Unit 4 Study guide

① CaCl$_2$ + Na$_2$CO$_3$ → CaCO$_3$ + 2 NaCl$_2$

$$\frac{65.14g\ CaCl_2}{} \left| \frac{1\ mol\ CaCl_2}{110.98g\ CaCl_2} \right| \frac{1\ mol\ Na_2CO_3}{1\ mol\ CaCl_2} \left| \frac{105.99g\ Na_2CO_3}{1\ mol\ Na_2CO_3} \right.$$

= 62.21 g Na$_2$CO$_3$ required to react w/ all CaCl$_2$

$\boxed{CaCl_2\ is\ LR}$ amt present is greater

② a) C$_{17}$H$_{14}$N$_3$SO$_2$F$_3$ molar mass = 381.37 g/mol

$\%C = \dfrac{17 \cdot 12.01g}{381.37g} = \boxed{53.54\%C}$ $\%S = \dfrac{32.06g}{381.37g} = \boxed{8.407\%S}$

$\%H = \dfrac{14 \cdot 1.008g}{381.37g} = \boxed{3.700\%H}$ $\%O = \dfrac{2 \cdot 16.00}{381.37g} = \boxed{8.391\%O}$

$\%N = \dfrac{3 \cdot 14.01g}{381.37g} = \boxed{11.02\%N}$ $\%F = \dfrac{3 \cdot 19.00g}{381.37g} = \boxed{14.95\%F}$

b) $\dfrac{20.0g\ C_6H_9N_3SO_2}{} \left| \dfrac{1\ mol\ C_6H_9N_3SO_2}{187.22g\ C_6H_9N_3SO_2} \right| \dfrac{1\ mol\ celebrex}{1\ mol\ C_6H_9N_3SO_2} \left| \dfrac{381.37g}{1\ mol\ celebrex} \right.$

= .107 mol = 40.7 g celebrex

$\dfrac{20.0g\ C_{11}H_9O_2F_3}{} \left| \dfrac{1\ mol\ C_{11}H_9O_2F_3}{230.18g\ C_{11}H_9O_2F_3} \right| \dfrac{1\ mol\ Celebrex}{1\ mol\ C_{11}H_9O_2F_3} \left| \dfrac{381.37g\ celebrex}{1\ mol\ celebrex} \right.$
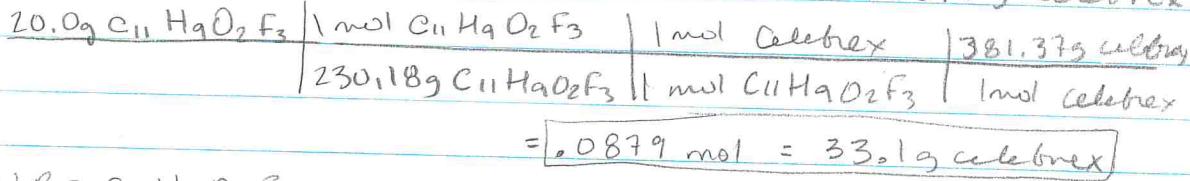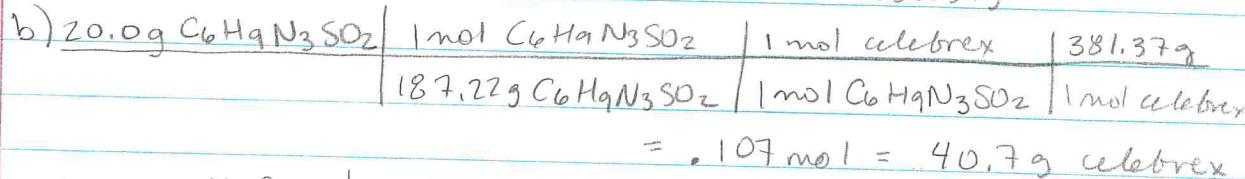
= $\boxed{.0879\ mol = 33.1g\ celebrex}$

c) LR = C$_{11}$H$_9$O$_2$F$_3$

ER = C$_6$H$_9$N$_3$SO$_2$

d) $\dfrac{20.0g\ LR}{} \left| \dfrac{1\ mol\ LR}{230.18g\ LR} \right| \dfrac{1\ mol\ ER}{1\ mol\ LR} \left| \dfrac{187.22g\ ER}{1\ mol\ ER} \right.$

