



Ionic Reactions

Experiment
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In this experiment you will study ionic reactions in aqueous solutions. The mixing of ions may result in the precipitation of an insoluble compound. Table 1 lists some solubility rules of ions in aqueous media.

Table 1. Solubility Rules

Soluble	Except	Insoluble	Except
$\text{Na}^+, \text{K}^+, \text{Li}^+, \text{NH}_4^+$	None	CO_3^{2-}	Group 1A, NH_4^+
NO_3^-	None	PO_4^{3-}	Group 1A, NH_4^+
$\text{Cl}^-, \text{Br}^-, \text{I}^-$	$\text{Ag}^+, \text{Pb}^{2+}$	S^{2-}	Group 1A, NH_4^+
SO_4^{2-}	$\text{Ca}^{2+}, \text{Ag}^+, \text{Pb}^{2+}, \text{Ba}^{2+}$	OH^-	Group 1A, $\text{Ca}^{2+}, \text{Ba}^{2+}$

Procedure

Part A Testing Solubility Rules. (Day 1)

1. Using the lower marks on the 4 test tubes as guides, add 1 mL of 0.1 M NH_4NO_3 to each.
2. Using the upper marks as guides, add 1 mL of 0.1 M NaBr to the first tube, 1 mL of 0.1 M Na_2SO_4 to the second, 1 mL of 2 M NaOH to the third, and 1 mL of 0.1 M Na_2CO_3 to the fourth. Shake each test tube gently and record your observations (include precipitate color if present)
3. Wash the test tube carefully, and rinse them with distilled water.
4. Repeat steps 1 through 3 with; 0.1 M $\text{Ba}(\text{NO}_3)_2$, 0.1 M AgNO_3 , 0.1 M $\text{Pb}(\text{NO}_3)_2$, and 0.1 M $\text{Ni}(\text{NO}_3)_2$ instead of NH_4NO_3 .
5. Centrifuge the contents of the test tube that originally contained 0.1 M $\text{Ni}(\text{NO}_3)_2$ and 2 M NaOH. About 1 min will be required. Decant (pour off) and discard the solution. Save the green precipitate for subsequent use.

Part B Acids and Bases. (Day 2)

1. Wash the three remaining test tubes, and rinse them with distilled water.
2. Obtain a pea-sized portion of CaCO_3 in one of the test tubes. Add 20 drops of 2 M HCl. Record your observations.
3. Add 8 drops of 2 M HCl to the precipitate that you saved from the reaction between $\text{Ni}(\text{NO}_3)_2$ and NaOH. Record the results.
4. Wash these test tubes, and rinse them with distilled water.
5. Using the lower marks as guides, add 1 mL of 2 M HCl to one test tube, 1 mL of 2 M $\text{HC}_2\text{H}_3\text{O}_2$ (acetic acid) to the second, 1 mL of 2 M NH_3 to the third, and 1 mL of 2 M NaOH to the fourth.
6. Take a drop of each solution on a clean stirring rod and touch it to a piece of red litmus paper. Record your observations.
7. Repeat Step 6 using the blue litmus paper.
8. Add the contents of the test tube containing HCl to the test tube containing NH_3 . Is heat evolved? Add the contents of the test tube containing $\text{HC}_2\text{H}_3\text{O}_2$ to the test tube containing NaOH. Is heat evolved? Record the results.

Results

Part 1. (Day 1) Testing the solubility rules

	Na Br	Na ₂ SO ₄	NaOH	Na ₂ CO ₃
NH ₄ NO ₃				
Ba(NO ₃) ₂				
AgNO ₃				
Pb(NO ₃) ₂				
Ni(NO ₃) ₂				

Part 2. (Day 2) Acids and Bases

HCl + CaCO _{3(s)}		HCl + green ppt	
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	Red Litmus paper	Blue Litmus paper
HCl		
HC ₂ H ₃ O ₂		
NH ₃		
NaOH		

	Heat Evolved?
HCl + NH ₃	
HC ₂ H ₃ O ₂ + NaOH	

Discussion

Did your experimental observations match the expected results from the solubility rules?

Post-Lab Questions

1. Write a balanced molecular and ionic equation for each successful precipitation reaction that you observed.
2. Which litmus paper would you use to test for an acid? Why?
3. Which litmus paper would you use to test for a base? Why?
4. Write a balanced molecular and ionic equation for each reaction of a solid with HCl.
5. Write a balanced molecular and ionic equation for the neutralization reaction in which heat was evolved.