LIFEPAC®

SCIENCE

STUDENT BOOK

7th Grade | Unit 2

Alpha Omega PUBLICATIONS

SCIENCE 702

Perceiving Things

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

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Perceiving Things

Introduction

God gave you five senses to use. With these senses you can **perceive**, or be aware of, God's creation all around you. With your eyes you perceive how things look. With your ears you perceive how things sound. With your hands you perceive how things feel. With your tongue and nose you perceive taste and odor.

When we use our ability to perceive, we take in information with our minds. We observe things and perceive how they are.

Measurement is a tool that we use in perceiving things as they are. We are always asking questions that involve measurement. How much is left? How many are going? How tall is that building? How heavy is the book? How far did he go? How soon are they coming? We answer all of these questions by measuring.

Measurement involves using a standard. *When we measure, we compare the object we are measuring with a measurement standard.* To find the measurement of the object, we count how many of the standard units are needed to equal the object.

In this LIFEPAC® you will learn about the standard units in the metric system of measurement. You will practice using these units, these standards, to measure objects around you. You will learn how to make a graph to report data you collect and how to use your graphs to predict additional information. In the Bible we learn that Christ is the standard by which our lives are measured. You will discover some Biblical standards for your life and determine how you measure up to God-given patterns and standards.

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. Name the units of measurement in the metric system.
2. Tell about the history of the metric system.
3. Explain the advantages of the metric system.
4. Use the metric measurement units correctly.
5. Construct several kinds of graphs.
6. Determine the best graph to represent various data.

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

1. MEASUREMENT

The **metric system** is a set of units for measuring length, temperature, time, and mass. The units for length can, in turn, be used to find the measurements of area and volume. No other system of measurement is so simple to use. Scientists have been using the metric system for years. The metric system seems difficult to many people because they are not familiar with the terms or the structure of the system. Once a person becomes thoroughly familiar with the terms and the structure, he finds the system easy to use. Learning the metric system is much like learning a foreign language. As long as you have to translate the foreign language into English to understand it, it is difficult to use. As soon as you know the foreign language well enough to *think* it without translating, it is easy. So it is with metrics.

In this section you will learn about the metric system. You will also practice using the various metric units of measurement. Remember, measurement can never be exact because of human error and inaccuracy of the measuring tools. Taking several measurements and finding an average gives a better estimate of the true measurement than does one single measurement.

SECTION OBJECTIVES

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

1. Name the units of measurement in the metric system:
    - 1.1 Name the units of length.
    - 1.2 Name the units of area.
    - 1.3 Name the units of volume.
    - 1.4 Name the units of temperature.
    - 1.5 Name the units of time.
    - 1.6 Name the units of mass.
2. Tell about the history of the metric system.
3. Explain the advantages of the metric system.
4. Use the metric measurement units correctly:
    - 4.1 Use the units for length.
    - 4.2 Use the units for area.
    - 4.3 Use the units for volume.
    - 4.4 Use the units for mass.

VOCABULARY

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

area (er’ ē u). An amount of surface.

centi- (sen’ tu). One-hundredth (.01).

centimeter (sen′ tu mē′ tur). A measure equal to one-hundredth of a meter.

circumference (sur kum′ fur uns). The distance around.

cubic centimeter (kyü′ bik sen′ tu mē′ tur). A unit of measure equal to the space enclosed by a cube 1 cm by 1 cm by 1cm.

cubic meter (kyü′ bik mē′ tur). A unit of measure equal to the space enclosed by a cube 1 m by 1 m by 1m.

cylinder (sil′ un dur). Any long, round object, solid or hollow, with flat ends.

decimal system (des′ u mul sis′ tum). A system of numeration that is based on units of ten.

decimeter (des′ u mē′ tur). Unit of measure equal to one-tenth of a meter.

diameter (dī am′ u tur). A line passing from one side to the other side through the center of a circle, sphere, or cylinder.

gram (gram). A unit of mass equal to the mass of 1 cubic centimeter of water at 4° C.

gravity (grav′ u tē). A force that pulls objects toward the center of earth and gives weight to objects.

kilo- (kē′ lō). One thousand (1,000).

kilogram (kil′ u gram). A measure equal to one thousand grams.

kilometer (ku lom′ u tur). A measure equal to one thousand meters.

liter (lē′ tur). The basic measure of volume in the metric system.

mass (mas). The quantity of matter anything contains.

measurement (mezh′ ur munt). Finding the size, quantity, or amount by comparing with a standard.

meter (mē′ tur). The basic measure of length in the metric system.

metric system (met′ rik sis′ tum). A decimal system of weights and measures.

milli- (mil′ u). One-thousandth (.001).

milliliter (mil′ u lē′ tur). Unit of measure equal to one-thousandth of a liter.

millimeter (mil′u mē′ tur). Unit of measure equal to one-thousandth of a meter.

perceive (pur sēv′). To be aware of through the senses.

square centimeter (skwer sen′ tu mē′ tur). Unit of measure of an area equal to 1 cm by 1 cm.

square kilometer (skwer ku lom′ u tur). Unit of measure of an area equal to 1 km by 1 km.

square meter (skwer mē′ tur). Unit of measure of an area equal to 1 m by 1 m.

standard unit (stan′ durd yü′ nit). Reference point from which all other measurements are made.

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

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**u̇**t, r**ü**le; **ch**ild; lo**ng**; **th**in; /ŦH/ for **th**en; /zh/ for mea**s**ure; /u/ represents /ɑ/ in **a**bout, /e/ in tak**e**n, /i/ in penc**i**l, /o/ in lem**o**n, and /u/ in circ**u**s.

HISTORY OF THE METRIC SYSTEM

The metric system began in France in 1670. Gabriel Mouton developed a system of **measurements** to replace the inefficient units then in use. His system was later revised by French scientists. Much of this revision was done by the scientist Lavoisier and the mathematician Lagrange. The system was called *metric* from the Greek word *metron* which means *measurement*.

The United States showed an early interest in the metric system. In 1792 the United States adopted the system of decimal currency. In 1821 John Quincy Adams asked Congress to adopt the entire metric system. It was not adopted at that time because the United States traded mostly with England and Canada and neither of these countries used the metric system. In 1866 Congress made metric units legal but did not take any action toward requiring the change to metric measurements.

