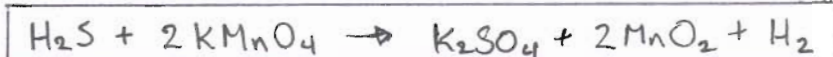


1. If 25.0 g of hydrogen sulphide reacts with 50.0 g of potassium permanganate to produce potassium sulphate, manganese (IV) oxide and hydrogen gas.

a) Write the balanced chemical equation for this reaction.



b) Determine which reactant is limiting and which is in excess.

$$25.0\text{g H}_2\text{S} \div 34.1\text{g/mol} = 0.733\text{ mol}$$

$$50.0\text{g KMnO}_4 \div 158.0\text{g/mol} = 0.316\text{ mol}$$

mole ratio  
 equation H<sub>2</sub>S : KMnO<sub>4</sub>  
 data 0.733 : 0.316  
 2.3 : 1

H <sub>2</sub> S	1X5
KMnO <sub>4</sub>	LR

c) What mass of the excess reactant will be left over at the end of the reaction?

$$\text{moles excess} = 0.733\text{ mol} - 0.316\text{ mol KMnO}_4 \times \frac{1\text{ mol H}_2\text{S}}{2\text{ mol KMnO}_4} = 0.158\text{ mol H}_2\text{S}$$

$$\text{mass of excess} = 0.158\text{ mol} \times 34.1\text{ g/mol} = \boxed{19.6\text{ g}}$$

d) What mass of manganese (IV) oxide will be produced?

$$0.316\text{ mol KMnO}_4 \times \frac{2\text{ mol MnO}_2}{2\text{ mol KMnO}_4} = 0.316\text{ mol MnO}_2$$

$$0.316\text{ mol} \times 86.9\text{ g/mol} = \boxed{27.5\text{ g}}$$

e) If all the potassium sulphate produced were dissolved in 1.5 L of water what would be the concentration of the potassium sulphate solution?

$$0.316\text{ mol KMnO}_4 \times \frac{1\text{ mol K}_2\text{SO}_4}{2\text{ mol KMnO}_4} = 0.158\text{ mol K}_2\text{SO}_4$$

$$[\text{K}_2\text{SO}_4] = \frac{0.158\text{ mol}}{1.5\text{ L}} = \boxed{0.11\text{ M}}$$

2. If 9.25 g of zinc are reacted with 100 mL of 1.00 M HCl, then zinc chloride and hydrogen gas are formed.

a) Write a balanced chemical equation for this reaction.



b) Show which reactant is in excess and which is the limiting factor.

$$9.25\text{g Zn} \div 65.4\text{g/mol} = 0.141\text{ mol Zn}$$

$$0.100\text{L} \times 1.00\text{ M HCl} = 0.100\text{ mol HCl}$$

mole ratio  
 Zn : HCl  
 1 : 2  
 0.141 : 0.100  
 1.4 : 1

Zn	1X5
HCl	LR

c) Calculate the mass of zinc chloride that should be formed from the limiting factor.

$$0.100\text{ mol HCl} \times \frac{1\text{ mol ZnCl}_2}{2\text{ mol HCl}} = 0.0500\text{ mol ZnCl}_2$$

$$0.0500\text{ mol ZnCl}_2 \times 136.4\text{ g/mol} = \boxed{6.82\text{ g}}$$

d) Calculate the volume of hydrogen gas that should be formed at STP.

$$0.100\text{ mol HCl} \times \frac{1\text{ mol H}_2}{2\text{ mol HCl}} = 0.0500\text{ mol H}_2$$

$$0.0500\text{ mol H}_2 \times 22.4\text{ L/mol} = \boxed{1.12\text{ L}}$$

e) What volume of hydrogen gas would be formed if the percentage yield is 89%?

$$\frac{x\text{ L}}{1.12\text{ L}} \times 100 = 89\%$$

$$x = \boxed{0.997\text{ L}}$$

Key.

