4.4 Review Questions

1. Indicate whether each of the following changes is endothermic or exothermic:
   (a) Barbecuing a steak

   (b) Freezing a tray full of water to make ice

   (c) Neutralizing an acid spill with baking soda

   (d) Making a grilled cheese sandwich

   (e) Lighting a barbecue igniter

   (f) Condensing water on a mirror

2. Convert the following ΔH notation equations into thermochemical equations using the smallest whole number coefficients possible:
   (a) $\frac{1}{2} C_3H_8(g) \rightarrow \frac{1}{2} C_3H_8(l)$ $\Delta H = -175$ kJ/mol

   (b) $Li(s) + \frac{1}{2} CaCl_2(aq) \rightarrow LiCl(aq) + \frac{1}{2} Ca(s)$ $\Delta H = -362$ kJ/mol

   (c) $2\ B(s) + 3\ H_2O(g) \rightarrow B_2H_6(g) + 3/2\ O_2(g)$ $\Delta H = 762$ kJ/mol

   (d) $\frac{1}{2} P_4(s) + 3\ Cl_2(g) \rightarrow 2\ PCl_3(s)$ $\Delta H = -613$ kJ/mol

   (e) $NH_3(g) + 3/2\ N_2O(g) \rightarrow 2\ N_2(g) + 3/2\ H_2O(l)$ $\Delta H = -505$ kJ/mol

   (f) $\frac{1}{2} Fe_3O_4(s) + \frac{1}{2} CO(g) \rightarrow 3/2\ FeO(s) + \frac{1}{2} CO_2(g)$ $\Delta H = 9$ kJ/mol

3. Convert the following thermochemical equations into ΔH notation using the smallest whole number coefficients possible.
   (a) $C(s) + 2\ H_2(g) + \frac{1}{2} O_2(g) \rightarrow CH_3OH(l) + 201$ kJ/mol

   (b) $\frac{1}{2} Cu(s) + \frac{1}{2} H_2(g) + \frac{1}{2} O_2(g) \rightarrow \frac{1}{2} Cu(OH)_2(s) + 225$ kJ/mol

   (c) 389 kJ/mol $+ \frac{1}{2} Sb_4O_6(s) + 3\ C(s) \rightarrow 2\ Sb(s) + 3\ CO(g)$

   (d) 56 kJ/mol $+ NO_2(g) \rightarrow NO(g) + \frac{1}{2} O_2(g)$

(e) $PCl_3(g) + \frac{1}{2} O_2(g) \rightarrow Cl_3PO(g) + 286$ kJ/mol

(f) $F_2(s) + \frac{1}{2} O_2(g) \rightarrow OF_2(g) + 22$ kJ/mol

4. Use the equations in question 3 to answer the following questions:
   (a) How much energy would be released during the formation of 4 mol of methanol?

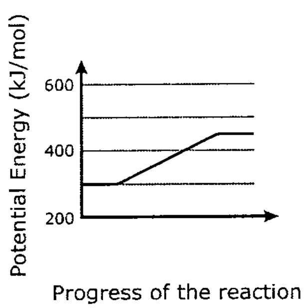
   (b) How many moles of nitrogen dioxide could be decomposed through the use of 168 kJ of energy?

   (c) Is more energy absorbed or released during the formation of Cl_3PO gas from PCl_3 and O_2 gas?

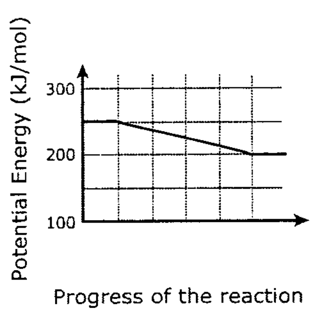
   (d) What is the ΔH value for the decomposition of OF_2 gas into its elements?

   (e) How much energy is required to decompose 1 mol of copper(II) hydroxide?

5. Does the following potential energy diagram represent an endothermic or an exothermic reaction? What is ΔH for this reaction?