The modern metric system is known as the International System of Units. The name International System of Units with the international abbreviation SI was given to the system by the General Conference on Weights and Measures in 1960.

When Great Britain began a ten-year plan in 1965 to adopt metrics, the United States again became interested. In 1968 Congress authorized a study of metrics and recommended a step-by-step conversion. In 1974 however, the House of Representatives defeated the bill calling for conversion to metrics. Some groups and certain industries still proceeded to convert to metrics. In 1975 President Gerald Ford signed the Metric Conversion Act, but the United States still has not changed completely to metrics. Canada began converting to the metric system in the early 1970s.

Complete these statements with the information from this section.

1.1 The metric system contains sets of units to measure a. ________________ ,

b. ____________________ , c. ____________________ , and d. ____________________ .

1.2 Scientists around the world use the ____________________ system.

1.3 *Meter* comes from the Greek word a. ____________________ , which means

b. _________________________ .

Complete these activities.

1.4 Complete the following time line to show the historical development of metrics in the United States.

1800

1980

ADVANTAGES OF THE METRIC SYSTEM

The use of the metric system has four advantages. First, the metric system is a **decimal system**. It is a base ten system similar to our currency system. Units in the metric system are increased or decreased by tens. For example, a **meter** has ten parts called **decimeters**. A decimeter has ten parts called **centimeters**. A centimeter has ten parts called **millimeters**. In the English system that our country currently uses this relationship is absent. For example, a yard does not have ten parts; it has three parts called feet. A foot does not have ten parts or three parts, but twelve parts called inches.

Second, the prefixes used in the metric system for designating parts of a unit are the same throughout the system. The prefixes **milli-, centi-,** and **kilo-** are used with **grams** as well as with meters or **liters**—all metric units. In the English system no such prefixes help us to understand the units of measurement.

Third, the metric system has only seven basic units that make up all measurements. For example, in measuring **volume** in metrics, the units are **milliliter** and liter. These two units replace the fluid ounce, teaspoon, tablespoon, cup, pint, quart, and gallon (units in the English system).

Finally, the metric system is much easier to use in computation of measurements. Compare the following two additions. The metric computation requires no changing of one unit to another. In the English system, the total number of inches is changed to feet and inches; and feet to yards and feet.

	1 yd.	2 ft.	8 in.	1.72 m
	2 yd.	2 ft.	10 in.	2.69 m
+	3 yd.	2 ft.	7 in.	3.53 m
	6 yd.	6 ft.	25 in.	7.94 m
=	6 yd.	8 ft.	1 in.	
=	8 yd.	2 ft.	1 in.	

Complete this activity.

1.5 List *and* give an example of the four advantages of using the metric system.

a. ____________________

Example: ____________________

b. ____________________

Example: ____________________

c. ____________________

Example: ____________________

d. ____________________

Example: ____________________

UNITS OF THE METRIC SYSTEM

A *standard* is the reference point from which all other measurements are made. Throughout history such things as a barley corn or the width of one's hand were used as standards. Noah used a unit of length called a cubit when he designed and built the ark as God told him. The cubit of Noah's time was the distance of an extended arm and hand from the elbow to the tip of the middle finger. In some respects this unit was a handy measuring unit. The unit was always available and reasonably convenient to use. To the early Babylonians and Egyptians, the cubit was an important unit of length.

Write an operational definition.

1.6 Throughout this LIFEPAC, you will be asked to write an operational *definition* for each kind of measurement. An operational definition is one that tells how to do something. It gives the steps and actions involved. Try writing an operational definition for measuring the length of an object. How would you measure your pencil if your standard of measurement were not a *centimeter,* but a paper clip? Write a step-by-step definition.

a. ____

____

____

____

Did your operational definition include what you used for a unit and what you did with it in order to find the length of your pencil? A possible operational definition can be stated:

To find the length of my pencil, I would use a paper clip as the unit of measurement. I would count how many times the paper clip fit along a line that is the same length as my pencil. The number of paper clips would tell me how many paper clips long my pencil is.

If you had no trouble writing the operational definition, go on to the next part. If you had trouble writing an operational definition, read the example again. Write an operational definition for measuring the width of your desk, using some handy object as a standard of measurement.

b. ____

____

____

____

Meter—the standard unit of length. We can measure such things as the height of a door, the length of a room, or the distance around a patio. We can use the meter to measure the height of a mountain or the length of a river. We can use the meter to measure the altitude of an airplane or the depth of an ocean. In metrics the meter is the **standard unit** of length.

The meter originally represented one ten-millionth of the distance from the North Pole to the equator along the line of longitude near Dunkerque, France. Today the meter is defined as the length of 1,650,763.73 wavelengths of the orange-red light from the isotope krypton 86 when measured in a vacuum. In more common terms the meter is slightly longer than a yard.

In order to measure small things more accurately we can use the centimeter (one-hundredth meter) or the millimeter (one-thousandth meter). To measure longer distances, such as those between cities, we can use the **kilometer** (one thousand meters).

Read about the history of measurement in an encyclopedia or other reference book.

1.7 On a piece of paper, write an essay explaining the need for a standard unit. Have your teacher read your essay and discuss it with you.

TEACHER CHECK ______________ ______________
initials date

Use a centimeter ruler to measure the following items.

1.8 Measure each item to the nearest centimeter.

a. ____________________ b. ____________________ c. ____________________

One meter contains one hundred centimeters (1 m = 100 cm). A centimeter is one-hundredth (.01) of a meter.

You can use the decimal system to write meters and centimeters just as you use the decimal system to write dollars and cents. If you have 364 cents, you can write the amount of money that you have as 364¢ or as $3.64. In the same way if you have 364 centimeters, you can write it as 364 cm or as 3.64 m. The abbreviation for centimeter and meter is *cm* and *m* respectively. You do not use a period after metric abbreviations.

Complete the following statements. The symbol ↔ means "is the same as," and the statement can be read either to the right or to the left. Example: 1 m ↔ 100 cm can be read "1 meter is the same as 100 centimeters" or "100 centimeters is the same as 1 meter."

