Activity 2  More Chemical Changes

GOALS
In this activity you will:

- Observe several typical examples of evidence that a chemical change is occurring.
- Make generalizations about the combinations of materials that result in the same evidence.
- Make generalizations about materials that tend to react with everything and materials that tend not to react with anything.
- Practice careful laboratory techniques, such as avoiding contamination of reactants, to ensure that results observed are repeatable and unambiguous.

What Do You Think?
Read the following sets of instructions for two different processes:

a) Mix 1 cup flour, 1/3 cup sugar, 1 teaspoon of baking powder with a cup of milk and 1 egg, well-beaten. Place the mixture in an oven for 30 minutes.

b) Add two drops of sodium carbonate (0.1 M Na₂CO₃) to two drops of sodium hydrogen sulfate (0.1 M NaHSO₄).

- Which of the instructions above involve chemistry? Explain your answer.
- Describe one similarity and one difference in the above instructions.

Record your ideas about these questions in your Active Chemistry log. Be prepared to discuss your responses with your group and the class.

Investigate
1. The following eight solid materials have been dissolved in distilled water to make solutions. You will combine the solutions (one to one) with each other in an organized manner in order to observe their interactions.
   - barium nitrate (Ba(NO₃)₂)
a) Begin by making a chart to record your data. Your chart will require an entire page of your notebook. Allow plenty of room to record your observations. A sample chart has been provided. You will have to replace the numbers with the names of the other chemicals. Notice that some of the blocks in this chart are marked with an X, indicating there is no need to mix those particular chemicals. Why do you suppose those particular blocks have an X?

2. Now it is time to mix the solutions. Begin with barium nitrate. Add three drops of the barium nitrate solution to each of seven wells of a well plate. Add three drops of sodium hydroxide solution to the first well. After mixing the two solutions, make notes on your chart of any changes you observe. Don’t overlook any color changes, the formation of a precipitate (sometimes observed as a cloudy solution), the formation of a gas (fizzing or bubbles), or a change in temperature. Using another dropper, continue by adding three drops of the sodium hydrogen carbonate to the second well. It is important that you do not allow the tip of the dropper of one solution to come in contact with another solution. Your attention to this detail will prevent contamination of the solutions. Continue by adding copper (II) sulfate to the third well, and so on.

a) After mixing the pairs of solutions, make note on your chart of any changes you observe. You have now completed the first row of your chart. Next, you should begin the second row. Continue by putting three drops of sodium hydroxide into each of seven wells and adding the other solutions.

You may have noticed that adding barium nitrate to the sodium hydroxide (in the second row of the chart) produced the same result as adding sodium hydroxide to the barium nitrate (in the first row of the chart).

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If you can explain why this is so, you can shorten the time needed for your investigation by not repeating other mixtures. After completing your entire chart in this fashion and mixing all possible one-to-one combinations of solutions, clean up your workstation. Your teacher will provide disposal information.

3. Use your chart to answer the following questions:

   a) Which combination of reactants seems to produce no reaction when mixed together?
   
   b) Which combination of reactants forms a gas? Can you guess which gas is formed? Try to deduce this from the reactants’ names and chemical formulas.
   
   c) Which combination of reactants produces a color change when mixed together?
   
   d) Which combination of reactants forms precipitates quickly? Slowly?
   
   e) Which combination of reactants forms a yellow precipitate? A muddy brown precipitate? A white precipitate? A blue precipitate?
   
   f) Which combination of reactants produces heat? How could you tell?
   
   g) What evidence indicates that a chemical change is occurring?

4. Place the following chemicals in a quart-size resealable plastic bag with a zipper seal:

   One teaspoon (scoop) of calcium chloride (CaCl₂)
   One teaspoon (scoop) of baking soda (NaHCO₃)

   Seal the bag and mix the powders.

   a) Record your observations in your Active Chemistry log. Did a chemical reaction occur? Pour 10 mL of phenol red indicator solution into the bag and seal quickly. Make sure the solids come in contact with the indicator solution.
   
   b) Observe the reaction and, in your Active Chemistry log, describe what you see.
   
   c) Did a chemical reaction occur in the plastic bag? If so, identify all of the evidence of the chemical change.
   
   d) For this particular reaction, calcium chloride and sodium hydrogen carbonate combined to produce an aqueous solution of sodium chloride and calcium carbonate in addition to the carbon dioxide, water, and heat. The balanced equation is:

\[
\text{CaCl}_2(aq) + 2\text{NaHCO}_3(aq) \rightarrow 2\text{NaCl}(aq) + \text{CaCO}_3(s) + \text{H}_2\text{O}(l) + \text{CO}_2(g)
\]

   What do you think are the names of the reactants? What do you think are the names of the products?
5. Your teacher will provide you with a small amount (~25 mL) of limewater, a solution of calcium hydroxide (Ca(OH)$_2$), in a test tube. One end of a straw should be submerged in the solution.

Gently blow through the straw into the solution for a minute or so. 

Caution! Blow gently, and be careful to only blow out through the straw. Avoid ingesting any of the solution. You are actually bubbling some carbon dioxide through the solution.

a) Did a chemical reaction occur? 
What is the evidence?

6. Clean up your workstation and dispose of the chemicals as directed by your teacher.

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**Chem Words**

chemical test: a procedure or chemical reaction used to identify a substance.

