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SCIENCE

STUDENT BOOK

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What Is Science?

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What Is Science?

Introduction

God created you. He gave you the ability and the opportunity to observe a variety of events and objects every day. On the ground you see a worm inching along over shiny bits of rock. In the forest you see a deer drinking from a cool stream and a bird tending her nest. In the night sky you see the stars God placed there. All around you are invitations from God for you to observe the beauties of His creation. God told man to "... subdue (the earth): and have dominion...over every living thing that moves...." Science is our opportunity to follow God's command. Through science we can observe, ask questions, and experiment to answer the questions. Science is knowledge gained from observations and experiments and arranged in an orderly way.

Science is very much a part of our lives. Scientific processes of solving problems are being applied all around us. The number of people involved in some field of scientific study grows each year.

What do people who are involved in science do? No single specific method is common to all, but a common tie brings all scientists together: All scientists are engaged in making scientific observations. They have a definite question in mind and are looking for specific information to answer that question. When we observe, we "look" to find an answer to a question we have asked.

In this LIFEPAC®, you will study about the *tools* and *methods* scientists employ in finding answers to questions. You will have an opportunity to use the same methods in answering some questions of your own. Studying the *work* of a scientist, you will read about the four major fields in science. You will find out about branches of study within each field. *Jobs* for a scientist will be studied, and you will have the opportunity to meet a scientist who learned from God what to look for in his laboratory. In placing God first in his life, he became one of the greatest scientists in our country.

Objectives

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

1. Tell about the observation process.
2. Tell about the relationship of observation and questioning.
3. Name three properties of objects often measured.
4. Name ways to classify.
5. Identify the inductive method of investigation.
6. Identify the deductive method of investigation.
7. Know and apply the five steps in the scientific method.
8. Summarize the life of a Christian scientist.
9. Define and classify the several sciences.
10. Define the professional functions of scientist and technicians.

Survey the LIFEPAC. Ask yourself some questions about this study and write your questions here.

1. TOOLS OF A SCIENTIST

God gave man five senses—sight, hearing, taste, touch, and smell. These five senses enable man to use observation to learn about the wonderful world that God created.

In addition God made man a thinking creature. Man can use his mind to gather data and recognize evidence. Man can ask questions and seek answers. He can develop systems of classification to give order to his observation.

God made man with the ability to reason. He can use his knowledge and observations and state conclusions and inferences to answer his questions. These conclusions and inferences sometimes lead to new ideas.

Man has developed instruments to increase his ability to gather information. He has made instruments to help him measure. He has made instruments to help him see such very tiny things as molecules and such faraway things as planets and galaxies. The instruments man has invented are tools to help him have dominion over the earth.

In this section you will learn about and practice using the tools that a scientist uses.

SECTION OBJECTIVES

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

1. Tell about the observation process.
   - 1.1 Name the five senses scientists use in observation.
   - 1.2 Name the three steps (or parts) in the observation process.
2. Tell about the relationship of observation and questioning.
3. Name three properties of objects often measured.
4. Name ways to classify:
   - 4.1 Describe the sorting system developed by Carolus Linnaeus.
   - 4.2 Name other ways to classify.
5. Identify the inductive method of investigation.
6. Identify the deductive method of investigation.

VOCABULARY

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

chemical reaction (kem' u kul rē ak' shun). A change in which one substance is converted into one or more other substances with different properties.

classification (klas' u fu kā' shun). Systematic arrangement into groups.

deductive method (di duk' tiv meth' ud). A reasoning process by which one starts with a general principle that is accepted as true, applies it to a particular case, and arrives at a conclusion.

eclipse (i klips'). Passing from sight because light is cut off. In an eclipse of the sun, the moon is between the earth and the sun, cutting off light.

evidence (ev' u duns). Something that tends to prove.

generalization (jen ur u lu zā' shun). A general idea, statement, rule, or principle.

gravity (grav' u tē). Force which tends to pull objects toward the center of the earth.