6. What is ΔH for this reaction?



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4.5 Review Questions

1. Malachite is a beautiful green mineral often sculpted into jewellery. It decomposes as follows:

   $Cu(OH)_2\ \ CuCO_3(s) \rightarrow 2\,CuO(s) + CO_2(g) + H_2O(l)$

   (a) How many moles of CuO are formed from the decomposition of 1.26 mol of malachite?

   (b) If a 1.5 kg piece of malachite is completely decomposed, how many grams of copper(II) oxide are formed?

   (c) If 706 g of copper(II) oxide are formed from the decomposition of a piece of malachite, how many litres of carbon dioxide gas would form at STP?

2. Nitromethane, a fuel occasionally used in drag racers, burns according to the reaction:

   $4\,CH_3NO_2(l) + 3\,O_2(g) \rightarrow 4\,CO_2(g) + 6\,H_2O(g) + 2\,N_2(g)$

   (a) What is the volume of nitrogen gas produced at STP if 3160 g of CH_3NO_2 is burned?

   (b) What is the mass of nitromethane burned if 955 g of nitrogen gas are produced in the exhaust of the drag racer?

   (c) What mass of water vapour is produced in the exhaust along with 3.5×10^{25} molecules of nitrogen gas?

3. What mass of zinc would completely react with 10.0 mL of 0.45 M hydrochloric acid solution?

   $Zn(s) + 2\,HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$

4. How much energy will be required to complete the reaction of 12.2 g of sodium to produce sodium oxide?

   $4\,Na(s) + O_2(g) + 124.7\text{ kJ} \rightarrow 2\,Na_2O(s)$

5. Potassium permanganate reacts with oxalic acid in aqueous sulphuric acid according to the equation:

   $2\,KMnO_4 + 5\,H_2C_2O_4 + 3\,H_2SO_4 \rightarrow 2\,MnSO_4 + 10\,CO_2 + 8\,H_2O + K_2SO_4$

   How many millilitres of a 0.250 M $KMnO_4$ solution are needed to react with 3.225 g of oxalic acid?

Begin the following calculations with a balanced equation.

6. The reaction of scrap aluminum with chlorine gas forms aluminum chloride. What mass of chlorine in the presence of excess aluminum is required to make 4.56 kg of aluminum chloride?

7. How many moles of sulphuric acid could neutralize 0.034 mol of potassium hydroxide solution?

8. What mass of water vapour would be formed from the complete combustion of 35.00 g of ethanol ($C_2H_5OH(l)$)?

9. Dihydrogen monosulphide gas may be prepared in a laboratory by the action of hydrochloric acid on iron(II) sulphide. How many grams of iron(II) sulphide would be needed to prepare 21.7 L of the gas at STP?

10. Carbon dioxide gas is produced in the reaction between calcium carbonate and hydrochloric acid. If 15.0 g of calcium carbonate reacted with an excess of hydrochloric acid, how many grams of carbon dioxide gas would be produced?

11. The Haber process for making ammonia gas from its elements was developed by Fritz Haber during World War I. Haber hoped to use the ammonia as fertilizer to grow food for Germany during the Allies' blockade. How many litres of hydrogen would be required to produce 40.0 L of ammonia at STP?

12. $PbI_2(s) \rightarrow Pb^{2+}(aq) + 2\,I^-(aq) \qquad \Delta H = 46.5$ kJ/mol
How much energy would be required to dissolve 5.00 g of lead (II) iodide?

13. A piece of zinc metal was dropped into a solution of tin(IV) nitrate. If 27.5 g of tin metal was displaced, how many grams of reducing agent were used?

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14. Solutions of barium nitrate and potassium sulfate were poured together. If this reaction required 6.5 mol of barium nitrate, how many grams of precipitate were formed?

15. Calcium carbonate (marble chips) is dissolved by hydrochloric acid. If 12.2 L of carbon dioxide gas forms at STP, what mass of marble chips was used?

16. When dinitrogen tetroxide decomposes into nitrogen dioxide, 56 kJ of energy is required for each mole of reactant decomposed. How much heat is absorbed if 1.25 g of product is formed?

17. A flask containing 450 mL of 0.500 M HBr was accidentally knocked to the floor. How many grams of K_2CO_3 would you need to put on the spill to completely neutralize the acid?