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**TESTS FOR CHEMICALS**

**Chemical Tests for Gases**

In this activity, you focused on chemical reactions, those processes that result in the formation of new products. You also tested for the presence of some of the new materials. You used chemical tests to identify the unknown substances. A chemical test is a form of a diagnostic test. To test for the presence of oxygen, you introduce a glowing splint into a test tube with a small amount of gas. If the splint bursts into a flame, you then know that the gas is oxygen. When you introduce a burning splint into a test tube and hear a loud pop, you assume the gas present to be hydrogen. In this activity you tested for the presence of carbon dioxide. Since carbon dioxide does not burn or support burning, by using a glowing or burning splint, you could not tell if a gas was carbon dioxide. (If the splint is extinguished you can say that the gas is neither oxygen nor hydrogen and therefore could be carbon dioxide.)
The test for carbon dioxide uses limewater, a clear, colorless solution of calcium hydroxide in water. When you blew bubbles into the test tube you were actually blowing some carbon dioxide from your lungs into the limewater. The carbon dioxide reacted with the calcium hydroxide forming a precipitate. The precipitate caused the limewater to turn cloudy in appearance.

**Indicators for Acids and Bases**

When acids and bases are involved in a chemical reaction the appearance of the products is often very similar to the appearance of the reactants. (You will learn more about acids and bases in a later activity.) Therefore, indicators are used to determine the presence of an acid or base. Substances that change color when they react with an acid or a base are called **acid-base indicators**.

In this activity you used phenol red, an acid-base indicator that turns yellow in the presence of an acid. Chemists use a great variety of acid-base indicators. You may also have used litmus in previous science classes. It is a very common indicator used in school laboratories.

**What Do You Think Now?**

At the beginning of this activity you were given two procedures and asked which ones involve a chemical reaction and/or chemistry.

Look back at your answers and compare them to what you think now. Are chemical changes usually carried out in a laboratory? What is the most common evidence that a chemical change is taking place?
Chem Essential Questions

What does it mean?

Chemistry explains a macroscopic phenomenon (what you observe) with a description of what happens at the nanoscopic level (atoms and molecules) using symbolic structures as a way to communicate. Complete the chart below in your Active Chemistry log.

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<th>MACRO</th>
<th>NANO</th>
<th>SYMBOLIC</th>
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<td>What evidence do you see that reactants have undergone a chemical change? What happens to substances as they undergo chemical change?</td>
<td>One evidence of chemical change is the production of a gas. Where did the gas come from in the reaction of calcium chloride and sodium hydrogen carbonate? How is the formation of this gas different from the boiling of water to make vapor? How is a gas different from a liquid at the atomic level?</td>
<td>In the following chemical equation, indicate the symbolic representation for carbon dioxide gas being produced. NaHCO$_3$(aq) + HCl(aq) → NaCl(aq) + $H_2$CO$_3$(aq) → NaCl(aq) + CO$_2$(g) + H$_2$O(l)</td>
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How do you know?

Refer to your Active Chemistry log and develop a list of the evidence revealed in this activity that indicates that a chemical reaction has taken place.

Why do you believe?

Give an example of a chemical reaction you have personally witnessed recently. It can involve cooking food. List the evidences of a chemical reaction for your example.

Why should you care?

Chemical changes are often exciting! Your Cool Chemistry Show will probably involve some kind of chemical reaction. How can you make your chemistry show more interesting by utilizing the evidences of chemical change?

Reflecting on the Activity and the Challenge

Recall that the fourth-grade teacher has specifically requested that your chemistry show addresses chemical and physical properties. You are right on track for the fourth graders. The fifth-grade teacher wants the students to learn more about chemical reactions that involve color changes. You have seen a few of those, too. If you had to conduct the show based on your experiences so far, which activity would you use? What additional information would you need to be able to explain the chemistry to fourth- and fifth-grade students?
1. In both Activity 1 and Activity 2, you gathered evidence for chemical changes. However, this evidence does not always indicate a chemical change. For instance, a change in color can be evidence of a chemical change. However, when you add water to a powdered drink mix, the color often changes, but a chemical change has not taken place.

In each of the following situations indicate whether the evidence suggests a chemical change or not. Include the evidence that you used to make your decision:

a) An acid is dissolved in water and heat is released.
b) A burning match produces light.
c) A “seed” crystal is placed in a supersaturated solution and the extra solute particles “join” the crystal and come out of the solution.
d) The glowing filament of a light bulb produces light.
e) A small piece of metal is placed into an acid and hydrogen is released.
f) Solutions of sodium hydroxide and copper (II) sulfate are mixed and a blue precipitate appears.

2. Anhydrous copper (II) sulfate (CuSO₄) is a white solid. When it is dissolved in water, the solution becomes blue. Is this a chemical change? Give an explanation to defend your answer.

3. If a glass of carbonated soda drink is allowed to sit out for a period of time, you will find that the drink seems to be flat. Discuss this observation in terms of whether this is a physical or chemical change.

4. Preparing for the Chapter Challenge

Select one of the reactions you observed in this activity that you thought was pretty cool. Describe how you might incorporate it into a possible event in the Cool Chemistry Show you are designing. Would it meet the needs of the fourth-grade teacher, the fifth-grade teacher, or both? What additional information would you need to be able to explain the chemistry to the audience?