AP Chemistry
Solution Chemistry Practice Problems

Name: _____ Date: _____ Period: _____

1. Consider a 1.00L solution containing 85.5g $Al_2(SO_4)_3$ (FW = 342.15) and 21.3g Na_2SO_4 (FW = 142.06). What are the molar concentrations of the aluminum, sodium and sulfate ions?

1. mol $Al_2(SO_4)_3$ = 85.5g/(342.15g/mol) = .250mol
= 0.50mol Al and 0.75mol SO_4^{2-}
mol Na_2SO_4 = 21.3g/(142.06g/mol) = .150mol
= 0.300mol Na and 0.150mol SO_4^{2-}
$[Al^{3+}]$ = 0.500mol/1.0L = **0.500M**
$[Na^+]$ = 0.300mol/1.0L = **0.300M**
$[SO_4^{2-}]$ = (0.750mol + 0.150mol)/1.0L = **0.900M**

2. The molecular equation is
$H_2SO_{4(aq)} + Sr(OH)_{2(aq)} \rightarrow SrSO_{4(s)} + 2H_2O_{(l)}$ The total ionic equation is
$H^+_{(aq)} + HSO_4^-{}_{(aq)} + Sr^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow SrSO_{4(s)} + 2H_2O_{(l)}$
(or $2H^+_{(aq)} + SO_4^{2-}{}_{(aq)} + Sr^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow SrSO_{4(s)} + 2H_2O_{(l)}$)
Since there are no spectator ions, **the total and net ionic equations are the same**.

3. Which of the following substances is a strong electrolyte in aqueous solution?
NaCl CH_4 H_2O CO CCl_4

NaCl. NaCl is a soluble ionic compound. The others either do not produce, or produce an extremely small number of ions (H_2O).

4. A 25.00mL sample of an aqueous solution of $Ba(OH)_2$ requires 18.45mL of 0.01500M $HCl_{(aq)}$ for its neutralization. What is the molarity of the $Ba(OH)_2$ solution?

moles of HCl used = .01845L(0.01500mol/L) = $2.77x10^{-4}$ mol HCl = mol H^+
This was able to neutralize $2.77x10^{-4}$ mol of OH^-. Since each $Ba(OH)_2$ produces $2OH^-$, there were $(2.77x10^{-4})/2 = 1.385x10^{-4}$ mol $Ba(OH)_2$. The molarity of the barium hydroxide is ($1.385x10^{-4}$mol)/(0.02500L) = **$5.54x10^{-3}$M**

5. Write net ionic equations for the following neutralization reactions:
   a. The strong base KOH and the weak acid $HC_2H_3O_2$.

   $HC_2H_3O_{2(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)} + C_2H_3O_2^-{}_{(aq)}$

   b. The strong base barium hydroxide and the strong acid perchloric acid.

   $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$
   c. The weak base methyl amine (CH_3NH_2) and the strong acid hydrobromic acid (HBr).

   $CH_3NH_{2(aq)} + H^+_{(aq)} \rightarrow CH_3NH_3^+{}_{(aq)}$

6. What is the molarity of a solution of hydroiodic acid if exactly 35.0mL of .010M lithium hydroxide is required to titrate 30.0mL of the acid solution to the equivalence point?

$LiOH + HI \rightarrow LiI + H2O$
mol LiOH = (.0350L)(.010M) = .000350mol
.000350mol LiOH (1mol HI / 1mol LiOH) = .000350mol HI M = .000350mol/.030L = **.012M**

7. Classify each (unbalanced) reaction as precipitation, acid-base neutralization or oxidation-reduction. Write a net ionic equation where possible.

a. $Mg_{(s)} + Cl_{2(g)} \rightarrow$
b. $Ba(OH)_{2(aq)} + H_2SO_{4(aq)} \rightarrow$
c. $Cu(NO_3)_{2(aq)} + Zn_{(s)} \rightarrow$
d. $Na_2CO_{3(aq)} + Al(NO_3)_{3(aq)} \rightarrow$

a. $Mg_{(s)} + Cl_{2(g)} \rightarrow MgCl_{2(s)}$ oxidation/reduction (synthesis)
b. $Ba^{2+}_{(aq)} + 2OH^{-}_{(aq)} + 2H^{+}_{(aq)} + SO_4^{2-}_{(aq)} \rightarrow 2H_2O_{(l)} + BaSO_{4(s)}$ neutralization.
c. $Cu^{2+}_{(aq)} + Zn_{(s)} \rightarrow Cu_{(s)} + Zn^{2+}_{(aq)}$ oxidation/reduction (single replacement)
d. $2Al^{3+}_{(aq)} + 3CO_3^{2-}_{(aq)} \rightarrow Al_2(CO_3)_3$ precipitation (metathesis, double displacement)