= 16.3 g C$_6$H$_9$N$_3$SO$_2$
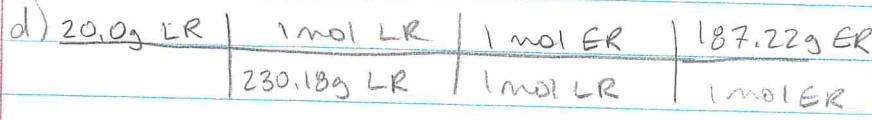
20.0g − 16.3g = $\boxed{3.7\ g\ C_6H_9N_3SO_2}$ $\left| \dfrac{1\ mol}{187.22\ g} \right.$ = $\boxed{.0199\ mol\ C_6H_9N_3SO_2}$
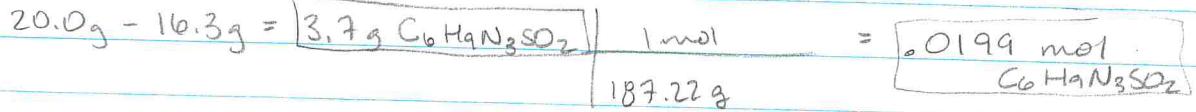
e) A = 28.0g celebrex

T = 33.1g celebrex

% yield = $\dfrac{A}{T}$ = $\dfrac{28.0g}{33.1g} \cdot 100$ = $\boxed{84.6\%}$

③ a i) $M_1 = 16M$ $M_2 = 6.0M$ $M_1V_1 = M_2V_2$

   $V_1 = ?$ $V_2 = 50. mL$ $V_1 = \dfrac{M_2V_2}{M_1} = \dfrac{(6.0)(50.mL)}{(16)}$

                                              $= \boxed{19 mL}$

ii) Add some volume of distilled H_2O to the
    50 mL volumetric flask. Use a graduated
    cylinder to measure 19 mL of the 16 M HNO_3
    stock solution + carefully add it to the
    H_2O in the v. flask, mix. Add distilled H_2O until
    the volume of solution is at the line in the flask.

b) $NaHCO_3$ is the best option to clean up the spill.
   HCO_3^- can accept a proton (H^+) and neutralize
   the acid spill during clean up.

c) $2\overset{0}{Ag}(s) + 2H\overset{+1}{N}O_3(aq) \rightarrow 2AgNO_3(aq) + \overset{0}{H_2}(g)$

   oxidized - Ag
   Reduced - H

d) $AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$ more c

   $Ag^+(aq) + NO_3^-(aq) + Na^+(aq) + Cl^-(aq) \longrightarrow$ complete ion

                    $AgCl(s) + Na^+(aq) + NO_3^-(aq)$

   $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$
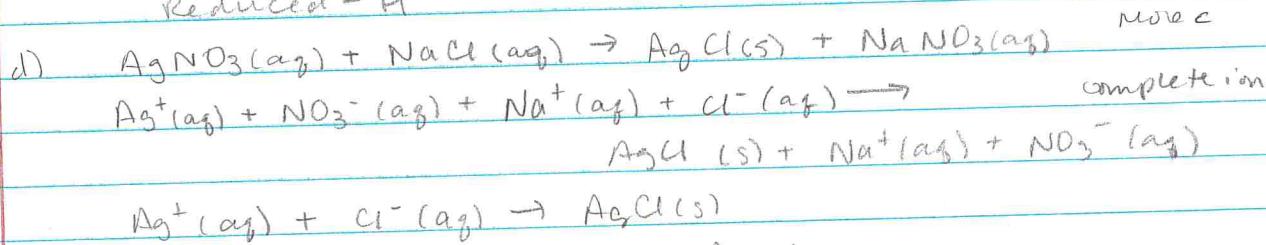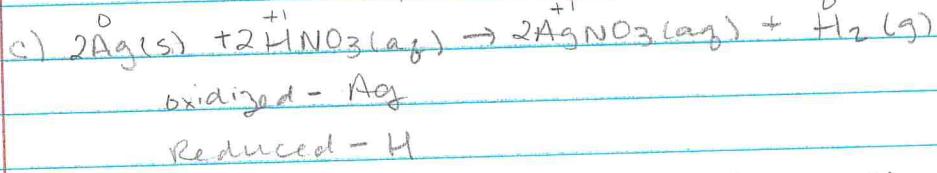
e) $29.2598g - 28.7210g = .5388g\ AgCl$

$.5388g\ AgCl$	$\dfrac{1\ mol\ AgCl}{143.32g\ AgCl}$	$\dfrac{1\ mol\ AgNO_3}{1\ mol\ AgCl}$ from precip. eqn	$\dfrac{2\ mol\ Ag}{2\ mol\ AgNO_3}$ from SR eqn	$\dfrac{107.87g\ Ag}{1\ mol\ Ag}$

   $= \boxed{.4055g\ Ag}$

④ a) $V = .0750 L$ $PV = nRT$

   $P = 750 mmHg$ $n = \dfrac{PV}{RT} = \dfrac{(750)(.0750)}{(62.36)(290)} = .0031\ mol\ CO_2$