1.9 100 cents ↔ ________________dollar

1.10 100 cm ↔ ________________ m

1.11 ________________ cents ↔ 7 dollars

1.12 ________________ cm ↔ 7m

1.13 3 dollars 97 cents ↔ ________________ cents

1.14 3 m 97 cm ↔ ________________ m or ________________ cm

1.15 ________________ ↔ $6.97

1.16 ________________ or ________________ ↔ 6.97 m

Use a meter stick to measure the following objects in your classroom. Compare your measurements with those of a classmate.

1.17 ______________________________________ height of classroom door

1.18 ______________________________________ distance around your desk

1.19 ______________________________________ width of a window

1.20 ______________________________________ length of your arm

A meter is made up of one thousand millimeters (1 m = 1,000 mm). A millimeter is one-thousandth (.001) of a meter. The abbreviation mm is used for millimeter. Millimeters are used to make more accurate measurements than you can make with meters or centimeters. The smaller the comparison unit, the more precise the measurement can be. For example, when a line is measured, it is more precise to say 18 mm than to say 2 cm.

Kilometers are used to measure distances between cities. The abbreviation km is used for kilometers. A kilometer is equal to one thousand meters (1 km = 1,000 m).

1,000 mm = 1 m

100 cm = 1 m

1,000 m = 1 km

Complete the following statements.

1.21 1000 mm ↔ ____________ m

1.22 3000 mm ↔ ____________ m

1.23 ____________ mm ↔ 5 m

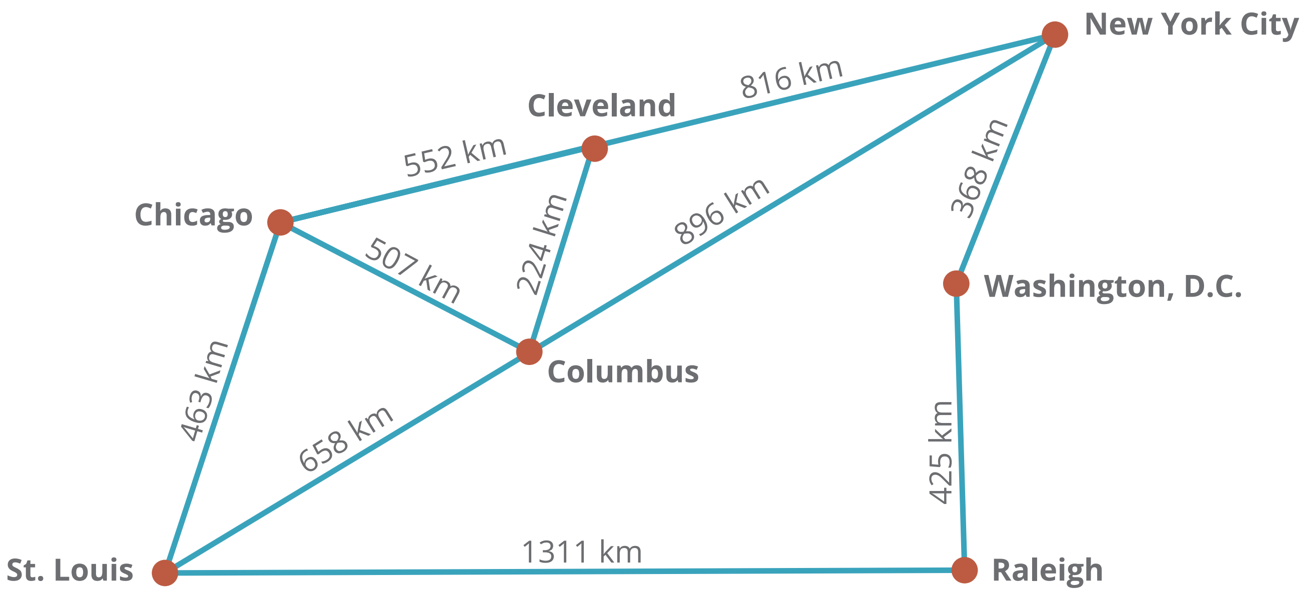
1.24 ____________ mm ↔ 2 m

1.25 1000 m ↔ ____________ km

1.26 4000 m ↔ ____________ km

1.27 ____________ m ↔ 7 km

1.28 ____________ m ↔ 9 km



Use the map to find the distance between the following cities.

1.29 Chicago to Cleveland is ____________ km.

1.30 Washington, D.C., to New York City is ____________ km.

1.31 Cleveland to Columbus is ____________ km.

1.32 New York City to St. Louis is ____________ km.

In summary, the meter is the basic unit of length in the metric system. The meter is a little more than a yard long. It is divided into one hundred equal parts called *centimeters.* The prefix *centi-* means one-hundredth (.01) of a meter just as a cent is one-hundredth (.01) of a dollar. A millimeter is one-thousandth (.001) of a meter. The prefix *milli-* means one-thousandth (.001). The prefix *kilo-* means one thousand. Hence a kilometer contains one thousand meters.

Complete the following activities. Do the work on a separate sheet of paper. Check your paper with your teacher. Save the data from Activity 1.38 to use later in this LIFEPAC.

1.33 Four of the five sides of a pentagon are 4 cm, 3 cm, 6 cm, and 2 cm long. Draw these four sides. Then draw the fifth side. Measure the side that you drew. How long is it?

____

1.34 Estimate the height of your desk. Measure it. How good was your estimate? Estimate and measure three other objects in your classroom. Use a chart like this to record your data on your separate paper.

Object	Estimate	Actual Measurement

Write a statement that describes your estimate.