8. In each reaction determine: a) the oxidation number of each element, b) which element is oxidized and which is reduced, c) the oxidizing agent and the reducing agent.

a. $4NH_3 + 6NO \rightarrow 5N_2 + 6H_2O$
b. $2LiI + F_2 \rightarrow 2LiF + I_2$

$$\overset{-3\ +1}{4NH_3} + \overset{+2\ -2}{6NO} \rightarrow \overset{0}{5N_2} + \overset{+1\ -2}{6H_2O}$$

$$\overset{+1\ -1}{2LiI} + \overset{0}{F_2} \rightarrow \overset{+1\ -1}{2LiF} + \overset{0}{I_2}$$

For the first equation, nitrogen is both oxidized and reduced. Ammonia is the reducing agent and nitrogen monoxide is the oxidizing agent.
In the second equation, iodine is oxidized and fluorine is reduced. Lithium iodide is the reducing agent and fluorine is the oxidizing agent.

9. A 100.g sample of an unknown alkali metal sulfate compound is dissolved in water. When excess barium nitrate is added, 164.31g of insoluble barium sulfate is produced. What is the identity of the original sulfate compound?

$SO_4^{2-}_{(aq)} + Ba(NO_3)_{2(aq)} \rightarrow BaSO_{4(s)} + 2NO_3^{-}_{(aq)}$
Moles of $BaSO_4$ = 164.31g / (233.39g/mol) = .704mol
.704mol $BaSO_4$ (1mol SO_4^{2-} / 1mol $BaSO_4$) = .704 mol SO_4^{2-}
.704mol SO_4^{2-} (2mol alkali metal / 1mol SO_4^{2-}) = 1.41 mol alkali metal

mass of sulfate ion = .704mol SO_4^{2-} (96.063g/mol) = 67.63g sulfate
mass of alkali metal = 100.g - 67.63g = 32.37g alkali metal

molar mass of alkali metal = 32.37g / 1.41mol = 22.98g/mol
This is the molar mass for sodium, so the compound is **Na_2SO_4**

10. How many milliliters of a 3.85M solution of Fe^{2+} are needed to titrate 250.0mL of a 0.125M CrO_4^{2-} solution (in acidic solution)?
$H^+ + CrO_4^{2-} + Fe^{2+} \rightarrow Fe^{3+} + Cr_2O_3 + H_2O$ (not balanced)

Each iron loses 1 electron; each chromium gains 3 electrons so the balanced equation is
$10H^+ + 2CrO_4^{2-} + 6Fe^{2+} \rightarrow 6Fe^{3+} + Cr_2O_3 + 5H_2O$
moles of CrO_4^{2-} = (0.125M)(.250L) = .0313mol
the mole ratio makes .0313mol CrO_4^{2-} (1mol Fe^{2+}/2mol CrO_4^{2-}) = .0157mol Fe^{2+}
volume of Fe^{2+} needed = .0157mol/(3.85mol/L) = 0.0041L = **4.1mL**

11. Determine the net ionic equation for the reaction between aqueous $Sr(OH)_2$ and $FeSO_4$ solutions.

$Sr(OH)_{2(aq)} + FeSO_{4(aq)} \rightarrow SrSO_{4(aq)} + Fe(OH)_{2(s)}$
$Fe^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Fe(OH)_{2(s)}$

12. What is the oxidation number of iron in Fe_3O_7?

Iron balances -14 from the oxygen. Since there are 3 iron atoms, 3 goes into 14
4 2/3 times.

13. When the following half reaction (unbalanced) occurs, determine the total number of electrons transferred.

$Br_{2(aq)} \rightarrow BrO_3^-{}_{(aq)}$

0 +5 -2
$Br_2 \rightarrow BrO_3^-$

$Br_2 + 6H_2O \rightarrow 2BrO_3^- + 12H^+ + 10e^-$
10 electrons are transferred.

14. **0.1621% C_2H_5OH**
.03546L(0.04961M) = .001759mol dichromate
.001759mol dichromate (1mol ethanol / 2mol dichromate) = 8.795x10-4mol ethanol
8.795x10-4mol ethanol (46.0684g/mol) = .040517g
.040517g ethanol / 25.00g plasma = .001621 = .1621%

15. Pb falls below Zn on the activity series of metals. Determine if there will be a reaction when a piece of solid zinc is placed into a solution of lead(II)nitrate.

Yes. Since Zn is higher on the activity series, it is able to reduce the lead so that the zinc can become the 2+ ion.