



OH-04-SN-EN-SE-V1_01



OHIO FOURTH GRADE

Scale, Proportion, Quantity

Measurement Systems

Objects have different properties, such as size, weight, and volume. Some properties can be measured. To measure means to represent with numbers. For example, the volume of your milk carton at lunch measures one cup. This one-cup measurement comes from the United States' customary system. Did you know that there are other ways to measure objects? The same milk carton measures eight fluid ounces and 236 milliliters in other systems.

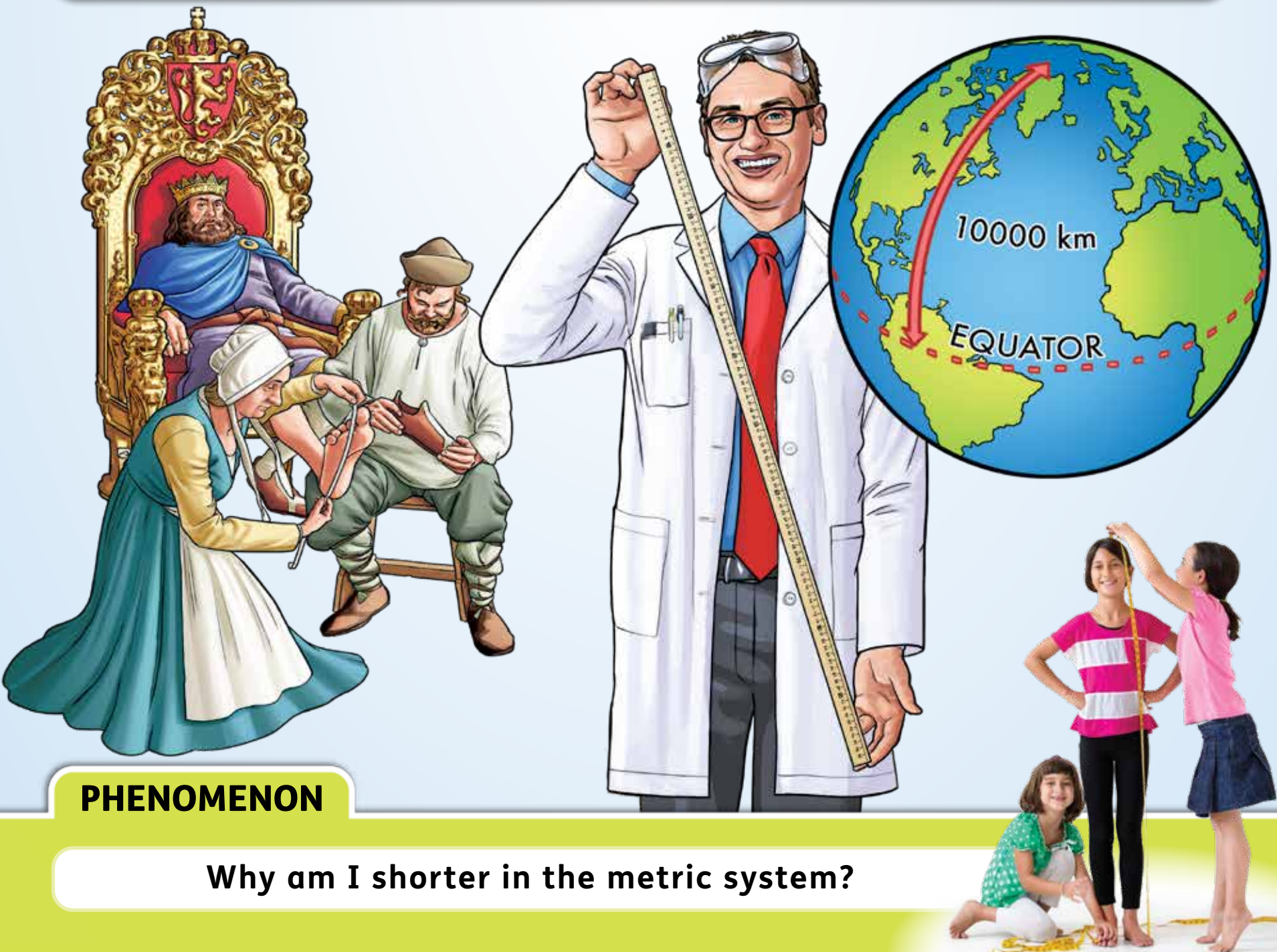
The U.S. customary system is based on Great Britain's imperial system. The imperial system was originally built around how big or small the country's leader was. One foot was exactly the length of the leader's foot. However, different leaders had different sizes of feet. Each country had a unique measurement for one foot. This made it very difficult to trade goods and share data between countries.