inductive method (in duk' tiv meth' ud). A reasoning process by which one collects many particular cases, finds out what is common, and forms a general rule that is taken to be true.

mass (mas). Measure of the quantity of matter a body contains, independent of gravity.

microscope (mi' kru skōp). An instrument with lenses for making small objects look larger.

observation (ob' zur vā' shun). The act, habit, or power of seeing and noting.

prefix (prē' fiks). A syllable at the beginning of a word to alter its meaning.

science (sī' uns). Knowledge based on observed facts and tested truths arranged in an orderly system.

scientist (sī' un tist). A person who has expert knowledge of some branch of science.

senses (sens' uz). The power or act of feeling or perceiving. Sight, hearing, touch, taste, and smell are the five senses.

volume (vol' yum). Space occupied, as measured in three dimensions.

weight (wāt). The force with which a body is attracted by gravity.

Note: *All vocabulary words in this LIFEPAC 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: h**a**t, **ā**ge, c**ã**re, f**ä**r; l**e**t, **ē**qual, t**ė**rm; **i**t, **ī**ce; h**o**t, **ō**pen, **ô**rder; **oi**l; **ou**t; c**u**p, p**u**t, r**ü**le; **ch**ild; lo**ng**; **th**in; /*ŦH*/ for **th**en; /*zh*/ for mea**s**ure; /*u*/ represents /*a*/ in **a**bout, /*e*/ in tak**e**n, /*i*/ in penc**i**l, /*o*/ in lem**o**n, and /*u*/ in circ**u**s.

OBSERVATION

Scientific **observation** involves *using the five* **senses** and requires *making exact observations.*

Using the five senses. What do you do when you want to find out about something? What actions do you take? You look at it, you touch it, you smell it, you listen to it, and sometimes you even taste it. When you do these kinds of things, you are using your God-given senses to gather information. We also have a spiritual "sense" that tells us what is right and wrong. Without our senses we would not be informed, and without information we would not know anything. When we use our physical senses to find out about things, we involve ourselves in the process of observation.

We observe things all around us with our senses. Most of the things that we can think about and can know about are easily observed. However, many things are not easily observed. Some things are beyond the power of our senses to record. A single drop of water may contain an entire community of life so small it is observable only with a **microscope**. Some sounds are either below or above the range of pitches our ears can hear. Man has invented instruments that extend the range of his senses so that more and more of God's creation can be observed.

| Our Five Senses

Use an encyclopedia to find out about these scientists and the instruments that they made available for man to use to extend his field of observation. Write what you found out on the lines after each name.

1.1 Gabriel Fahrenheit: _____

_____

_____

_____

1.2 Galileo: _____

_____

_____

_____

1.3 Otto von Guericke: _____

_____

_____

_____

1.4 Robert Hooke: _____

_____

_____

_____

1.5 Johannes Kepler: _____

_____

_____

_____

1.6 Anton van Leeuwenhoek: _____

_____

_____

_____

1.7 Torricelli: _____

_____

_____

_____

Making exact observations. When a **scientist** is looking for information, he must make very careful observations. The data that the scientist gathers will be used in formulating ideas. If his observations are not accurate, his conclusions will most likely be incorrect. While the scientist is making his observations and collecting his data, he is also making comparisons. He is comparing this new information with information he has from previous experiences. In addition, the scientist must be able to recognize which observations lead to finding the solution to the problem he is researching. The importance of data he collects will depend on his ability to observe and to recognize what is **evidence** and what is not. This ability, in turn, depends upon his ability to think. **Science** is a process of orderly observation and thinking.

Observe a tree. Choose any tree to observe. Examine the bark, the leaves, the branches, the roots, the smell and sounds of the tree, the animal life in or around it.

List fifteen observations you made about the tree.

1.8 Beside each observation, list the sense you used.

	Observation	Sense
a.	_____	_____
b.	_____	_____
c.	_____	_____
d.	_____	_____
e.	_____	_____
f.	_____	_____
g.	_____	_____
h.	_____	_____
i.	_____	_____
j.	_____	_____
k.	_____	_____
l.	_____	_____
m.	_____	_____
n.	_____	_____
o.	_____	_____

Write the number of observations you made with each sense.

