Answers: Moles and Stoichiometry Practice Problems

1) How many moles of sodium atoms correspond to 1.56×10^{21} atoms of sodium?

$$1.56 \times 10^{21} \text{ atoms Na} \times \frac{1 \text{ mol Na}}{6.022 \times 10^{23} \text{ atoms Na}} = 2.59 \times 10^{-3} \text{ mol Na}$$

2) Determine the mass in grams of each of the following:

a. 1.35 mol of Fe

$$1.35 \text{ mol Fe} \times \frac{55.845 \text{ g Fe}}{1 \text{ mol Fe}} = 75.4 \text{ g Fe}$$

b. 24.5 mol O

$$24.5 \text{ mols O} \times \frac{15.999 \text{ g O}}{1 \text{ mol O}} = 392 \text{ g O}$$

c. 1.25 mol $Ca_3(PO_4)_2$

$$1.25 \text{ mols } Ca_3(PO_4)_2 \times \frac{310.174 \text{ g } Ca_3(PO_4)_2}{1 \text{ mol } Ca_3(PO_4)_2} = 388 \text{ g } Ca_3(PO_4)_2$$

d. 0.625 mol $Fe(NO_3)_3$

$$0.625 \text{ mols } Fe(NO_3)_3 \times \frac{241.857 \text{ g } Fe(NO_3)_3}{1 \text{ mol } Fe(NO_3)_3} = 151 \text{ g } Fe(NO_3)_3$$

e. 0.600 mol C_4H_{10}

$$0.600 \text{ mols } C_4H_{10} \times \frac{58.124 \text{ g } C_4H_{10}}{1 \text{ mol } C_4H_{10}} = 34.9 \text{ g } C_4H_{10}$$

3) Calculate the number of moles of each compound:

a. 21.5g $CaCO_3$

$$21.5 \text{ g } CaCO_3 \times \frac{1 \text{ mol } CaCO_3}{100.086 \text{ g } CaCO_3} = 0.215 \text{ mol } CaCO_3$$

b. 1.56g NH_3

$$1.56 \text{ g } NH_3 \times \frac{1 \text{ mol } NH_3}{17.031 \text{ g } NH_3} = 0.0916 \text{ mol } NH_3$$

c. 16.8g $Sr(NO_3)_2$

$$16.8 \text{ g } Sr(NO_3)_2 \times \frac{1 \text{ mol } Sr(NO_3)_2}{211.658 \text{ g } Sr(NO_3)_2} = 0.0794 \text{ mol } Sr(NO_3)_2$$

4) How many moles of Al are needed to combine with 1.58 mol of O_2 to make aluminum oxide, Al_2O_3?

$4\ Al\ (s) + 3\ O_2\ (g) \rightarrow 2\ Al_2O_3\ (s)$

$$1.58 \text{ mol } O_2 \times \frac{4 \text{ mol Al}}{3 \text{ mol } O_2} = 2.11 \text{ mol Al}$$

5) How many moles of Al are in 2.16 mol of Al_2O_3?

There are 2 Al atoms for each Al_2O_3 formula unit

2.16 mol $Al_2O_3 \times 2 = 4.32$ mol Al

6) How many moles of H_2 and N_2 can be formed by the decomposition of 0.145 mol of ammonia, NH_3?
Balanced equation

$$2NH_3\,(g) \xrightarrow{\Delta} 3H_2\,(g) + N_2\,(g)$$

$$0.145\ \text{mol } NH_3 \times \frac{3\ \text{mol } H_2}{2\ \text{mol } NH_3} = 0.218\ \text{mol } H_2$$

$$0.145\ \text{mol } NH_3 \times \frac{1\ \text{mol } N_2}{2\ \text{mol } NH_3} = 0.0725\ \text{mol } N_2$$

7) What is the total number of atoms in 0.260 mol of glucose, $C_6H_{12}O_6$

$$0.260\ \text{mol } C_6H_{12}O_6 \times \frac{6.02 \times 10^{23}\ \text{molecules } C_6H_{12}O_6}{1\ \text{mol } C_6H_{12}O_6} \times \frac{24\ \text{atoms}}{1\ \text{molecule } C_6H_{12}O_6} = 3.76 \times 10^{24}\ \text{atoms}$$

(24 atoms in each molecule)

8) Chlorine is used by textile manufacturers to bleach cloth. Excess chlorine is destroyed by its reaction with sodium thiosulfate, $Na_2S_2O_3$:

$$Na_2S_2O_{3(aq)} + 4Cl_{2(g)} + 5H_2O_{(aq)} \rightarrow 2NaHSO_{4(aq)} + 8HCl_{(aq)}$$

a. How many moles of $Na_2S_2O_3$ are needed to react with 0.12mol of Cl_2?

$$0.12\ \text{mol } Cl_2 \times \frac{1\ \text{mol } Na_2S_2O_3}{4\ \text{mol } Cl_2} = 0.030\ \text{mol } Na_2S_2O_3$$

b. How many moles of HCl can form from 0.12mol of Cl_2?

