

4.5 Review questions

1. a)  $1.26 \text{ mol M} \times \frac{2 \text{ mol CuO}}{1 \text{ mol M}} = 2.52 \text{ mol CuO} //$

b)  $1.5 \text{ Kg} \times \frac{10^3 \text{ g}}{1 \text{ Kg}} \times \frac{1 \text{ mol M}}{221.0 \text{ g}} \times \frac{2 \text{ mol CuO}}{1 \text{ mol M}} \times \frac{79.5 \text{ g}}{1 \text{ mol}} = 1100 \text{ g CuO}$

c)  $706 \text{ g} \times \frac{1 \text{ mol}}{79.5 \text{ g CuO}} \times \frac{1 \text{ mol CO}_2}{2 \text{ mol CuO}} \times \frac{22.4 \text{ L CO}_2}{1 \text{ mol CO}_2} = 99.5 \text{ L CO}_2$

2. a)  $3160 \text{ g} \times \frac{1 \text{ mol CH}_3\text{NO}_2}{61.0 \text{ g}} \times \frac{2 \text{ mol N}_2}{4 \text{ mol CH}_3\text{NO}_2} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = 580 \times 10^2 \text{ L N}_2$

b)  $955 \text{ g} \times \frac{1 \text{ mol N}_2}{28.0 \text{ g}} \times \frac{4 \text{ mol CH}_3\text{NO}_2}{2 \text{ mol N}_2} \times \frac{61.0 \text{ g}}{1 \text{ mol}} = 4160 \text{ g CH}_3\text{NO}_2$

c)  $3.5 \times 10^{25} \text{ molec N}_2 \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molec}} \times \frac{6 \text{ mol H}_2\text{O}}{2 \text{ mol N}_2} \times \frac{18.0 \text{ g}}{1 \text{ mol}} = 3100 \text{ g H}_2\text{O}$

3.  $10.0 \text{ mL} \times \frac{0.45 \text{ mol HCl}}{1000 \text{ mL}} \times \frac{1 \text{ mol Zn}}{2 \text{ mol HCl}} \times \frac{65.4 \text{ g}}{1 \text{ mol}} = 0.15 \text{ g Zn}$

omit 4.  $12.2 \text{ g Na} \times \frac{1 \text{ mol Na}}{23.0 \text{ g Na}} \times \frac{124.7 \text{ kJ}}{4 \text{ mol Na}} = 16.5 \text{ kJ} //$  or  $33.0 \text{ kJ}$

5.  $3.225 \text{ g} \times \frac{1 \text{ mol H}_2\text{C}_2\text{O}_4}{90.0 \text{ g}} \times \frac{2 \text{ mol KMnO}_4}{5 \text{ mol H}_2\text{C}_2\text{O}_4} \times \frac{1000 \text{ mL}}{0.250 \text{ mol}} = \text{KMnO}_4 \text{ } 57.3 \text{ mL}$

6.  $2\text{Al} + 3\text{Cl}_2 \rightarrow 2\text{AlCl}_3$   
 $4.56 \text{ Kg} \times \frac{1 \text{ mol}}{0.1335 \text{ Kg}} \times \frac{3 \text{ mol Cl}_2}{2 \text{ mol AlCl}_3} \times \frac{71.0 \text{ g}}{1 \text{ mol}} = 3640 \text{ g Cl}_2$

7.  $\text{H}_2\text{SO}_4 + 2\text{KOH} \rightarrow \text{K}_2\text{SO}_4 + 2\text{H}_2\text{O}$   
 $0.034 \text{ mol KOH} \times \frac{1 \text{ mol H}_2\text{SO}_4}{2 \text{ mol KOH}} = 0.017 \text{ mol H}_2\text{SO}_4$

8.  $\text{C}_2\text{H}_5\text{OH} + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 3\text{H}_2\text{O} \checkmark$   
 $35.00 \text{ g C}_2\text{H}_5\text{OH} \times \frac{1 \text{ mol}}{46.0 \text{ g}} \times \frac{3 \text{ mol H}_2\text{O}}{1 \text{ mol C}_2\text{H}_5\text{OH}} \times \frac{18.0 \text{ g}}{1 \text{ mol}} = 41.1 \text{ g H}_2\text{O}$

