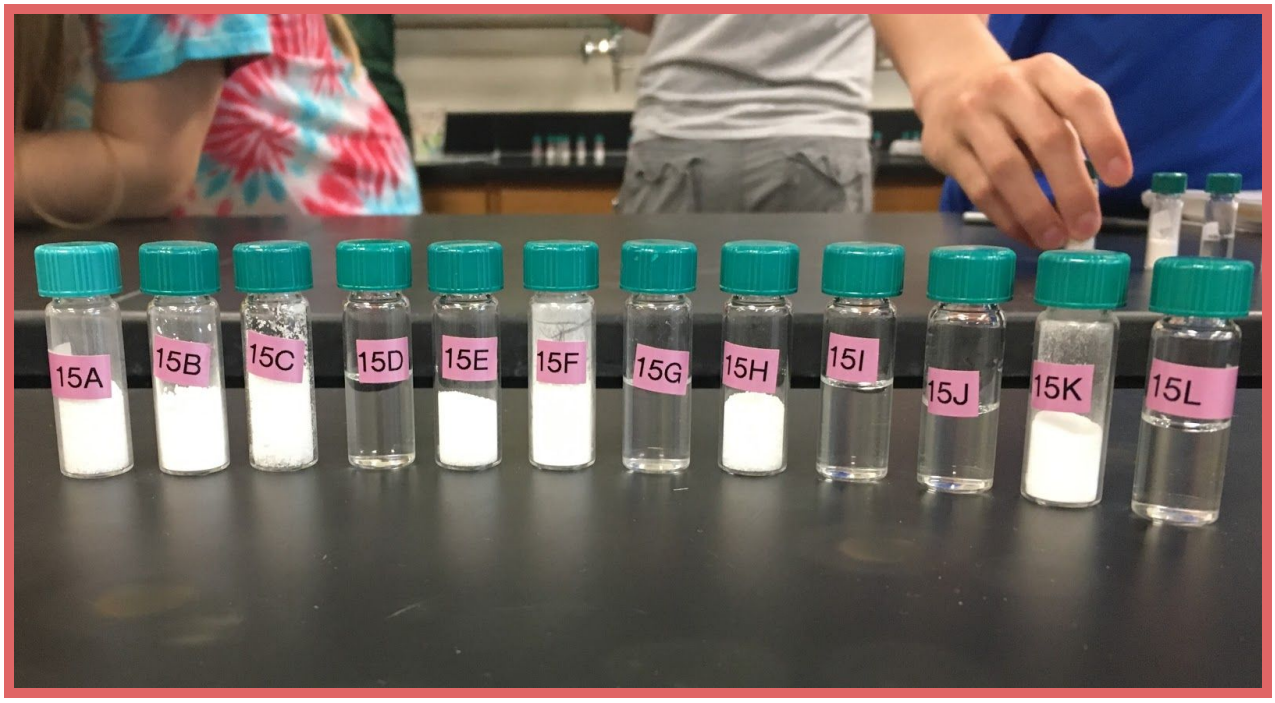
AP Chemistry Lab Final

Exam Analysis of Unknown Compounds

Unknown Vial: 15



Evelyn Arnold
1st Hour

Purpose: To know and utilize information from both Analytical Chemistry and Advanced Placement Chemistry regarding reactions, solubility, precipitation and other chemical and physical properties to identify 12 unknown compounds.

15A: $Pb(C_2H_3O_2)_2$

Description:

Vial A contains a white solid that has a small scent of vinegar. Along with this, it's texture is crumbly like fake snow. It has a pH of 6.

