Qualitative Analysis Lab Chemistry 101 Name______________________________

Preparation for Lab

1. The symbol M stands for Molarity. Molarity is another unit of measurement for concentration. Molarity = # of moles of a solute / Liters of Solution. For example: If you had 15 grams of NaCl (MW: 58.44 g/mol) and you dissolved the NaCl in water until the total volume was 200 mL you would have a solution of:

$$\frac{15\ g\ \text{NaCl}}{}\ \frac{1\ mole\ NaCl}{58.44\ g} = \_\_\_\_\_\_\_\_\_\_\_\_\ \text{moles NaCl}$$

$$\text{Molarity} = \frac{moles\ NaCl}{0.200\ L\ Solution} = \_\_\_\_\_\_\_\_\_\_\_\_\ \text{M}$$

2. How many grams of anhydrous (dry) Na_2CO_3 would you need to make 1 Liter of a 1.0 M aqueous solution of Na_2CO_3?

3. What is the w/w% of your 1 M Na_2CO_3 solution? For this you need to assume that the density of water is 1.00g/mL and that the volume of water needed to dissolve your Na_2CO_3 was 880 mL.

4. If NaCl $_{(aq)}$ and KI $_{(aq)}$ are mixed together, no reaction occurs. However, if $Pb(NO_3)_{2\ (aq)}$ and KI $_{(aq)}$ are mixed, a reaction occurs giving a precipitate. Write this reaction in full, balance it and then provide the Net Ionic Equation for the reaction.

Introduction: The definition of qualitative analysis is the examination of non-measurable data. With that said, this will be the least scary lab yet. There will be no math, just observations! Qualitative analysis often requires in-depth knowledge of various aspects of chemistry including acid-base equilibrium, redox reactions, solubility, etc. However, in the deductive process of identifying the presence of a compound, common sense and logic may be just as helpful. In modern chemistry, most qualitative analysis tests have been replaced with spectroscopic methods however qualitative analysis is very useful in illustrating general laboratory techniques and in quickly identifying specific cations or anions present in a solution.

Additionally, the observations we make can help us deduce the reactions that took place. We can quickly see if a precipitation reaction occurred and can use our solubility rules to determine which is our precipitate. In lecture, we saw a classic example of the mixing of $Pb(NO_3)_{2\,(aq.)}$ with $KI_{(aq.)}$ to give a yellow solid.

The Full Balanced Reaction:

$$Pb(NO_3)_{2\,(aq.)} + 2\ KI_{(aq.)} \rightarrow PbI_{2\,(s)} + 2\ KNO_{3\,(aq.)}$$

In this reaction we started with Pb^{2+} cations, NO_3^{1-} anions, K^{1+} cations, and I^{1-} anions all in solution(dissolved in water). When the two solutions were mixed the Lead (Pb^{2+}) and the Iodide (I^{1-}) formed a precipitate while the Potassium cations (K^{1+}) and nitrate anions (NO_3^{1-}) stayed in solution. Being that the Potassium and nitrate ions did not react we call them spectator ions (they just watched the reaction take place) and they are not a part of a Net Ionic equation.

The Net Ionic Equation for the above reaction is:

$$Pb^{2+}_{(aq.)} + 2\ I^{1-}_{(aq.)} \rightarrow PbI_{2\,(s)}$$

In this laboratory exercise we will look into a variety of solutions and try to understand the reactions that take place (or do not take place) and make sense of those observations. In the first part of this lab you will look at 9 different solutions reacting them together. You will record your observations. After this, you will then look at the same 9 solutions but they will not be identified (and will be a series of 9 unknowns) and you will need to react them to figure out which solution is which.

The solutions that you will be looking at are:

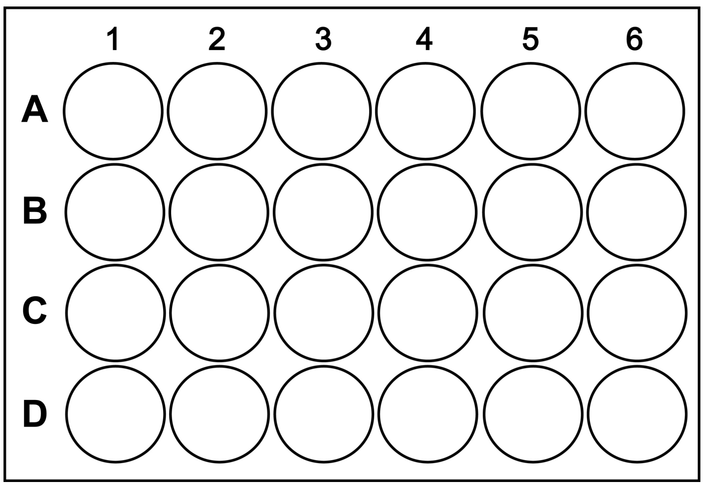
- 0.5 M $MgCl_2$
- 0.03 M $Fe(NH_4)_2SO_4$
- 0.01 M $KMnO_4$
- 0.5 M $Ba(NO_3)_2$
- 0.8 M K_2CO_3
- 1.0 M Na_2SO_4
- 0.1 M KSCN
- 1.0 M NaOH
- 1.0 M HNO_3