To fix these problems, French scientists set up the metric system. Their idea was to create a

measurement system that used decimals and multiples of 10. They also decided to base the system off of one measurement, called the meter. One meter is one ten-millionth of the distance from the Equator to the North Pole.

After choosing its length, several metal bars were made to be exactly one meter long. These bars were made of a material that does not change shape or size. They were locked in special labs all over the world. Sometimes, the bars are taken out and compared to make sure that they are still the same.

It took many years before the metric system became popular. Today, its use is very common, especially in science. Under the metric system, the base units of measurement are the meter, liter, and gram. All conversions between these units are based on the number 10. You either multiply or divide by 10. If you are multiplying, add a zero to the number. If you are dividing, remove a zero from the number.



PHENOMENON

Why am I shorter in the metric system?

Measurement Tools

One of the most important things that scientists and engineers do is collect data. They use data to learn about the world and to make predictions about the future. To gather their data, scientists use special tools. Each tool is used to measure a different property of an object.

Rulers and measuring tapes are tools used to measure length. To measure an object using a ruler, start with the first line. Count that line as zero. With a measuring tape, you usually start with the left edge as zero. Measuring tape is better for calculating long distances. Imagine trying to measure the length of a school hallway with a ruler. It would take a long time! You would have to constantly move the ruler and add up the numbers.



Calendars, clocks, and stopwatches are tools used to measure time. Calendars measure days, weeks, months, and years. Clocks measure hours, minutes, and seconds. Stopwatches can also measure hours, minutes, and seconds, but they are easier to carry around. If you wanted to see how long it takes your friend to do 15 jumping jacks, which tool would you use? You could use a clock, but you would have to pay close attention to it, then calculate the time. If you used a stopwatch, you could start and stop the timer with the press of a button. The time would already be calculated for you!

Scales are used to measure weight. There are two different types of scales: balance scales and weighing scales. Beakers, syringes, and graduated cylinders are used to measure volume. The tool that you use depends on the amount of liquid you need to measure. Typically, beakers measure larger amounts, and syringes measure smaller amounts, with graduated cylinders in the middle. Thermometers are used to measure temperature.

As you take measurements this year, make sure to use your tools properly. If your data is inaccurate, you will not be able to make the correct conclusions. You should also always take your measurements twice before recording them. That way, you can be sure that you have the most precise measurements possible.



Prefixes in the Metric System

All units in the metric system use specific prefixes. The three most common prefixes are kilo-, centi-, and milli-. To convert from one prefix to the next, all you need to do is multiply or divide by 10.

