1.2: Metric Units of Measurement

Learning Objectives

1. Describe the general relationship between the U.S. customary units and metric units of length, weight/mass, and capacity.
2. Define the metric prefixes and use them to perform basic conversions among metric units.
3. Perform arithmetic calculations on metric units of length, mass, and capacity.
4. Solve application problems involving metric units of length, mass, and volume.

Introduction

In the United States, both the **U.S. customary measurement system** and the **metric system** are used, especially in medical, scientific, and technical fields. In most other countries, the metric system is the primary system of measurement. If you travel to other countries, you will see that road signs list distances in kilometers and milk is sold in liters. People in many countries use words like “kilometer,” “liter,” and “milligram” to measure the length, capacity, and weight of different objects. These measurement units are part of the metric system.

Unlike the U.S. customary system of measurement, the metric system is based on 10s. For example, a liter is 10 times larger than a deciliter, and a centigram is 10 times larger than a milligram. This idea of “10” is not present in the U.S. customary system—there are 12 inches in a foot, and 3 feet in a yard…and 5280 feet in a mile! The benefit of the metric system is that the conversion works identically for any unit, i.e. converting grams to kilograms is the same as converting meters to kilometers. This system is not limited to units describing length, capacity, and weight, but also applies to units measuring time (seconds), current (amperes), power (watts) and many more.

So, what if you have to find out how many milligrams are in a decigram? Or, what if you want to convert meters to kilometers? Understanding how the metric system works is a good start.

What is Metric?

The metric system uses units such as meter, liter, and gram to measure length, capacity, and mass, just as the U.S. customary system uses feet, quarts, and ounces to measure these.

In addition to the difference in the basic units, the metric system is based on factors of 10, and different measures for length include kilometer, meter, decimeter, centimeter, and millimeter. Notice that the word “meter” is part of all of these units. The prefix determines the "size" of the unit and indicates a fixed power of 10. For example "kilo" represents $10^3 = 1000$.

The metric system also applies the idea that units within the system get larger or smaller by a power of 10. This means that a meter is 100 times larger than a centimeter, and a kilogram is 1000 times heavier than a gram. You will explore this idea a bit later. For now, notice how this idea of “getting bigger or smaller by 10” is very different than the relationship between units in the U.S. customary system, where 3 feet equals 1 yard, and 16 ounces equals 1 pound.

Length, Mass, and Capacity

The table below shows the basic units of the metric system. Note that the names of all metric units follow from these three basic units.

Length	Mass	Capacity
basic units		
meter	gram	liter
other units you may see		
kilometer	kilogram	kiloliter
centimeter	centigram	centiliter
millimeter	milligram	milliliter

In the metric system, the basic unit of length is the meter. A meter is slightly larger than a yardstick, or just over three feet.

The basic metric unit of mass is the gram. A regular-sized paperclip has a mass of about 1 gram.

Among scientists, one gram is defined as the mass of water that would fill a 1-centimeter cube. You may notice that the word "mass" is used here instead of "weight." In the sciences and technical fields, a distinction is made between weight and mass. Weight is a measure of the pull of gravity on an object. For this reason, an object's weight would be different if it was weighed on Earth or on the moon because of the difference in the gravitational forces. However, the object's mass would remain the same in both places because mass measures the amount of substance in an object. As long as you are planning on only measuring objects on Earth, you can use mass/weight fairly interchangeably—but it is worth noting that there is a difference!

Finally, the basic metric unit of capacity is the liter. A liter is slightly larger than a quart.

		
The handle of a shovel is about 1 meter.	A paperclip weighs about 1 gram.	A medium-sized container of milk is about 1 liter.

Though it is rarely necessary to convert between the customary and metric systems, sometimes it helps to have a mental image of how large or small some units are. The table below shows the relationship between some common units in both systems.

	Common Measurements in Customary and Metric Systems
Length	1 centimeter is a little less than half an inch.
	1.6 kilometers is about 1 mile.
	1 meter is about 3 inches longer than 1 yard.
Mass	1 kilogram is a little more than 2 pounds
	28 grams is about the same as 1 ounce.
Capacity	1 liter is a little more than 1 quart.
	4 liters is a little more than 1 gallon.

Prefixes in the Metric System

The metric system is a base-10 system. This means that each successive unit is 10 times larger than the previous one.

The names of metric units are formed by adding a prefix to the basic unit of measurement. To tell how large or small a unit is, you look at the prefix. To tell whether the unit is measuring length, mass, or capacity, you look at the base.

