



# SCIENCE

STUDENT BOOK

▶ **8th Grade | Unit 3**

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# SCIENCE 803

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# Structure of Matter Part 2

## Introduction

In Science LIFEPAK® 802 you learned something about the structure of matter and the different properties of various kinds of matter. Frequently when you put two kinds of matter together, a definite change occurs. These changes are sometimes simple and sometimes very complex. Although only 103 elements are known, these elements combine with each other to form thousands of compounds. Compounds combine to form still other compounds. The study of chemistry attempts to unfold the many ways matter changes as it combines. In this LIFEPAK you will learn about matter in change and about three common chemical compounds: acids, bases, and salts.

Are you matter? You surely are! You are made up of a variety of compounds which contain the elements carbon, hydrogen, oxygen, and nitrogen. Are you changing? The answer again is yes! Your body is in

constant change, particularly as you pass through the teens. What about your spiritual growth? If you are a Christian are you growing? Do you have areas in your life you would like to have changed? Most people do. Since God's Word is the source of truth and life, why don't you do a spiritual experiment as you progress through this LIFEPAK. Read Joshua 1:8 once a day while you are working on this LIFEPAK and do what it says. First, repeat this prayer to your Heavenly Father right now.

*Dear Heavenly Father, I thank you for your Word and for sending my Savior. Guide me as I read and say your Word each day. I believe I will be successful and prosperous. As I study about your great Creation in change, I believe your Spirit will reveal areas in my life that you would like to help me change. Thank you for doing this. In Jesus' Name,... Amen.*

## Objectives

Read these objectives. The objectives tell you what you will be able to do when you have successfully completed this LIFEPAK. When you have finished this LIFEPAK, you should be able to:

1. Define physical change.
2. List three examples of physical change.
3. Define chemical change.
4. Describe a way by which a liquid may be tested to see if it is acid, base, or neither.
5. State the differences among evaporation, condensation, dissolving, and distillation.
6. Define nuclear change.
7. List three kinds of radiation given off by radioactive matter.
8. Compare and contrast fission and fusion.
9. Name an instrument used to detect and study radiation.
10. State two properties of an acid.
11. Identify the chemical formula for several acids.
12. List three examples of an acid.
13. Name three common uses of acids.
14. Explain two properties of a base.
15. List three examples of a base.
16. Identify the chemical formula for several common bases.
17. Explain neutralization.
18. List four uses of salts.
19. Explain the difference between hard and soft water.

# 1. MATTER AND CHANGE

Change is all around us. The world is constantly changing. In winter, water changes from liquid to solid on lakes and streams. Clothes on the wash line change from wet to dry. Lead solder changes when heated. Silver tarnishes from shiny to black. Dead plants and animals change with decay. Your body grows and you change to larger clothes. A popsicle melts in the sun. All these examples describe changes in matter.

Matter changes in many different ways. Scientists put all changes in matter into three

groups: physical changes, chemical changes, and nuclear changes. Describing physical, chemical, and nuclear changes is what this section is about. As you learn how matter changes, think about how you are changing. You are certainly growing physically. Are you growing spiritually? God wants us to grow and change spiritually as well as physically. Ephesians 4:15 states that we are to grow up in all aspects unto Him, who is the head, even Christ.

## SECTION OBJECTIVES

**Review these objectives.** When you have completed this section, you should be able to:

1. Define physical change.
2. List three examples of physical change.
3. Define chemical change.
4. Describe a way by which a liquid may be tested to see if it is acid, base, or neither.
5. State the differences among evaporation, condensation, dissolving, and distillation.
6. Define nuclear change.
7. List three kinds of radiation given off by radioactive matter.
8. Compare and contrast fission and fusion.
9. Name an instrument used to detect and study radiation.

## Vocabulary

**Study these words to enhance your learning success in this section.**

**composition** (kom' pu zish' un). The makeup of anything.

**condensation** (kon' den sã' shun). Act of changing a vapor to a liquid.

**decompose** (dē' kum pōz'). To decay, rot.

**dissolve** (di zolv'). To become liquid by breaking up into parts.

**distillation** (dis' tu lã' shun) The process of separating the parts of a substance by heating.

**electron** (i lek' tron). A small particle of an atom with a negative charge.

**evaporation** (i vap' u rã' shun). The act of changing a liquid of solid to a gas.

**fission** (fish' un). The splitting that occurs when the nucleus of an atom absorbs a neutron.

**fusion** (fyü' zhun). A melting together.

**nuclear** (nü' klē ur). Having to do with the nucleus of an atom.

**oxidation** (ok' su dā' shun). Process of combining an element with oxygen.

**product** (prod' ukt). The end result of a chemical reaction.

**radioactive** (rā' dē ō ak' tiv). Giving off radiant energy in the form of alpha particles, beta particles, or gamma rays.