Metric Conversion							
Used to measure ↓	Kilo	Hecto	Deca	Unit	Deci	Centi	Milli
	1000 x larger	100 x larger	10 x larger	1 unit	10 x smaller	100 x smaller	1000 x smaller
Length	kilometer (km)	hectometer (hm)	decameter (dam)	Meter (m) ↔	decimeter (dm)	centimeter (cm)	millimeter (mm)
Liquid volume	kiloliter (kl)	hectoliter (hl)	decaliter (dal)	Liter (l) ↔	deciliter (dl)	centiliter (cl)	milliliter (ml)
Mass / weight	kilogram (kg)	hectogram (hg)	decagram (dag)	Gram (g) ↔	decigram (dg)	centigram (cg)	milligram (mg)
Unit conversions	1 kilo = 1,000 units	1 hecto = 100 units	1 deca = 10 units	1 unit	10 deci = 1 unit	100 centi = 1 unit	1,000 milli = 1 unit

Length

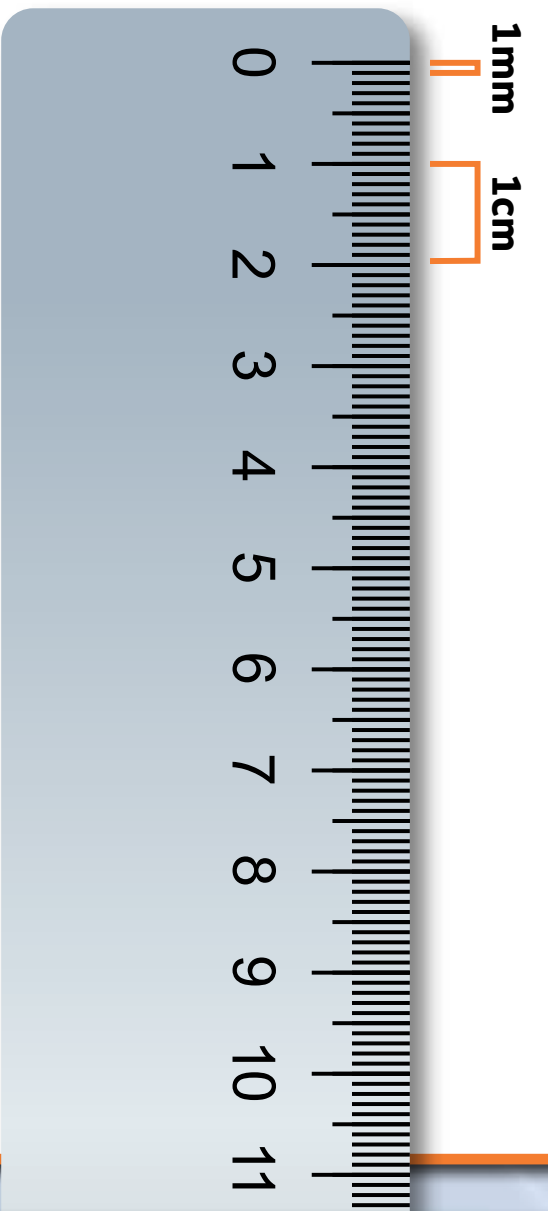
Have you ever wondered how far your favorite restaurant is from your house? This distance is defined as a length. To determine the length of an object, you have to measure how long it is. You could measure the length of your classroom or the length of a pencil. These lengths, however, would likely

be measured in different units. The base unit for measuring length in the metric system is the meter. The millimeter, centimeter, and kilometer are three commonly used units based off of the meter. These units are often abbreviated because abbreviating them is easier than writing them out

