Chapters 8 Study Questions

1. Chromium reacts with hydrochloric acid in a single replacement reaction. The balanced equation is:

$$2\ Cr(s) + 6\ HCl(aq) \rightarrow 2\ CrCl_3(aq) + 3\ H_2(g)$$

a) How many moles of HCl are needed to produce 1.60 moles of $CrCl_3$?
b) How many grams of Cr are needed to produce 3.20 g H_2?
c) In an experiment, 10.2 grams of $CrCl_3$ are produced starting from 8.30 grams of HCl. What was the theoretical yield and the percent yield in this experiment?
d) When 6.0 moles of Cr are combined with 12.0 moles of HCl, which reactant is limiting? How many moles of excess reactant are left over?
e) How many grams of $CrCl_3$ are produced starting from 13.0 g of Cr and 43.8 g of HCl?

2. Octane undergoes complete combustion to form carbon dioxide and water.

$$2\ C_8H_{18}(l) + 25\ O_2(g) \rightarrow 16\ CO_2(g) + 18\ H_2O(l)$$

a) How many moles of oxygen are required to burn 1.00 mole of octane?
b) What mass of CO_2 is produced when 4.77 grams of oxygen gas are used up?
c) How many grams of CO_2 are produced from 11.4 g C_8H_{18} and 32.0 g O_2?
d) In an experiment, 2.28 g C_8H_{18} produced 2.43 g of H_2O. What is the theoretical yield (the amount of H_2O expected from 2.28 g C_8H_{18})? What is the percent yield?

Summary of Chapter 8: Quantities in Chemical Reactions

Calculations from a balanced chemical equation:
- mole relationships between reactants and products
- mass relationships between reactants and products

limiting reactant
theoretical yield
actual yield
calculating percent yield
enthalpy of reactions

Answers to Chapters 8 Study Questions

1. a) $1.60 \text{ mol } CrCl_3 \times \frac{6 \text{ mol } HCl}{2 \text{ mol } CrCl_3} = 4.80 \text{ moles } HCl$

b) $3.20 \text{ g } H_2 \times \frac{1 \text{ mol } H_2}{2.016 \text{ g } H_2} \times \frac{2 \text{ mol } Cr}{3 \text{ mol } H_2} \times \frac{52.0 \text{ g } Cr}{1 \text{ mol } Cr} = 55.0 \text{ g } Cr$

c) $8.30 \text{ g } HCl \times \frac{1 \text{ mol } HCl}{36.46 \text{ g } HCl} \times \frac{2 \text{ mol } CrCl_3}{6 \text{ mol } HCl} \times \frac{158.35 \text{ g } CrCl_3}{1 \text{ mol } CrCl_3} = 12.0 \text{ g } CrCl_3$

theoretical yield = 12.0 g $CrCl_3$

$\% \text{ Yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\% = \frac{10.2 \text{ g}}{12.0 \text{ g}} \times 100\% = 85.0\%$

d) $6.0 \text{ moles } Cr \times \frac{2 \text{ mol } CrCl_3}{2 \text{ mol } Cr} = 6.0 \text{ moles } CrCl_3$

$12.0 \text{ moles } HCl \times \frac{2 \text{ mol } CrCl_3}{6 \text{ mol } HCl} = 4.0 \text{ moles } CrCl_3$; therefore, HCl is limiting

$4.0 \text{ moles } CrCl_3 \times \frac{2 \text{ mol } Cr}{2 \text{ mol } CrCl_3} = 4.0$ moles Cr used up.

6.0 - 4.0 = 2.0 moles Cr left over.

e) $13.0 \text{ g } Cr \times \frac{1 \text{ mol } Cr}{52.0 \text{ g } Cr} \times \frac{2 \text{ mol } CrCl_3}{2 \text{ mol } Cr} \times \frac{158 \text{ g } CrCl_3}{1 \text{ mol } CrCl_3} = 39.5 \text{ g } CrCl_3$

$43.8 \text{ g } HCl \times \frac{1 \text{ mol } HCl}{36.5 \text{ g } HCl} \times \frac{2 \text{ mol } CrCl_3}{6 \text{ mol } HCl} \times \frac{158 \text{ g } CrCl_3}{1 \text{ mol } CrCl_3} = 63.2 \text{ g } CrCl_3$

since 39.5 g < 63.2 g, 39.5 g $CrCl_3$ is produced.

2. a) $1.00 \text{ mol } C_8H_{18} \times \frac{25 \text{ mole } O_2}{2 \text{ mole } C_8H_{18}} = 12.5 \text{ mol } O_2$

b) $4.77 \text{ g } O_2 \times \frac{1 \text{ mole } O_2}{32.0 \text{ g } O_2} \times \frac{16 \text{ mole } CO_2}{25 \text{ mole } O_2} \times \frac{44.0 \text{ g } CO_2}{1 \text{ mole } CO_2} = 4.20 \text{ g } CO_2$

c) $11.4 \text{ g } C_8H_{18} \times \frac{1 \text{ mole } C_8H_{18}}{114 \text{ g } C_8H_{18}} \times \frac{16 \text{ mole } CO_2}{2 \text{ mole } C_8H_{18}} \times \frac{44.0 \text{ g } CO_2}{1 \text{ mole } CO_2} = 35.2 \text{ g } CO_2$

$32.0 \text{ g } O_2 \times \frac{1 \text{ mole } O_2}{32.0 \text{ g } O_2} \times \frac{16 \text{ mole } CO_2}{25 \text{ mole } O_2} \times \frac{44.0 \text{ g } CO_2}{1 \text{ mole } CO_2} = 28.2 \text{ g } CO_2$

Since 28.2 g is less than 35.2 g, 28.2 g CO_2 are produced.

d) 2.28 g C_8H_{18} $x \frac{1\, mole\, C_8H_{18}}{114\, g\, C_8H_{18}} x \frac{18\, mole\, H_2O}{2\, mole\, C_8H_{18}} x \frac{18.0\, g\, H_2O}{1\, mole\, H_2O}$ = 3.24 g H_2O

The theoretical yield is 3.24 g H_2O

percent yield = $\frac{actual\ yield}{theoretical\ yield} \times 100\% = \frac{2.43\, g}{3.24\, g} \times 100\%$ = 75.0%