____

____

1.35 Name three objects that are each about 1 m long, about 3 m long, and about 5 m long.

a. 1 m: ____

b. 3 m: ____

c. 5 m: ____

1.36 List three things that you would measure in millimeters, three in meters, and three in kilometers.

a. mm: ____

b. m: ____

c. km: ____

1.37 The following metric translations were made from sayings that involve measurements.

What is the English version of each metric translation? Can you add two or three more? Choose the one you like best to add to your class metric translation chart.

a. A miss is about as good as 1.6 kilometers. ______________________________

____

b. Give him two centimeters, he'll take a meter.______________________________

____

c. He's going slowly, just two-centimetering along. ______________________________

____

1.38 How accurately can you measure the **circumference** and **diameter** of a circle? Measure the circumference of a **cylinder** (fruit juice can) carefully. Measure in millimeters. To measure the circumference of a cylinder, wrap a strip of thin paper tightly around it and, using a pin, make a hole through the paper where it overlaps itself. Then measure the distance between the two pinholes. Measure the diameter of the cylinder. You may wish to make several measurements for each cylinder and take an average value for the circumference and also for the diameter.

Measure the circumference and diameter of four different-sized cylinders.

a. ______________________ b. ______________________

c. ______________________ d. ______________________

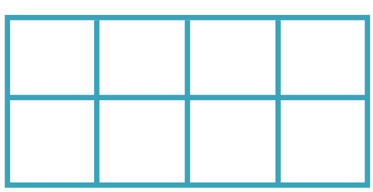
1.39 Answer this question about your work in 1.38. Why is it better to take the average of several readings for each cylinder? ______________________________

____

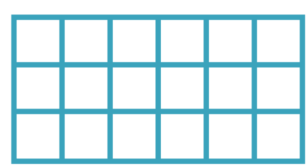
____

The **square centimeter** is the standard unit of **area**. An area is made up of the set of points inside a closed curve. The square centimeter (cm^2), the **square meter** (m^2), and the **square kilometer** (km^2) are used for area measurements. When you measure the area of an object, you are making a *comparison* between the surface being measured and the unit of measurement being used. To find the area you multiply the length of the base times the length of the height, or length x width.

Name the area for the following drawings.



area of Jane's book



area of John's book

1.40 ____________ square units of Jane's Book

1.41 ____________ square units of John's

Write an operational definition for finding the area of a rug.

1.42 Tell what you will use, how you will do it, and what you find out.

____

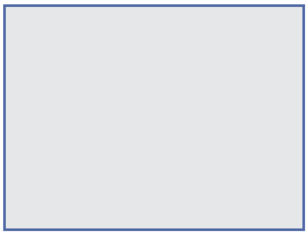
____

____

____

Calculate areas.

The unit for measuring the surface of small areas is the square centimeter (cm^2). Area can be computed by multiplying the number of units of length on one side (horizontal) by the number of units of length on the other side (vertical). One unit of length is called *length*, and the other unit of length is called *width*. Area = length times width ($A = l \times w$). Using this formula, find the area for the following shapes. Use a centimeter ruler to measure the length and the width.



1.43 area ____________

1.44 area ____________

Calculate areas.

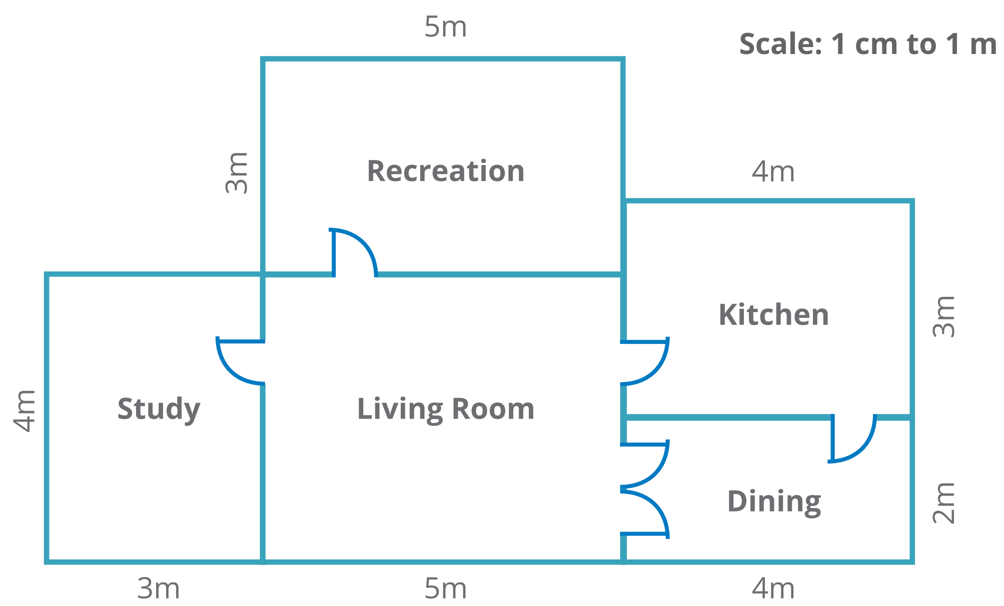
A square meter (m^2) is used for measuring the area of larger surfaces. Figure the areas for the following rooms in this house plan.

1.45 kitchen area ____________

1.46 living room area ____________

1.47 recreation room area ____________

1.48 study area ____________



Measure the following objects. Use cm^2 or m^2, whichever unit is the best for the particular job.

1.49 postage stamp area ___________

1.50 envelope area ___________

1.51 this LIFEPAC area ___________

1.52 classroom door area ___________

Choose *one* of the next three activities.

1.53 Put a ✓ in the ☐ beside the one you choose. Do your work on another sheet of paper. Check the work with your teacher when you complete it.

