Problem Set

page 1

(2) $(NH_4)_2Cr_2O_7 \Rightarrow Cr_2O_3 + 4H_2O + N_2$

$$1.4\ mol\ (NH_4)_2Cr_2O_7 \left(\frac{1\ mol\ Cr_2O_7}{1\ mol\ (NH_4)_2Cr_2O_7}\right) = \boxed{1.4\ mol\ Cr_2O_3}$$

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$H_2SO_4 + 2\ NaOH \Rightarrow 2H_2O + Na_2SO_4$

(3) $$520.\ g\ H_2SO_4 \left(\frac{1\ mol\ H_2SO_4}{98.1\ g\ H_2SO_4}\right)\left(\frac{2\ mol\ NaOH}{1\ mol\ H_2SO_4}\right) = \boxed{10.6\ mol\ NaOH}$$

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(4) $2C_6H_6 + 15O_2 \Rightarrow 12CO_2 + 6H_2O$

$$156.24\ g\ C_6H_6 \left(\frac{1\ mol\ C_6H_6}{78.0\ g\ C_6H_6}\right)\left(\frac{12\ mol\ CO_2}{2\ mol\ C_6H_6}\right)\left(\frac{44.0\ g\ CO_2}{1\ mol\ CO_2}\right) = \boxed{528.8\ g\ CO_2}$$

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(4) $2C_6H_6 + 15O_2 \Rightarrow 12CO_2 + 6H_2O$

$$8.5\ mol\ C_6H_6 \left(\frac{12\ mol\ CO_2}{2\ mol\ C_6H_6}\right)\left(\frac{6.02\times10^{23}\ molecules\ CO_2}{1\ mol\ CO_2}\right) = \boxed{3.07\times10^{25}\ molecules\ CO_2}$$

Volume – Volume Problems

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(17) $2CO(g) + O_2(g) \rightarrow 2CO_2(g)$

How many liters of oxygen are required to burn 3.86 L carbon monoxide?

2 steps

$$3.86\ L\ CO \left(\frac{1\ mol\ CO}{22.4\ L\ CO}\right)\left(\frac{1\ mol\ O_2}{2\ mol\ CO}\right) = 0.087\ mol\ O_2$$

$$0.087\ mol\ O_2 \left(\frac{22.4\ L\ O_2}{1\ mol\ O_2}\right) = \boxed{1.93\ L\ O_2}$$

or

one step.

$$3.86\ L\ CO \left(\frac{1\ mol\ CO}{22.4\ L\ CO}\right)\left(\frac{1\ mol\ O_2}{2\ mol\ CO}\right)\left(\frac{22.4\ L\ O_2}{1\ mol\ O_2}\right) = \boxed{1.93\ L\ O_2}$$

(25) p 370

$$C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(g)$$

If 2.70 mol C_2H_4 is reacted with 6.30 mol O_2, identify the limiting reagent.

$$2.70 \text{ mol } C_2H_4 \left(\frac{3 \text{ mol } O_2}{1 \text{ mol } C_2H_4}\right) = 8.1 \text{ mol } O_2 \text{ needed}$$

6.3 mol O_2 given

So.... O_2 is limiting

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(26) $Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$

What is the limiting reagent when 6.00 g HCl reacts with 5.00 g Mg?

$$6.00 \text{ g HCl} \left(\frac{1 \text{ mol HCl}}{36.5 \text{ g HCl}}\right)\left(\frac{1 \text{ mol Mg}}{2 \text{ mol HCl}}\right) = 0.082 \text{ mol Mg needed}$$

~~5.00~~ 0.206 mol Mg given

$$5.00 \text{ g Mg} \left(\frac{1 \text{ mol Mg}}{24.3 \text{ g Mg}}\right)\left(\frac{2 \text{ mol HCl}}{1 \text{ mol Mg}}\right) = 0.412 \text{ mol HCl needed}$$

~~0.206~~ 0.164 mol HCl given

Mg is excess

HCl is limiting

(27) p371

$$C_2H_4(g) + 2O_2(g) \Rightarrow 2CO(g) + 2H_2O(g)$$

If 2.70 mol C_2H_4 is reacted with 6.30 mol O_2

a) identify limiting

b) calculate moles of water produced

a) $2.70 \text{ mol } C_2H_4 \left(\frac{2 \text{ mol } O_2}{1 \text{ mol } C_2H_4}\right) =$ 5.40 mol O_2 needed; 6.30 mol O_2 given

O_2 in excess

$6.30 \text{ mol } O_2 \left(\frac{1 \text{ mol } C_2H_4}{2 \text{ mol } O_2}\right) = 3.15 \text{ mol } C_2H_4$

3.15 mol C_2H_4 needed; 2.70 mol C_2H_4 given

C_2H_4 is limiting

b) Using the limiting reactant

$$2.70 \text{ mol } C_2H_4 \left(\frac{2 \text{ mol } H_2O}{1 \text{ mol } C_2H_4}\right) = 5.40 \text{ mol } H_2O$$

(28)

$$2C_2H_2(g) + 5O_2(g) \rightarrow 4CO_2(g) + 2H_2O(g)$$

How many grams of water can be produced by the reaction of 2.40 mol C_2H_2 with 7.40 mol O_2?

