LIFEPAC®

SCIENCE

STUDENT BOOK

9th Grade | Unit 2

Alpha Omega
PUBLICATIONS

SCIENCE 902

Volume, Mass, and Density

LIFEPAC Test is located in the center of the booklet. Please remove before starting the unit.

Author:
Harold Wengert, Ed.D.

Editor:
Richard W. Wheeler, M.A.Ed
Consulting Editor:
Rudolph Moore, Ph.D.
Revision Editor:
Alan Christopherson, M.S

Westover Studios Design Team:
Phillip Pettet, Creative Lead
Teresa Davis, DTP Lead
Nick Castro
Andi Graham
Jerry Wingo
Don Lechner

804 N. 2nd Ave. E.
Rock Rapids, IA 51246-1759

Volume, Mass, and Density

Introduction

This LIFEPAC® is designed to help you get a better understanding of why things sink or float on water, what the difference is between *mass* and *weight*, and how standard units of volume and mass are helpful. You will make your own equal-arm balance and use it in mass measurements. You will also have a chance to make clay boats and see what makes them float. This should be a good time of learning about God's universe.

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. Measure and calculate the volumes of solids, liquids, and gases.
2. Define a standard volume unit.
3. Use a balance to measure mass.
4. Use standard mass units.
5. Define and use weight.
6. Define and calculate density.
7. Describe variables of density.
8. Define and calculate specific gravity.
9. Define and use Archimedes' Principle

1. VOLUME

Matter can be described in several ways. The most common descriptions are based on its two *general properties*: that matter takes up space (has volume) and has mass (measurable "stuff"). Sometimes we say that something is large or small. We may compare different amounts of the same substance by saying we have more water in this cup than in that one. In each case we are using the property of matter, which we call *volume*, to describe the substance.

SECTION OBJECTIVES

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

1. Measure and calculate the volumes of solids, liquids, and gases.
2. Define a standard volume unit.
   - 2.1 Explain why a standard is necessary.
   - 2.2 Convert among metric volume units.
   - 2.3 Define the *liter* (L).

VOCABULARY

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

liter (lē ' tur). Standard unit of volume, equaling a cube ten centimeters on a side; symbolized by L.

standard (stan' durd). Accepted reference unit that is mutually agreed upon as the basis of measurement for that physical characteristic.

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**ėr**m; **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.

VOLUME AS A MEASURE OF MATTER

Volume is defined as the amount of space a substance occupies. Solids, liquids, and gases have volume. Volume is one of the general properties of matter.

The names used to measure volume have changed often over the years. Some common units of volume used in Biblical times are listed in Figure 1.

Liquid Measure	gallons	quarts	pints	gills
A caph	—	—	—	2.5
1.3 caph = 1 log	—	—	—	3.5
4 logs = 1 cab	—	1	1	2.1
3 cabs = 1 hin	1	1	0	2.16
2 hins = 1 seah	2	2	1	0.25
3 seahs = 1 bath, or ephah	7	3	1	0.75
10 ephahs = 1 kor, or homer	78	3	1	3.5

Dry Messure	pecks	gallons	pints
A gachal	—	—	0.1416
20 gachals = 1 cab	—	—	2.8333
1.8 cab = 1 omer	—	—	5.1
3.3 omers = 1 seah	1	0	1
3 seahs = 1 ephah	3	0	3
5 ephahs = 1 letech	16	0	0
2 letechs 1 kor, or homer	32	0	0

Figure 1 | Common Volume Units in Biblical Times

Standard units. The **standards** of volume measurement have changed frequently through history. Units like *handfuls, double handfuls, gourdfuls,* and *dipperfuls* are units still used as standards in some parts of the world. Let's study some ideas of standards of volume measurement.

View 902 Units of Measure, from the Grade 9 SCIENCE EXPERIMENTS Video

Let's investigate.

These supplies are needed:

- baby food jar (middle size)
- five large jars (different sizes)
- five small vials (different sizes)

Follow the directions.

1.1 Using the units of baby food jarfuls as the basic unit (the *standard*), determine the volume of at least five large jars. Use water to measure the volume. Record your results on Figure 2, Column 1. Measure to the nearest whole jarful.

Jar #	Jarfuls	Nearest ½ jar	Nearest 1/10 jar
a. 1			
b. 2			
c. 3			
d. 4			
e. 5			

Figure 2 | Baby Food Jar Measurements

1.2 Devise a way to mark the baby food jar so that you know when it is one-half full. Using this newly marked standard, measure the volume of the same five jars used in 1.1. Record your results in Figure 2, Column 2.