1.9 a. sight _____ b. hearing _____

c. smell _____ d. taste _____

e. touch _____

Analyze your statements to see how many fit in each of the following categories.

1.10 a. observations about color _____ b. observations about shape _____

c. observations about size _____ d. observations about smell _____

e. observations about feel _____ f. observations about sound _____

g. observations about life _____

Write any observations you made using more than one sense.

1.11 _____

_____

_____

While you were observing the tree or while you were reviewing your observation, did any questions come to your mind?

Write the questions you asked yourself.

1.12 _____

_____

_____

If no questions came to your mind during your observation, think of some questions about trees that you would like to have answered.

Write your questions here:

1.13 _____

_____

_____

Complete these statements.

1.14 The process of _____ involves using all our senses.

1.15 The five senses are a. _____ , b. _____ , c. _____ , d. _____ , and e. _____ .

1.16 Man invented various _____ to extend his senses.

1.17 In order to make exact observations, a scientist must be able to a. _____ , b. _____ , and c. _____ .

1.18 Science is a process of a. _____ and b. _____ .

QUESTIONS

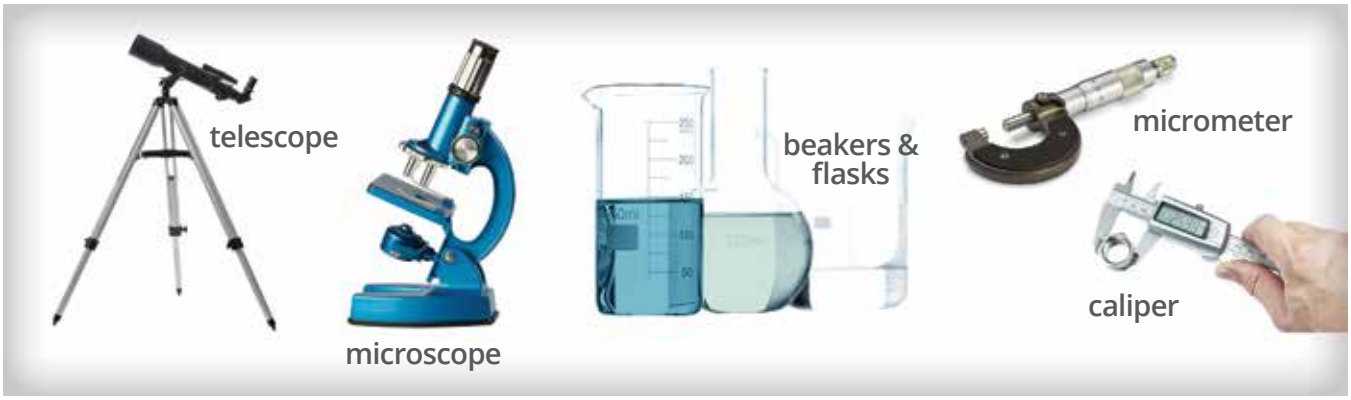
You might ask which comes first, the questions or the observation? The scientific process does not say which has to come first. Often, observations cause us to ask questions. It really doesn't matter which comes first because both go together. A scientist both observes and asks questions. The scientist is really involved in a cycle of question asking, observing, thinking, question asking, observing, thinking, question asking, and so forth.

MEASUREMENT

Observations often result in making measurements and measurements result in making closer observations. Scientists try to find out as much as possible about the physical properties of things they are investigating. This "finding out" involves measurement. Properties such as **weight**, height, or **volume** are measured and compared.

Some of the basic metric units are: mass— kilogram; length—meter; volume—liter.

These three steps of the scientific process—observation, questioning, and measurement—often occur at the same time rather than in any particular sequence. Each step is important and builds toward the final conclusion or **generalization**.



| Scientists use many measuring tools.

Write the name of the basic unit of length, mass, and volume used in the metric system.