9.  $2\text{HCl} + \text{FeS} \rightarrow \text{H}_2\text{S} + \text{FeCl}_2 \checkmark$   
 $21.7 \text{ L} \times \frac{1 \text{ mol H}_2\text{S}}{22.4 \text{ L}} \times \frac{1 \text{ mol FeS}}{1 \text{ mol H}_2\text{S}} \times \frac{87.9 \text{ g}}{1 \text{ mol}} = 85.2 \text{ g FeS}$

10.  $\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2 \checkmark$   
 $15.0 \text{ g CaCO}_3 \times \frac{1 \text{ mol CaCO}_3}{100.1 \text{ g}} \times \frac{1 \text{ mol CO}_2}{1 \text{ mol CaCO}_3} \times \frac{44.0 \text{ g CO}_2}{1 \text{ mol CO}_2} = 6.59 \text{ g CO}_2$

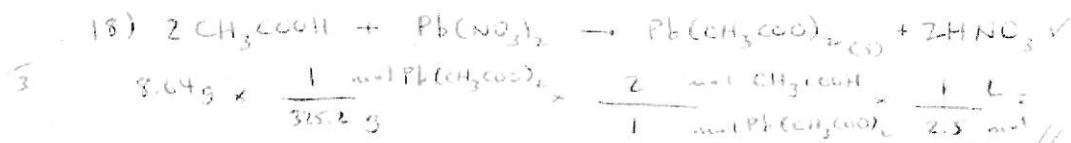
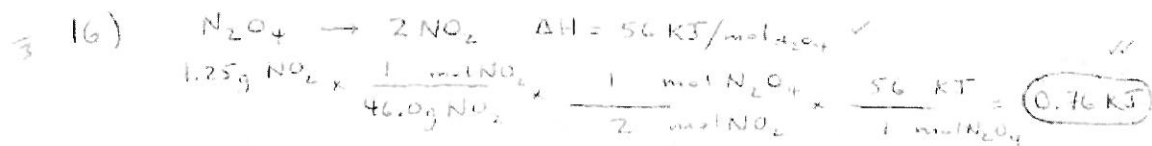
11.  $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3 \checkmark$   
 $40.0 \text{ L NH}_3 \times \frac{3 \text{ L H}_2}{2 \text{ L NH}_3} = 60.0 \text{ L H}_2$

omit 12.  $5.00 \text{ g PbI}_2 \times \frac{1 \text{ mol PbI}_2}{461.0 \text{ g}} \times \frac{46.5 \text{ kJ}}{1 \text{ mol PbI}_2} = 0.504 \text{ kJ} //$

13.  $2\text{Zn} + \text{Sn}(\text{NO}_3)_4 \rightarrow 2\text{Zn}(\text{NO}_3)_2 + \text{Sn} \checkmark$  (Zn is the R.A.)  
 $27.5 \text{ g Sn} \times \frac{1 \text{ mol Sn}}{118.7 \text{ g Sn}} \times \frac{2 \text{ mol Zn}}{1 \text{ mol Sn}} \times \frac{65.3 \text{ g Zn}}{1 \text{ mol Zn}} = 30.3 \text{ g Zn}$

14.  $\text{Ba}(\text{NO}_3)_2 + \text{K}_2\text{SO}_4 \rightarrow \text{BaSO}_4 + 2\text{KNO}_3 \checkmark$   
 $6.5 \text{ mol Ba}(\text{NO}_3)_2 \times \frac{1 \text{ mol BaSO}_4}{1 \text{ mol Ba}(\text{NO}_3)_2} \times \frac{233.4 \text{ g}}{1 \text{ mol}} = 1500 \text{ g} //$

15. See Q 10 for EGN  
 $12.2 \text{ L CO}_2 \times \frac{1 \text{ mol CO}_2}{22.4 \text{ L CO}_2} \times \frac{1 \text{ mol CaCO}_3}{1 \text{ mol CO}_2} \times \frac{100.1 \text{ g}}{1 \text{ mol}} = 54.5 \text{ g} //$



Key

## 4.6 Review Questions

1. Do all reactions between two chemicals result in a complete reaction in such a way that all the reactants are consumed and turn in to products? Explain. *no, excess + limiting*

