Experiment #2 – Qualitative Analysis Lab

Introduction

The definition of qualitative analysis is the examination of non-measurable data. Through observations alone you will be able to scientifically determine a series of unknowns! 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. A classic example of precipitation reaction is 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.) → PbI_2 (s) + 2 KNO_3 (aq.)

The precipitation reaction starts 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.) → 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 nine different solutions reacting them together. You will record your observations. After this, you will then look at the same nine solutions but they will not be identified (and will be a series of nine unknowns) and you will need to react them together to figure out which solution is which.

The solutions that you will be looking at are:

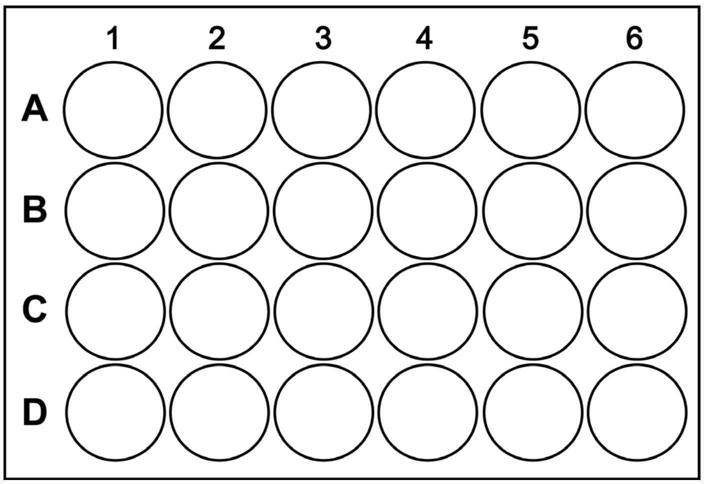
- 0.5 M $MgCl_2$
- 0.03 M $Fe(NH_4)_2SO_4$
- 0.01 M $KMnO_4$
- 0.5 M $Ba(NO_3)_2$
- 0.8 M K_2CO_3
- 1.0 M Na_2SO_4
- 0.1 M KSCN
- 1.0 M NaOH
- 1.0 M HNO_3

With this lab 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) and record your observations.

Procedure

Below is an illustration of a 24-well plate. Well-plates are used to test series of reactions. In this experiment dropper bottles of the varying solutions will be used 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. Note the color.

Mark: **BUBBLES!** For reactions that release gas or fizz!

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.

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.

It is suggested to start with $KMnO_4$ (aq).

Unknown Set #

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	

Obtain **A DIFFERENT SET OF UNKNOWNS FROM A DIFFERENT GROUP, BUT MAKE SURE YOU GRAB THE ENTIRE SET, and go to the next page!**

Find a volunteer with a stopwatch. Ask them to begin timing your effort.

As fast as you can, determine the unknowns. Make sure you are correct, or 20 seconds will be added for every time you turn in an incorrect assignment.

Unknown Set #

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	

Completion Time _______________________

Names _______________________________________ & ______________________________________

High School ____

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.