☐ **A.** Find the area of a leaf. Place a leaf on a piece of graph paper. Trace the outline of the leaf. Determine the area covered by the leaf. The following procedure is helpful: Count all the whole squares first. Record. Then pair the remaining squares so that each pair will form about one single square. Record. Add the two together to find the total number of squares. Try the same procedure with another irregular shape, such as a star or pentagon shape. Have a classmate find the area for the same shape. Do your answers agree? If not, ask a third person to perform the measurements. If there is not too great a difference in your answers, would an average answer be the best answer?

a. _______________

Why? ____

☐ **B**. Rectangles whose lengths and widths are different may have the same area. For example, a 6-cm by 4-cm rectangle contains 24 cm^2. What other dimensions would also give an area of 24 cm^2? Clue: Think about the factors for 24 to find your answers. The factors for 24 are 1, 2, 3, 4, 6, 8, 12, and 24. You could make rectangles with the dimensions of 1 cm × 24 cm, 2 cm × 12 cm, 3 cm × 8 cm, and 4 cm × 6 cm. The area of all of these rectangles would be 24 cm^2.

a. List the rectangles you could make if the area was 36 cm^2. ________________________

____

b. List the rectangles you could make if the area was 40 cm^2. ________________________

____

c. What three numbers between 1 and 100 have the most factors? ________________

How many rectangles can be formed by these factors? ________________

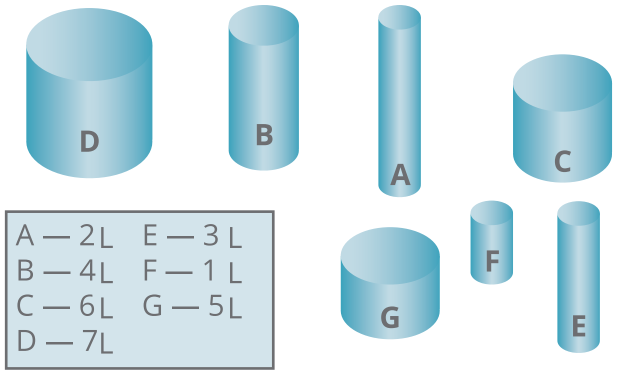
____

☐ **C.** Make a scale drawing of your home. Compute the area for each room and the total area for your home in metric.

TEACHER CHECK ____________ ____________
initials date

Liter—the standard unit of volume. Volume is the measure of how much a container will hold. Matter takes up space; the measure of this space is volume. The volume unit of liter (L) and its subdivision the milliliter (ml) are usually reserved for liquids.

Suppose that you were asked to put in order the following containers from the one that would hold the most to the one that would hold the least. Just looking at them would not be a great deal of help. We need to know how much each one holds. To find out how much each one holds we need to use a standard unit of volume for comparison. Suppose that each one holds the amount shown in the chart. Now you can easily order them from the one that will hold the most to the one that will hold the least. The order would be D, C, G, B, E, A, and F.



Write an operational definition.

1.54 Explain how to measure the amount of liquid a particular pitcher can hold. Define the unit of volume you will use. ____

____

____

____

____

Complete the following statements.

A liter (L) contains one thousand milliliters (ml). A milliliter is one-thousandth (.001) of a liter.

1.55 1,000 ml ↔ __________ L

1.56 __________ L ↔ 3,000 ml

1.57 __________ ml ↔ 2 L

1.58 __________ L ↔ 6,000 ml

Complete the following statements.

1,000 mills ↔ 1 dollar — 5 dollars 239 mills ↔ \$5.239 or \$5.24

1,000 ml ↔ 1 L — 5,239 ml ↔ 5.239 L

1.59 3.824 L ↔ __________ L __________ ml

1.60 2.486 L ↔ __________ L __________ ml

1.61 6 L 481 ml __________ L

1.62 4 L 592 ml ↔ __________ L

The volume of a container can be measured in **cubic meters** (m^3) or in **cubic centimeters** (cm^3) as well as in liters and milliliters. When scientists defined the unit of **mass**, the *gram*, they used a cube that measured one centimeter on each edge. The cube was filled with distilled water. The water took up space, but how much space? The simple way of finding the volume of the water is to calculate the volume of the cube. The volume of the cube is determined by first finding the product of the number of units of length (l) and the number of units of the width (w) of the cube. This product, multiplied by the number of units of height (h) of the cube, will give the number of the cubic units in the volume of the cube ($l \times w \times h$). The water sample is 1 • 1 • 1 or 1 cubic centimeter (cm^3). Thus the space that was occupied by one gram of water, under a certain set of conditions, can be used as the basic unit of volume.

A cubic centimeter of water and a milliliter of water are the same. A cubic centimeter is the size of a container that will hold exactly one milliliter of water. Therefore, a cubic centimeter and a milliliter are the same ($1\ cm^3 = 1$ ml).

View 702 Volume, from the Grade 7 SCIENCE EXPERIMENTS Video

Complete the following activities. Keep your data and computations on another sheet of paper.

1.63 Determine the volume of different objects. Fill an overflow can (a plant and watering can with a spout) with water. Let the water drain down to the level of the spout. Carefully lower a rock into the can. Catch the water that overflows in a graduated cylinder or medicine cup. Measure the amount of water. Record this amount. Determine and record the volume of five other objects.

Discuss the answers to these questions with your teacher or another adult.

a. Can the water and the rock be in exactly the same place at exactly the same time?

____

b. What is the result of lowering the rock into the water? ____________________

____

c. What is true about the volume of the rock and the volume of overflow water? ________

____

d. Could you measure the volume of a sample of a gas by this method? ____________

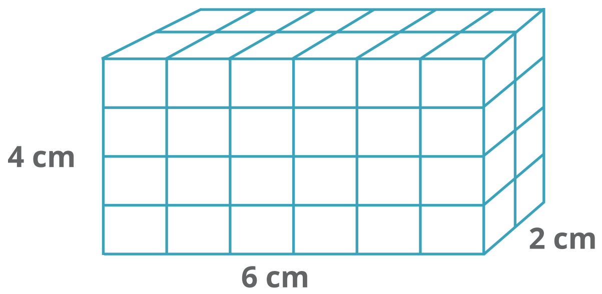
____

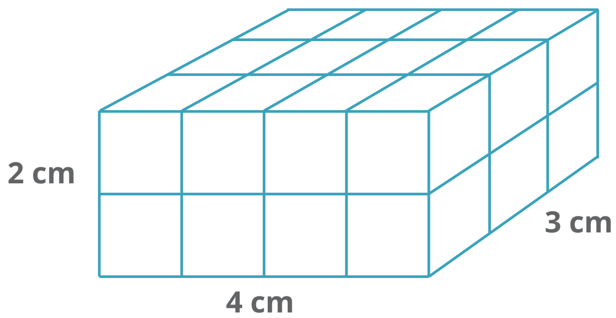
TEACHER CHECK ____________ initials ____________ date

Volume Experiment

Compute the volume for the following cubes.

The volume of a cube can be found by multiplying the length by the width by the height.
V = *l* × *w* × *h*.