On the upcoming page you will find a chart that provides all these solutions in a combinatorial fashion. You will add drops of each of these solutions to each other (**ONLY IN THE WELL-PLATE PROVIDED**).

Procedure:

Below is an illustration of a 24-well plate. Well-plates are used to test series of reactions. In this laboratory you are going to use dropper bottles of the varying solutions to qualitatively observe what kinds of reactions are taking place.

24 Well-Plate:



Part 1: Use your dropper bottles and your well plate to mix the solutions together systematically. There is a chart on the next page for your convenience. What you are looking for are noticeable reactions that take place. Indicate on your Chart the reaction observations that you see from the corresponding mixtures.

Mark: **NO RXN** for mixes that yield no discernible reaction.

Mark: **PPT** for reaction that produce solid precipitates.

Mark: **BUBBLES!** For reactions that release bubbles!

The reactions that we are looking at are either Double-displacement or Neutralization reactions. This categorizing of reactions will be necessary for when we write Net Ionic Equations in the next step.

Throughout the lab you may fill up your 24-well plate or just want to clean it and start again as to keep your chart and observations tidy. Feel free to use the Deionized water squirt bottle and rinse/wash your well-plate into the AQUEOUS WASTE.

After you have recorded all of your observations for each mixture proceed to Part 2 of the lab.

QA CHART	0.5 M $MgCl_2$	0.03 M $Fe(NH_4)_2SO_4$	0.01 M $KMnO_4$	0.5 M $Ba(NO_3)_2$	0.8 M K_2CO_3	1.0 M Na_2SO_4	0.1 M KSCN	1.0 M NaOH	1.0 M HNO_3
0.5 M $MgCl_2$	X								
0.03 M $Fe(NH_4)_2SO_4$		X							
0.02 M $KMnO_4$			X						
0.5 M $Ba(NO_3)_2$				X					
0.8 M K_2CO_3					X				
1.0 M Na_2SO_4						X			
0.1 M KSCN							X		
1.0 M NaOH								X	
1.0 M HNO_3									X

Fill out this chart with either (**No RXN**) or indicate the formation of a precipitate (**PPT**) indicating the color of the precipitate.
Be sure to also indicate any other key observations like bubbling or color changes to the solution.

Part 2: Devise a Strategy to find your solutions.

Now that you know how the solutions react with each other you will now correctly identify all of these same solutions using a personal strategy to find each solution.

Obtain a set of numbered solutions. Systematically identify all of them.

I suggest you start with $KMnO_4$ (aq).

SOLUTION	NUMBER of UNKNOWN
0.5 M $MgCl_2$	
0.03 M $Fe(NH_4)_2SO_4$	
0.01 M $KMnO_4$	
0.5 M $Ba(NO_3)_2$	
0.8 M K_2CO_3	
1.0 M Na_2SO_4	
0.1 M KSCN	
1.0 M NaOH	
1.0 M HNO_3	

In words, describe your strategy in a step-wise fashion: (I started it for you)

Step 1: Identified $KMnO_4$ solution because it is purple.
Step 2: Used $KMnO_4$ against all solutions to identify____________________

Step 3:

Step 4:

(etc.)

Post-Lab Questions

1. Write the Full reaction and the Net Ionic Equation for the reaction of $Ba(NO_3)_{2\ (aq)}$ and $Na_2SO_{4\ (aq)}$.

Full Balanced Reaction:

Net Ionic Equation:

Identify the Spectator ions: ___________________________

2. In two reactions above we visualized a neutralization reaction through bubbling. Which reagents produced this observation. Write the balanced equations indicating the gases that were produced.

   Reaction 1:

   Gas_________

   Reaction 2:

   Gas__________

3. When color changes occur and the reactions stay in solution (No precipitate) this is sometimes characterized by a Reduction / Oxidation reaction in which there is an exchange of electrons instead and/or in addition to cations/anions. Which pairs of compounds produced reduction/oxidation reactions? (Just indicate pairs, we do not need to balance electrons right now).