   $T = 20°C = 290 K$

                    $\dfrac{.0031\ mol\ CO_2}{} \Big| \dfrac{44.01g}{1\ mol} = \boxed{.14g\ CO_2}$

b) $CaCO_3(s) \overset{\Delta}{\longrightarrow} CaO(s) + CO_2(g)$

   $MgCO_3(s) \overset{\Delta}{\longrightarrow} MgO(s) + CO_2(g)$

⑤ a) a different precipitate forms of PbI_2

b) $\dfrac{.150g\ Pb(NO_3)_2}{}\ \dfrac{1\ mol}{331.22\ g} = \boxed{4.53 \cdot 10^{-4}\ mol\ Pb(NO_3)_2}$

$\dfrac{125mL}{}\ \dfrac{1L}{1000mL}\ \dfrac{.100mol\ NaI}{1L} = \boxed{.0125\ mol\ NaI}$

c) $\dfrac{.0125\ mol\ NaI}{}\ \dfrac{1\ mol\ Pb(NO_3)_2}{2\ mol\ NaI} = .00625\ mol\ Pb(NO_3)_2$

more than in b

$Pb(NO_3)_2$ is LR
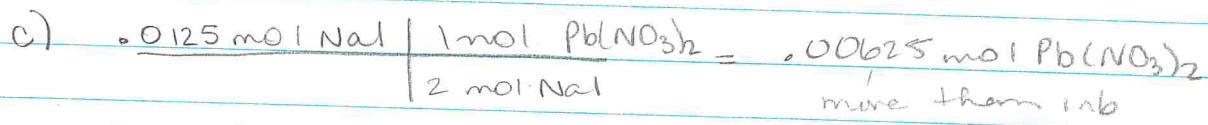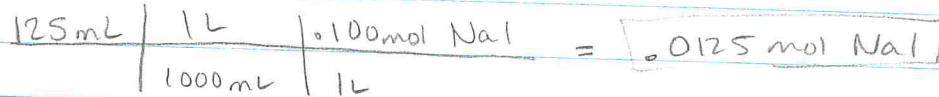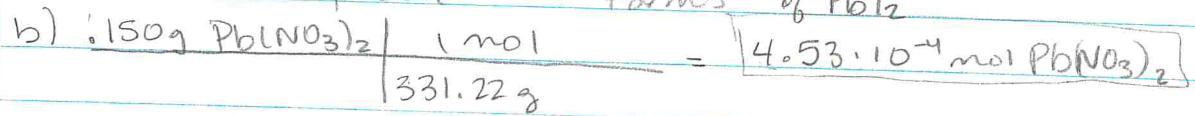
d) all NO_3^- comes from $Pb(NO_3)_2$ and is not used up.

$\dfrac{4.53 \cdot 10^{-4}\ mol\ Pb(NO_3)_2}{}\ \dfrac{2\ mol\ NO_3^-}{1\ mol\ Pb(NO_3)_2}$

$\dfrac{= 9.06 \cdot 10^{-4}\ mol\ NO_3^-}{.125\ L} = \boxed{.00723M\ NO_3^-}$
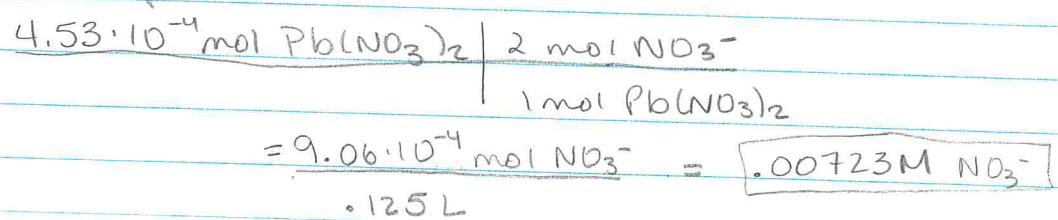
e) upper right diagram — all Pb^{2+} is precipitated as PbI_2 ∴ no Pb^{2+} ions in soln. NO_3^- is a spectator ion, as is Na^+, so both are present in soln. NaI is the excess reagent, so excess I^- ions will be in soln.