2. What do we call the chemicals that remain unreacted following a chemical change?  
*excess reactants.*

3. What is the percentage yield of a reaction?  
 $PY = \frac{\text{actual}}{\text{expected}}$

4. Are all reactants in a chemical reaction completely pure? How might this affect a stoichiometry calculation?  
*no, less than 100% yield*

**Limit**

5. A saturated solution of lithium fluoride, which is sometimes used as a rinse to prevent tooth decay, contains 0.132 g of LiF in 100.0 g of water. Calculate the percentage purity by mass of the LiF. *LiF(s)*

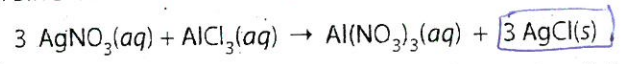


**Limit**

6. Automotive air bags inflate when solid sodium azide ( $\text{NaN}_3$ ) decomposes explosively into its constituent elements. What volume of nitrogen gas is formed if 120 g of 85% pure sodium azide decomposes? Assume STP conditions.

$$0.85 \times 120 \text{ g NaN}_3 \times \frac{1 \text{ mol}}{65.0 \text{ g}} \times \frac{3 \text{ mol N}_2}{2 \text{ mol NaN}_3} \times \frac{22.4 \text{ L}}{1 \text{ mol N}_2} = \boxed{53.4 \text{ L N}_2}$$

7. Silver nitrate and aluminum chloride react with each other by exchanging anions:



What mass of precipitate is produced when 4.22 g of silver nitrate react with 7.73 g of aluminum chloride in solution?

$$4.22 \text{ g AgNO}_3 \times \frac{1 \text{ mol AgNO}_3}{169.9 \text{ g}} \times \frac{3 \text{ mol AgCl}}{3 \text{ mol AgNO}_3} \times \frac{143.4 \text{ g}}{1 \text{ mol AgCl}} = \boxed{3.56 \text{ g AgCl}} *$$

$$7.73 \text{ g AlCl}_3 \times \frac{1 \text{ mol AlCl}_3}{133.5 \text{ g}} \times \frac{3 \text{ mol AgCl}}{1 \text{ mol AlCl}_3} \times \frac{143.4 \text{ g}}{1 \text{ mol AgCl}} = 24.9 \text{ g AgCl}$$

**Limit**

8.  $\text{GeF}_3\text{H}$  is synthesized in the reaction:  $\text{GeH}_4 + 3 \text{GeF}_4 \rightarrow 4 \text{GeF}_3\text{H}$ . If the reaction yield is 91.5%, how many moles of  $\text{GeH}_4$  are needed to produce 8.00 mol of  $\text{GeF}_3\text{H}$ ?

$$8.00 \text{ mol GeF}_3\text{H} \times \frac{1 \text{ mol GeH}_4}{4 \text{ mol}} \times \frac{2 \text{ mol}}{2 \text{ mol}} = \boxed{3.66 \text{ mol GeH}_4}$$

9. What is the maximum mass of sulphur trioxide gas that can be formed from the combination of 5.00 g each of  $\text{S}_8$  solid with  $\text{O}_2$  gas? Begin with a balanced equation.



$$5.00 \text{ g S}_8 \times \frac{1 \text{ mol S}_8}{256.8} \times \frac{8 \text{ mol SO}_3}{1 \text{ mol S}_8} \times \frac{80.1 \text{ g}}{1 \text{ mol SO}_3} = 12.5 \text{ g SO}_3$$

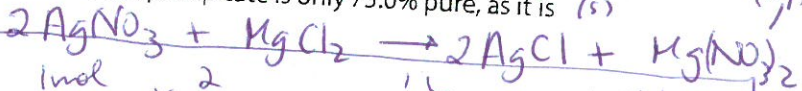
$$5.00 \text{ g O}_2 \times \frac{1 \text{ mol O}_2}{32.0 \text{ g}} \times \frac{8 \text{ mol SO}_3}{12 \text{ mol O}_2} \times \frac{80.1 \text{ g}}{1 \text{ mol SO}_3} = \boxed{8.34 \text{ g SO}_3} *$$