18. The acetic acid in a 2.5 mol/L sample of a solution of a kettle scale remover is reacted with an excess of a lead(II) nitrate solution to form a precipitate, which is then filtered and dried. The mass of the precipitate is 8.64 g. What volume of the solution was required to produce that mass?

19. How many milliliters of a 0.610 M NaOH solution are needed to completely neutralize 25.0 mL of a 0.356 M phosphoric acid solution?

20. What volume of hydrogen gas is formed at STP by the reaction of excess zinc metal with 150 mL of 0.185 mol/L hydroiodic acid?

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.

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

3. What is the percentage yield of a reaction?

4. Are all reactants in a chemical reaction completely pure? How might this affect a stoichiometry calculation?

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.

6. Automotive air bags inflate when solid sodium azide (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.

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

   $3\ AgNO_3(aq) + AlCl_3(aq) \rightarrow Al(NO_3)_3(aq) + 3\ AgCl(s)$

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

8. GeF_3H is synthesized in the reaction: $GeH_4 + 3\ GeF_4 \rightarrow 4\ GeF_3H$. If the reaction yield is 91.5%, how many moles of GeH_4 are needed to produce 8.00 mol of GeF_3H?

9. What is the maximum mass of sulphur trioxide gas that can be formed from the combination of 5.00 g each of S_8 solid with O_2 gas? Begin with a balanced equation.

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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?

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.

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.

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?

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?

15. An aqueous solution containing 46.7 g of copper(I) nitrate is placed into an aqueous solution containing 30.8 g of strontium bromide. The resulting mixture was filtered to remove the copper(I) bromide precipitate. Assuming a 100% yield:

(a) What is the mass of solid collected on the filter paper?

(b) Which reactant is in excess?

(c) How many grams of the excess reactant remains when the reaction has gone to completion?

16. A 20.0 g piece of calcium metal reacts with 18.0 mL of water over time. If 10.0 L of hydrogen gas is formed under STP conditions, what is the percentage yield of the reaction? (Recall the density of water is 1.00 g/mL.)

17. Excess silver nitrate is dissolved in a total volume of 250 mL of 0.103 mol/L calcium chloride solution. The resulting reaction produces 4.41 g of silver chloride precipitate. What was the percentage purity of the calcium chloride?

18. A sample of impure silver with a mass of 0.7294 g was dissolved in excess concentrated nitric acid according to the following *unbalanced* equation:

$Ag(s) + HNO_3(aq) \rightarrow AgNO_3(aq) + NO(g) + H_2O(l)$

Once the nitrogen monoxide gas was vented off in a fume hood, the resulting silver nitrate solution was reacted with a slight excess of hydrochloric acid to form a precipitate of silver chloride. The dried precipitate's mass was 0.3295 g. What was the percentage purity of the silver sample?

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Stoich Review pack answer Key