FIRST – who is limiting?

$$2.40 \text{ mol } C_2H_2 \left(\frac{5 \text{ mol } O_2}{2 \text{ mol } C_2H_2}\right) = 6 \text{ mol } O_2 \text{ needed}$$

7.40 mol O_2 given

$\Downarrow$

O_2 in excess

$$7.40 \text{ mol } O_2 \left(\frac{2 \text{ mol } C_2H_2}{5 \text{ mol } O_2}\right) = 2.96 \text{ mol } C_2H_2 \text{ needed}$$

2.40 mol C_2H_2 given

$\Downarrow$

C_2H_2 is limiting

So...

$$2.40 \text{ } C_2H_2 \left(\frac{2 \text{ mol } H_2O}{2 \text{ mol } C_2H_2}\right)\left(\frac{18.0 \text{ g } H_2O}{1 \text{ mol } H_2O}\right) = 43.2 \text{ g } H_2O$$

Theoretical Yield

- the MAXIMUM AMOUNT of PRODUCT that will form DURING A REACTION

ACTUAL Yield

- the AMOUNT of PRODUCT that ACTUALLY forms when the reaction is carried out in a laboratory.

$$\text{Percent Yield} = \frac{\text{ACTUAL YIELD}}{\text{Theoretical Yield}} \times 100\%$$

p 374 Theoretical Yield Problems

(29) $Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$

When 84.8 g iron (III) oxide reacts with an excess of carbon monoxide, what is the TY of iron produced?

Fe_2O_3 is limiting

$$84.8\text{ g } Fe_2O_3 \left(\frac{1\text{ mol } Fe_2O_3}{159.6\text{ g } Fe_2O_3}\right)\left(\frac{2\text{ mol Fe}}{1\text{ mol } Fe_2O_3}\right)\left(\frac{55.8\text{ g Fe}}{1\text{ mol Fe}}\right) =$$

59.3 g Fe

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(30) $Cu(s) + 2AgNO_3(aq) \Rightarrow Cu(NO_3)_2(aq) + 2Ag(s)$

When 5.00 g Cu reacts with excess silver nitrate, what is the TY of Silver?

First, Cu is limiting

$$5.00\,g\,Cu\left(\frac{1\,mol\,Cu}{63.5\,g\,Cu}\right)\left(\frac{2\,mol\,Ag}{1\,mol\,Cu}\right)\left(\frac{107.9\,g\,Ag}{1\,mol\,Ag}\right) = \boxed{17.0\,g\,Ag}$$

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p. 375 % yield Problems

(31) $SiO_2(s) + 3C(s) \Rightarrow SiC(s) + 2CO(g)$

First, SiO_2 is limiting because they said you have an excess of carbon

$$50.0\,g\,SiO_2\left(\frac{1\,mol\,SiO_2}{60.1\,g\,SiO_2}\right)\left(\frac{1\,mol\,SiC}{1\,mol\,SiO_2}\right)\left(\frac{40.1\,g\,SiC}{1\,mol\,SiC}\right) = \boxed{33.4\,g\,SiC}$$

THEORETICAL YIELD

$$TY = 33.4\,g\,SiC$$

$$AY = 27.9\,g\,SiC$$

$$\frac{27.9}{33.4} = \boxed{83.5\,\%\ \text{yield SiC}}$$

(32) $N_2(g) + 3H_2(g) \Rightarrow 2NH_3(g)$

FIRST, determine limiting.

$$15.0\,g\,N_2\left(\frac{1\,mol\,N_2}{28.0\,g\,N_2}\right)\left(\frac{3\,mol\,H_2}{1\,mol\,N_2}\right) = 1.61\,mol\,H_2 \text{ needed}$$

$$15.0\,g\,H_2\left(\frac{1\,mol\,H_2}{2.0\,g\,H_2}\right) = 7.5\,mol\,H_2 \text{ given}$$

so H_2 is excess and N_2 is limiting

$$15.0\,g\,N_2\left(\frac{1\,mol\,N_2}{28.0\,g\,N_2}\right)\left(\frac{2\,mol\,NH_3}{1\,mol\,N_2}\right)\left(\frac{17.0\,g\,NH_3}{1\,mol\,NH_3}\right) = 18.2\,g\,NH_3$$

TY

10.5 g NH_3 ACTUAL YIELD

$$\frac{10.5\,g}{18.2\,g} = 57.7\,\%\ \text{Yield}$$

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(35) What is the % yield if 4.65 g of copper is produced when 1.87 g of aluminum reacts with an excess of copper (II) sulfate?

$$2\,Al(s) + 3\,CuSO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3\,Cu(s)$$

First, $CuSO_4$ is excess so Al is limiting.

$$1.87\text{ g Al}\left(\frac{1\text{ mol Al}}{27.0\text{ g Al}}\right)\left(\frac{3\text{ mol Cu}}{2\text{ mol Al}}\right)\left(\frac{63.5\text{ g Cu}}{1\text{ mol Cu}}\right) = \boxed{6.6\text{ g Cu}}$$

Theoretical Yield

$$\text{Actual Yield} = \frac{4.65\text{ g Cu}}{6.6\text{ g Cu}} = \boxed{70.5\%\text{ Yield}}$$