Prefixes in the Metric System						
kilo-	*hecto-*	*deka-*	*meter/gram/liter*	*deci-*	*centi-*	*milli-*
1000 times **larger** than base unit	100 times **larger** than base unit	10 times **larger** than base unit	base units	10 times **smaller** than base unit	100 times **smaller** than base unit	1000 times **smaller** than base unit

Using this table as a reference, you can see the following:

- A kilogram is 1000 times larger than one gram (so 1 kilogram = 1000 grams).
- A centimeter is 100 times smaller than one meter (so 1 meter = 100 centimeters).
- A dekaliter is 10 times larger than one liter (so 1 dekaliter = 10 liters).

Here is a similar table that just shows the metric units of measurement for mass, along with their size relative to 1 gram (the base unit). The common abbreviations for these metric units have been included as well.

Prefixes in the Metric System						
kilogram (kg)	hectogram (hg)	dekagram (dag)	gram (g)	decigram (dg)	centigram (cg)	milligram (mg)
1000 gram	100 gram	10 gram	gram	0.1 gram	0.01 gram	0.001 gram

Since the prefixes remain constant through the metric system, you could create similar charts for length and capacity. The prefixes have the same meanings whether they are attached to the units of length (meter), mass (gram), or capacity (liter).

Try It 1.2.1

Which of the following sets of three units are all metric measurements of length?

A. inch, foot, yard
B. kilometer, centimeter, millimeter
C. kilogram, gram, centigram
D. kilometer, foot, decimeter

Answer

A. Incorrect. Although these units do measure length, they are all units of measurement from the U.S. customary system.
B. Correct. All of these measurements are from the metric system. You can tell they are measurements of length because they all contain the word “meter.”
C. Incorrect. These measurements are from the metric system, but they are measurements of mass, not length.
D. Incorrect. Kilometer and decimeter are metric units of length, but foot is not.

Converting Units Up and Down the Metric Scale

Converting between metric units of measure requires knowledge of the metric prefixes and an understanding of the decimal system—that’s about it.

For instance, you can figure out how many centigrams are in one dekagram by using the table above. One dekagram is larger than one centigram, so you expect that one dekagram will equal many centigrams.

In the table, each unit is 10 times larger than the one to its immediate right. This means that 1 dekagram = 10 grams; 10 grams = 100 decigrams; and 100 decigrams = 1000 centigrams. So, 1 dekagram = 1000 centigrams.

Example 1.2.1

How many milligrams are in one decigram?

Solution

Identify locations of milligrams and decigrams.

kg	hg	dag	g	**dg**	cg	**mg**

Decigrams (dg) are larger than milligrams (mg), so you expect there to be many mg in one dg.

dg is 10 times larger than a cg, and a cg is 10 times larger than a mg.

kg	hg	dag	g	**dg**	cg	**mg**
				→	→ → →	→
					x10	x10

Since you are going from a larger unit to a smaller unit, multiply.

Multiply: $1 \cdot 10 \cdot 10$, to find the number of milligrams in one decigram.

$$1 \text{ dg} \cdot 10 \cdot 10 = 100 \text{ mg}$$

Answer: There are 100 milligrams (mg) in 1 decigram (dg).

Example 1.2.2

Convert 1 centimeter to kilometers.

Solution

Identify locations of kilometers and centimeters.

km	hm	dam	m	dm	**cm**	mm

Kilometers (km) are larger than centimeters (cm), so you expect there to be less than one km in a cm.

cm is 10 times smaller than a dm; a dm is 10 times smaller than a m, etc.

km	hm	dam	m	dm	**cm**	mm
←	← ← ←	← ← ←	← ← ←	← ← ←	←	
÷10	÷10	÷10	÷10	÷10		

Since you are going from a smaller unit to a larger unit, divide.

Divide: $1 \div 10 \div 10 \div 10 \div 10 \div 10$, to find the number of kilometers in one centimeter.

$$1 \text{ cm} \div 10 \div 10 \div 10 \div 10 \div 10 = 0.00001 \text{ km}$$

Answer: 1 centimeter (cm) = 0.00001 kilometers (km).

Once you begin to understand the metric system, you can use a shortcut to convert among different metric units. The size of metric units increases tenfold as you go up the metric scale. The decimal system works the same way: a tenth is 10 times larger than a hundredth; a hundredth is 10 times larger than a thousandth, etc. By applying what you know about decimals to the metric system, converting among units is as simple as moving decimal points.