4.4 Review Questions (p. 205)

1. Indicate whether each of the following changes is endothermic or exothermic:
   (a) Barbecuing a steak
   endothermic
   (b) Freezing a tray full of water to make ice
   exothermic
   (c) Neutralizing an acid spill with baking soda
   exothermic
   (d) Making a grilled cheese sandwich
   endothermic
   (e) Lighting a barbecue igniter
   endothermic
   (f) Condensing water on a mirror
   exothermic
2. Convert the following ΔH notation equations into thermochemical equations using the smallest whole number coefficients possible:
   (a) $\frac{1}{2} C_3H_8(g) \rightarrow \frac{1}{2} C_3H_8(l) \quad \Delta H = -175$ kJ/mol
   $C_3H_{8(g)} \rightarrow C_3H_{8(l)} + 350 \frac{kJ}{mol}$
   (b) $Li(s) + \frac{1}{2} CaCl_2(aq) \rightarrow LiCl(aq) + \frac{1}{2} Ca(s) \quad \Delta H = -362$ kJ/mol
   $2Li_{(s)} + CaCl_{2(aq)} \rightarrow 2LiCl_{(aq)} + Ca_{(s)} + 724 \frac{kJ}{mol}$
   (c) $2 B(s) + 3 H_2O(g) \rightarrow B_2H_6(g) + 3/2\, O_2(g) \quad \Delta H = 762$ kJ/mol
   $4B_{(s)} + 6H_2O_{(g)} + 1524 \frac{kJ}{mol} \rightarrow 2B_2H_{6(g)} + 3O_{2(g)}$
   (d) $\frac{1}{2} P_4(s) + 3 Cl_2(g) \rightarrow 2 PCl_3(s) \quad \Delta H = -613$ kJ/mol
   $P_{4(s)} + 6Cl_{2(g)} \rightarrow 4PCl_{3(s)} + 1226 \frac{kJ}{mol}$
   (e) $NH_3(g) + 3/2\, N_2O(g) \rightarrow 2 N_2(g) + 3/2\, H_2O(l) \quad \Delta H = -505$ kJ/mol
   $2NH_{3(g)} + 3N_2O_{(g)} \rightarrow 4N_{2(g)} + 3H_2O_{(l)} + 1010 \frac{kJ}{mol}$
   (f) $\frac{1}{2} Fe_3O_4(s) + \frac{1}{2} CO(g) \rightarrow 3/2\, FeO(s) + \frac{1}{2} CO_2(g) \quad \Delta H = 9$ kJ/mol
   $Fe_3O_{4(s)} + CO_{(g)} + 18 \frac{kJ}{mol} \rightarrow 3FeO_{(s)} + CO_{2(g)}$
3. Convert the following thermochemical equations into ΔH notation using the smallest whole number coefficients possible.
   (a) $C(s) + 2 H_2(g) + \frac{1}{2} O_2(g) \rightarrow CH_3OH(l) + 201$ kJ/mol
   $2C_{(s)} + 4H_{2(g)} + O_{2(g)} \rightarrow 2CH_3OH_{(l)} \quad \Delta H = -402 \frac{kJ}{mol}$
   (b) $\frac{1}{2} Cu(s) + \frac{1}{2} H_2(g) + \frac{1}{2} O_2(g) \rightarrow \frac{1}{2} Cu(OH)_2(s) + 225$ kJ/mol
   $Cu_{(s)} + H_{2(g)} + O_{2(g)} \rightarrow Cu(OH)_{2(s)} \quad \Delta H = -450 \frac{kJ}{mol}$
   (c) 389 kJ/mol $+ \frac{1}{2} Sb_4O_6(s) + 3 C(s) \rightarrow 2 Sb(s) + 3 CO(g)$
   $Sb_4O_{6(s)} + 6C_{(s)} \rightarrow 4Sb_{(s)} + 6CO_{(g)} \quad \Delta H = 778 \frac{kJ}{mol}$
   (d) 56 kJ/mol $+ NO_2(g) \rightarrow NO(g) + \frac{1}{2} O_2(g)$
   $2NO_{2(g)} \rightarrow 2NO_{(g)} + O_{2(g)} \quad \Delta H = 112 \frac{kJ}{mol}$

(e) $PCl_3(g) + ½ O_2(g) \rightarrow Cl_3PO(g) + 286$ kJ/mol.

$2PCl_{3(g)} + O_{2(g)} \rightarrow 2Cl_3PO_{(g)}$ $\Delta H = -572 \frac{kJ}{mol}$

(f) $F_2(s) + ½ O_2(g) \rightarrow OF_2(g) + 22$ kJ/mol

$2F_{2(s)} + O_{2(g)} \rightarrow 2OF_{2(g)}$ $\Delta H = -44 \frac{kJ}{mol}$

4. Use the equations in question 3 to answer the following questions:

(a) How much energy would be released during the formation of 4 mol of methanol?

$\frac{4 \text{ mol } CH_3OH}{\text{mol rxn}} \times \frac{1 \text{ mol rxn}}{2 \text{ mol } CH_3OH} \times \frac{-402 \text{ kJ}}{1 \text{ mol rxn}} = 802 \frac{kJ}{\text{mol rxn}}$

(b) How many moles of nitrogen dioxide could be decomposed through the use of 168 kJ of energy?