Test Performed	Result of Test
Reacted with KI	Yellow precipitate formed (PbI_2)
Reacted with $CaCO_3$	White precipitate formed ($PbCO_3$)
Reacted with $NaHCO_3$	White precipitate formed ($Pb(HCO_3)$)
Reacted with Na_2SO_4	White precipitate formed ($PbSO_4$)
Reacted with NaOH	White precipitate formed ($Pb(OH)_2$)
Reacted with NaCl	White precipitate formed ($PbCl_2$)
Reacted with Acetic Acid	No Reaction
Mixed with $Ca(OH)_2$	No Reaction
Mixed with H_2O	soluble
Mixed with hexane	No Reaction
Mixed with ethanol	No Reaction
Mixed with $Ag(NO_3)$	No Reaction
Smell Test	Faint scent of Vinegar

Net Ionic Equations:

$Pb^{+2}(aq) + 2I^{-}(aq)$ -------> $PbI_2(s)$

$Pb^{+2}(aq) + 2OH^{-}(aq)$ -------> $Pb(OH)_2(s)$

$Pb^{+2}(aq) + SO4^{-2}(aq)$ ----------> $PbSO_4(s)$

$Pb^{+2}(aq) + CO3^{-2}(aq)$ ----------> $PbCO_3(s)$

$Pb^{+2}(aq) + 2HCO3^{-}(aq)$ ---------> $Pb(HCO_3)_2(s)$

$Pb^{+2}(aq) + 2Cl^{-}(aq)$ ----------> $PbCl_2$ (s)

Reasons for Verifications:

$Pb(C_2H_3O_2)_2$ is a solid with a faint scent of vinegar due to the presence of acetate. Vial 15A had a scent of vinegar to prove its presence of acetate. Along with this, the Pb^{+2} ion precipitated with other aqueous solutions available such as HCO_3^-, CO_3^{-2}, SO_4^{-2}, OH^-, I^-, and Cl^-. The most obvious confirmation was the bright yellow precipitate made when vial 15A and KI were mixed to create PbI_2. Also, a white precipitate was made when NaCl and vial 15A were mixed to precipitate lead and chloride. This proves that vial 15A is $Pb(C_2H_3O_2)_2$ because chloride only precipitates with lead, mercury, and silver. Lastly, another double replacement reaction occured with vial 15A when mixed with aqueous Na_2SO_4 to create a white precipitate of $PbSO_4$ to again confirm the presence of the lead ion.

15B: $CaCO_3$

Description:

Vial B contained a powdery white solid that had a texture like flour. It has no distinct smell with a pH of 8.

It was also difficult to dissolve in water, turning white and cloudy.

Test Performed	Result of Test
Reacted with $Pb(C_2H_3O_2)_2$	White precipitate formed ($PbCO_3$)
Reacted with Acetic Acid	Bubbling (CO_2)
Reacted with $Ag(NO_3)$	Dirty yellow precipitate formed (Ag_2CO_3)
Reacted with NaOH	White precipitate formed ($Ca(OH)_2$)
Mixed with H_2O	insoluble
Mixed with $NaHCO_3$	No Reaction
Mixed with Na_2SO_4	No Reaction
Mixed with NaCl	No Reaction
Mixed with $Ca(OH)_2$	No Reaction
Mixed with KI	No Reaction
Mixed with ethanol	No Reaction
Mixed with hexane	No Reaction

Net Ionic Equations:

$CO_3^{-2}(aq) + Pb^{+2}(aq)$ --------> $PbCO_3(s)$

$CO_3^{-2}(aq) + 2Ag^{+}(aq)$ ----------> Ag_2CO_3 (s)

$Ca^{+2}(aq) + 2OH^{-}(aq)$ ----------> $Ca(OH)_2$ (s)

$CaCO_3(s) + 2H^{-}(aq)$ ---------> H_2O (l) + $CO_2(g)$ + $Ca^{+2}(aq)$

Reasons for Verifications:

Vial 15B contained $CaCO_3$ due to a combustion reaction occurring when placed in acetic acid which produces carbon dioxide gas and causes bubbling. Along with

this, Vial 15B precipitated with $AgNO_3$ to create a dirty yellow/tan color known as Ag_2CO_3 to prove the presence of carbonate. Lastly, the solid precipitated white with NaOH to create $Ca(OH)_2$ and to prove the presence of a calcium ion.

15C: KI

Description:

Vial C contains a white solid that has a sticky texture and sticks to itself and the vial. Along with this, it has a pH of 5 and smells like plastic.