10. In the reaction in question 9, 63.2 g of sulphur trioxide are produced using 40.0 g of oxygen and 48.0 g of sulphur. What is the percentage yield?

$$40.0 \text{ g O}_2 \times \frac{1 \text{ mol O}_2}{32.0 \text{ g}} \times \frac{8 \text{ mol SO}_3}{12 \text{ mol O}_2} \times \frac{80.1 \text{ g SO}_3}{1 \text{ mol SO}_3} = 66.8 \text{ g SO}_3 \leftarrow \text{expected}$$

$$P.Y = \frac{63.2 \text{ g}}{66.8 \text{ g}} \times 100\% = \boxed{94.6\%}$$

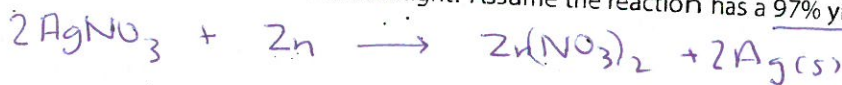
11. What volume of 0.105 mol/L silver nitrate solution would be required to react completely with an excess of magnesium chloride solution to produce 8.95 g of precipitate? Assume the precipitate is only 75.0% pure, as it is still damp following filtration. Begin with a balanced equation.



$$\left( 0.750 \times \frac{8.95 \text{ g AgCl}}{x \text{ g AgCl}} \right) \times \left( 6.71 \text{ g AgCl} \times \frac{1 \text{ mol}}{143.4 \text{ g}} \times \frac{2}{2 \text{ mol}} \times \frac{1 \text{ L}}{0.105} \right) = 0.476 \text{ L}$$

$$0.750x = \frac{8.95}{0.750} \therefore 11.9 \text{ g AgCl} \times \frac{1 \text{ mol AgCl}}{143.4 \text{ g}} \times \frac{2 \text{ mol AgNO}_3}{2 \text{ mol AgCl}} \times \frac{1 \text{ L}}{0.105 \text{ mol AgNO}_3} = \boxed{0.793 \text{ L AgNO}_3}$$

12. What mass of silver could be formed if a large zinc wire is placed in a beaker containing 145.0 mL of 0.095 mol/L silver nitrate and allowed to react overnight? Assume the reaction has a 97% yield.



$$0.145 \text{ L} \times \frac{0.095 \text{ mol AgNO}_3}{1 \text{ L}} \times \frac{2 \text{ mol Ag}}{2 \text{ mol AgNO}_3} \times \frac{107.9 \text{ g Ag}}{1 \text{ mol Ag}} = 1.49 \text{ g Ag}$$

$$P.Y = \frac{x}{1.49} \rightarrow 97\% = \frac{x}{1.49} \quad (0.97)(1.49) = \boxed{1.4 \text{ g Ag}}$$

13. 8.92 g of indium oxide is reacted with an excess of water and forms 10.1 g of base. What is the percent yield?



$$8.92 \text{ g In}_2\text{O}_3 \times \frac{1 \text{ mol}}{277.6 \text{ g}} \times \frac{2 \text{ mol In(OH)}_3}{2 \text{ mol In}_2\text{O}_3} \times \frac{165.8 \text{ g}}{1 \text{ mol In(OH)}_3} = 10.7 \text{ g}$$

$$P.Y = \frac{10.1}{10.7} \times 100\% = \boxed{94.4\%}$$

$$\begin{array}{r} \text{In} = 114.8 \\ 3 \text{O} = 48.0 \\ 3 \text{H} = 3.0 \\ \hline 165.8 \end{array}$$

14. What volume of chlorine gas could be produced under STP conditions if 39.8 g of 84.0% pure potassium chloride were reacted with an excess of fluorine gas?



$$\begin{array}{r} 1 \text{K} = 39.1 \\ 1 \text{Cl} = 35.5 \\ \hline 74.6 \end{array}$$

$$(0.84)(39.8 \text{ g KCl})$$

$$33.4 \text{ g KCl} \times \frac{1 \text{ mol KCl}}{74.6 \text{ g}} \times \frac{1 \text{ mol Cl}_2}{2 \text{ mol KCl}} \times \frac{22.4 \text{ L}}{1 \text{ mol Cl}_2} =$$

$$\boxed{5.02 \text{ L Cl}_2}$$