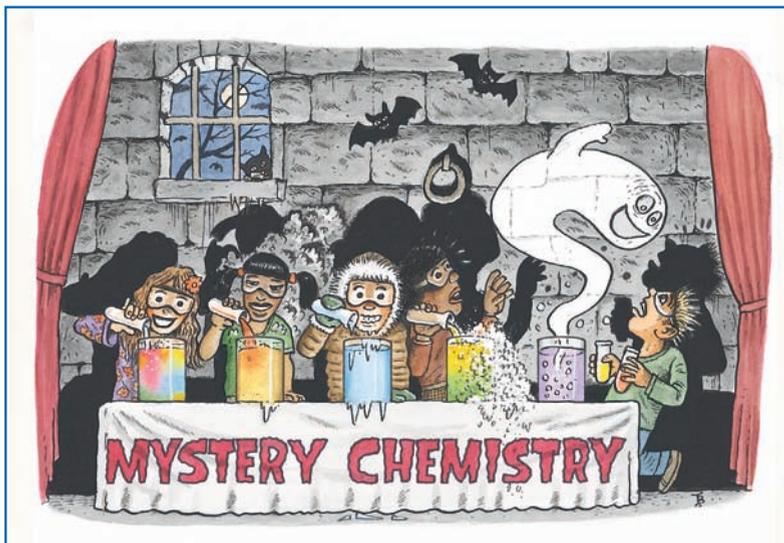




Activity 1

Chemical and Physical Changes



GOALS

In this activity you will:

- Learn to differentiate between chemical and physical changes.
- Make observations and cite evidence to identify changes as chemical or physical.
- Explore the new properties exhibited when new materials are made from combinations of two or more original materials.
- Design an experiment to test properties of different combinations of materials.

What Do You Think?

There are two basic types of changes that matter can undergo: chemical change and physical change. Consider two wooden matches. One is broken in half and the other is ignited by striking it along the side of the matchbox. In both of these instances matter has changed.

- **Which match has undergone a chemical change and which has undergone a physical change? Give specific reasons to support your answer.**

Record your ideas about this question in your *Active Chemistry* log. Be prepared to discuss your responses with your small group and with the class.

Investigate

1. Listed on the following page are 15 opportunities for you to observe changes in matter. Your teacher may choose to do some or all of these as a demonstration or set up stations for you to visit. Notice that the directions call for small amounts of substances.



Safety goggles and a lab apron must be worn during this activity.

Make a data table to organize your observations of the matter before and after any change(s) that may occur. Be detailed in your observations.

- Heat an ice cube in a beaker.
- Boil a small amount of water.
- Melt a small amount of candle wax. Then allow the melted wax to cool.
- Break a wooden splint into several pieces.
- Hold a wooden splint in a flame.
- Add a few drops of lemon juice to a small amount of milk.
- Add a few drops of vinegar to a small amount of baking soda (NaHCO_3).
- Add a small amount of table salt to water; stir; boil the solution to dryness; cool and record the result.
- Add several drops of iodine solution to a small amount of starch.
- Add a small piece of zinc to a small amount of hydrochloric acid (0.1 M HCl).
- Add a drop of phenolphthalein indicator solution to a solution of sodium hydroxide (0.1 M NaOH).
- Add two drops of sodium carbonate (0.1 M Na_2CO_3) to two drops of sodium hydrogen sulfate (0.1 M NaHSO_4).
- Add a few drops of household ammonia to a small amount of a copper (II) sulfate (0.1 M CuSO_4) solution.
- Add a few drops of vinegar to a small piece of chalk.

- Sharpen a pencil and collect the shavings.

Dispose of the materials as directed by your teacher. Clean up your workstation and then wash your hands.

2. Organize the information in your data table.
 - a) Prepare and complete a chart that organizes your observations into separate columns — one that includes the situations where color changes occurred, one that notes the formation of precipitates (sometimes visible as a cloudy solution), one that includes gas formation (fizz), one to note other changes, and one where no visible change occurred.
3. A physical change involves changes in the appearance of the material but does not involve creation of new materials. A chemical change involves the formation of new materials. Chemical reactions are characterized by a number of changes, including color changes and the formation of a precipitate or gas.
 - a) Which of the interactions you observed were chemical changes? Explain your answer.
 - b) Which of the interactions you observed were physical changes? Explain your answer.
 - c) When you placed the wooden splint into a flame, what other evidence (besides the color change) indicated that a chemical change took place?
 - d) Imagine a situation where two colorless solutions are mixed



together. There is no color change, no precipitate is formed, and no gas is released. However, heat is released as the solutions are mixed. Is this an example of a chemical or physical change? Explain your choice.

