

1. 485 mL of 0.200 M aqueous copper (II) nitrate will react with solid zinc to form solid copper and aqueous zinc nitrate.

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



b) How many moles of copper (II) nitrate are reacting?

$$n = M \cdot V \quad 0.200 \text{ M} \times 0.485 \text{ L} = \underline{0.0970 \text{ mol Cu}(\text{NO}_3)_2}$$

c) What mass of zinc will react completely with the copper (II) nitrate solution?

$$0.0970 \text{ mol Cu}(\text{NO}_3)_2 \times \frac{1 \text{ mol Zn}}{1 \text{ mol Cu}(\text{NO}_3)_2} = 0.0970 \text{ mol Zn}$$

$$0.0970 \text{ mol Zn} \times 65.4 \text{ g/mol} = \underline{6.34 \text{ g Zn}}$$

d) What mass of copper product would you expect?

$$0.0970 \text{ mol Cu}(\text{NO}_3)_2 \times \frac{1 \text{ mol Cu}}{1 \text{ mol Cu}(\text{NO}_3)_2} = 0.0970 \text{ mol Cu}$$

$$0.0970 \text{ mol Cu} \times 63.6 \text{ g/mol} = \underline{6.17 \text{ g Cu}}$$

2. If 9.25 grams of zinc are reacted with 125 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 reactant is limiting.

$$\text{mol Zn} = 9.25 \text{ g} \times \frac{1 \text{ mol}}{65.4 \text{ g}} = 0.141 \text{ mol Zn}$$

$$\text{mol HCl} = 1.00 \text{ M} \times 0.125 \text{ L} = 0.125 \text{ mol HCl}$$

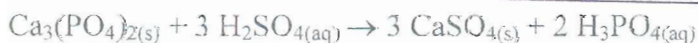
equation Zn : HCl
1 : 2
actual 0.141 : 0.125

c) How many litres of hydrogen gas should be formed at STP?

Zn INXS
HCl Limiting

$$0.125 \text{ mol HCl} \left(\frac{1 \text{ mol H}_2}{2 \text{ mol HCl}} \right) = 0.0625 \text{ mol}$$

$$0.0625 \text{ mol} \times 22.4 \text{ L/mol} = \underline{1.40 \text{ L H}_2}$$



4.719 g of $\text{Ca}_3(\text{PO}_4)_2$ and 225.0 mL of 0.450 M H_2SO_4 are mixed together; 4.087 g of CaSO_4 is produced.

a) Is there a limiting reagent? If so, what is it?

mol Ratio
 $\text{Ca}_3(\text{PO}_4)_2$: H_2SO_4
1 : 3
0.01521 : 0.1013
1 : 6

$$\text{mol Ca}_3(\text{PO}_4)_2 = 4.719 \text{ g} \times \frac{1 \text{ mol}}{310.3 \text{ g}} = 0.01521 \text{ mol}$$

$$\text{mol H}_2\text{SO}_4 = 0.450 \text{ M} \times 0.225 \text{ L} = 0.1013 \text{ mol}$$

yes, LR is $\text{Ca}_3(\text{PO}_4)_2$

b) Determine the percent yield of the reaction.

$$\text{mol CaSO}_4 = 0.01521 \text{ mol Ca}_3(\text{PO}_4)_2 \left(\frac{3 \text{ mol CaSO}_4}{1 \text{ mol Ca}_3(\text{PO}_4)_2} \right) = 0.04563 \text{ mol CaSO}_4$$

$$\text{g CaSO}_4 = 0.04563 \text{ mol} \times 136.2 \text{ g/mol} = 6.215 \text{ g}$$

$$\% \text{ yield} = \left(\frac{4.087 \text{ g}}{6.215 \text{ g}} \right) \times 100 = 65.8 \% \text{ yield}$$

Key

4. The oxidation of NH_3 is an important reaction in the preparation of nitric acid. The equation for the first step of that process is



- a) How many litres of oxygen at STP are needed to react with 5.0 kg of NH_3 ?

$$5.0 \text{ kg} \times \frac{1000 \text{ g}}{1 \text{ kg}} \times \frac{1 \text{ mol}}{17.0 \text{ g}} = 294 \text{ mol NH}_3$$

$$294 \text{ mol NH}_3 \times \frac{5 \text{ mol O}_2}{4 \text{ mol NH}_3} = 368 \text{ mol O}_2$$

$$368 \text{ mol O}_2 \times 22.4 \text{ L/mol} = \underline{8.2 \times 10^3 \text{ L O}_2}$$

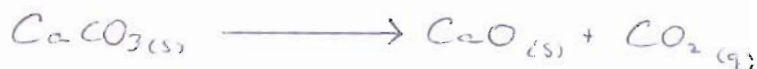
- b) How many litres of air are required assuming air is 21% oxygen by volume?

$$21\% = \frac{8.2 \times 10^3 \text{ L O}_2}{\text{air}} \times 100$$

$$\underline{\underline{\text{air} = 3.9 \times 10^4 \text{ L}}}$$

5. The thermal decomposition of calcium carbonate produces calcium oxide and carbon dioxide gas.

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



- b) If a 28.0 g sample of calcium carbonate is heated for 20 minutes the solid weighs 25.0 grams. How many litres of carbon dioxide gas will be produced in 20 minutes at STP?

$$28.0 \text{ g} - 25 \text{ g} = 3.0 \text{ g CO}_2 \text{ released} \quad 3.0 \text{ g} \times \frac{1 \text{ mol}}{44.0 \text{ g}} = 0.068 \text{ mol}$$

$$0.068 \text{ mol} \times 22.4 \text{ L/mol} = \underline{1.5 \text{ L CO}_2}$$

- c) What is the mass of calcium oxide in the 25.0 g solid?

$$0.068 \text{ mol CO}_2 \times \frac{1 \text{ mol CaO}}{1 \text{ mol CO}_2} = 0.068 \text{ mol CaO}$$

$$0.068 \text{ mol CaO} \times \frac{56.1 \text{ g}}{1 \text{ mol}} = \underline{3.8 \text{ g CaO}} \text{ the rest is unreacted CaCO}_3(\text{s})$$

- d) What is the percentage yield of this reaction?

$$\text{Yield is } 3.0 \text{ g CO}_2 + 3.8 \text{ g CaO} = 6.8 \text{ g product}$$

$$\frac{6.8 \text{ g}}{28.0 \text{ g}} \times 100 = \underline{24.0\%}$$