**soluble** (sol' yu bul). Capable of being dissolved or made into a liquid.

**subscript** (sub' skript). Written underneath or below.

**Note:** All vocabulary words in this LIFEPAAC appear in **boldface** print the first time they are used. If you are not sure of the meaning when you are reading, study the definitions given.

**Pronunciation Key:** hat, āge, cāre, fār; let, ēqual, tērm; it, īce; hot, ōpen, ōrder; oil; out; cup, pūt, rüle; child; long; thin; /ʒh/ for then; /zh/ for measure; /u/ represents /a/ in about, /e/ in taken, /i/ in pencil, /o/ in lemon, and /u/ in circus.

## PHYSICAL CHANGE

Have you had to cut up wood into small pieces for a fire? Cutting the larger pieces of wood into smaller ones changed the appearance of the original piece of wood. This kind of change is called a physical change. In this section you will study various ways changes occur and how heat is important in many of these changes.

**Change in the properties.** A physical change is a change in the size and shape of a substance. Hardness, shape, mass, and density

are physical properties, which may be involved in a physical change. Sodium metal can be cut with a knife because it is very soft. Hydrogen is a light gas. Chlorine is a green gas that is heavier than air. Sugar is sweet. These properties are physical. In a physical change, the kind of matter does not change. No new substance is formed. Therefore, a physical change is a change in the physical properties of a substance without a change in its chemical **composition**.



View 803 Physical &amp; Chemical Change, from the Grade 8 SCIENCE EXPERIMENTS Video

**Try this activity.****These supplies are needed:**

- paper
- soda cracker
- lump of sugar
- stirring rod
- small glass of water

**Follow these directions and answer the questions.** Put a check mark in the box when each step is completed.

- 1. Place a lump of sugar in a glass of water.
- 2. Stir the water a few times.
- 3. Taste the water.
- 4. Now tear a piece of paper into several pieces.
- 5. Crumble a soda cracker over a sheet of paper.

**1.1** What kind of change occurred in each case? Use complete sentences. \_\_\_\_\_

\_\_\_\_\_

**1.2** How do you know the kind of change? \_\_\_\_\_

\_\_\_\_\_



## Physical Change Experiment

**Follow these directions.**

**1.3** List four physical properties of matter.

a. \_\_\_\_\_ b. \_\_\_\_\_

c. \_\_\_\_\_ d. \_\_\_\_\_

**1.4** Write one example of a physical change. \_\_\_\_\_

**Write true or false.**

- 1.5 \_\_\_\_\_ A physical change involves a change in composition.
- 1.6 \_\_\_\_\_ A physical change creates a new substance.
- 1.7 \_\_\_\_\_ A change in appearance is a part of a physical change.

**Physical states.** All substances exist as solid, liquid, or gas. Some substances exist as all three *phases*. When the liquid (water) freezes, it becomes the solid phase (ice). When the solid melts, it becomes a liquid. The liquid phase (water) escapes into the air in the form of the gaseous phase (water vapor). Water vapor in the air can change to liquid water inside a car and fog the windows. Each case is a physical *change of phase*.

A change in the phase of a substance is explained by the *kinetic theory*. The kinetic theory states that the particles of a substance are in motion. When heat is added to matter, the particles, atoms, or molecules move faster. If heat is removed, the particles in the substance slow down. In a change of phase, particles either separate or move closer together. They may become more attracted to each other or less.

Physical properties can change *without* a change of phase occurring.

**Change within a phase.** If you hold a copper wire in flame, the wire gets hot; but that isn't the only effect of heat. If you were to measure the copper wire before and after it was heated, you would have found that the heated wire is a little longer and thicker while it is hot. When a solid such as copper wire is heated, it *expands*. Different solids expand different amounts. Figure 1 shows how different solids expand when heated. Each of the rods expanded to a different length.

Liquids and gases also expand as they become warmer. Like solids, different liquids expand at different rates. In general, matter expands as it becomes warmer. Matter shrinks in size, or contracts, as it cools. However, water is an exception in that it expands as it cools from 4°C until it freezes. You might remember seeing a jar of liquid crack open as it froze. The jar cracked because the liquid expanded as it turned to ice.

