NAME: _____ Grade: _____/10

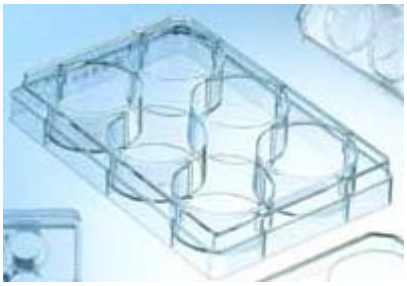
Chemistry 111 Laboratory

AQUEOUS SOLUTION REACTIONS AND NET IONIC EQUATIONS

Introduction

This laboratory exercise will lead you to perform a large number of short experiments. The observations you make for each experiment will lead you to conclusions about what reactions are occurring as well as giving you the opportunity to create some generalized rules about reactivity.

Procedure



Most of the reactions performed in this experiment will be done using small amounts in a "well plate." The well plate has 12 indentations into which you can add small amounts of reactants either as solutions or as solids.

General rules for performing these reactions:

1. For reactions between two solutions, add 8-10 drops of one solution and then add 8-10 drops of the other. If nothing happens, then stir using your glass stir rod.

2. For reactions between a solid and a solution, add the small spatula-tipfull of the solid to the well and then add 5-6 drops of the solution on top of it. Stir. If it appears that the solid might be dissolving but not completely, go ahead and add more of the solution to see if you can get it to dissolve.

3. Place a sheet of white paper under the well plate. Some precipitates are hard to see.

What to Record

For each mixture, you should record what you see happen. In particular, does a solid form or dissolve? Does the color change? Is a gas formed? If so, what color, if any? Not all compounds react with each other- sometimes nothing will happen. Then again, sometimes something does happen but you can't detect it by eye. All you can do is record what you see and go from there.

What to do Next

For each mixture that does react in some way, write the overall equation and the net-ionic equation. Both need to be properly balanced. Also, note what kind or kinds of reactions are taking place each time. This experiment does not have a separate writeup. You fill in this handout and hand it in *before leaving lab* on the day you do the experiment. ***Work individually to perform the reactions, but team up to figure out the reaction equations.***

1. $Fe(NO_3)_3(aq) + NaOH(aq)$

Observations	
Overall Equation	
Net-Ionic Equation	

2. $KNO_3(aq) + NaOH(aq)$

Observations	
Overall Equation	
Net-Ionic Equation	

3. $Al(NO_3)_3(aq) + NaOH(aq)$

Observations	
Overall Equation	
Net-Ionic Equation	

4. $Ni(NO_3)_2(aq) + NaOH(aq)$

Observations	
Overall Equation	
Net-Ionic Equation	

5. $Ni(NO_3)_2(aq) + Na_2SO_4(aq)$

Observations	
Overall Equation	
Net-Ionic Equation	

6. $Ba(NO_3)_2(aq) + Na_2SO_4(aq)$

Observations	
Overall Equation	
Net-Ionic Equation	

7. $AgNO_3(aq) + NaCl(aq)$

Observations	
Overall Equation	
Net-Ionic Equation	

8. $Pb(NO_3)_2(aq) + KI(aq)$

Observations	
Overall Equation	
Net-Ionic Equation	

9. $Pb(NO_3)_2(aq) + K_2CrO_4(aq)$

Observations	
Overall Equation	
Net-Ionic Equation	

10. $Ca(NO_3)_2(aq) + Na_3PO_4(aq)$

Observations	
Overall Equation	
Net-Ionic Equation	

11. $Ni(NO_3)_2(aq) + Na_3PO_4(aq)$

Observations	
Overall Equation	
Net-Ionic Equation	

12. $Ca_3(PO_4)_2(s) + HCl(aq)$

Observations	
Overall Equation	
Net-Ionic Equation	

13. $Ca_3(PO_4)_2(s) + H_2SO_4(aq)$

Observations	
Overall Equation	
Net-Ionic Equation	

14. $Cu(s) + AgNO_3(aq)$

Observations	
Overall Equation	
Net-Ionic Equation	

15. $Cu(s) + HCl(aq)$

Observations Type:	
Overall Equation	
Net-Ionic Equation	

16. $Cu(s) + HNO_3(aq)$

Observations	
Overall Equation	
Net-Ionic Equation	

17. $Zn(s) + HCl(aq)$

Observations	
Overall Equation	
Net-Ionic Equation	

18. $CaCO_3(s) + HCl(aq)$

Observations	
Overall Equation	
Net-Ionic Equation	

19. $NaHCO_3(aq) + HCl(aq)$

Observations	
Overall Equation	
Net-Ionic Equation	

20. $Na_2CO_3(aq) + HCl(aq)$

Observations	
Overall Equation	
Net-Ionic Equation	

On this page you perform four additional reactions using the reagents available. Record your observations and write in the equations for any reactions that occur.