⑥ $V = 454 mL = .454\ L$ $P_{H_2} = 712\ mmHg - 19.8\ mmHg = 692\ mmHg$

$T = 23.0°C = 296.2\ K$ $PV = nRT$

$P_{tot} = 712\ mmHg$ $n_{H_2} = \dfrac{PV}{RT} = \dfrac{(692)(.454)}{(62.36)(296.2)}$

$P_{H_2O} = 19.8\ mmHg$

$m_{Zn} = ?$ $= .0170\ mol\ H_2$

$\dfrac{.0170\ mol\ H_2}{}\ \dfrac{1\ mol\ Zn}{1\ mol\ H_2}\ \dfrac{65.38g}{1\ mol\ Zn} = \boxed{1.06g\ Zn}$

⑦ $Ba(NO_3)_2 + 2KIO_3 \longrightarrow Ba(IO_3)_2 (s) + 2 KNO_3$

.100L	.060 mol $Ba(NO_3)_2$	1 mol $Ba(IO_3)_2$	487.13g $Ba(IO_3)_2$
	1L	1 mol $Ba(NO_3)_2$	1 mol $Ba(IO_3)_2$

$$= \boxed{2.92 \ Ba(IO_3)_2}$$

.150L	.12 mol KIO_3	1 mol $Ba(IO_3)_2$	487.13g $Ba(IO_3)_2$
	1L	2 mol KIO_3	1 mol $Ba(IO_3)_2$

$$= 4.4 g \ Ba(IO_3)_2$$
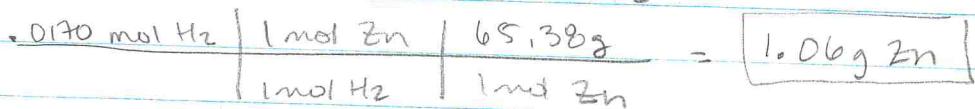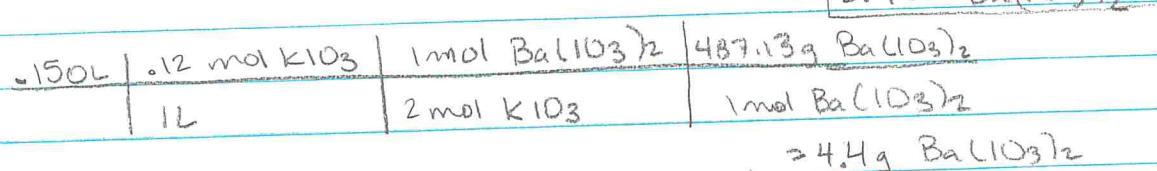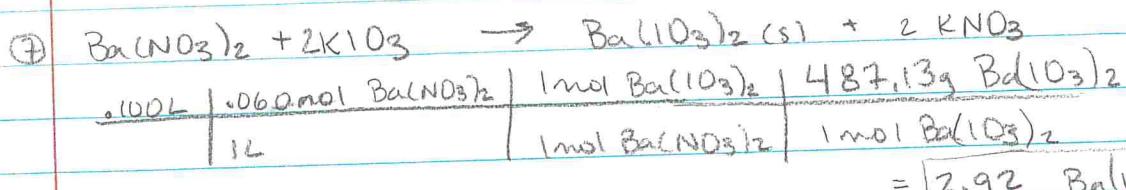
⑧ a) $Na_3PO_4(s) \longrightarrow 3Na^+(aq) + PO_4^{3-}(aq)$

b) $(NH_4)_2CO_3(aq) + Pb(NO_3)_2(aq) \longrightarrow PbCO_3(s) + 2NH_4NO_3$

c) $H_2O(l) \xrightarrow{\Delta} H_2O(g)$

d) $CH_4(g) + 2 O_2(g) \longrightarrow CO_2(g) + 2 H_2O(g \text{ or } l)$

⑨ or $MSO_4 + BaCl_2 \longrightarrow MCl_2 + BaSO_4$

$M_2SO_4(aq) + BaCl_2(aq) \longrightarrow 2 MCl(aq) + BaSO_4(s)$
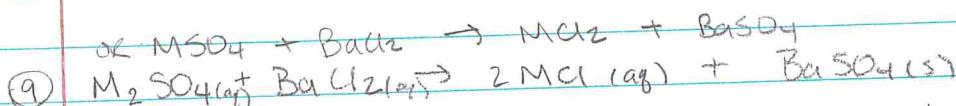
a) Dissolve the M_2SO_4 in H_2O. React w/ aqueous $BaCl_2$ to form precipitate. Filter precipitate + dry. Use mass of precipitate ($BaSO_4$) to calculate moles M_2SO_4 that reacted. Use mass + moles M_2SO_4 to calculate molar mass.