4. Each group will be given a piece of disposable diaper. Place the piece in a beaker.
 - a) Predict how much liquid the diaper will be able to hold. Record your prediction in your log.
 - b) Design an investigation to measure the amount of liquid that the diaper can absorb. Record your procedure in your log.
 - c) With the approval of your teacher, carry out your investigation. Record your results.



- d) Explain how your prediction compared with your observations.
 - e) The diaper is made of a material called sodium polyacrylate. When it absorbs water, is this a physical or chemical change? Explain your answer.
5. Your teacher will show you a solution of sodium acetate in a 250-mL flask. Observe the solution carefully.
 - a) Record your observations in your *Active Chemistry* log.
Your teacher will then add one crystal of sodium acetate to the flask.
 - b) What happens? Record your observations in your log.
 - c) Was this a chemical or physical change?
6. In a large throwaway glass jar, mix 100 mL of sodium silicate (sometimes called water-glass solution) and 400 mL of water.
Carefully drop solid-colored crystal compounds of cobalt, copper, nickel, iron, and/or manganese in different locations inside the jar.
 - a) Is there evidence of a change immediately? In several minutes? In several hours? In several days? In your *Active Chemistry* log, describe the results.
 - b) Is the phenomenon you see the result of a physical or a chemical change? Explain your answer.

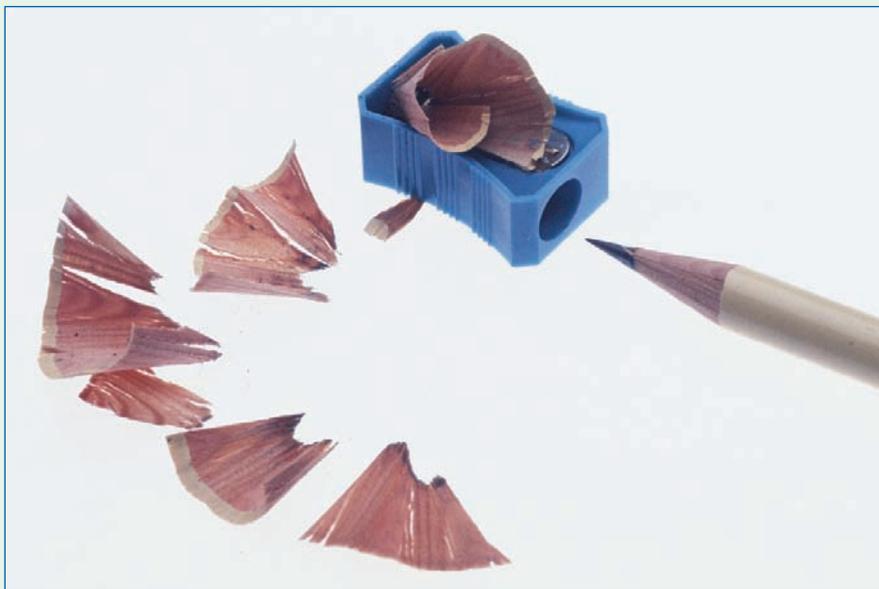
ChemTalk

CHANGES IN MATTER

Physical and Chemical Changes

In this activity you observed a number of situations that involved changes in matter, both physical and chemical. A **physical change** involves changes in the appearance of the material but does not involve creation of new materials. A change of a solid to a liquid is a physical change. When the candle wax melted it may have appeared different, but it was still wax. After it solidified, it had a similar appearance to the initial product. Dissolving is also a physical change. When you added the salt to the water, the salt crystals seemed to disappear as they dissolved in the water. However, they had only spread out into a solution. A **solution** is a homogeneous mixture of at least two different materials. The material being dissolved is called the **solute**, and the material present in the largest amount is called the **solvent**. When you boiled away the solvent, water, the solute, the salt crystals, remained the same as they were originally.

A **chemical change** involves the formation of new materials. The new materials are called **products** and the starting materials are



Chem Words

physical change: a change that involves changes in the state or form of a substance but does not cause any change in chemical composition.

solution: a homogeneous mixture of two or more substances.

solute: the substance that dissolves in a solvent to form a solution.

solvent: the substance in which a solute dissolves to form a solution.

chemical change: a change that converts the chemical composition of a substance into different substance(s) with different chemical composition.

product: the substance(s) produced in a chemical reaction.