21. _____

Observations	
Overall Equation	
Net-Ionic Equation	

22. _____

Observations	
Overall Equation	
Net-Ionic Equation	

23. _____

Observations	
Overall Equation	
Net-Ionic Equation	

24. _____

Observations	
Overall Equation	
Net-Ionic Equation	

Solubility Rules

SOLUBLE COMPOUNDS	EXCEPTIONS
Almost all salts of Na^+, K^+, NH_4^+	
Salts of nitrate, NO_3^- chlorate, ClO_3^- perchlorate, ClO_4^- acetate, $CH_3CO_2^-$	
Almost all salts of Cl^-, Br^-, I^-	Halides of Ag^+, Hg_2^{2+}, Pb^{2+}
Compounds containing F^-	Fluorides of Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}
Salts of sulfate, SO_4^{2-}	Sulfates of Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}

INSOLUBLE COMPOUNDS	EXCEPTIONS
Most salts of carbonate, CO_3^{2-} phosphate, PO_4^{3-} oxalate, $C_2O_4^{2-}$ chromate, CrO_4^{2-}	Salts of NH_4^+ and the alkali metal cations Na^+, K^+
Most metal sulfides, S^{2-}	
Most metal hydroxides OH^- and oxides O^{2-}	$Ba(OH)_2$ is soluble

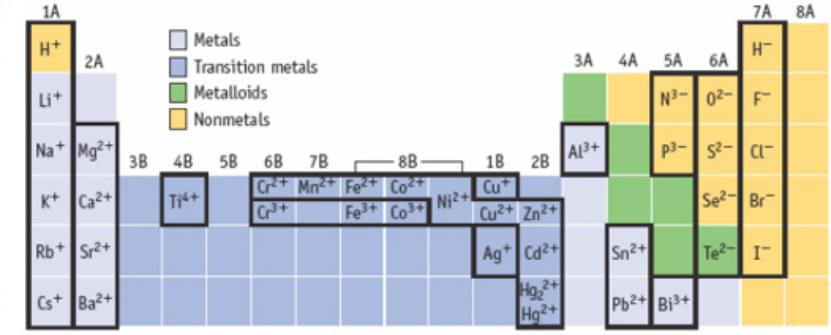


Table 3.1 Formulas and Names of Some Common Polyatomic Ions

Formula	Name	Formula	Name
CATION: Positive Ion			
NH_4^+	ammonium ion		
ANIONS: Negative Ions			
Based on a Group 4A element		**Based on a Group 7A element**	
CN^-	cyanide ion	ClO^-	hypochlorite ion
$CH_3CO_2^-$	acetate ion	ClO_2^-	chlorite ion
CO_3^{2-}	carbonate ion	ClO_3^-	chlorate ion
HCO_3^-	hydrogen carbonate ion (or bicarbonate ion)	ClO_4^-	perchlorate ion
Based on a Group 5A element		**Based on a transition metal**	
NO_2^-	nitrite ion	CrO_4^{2-}	chromate ion
NO_3^-	nitrate ion	$Cr_2O_7^{2-}$	dichromate ion
PO_4^{3-}	phosphate ion	MnO_4^-	permanganate ion
HPO_4^{2-}	hydrogen phosphate ion		
$H_2PO_4^-$	dihydrogen phosphate ion		
Based on a Group 6A element			
OH^-	hydroxide ion		
SO_3^{2-}	sulfite ion		
SO_4^{2-}	sulfate ion		
HSO_4^-	hydrogen sulfate ion (or bisulfate ion)		

Strong Acids	Strong Bases
HCl	LiOH
HBr	NaOH
HI	KOH
HNO_3	$Ca(OH)_{2\,(s)}$
$HClO_4$	$Ba(OH)_{2\,(s)}$
H_2SO_4	

Weak Acids	Weak Bases
CH_3COOH	CH_3COO^-
NH_4^+	NH_3
H_2CO_3	CO_3^{2-}
$H_2C_2O_4$	$C_2O_4^{2-}$
H_2SO_3	SO_3^{2-}
H_2S	S^{2-}
H_3PO_4	PO_4^{3-}
HCN	CN^-
HF	F^-
NHO_2	NO_2^-
HClO	ClO^-

Gas Forming Reactions:

$2\,H^+ + CO_3^{2-} \longrightarrow H_2O(l) + CO_2(g)$

$2\,H^+ + S^{2-} \longrightarrow H_2S(g)$

$2\,H^+ + SO_3^{2-} \longrightarrow H_2O(l) + SO_2(g)$

$2\,H^+ + M \longrightarrow M^{2+} + H_2(g)$

M = a metal atom

Strong Electrolytes:
Soluble ionic compounds
Strong acids and strong bases

Determining Net Ionic Equations

1. Write out all reactants as they exist in solution

2. Identify acids and bases

   2a. If both an acid and a base are present, an acid-base reaction occurs

   2b. Be sure to look for hidden bases that are anions in other ionic compounds, such as CO_3^{2-} in $CaCO_3$.

3. Look for ions that will form an insoluble compound. If so, they form a precipitate.

4. Look for one of the known gas-forming reactions.

5. Write out products as they exist in solution.

6. Cancel spectator ions. Note: ions that are "always soluble" will be spectator ions in acid-base or precipitation reactions.