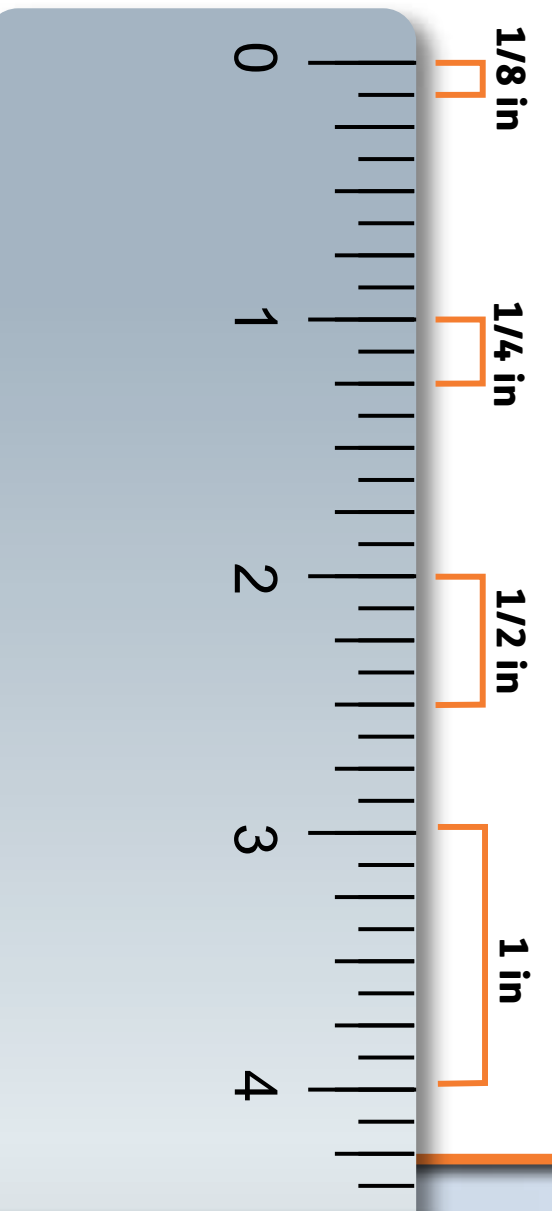
every time. Here are the abbreviations for the four main metric units of length:

- millimeter = mm
 - centimeter = cm
 - meter = m
 - kilometer = km
- To measure length in the metric system, you would use a metric ruler or a meter stick. These tools are labeled with two different units: centimeters and millimeters (cm and mm). Centimeters are marked with larger lines and numbers, just like inches on standard rulers. The smaller lines in between the centimeters represent millimeters. There are 100 centimeters in a meter and 1,000 millimeters in a meter. To convert meters to centimeters, multiply the number of meters by 100.
- The units in the customary system are different from those used in the metric system. Those used to measure length include the inch, foot, yard, and mile. Their abbreviations are:
- inch = in
 - foot = ft
 - yard = yd
 - mile = mi
- To measure length in the customary system, you would use a standard ruler or a yardstick. The ruler equals one foot; the yardstick is as long as three rulers, or three feet. Both tools are divided into inches. It is harder to convert between different units in the customary system because it requires memorization. For example, to convert measurements of length, you would have to remember that there are 12 inches in one foot, three feet in one yard, and 1,760 yards in one mile.

Metric Ruler



Standard Ruler



Mass

Mass is the amount of matter or substance that makes up an object. In the metric system, the base unit for mass is the gram. One gram weighs about the same as two paper clips. Like the meter, the gram can be converted into smaller and larger measurements. The kilogram, for example, equals 1,000 grams. Grams and kilograms are the most commonly used units for measuring mass. Just like units of length, units of mass are often abbreviated:

- gram = g
 - kilogram = kg
- To convert kilograms into grams, multiply the number of kilograms by 1,000.
- To measure weight in the customary system, ounces, pounds, and tons are used. These units are abbreviated as:
- ounce = oz
 - pound = lb
 - ton = t
- Again, it is more difficult to convert between customary units. You have to remember that there are 16 ounces in a pound and 2,000 pounds in a ton.