b) no — mixing $M_2SO_4(aq) + MgCl_2(aq)$ would not produce a precipitate ($MgSO_4$ is soluble)
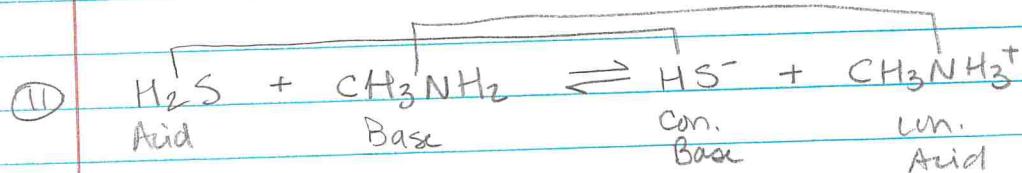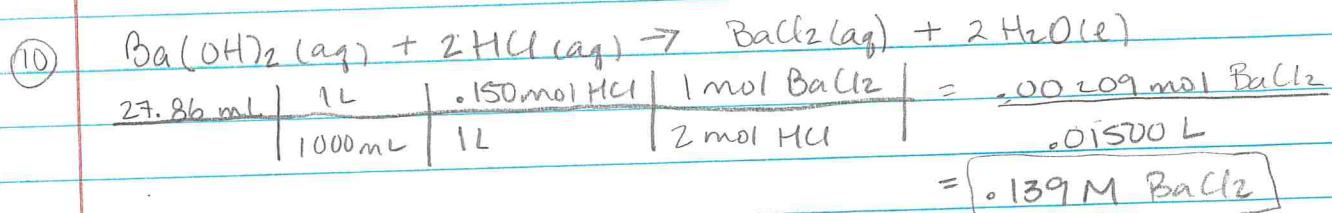
⑩ $Ba(OH)_2(aq) + 2HCl(aq) \longrightarrow BaCl_2(aq) + 2H_2O(l)$

27.86 mL	1L	.150 mol HCl	1 mol $BaCl_2$	= $\underline{.00209 \ mol \ BaCl_2}$
	1000mL	1L	2 mol HCl	.01500 L

$$= \boxed{.139 M \ BaCl_2}$$

⑪ $H_2S \ + \ CH_3NH_2 \ \rightleftharpoons \ HS^- \ + \ CH_3NH_3^+$

   Acid   Base   Con.   Con.
                             Base   Acid

(12) a) $C_xH_y + O_2 \rightarrow CO_2 + H_2O$

$$\underset{STP}{7.2L} \qquad 7.2g$$

$$\frac{7.2g\ H_2O}{} \left| \frac{1\ mol\ H_2O}{18.02g\ H_2O} \right| \frac{2\ mol\ H}{1\ mol\ H_2O} = .80\ mol\ H$$

$$\frac{7.2L\ CO_2}{} \left| \frac{1\ mol\ CO_2}{22.4L} \right| \frac{1\ mol\ C}{1\ mol\ CO_2} = .32\ mol\ C$$

$$\frac{.32\ mol\ C}{.32} = 1 \times 2 \qquad \frac{.80\ mol\ H}{.32} = 2.5 \times 2$$

$$\boxed{EF = C_2H_5}$$

b) $\dfrac{7.2g\ H_2O}{} \left| \dfrac{1\ mol\ H_2O}{18.02g\ H_2O} \right| \dfrac{13\ mol\ O_2}{10\ mol\ H_2O} \left| \dfrac{32.00g\ O_2}{1\ mol\ O_2} \right. = \boxed{17g\ O_2}$

$$4C_2H_5 + 13O_2 \rightarrow 8CO_2 + 10H_2O$$

(13)

$$Fe^{2+} + MnO_4^- \rightarrow Fe^{3+} + Mn^{2+}$$

a)
$$(Fe^{2+} \rightarrow Fe^{3+} + 1e^-)5$$

$$5e^- + 8H^+ + MnO_4^- \rightarrow Mn^{2+} + 4H_2O$$

$$5Fe^{2+} + 5e^- + 8H^+ + MnO_4^- \rightarrow 5Fe^{3+} + 5e^- + Mn^{2+} + 4H_2O$$

$$\boxed{5Fe^{2+} + 8H^+ + MnO_4^- \rightarrow 5Fe^{3+} + Mn^{2+} + 4H_2O}$$
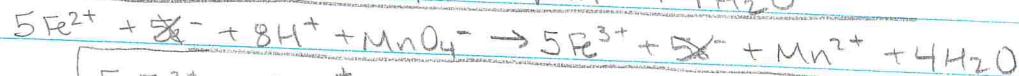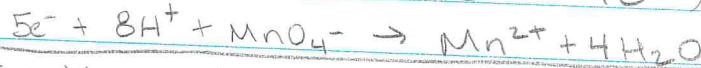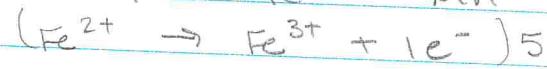
b) oxidized: Fe