Test Performed	Result of Test
Reacted with $Pb(C_2H_3O_2)_2$	Yellow precipitate formed (PbI_2)
Reacted with $Ag(NO_3)$	Pale yellow precipitate formed (AgI)
Mixed with $NaHCO_3$	No Reaction
Mixed with $Ca(OH)_2$	No Reaction
Mixed with $CaCO_3$	No Reaction
Mixed with Na_2SO_4	No Reaction
Mixed with NaCl	No Reaction
Mixed with water	Soluble (basic pH of 8)
Mixed with acetic acid	No Reaction
Mixed with hexane	No Reaction
Mixed with ethanol	No Reaction
Sprayed on paper and left overnight	Paper turned brown

Net Ionic Equations:

$Ag^{+}(aq) + I^{-}(aq)$ ----------> $AgI(s)$

$Pb^{+2}(aq) + I^{-}(aq)$ ----------> $PbI_2(s)$

Reasons for Verifications:

The main determining factor for the presence of KI in vial 15C was the yellow precipitates it made with both $AgNO_3$ to make AgI and $Pb(C_2H_3O_2)_2$ to make PbI_2

to confirm the presence of iodide. Along with this, when sprayed on paper and left overnight, the iodide in KI oxidized with the paper to make it brown and again, prove it's presence. Lastly, the KI readily dissolved in water to finally prove its presence.

15D: CH_3COOH

Description:

Vial D contains a transparent liquid that smells very strongly of vinegar. Along with this, it has a pH of 2-3.

Test Performed	Result of Test
Smell Test	Strong scent of Vinegar
Reacted with $CaCO_3$	Bubbling
Reacted with $NaHCO_3$	Bubbling
Litmus Paper Test	Acidic (2-3)
Mixed with $Ca(OH)_2$	No Reaction
Mixed with KI	No Reaction
Mixed with Na_2SO_4	No Reaction
Mixed with NaCl	No Reaction
Mixed with $Pb(C_2H_3O_2)_2$	No Reaction
Mixed with Water	No Reaction
Mixed with hexane	Immiscible
Mixed with ethanol	No Reaction
Mixed with $AgNO_3$	No Reaction
Mixed with NaOH	No Reaction

Net Ionic Equations:

$CaCO3(s) + 2H^+(aq)$ ---------> $H2O\ (l) + CO2(g) + Ca+2(aq)$
$NaHCO3(s) + H^+(aq)$ ----------> $H2O(l) + CO2(g) + Na+\ (aq)$

Reasons for Verifications:

- The distinct smell of vinegar was the main determining factor for the presence of acetic acid in vial 15D. Along with this, the litmus paper

resulted in a pH of 2 to prove that an acid was present. Lastly, two combustion reaction occurred with both $NaHCO_3$ and $CaCO_3$ to create carbon dioxide gas and bubbling to again prove the presence of acetic acid in vial 15D.

15E: NaCl

Description:

Vial E contains a white solid that has a texture like table salt and does not stick to the vial. It also has a pH of ~ 7 when dissolved in water.

Test Performed	Result of Test
Reacted with $Ag(NO_3)$	Silver precipitate formed (AgCl)
Dissolved in H_2O	Neutral pH (7)
Reacted with $Pb(C_2H_3O_2)_2$	White precipitate formed ($PbCl_2$)
Mixed with $Ca(OH)_2$	No Reaction
Mixed with KI	No Reaction
Mixed with $CaCO_3$	No Reaction
Mixed with $NaHCO_3$	No Reaction
Mixed with Na_2SO_4	No Reaction
Mixed with Acetic Acid	No Reaction
Mixed with NaOH	No Reaction
Mixed with hexane	No Reaction
Mixed with ethanol	No Reaction

Net Ionic Equations:

$Ag^{+}(aq) + Cl^{-}(aq)$ ---------> $AgCl(s)$

$Pb^{+2}(aq) + 2Cl^{-}(aq)$ ---------> $PbCl_2(s)$

Reasons for Verifications:

NaCl was present in vial 15E due to its double replacement reaction with $AgNO_3$ to created AgCl, a white precipitate. Along with this, vial 15E only precipitated with $AgNO_3$ and $Pb(C_2H_3O_2)_2$ to prove the presence of chloride. Lastly, when dissolved in water, the pH was neutral to prove the presence of both Na^+ and Cl^- and the properties of strong acids and bases.