$168 \text{ kJ} \times \frac{1 \text{ mol rxn}}{112 \text{ kJ}} \times \frac{2 \text{ mol } NO_2}{1 \text{ mol rxn}} = 3.00 \text{ mol } NO_2$

(c) Is more energy absorbed or released during the formation of Cl_3PO gas from PCl_3 and O_2 gas?

released (Exo)

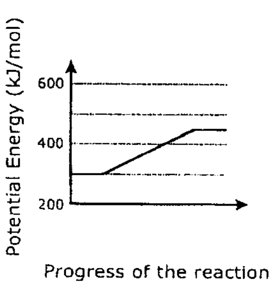
(d) What is the ΔH value for the decomposition of OF_2 gas into its elements?

ΔH decomposition of OF_2 = 44 kJ/mol OF_2

(e) How much energy is required to decompose 1 mol of copper(II) hydroxide?

450. kJ/mol $Cu(OH)_2$

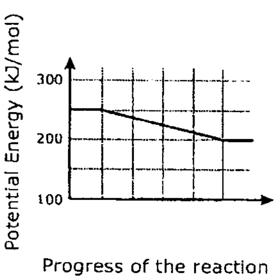
5. Does the following potential energy diagram represent an endothermic or an exothermic reaction? What is ΔH for this reaction?



$\Delta H = 150 \frac{kJ}{mol}$

endothermic

6. What is ΔH for this reaction?



$\Delta H = -50 \frac{kJ}{mol}$

exothermic

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4.5 Review Questions (p. 217)

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

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

c) $706 \text{ g} \times \frac{1 \text{ mol}}{79.5 \text{ g CuO}} \times \frac{1 \text{ mol } CO_2}{2 \text{ mol CuO}} \times \frac{22.4 \text{ L } CO_2}{1 \text{ mol } CO_2} = \boxed{99.5 \text{ L}}$ ✓✓

2\. a) $3160 \text{ g} \times \frac{1 \text{ mol } CH_3NO_2}{61.0 \text{ g}} \times \frac{2 \text{ mol } N_2}{4 \text{ mol } CH_3NO_2} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = \boxed{580. \text{ L}}$ ✓✓

b) $955 \text{ g} \times \frac{1 \text{ mol } N_2}{28.0 \text{ g}} \times \frac{4 \text{ mol } CH_3NO_2}{2 \text{ mol } N_2} \times \frac{61.0 \text{ g}}{1 \text{ mol}} = \boxed{4160 \text{ g}}$ ✓✓

c) $3.5 \times 10^{25} \text{ molec } N_2 \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molec}} \times \frac{6 \text{ mol } H_2O}{2 \text{ mol } N_2} \times \frac{18.0 \text{ g}}{1 \text{ mol}} = \boxed{3100 \text{ g}}$ ✓✓

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

4\. $12.2 \text{ g Na} \times \frac{1 \text{ mol Na}}{23.0 \text{ g Na}} \times \frac{124.7 \text{ kJ}}{4 \text{ mol Na}} = \boxed{16.5 \text{ kJ}}$ ✓✓

5\. $3.225 \text{ g} \times \frac{1 \text{ mol } H_2C_2O_4}{90.0 \text{ g}} \times \frac{2 \text{ mol } KMnO_4}{5 \text{ mol } H_2C_2O_4} \times \frac{1000 \text{ mL}}{0.250 \text{ mol}}$ = 57.3 mL

6\. $2Al + 3Cl_2 \rightarrow 2AlCl_3$ $\quad 4.56 \text{ kg} \times \frac{1 \text{ mol}}{0.1335 \text{ kg}} \times \frac{3 \text{ mol } Cl_2}{2 \text{ mol } AlCl_3} \times \frac{71.0 \text{ g}}{1 \text{ mol}} = \boxed{3640 \text{ g}}$

7\. $H_2SO_4 + 2KOH \rightarrow K_2SO_4 + 2H_2O$ $\quad 0.034 \text{ mol KOH} \times \frac{1 \text{ mol } H_2SO_4}{2 \text{ mol KOH}} = \boxed{0.017 \text{ mol}}$ ✓