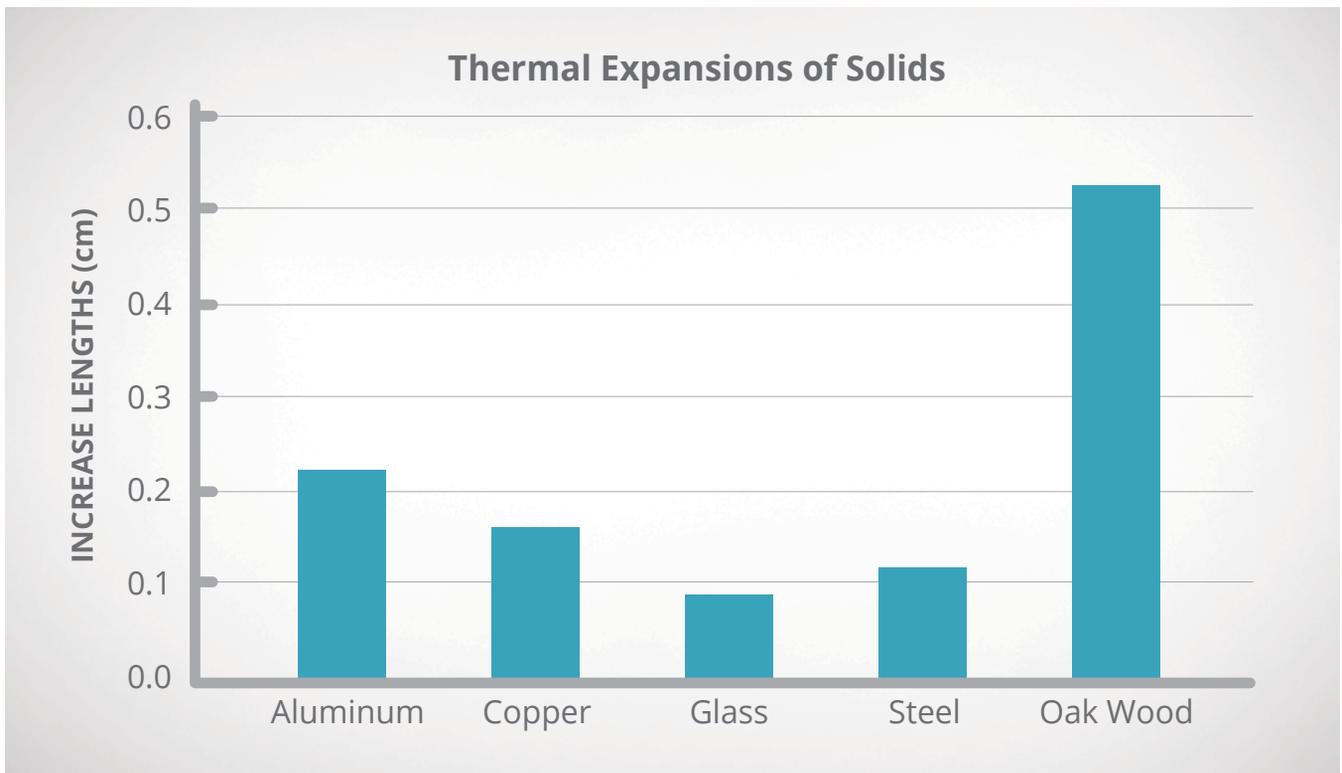


Figure 1 | Thermal Expansion of Solids



Look at Figure 1 and answer the following questions.

- 1.8 Which item expanded the least? \_\_\_\_\_
- 1.9 Which item expanded the most? \_\_\_\_\_
- 1.10 What approximate length did the oak wood expand to? \_\_\_\_\_
- 1.11 What approximate length did the glass expand to? \_\_\_\_\_

Write true or false.

- 1.12 \_\_\_\_\_ When heated, most matter expands.
- 1.13 \_\_\_\_\_ When matter other than water cools, it contracts.
- 1.14 \_\_\_\_\_ Contract means to get larger.
- 1.15 \_\_\_\_\_ Liquids and gases also expand as they become warmer.
- 1.16 \_\_\_\_\_ Most solids expand at the same rate.

You will recall from Science LIFEPAK 802 that all matter has *mass* and takes up space. The amount of space a piece of matter takes up is its *volume*. The amount of mass in a certain volume is called the *density* of that matter. You can calculate density by dividing the volume into the mass

$$\left( D = \frac{m}{v} \right)$$

Heat is involved in many kinds of changes. When heat is removed, most substances get smaller (contract). A change in temperature

causes a change in the density of matter. Adding or taking away heat causes a change in the size of matter. However, adding or taking away heat does not add or take away matter, or change the mass.