15F: $Ca(OH)_2$

Description:

Vial F contains a white solid that is very powdery with no distinct smell. It is very milky when dissolved in water and has a pH of 11.

Test Performed	Result of Test
Reacted with $Ag(NO_3)$	Brown precipitate formed (AgOH)
Reacted with $NaHCO_3$	White precipitate formed ($Ca(HCO_3)_2$)
Reacted with Acetic Acid	Slight bubbling after a couple minutes (exothermic)
Dissolved in Water	Soluble
Mixed with KI	No Reaction
Mixed with $CaCO_3$	No Reaction
Mixed with Na_2SO_4	No Reaction
Mixed with NaCl	No Reaction
Mixed with $Pb(C_2H_3O_2)_2$	White precipitate formed ($Pb(OH)_2$)
Mixed with Acetic Acid	No Reaction
Mixed with Hexane	No Reaction
Mixed with ethanol	No Reaction
Mixed with NaOH	No Reaction

Net Ionic Equations:

$Ag^{+}(aq) + OH^{-}(aq)$ -------> $AgOH(s)$

$Ca^{+2}(aq) + 2HCO3^{-}(aq)$ ----------> $Ca(HCO_3)_2\ (s)$

$Pb^{+2}(aq) + 2OH^{-}(aq)$ ----------> $Pb(OH)_2\ (s)$

Reasons for Verifications:

$Ca(OH)_2$ is a strong base so it completely ionizes in water. Along with this, it has a high pH. Vial 15F contained a very basic solid (pH of 11) that completely dissolved in water. Along with this, it also created a brown precipitate with $AgNO_3$ to prove the presence of the hydroxide ion which created Ag(OH). Lastly, white precipitates were made when mixed with both $Pb(C_2H_3O_2)_2$ and $NaHCO_3$ to prove the presence of both the hydroxide ion ($Pb(OH)_2$) and the calcium ion ($Ca(HCO_3)_2$).

15G: NaOH

Description:

Vial G contains a transparent liquid with a pH of 11. This liquid has no distinct smell.

Test Performed	Result of Test
Reacted with $Ag(NO_3)$	Brown precipitate formed (AgOH)
Reacted with $CaCO_3$	White precipitate formed ($Ca(OH)_2$)
Reacted with $Pb(C_2H_3O_2)_2$	White precipitate formed ($Pb(OH)_2$)
Litmus Paper Test	Basic (pH of 11)
Mixed with $Ca(OH)_2$	No Reaction
Mixed with KI	No Reaction
Mixed with $NaHCO_3$	No Reaction
Mixed with Na_2SO_4	No Reaction
Mixed with NaCl	No Reaction
Mixed with H_2O	Miscible
Mixed with hexane	No Reaction
Mixed with ethanol	No Reaction

Net Ionic Equations:

$Ag^{+}(aq) + OH^{-}(aq)$ -------> $AgOH(s)$

$Ca^{+2}(aq) + 2OH^{-}(aq)$ -------> $Ca(OH)_2(s)$

$Pb^{+2}(aq) + 2OH^{-}(aq)$ ---------> $Pb(OH)_2(s)$

Reasons for Verifications:

NaOH is a very basic solution and vial 15G had the highest pH of all the liquids (11). Along with this, vial 15G precipitated distinctly with $AgNO_3$, $CaCO_3$, and $Pb(C_2H_3O_2)_2$. The OH^- ion made a brown precipitate with Ag^+, and a white precipitate with both Ca^{+2} and Pb^{+2} proving the presence of NaOH in vial 15G.