Reduced: Mn

c) $\dfrac{37.93\ mL}{} \left| \dfrac{1L}{1000\ mL} \right| \dfrac{.1350\ mol\ MnO_4^-}{1L} \left| \dfrac{5\ mol\ Fe^{2+}}{1\ mol\ MnO_4^-} \right.$

$$= \frac{.02560\ mol\ Fe^{2+}}{.02250L} = \boxed{1.138\ M\ Fe^{2+}}$$

Practice AP Questions

①

(B) $\dfrac{.40\ mol\ Al}{} \left| \dfrac{2\ mol\ Al_2O_3}{4\ mol\ Al} \right. = \dfrac{.40 \cdot 2}{4} = \boxed{.2\ mol\ Al_2O_3}$

$$\frac{.40\ mol\ O_2}{} \left| \frac{2\ mol\ Al_2O_3}{3\ mol\ O_2} \right. = \frac{.40 \cdot 2}{3} = \frac{.8}{3} = .27$$

$$4Al + 3O_2 \rightarrow 2Al_2O_3$$

Redox

② $Zn + H^+ + NO_3^- \rightarrow Zn^{2+} + NH_4^+ + H_2O$

Ⓑ
$$(Zn \rightarrow Zn^{2+} + 2e^-)\, 4$$
$$8e^- + 10H^+ + NO_3^- \rightarrow NH_4^+ + 3H_2O$$
$$\overline{8e^- + 10H^+ + NO_3^- + 4Zn \rightarrow NH_4^+ + 3H_2O + 4Zn^{2+} + \cancel{8e^-}}$$
$$④\, Zn + 10H^+ + NO_3^- \rightarrow 4Zn^{2+} + NH_4^+ + 3H_2O$$

③ $SnCl_2 + CuSO_4 \rightarrow SnSO_4(aq) + CuCl_2(aq)$

Ⓔ $ZnSO_4 + SnF_2 \rightarrow SnSO_4(aq) + \underline{ZnF_2(s)}$

④ $2N_2H_4(g) + N_2O_4(g) \rightarrow 3N_2(g) + 4H_2O(g)$

$$\dfrac{8.0g\ N_2H_4}{}\left|\dfrac{1\ mol\ N_2H_4}{32\ g\ N_2H_4}\right|\dfrac{4\ mol\ H_2O}{2\ mol\ N_2H_4}\left|\dfrac{18.02g\ H_2O}{1\ mol\ H_2O}\right. = \dfrac{8\cdot4\cdot18}{32\cdot2} = 9$$

ⓐ
$$\dfrac{92g\ N_2O_4}{}\left|\dfrac{1\ mol\ N_2O_4}{92g\ N_2O_4}\right|\dfrac{4\ mol\ H_2O}{1\ mol\ N_2O_4}\left|\dfrac{18g\ H_2O}{1\ mol\ H_2O}\right. = \dfrac{\cancel{92}\cdot4\cdot18}{\cancel{92}} = \text{more than } 9$$

⑤ $1.0\,L$

$\left.\begin{array}{l} .10\ mol\ NaCl = .10\ mol\ Cl^- \\ .10\ mol\ CaCl_2 = .20\ mol\ Cl^- \end{array}\right\}\ \underline{.30\ mol\ Cl^-}$