8\. $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$ ✓

$35.00 \text{ g } C_2H_5OH \times \frac{1 \text{ mol}}{46.0 \text{ g}} \times \frac{3 \text{ mol } H_2O}{1 \text{ mol } C_2H_5OH} \times \frac{18.0 \text{ g}}{1 \text{ mol}} = \boxed{41.1 \text{ g}}$ ✓✓

9\. $2HCl + FeS \rightarrow H_2S + FeCl_2$ ✓

$21.7 \text{ L} \times \frac{1 \text{ mol } H_2S}{22.4 \text{ L}} \times \frac{1 \text{ mol FeS}}{1 \text{ mol } H_2S} \times \frac{87.9 \text{ g}}{1 \text{ mol}} = \boxed{85.2 \text{ g}}$ ✓✓

10\. $CaCO_{3(s)} + 2HCl \rightarrow CaCl_2 + H_2O + CO_{2(g)}$ ✓

$15.0 \text{ g } CaCO_3 \times \frac{1 \text{ mol } CaCO_3}{100.1 \text{ g}} \times \frac{1 \text{ mol } CO_2}{1 \text{ mol } CaCO_3} \times \frac{44.0 \text{ g } CO_2}{1 \text{ mol } CO_2} = \boxed{6.59 \text{ g}}$ ✓✓

11\. $N_2 + 3H_2 \rightarrow 2NH_3$ ✓ $\quad 40.0 \text{ L } NH_3 \times \frac{3 \text{ L } H_2}{2 \text{ L } NH_3} = \boxed{60.0 \text{ L}}$ ✓✓

12\. $5.00 \text{ g } PbI_2 \times \frac{1 \text{ mol } PbI_2}{461.0 \text{ g}} \times \frac{46.5 \text{ kJ}}{1 \text{ mol } PbI_2} = \boxed{0.504 \text{ kJ}}$ ✓✓

13\. $2Zn + Sn(NO_3)_4 \rightarrow 2Zn(NO_3)_2 + Sn$ ✓ (Zn is the R.A.)

$27.5 \text{ g Sn} \times \frac{1 \text{ mol Sn}}{118.7 \text{ g Sn}} \times \frac{2 \text{ mol Zn}}{1 \text{ mol Sn}} \times \frac{65.3 \text{ g Zn}}{1 \text{ mol Zn}} = \boxed{30.3 \text{ g}}$ ✓✓

14\. $Ba(NO_3)_2 + K_2SO_4 \rightarrow BaSO_{4(s)} + 2KNO_3$ ✓

$6.5 \text{ mol } Ba(NO_3)_2 \times \frac{1 \text{ mol } BaSO_4}{1 \text{ mol } Ba(NO_3)_2} \times \frac{233.4 \text{ g}}{1 \text{ mol}} = \boxed{1500 \text{ g}}$ ✓✓

15\. See Q 10 (15) for EQN

$12.2 \text{ L } CO_2 \times \frac{1 \text{ mol } CO_2}{22.4 \text{ L } CO_2} \times \frac{1 \text{ mol } CaCO_3}{1 \text{ mol } CO_2} \times \frac{100.1 \text{ g}}{1 \text{ mol}} = \boxed{54.5 \text{ g}}$ ✓✓

/3 16) $N_2O_4 \rightarrow 2NO_2$ $\Delta H = 56\ kJ/mol_{N_2O_4}$ ✓

$1.25\,g\ NO_2 \times \frac{1\ mol\ NO_2}{46.0\,g\ NO_2} \times \frac{1\ mol\ N_2O_4}{2\ mol\ NO_2} \times \frac{56\ kJ}{1\ mol\ N_2O_4} = \boxed{0.76\ kJ}$ ✓✓

/3 17) $2HBr + K_2CO_3 \rightarrow 2KBr + H_2O + CO_2$ ✓

$450\,mL \times \frac{0.560\ mol\ HBr}{1000\ mL} \times \frac{1\ mol\ K_2CO_3}{2\ mol\ HBr} \times \frac{138.2\ g}{1\ mol} = \boxed{16\ g}$ ✓✓