15H: Na_2SO_4

Description:

Vial H contains a white solid that has thick shiny crystals and no smell, it also has a pH of ~6-7

Test Performed	Result of Test
Reacted with $Pb(C_2H_3O_2)_2$	White precipitate formed ($PbSO_4$)
Reacted with $Ag(NO_3)$	White precipitate formed (Ag_2SO_4)
Dissolved in H2O	Neutral (pH of ~7)
Mixed with $Ca(OH)_2$	No Reaction
Mixed with KI	No Reaction
Mixed with $CaCO_3$	No Reaction
Mixed with $NaHCO_3$	No Reaction
Mixed with Acetic Acid	No Reaction
Mixed with Hexane	No Reaction
Mixed with ethanol	No Reaction
Mixed with H_2O	Soluble
Mixed with NaOH	No Reaction

Net Ionic Equations:

Pb^{+2} (aq) + SO_4^{-2}(aq) ----------> $PbSO_4$(s)

$2Ag^{+}$(aq) + SO_4^{-2}(aq)----------> Ag_2SO_4(s)

Reasons for Verifications:

Na_2SO_4 is a neutral solution when dissolved in water due to properties of strong acids and bases. When vial 15H was dissolved in water, it had a neutral pH of 7 to

prove the presence of both Na^{+} and SO_4^{-2}. Along with this, vial 15H made white precipitates with both $Pb(C_2H_3O_2)_2$ and $AgNO_3$. The SO_4^{-2} ion made both Ag_2SO_4 and $PbSO_4$ to again prove the presence of the sulfate ion in vial 15H.

15I: C_6H_{14}

Description:

Vial I contains a transparent liquid that has a strong smell of rubber cement. It evaporated fairly quickly and has a pH of 6.

Test Performed	Result of Test
Smell Test	Rubber Cement
Mixed with Water	Immiscible
Swipe Test	Evaporated almost instantly
Mixed with $Ca(OH)_2$	No Reaction
Mixed with KI	No Reaction
Mixed with $CaCO3_3$	No Reaction
Mixed with $NaHCO_3$	No Reaction
Mixed with Na_2SO_4	No Reaction
Mixed with NaCl	No Reaction
Mixed with $Pb(C_2H_3O_2)_2$	No Reaction
Mixed with ethanol	Immiscible
Mixed with NaOH	Immiscible
Mixed with Acetic Acid	Immiscible

Net Ionic Equations:

N/A

Reasons for Verifications:

The substance in vial 15I had a distinct smell of rubber cement, confirming hexane. When a swipe test was performed, it evaporates faster than both ethanol and water. Lastly, the liquid was immiscible in all the liquids proving that it was a nonpolar liquid with weak intermolecular forces which are all properties of hexane.

15J: H_2O

Description:

Vial J contains a transparent liquid with no distinct smell. It also has a neutral pH of 7, it also did not precipitate with any of the solids.

Test Performed	Result of Test
Litmus Paper Test	Neutral (pH of 7)
Mixed with $CaCO_3$	Insoluble
Mixed with $NaHCO_3$	soluble
Mixed with $Ca(OH)_2$	No Reaction, insoluble
Mixed with KI	No Reaction (basic), soluble
Mixed with Na_2SO_4	No Reaction (neutral), soluble
Mixed with NaCl	No Reaction (neutral), soluble
Mixed with $Pb(C_2H_3O_2)_2$	No Reaction, soluble
Mixed with Acetic Acid	No Reaction (acidic), miscible
Mixed with NaOH	No Reaction (basic), miscible
Mixed with hexane	No reaction,Immiscible
Mixed with ethanol	No Reaction, miscible
Mixed with $AgNO_3$	No Reaction, miscible
Swipe test with distilled water	Evaporated similarly
Swipe test with hexane	Evaporated much slower

Net Ionic Equations:

N/A

Reasons for Verifications:

When swiped on a counter next to hexane and distilled water, vial 15J took much longer than hexane but almost the same amount of time as the distilled water, proving the presence of water. Also, hexane was immiscible in vial 15J to prove that the liquid was polar with strong intermolecular forces which is a property of water. Lastly, when a pH test was performed with both vial 15J and the distilled water present, they both produced the same light orange color to prove its neutrality and the presence of water.