Ⓒ $Ag^+ + Cl^- \rightarrow AgCl$

⑥ $100.\ mL\ BaCl_2$

$BaCl_2 + H_2SO_4 \rightarrow BaSO_4(s) + 2HCl$
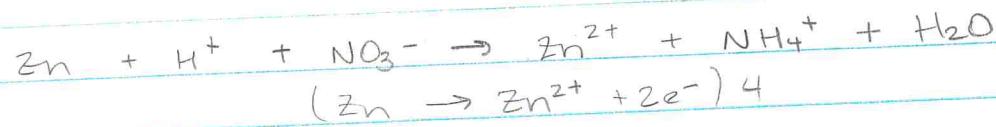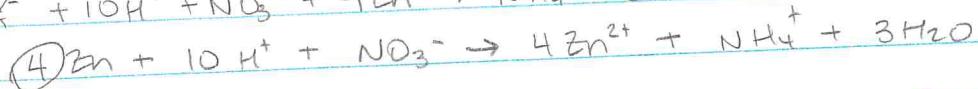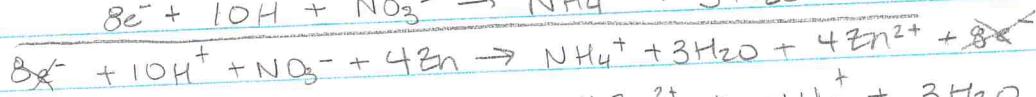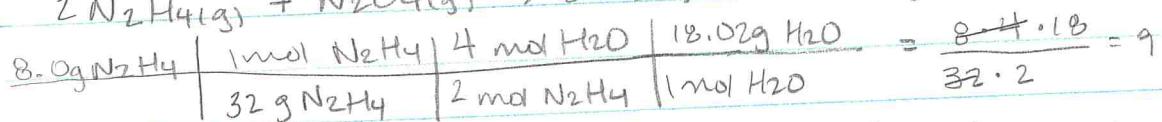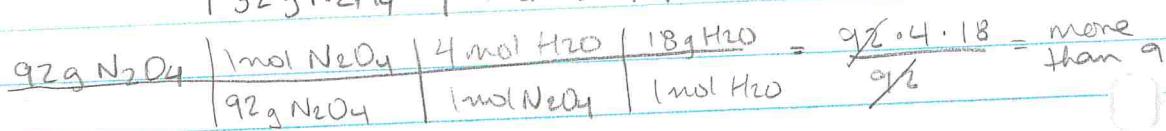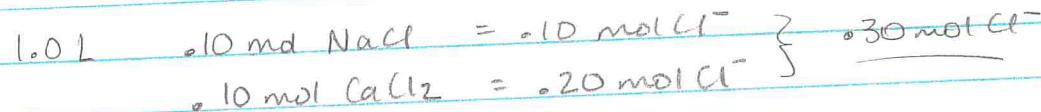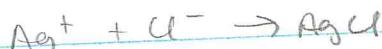
$.10M\ BaCl_2$

$100.\ mL\ H_2SO_4$

$.050M\ H_2SO_4$

$$\dfrac{.1L}{}\left|\dfrac{.1mol\ BaCl_2}{1L}\right. = .01\ mol\ BaCl_2 = .01\ mol\ Ba^{2+}$$

$$\dfrac{.1L}{}\left|\dfrac{.05mol\ H_2SO_4}{1L}\right. = .005\ mol\ H_2SO_4 = .005\ mol\ SO_4^{2-}$$

Ⓒ All SO_4^{2-} reacts, only .005 mol Ba^{2+} reacts,

leaving .005 mol Ba^{2+}

$$\dfrac{.005\ mol\ Ba^{2+}}{.2L} = .025\ M$$

(7)

$$\frac{250\,mL}{} \bigg| \frac{1L}{1000\,mL} \bigg| \frac{.120\,mol\ Ba(OH)_2}{1L} \bigg| \frac{2\,mol\ HCl}{1\,mol\ BaCl_2} \bigg| \frac{1L}{.150\,\frac{mol}{HCl}} \bigg| \frac{1000\,m}{1L}$$

(c) $2HCl + Ba(OH)_2 \rightarrow 2H_2O + BaCl_2$

$$= \frac{25 \cdot .120 \cdot 2 \cdot 1000}{1000 \cdot .15} = \frac{25 \cdot .120 \cdot 2}{.15} = \frac{5 \cdot 5 \cdot .25 \cdot 4 \cdot}{5 \cdot 5}$$

$$= 5 \cdot 4 \cdot 2 = \boxed{40}$$

(8) 40.0 mL   .25 M KOH = .25 M OH^-

60.0 mL   .15 M $Ba(OH)_2$ = .30 M OH^-

$$[OH^-] = \frac{(.25\,\tfrac{mol}{L}\ OH^-)(.04\,L\ OH^-) + (.30\,\tfrac{mol}{L}\ OH^-)(.06\,L\ OH^-)}{.1\,L}$$

(c)

$$= \frac{.25 \cdot .4 \quad + .30 \cdot .6}{.1}$$

$$\frac{.1 \quad + \quad .18}{} = .28\,M$$

(9)

$$\overset{+4\ -2}{CO_2} \qquad \overset{+4\ -2}{PbO_2} \qquad \overset{+2\ -2}{CaO} \qquad \overset{+5\ -2}{N_2O_5} \qquad \overset{+1\quad -2}{Cu_2O}$$

(e)

(10) ① 　 ② 　 ③ 　 ④

(e)

(11) a) $\overset{}{16H^+} + \overset{+7}{2MnO_4^-} + \overset{+3\ -2}{5C_2O_4^{2-}} \rightarrow Mn^{2+} + \overset{+4\ -2}{10CO_2} + 8H_2O$

oxidized   C

reduced   Mn

b)

$$\frac{.01780\,L\ MnO_4^-}{} \bigg| \frac{.0150\,mol\ MnO_4^-}{1L} \bigg| \frac{5\,mol\ C_2O_4^{2-}}{2\,mol\ MnO_4^-} = \frac{.000668}{mol\ C_2O_4^{2-}}$$

