SCIENCE 10 LAB

ANALYSIS OF SOLUTIONS

INTRODUCTION

The purpose of this experiment is to identify the contents of six bottles. In no particular order, the bottles contain solutions of the following compounds.

$AgNO_3$	(silver nitrate)	$Pb(NO_3)_2$	(lead(II) nitrate)
HCl	(hydrochloric acid)	NaCl	(sodium chloride)
Na_2CO_3	(sodium carbonate)	KI	(potassium iodide)

When these chemicals dissolve in water, they produce the ions listed in the table below.

Chemical	Positive ion produced	Negative ion produced
$AgNO_3$	Ag^+	
HCl	H^+	Cl^-
Na_2CO_3	Na^+	
$Pb(NO_3)_2$	Pb^{2+}	
NaCl	Na^+	Cl^-
KI	K^+	I^-

When the ions in the above table are mixed, some combinations of ions do nothing while others produce a visible result. The ion combinations that produce a cloudy solid (a PRECIPITATE) or produce a gas (EFFERVESCENCE) are shown in the next table.

Positive ion	Negative ion	Product	Comments
Ag^+	Cl^-	AgCl	Solid (silver chloride)
Ag^+	I^-	Ag I	Solid (silver iodide)
2 Ag^+		Ag_2CO_3	Solid (silver carbonate)
Pb^{2+}	2 Cl^-	$PbCl_2$	Solid (lead(II) chloride)
Pb^{2+}	2 I^-	Pb I_2	Solid (lead(II) iodide)
Pb^{2+}	CO_3^{2-}	$PbCO_3$	Solid (lead (II) carbonate)
2 H^+	CO_3^{2-}	$H_2O + CO_2$	Water and a gas (carbon dioxide)

You will be given two sets of bottles. One set is properly labeled so you know which ions are reacting. The second set contains the same compounds as UNKNOWNS with a scrambled order. You will mix every combination of the known set of bottles and record what you see. Then you will mix every combination of the UNKNOWN set of bottles and again record what you see. By comparing the two sets of observations you should be able to identify the contents of each bottle of UNKNOWN solution.

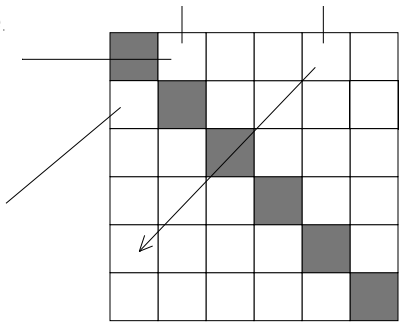
PROCEDURE

PART I : Known Solutions

1. Obtain: one set of 6 bottles labeled with the known compounds
   one set of 6 bottles labeled A, B, C, D, E and F (these are the UNKNOWNS)
   24 transparent plastic "well plates"

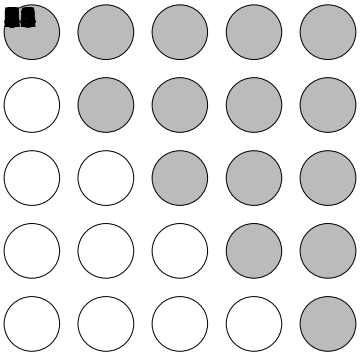
2. Look at the diagram below, which is meant to help you see how to enter information into Data Table I. Notice that there is a diagonal band of grey squares running from top left to bottom right. You will not mix these combinations. To the left of the band of grey squares there is a total of 15 numbered blank squares arranged in a triangular pattern. Below the band of grey squares is another triangular block of 15 numbered blank squares. The blank square labeled #1 is at the intersection of the "silver nitrate" column and "hydrochloric acid" row. When the result of mixing silver nitrate with hydrochloric acid is obtained, it is entered in square #1 **AND** a copy of the result is entered at the starred position "kitty corner" to position #1 (see the diagram). Similarly, when sodium chloride is mixed with hydrochloric acid, the result is entered at square #4 and its "kitty corner" counterpart, as shown on the diagram.

   Sil [illegible] the results for silver nitrate + hydrochloric acid **here**.



3. Place **two** well plates together to form a set of circular wells at least 5 wide by 5 high. Into well #1 place 1 drop of silver nitrate ($AgNO_3$) and 1 drop of hydrochloric acid (HCl). Record what you see in both blank squares labeled "1" in Data Table I as follows.
   - If there is no reaction, place a "—".
   - If there is a change in the appearance of the solutions, record exactly what you see.

   Note: The colour of any solids or milkiness produced is especially valuable information and MUST be recorded.



4. Similar to what you did in part 3, above, use Data Table I to help you mix the remaining solutions and fill in wells 2 through to 15.

PART II : UNKNOWN Solutions

5. Now place your remaining two well plates together and use Data Table II to record what happens when you mix UNKNOWN solutions A, B, C, D, E and F.

DATA

Table I : Results of Mixing KNOWN Solutions

	silver nitrate $AgNO_3$	hydrochloric acid HCl	sodium carbonate Na_2CO_3	lead (II) nitrate $Pb(NO_3)_2$	sodium chloride NaCl	potassium iodide KI
silver nitrate $AgNO_3$		1	2	3	4	5
hydrochloric acid HCl	1		6	7	8	9
sodium carbonate Na_2CO_3	2	6		10	11	12
lead (II) nitrate $Pb(NO_3)_2$	3	7	10		13	14
sodium chloride NaCl	4	8	11	13		15
potassium iodide KI	5	9	12	14	15	

Table II : Results of Mixing UNKNOWN Solutions

	UNKNOWN A	UNKNOWN B	UNKNOWN C	UNKNOWN D	UNKNOWN E	UNKNOWN F
UNKNOWN A						
UNKNOWN B						
UNKNOWN C						
UNKNOWN D						
UNKNOWN E						
UNKNOWN F						

ANALYSIS OF RESULTS

Compare the observations you recorded in Data Table I to the observations you recorded in Data Table II. Let's pretend Data Table II shows that mixing solutions A and B produces a blue precipitate and a green gas. If you found that mixing HCl and NaCl gives a blue precipitate and a green gas according to Data Table I (they don't give that result but, hey, we're pretending!), then you know that one of solution A and B is HCl and the other is NaCl. At this point you don't know which is which. By seeing what other special results are found for solution A and finding similar results in Data Table I, you can eventually decide whether solution A is HCl or NaCl (in our pretend analysis). Continue in this way until you have completely analyzed which solution is which. **HINT:** The presence of effervescence, the colour of precipitates and the number of precipitates formed by a compound are all important. Good luck and have fun!

CONCLUDING QUESTIONS

1. Show the results of your analysis by filling in the table below.

Actual Chemical in Solution	UNKNOWN Bottle Label
$AgNO_3$	
HCl	
Na_2CO_3	
$Pb(NO_3)_2$	
NaCl	
KI	

2. You have been hired to analyze a water sample. The person bringing you the sample tells you that it is one of the following samples:

   a solution containing only Pb^{2+}
   a solution containing only Ag^{+}, or
   a solution contain neither Pb^{2+} nor Ag^{+},

   but she does not know which sample it is. How could you use the results of adding KI to the water sample to find what is in the sample you have been given? Note: you must be very specific in stating how to analyze the results. For example: "If I see ... then I know that the solution contains ..."

3. Why isn't it necessary to mix the chemical combinations for the grey squares in Data Table I?

4. Why is it unnecessary to mix **BOTH** the solutions in the upper triangle of 15 squares **AND** the lower triangle of 15 squares in Data Table I? In other words, why is it permissible to copy the results from the upper set of 15 squares into the "kitty corner" set of 15 squares below the grey band?