/17

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) $3160 \text{ g} \times \frac{1 \text{ mol } CH_3NO_2}{61.0 \text{ g}} \times \frac{2 \text{ mol } N_2}{4 \text{ mol } CH_3NO_2} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = 5.80 \times 10^2 \text{ L } N_2$

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

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

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 kJ

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

6. $2Al + 3Cl_2 \rightarrow 2AlCl_3$

$4.56 \text{ kg} \times \frac{1 \text{ mol}}{0.1335 \text{ kg}} \times \frac{3 \text{ mol } Cl_2}{2 \text{ mol } AlCl_3} \times \frac{71.0 \text{ g}}{1 \text{ mol}} = 3640 \text{ g } Cl_2$

7. $H_2SO_4 + 2KOH \rightarrow K_2SO_4 + 2H_2O$

$0.034 \text{ mol KOH} \times \frac{1 \text{ mol } H_2SO_4}{2 \text{ mol KOH}} = 0.017 \text{ mol } H_2SO_4$

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

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

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

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

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

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

11. $N_2 + 3H_2 \rightarrow 2NH_3$ ✓

$40.0 \text{ L } NH_3 \times \frac{3 \text{ L } H_2}{2 \text{ L } NH_3} = 60.0 \text{ L } H_2$

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

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

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

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

15. See Q 10 for EQN

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

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

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

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

$$450\ mL \times \frac{0.500\ mol\ HBr}{1000\ mL} \times \frac{1\ mol\ K_2CO_3}{2\ mol\ HBr} \times \frac{138.2\ g}{1\ mol} = \boxed{16\ g}$$ ✓✓

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

/3 $$8.64g \times \frac{1\ mol\ Pb(CH_3COO)_2}{325.2\ g} \times \frac{2\ mol\ CH_3COOH}{1\ mol\ Pb(CH_3COO)_2} \times \frac{1\ L}{2.5\ mol} = \boxed{0.021\ L}$$ ✓✓ (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 $$150\ mL \times \frac{0.185\ mol\ HI}{1000\ mL} \times \frac{1\ mol\ H_2}{2\ mol\ HI} \times \frac{22.4\ L\ H_2}{1\ mol\ H_2} = \boxed{0.31\ L}$$ ✓✓

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?

   $PY = \frac{actual}{expected}$

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

   no, less than 100% yield

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. $LiF(s) \rightarrow$

   omit

   $2NaN_3(s) \rightarrow 2Na(s) + 3N_2(g)$

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.

   omit

   $0.85 \times 120g\ NaN_3 \times \frac{1\ mol}{65.0\ g} \times \frac{3\ mol\ N_2}{2\ mol\ NaN_3} \times \frac{22.4\ L}{1\ mol\ N_2} = 53\ L\ N_2$

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?

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

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

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?

   omit

   $8.00\ mol\ GeF_3H \times \frac{1\ mol\ GeH_4}{4\ mol} \times \frac{2\ mol}{} \times = 3.66\ mol\ GeH_4$

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

   $S_8 + 12O_2 \rightarrow 8SO_3(g)$

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

   ER

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

   LR

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?

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

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

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.

$2AgNO_3 + MgCl_2 \rightarrow 2AgCl_{(s)} + Mg(NO_3)_{2(aq)}$

$\left(0.750 = \frac{8.95\ AgCl}{x\ g\ AgCl}\right) x$ | $6.71g\ AgCl \times \frac{1\ mol}{143.4g} \times \frac{2}{2\ mol} \times \frac{1L}{0.105} = 0.446L\ AgNO_3$

$0.750x = \frac{8.95}{0.750}$ ∴ $11.9g\ AgCl \times \frac{1\ mol\ AgCl}{143.4g} \times \frac{2\ mol\ AgNO_3}{2\ mol\ AgCl} \times \frac{1L}{0.105\ mol\ AgNO_3} = 0.793\ L\ AgNO_3$

$x = 11.9g\ AgCl$ ← expected

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.

$2AgNO_3 + Zn \rightarrow Zn(NO_3)_2 + 2Ag_{(s)}$

$0.145L \times \frac{0.095\ mol\ AgNO_3}{1L} \times \frac{2\ mol\ Ag}{2\ mol\ AgNO_3} \times \frac{107.9g\ Ag}{1\ mol\ Ag} = 1.49g\ Ag$ ← expected

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

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?

$In_2O_3 + 3H_2O \rightarrow 2In(OH)_{3(aq)}$

In = 114.8
3 O = 48.0
3 H = 3.0
165.8

$8.92g\ In_2O_3 \times \frac{1\ mol}{277.6g} \times \frac{2\ mol\ In(OH)_3}{1\ mol\ In_2O_3} \times \frac{165.8g}{1\ mol\ In(OH)_3} = 10.7g$ ← expected

In₂ = 229.6
3O = 48.0
277.6

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

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?

$2KCl + F_2 \rightarrow 2KF + Cl_2$

1 K = 39.1
1 Cl = 35.5
74.6

$(0.84)(39.8g\ KCl)$

$33.4g\ KCl \times \frac{1\ mol\ KCl}{74.6g} \times \frac{1\ mol\ Cl_2}{2\ mol\ KCl} \times \frac{22.4L}{1\ mol\ Cl_2} =$

$5.02\ L\ Cl_2$