1.19 Unit of length: _____

1.20 Unit of mass: _____

1.21 Unit of volume: _____

NOTE: The **prefixes** milli-, kilo-, centi-, and micro- have definitions based on size.

Write the definition of each prefix. (Use a dictionary if you are not sure.)

1.22 micro-_____

1.23 milli- _____

1.24 centi- _____

1.25 kilo-_____

Angstrom, micron, and *light year* are also units of measurement.
Use a dictionary and write their definitions.

1.26 angstrom _____

1.27 light-year _____

1.28 micron _____

CLASSIFICATION

Classification systems help people sort and organize data. Living things are classified according to *similarities and differences in structure.*

Classification systems. The unending variety of shapes and sizes and kinds of things has intrigued man since his earliest days. Before recorded history, man's ability to reason allowed him to use his senses to classify objects by size and shape and use.

The Swedish naturalist, Carolus Linnaeus (1707-1778), spent his lifetime revising and perfecting a classification system that he began when he was a teenager. His system is still used today. Linnaeus observed that natural objects can be divided into three kingdoms: the mineral kingdom, the vegetable kingdom, and the animal kingdom. Each kingdom has its own characteristics: minerals grow; plants grow and live; animals grow, live, and have feeling. To clearly understand and identify natural objects, Linnaeus developed a methodical system of classifying and naming them. Classification and naming would be the foundation of the emerging science of nature. He also believed that all knowledge of the natural world is learned through the physical senses: touching, tasting, smelling, hearing, and seeing. For Linnaeus, seeing was the most important sense for knowing nature.

Similarities and differences. To tell a zebra from a lion is easy. The differences of color, size, and shape are very evident. After a period of observation, the differences in eating habits, sleeping patterns, and social behavior become evident. One might assume that all zebras are alike. However, among the zebra population in Africa are six distinctly different kinds. In such instances, the similarities are much more evident, and we really have to observe very carefully to note the differences.

To tell a corn seed from a bean seed is easy. The differences are evident. However, among corn seeds there are also many differences. Again, as with the zebras, the similarities among corn seeds are more evident than the differences. Even among the seeds from one ear of corn, differences will occur. Growing rates may be different, and plants grown from each will differ in some ways.

Using a given set of objects, one person may classify them by color, but another person may choose to classify them according to shape or size or use of material or some other characteristic. The sorting system chosen will determine the way in which items are grouped.

Classify some objects.

1.29 Using the objects in the box your teacher has assembled, classify the objects in at least three ways. Write the classification system you used each time. Collect your data on another sheet of paper. Have your teacher evaluate the classification.

TEACHER CHECK _____ initials _____ date

Complete the following statements.

1.30 Linnaeus listed three kingdoms of nature: a. _____ , b. _____ , and c. _____ .

1.31 According to Linnaeus, the characteristics of each of the three kingdoms are: minerals a. _____ ; plants b. _____ ; and animals c. _____ _____ .

1.32 Compare a lion and a zebra. List both similarities and differences.

	Similarities	**Differences**
a.	_____	_____
b.	_____	_____
c.	_____	_____

Develop your own classification system.

1.33 Pretend that you are Adam and that God gave you the responsibility of classifying and naming the animals He had created. Read the account of Adam and Eve in the Bible again. Develop a system to classify the animals different from the one we use today. Tell the names you would give to the animals. Tell why you chose those names. Do your work on another paper. Share your ideas with a classmate.

HELPER CHECK _____ initials _____ date

Conduct a survey.

1.34 Choose two objects in the classroom such as a paper clip and a ruler. Ask several classmates to tell you in what ways the two objects are alike and in what ways the two objects are different. Record what they say on a data chart similar to the following one. Did your friends list more differences or more similarities? In which area did most of the observations fall?

	Similarities					Differences				
	size	shape	use	material	color	size	shape	use	material	color
clip										
ruler										

TEACHER CHECK _____ initials _____ date

Answer these questions on the lines.