18) $2CH_3COOH + Pb(NO_3)_2 \rightarrow Pb(CH_3COO)_{2(s)} + 2HNO_3$ ✓

/3 $8.64\,g \times \frac{1\ mol\ Pb(CH_3COO)_2}{325.2\ g} \times \frac{2\ mol\ CH_3COOH}{1\ mol\ Pb(CH_3COO)_2} \times \frac{1\ L}{2.5\ mol} = \boxed{0.021\ L}$ (21 mL) ✓✓

19) $3NaOH + H_3PO_4 \rightarrow Na_3PO_4 + 3H_2O$ ✓

/3 $25.0\,mL \times \frac{0.356\ mol\ H_3PO_4}{1000\ mL} \times \frac{3\ mol\ NaOH}{1\ mol\ H_3PO_4} \times \frac{1000\ mL}{0.610\ mol} = \boxed{43.8\ mL}$ ✓✓

20) $Zn + 2HI \rightarrow ZnI_2 + H_2$ ✓

/3 $150\,mL \times \frac{0.185\ mol\ HI}{1000\ mL} \times \frac{1\ mol\ H_2}{2\ mol\ HI} \times \frac{22.4\ L\ H_2}{1\ mol\ H_2} = \boxed{0.31\ L}$ ✓✓

4.6 Review Questions (p. 230)

1. NO
- Reactants may be impure
- Bxn may not go 100% to completion.
- One reactant may be in excess.

2. What are the reactants that are not completely consumed called?

Excess

3. (obtained / expected) x 100%

4. Rarely. Need to apply % purity. (makes product mass smaller)

5. $\frac{0.132\,g}{100.132\,g}$ ~~x 100% = 0.132%~~

6. $2NaN_3 \rightarrow 2Na + 3N_2$

$0.85\,(NaN_3\ 120\,g) = 102\,g$ pure NaN_3

$102\,g\ NaN_3 \times \frac{1\,mol\ NaN_3}{65.0\,g} \times \frac{3\,mol\ N_2}{2\,mol\ NaN_3} \times \frac{22.4\,L\ N_2}{1\,mol\ N_2}$ ~~= 53 L~~

7. Limiting

↳ $4.22\,g \times \frac{1\,mol}{169.9\,g} \times \frac{3\,mol\ AgCl}{3\,mol\ AgNO_3} \times \frac{143.4\,g}{1\,mol}$ ~~= 3.56 g~~

Excess

↳ $7.73\,g\ AlCl_3 \times \frac{1\,mol}{133.5\,g} \times \frac{3\,mol\ AgCl}{1\,mol\ AlCl_3} \times \frac{143.4\,g}{1\,mol}$ ~~= 24.9 g~~

8. 100% yield would produce

$\frac{8.00\,mol}{0.915}$ ~~= 8.74 mol, so~~ $8.74\,mol\ GeF_3H \times \frac{1\,mol\ GeH_4}{4\,mol\ GeF_3H}$ = 2.19 mol

$S_8 + 12O_2 \rightarrow 8SO_3$

9. Excess

↳ $5.00g\ S_8 \times \frac{1mol\ S_8}{256.8g} \times \frac{8\ mol\ SO_3}{1\ mol\ S_8} \times \frac{80.1g}{1\ mol} = 12.5g$

Limits

↳ $5.00g\ O_2 \times \frac{1mol}{32.0g} \times \frac{8\ mol\ SO_3}{12\ mol\ O_2} \times \frac{80.1g}{1\ mol} = 8.34g$

10. Limiting

↳ $40.0g\ O_2 \times \frac{1mol\ O_2}{32.0g} \times \frac{8\ mol\ SO_3}{12\ mol\ O_2} \times \frac{80.1g}{1\ mol} = 66.8g$

Excess

↳ $48.0g\ S_8 \times \frac{1mol\ S_8}{256.8g} \times \frac{8\ mol\ SO_3}{1\ mol\ S_8} \times \frac{80.1g}{1\ mol} = 120.\ g$

$\%\ yield = \frac{63.2g}{66.75\ g} \times 100\% = 94.7\%$

11. $8.95g\ impure\ AgCl \times \frac{75.0g\ pure}{100g\ impure} \times \frac{1mol\ AgCl}{143.4g} \times \frac{2\ mol\ AgNO_3}{2\ mol\ AgCl} \times \frac{1L}{0.105mol} = 0.446L$