3. Gold dissolves in the acid mixture known as aqua regia according to the following reaction:



- a) If you had 1.25 mg of gold, what volume of 18 M  $\text{HNO}_3$  would you need to react with the gold, assuming excess HCl is available?

$$1.25 \times 10^{-3} \text{ g Au} \div 197.0 \text{ g/mol} = 6.35 \times 10^{-6} \text{ mol Au}$$

$$6.35 \times 10^{-6} \text{ mol Au} \times \frac{1 \text{ mol HNO}_3}{1 \text{ mol Au}} = 6.35 \times 10^{-6} \text{ mol HNO}_3$$

$$V = \frac{n}{M} = \frac{6.35 \times 10^{-6} \text{ mol}}{18 \text{ M}} = \boxed{3.5 \times 10^{-7} \text{ L}}$$

- b) How many grams of gold (III) chloride would be produced?

$$6.35 \times 10^{-6} \text{ mol Au} \times \frac{1 \text{ mol AuCl}_3}{1 \text{ mol Au}} = 6.35 \times 10^{-6} \text{ mol AuCl}_3$$

$$6.35 \times 10^{-6} \text{ mol} \times 303.5 \text{ g/mol} = \boxed{1.93 \times 10^{-3} \text{ g}}$$

4. Phosphorus pentachloride decomposes to produce phosphorus trichloride and chlorine gas.

- a) Write a balanced chemical equation for this reaction.



- b) If you react 18.5 grams of phosphorus pentachloride, what mass of phosphorus trichloride should be produced?

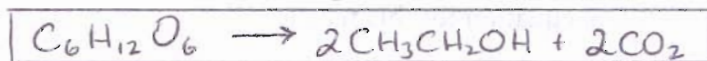
$$18.5 \text{ g PCl}_5 \div 208.5 \text{ g/mol} = 0.0887 \text{ mol PCl}_5$$

$$0.0887 \text{ mol PCl}_5 \times \frac{1 \text{ mol PCl}_3}{1 \text{ mol PCl}_5} = 0.0887 \text{ mol PCl}_3$$

$$0.0887 \text{ mol PCl}_3 \times 137.5 \text{ g/mol} = \boxed{12.2 \text{ g PCl}_3}$$

5. Glucose,  $\text{C}_6\text{H}_{12}\text{O}_6$ , can be converted to ethanol,  $\text{CH}_3\text{CH}_2\text{OH}$ , and  $\text{CO}_2$  gas by fermentation.

- a) Write a balanced chemical equation for the reaction.



- b) If 1.00 kg of glucose was used, what would be the concentration of the ethanol if 20.0 L of ethanol was produced?

$$\text{FW C}_6\text{H}_{12}\text{O}_6 = 180 \text{ u}$$

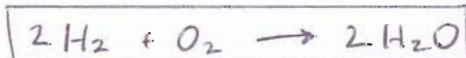
$$1.00 \times 10^3 \text{ g glucose} \div 180 \text{ g/mol} = 5.56 \text{ mol glucose}$$

$$5.56 \text{ mol glucose} \times \frac{2 \text{ mol ethanol}}{1 \text{ mol glucose}} = 11.1 \text{ mol ethanol}$$

$$[\text{ethanol}] = \frac{11.1 \text{ mol}}{20.0 \text{ L}} = \boxed{0.556 \text{ M}}$$

6. When hydrogen is exposed to a flame, it combusts to form water.

- a) Write a balanced chemical equation for this reaction.



- b) If you had 22.4 mL of hydrogen gas at STP, how many grams of water would be produced?

$$22.4 \times 10^{-3} \text{ L} \div 22.4 \text{ L/mol} = 1.00 \times 10^{-3} \text{ mol H}_2$$

$$1.00 \times 10^{-3} \text{ mol H}_2 \times \frac{2 \text{ mol H}_2\text{O}}{2 \text{ mol H}_2} = 1.00 \times 10^{-3} \text{ mol H}_2\text{O}$$

$$1.00 \times 10^{-3} \text{ mol} \times 18.0 \text{ g/mol} = \boxed{0.0180 \text{ g}}$$

$$\text{FW H}_2\text{O} = 18.0 \text{ u}$$