1.35 Did your friends list more similarities or differences? _____

1.36 In which classification area did most observations fall? _____

_____

1.37 Which classification area would you emphasize? _____

Why? _____

_____

_____

_____

_____

_____

_____

INDUCTIVE METHOD

Common sense often forms the basis of inductive reasoning. Inductive reasoning produces the knowledge we accumulate through a variety of experiences.

Antoine Lavoisier, a French scientist who lived in the 18th century, devoted his life to experimentation. Most of his experiments were with problems involving measurement of mass. Lavoisier was the first man to recognize the importance of an analytical balance as a tool to use in performing chemical experiments. He made a point of weighing the substances he started with for a chemical experiment. He then weighed the substances that were formed during the **chemical reactions**. He observed in *every one* of these reactions that the **mass** (that is, the quantity of matter) of the beginning ingredients was exactly equal to the mass of the products that resulted from the reactions. Lavoisier then reasoned that this mass relationship must apply to *every* possible chemical reaction. He summarized his experimental results in general terms by stating, "There is no gain or loss of mass in a chemical reaction." This is called the law of conservation of matter.

Lavoisier's generalization, or law, is the result of using the **inductive method**. He performed a number of experiments, realized that a principle applied to each of them, and then applied this principle to all similar situations. Inductive evidence is gathered from a small number of experiments and then applied to *all* similar situations.

Complete these statements.

1.38 The inductive method of reasoning begins with a(n) a. _____ and results in a(n) b. _____ .

1.39 The law that states there is no loss or gain in mass in a chemical reaction is called the Law of _____ .

DEDUCTIVE METHOD

Deductive reasoning means applying a general principle to specific cases. It is the opposite of inductive reasoning. For example, we may begin by accepting the proposition that "All Greeks have beards." Then, if "Zeno is a Greek," we can conclude that "Zeno has a beard." We usually refer to conclusions reached through deductive reasoning as being *valid* rather than being *true*. We must make a distinction between statements that follow logically and those that are actually facts.

A great deal of scientific knowledge is derived from deductive reasoning. Whereas *inductive* reasoning proceeds from the specific to the general (the observations to the generalization), *deductive* reasoning proceeds from the general to the specific. The discovery of the Law of Gravitation by the English scientist Isaac Newton in 1687 is both an example of inductive and deductive reasoning.

That Newton observed an apple fall to the earth from a tree under which he sat is popularly reported. Perhaps after a few more apples, Newton generalized that *all* objects are attracted toward the earth, and he called this attraction **gravity**. Up to a point, Newton was reasoning *inductively*: going from specific happenings to a general principle. Then

Newton made a guess. He guessed that gravity extended beyond the earth. He went even further and stated that a gravitational pull existed between the earth and the moon, and a gravitational pull existed also between the earth and the sun. This process is *deductive* reasoning: going from a generalization (all objects are attracted toward the earth) to a specific case (the moon is attracted toward the earth.) Assuming that gravity was universal, Newton stated that he could predict and calculate the path of the moon around the earth. He stated he would be able to predict **eclipses** of the moon to within a second of time. He then proceeded to make his computations and they did, in fact, agree with actual observations made by astronomers.

Prediction is a test of a deductive statement. Newton stated a general theory of gravity, which he then applied in such particular cases as the path of the moon around the earth. The law allowed other facts to be predicted accurately. The facts involved the earth and the moon, the earth and the sun, objects on the earth, and even the earth and all celestial bodies. The predictions were proved true through observation; therefore, the deductive statement must have been true.

Define the following concepts.

1.40 *Deductive method*: _____

_____

_____

1.41 *Inductive method:* _____

_____

_____

Complete the following activities. Write the word *inductive* or *deductive* to tell whether the inductive method or the deductive method is used to reach the conclusion.

1.42 _____ All human beings have a head.
John is a human being.
Therefore, John has a head.

1.43 _____ Everyone who lives on Blue Shark Island is Chinese.
Li Lun lives on Blue Shark Island.
Therefore, Li Lun is Chinese.