1.3 Using your standard baby food jar, devise a way to divide it into ten equal volumes. Now repeat the volume measurement, recording the data to the nearest one-tenth baby food jarfuls. Record these data in Figure 2, Column 3. Discuss your method for division of the standard into ten equal parts with your teacher.

1.4 What conclusions can you make about the accuracy of the three methods of measurement?

Units of Measure Experiment

1.5 Now measure the volume of five small containers—the vials or small bottles. Use your standard baby food jar to measure these volumes. Record your data in Figure 3.

Vial #	Volume
a. 1	
b. 2	
c. 3	
d. 4	
e. 5	

Figure 3 | Small Container Measurements

1.6 What do you conclude about the accuracy of your standards?

_____

_____

_____

_____

TEACHER CHECK _____ initials _____ date

1.7 Do you think that every other student in the class would have exactly the same size standard as you did in 1.3? _____

1.8 Why or why not (1.7)? _____

_____

_____

_____

_____

1.9 If you tried to make a new standard like the one you made in 1.3, would each new one-tenth division of a baby food jar be the same as the one you made before?

_____

_____

Units of Measure Experiment

1.10 Why or why not (1.9)? _____

_____

_____

_____

1.11 What are some factors that determine the consistency of standard units from one person or time to another? _____

_____

_____

_____

_____

_____

1.12 Why is accuracy poor when a large standard is used to measure small amounts?

_____

_____

_____

_____

_____

_____

_____

1.13 Write the complete dictionary definition of *standard.* _____

_____

_____

_____

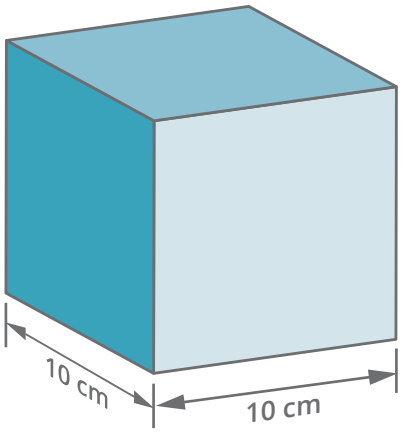
Units of Measure Experiment

Standards of volume measurement have changed. Any good standard must have these characteristics:

1. Is easily used and accessible.
2. Will measure many different volumes.
3. Is accepted by most people.

In early history many standards existed. Each tribe and each village had its own standard. When a traveler or trader went from one town to another, standards were often different. Different standards produce confusion, dishonesty, and distrust. God knew that man must have only one unchanging standard or he would be confused and lost. As a result the standard he gave man to live by is *perfection.* In Matthew 5:48 Jesus said, "Be ye therefore perfect, even as your Father which is in heaven is perfect." We cannot live up to this standard for our lives. God says in Romans 3:23, "For all have sinned and come short of the glory of God." However, through our acceptance of Jesus, we do meet the divine standard because He met it for us. He measured up to God's standard in ways we could not. According to Romans 3:24-25, we are "...justified freely by his grace through the redemption that is in Christ Jesus: Whom God hath set forth to be a *propitiation* [standard bearer] through faith in his blood, to declare his righteousness for the remission of sins that are past, through the forbearance of God."

Today several standards of volume are in use in the world. The one we will use in science is



the **liter** (L). The international standard is kept in Paris, France. Copies are made of that standard and are used in many places in the world. The liter standard we use may be a copy of a copy of a copy, which means that our measurements will have some error due to reproduction error.

A liter is a volume equal to a cube ten centimeters (10 cm) on each side.

Complete these activities.

1.14 When a standard is copied several times, what happens to the accuracy of the reproduction?

_____

_____

_____

Subdivision of units. As we found with our baby food jar standards, divisions of the standard are necessary. The standard liter is subdivided into 1,000 smaller units called *milliliters* (ml).

1 L = 1,000 ml

0.001 L = 1 ml

Complete this chart of conversions.

	L	ml	L	ml	L	ml
1.15	1	a. _____	b. _____	1,000	c. _____	602
1.16	10	a. _____	0.010	b. _____	c. _____	62
1.17	0.10	a. _____	b. _____	0.01	c. _____	6,200
1.18	0.01	a. _____	0.0001	b. _____	c. _____	6.2

Figure 4 | Conversion Chart

If we should want to measure the volume of solids and gases, the same standard is used. How can we catch a gas to measure it or determine the volume of an irregularly-shaped rock? The easiest way is to displace a liquid volume by putting the solid or gas into the liquid. If you take a marked container like a graduated cylinder or beaker, put in a measured amount of water, put in the solid, and measure the resulting volume, then the increase in volume is equal to the volume of the solid. Figure 5 illustrates this method.

