Homework Set 6 Solutions

(Distributed 10/12/15; Due on 10/19/16)

Read Chapters 9 & 10 in Zumdahl and complete the listed questions from the text: Chapter 9: 19, 30, 36, 40, 42, 49; Chapter 10: 23, 42, 44; as well as the following problems:

A. In the production of superconductors, the reaction shown is being studied:

$$Tl_2O_3 + \mathbf{2}\ BaO + 3\ CaO + 4\ CuO \text{ ----------> } Tl_2Ba_2Ca_3Cu_4O_{12}$$

What mass of the product can be made using 5.0 g of CaO and the necessary amounts of the other reagents?

5.0 g x 1mole/56 g = 0.089 moles CaO x 1 mole $Tl_2Ba_2Ca_3Cu_4O_{12}$/3 moles **CaO = 0.030 moles x 1082.52 g/mole = 32.2 g**

B. The Sabatier reaction uses hydrogen gas to generate water on Space stations:

$$CO_2(g) + 4\ H_2(g) \text{ ----------> } H_2O(l) + CH4(g)$$

How many grams of water can be made when 2.0 Liters of hydrogen (density = 0.070 g/L) is used?

2.0 L x 0.070 g/L = 0.14 g H2 x 1 mole H2O/4 moles H2 = 0.035 moles H2O x 18 g/mole = 0.63 grams H2O

C. Antacids, such as $CaCO_3$, are used to neutralize excess stomach acid, HCl:

$$CaCO_3 + 2\ HCl \text{ ----------> } CaCl_2 + CO_2 + H2O$$

How many grams of HCl are neutralized by 400 mg of $CaCO_3$? How many grams of CO2 is produced?

400 mg x 1 g/1000 mg = 0.4 g x 1 mole/100 g = 0.004 moles $CaCO_3$ x 2 moles HCl/1 mole CaCO3 = 0.008 moles HCl = 0.29 g
0.004 moles $CaCO_3$ x 1 mole CO2/1 mole $CaCO_3$ = 0.004 moles CO_2 x 44 g/mol = 0.176 g

D. Butane combusts with oxygen to generate carbon dioxide and water. It is a volatile fuel often used in camping stoves:

$2\ C_4H_{10} + 13\ O_2 \text{ ----------> } 8\ CO_2 + 10\ H_2O + 5756$ kJoules

If 7.0 g of butane in gasoline combusts, how much heat energy is released?

7.0 g x 1 mole/58 g = 0.121 moles
5756 kJ/2 moles C4H10 x 0.121 moles = 347.4 kJ

Problems from Zumdahl:
Chapter 9:
19. (a) 0.148 moles (b) 8.97×10^{-6} moles (c) 32.7 moles
(d) 5.55×10^{-6} moles (e) 139 moles

30. 0.959 g Na_2CO_3

36. 8.62 kg Hg

40. 1 lb CO2 x 1 kg/2.2 lb x 1000g/kg = 454.5 g CO2
454.4 g x 1 mole/44g x 2 mol C8H18/16 mol CO2 = 1.29 moles C8H18
1.29 moles C8H18 x 114 g/mole x 1 mL/0.75 g = 196.3 mL
196.3 mL x 1 L/1000 mL x 1 Gal/3.78 L = 0.052 Gal/mile or 19.3 miles per Gallon

42. Calculate the number of moles of each reagent and compare to the molar ratio determined by the coefficient of the balanced equation.

49 (a) UO_2 is limiting; 1.16 g UF_4 and 0.133 g H_2O
(b) $NaNO_3$ is limiting; 0.836 g Na_2SO_4 0.741 g HNO_3
(c) HCl is limiting; 1.87 g $ZnCl_2$ 0.0276 g H_2
(d) CH3OH is the limiting reagent 1.08 g $B(OCH_3)_3$ 0.562 g H_2O

Chapter 10:
23. 25.2 kJ

42. (1) –9.23 kJ (b) –148 kJ (c) +296 kJ/mole

44. (a) –29.5 kJ (b) ΔH = –1360 kJ (c) 453 kJ/mole H_2O