Key

Worksheet: Limiting Reactants

1. Nitrogen gas can be prepared by passing ammonia over hot copper (II) oxide according to the equation

$$3\ CuO\ (s) + 2\ NH_3\ (g) \rightarrow N_2\ (g) + 3\ Cu\ (s) + 3\ H_2O\ (g)$$

How many moles of N_2 are prepared from the following mixtures?

(a) 3.00 mol of CuO and 3.00 mol of NH_3

3 mol NH_3 x 1 mol N_2 / 2 mol NH_3 = 1.5 mol N_2 3 mol CuO x 1 mol N_2 / 3 mol CuO = **1 mol N_2**

(b) 3.00 mol of CuO and 2.00 mol of NH_3

" 1 mol " 1 mol **1 mol N_2**

(c) 3.00 mol of CuO and 1.00 mol of NH_3

" 1 mol " 0.5 mol **0.500 mol N_2**

(d) 0.628 mol of CuO and 0.430 mol of NH_3

0.628 mol x 1 mol N_2 / 3 mol CuO = **0.210 mol** 0.430 mol x 1 mol N_2 / 2 mol NH_3 = 0.215 mol

(e) 5.44 mol of CuO and 3.50 mol of NH_3

5.44 mol x 1 mol / 3 mol = 1.81 3.50 mol NH_3 x 1 mol / 2 mol = **1.75 mol**

2. How many moles remain of the reactant in excess in (a) and (c) of problem 1?

0.5 mol x 2 mol NH_3 / 1 mol N_2

a.) 3 mol NH_3 / 1.5 mol N_2 = x NH_3 / 1 mol N_2 = 2 mol NH_3 needed 3 mol - 2 mol = 1 mol excess

0.5 mol N_2 x 3 mol CuO / 1 mol N_2

c.) 3 mol CuO / 1 mol N_2 = x CuO / 0.5 mol N_2 = 1.5 mol 3 mol - 1.5 mol = 1.5 mol excess

3. Consider the equation

$$2\ Al + 3\ H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3\ H_2$$

0.800 mol 1.00 mol ? mol

If 0.800 mole of Al is mixed with 1.00 mol of H_2SO_4, how many moles of H_2 are produced? How many moles of one of the reactants remain?

0.800 mol Al x 3 mol H_2 / 2 mol Al = 1.2 mol H_2 0.800 Al / 1.2 H_2 = x Al / 1.00 mol H_2

x = 0.667 mol

1.00 mol H_2SO_4 x 3 mol / 3 mol = **1.00 mol H_2**

0.8 - 0.667 = **0.133 mol Al left**

0.20 mol H_2 x 2 mol Al / 3 mol H_2 = 0.133 mol

4. Consider the equation

$$2\,C_5H_6 + 13\,O_2 \rightarrow 10\,CO_2 + 6\,H_2O$$

If 3.44 mol of C_5H_6 is mixed with 20.6 mol of O_2, what mass of CO_2 is formed?

3.44 mol C5H6 × 10 mol CO2 / 2 mol = 17.2 mol CO2

20.6 mol O2 × 10 mol / 13 mol = 15.85 mol CO2 × 44 g / 1 mol = 697 g CO2

5. Consider the equation

$$4\,NH_3\,(g) + 3\,O_2\,(g) \rightarrow 2\,N_2\,(g) + 6\,H_2O\,(l)$$

If a 40.0 g sample of O_2 is mixed with 1.50 mol of NH_3, which is the limiting reactant? How many moles of N_2 form?

40.0 g O2 × 1 mol / 32 g × 2 mol N2 / 3 mol O2 = 0.833 mol

1.50 mol NH3 × 2 mol N2 / 4 mol NH3 = 0.75 mol N2

NH3 is limiting

6. Consider the equation

0.064 mol AgCl × 1 mol CaCl2 / 2 mol AgCl × 110 g / 1 mol

3.52 g CaCl2

mol

0.091 mol

$$2\,AgNO_3\,(aq) + CaCl_2\,(aq) \rightarrow 2\,AgCl\,(s) + Ca(NO_3)_2\,(aq)$$

20.0 g 10.0 g ? g

If a solution containing 20.0 g of $AgNO_3$ is mixed with a solution containing 10.0 g of $CaCl_2$, which compound is the limiting reactant? What mass of AgCl forms? What mass of one of the reactants remains?

Ca 40
Cl + 70
110

Ag 108
Cl + 35
143

10.0 g CaCl2 × 1 mol / 110 g × 2 mol AgCl / 1 mol CaCl2 = 0.182 mol

Ag 108
N 14
O + 48
170

20.0 g AgNO3 × 1 mol / 170 g × 2 mol AgCl / 2 mol = 0.118 mol × 143 g AgCl / 1 mol = 16.9 g AgCl

0.091 mol CaCl2 / 0.182 mol AgCl = x / 0.118 mol AgCl

AgNO3 is limiting

x = 0.059 mol CaCl2 needed

3.52 g CaCl2

0.091 − 0.059 = 0.032 mol × 110 g / 1 mol =

H 1
N 14
O + 48
63

H 2
S + 32
34

N 14
O + 16
30

7. Consider the balanced equation

H_2S is limiting

$$2\,HNO_3\,(aq) + 3\,H_2S\,(aq) \rightarrow 2\,NO\,(g) + 4\,H_2O\,(l) + 3\,S\,(s)$$

10.0g 5.00g ?g ?g ?g

If a 10.0 g quantity of HNO_3 is mixed with 5.00 g of H_2S, what are the masses of each product and of the reactant present in excess after the reaction occurs?

$10.0g\ HNO_3 \times \frac{1mol}{63g} \times \frac{2mol}{2mol} = 0.159\ mol\ NO$

$5.00g\ H_2S \times \frac{1mol}{34\ g} \times \frac{2mol}{3mol} = 0.0980\ mol\ NO \times \frac{30g}{1mol} =$ **2.94g NO**

$= 0.147\ mol\ H_2S \times \frac{4mol}{3mol} \times \frac{18g}{1mol} =$ **3.53 g H_2O**

$0.147\ mol\ H_2S \times \frac{3mol}{3mol} \times \frac{32g}{1mol} =$ **4.70gS**

$0.147\ mol\ H_2S \times \frac{2mol}{3mol} \times \frac{63g\ HNO_3}{1mol}$

6.17g HNO_3

10.0g − 6.17g = **3.83g HNO_3 left**

see below for other method

8. Photosynthesis is a complex process composed of many steps. The initial reactants are carbon dioxide and water, and the final products are glucose ($C_6H_{12}O_6$) and oxygen. If a plant needs to make 30.0 g of glucose through photosynthesis, how many grams of water are needed? (Hint: How many mLs of water?)

C 6(12) = 72
H 12(1) = 12
O 6(16) = 96
180

$$6\,CO_2 + 6\,H_2O \rightarrow C_6H_{12}O_6 + 6\,O_2$$

?g 30g

$30g\ C_6H_{12}O_6 \times \frac{1mol}{180g} \times \frac{6\,mol\ H_2O}{1mol} \times \frac{18g}{1mol} =$ **18.0g H_2O**

0.159
−0.0980

$0.061\ mol\ NO \times \frac{2\,mol\ NO}{2\,mol\ HNO_3} \times \frac{63g}{1mol} =$ **3.84 g HNO_3 left**