$$0.12\ \text{mol } Cl_2 \times \frac{8\ \text{mol HCl}}{4\ \text{mol } Cl_2} = 0.24\ \text{mol HCl}$$

c. How many moles of H_2O are required for the reaction of 0.12mol of Cl_2?

$$0.12\ \text{mol } Cl_2 \times \frac{5\ \text{mol } H_2O}{4\ \text{mol } Cl_2} = 0.15\ \text{mol } H_2O$$

d. How many moles of H_2O react if 0.24mol HCl is formed?

$$0.24\ \text{mol HCl} \times \frac{5\ \text{mol } H_2O}{8\ \text{mol HCl}} = 0.15\ \text{mol } H_2O$$

9) The incandescent white of a fireworks display is caused by the reaction of phosphorous with O_2 to give P_4O_{10}.

a. Write the balanced chemical equation for the reaction.

$$P_4\,(s) + 5O_2\,(g) \rightarrow P_4O_{10}\,(g)$$

b. How many grams of O_2 are needed to combine with 6.85g of P_4?

$$6.85\ \text{g } P_4 \times \frac{1\ \text{mol } P_4}{123.896\text{g } P_4} \times \frac{5\ \text{mol } O_2}{1\ \text{mol } P_4} \times \frac{31.998\text{g} O_2}{1\ \text{mol } O_2} = 8.85\ \text{g } O_2$$

c. How many grams of P_4O_{10} can be made from 8.00g of O_2?

$$8.00\ \text{g } O_2 \times \frac{1\ \text{mol } O_2}{31.998\ \text{g } O_2} \times \frac{1\ \text{mol } P_4O_{10}}{5\ \text{mol } O_2} \times \frac{283.886\text{g } P_4O_{10}}{1\ \text{mol } P_4O_{10}} = 14.2\ \text{g } P_4O_{10}$$

d. How many grams of P are needed to make 7.46g P_4O_{10}?

$$7.46\ \text{g } P_4O_{10} \times \frac{1\ \text{mol } P_4O_{10}}{283.886\ \text{g} P_4O_{10}} \times \frac{1\ \text{mol } P_4}{1\ \text{mol } P_4O_{10}} \times \frac{123.896\ \text{g } P_4}{1\ \text{mol } P_4} = 3.26\ \text{g } P_4$$

10) In dilute nitric acid, HNO_3, copper metal dissolves according to the following equation:

$$3Cu_{(s)} + 8HNO_{3(aq)} \rightarrow 3Cu(NO_3)_{2(aq)} + 2NO_{(g)} + 4H_2O_{(aq)}$$

How many grams of HNO_3 are needed to dissolve 11.45g of Cu?

$$11.45\text{ g Cu} \times \frac{1\text{ mol Cu}}{63.546\text{ g Cu}} \times \frac{8\text{ mol }HNO_3}{3\text{ mol Cu}} \times \frac{63.012\text{ g }HNO_3}{1\text{ mol }HNO_3} = 30.28\text{ g }HNO_3$$

11) The reaction of powdered aluminum and iron(II)oxide,

$$2Al_{(s)} + Fe_2O_{3(s)} \rightarrow Al_2O_{3(s)} + 2Fe_{(l)}$$

produces so much heat the iron that forms is molten. Because of this, railroads use the reaction to provide molten steel to weld steel rails together when laying track. Suppose that in one batch of reactants 4.20mol Al was mixed with 1.75mol Fe_2O_3.

a. Which reactant, if either, was the limiting reactant?

4.20 mol Al /2 = 2.10

1.75 mol Fe_2O_3 /1 = 1.75 mol → smaller number, LR

b. Calculate the mass of iron (in grams) that can be formed from this mixture of reactants.

$$1.75\text{ mol }Fe_2O_3 \times \frac{2\text{ mol Fe}}{1\text{ mol }Fe_2O_3} \times \frac{55.845\text{ g Fe}}{1\text{ mol Fe}} = 195\text{ g Fe}$$

12) Silver nitrate, $AgNO_3$, reacts with iron(III) chloride, $FeCl_3$, to give silver chloride, AgCl, and iron(III) nitrate, $Fe(NO_3)_3$. A solution containing 18.0g $AgNO_3$ was mixed with a solution containing 32.4g $FeCl_3$. How many grams of which reactant *remains* after the reaction is over?

Balanced equation

$$3AgNO_{3\ (aq)} + FeCl_{3\ (aq)} \rightarrow 3AgCl_{\ (s)} + Fe(NO_3)_{3\ (aq)}$$

Determine the limiting reagent

18.0g $AgNO_3$ / 169.872 g/mol = 0.10596 mol / 3 = 0.03532 → smaller #, LR

34.2g $FeCl_3$ / 162.204 g/mol = 0.2108 mol / 1 = 0.2108

$$18.0\text{g }AgNO_3 \times \frac{1\text{ mol }AgNO_3}{169.872\text{g }AgNO_3} \times \frac{1\text{ mol }FeCl_3}{3\text{ mol }AgNO_3} \times \frac{162.204\text{g }FeCl_3}{1\text{ mol }FeCl_3} = 5.73\text{ g }FeCl_3$$

Therefore 32.4g – 5.73g = 26.7g $FeCl_3$ remains after the reaction is over.