An important point to know is that the density changes when heat is added or taken away. If a piece of matter contracts, the same amount of matter takes up less space. That is, a greater amount of mass is contained in a certain volume. So when a piece of matter contracts, its density becomes greater.



**Complete these sentences.**

- 1.17 Matter that becomes smaller when it cools is said to \_\_\_\_\_ .
- 1.18 Expansion or contraction does *not* change the \_\_\_\_\_ of that matter.
- 1.19 Expansion or contraction does change the \_\_\_\_\_ of that matter.
- 1.20 The amount of matter present in an object is called its \_\_\_\_\_ .
- 1.21 The amount of mass divided by volume is the \_\_\_\_\_ of that object.

**Explain this problem.**

- 1.22 A certain man lived in North Dakota where summers are warm and winters are very cold. Every year about the same time he noticed that his front door began to squeak and became difficult to close. He would have to push and push until finally it would close.
  - a. Give an explanation of why the door was difficult to close. \_\_\_\_\_  
\_\_\_\_\_
  - b. In what season did he have the most difficulty with his door? \_\_\_\_\_  
\_\_\_\_\_

**Solutions.** Another kind of physical change takes place when two substances are mixed together. For example, when you mix sugar in water, you make a *solution*. In making a sugar-water solution, the molecules of sugar become separated from each other and

become scattered among the water molecules. The sugar dissolves in the water. The physical property of being able to **dissolve** is called **solubility**. A substance which does not dissolve in a liquid is said to be insoluble.



**Use a physical change to separate a mixture.**

**These supplies are needed:**

- sugar
- water
- beaker
- stirring rod
- dish
- teaspoon

**Follow these directions and answer the questions.** Put a check mark in the box when each step is completed.

- 1. Place several teaspoons of sugar in a small beaker half full of water, and stir it until the water is clear.
- 2. Pour some of the solution into a dish. Set the dish on a shelf or windowsill. Observe the dish for a day or two. Record what you observe.

**1.23** What happened to the sugar? \_\_\_\_\_

\_\_\_\_\_

**1.24** What physical change was used to separate the sugar from the water? \_\_\_\_\_

\_\_\_\_\_

**1.25** Name another mixture that could be separated in this way. \_\_\_\_\_

\_\_\_\_\_



## Physical Change Experiment

**Write true or false.**

- 1.26 \_\_\_\_\_ The physical property of being able to dissolve is called solubility.
- 1.27 \_\_\_\_\_ The sugar-water mixture is a solution.

**Change in phase: solid/liquid.** You know that adding heat to ice causes the ice to melt. When ice melts, it changes into water. Heat also causes water to boil and change into steam. Cooling, or removing heat, causes steam to change back into water. Cooling can also cause water to change into ice. So adding and removing heat causes changes in the phase of water.

Ice melts at  $0^{\circ}\text{C}$ . This temperature is called the melting point of ice. Water freezes at  $0^{\circ}\text{C}$  ( $32^{\circ}\text{F}$ ). This temperature is called the *freezing point* of water. Different substances melt or freeze at different temperatures. However, for any one substance, the melting and freezing points are virtually the same temperature.

If enough heat is added to a liquid, the liquid begins to boil. Each kind of liquid boils at a different temperature. The temperature at which a liquid boils is its *boiling point*. Water boils at  $100^{\circ}\text{C}$  at sea level. Water and other liquids, however, do not boil at the same temperature everywhere. The boiling point depends on how hard the air is pushing down on the surface of the liquid. That is, the boiling point temperature depends on the air pressure. The lower the air pressure, the lower the boiling point. Water would boil below  $100^{\circ}\text{C}$  on a mountain due to the lower pressure and higher altitude. Mountain campers often require more time to cook food due to this change in air pressure.

**View 803 Heat of Fusion, from the Grade 8 SCIENCE EXPERIMENTS Video****Try this investigation.****These supplies are needed:**

- crushed ice
- string
- burner
- beaker
- wire gauze
- thermometer
- (time piece with a second hand)
- ring stand



