

EXPERIMENT & REPORT 9: Electrolytes and Net-ionic Equations

Name _____

Last

First

Instructor's initials _____

INTRODUCTION

A. ELECTROLYTES

An **electrolyte** is a substance that dissolves in water to give a solution that conducts electricity. A **nonelectrolyte** is a substance that dissolves in water to give a solution that does not conduct electricity. Therefore, to be an electrolyte a substance 1) must be soluble in water and 2) must be in solution as ions (the solute particles are ions).

Elements

Elements are not soluble in water so elements are neither electrolytes nor nonelectrolytes.

Compounds

1. Solubility, Dissociation, and Ionization

When any compound dissolves in water, its particles **dissociate**—that is, its particles are all separated from each other and each becomes surrounded by water molecules. Dissociation is a physical change.

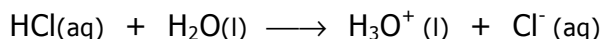
a. Soluble Ionic Compounds

[Reminder: You have a set of rules for determining solubilities of ionic compounds in water.] As a result of **dissociation** upon dissolving in water, the solute particles in aqueous solutions of ionic compounds (salts and metal hydroxides) are **ions**, thus the solution conducts electricity strongly. Therefore, all soluble ionic compounds are **strong electrolytes**.

b. Soluble Molecular Compounds

[Reminder: In general, only polar molecular compounds are soluble in water, while nonpolar compounds are not.] As a result of **dissociation** upon dissolving in water, the solute particles in aqueous solutions of molecular compounds (*acids*, *nitrogenous bases* and *covalent compounds*) are **molecules**. Since molecules are uncharged, these solutions do not conduct electricity. Soluble *covalent compounds* are **nonelectrolytes**.

Other soluble molecular compounds, (*acids* and *nitrogenous bases*), chemically react with water to produce ions. This is called an **ionization reaction**. For example:



In the case of the molecular compounds that we identify as **strong acids**, all of the dissolved molecules react with water to produce **ions** so that the solute particles in a solution of a strong acid are ions. Therefore, strong acids are **strong electrolytes**.

In an aqueous solution of a **weak acid** or a *nitrogenous base* (**weak base**) only a small fraction of the dissolved molecules react to form ions so that the solute particles

in a solution of a weak acid or base are mostly molecules. However, there are some ions in the solution—enough to conduct electricity weakly, therefore weak acids and weak bases are **weak electrolytes**.

B. NET IONIC EQUATIONS

C. PREDICTING CONDUCTIVITY OF REACTION MIXTURES

AQUEOUS SOLUTIONS OF COMPOUNDS

TYPE OF COMPD	PARTICLES COMPOUND MADE OF	CLASS OF COMPOUND	CRITERIA FOR SOLUBILITY IN WATER	SOLUBILITY IN WATER	SOLUTE PARTICLES RESULTING FROM DISSOCIATION IN WATER UPON DISSOLVING	SOLUTE PARTICLES (MOLECULES) UNDERGO IONIZATION REACTION WITH WATER	COMPOUND DESCRIPTION	SOLUTE PARTICLES PRESENT IN SOLUTION	<i>STRONG, WEAK, OR NON-ELECTROLYTE</i>
I O N I C	IONS	SALT	Cation is from group IA, NH_4^+ , Anion is $\text{C}_2\text{H}_3\text{O}_2^-$ NO_3^- Anion is Cl^- , Br^- , I^- , or SO_4^{2-} , with exceptions	Soluble	ions	no	Soluble Salt	ions only	
			Anion is CO_3^{2-} , PO_4^{3-} , CrO_4^{2-} , or S^{2-} , with exceptions	Insoluble	—	—	Insoluble Salt	—	
		METAL OXIDE							
		METAL HYDROXIDE	Cation is from Group IA or is Ca^{2+} , Sr^{2+} , Ba^{2+}	Soluble	ions	no	Strong Base (soluble metal hydroxide)	ions only	
			All the rest of the metal hydroxides	Insoluble	—	—	Insoluble Metal Hydroxide	—	
M O L E C U L A R	MOLECULES	NITROGENOUS BASE	Polar	Soluble	molecules	NH_3 yes (very little)	Weak Base NH_3	molecules (plus a <i>few</i> ions)	
		COVALENT	Polar	Soluble	molecules		Polar Covalent	molecules only	
			Nonpolar	Insoluble	—	—	Nonpolar Covalent	—	
		ACID	Polar (all acids are polar)	Soluble	molecules	yes (100%)	HCl, HBr, HI, Strong Acid HNO_3 , H_2SO_4 , HClO_4	ions only	
						yes (very little)	Weak Acid	molecules (plus a <i>few</i> ions)	

For each of the following:

- Write the molecular, total-ionic, and net-ionic equations.
- Predict the expected electrical conductivity after stoichiometrically equivalent amounts of the reactants are mixed together.
- Justify your answer by listing the ions causing the electrical conductivity, if any.