Metric System

2,700kg
2,700,000g

Customary System

2.9t
5,800lb
92,800oz



Name _____

Volume

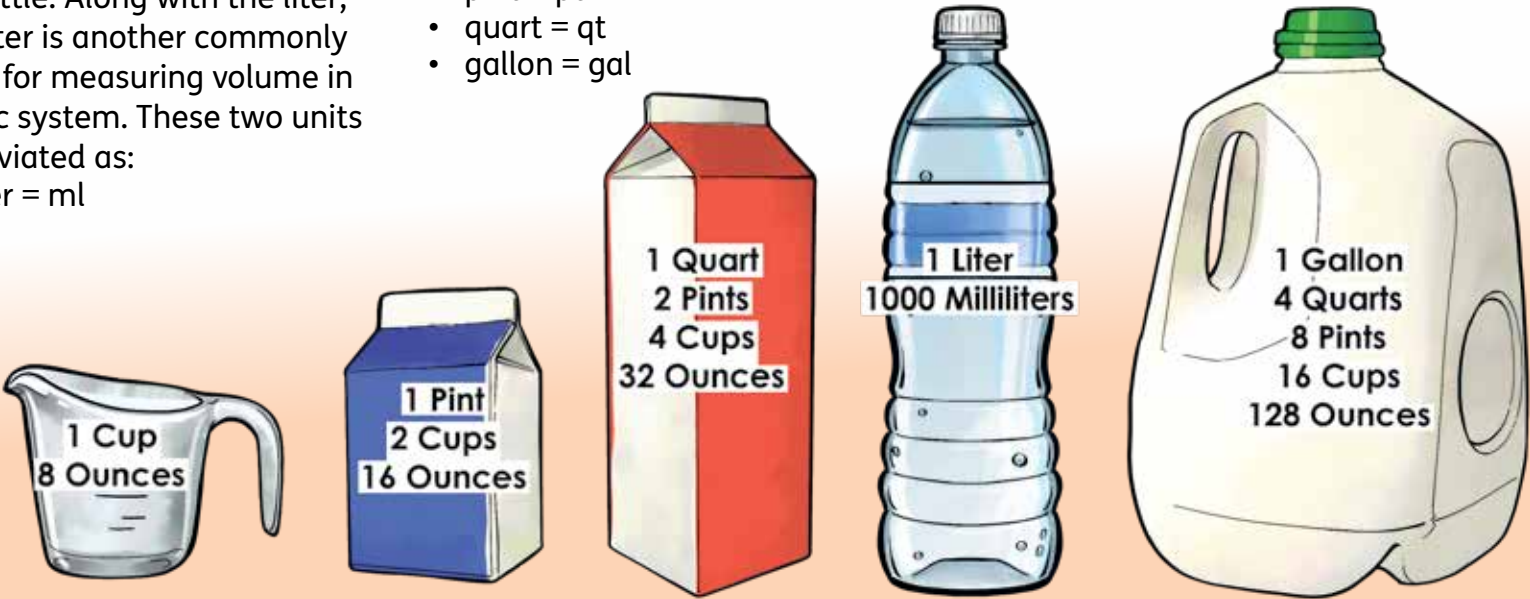
Have you ever drunk soda from a two-liter bottle and wondered what a liter is? The liter is the base unit for volume in the metric system. Volume is how much space something takes up. For example, there are two liters of space being taken up by the soda in that bottle. Along with the liter, the milliliter is another commonly used unit for measuring volume in the metric system. These two units are abbreviated as:

- milliliter = ml
- liter = l

The customary system has different units for measuring volume. These include the fluid ounce, cup, pint, quart, and gallon. Their abbreviations are:

- fluid ounce = fl oz
- cup = c
- pint = pt
- quart = qt
- gallon = gal

To convert customary units of volume, recall the following rules: There are eight fluid ounces in one cup. There are two cups in one pint. There are two pints in one quart. There are four quarts in one gallon.



Properties of Books

Measure the length, width, height, and volume of three books. Find the average of the measurements. Fill out the first four rows of the data table below. Then, compare your findings with those of three other students and complete the data table.

	Length	Width	Height	Volume
First Book				
Second Book				
Third Book				
Average of All Measurements				
First Student's Averages				
Second Student's Averages				
Third Student's Averages				

Why did you use three different books? Did they have the same measurements? Why or why not? Were your measurements the same as those of your classmates? Explain any differences.