.00668 mol $C_2O_4^{2-}$ = .00668 mol BeC_2O_4

$$\frac{.000668\,mol\ BeC_2O_4}{} \bigg| \frac{97.03g\ BeC_2O_4}{1\,mol\ BeC_2O_4} = .0648\,g\ BeC_2O_4\ in$$

20.0 mL

$$\frac{.0648\,g\ BeC_2O_4}{20.0\,mL} = \frac{x\,g}{100.\,mL} \qquad x = \boxed{.324g \\ pure\ BeC_2O_4}$$

⑫ a) $Pb(NO_3)_2 + NaCl \rightarrow \boxed{PbCl_2}$

b) C_2H_5OH — this is a molecular compound. The others are ionic + dissociate into ions + ∴ conduct electricity.

c) $KMnO_4$

$2Cl^- \rightarrow \boxed{Cl_2} + 2e^- (lose\ e^-)$

⑬ a) the Al + $CuSO_4$ react. Al is higher on the activity series than Cu and will replace it

$2Al + 3CuSO_4 \rightarrow Al_2(SO_4)_3 + 3Cu$ (molecular)

$2Al + 3Cu^{2+} \rightarrow 2Al^{3+} + 3Cu$ (net ionic

(I would accept either equation)

b) The T inside the metal container is high, as the steam (gas) is hot. As the container cools, the gas inside cools, lowering the pressure. Eventually, the pressure inside the container is lower than the pressure outside and the container implodes.

c) The rubbing alcohol absorbs heat from your skin, interrupting the intermolecular forces that hold the alcohol molecules together + causing the rubbing alcohol to evaporate

d) The baking soda neutralizes the methanoic acid

$HCO_2H + NaHCO_3 \rightarrow NaHCO_2 + H_2CO_3$

H_2CO_3 decomposes to $H_2O + CO_2$

$HCO_2H + NaHCO_3 \rightarrow NaHCO_3 + H_2O + CO_2$

(14)

$$\text{Aspirin-H} + \text{NaOH} \rightarrow \text{Aspirin-Na} + \text{H}_2\text{O}$$
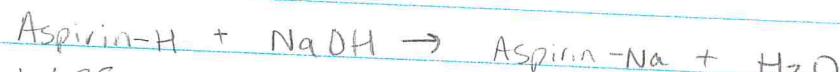
1.625 g   88.43 ml

.102 M

$$\frac{.08843 \text{ L}}{} \left| \frac{.102 \text{ mol NaOH}}{1 \text{ L}} \right| \frac{1 \text{ mol Aspirin-H}}{1 \text{ mol NaOH}} = .00902 \text{ mol aspirin}$$

$$\text{Molar mass} = \frac{g}{\text{mol}} = \frac{1.625 \text{ g}}{.00902 \text{ mol}} = \boxed{180.9 \text{ g/mol}}$$

(15) a) $2 \overset{+7}{\text{K} \text{MnO}_4} + 5 H_2 \overset{+3}{\text{C}_2\text{O}_4} + 3 H_2 SO_4 \rightarrow 2 \overset{+2}{\text{Mn}} SO_4 + 10 \overset{+4}{\text{C}} O_2 + 8 H_2O + k_2 S$
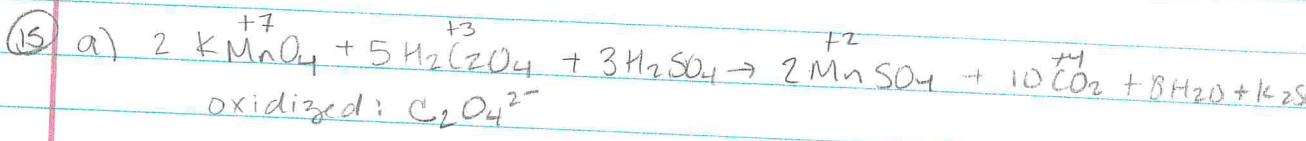
oxidized: $C_2O_4^{2-}$

Reduced: Mn

b) the MnO_4^- indicates the end point. When the end point has been reached, all of the purple MnO_4^- has been Reduced to not purple Mn^{2+}. Adding additional MnO_4^- to the flask will result in a colored solution instead of clear.

c) need to know the mass of oxalic acid in flask and the initial volume + final volume readings on buret

d) Perform the titration, stopping when the flask shows a permanent light pink color. Use the mass of oxalic acid in the flask to determine the moles of oxalic acid. Use stoichiometry + the balanced equation to calculate the moles of $KMnO_4$ that reacted. Divide the moles of $KMnO_4$ by the volume of $KMnO_4$ soln added in L to calculate molarity

e) $[KMnO_4]$ would not be affected. H_2O is not a reactant + ... does not affect stoich. It is only used to dissolve oxalic acid