1. Aqueous solutions of potassium carbonate and ferrous bromide are mixed.

ME _____

TIE _____

NIE _____

a. Predicted conductivity of reaction mixture: strong, weak, or none? _____

b. List which ions are responsible for the conductivity, if any. _____

2. Lithium hydroxide is added to an aqueous solution of lead (II) nitrate.

ME _____

TIE _____

NIE _____

a. Predicted conductivity of reaction mixture: strong, weak, or none? _____

b. List which ions are responsible for the conductivity, if any. _____

3. Zinc is added to an aqueous solution of acetic acid.

ME _____

TIE _____

NIE _____

a. Predicted conductivity of reaction mixture: strong, weak, or none? _____

b. List which ions are responsible for the conductivity, if any. _____

4. Aqueous solutions of copper(II)bromide and potassium phosphate are mixed.

ME _____

TIE _____

NIE _____

a. Predicted conductivity of reaction mixture: strong, weak, or none? _____

b. List which ions are responsible for the conductivity, if any. _____

5. Aqueous solutions of magnesium sulfide and nickel(II) chloride are mixed.

ME _____

TIE _____

NIE _____

a. Predicted conductivity of reaction mixture: strong, weak, or none? _____

b. List which ions are responsible for the conductivity, if any. _____

6. Aqueous solutions of ammonium chloride and sodium sulfate are mixed.

ME _____

TIE _____

NIE _____

a. Predicted conductivity of reaction mixture: strong, weak, or none? _____

b. List which ions are responsible for the conductivity, if any. _____

7. Aqueous solutions of calcium hydroxide and sulfuric acid are mixed.

ME _____

TIE _____

NIE _____

a. Predicted conductivity of reaction mixture: strong, weak, or none? _____

b. List which ions are responsible for the conductivity, if any. _____

8. Aqueous solutions of barium hydroxide and sodium iodide are mixed.

ME _____

TIE _____

NIE _____

a. Predicted conductivity of reaction mixture: strong, weak, or none? _____

b. List which ions are responsible for the conductivity, if any. _____

9. Aqueous solutions of silver nitrate and calcium bromide are mixed.

ME _____

TIE _____

NIE _____

a. Predicted conductivity of reaction mixture: strong, weak, or none? _____

b. List which ions are responsible for the conductivity, if any. _____

10. Aqueous solutions of sodium carbonate and nitric acid are mixed.

ME _____

TIE _____

NIE _____

a. Predicted conductivity of reaction mixture: strong, weak, or none? _____

b. List which ions are responsible for the conductivity, if any. _____

11. Aqueous solutions of Lithium phosphate and ammonium sulfide are mixed.

ME _____

TIE _____

NIE _____

a. Predicted conductivity of reaction mixture: strong, weak, or none? _____

b. List which ions are responsible for the conductivity, if any. _____

12. Aqueous solutions of calcium hydroxide and phosphoric acid are mixed.

ME _____

TIE _____

NIE _____

a. Predicted conductivity of reaction mixture: strong, weak, or none? _____

b. List which ions are responsible for the conductivity, if any. _____

13. Aqueous solutions of barium hydroxide and chromic acid are mixed.

ME _____

TIE _____

NIE _____

a. Predicted conductivity of reaction mixture: strong, weak, or none? _____

b. List which ions are responsible for the conductivity, if any. _____

14. Aqueous solutions of hydrochloric acid and calcium carbonate are mixed

ME _____

TIE _____

NIE _____

a. Predicted conductivity of reaction mixture: strong, weak, or none? _____

b. List which ions are responsible for the conductivity, if any. _____

15. Aqueous solutions of potassium hydroxide and ammonium iodide are mixed.

ME _____

TIE _____

NIE _____

a. Predicted conductivity of reaction mixture: strong, weak, or none? _____

b. List which ions are responsible for the conductivity, if any. _____

16. Aqueous solutions of potassium chromate and strontium hydroxide are mixed.

ME _____

TIE _____

NIE _____

a. Predicted conductivity of reaction mixture: strong, weak, or none? _____

b. List which ions are responsible for the conductivity, if any. _____

17. Aqueous solutions of nickel (II) chloride and ammonium phosphate are mixed.

ME _____

TIE _____

NIE _____

a. Predicted conductivity of reaction mixture: strong, weak, or none? _____

b. List which ions are responsible for the conductivity, if any. _____

17. Aqueous solutions of sodium bromide and ammonium nitrate are mixed.

ME _____

TIE _____

NIE _____

a. Predicted conductivity of reaction mixture: strong, weak, or none? _____

b. List which ions are responsible for the conductivity, if any. _____

18. Aqueous solutions of potassium phosphate and strontium hydroxide are mixed.

ME _____

TIE _____

NIE _____

a. Predicted conductivity of reaction mixture: strong, weak, or none? _____

b. List which ions are responsible for the conductivity, if any. _____

19. Aqueous solutions of ferric chloride and ammonium sulfate are mixed.

ME _____

TIE _____

NIE _____

a. Predicted conductivity of reaction mixture: strong, weak, or none? _____

b. List which ions are responsible for the conductivity, if any. _____

20. Aqueous solutions of lead (II) nitrate and sodium sulfide are mixed.

ME _____

TIE _____

NIE _____

a. Predicted conductivity of reaction mixture: strong, weak, or none? _____

b. List which ions are responsible for the conductivity, if any. _____

QUESTIONS

1. Name the three classes of compounds that are strong electrolytes.

a. _____ b. _____ c. _____

2. Which of the following are written as ions when writing the total ionic equation?

a. strong electrolytes b. weak electrolytes. c. non-electrolytes.

3. What are spectator ions in a chemical reaction?

4. Define electrolyte

5. Define nonelectrolyte