1.44 _____ Perch, salmon, and tuna are fish.
Perch, salmon, and tuna are cold-blooded. Therefore, all fish are cold-blooded.

1.45 _____ All oak trees have acorns.
This tree has acorns.
Therefore, this is an oak tree.

1.46 _____ Tracy Todd and Joanne Todd live in Englewood.
They are related to all the other Todds in Englewood.
Therefore, everyone in Englewood named Todd is related.

Complete the sentences.

1.47 Antoine Lavoisier was the first scientist to recognize the importance of using a(n) _____ as a tool in performing chemical experiments.

1.48 Lavoisier found that matter neither a. _____ nor b. _____ mass during a chemical reaction.

1.49 Lavoisier's findings constitute the basis for the Law of _____ _____ .

1.50 Lavoisier's observations illustrate the _____ method of logical thinking.

1.51 Newton developed the Law of Gravitation using the _____ method to go from specific happening to the general principle.

1.52 Newton's predictions were based on the _____ method.

Write your answer.

1.53 Write a set of three sentences that illustrate the deductive method.

_____

_____

_____

1.54 Write a set of three sentences that illustrate the inductive method.

_____

_____

_____

Review the material in this section in preparation for the Self Test. The Self Test will check your mastery of this particular section. The items missed on this Self Test will indicate specific areas where restudy is needed for mastery.

TEACHER CHECK _____ initials _____ date

SELF TEST 1

Match the following tools that a scientist uses in thinking with the process involved (each answer, 2 points).

1.01 _____ observation
1.02 _____ questions
1.03 _____ measurement
1.04 _____ classification
1.05 _____ inductive method
1.06 _____ deductive method

a. organizing knowledge according to a particular system of categories
b. learning through the use of our five senses
c. reasoning from particular cases to a general rule
d. increasing powers of the five senses
e. identifying length, mass, volume, etc.
f. reasoning from a generalization to a particular case
g. wondering about the how's and why's

Complete this list (each answer, 3 points).

1.07 List the five senses:

a. _____ b. _____

c. _____ d. _____

e. _____

Match the following scientists with the instrument they invented, improved, or used to aid man in making more careful observations (each answer, 2 points).

1.08 _____ Galileo
1.09 _____ Torricelli
1.010 _____ van Leeuwenhoek
1.011 _____ Fahrenheit
1.012 _____ Hooke
1.013 _____ Kepler
1.014 _____ von Guericke

a. telescope
b. microscope
c. thermometer
d. barometer

Classify the following animals correctly according to the two categories. Write the names in the correct columns (each answer, 2 points).

alligator	eagle	horse	mouse
canary	elephant	lion	rattlesnake
codfish	giraffe	lizard	whale

1.015 Land animals:

a. _____ b. _____

c. _____ d. _____

e. _____ f. _____

g. _____

1.016 Animals whose name contains three or more syllables:

a. _____ b. _____

c. _____ d. _____

Write the letter *a* on the line if the conclusion logically follows from the statements. Write the letter *b* on the line if it does not follow logically (each answer, 2 points).

All rwenks are blue.

All blue things melt in the sun.

Therefore,

1.017 Rwenks melt in the sun. _____

1.018 All blue things are rwenks. _____

Select a second statement from choices a, b, and c that leads logically to the conclusion and circle the letter of the conclusion (each answer, 2 points).

1.019 Statement One — To be a good student a person must work hard.
Statement Two — _____
Conclusion — Therefore, some football players work hard.
a. No football players are good students. b. Some football players are good students.
c. If a person is a good student, he will play football.

1.020 Statement One — Beauty is in the eye of the beholder.
Statement Two — _____
Conclusion — Therefore, all babies are beautiful.
a. All mothers see their babies as beautiful. b. Beautiful babies have big eyes.
c. Only beautiful mothers have beautiful babies.

Write a paragraph about why observation is probably the most important single tool the scientist uses (this answer, 5 points). Your teacher will help you assign the points.

1.021 ____

61/76 **SCORE** ____________ **TEACHER** ____________ ____________
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