1.64 ______________________

1.65 ______________________

Complete these activities.

1.66 Use the set of containers your teacher has. Measure and label the containers according to the amount they will hold. Order them from the one that holds the most to the one that holds the least.

1.67 If a faucet drips 5 ml of water each minute, what is the volume of water dripped at the end of

a. 1 hour: ______________________ b. 1 day: ______________________

Make a table.

1.68 Show the comparisons for customary measurements of capacity with metric measurements of capacity. Example: __________ = 1 teaspoon.

List the measurements for tablespoon, cup, pint, quart, and gallon.

TEACHER CHECK __________ initials __________ date

Kilogram—the standard unit of mass. A gram is a small unit of mass. About 28 grams equal one ounce. A larger unit of mass is the **kilogram** (kg). A kilogram equals about two and one-fifth pounds and is the *standard* mass unit. One gram (g) is one-thousandth (.001) of a kilogram (kg). A kilogram contains one thousand (1,000) grams.

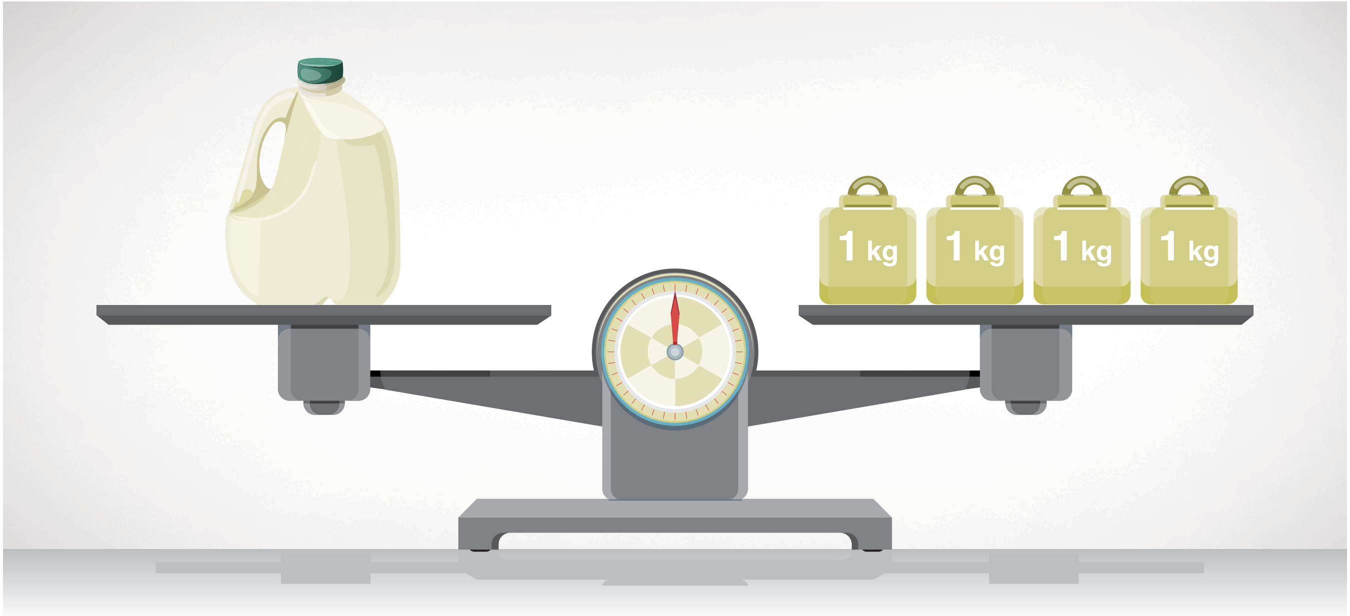
Once the unit of mass was defined, samples of matter could be compared to the unit and thus measured. Comparing a sample of matter to the standard unit of mass or to its subdivision the gram, can be done on an equal-arm balance. When making this comparison, a sample of matter is placed on one pan of a balance. On the other pan are placed as many gram units or kilogram units as are necessary to create a balance. The mass of the sample is then the number of grams required to balance the sample on the equal-arm balance. This number would be *the same* for that sample at sea level, at three kilometers above sea level, or even at three thousand kilometers above sea level. This illustration shows an extremely important characteristic of mass. For a particular sample of matter, *the mass does not vary.*

Why are we using the term *mass* instead of *weight*? We are careful to use the correct term because mass is *not the same* as weight. To understand the difference picture an elephant. Picture an elephant here where you are. Next picture the elephant in a satellite orbiting the earth.

Then picture the elephant in space out beyond the moon. In each case—on the earth, above the earth, and in space—has the elephant changed? Aside from small changes produced by bodily functions, has the elephant gained or lost matter? If the elephant neither gains nor loses matter, then the elephant's *mass* is the same wherever he happens to be.

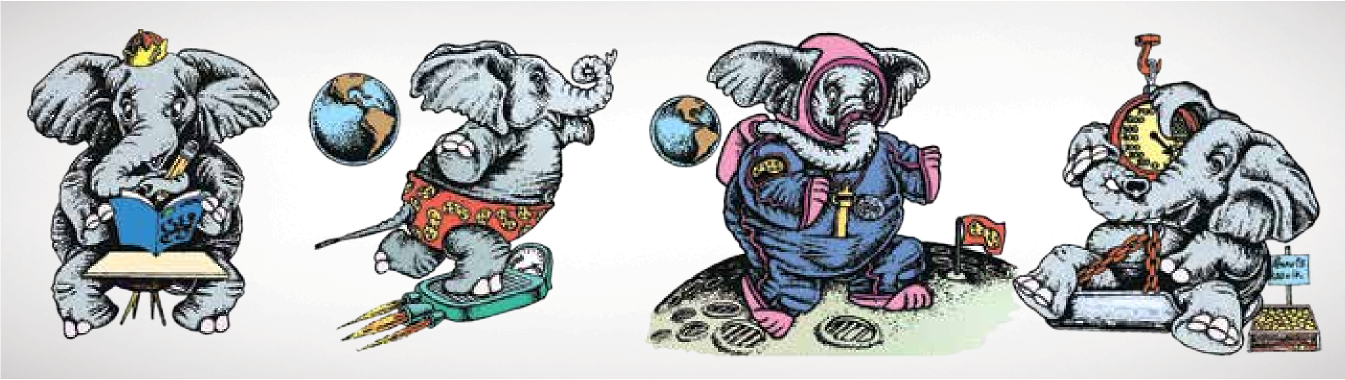
Mass is a property of matter. Any object—any piece of matter—has mass. T*he mass of an object remains the same.*

How about the elephant's *weight*? Does that change? You have seen enough television and magazine pictures of men in space to know that as objects leave the earth they weigh less. You have seen men hopping over the surface of the moon like beach balls. They were able to move so easily because on the moon they weighed less than on the earth.



