Name _____ Date _____ Class _____

Double Replacement Reactions

Small Scale Lab 27

Text reference: ***Chapter 9***

Introduction

As you may have read in Chapter 9 of your textbook, antacid tablets contain the compound calcium carbonate, $CaCO_3$. This compound reacts with the hydrochloric acid, HCl, in your stomach in the following way:

$$CaCO_3(aq) + 2HCl(aq) \rightarrow CaCl_2(s) + H_2CO_3(aq)$$

This reaction is an everyday example of a double replacement reaction.

A double replacement reaction usually takes place between two ionic compounds that are dissolved in water. The cation of one compound replaces the cation in another compound to produce two new compounds. The new combination of cations and anions yields a product that may be a precipitate, a gas, or water. Precipitates are solids that form from the reaction between compounds that are soluble in water.

In this investigation you will mix several pairs of aqueous solutions and ionic compounds. You will observe which combinations of solutions result in the formation of a precipitate, and you will write balanced equations for the reactions.

Pre-Lab Discussion

Read the entire laboratory investigation and the relevant pages of your textbook. Then answer the questions that follow.

1. What is a double replacement reaction? _____

_____

_____

_____

2. What evidence indicates that a double replacement reaction has occurred between two dissolved compounds? _____

_____

_____

3. What type of evidence will you be looking for in this investigation? _____

4. What hazards are associated with using silver nitrate, and what precautions should you take in this investigation? _____

_____

_____

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Problem

Which combinations of ionic solutions form precipitates that indicate a double replacement reaction has occurred?

Materials

chemical splash goggles
laboratory apron
latex gloves
marking pen
well plate
sheet of white paper
beaker to hold micropipets
dropper (for cleanup)

7 micropipets, each filled with one of the following 0.1 *M* solutions:
silver nitrate ($AgNO_3$)
iron(III) nitrate ($Fe(NO_3)_3$)
copper(II) nitrate ($Cu(NO_3)_2$)
sodium phosphate (Na_3PO_4)
sodium sulfate (Na_2SO_4)
sodium hydroxide (NaOH)
sodium chloride (NaCl)

Safety

Wear your goggles and lab apron at all times during the investigation. Wear gloves when handling silver nitrate as it is toxic and can cause stains to skin and clothing. Handle all chemicals with care; avoid spills and contact with your skin. If contact occurs, wash with plenty of cold water and tell your teacher.

Note the caution alert symbols here and with certain steps of the Procedure. Refer to page *xi* for the specific precautions associated with each symbol.

Procedure

1. Put on your goggles, gloves, and lab apron. Label the wells of the well plate as shown in Figure 27–1. Place the well plate on the sheet of white paper. Use a micropipet to place five drops of silver nitrate solution, $AgNO_3$, into each of wells A1 through A4. **CAUTION:** *Silver nitrate is poisonous. Be careful not to get it on your skin or clothing, as it will produce a stain that is hard to remove. If any spills occur, ask your teacher how to clean up safely.*
2. Place five drops of iron(III) nitrate solution, $Fe(NO_3)_3$, into each of wells B1 through B4. Then place five drops of copper(II) nitrate solution, $Cu(NO_3)_2$, into each of wells C1 through C4.
3. Now you will add a different ionic compound to each column of wells. To avoid contamination of the ionic solution in the micropipet, do not let its tip touch the solutions that are already in the wells. Add five drops of sodium phosphate solution, Na_3PO_4, to each of the solutions in wells A1, B1, and C1. Observe whether or not a precipitate forms in each well and record your observations in the Data Table. If a precipitate forms, record the color. If a precipitate does not form, write *NR* for *No Reaction*.

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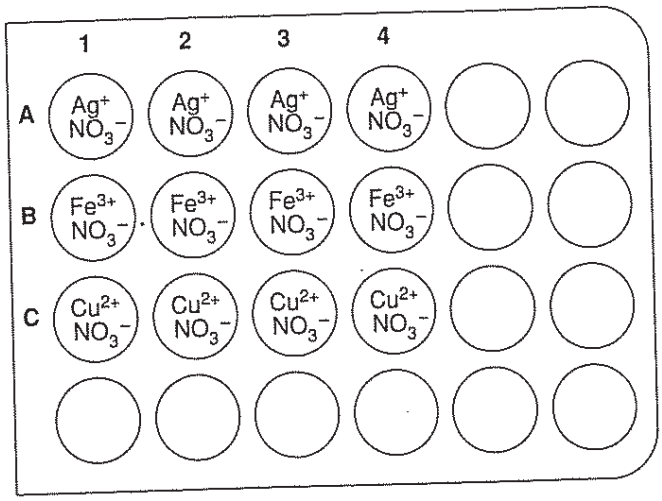

Figure 27–1

4. Add five drops of sodium sulfate solution, Na_2SO_4, to each of the solutions in wells A2, B2, and C2. Record your observations in the Data Table.

5. Add five drops of sodium hydroxide solution, NaOH, to each of the solutions in wells A3, B3, and C3 and record your observations. **CAUTION:** *Sodium hydroxide solution is caustic. Avoid spilling it on your skin or clothing. Wash spills with plenty of cold water.*

6. Add five drops of sodium chloride solution, NaCl, to the solutions in wells A4, B4, and C4 and record your observations.

7. Use a dropper to pull up the silver solutions in the row A wells of the well plate and deposit the material into the container provided by your teacher. Any silver nitrate solution left in a micropipet should be disposed of in a similar manner. Wash the sodium hydroxide down the drain with plenty of water. Clean up your work area and wash your hands before leaving the laboratory.

Observations

DATA TABLE

		1	2	3	4
	Ionic Solutions	Na^+ PO_4^{3-}	Na^+ SO_4^{2-}	Na^+ OH^-	Na^+ Cl^-
A	Ag^+ NO_3^-				
B	Fe^{3+} NO_3^-				
C	Cu^{2+} NO_3^-				

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Critical Thinking: Analysis and Conclusions

1. For which combinations of solutions did no precipitate form? Based on these observations, which compounds are soluble in water? Explain. *(Drawing conclusions)* _____

2. Based on your observations, which positive ion reacts to form the greatest number of precipitates: Ag^+, Fe^{3+}, or Cu^{2+}? Explain. *(Interpreting data)* _____

3. Use a solubility table to determine the identity of the precipitates that formed in the wells in column 1. Then write the balanced equation for the reactions, including the symbols for phase, *(s)* and *(aq)*. *(Interpreting data)*

Critical Thinking: Applications

1. Write the equation for the reaction that takes place when a solution of silver nitrate is added to a solution of sodium chloride. *(Applying concepts)* _____

2. Sodium hydrogen carbonate, $NaHCO_3$, and sodium chloride, NaCl, are both soluble in water. Will a double replacement reaction take place if a solution of sodium hydrogen carbonate is added to a solution of sodium chloride? Explain. *(Making inferences)* _____

Going Further

1. Given a solution that contains one or more of the compounds used in this investigation, explain how you could identify the unknown compound or compounds. Use a chart to show your scheme.