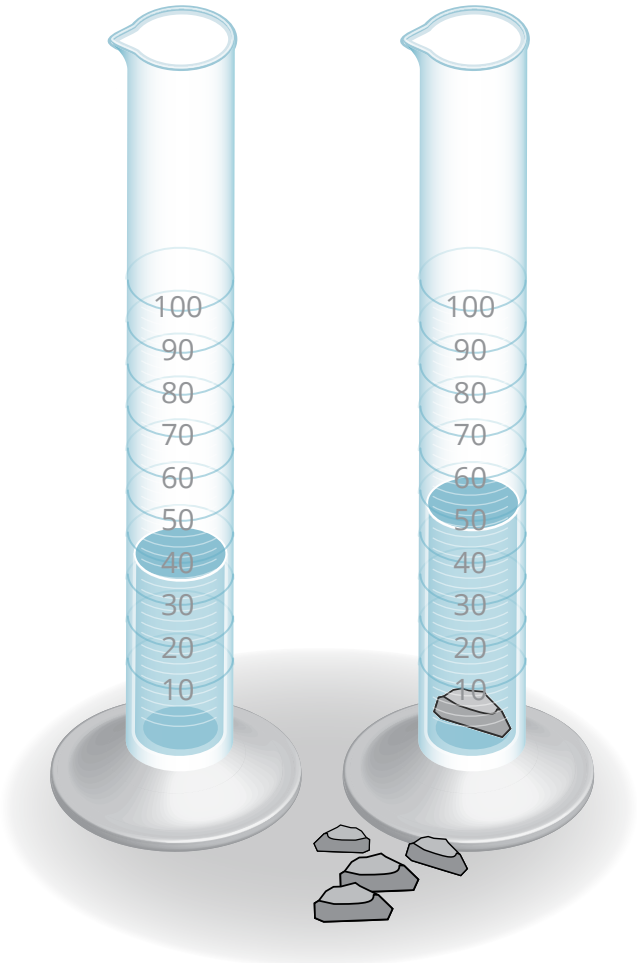


Figure 5 | Displacement Method of Determining Volume

SELF TEST 1

Match these items. The choices may be used more than once (each answer, 2 points).

1.01 _____ L
1.02 _____ ml
1.03 _____ standard unit of volume
1.04 _____ 10 cm cube
1.05 _____ 0.001 L

a. milliliter
b. liter
c. centiliter

Complete these statements (each answer, 3 points).

1.06 Three characteristics of a good standard are a. _____ , b. _____ , and c. _____ .

1.07 One method used to determine the volume of solids and liquids is _____ .

Complete this exercise (each answer, 3 points).

1.08 Convert each of these given volumes to the units missing.

L	ml
0.01	a.
b.	100
c.	62

L	ml
1.02	d.
e.	912
0.55	f.

Answer these questions (each answer, 5 points).

1.09 Given a small piece of coal, describe exactly how you would determine its volume using the displacement method. _____

_____

_____

_____

_____

1.010 Write one reason each why volume is a poor indicator of

a. the amount of solid present in a sample. _____

_____

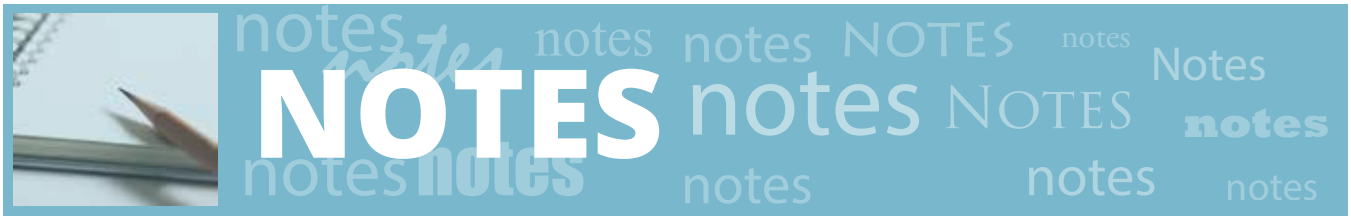
_____

b. the amount of gas present in a sample. _____

_____

_____

44/55 **SCORE** _____ **TEACHER** _____ _____
initials date


NOTES
notes
notes
notes
notes
NOTES
notes
Notes
NOTES
notes
notes
notes
notes
notes
notes

SCI0902 – May '14 Printing
ISBN 978-0-86717-782-4

Alpha Omega
PUBLICATIONS

804 N. 2nd Ave. E.
Rock Rapids, IA 51246-1759

800-622-3070
www.aop.com