Chemistry 11 Stoichiometry Worksheet 2

Name: Key

1. Solve the following stoichiometry problems. Write a balanced equation for each.

a) How many grams of aluminum are required to produce 415 g of aluminum oxide, through reaction with oxygen gas? Equation: $4Al_{(s)} + 3O_{2(g)} \rightarrow 2Al_2O_{3(s)}$

$415\,g\ Al_2O_3 \times \frac{1\ mol}{102.0\,g} = 4.069\ mol\ Al_2O_3$

$4.069\ mol\ Al_2O_3 \times \frac{4\ mol\ Al}{2\ mol\ Al_2O_3} = 8.137\ mol\ Al$

$8.137\ mol\ Al \times 27.0\,g/mol = 219.7\,g$ 220. g (3 sf.)

b) How many grams of solid iodine are produced by the decomposition of 25.4 grams of hydrogen iodide gas? Equation: $2HI_{(g)} \rightarrow H_{2(g)} + I_{2(g)}$

$25.4\,g\ HI \times \frac{1\ mol}{127.9\,g} = 0.1986\ mol\ HI$

$0.1986\ mol\ HI \times \frac{1\ mol\ I_2}{2\ mol\ HI} = 0.09930\ mol\ I_2$

$0.09930\ mol\ I_2 \times 253.8\,g/mol = 25.20\,g$ 25.2 g (3 sf)

2. Aluminum oxide is made by burning 1.37 g. of solid aluminum.

a) What is the balanced chemical equation for this reaction?

$4\,Al_{(s)} + 3O_{2(g)} \rightarrow 2Al_2O_{3(s)}$

b) How many moles of solid aluminum are burned?

$1.37\,g \times \frac{1\ mol}{27.0\,g} = 0.0507\ moles\ Al$

c) If all the aluminum reacts how many moles of aluminum oxide are formed?

$0.0507\ mol\ Al \times \frac{2\ mol\ Al_2O_3}{4\ mol\ Al} = 0.0254\ mol\ Al_2O_3$

d) What mass of aluminum oxide product would you expect?

$0.0254\ mol\ Al_2O_3 \times \frac{102.0\,g}{1\ mol} = 2.59\,g\ Al_2O_3$

Copper (I) iodide is not stable, so it is generally made just before using. Copper (I) iodide can be made by the following reaction: $2\ CuSO_4 + 4\ HI \rightarrow 2\ CuI + 2\ H_2SO_4 + I_2$
If 10.4 g of $CuSO_4$ are used:

a) Calculate the number of grams of HI needed to react completely with the copper (II) sulphate.

$10.4\,g\ CuSO_4 \times \frac{1\ mol}{159.7\,g} = 0.06512\ mol\ CuSO_4$

$0.06512\ mol\ CuSO_4 \times \frac{4\ mol\ HI}{2\ mol\ CuSO_4} = 0.1302\ mol\ HI$

$0.1302\ mol\ HI \times \frac{127.9\,g}{1\ mol} = 16.7\,g\ HI$

b) Calculate the number of grams of copper (I) iodide formed.

$0.06512\ mol\ CuSO_4 \left(\frac{2\ mol\ CuI}{2\ mol\ CuSO_4}\right) = 0.06512\ mol\ CuI$

$0.06512\ mol\ CuI \times \frac{190.5}{1\ mol} = 12.4\,g\ CuI$

c) Calculate the mass of iodine produced.

$0.06512\ mol\ CuSO_4 \times \frac{1\ mol\ I_2}{2\ mol\ CuSO_4} = 0.03256\ mol\ I_2$

$0.03256\ mol\ I_2 \times \frac{253.8\,g}{1\ mol} = 8.26\,g\ I_2$

Key

4. Aluminum chloride and hydrogen gas are produced when aluminum is reacted with an excess of hydrogen chloride.

a) What is the balanced chemical equation for this reaction?

$$2\,Al_{(s)} + 6\,HCl_{(g)} \longrightarrow 2\,AlCl_{3(s)} + 3\,H_{2(g)}$$

b) How many grams of aluminum must be used to produce 30.0 grams of aluminum chloride?

$30.0\text{ g } AlCl_3 \times \frac{1\text{ mol}}{133.5\text{ g}} = 0.2247\text{ mol } AlCl_3$

$0.2247\text{ mol } AlCl_3 \times \frac{2\text{ mol Al}}{2\text{ mol } AlCl_3} = 0.2247\text{ mol Al}$

$0.2247\text{ mol Al} \times \frac{27.0\text{ g}}{1\text{ mole}} = \underline{6.07\text{ g}}$

5. 1.6 g. of H_2 and 36.0 g. of O_2 react to make water.

a) What is the balanced chemical equation for this reaction?

$$2\,H_{2(g)} + O_{2(g)} \longrightarrow 2\,H_2O_{(l)}$$

b) Which is the limiting reactant?

$1.6\text{ g } H_2 \times \frac{1\text{ mol}}{2.0\text{ g}} = 0.800\text{ mol } H_2$

$36.0\text{ g } O_2 \times \frac{1\text{ mol}}{32.0\text{ g}} = 1.125\text{ mol } O_2$

Ratio	$H_2 : O_2$
equation	2 : 1
problem	0.80 : 1.125
or	= 0.71 : 1

H_2 is limiting reactant

c) How many grams of excess reactant remains?

$0.80\text{ mol } H_2 \times \frac{1\text{ mol } O_2}{2\text{ mol } H_2} = 0.400\text{ mol } O_2 \text{ used}$

$1.125\text{ mol } O_2 - 0.400\text{ mol } O_2 = 0.725\text{ mol } O_2 \text{ XS}$

$0.725\text{ mol} \times \frac{32.0\text{ g}}{1\text{ mol}} = \underline{23\text{ g } O_2}$

d) How many grams of water are produced?

$0.80\text{ mol } H_2 \times \frac{2\text{ mol } H_2O}{2\text{ mol } H_2} = 0.800\text{ mol } H_2O$

$0.800\text{ mol } H_2O \times \frac{18.0\text{ g}}{1\text{ mol}} = \underline{14\text{ g } H_2O}$

6. 5.0 g. of hydrogen gas combine with 29.0 g. of nitrogen gas to make ammonia (NH_3).

a) What is the balanced chemical equation for this reaction?

$$3\,H_{2(g)} + N_{2(g)} \longrightarrow 2\,NH_{3(g)}$$

b) Show which reactant is the limiting reactant.

$5.0\text{ g } H_2 \times \frac{1\text{ mol}}{2.0\text{ g}} = 2.50\text{ mol}$

$29.0\text{ g } N_2 \times \frac{1\text{ mol}}{28.0\text{ g}} = 1.036\text{ mol}$

Ratio	$H_2 : N_2$
equation	3 : 1
	2.50 : 1.036
	2.4 : 1

H_2 is limiting reactant

c) Assuming 100% yield, what mass of ammonia should be produced?

$2.50\text{ mol } H_2 \times \frac{2\text{ mol } NH_3}{3\text{ mol } H_2} = 1.67\text{ mol } NH_3$

$1.67\text{ mol } NH_3 \times \frac{17.0\text{ g}}{1\text{ mol}} = \underline{28\text{ g } NH_3}$

d) If 9.3 g. of ammonia is produced what is the % yield?

$\%\text{ yield} = \frac{9.3\text{ g}}{28.4\text{ g}} \times 100 = \underline{33\%}$