Chem Words

reactants: the starting materials in a chemical reaction.

chemical reaction: a process in which new substance(s) are formed from starting substance(s).

precipitate: an insoluble solid formed in a liquid solution as a result of some chemical reactions.

concentration: a measure of the composition of a solution, often given in terms of moles of solute per liter of solution.

saturated solution: a maximum amount of solute that can be dissolved at a given temperature and pressure.

polymer: a substance that is a macromolecule consisting of many similar small molecules (monomers) linked together in long chains.

called **reactants**. The process that brings about a chemical change is called a **chemical reaction**. Chemical reactions are characterized by a number of changes, including color changes, the formation of a **precipitate** or gas, a release of heat or light. Chemical changes are usually not easy to reverse. When you burned the wooden splint you could not put the charcoal together to form the original splint as you could when you simply broke the splint into pieces.

Saturated and Supersaturated Solutions

The solution your teacher used in the demonstration was a supersaturated solution of sodium acetate. Solutions are commonly described in terms of **concentration**. The concentration of a solution is the ratio of the quantity of solute to the quantity of solution. A dilute solution has fewer solute molecules per volume than a concentrated solution. However, in both the dilute and concentrated solutions more solute can dissolve in the solvent. These solutions are unsaturated.

You probably recognize the term “saturated.” When something is saturated, it is full. A saturated sponge is full of water; it can’t hold any more. A **saturated solution** is one in which no more solute

will dissolve under the given conditions. To say that the sodium acetate solution is supersaturated means that it is “over full.” A supersaturated solution contains more solute



particles than it normally would under the given conditions. A supersaturated solution can be made using some solutes. If a saturated solution at a high temperature is allowed to cool undisturbed, all the solute may remain dissolved at the lower temperature. The solution is then supersaturated. As you observed in the activity, such solutions are unstable. By introducing a “seed” crystal the extra solute particles “joined” the crystal and came out of the solution.

Polymers

The chemical material that you were working with when you investigated the absorbency of the diaper was sodium polyacrylate. It is a chemical compound called a **polymer**. It is made up of many (poly) repeating units of a smaller group of elements (the monomer called acrylate). This particular polymer has a unique property. It will absorb more than 800 times its own mass in distilled water. The fascinating ability of this polymer (sodium polyacrylate) to absorb large amounts of water has led to its use in a number of commercial endeavors.

Checking Up

1. What is a physical change? Provide two examples.
2. Explain the meaning of a solution, a solute, and a solvent.
3. What is a chemical change? Provide two examples.
4. What “clues” can you look for to determine if a chemical change has occurred?
5. How do you describe the concentration of a solution?
6. Explain the difference between a saturated and a supersaturated solution.

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 and changes. 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?

Chemistry to Go

1. Which of the following are chemical changes and why?
 - a) Toast turns black after being in the toaster too long.
 - b) Water condenses on the outside of a glass of iced tea.



- c) Green leaves turn orange, yellow, and red in the fall.
 - d) Green bananas become yellow.
 - e) Butter melts on a hot summer day.
2. Think back to a recent lunch or dinner. Describe two physical and two chemical changes that were involved in the meal and explain why you think each was a physical or chemical change.
 3. Write a paragraph describing a common activity (such as making a cake or driving a car). Underline the physical changes (use one line) and chemical changes (use two lines) taking place within the activity. Select and describe an activity that is sure to have at least two physical changes and two chemical changes.
 4. The following information is obtained for the element aluminum. Identify which are physical (use one line) and which are chemical (use two lines) properties.

Aluminum is a shiny silver metal and melts at 660°C . When a strip of aluminum is placed in hydrochloric acid, hydrogen gas is released. The density of aluminum is 2.70 g/cm^3 . When polished aluminum is exposed to oxygen over a period of time it forms aluminum oxide (Al_2O_3) on the surface of the metal.
 5. How would you determine whether a clear solution in a beaker is saturated sugar water or just water? Remember, you do not taste samples in the laboratory.
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Preparing for the Chapter Challenge

Describe how you would demonstrate the difference between a physical and

chemical change in a “cool” way.

Inquiring Further

Factors affecting solubility and the rate of dissolving

Understanding the factors that affect how quickly a solute dissolves in a solvent is important in many practical applications in manufacturing. Design an investigation to determine the factors that affect solubility. Consider the following:

- nature of the solute and solvent
- temperature

- agitation (stirring or shaking)
- surface area (for example, try using a sugar cube, granulated sugar, and icing sugar)
- pressure of gases

Remember that your investigation must be controlled, if your results are to be reliable. What will be your independent and what will be your dependent variables?