CHEM 101A – Chapter 4 Aqueous Solutions Problems

Na^+ SO_4^{2-} Pb^{2+} NO_3^-

1. Aqueous solutions containing sodium sulfate and lead(II) nitrate are mixed.

   a. What species precipitates?

1 : 1

$Na_2SO_4(aq) + Pb(NO_3)_2(aq) \rightarrow 2NaNO_3(aq) + PbSO_4(s)$

2.00 L × 0.0250 M = 0.0500 mol (L.R.)

1.25 L × 0.0500 M = 0.0625 mol

lead(II) sulfate precipitates

   b. Calculate the mass of precipitate formed when 1.25 L of 0.0500 *M* $Pb(NO_3)_2$ and 2.00 L of 0.0250 *M* Na_2SO_4 are mixed.

L.R. $0.0500\ mol\ Na_2SO_4 \times \frac{1\ mol\ PbSO_4}{1\ mol\ Na_2SO_4} \times \frac{303.27\ g\ PbSO_4}{1\ mol\ PbSO_4}$

$= 15.1635\ g\ PbSO_4$

$15.2\ g\ PbSO_4$ (3)

2. Complete and balance each acid-base reaction below. Write the net ionic equation of equations **a** and **c.**

SA/SB

a. $HBr(aq) + KOH(aq) \rightarrow$ $H_2O(l) + KBr(aq)$

$H^+ + Br^- + K^+ + OH^- \rightarrow H_2O + K^+ + Br^-$

$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

$Na^+ \; SO_4^{2-}$

Na^+

b. $H_2SO_4(aq) + 2NaOH(aq) \rightarrow 2H_2O(l) + Na_2SO_4(aq)$

$Ca^{2+} \; C_2H_3O_2^-$

c. $Ca(OH)_2(aq) + 2HC_2H_3O_2(aq) \rightarrow Ca(C_2H_3O_2)_2(aq) + 2H_2O(l)$

Spectator

$Ca^{2+} + 2OH^- + 2HC_2H_3O_2 \rightarrow Ca^{2+} + 2C_2H_3O_2^- + 2H_2O$

$2OH^-(aq) + 2HC_2H_3O_2(aq) \rightarrow 2C_2H_3O_2^-(aq) + 2H_2O(l)$

H^+

3. You combine 28.0 mL of 0.250*M* HNO_3 with 53.0 mL of 0.200*M* KOH. K^+ OH^-

a. Write the net ionic equation.

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$$

b. Calculate the molarity of excess H^+ or OH^- ions.

.250M H^+ × 0.0280L + .200M OH^- × 0.0530L

0.00700 mol H^+ L.R. (1:1)

0.0106 mol OH^- − 0.00700 mol OH^- → excess → given → react

0.0036 mol OH^-

$$\frac{0.0036 \text{ mol } OH^-}{0.081 \text{ L}} = 0.44 \text{ M } OH^-$$

$$.00700 \text{ mol } H^+ \times \frac{1 \text{ mol } OH^-}{1 \text{ mol } H^+} = 0.00700 \text{ mol } OH^- \text{ react}$$

c. Calculate the volume of H_2O formed (assume H_2O density = 1.00 g/mL). Would the volume change substantially or negligibly?

0.00700 mol H^+ → ? g H_2O

$$0.00700 \text{ mol } H^+ \times \frac{1 \text{ mol } H_2O}{1 \text{ mol } H^+} = 0.00700 \text{ mol } H_2O \times \frac{18.016 \text{ g}}{1 \text{ mol}} = 0.126 \text{ g } H_2O$$

0.126 mL H_2O

81.0 mL

.126 mL

5. Assign oxidation state to all atoms in the equation below. Is the reaction redox?

$H_3PO_4(aq) + 3KOH(aq) \rightarrow 3H_2O(l) + K_3PO_4(aq)$ NO

Atom	Ox State Reactant	Ox State Product
H	+1	+1
P	+5	+5
O (in phosphate)	-2	-2
O (in hydroxide/water)	-2	-2
K	+1	+1

6. Determine the oxidizing agent and the number of electrons transferred in each redox reaction below.

a. $2AgNO_3(aq) + Cu(s) \rightarrow 2Ag(s) + Cu(NO_3)_2(aq)$ OA

$2Ag^+ + 2NO_3^- + Cu^0 \rightarrow 2Ag^0 + Cu^{2+} + 2NO_3^-$

red: $2Ag^+ + 2e^- \rightarrow 2Ag$ $n = 2e^-$

ox: $Cu \rightarrow Cu^{2+} + 2e^-$

b. $14H^+(aq) + Cr_2O_7^{2-}(aq) \rightarrow 2Cr^{3+}(aq) + 7H_2O(l)$

c. $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$

-4 +1 0 +4 -2 +1 -2

O.A.

$n = 8e^-$

ox: $C^{-4} \rightarrow C^{+4} + 8e^-$

red: $8e^- + 4 \cdot O^0 \rightarrow 4O^{-2}$

4. A mixture contains only sodium chloride and potassium chloride. A 0.1586-g sample of the mixture was dissolved in water. It took 22.90 mL of 0.1000 *M* $AgNO_3$ to completely precipitate all the chloride present. What is the composition (by mass percent) of the mixture?

= .002290 mol $AgNO_3$

~~NaCl + KCl~~ →

1:1

$NaCl + AgNO_3 \rightarrow AgCl(s) + NaNO_3$

$KCl + AgNO_3 \rightarrow AgCl(s) + KNO_3$

let x = moles NaCl → ? g

let y = moles KCl → ? g

1) $58.44(x + y = .002290)$ moles NaCl & KCl

-0.1331

2) $58.44x + 74.55y = 0.1586$ grams " "

$16.11y = 0.0255$

$y = 1.58 \times 10^{-3}$ mol KCl

↳ 0.1181 g KCl

0.0405 g NaCl } 0.1586g

74.46% KCl

25.54% NaCl