15K: $NaHCO_3$

Description:

Vial K contains a white solid that is very powdery and a texture of baking soda with no distinct smells and a pH of 8 when dissolved in water.

Test Performed	Result of Test
Reacted with $Pb(C_2H_3O_2)_2$	White precipitate formed ($PbCO_3$)
Mixed with KI	No reaction
Reacted with $Ca(OH)_2$	White precipitate formed ($Ca(HCO_3)_2$)
Reacted with Acetic Acid	No Reaction
Mixed with $CaCO_3$	No Reaction
Mixed with Na_2SO_4	No Reaction
Mixed with NaCl	No Reaction
Mixed with water	Soluble, milky
Mixed with NaOH	No Reaction
+Mixed with hexane	No Reaction
Mixed with ethanol	No Reaction
Mixed with $AgNO_3$	No Reaction

Net Ionic Equations:

$Pb^{+2}(aq) + 2HCO_3^-(aq)$------> $Pb(HCO_3)_2(s)$

$NaHCO_3(s) + H+(aq)$ ----------> $H_2O(l) + CO_2(g) + Na^+$ (aq)

$Ca^{+2}(aq) + 2HCO3^-(aq)$ ----------> $Ca(HCO_3)_2$ (s)

Reasons for Verifications:

When vial 15K was mixed with acetic acid, a combustion reaction occurred to produce carbon dioxide gas and bubbling. Along with this, vial 15K made white

precipitates with both $Pb(C_2H_3O_2)_2$ and $Ca(OH)_2$ creating $Pb(HCO_3)_2$ and $Ca(HCO_3)_2$ which both proved the presence of the bicarbonate ion.

15L: CH_3CH_2OH

Description:

Vial L contains a clear liquid that smells like strong nail polish remover with a pH of 6. This liquid did not precipitate with any of the solids