Equation: $2AgNO_3 + MgCl_2 \rightarrow 2AgCl(s) + Mg(NO_3)_2$

12. $Zn + 2AgNO_3 \rightarrow Zn(NO_3)_2 + 2Ag$

$\left(145.0mL \times \frac{0.095\ mol\ AgNO_3}{1000\ mL} \times \frac{2\ mol\ Ag}{2\ mol\ AgNO_3} \times \frac{107.9g}{1mol}\right) \times 0.97 = 1.4g$

13. $Th\ yield = 8.92g\ In_2O_3 \times \frac{1mol}{277.6g} \times \frac{2\ mol\ In(OH)_3}{1\ mol\ In_2O_3} \times \frac{165.8g}{1\ mol} = 10.7g$

$\therefore \frac{10.1g}{10.7g} \times 100\% = 94.8\%$

$In_2O_3 + 3H_2O \rightarrow 2In(OH)_3$

14. $2KCl + F_2 \rightarrow 2KF + Cl_2$ (at STP)

$39.8g \times \frac{84.0g\ Pure}{100g\ impure} \times \frac{1\ mol\ KCl}{74.6g\ KCl} \times \frac{1\ mol\ Cl_2}{2\ mol\ KCl} \times \frac{22.4L}{1\ mol} = 5.02L$

15. $2CuNO_3 + SrBr_2 \rightarrow 2CuBr(s) + Sr(NO_3)_2$

Excess

$46.7g\ CuNO_3 \times \frac{1 mol}{125.5g} \times \frac{2 mol\ CuBr}{2 mol\ CuNO_3} \times \frac{143.4g}{1 mol} = 53.4g$

Limiting

$30.0g\ SrBr_2 \times \frac{1 mol}{247.4g} \times \frac{2 mol\ CuBr}{1 mol\ SrBr_2} \times \frac{143.4g}{1 mol} = 35.7g$ ~~ppt form~~

$CuNO_3$ in Excess

Used up

$30.0g\ SrBr_2 \times \frac{1 mol}{247.4g} \times \frac{2 mol\ CuNO_3}{1 mol\ SrBr_2} \times \frac{125.5g}{1 mol}$ ~~$= 31.2g\ CuNO_3$~~

∴ ~~46.7 − 31.2~~ = 15.5g left over.

16. $20.0g\ Ca \times \frac{1 mol}{40.1g} \times \frac{1 mol\ H_2}{1 mol\ Ca} \times \frac{22.4L}{1 mol}$ = ~~11.2L~~

$18.0 mL \times \frac{1.00g}{1 mL} \times \frac{1 mol}{18.0g} \times \frac{1 mol\ H_2}{2 mol\ H_2O} \times \frac{22.4L}{1 mol} = 11.2L$

Stoichiometric Amounts!! (ALL CONSUMED) ∴ $\frac{10.0L}{11.2L} \times 100\% = 89.5\%$ yield

17. $2AgNO_3 + CaCl_2 \rightarrow Ca(NO_3)_2 + 2AgCl(s)$

pure reacted $= 4.41g\ AgCl \times \frac{1 mol}{143.4g} \times \frac{1 mol\ CaCl_2}{2 mol\ AgCl} \times \frac{1000 mL}{0.103 mol} = 149 mL$

Purity Was

∴ $\frac{149 mL}{250 mL} \times 100\% = 59.7 \rightarrow 60\%$

18. $3Ag(s) + 4HNO_3(aq) \rightarrow 3AgNO_3(aq) + NO(g) + 2H_2O(l)$

$0.3295g\ AgCl \times \frac{1 mol}{143.4g} \times \frac{1 mol\ AgNO_3}{1 mol\ AgCl} \times \frac{3 mol\ Ag}{3 mol\ AgNO_3} \times \frac{107.9g\ Ag\ Pure}{1 mol\ Ag} = 0.2479g$

Purity $= \frac{0.2479g}{0.7294g} \times 100\% = 33.99\%$