

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: $4\text{Al}_{(s)} + 3\text{O}_{2(g)} \rightarrow 2\text{Al}_2\text{O}_{3(s)}$

$$415\text{g Al}_2\text{O}_3 \times \frac{1\text{mol}}{102.0\text{g}} = 4.069\text{ mol Al}_2\text{O}_3$$

$$4.069\text{ mol Al}_2\text{O}_3 \times \frac{4\text{ mol Al}}{2\text{ mol Al}_2\text{O}_3} = 8.137\text{ mol Al}$$

$$8.137\text{ mol Al} \times 27.0\text{g/mol} = 219.7\text{g} \quad \underline{220.\text{g}} \quad (3\text{ sf.})$$

b) How many grams of solid iodine are produced by the decomposition of 25.4 grams of hydrogen iodide gas? Equation: $2\text{HI}_{(g)} \rightarrow \text{H}_{2(g)} + \text{I}_{2(g)}$

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

$$0.1986\text{ mol HI} \times \frac{1\text{mol I}_2}{2\text{ mol HI}} = 0.09930\text{ mol I}_2$$

$$0.09930\text{ mol I}_2 \times 253.8\text{g/mol} = 25.20\text{g} \quad \underline{25.2\text{g}} \quad (3\text{ sf.})$$

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

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



b) How many moles of solid aluminum are burned?

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

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

$$0.0507\text{ mol Al} \times \frac{2\text{ mol Al}_2\text{O}_3}{4\text{ mol Al}} = 0.0254\text{ mol Al}_2\text{O}_3$$

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

$$0.0254\text{ mol Al}_2\text{O}_3 \times \frac{102.0\text{g}}{1\text{mol}} = 2.59\text{g Al}_2\text{O}_3$$

Copper (I) iodide is not stable, so it is generally made just before using. Copper (I) iodide can be made by the following reaction: $2\text{CuSO}_4 + 4\text{HI} \rightarrow 2\text{CuI} + 2\text{H}_2\text{SO}_4 + \text{I}_2$

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.

$$10.4\text{g CuSO}_4 \times \frac{1\text{mol}}{159.7\text{g}} = 0.06512\text{ mol CuSO}_4$$

$$0.06512\text{ mol CuSO}_4 \times \frac{4\text{ mol HI}}{2\text{ mol CuSO}_4} = 0.1302\text{ mol HI}$$

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

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

$$0.06512\text{ mol CuSO}_4 \left(\frac{2\text{ mol CuI}}{2\text{ mol CuSO}_4} \right) = 0.06512\text{ mol CuI}$$

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

c) Calculate the mass of iodine produced.

$$0.06512\text{ mol CuSO}_4 \times \frac{1\text{mol I}_2}{2\text{ mol CuSO}_4} = 0.03256\text{ mol I}_2$$

$$0.03256\text{ mol I}_2 \times \frac{253.8\text{g}}{1\text{mol}} = 8.26\text{g I}_2$$

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

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



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

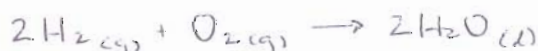
$$30.0 \text{ g AlCl}_3 \times \frac{1 \text{ mol}}{133.5 \text{ g}} = 0.2247 \text{ mol AlCl}_3$$

$$0.2247 \text{ mol AlCl}_3 \times \frac{2 \text{ mol Al}}{2 \text{ mol AlCl}_3} = 0.2247 \text{ mol Al}$$

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

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?



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 $\text{H}_2 : \text{O}_2$
equation 2 : 1

problem 0.800 : 1.125
or = 0.71 : 1

H₂ is limiting reactant

c) How many grams of excess reactant remains?

$$0.80 \text{ mol H}_2 \times \frac{1 \text{ mol O}_2}{2 \text{ mol H}_2} = 0.400 \text{ mol O}_2 \text{ used}$$

$$1.125 \text{ mol O}_2 - 0.400 \text{ mol O}_2 = 0.725 \text{ mol O}_2 \text{ INXS}$$

$$\left. \begin{array}{l} 0.725 \text{ mol} \times \frac{32.0 \text{ g}}{1 \text{ mol}} \\ = 23 \text{ g O}_2 \end{array} \right\}$$

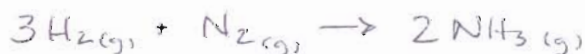
d) How many grams of water are produced?

$$0.80 \text{ mol H}_2 \times \frac{2 \text{ mol H}_2\text{O}}{2 \text{ mol H}_2} = 0.800 \text{ mol H}_2\text{O}$$

$$0.800 \text{ mol H}_2\text{O} \times \frac{18.0 \text{ g}}{1 \text{ mol}} = \underline{\underline{14 \text{ g H}_2\text{O}}}$$

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?



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 $\text{H}_2 : \text{N}_2$
equation 3 : 1

2.50 : 1.036
2.4 : 1

H₂ is limiting reactant

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

$$2.50 \text{ mol H}_2 \times \frac{2 \text{ mol NH}_3}{3 \text{ mol H}_2} = 1.67 \text{ mol NH}_3$$

$$1.67 \text{ mol NH}_3 \times \frac{17.0 \text{ g}}{1 \text{ mol}} = \underline{\underline{28 \text{ g NH}_3}}$$

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

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