An object's weight, then, depends on where the object happens to be. Our elephant weighs less in a satellite than on the earth, and is almost weightless in space. Weight is the measure of the pull of **gravity** on an object.

If mass and weight are different, are they measured differently? Yes: *mass* is measured on a *balance* and *weight* is measured on a *scale.*



Write the definitions.

1.69 mass ____

____

____

____

1.70 gravity ____

____

____

____

1.71 weight ____

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____

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Answer this question.

1.72 What is the standard unit of mass? ______________________________

The metric units of volume and mass are related to water. One *cubic centimeter* of water equals one *milliliter* of water, and the mass of each volume is one *gram.* A small box that is one cubic centimeter in size holds exactly one milliliter of water, and that one milliliter of water has a mass of one gram.

Remember, *mass* is the measure of matter. Mass does not depend upon distance from the earth, moon, or sun as weight does. It depends only upon the make-up of the object, and it is a property of that object. We measure samples of matter by *comparing* them with standard units of mass.

View 702 Mass, from the Grade 7 SCIENCE EXPERIMENTS Video

Do this investigation.

Compare the mass of available objects. You will need to construct a balance.

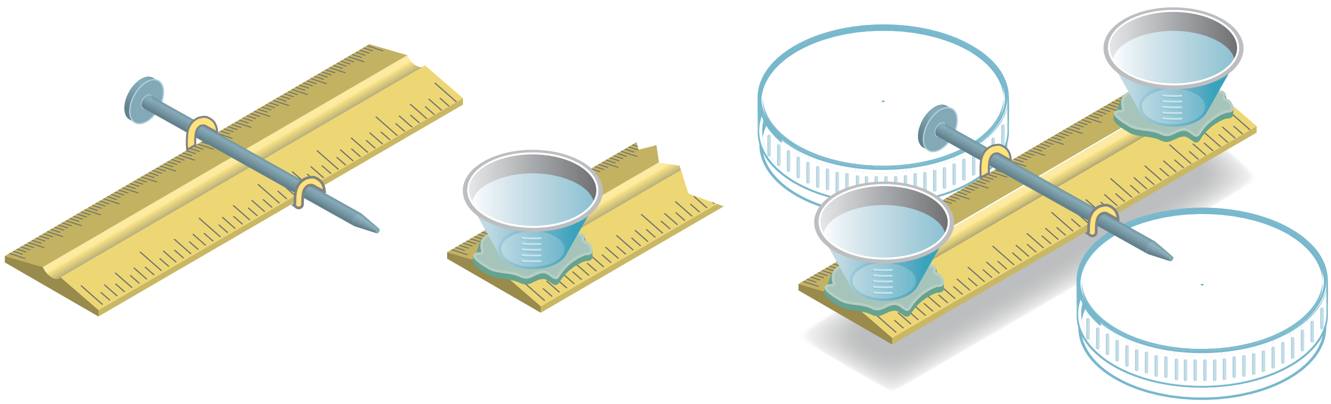
These supplies are needed:

- a ruler
- two medicine cups
- a nail
- some clay
- a rubber band

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

- ☐ 1. Use the rubber band to fasten a nail across the center of the ruler. If the nail is loose, double the rubber band.
- ☐ 2. Use pieces of clay to stick a medicine cup to each end of the ruler.
- ☐ 3. Rest the nail on two jar lids, blocks, or other objects to raise it off the table.
- ☐ 4. Balance your ruler by adding more clay to the light end or by moving the rubber band toward the heavy end.
- ☐ 5. Select the unit of mass you will use. Objects that are readily available in your room make good mass units. Some possibilities are paper clips, paper fasteners, or small washers.
- ☐ 6. Find the mass for available objects. Keep your data on another sheet of paper.

Mass Experiment



| A Balance

Complete this activity.

1.73 Write an operational definition for finding the mass of an object. ______________________

____

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Complete the following statements.

Remember that the volume and mass of water are related.

1.74 1 cm^3 of water has a mass of ______________ g.

1.75 1 ml of water has a mass of ______________ g.

1.76 500 ml of water have a mass of ______________ g.

1.77 300 cm^3 of water have a mass of ______________ g.

1.78 ______________ ml of water have a mass of 750 g.

1.79 ______________ cm^3 of water have a mass of 690 g.

Study the following example and complete the statements.

1,000 cm^3 of water equals 1 liter of water. Both have a mass of 1 kg.

1.80 3 L of water have a mass of ____________ kg.

1.81 ____________ L of water have a mass of 8 kg.

1.82 3.7 L of water have a mass of ____________ kg.

1.83 5,000 cm^3 of water have a mass of ______________ kg.

1.84 ______________ cm^3 of water have a mass of 9 kg.

1.85 2,000 cm^3 of water have a mass of ______________ kg.

Practice measuring mass.

1.86 Collect a variety of objects from around your classroom. Use a balance to find the mass of each object. Order them from the heaviest to the lightest. Have a classmate perform the same measurements. Does your data agree? Recheck measurements that do not agree.

Measure	Unit	Original Definition
Length	Meter	One-ten millionth of quadrant of earth's meridian passing through Barcelona, Spain and Dunkirk, France
Mass	Kilogram	Mass of one cubic decimeter (1,000 cm^3) of water at its maximum density (4 degrees Celsius)
Time	Second	One-eighty-six thousand, four hundredth (1/86,400) of mean solar day. The mean solar day is 1/365.2422th of the tropical year measured from vernal equinox to vernal equinox.
Temperature	Degree Celsius	One-hundredth interval between freezing point of water (0 degrees Celsius) and the boiling point of water (100 degrees Celsius).