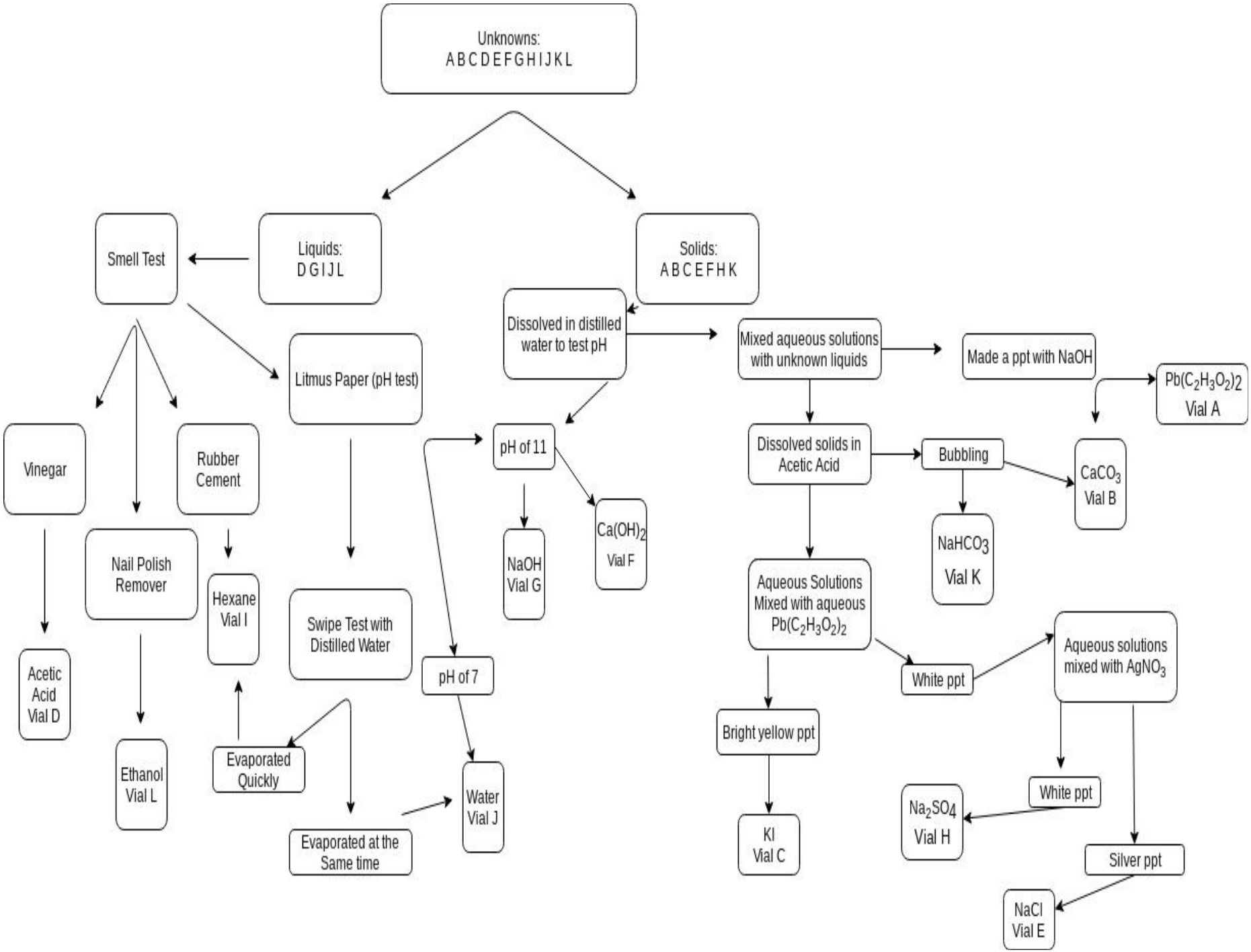
Test Performed	Result of Test
Smell Test	Smells strongly of nail polish remover
Mixed with hexane	Immiscible
Mixed with water	Miscible
Swipe test with water	Evaporated much faster
Swipe test with hexane	Evaporated slower
Mixed with $Ca(OH)_2$	No Reaction
Mixed with KI	No Reaction
Mixed with $CaCO_3$	No Reaction
Mixed with $NaHCO_3$	No Reaction
Mixed with Na_2SO_4	No Reaction
Mixed with NaCl	No Reaction
Mixed with $Pb(C_2H_3O_2)_2$	No Reaction
Mixed with Acetic Acid	No Reaction
Mixed with NaOH	No Reaction
Mixed with $AgNO_3$	No Reaction

Net Ionic Equations:

N/A

Reasons for Verifications:

Ethanol has a distinct smell of nail polish remover and vial 15L had this strong smell, proving the presence of this alcohol. Along with this, when a swipe test was performed with both hexane and water, hexane evaporated first, vial 15L next, then water showing the presence of an alcohol. Lastly, vial 15L was immiscible in hexane and miscible in water to prove that it was a polar liquid with strong intermolecular forces.


Unknowns:
A B C D E F G H I J K L
Liquids:
D G I J L
Solids:
A B C E F H K
Smell Test
Litmus Paper (pH test)
Vinegar
Rubber Cement
Nail Polish Remover
Acetic Acid Vial D
Ethanol Vial L
Hexane Vial I
Evaporated Quickly
Swipe Test with Distilled Water
Evaporated at the Same time
Water Vial J
pH of 7
Dissolved in distilled water to test pH
pH of 11
NaOH Vial G
$Ca(OH)_2$ Vial F
Mixed aqueous solutions with unknown liquids
Made a ppt with NaOH
$Pb(C_2H_3O_2)2$ Vial A
Dissolved solids in Acetic Acid
Bubbling
$CaCO_3$ Vial B
$NaHCO_3$ Vial K
Aqueous Solutions Mixed with aqueous $Pb(C_2H_3O_2)_2$
White ppt
Aqueous solutions mixed with $AgNO_3$
Bright yellow ppt
KI Vial C
White ppt
Na_2SO_4 Vial H
Silver ppt
NaCl Vial E