac{1\,Fe_2O_3}{3\,Zn} \times \frac{159.7\,\text{g}\,Fe_2O_3}{1\,\text{mol}\,Fe_2O_3} = \boxed{16.28\,\text{g}\,Fe_2O_3} \tag{2}$$

2 Topic A Problem 13

x moles of C_4H_{10} reacts with oxygen according to the following equation:

$$2\,C_4H_{10} + 13\,O_2 \longrightarrow 8\,CO_2 + 10\,H_2O \tag{3}$$

a) How many moles of water are formed?
b) How many moles of oxygen are consumed?

2.1 Solution (a)

The ratio of C_4H_{10} used to H_2O created in this reaction is 1:5. With x moles of C_4H_{10}, that would gives us $\boxed{5x\,\text{mol}\,H_2O}$.

2.2 Solution (b)

The ratio of C_4H_{10} used to O_2 consumed in this reaction is 2:13. With x moles of C_4H_{10}, that would gives us $\boxed{\frac{13}{2}x\,\text{mol}\,O_2}$.

3 Topic A Problem 14

10.00 g of N_2 is mixed with 33.61 g of F_2, and the elements react according to the following equation:

$$N_2 + 3\,F_2 \longrightarrow 2\,NF_3 \tag{4}$$

a) Which element is the limiting reactant?
b) What is the theoretical yield of NF_3?
c) If the reaction goes to completion, how many grams of the excess reactant will remain?
d) Set up an ICE table for this reaction.

3.1 Solution (a)

First, we calculate the theoretical yields for each for the reactants.

$$m_{N_2} = 10.00\,g \times \frac{1\,mol\,N_2}{28.02\,g\,N_2} \times \frac{2\,NF_3}{1\,N_2} \times \frac{71.01\,g\,NF_3}{1\,mol\,NF_3} = 50.69\,g\,NF_3 \tag{5}$$

$$m_{F_2} = 33.61\,g \times \frac{1\,mol\,F_2}{38.00\,g\,F_2} \times \frac{2\,NF_3}{3\,F_2} \times \frac{71.01\,g\,NF_3}{1\,mol\,NF_3} = 41.87\,g\,NF_3 \tag{6}$$

With a lower final mass, $\boxed{F_2}$ is the limiting reactant.

3.2 Solution (b)

The theoretical yield was found in part (a). $\boxed{41.87\,g\,NF_3}$

3.3 Solution (c)

Use a similar strategy to part (a).

$$33.61\,g \times \frac{1\,mol\,F_2}{38.00\,g\,F_2} \times \frac{1\,N_2}{3\,F_2} \times \frac{28.02\,g\,N_2}{1\,mol\,N_2} = 8.261\,g\,NF_3 \tag{7}$$

Subtract this from the available mass of N_2 to get the final N_2.

$$10.00\,g\,N_2 - 8.261\,g\,N_2 = \boxed{1.74\,g\,N_2} \tag{8}$$

3.4 Solution (d)

I used tabular for this table. Please excuse any poor or improper formatting.

mol	N_2	$+\,3\,F_2$	$\longrightarrow 2\,NF_3$
I	0.3569	0.8844	0
C	-0.2948	-0.8844	0.5896
E	0.0621	0	0.5896

4 Topic A Problem 15

a) If 58.26 g of iodine reacts with excess aluminum, what is the theoretical yield of aluminum iodide? The reaction is $2\,\mathrm{Al} + 3\,\mathrm{I_2} \longrightarrow 2\,\mathrm{AlI_3}$.
b) If 56.11 g of aluminum iodide is actually formed in the reaction in part a, what is the percent yield of aluminum iodide?

4.1 Solution (a)

5 Topic A Problem 16

A chemist mixes 16.00 g of HCl with 10.00 g of Mg and obtains an 81.3% yield of $MgCl_2$. What mass of $MgCl_2$ did the chemist obtain? The chemical reaction is:

$$Mg + 2\,HCl \longrightarrow MgCl_2 + H_2 \tag{9}$$

5.1 Solution

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