## Heat of Fusion Experiment

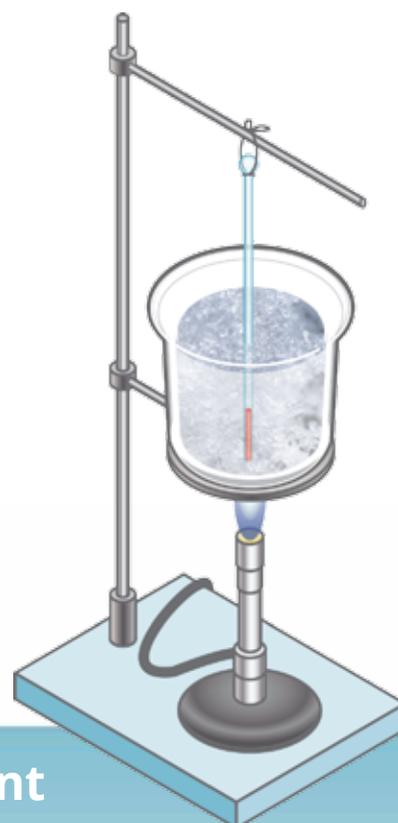


**Follow these directions and answer the questions.** Put a check mark in the box when each step is completed.

1. Pack the beaker full of crushed ice. Suspend a thermometer in the ice so the bulb of the thermometer does not touch the bottom of the beaker throughout the experiment.
2. Record the temperature of the contents in the beaker at the start and every *fifteen seconds*.
3. Warm the beaker with heat source. Stir gently. Be careful not to let the thermometer touch the beaker.
4. Record the phase or phases in the beaker each time the temperature is recorded. Use additional paper if necessary.
5. Record several temperatures as the water begins to boil.

time every 15 seconds	temp	phases
0		
15		
30		
45		
1:00		
1:15		
1:30		
1:45		
2:00		
2:15		
2:30		
2:45		
3:00		

*Chart continues on the next page.*



## Heat of Fusion Experiment

## SELF TEST 1

Match these items (each answer, 2 points).

- |       |       |              |    |   |
|-------|-------|--------------|----|---|
| 1.01  | _____ | evaporation  | a. | pertaining to the nucleus                 |
| 1.02  | _____ | reactants    | b. | a reaction between a substance and oxygen |
| 1.03  | _____ | gamma rays   | c. | radiation                                 |
| 1.04  | _____ | rusting      | d. | Celsius temperature scale                 |
| 1.05  | _____ | 0° C         | e. | freezing point of water                   |
| 1.06  | _____ | distillation | f. | to fuse or join together                  |
| 1.07  | _____ | oxidation    | g. | involves evaporation and condensation     |
| 1.08  | _____ | nuclear      | h. | change from liquid to gas state           |
| 1.09  | _____ | fission      | i. | rapid oxidation                           |
| 1.010 | _____ | Centigrade   | j. | splitting of the atom                     |
| 1.011 | _____ | burning      | k. | the combining substances in a reaction    |
| 1.012 | _____ | thermo-      | l. | heat                                      |
|       |       |              | m. | slow oxidation                            |

Write **C** if the change is chemical, and **P** if the change is physical (each answer, 2 points).

- 1.013 \_\_\_\_\_ burning a match
- 1.014 \_\_\_\_\_ melting ice
- 1.015 \_\_\_\_\_ evaporating water
- 1.016 \_\_\_\_\_ making pencil marks on paper
- 1.017 \_\_\_\_\_ blowing up a balloon
- 1.018 \_\_\_\_\_ baking a cake
- 1.019 \_\_\_\_\_ making a chocolate milkshake

**Define the terms** (each answer, 5 points).

**1.020** chemical change \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**1.021** physical change \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**1.022** chemical property \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Make a list** (each answer, 3 points).

**1.023** List five physical properties of matter.

- a. \_\_\_\_\_ b. \_\_\_\_\_  
c. \_\_\_\_\_ d. \_\_\_\_\_  
e. \_\_\_\_\_

**1.024** List three kinds of radiation given off by radioactive substances.

- a. \_\_\_\_\_ b. \_\_\_\_\_  
c. \_\_\_\_\_

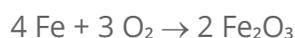
**Define these terms** (each answer, 5 points).

**1.025** latent heat of fusion \_\_\_\_\_  
\_\_\_\_\_

**1.026** latent heat of vaporization \_\_\_\_\_  
\_\_\_\_\_

**1.027** kinetic theory \_\_\_\_\_  
\_\_\_\_\_

**Answer the questions on the basis of the chemical equation** (each answer, 4 points).



**1.028** Write the reactants.

a. \_\_\_\_\_ b. \_\_\_\_\_

**1.029** How many *atoms* do the reactants represent? \_\_\_\_\_

**1.030** How many atoms does the product represent? \_\_\_\_\_

**1.031** Why are the number of atoms the same on each side of the arrow?  
\_\_\_\_\_

90

112

SCORE \_\_\_\_\_

TEACHER \_\_\_\_\_

initials

date



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