Prefix	Symbol	Power		Example
tera	T	10^{12} =	1,000,000,000,000	
giga	G	10^{9} =	1,000,000,000	gigahertz (GHz)
mega	M	10^{6} =	1,000,000	megawatt (MW)
kilo	k	10^{3} =	1,000	kilometer (km)
hecto	h	10^{2} =	100	
deca	da	10^{1} =	10	
deci	d	10^{-1} =	.1	
centi	c	10^{-2} =	.01	
milli	m	10^{-3} =	.001	milligram (mg)
micro	μ	10^{-6} =	.000001	microsecond (μs)
nano	n	10^{-9} =	.000000001	nanometer (nm)
pico	p	10^{-12} =	.000000000001	picofarad (pf)
femto	f	10^{-15} =	.000000000000001	
atto	a	10^{-18} =	.000000000000000001	

CHRIST, THE PATTERN FOR OUR LIVES

In Luke 2:52 we read, "And Jesus increased in wisdom and stature, and in favor with God and man." Jesus measured up to God's pattern in all four areas of life: *mental, physical, spiritual,* and *social*.

The Bible says we should strive to be more like Christ. As we pattern our lives after Christ, we are measuring up to the pattern God set out for us.

The following verses tell us what our lives will be like if we are following God's purpose.

After reading the verse, list examples of things that you are doing or could do to increase in wisdom, in stature, and in favor with God and man.

LIFE'S PURPOSE:

1.87 Service of God — Joshua 24:15
"...Choose you this day whom ye will serve...but as for me and my house, we will serve the Lord."

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1.88 Seeking God's kingdom — Matthew 6:33
"But seek ye first the kingdom of God, and his righteousness; and all these things shall be added unto you."

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1.89 Doing the Father's will — John 4:34
"Jesus saith unto them, My meat is to do the will of him that sent me, and to finish his work."

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1.90 Finishing the divine task — John 17:4
"...I have finished the work which thou gavest me to do."

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1.91 Completing the course joyfully — Acts 20:24
"...so that I might finish my course with joy...."

____

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____

1.92 Attaining Christ-likeness — Philippians 3:13, 14
"...this one thing I do...I press toward the mark for the prize of the high calling of God in Christ Jesus."

____

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____

TEACHER CHECK ____________ ____________
initials date

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.

SELF TEST 1

Complete the following sentences (each answer, 3 points).

1.01 The metric system is a set of units for measuring a. ____________________ , b. __________________ , c. ___________________ , and d. ____________________ .

1.02 Units of length can be used to measure the a. __________________ (surface) and the b. _________________ (space) of an object.

1.03 The metric system was developed in a. _________________ in the year b. __________ .

1.04 The *standard* unit for mass is the ______________________ .

1.05 The standard unit for length is the ______________________ .

1.06 The standard unit for volume is the ______________________ .

1.07 The unit of length that Noah used in building the ark was the _________ .

1.08 The pattern by which our lives will be measured is _____________________ .

Answer true or false. If a sentence is false, cross out the incorrect word or words and write in words which make the statement correct (each true-false, 1 point; each correction, 3 points).

1.09 __________ The United States is one of the few countries that does not fully use the metric system for measurement.

1.010 __________ The mass of an object changes as the distance from the center of gravity changes.

1.011 __________ An equal-arm balance is used to measure mass.

1.012 __________ Weight measures the matter in an object.

1.013 __________ One milliliter is equal to one cubic centimeter.

1.014 __________ Mass is the amount of matter an object contains.

1.015 __________ Measurement helps us perceive things as they are.

Match these words and abbreviations. On the line in front of each unit in Column I write the letter from Column II that tells what the unit measures. On the line following each unit, write the correct abbreviation for that unit (each numbered item, 2 points).

	Column I	Column II
1.016	_______ meter ________	a. mass
1.017	_______ liter ________	b. area
1.018	_______ square centimeter ________	c. volume
1.019	_______ cubic centimeter ________	d. length
1.020	_______ gram ________	
1.021	_______ centimeter ________	
1.022	_______ square meter ________	
1.023	_______ square kilometer ________	
1.024	_______ millimeter________	
1.025	_______ milliliter ________	
1.026	_______ cubic meters ________	
1.027	_______ kilometer ________	
1.028	_______ kilogram ________	

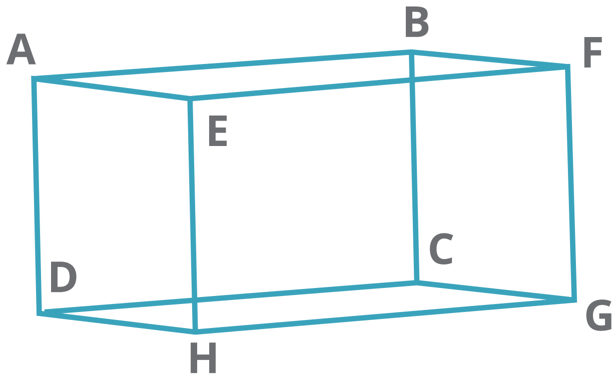
Measure and compute (each answer, 3 points).

1.029 **Measure** the length of each line segment to the nearest centimeter.

a. AE _________

b. AB _________

c. AD _________



1.030 **Compute** the area of each side.

a. ABFE _________

b. BFGC _________

c. EFGH _________

1.031 **Compute** the volume of the figure. _________

Write the answers to the following questions. Your teacher will help you assign points for each answer (each answer, 5 points).

1.032 Write an operational definition for finding the mass of your shoe. ________________________________

____

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____

1.033 Tell how the mass for a gram unit was chosen. ________________________________

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____

Complete these activities (each numbered item, 5 points).

1.034 List four advantages of the metric system.

a. ____

b. ____

c. ____

d. ____

1.035 Tell why it is necessary to have standard units if we want to communicate measurements to other people. ________________________________

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____

95/119 **SCORE** __________ **TEACHER** __________ __________
initials date

NOTES

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