Here is the first problem from above: How many milligrams are in one decigram? You can recreate the order of the metric units as shown below:

kg hg dag g dg cg mg

This question asks you to start with 1 decigram and convert that to milligrams. As shown above, milligrams is two places to the right of decigrams. You can just move the decimal point two places to the right to convert decigrams to milligrams: $1.\text{ dg} = 100.\text{ mg}$ (Note the location of the decimal points).

The same method works when you are converting from a smaller to a larger unit, as in the problem: Convert 1 centimeter to kilometers.

km hm dam m dm cm mm

Note that instead of moving to the right, you are now moving to the left—so the decimal point must do the same: $1.\text{ cm} = 0.00001\text{ km}$.

Try It 1.2.2

How many milliliters are in 1 liter?

Answer

There are 10 milliliters in a centiliter, 10 centiliters in a deciliter, and 10 deciliters in a liter. Multiply: $10 \cdot 10 \cdot 10$, to find the number of milliliters in a liter, which comes out 1000 milliliters in a liter.

Summary

The metric system is an alternative system of measurement used in most countries, as well as in the United States. The metric system is based on joining one of a series of prefixes, including kilo- , hecto-, deka-, deci-, centi-, and milli-, with a base unit of measurement, such as meter, liter, or gram. Units in the metric system are all related by a power of 10, which means that each successive unit is 10 times larger than the previous one. This makes converting one metric measurement to another a straightforward process, and is often as simple as moving a decimal point. It is always important, though, to consider the direction of the conversion. If you are converting a smaller unit to a larger unit, then the decimal point has to move to the left (making your number smaller); if you are converting a larger unit to a smaller unit, then the decimal point has to move to the right (making your number larger).

Converting within the Metric System

Introduction

While knowing the different units used in the metric system is important, the real purpose behind learning the metric system is for you to be able to use these measurement units to calculate the size, mass, or capacity of different objects. In practice, it is often necessary to convert one metric measurement to another unit—this happens frequently in the medical, scientific, and technical fields, where the metric system is commonly used.

If you have a prescription for 5000 mg of medicine, and upon getting it filled, the dosage reads 5 g of medicine, did the pharmacist make a mistake?

For a moment, imagine that you are a pharmacist. You receive three prescriptions for liquid amoxicillin: one calls for 2.5 centiliters, one calls for 0.3 deciliters, and one calls for 450 milliliters. Amoxicillin is stored in the refrigerator in 1 liter, 1 deciliter, and 1 centiliter containers. Which container should you use to ensure you are not wasting any of the unused drug?

To solve this problem, you need to know how to convert from one measurement to another as well as how to add different quantities together. Let's take a look at how to do this.

Converting from Larger to Smaller Units

Converting between measurements in the metric system is simply a matter of identifying the unit that you have, the unit that you want to convert to, and then counting the number of units between them. A basic example of this is shown below.

Example 1.2.3

Convert 1 kilometer to decimeters

Solution

Identify locations of kilometers and decimeters.

km	hm	dam	m	**dm**	cm	mm

Kilometers (km) are larger than decimeters (dm), so you expect there to be more than one dm in a km.

km	hm	dam	m	**dm**	cm	mm
→	→ → →	→ → →	→ → →	→		
	x10	x10	x10	x10		

Count the intermediate units, multiplying by 10 as you go. (Since you are going from a larger unit to a smaller unit, you multiply.)

Multiply to find the number of decimeters in one kilometer.

$$1\text{ km} \cdot 10 \cdot 10 \cdot 10 \cdot 10 = 10000\text{ dm}$$

Answer: 1 kilometer = 10,000 decimeters

This problem is straightforward because you are converting 1 kilometer to another unit. The example below shows how you would solve this problem if you were asked to convert 8.2 kilometers to decimeters. Notice that most steps are the same; the critical difference is that you multiply by 8.2 in the final step.

Example 1.2.4

Convert 8.2 kilometers to decimeters

Solution

Identify locations of kilometers and decimeters.

km	hm	dam	m	**dm**	cm	mm

Kilometers (km) are larger than decimeters (dm), so you expect there to be more than one dm in a km.

km	hm	dam	m	**dm**	cm	mm
→	→ → →	→ → →	→ → →	→		
	x10	x10	x10	x10		

Count the intermediate units, multiplying by 10 as you go. Since you are going from a larger unit to a smaller unit, multiply.

Multiply to find the number of decimeters in 8.2 kilometers.

$$8.2\ \text{km} \cdot 10 \cdot 10 \cdot 10 \cdot 10 = 82,000\ \text{dm}$$

Answer: 8.2 kilometer = 82,000 decimeters

You can also apply the rules of base 10 to use the "move the decimal" shortcut method in this example. Notice how decimeters (dm) is four places to the right of kilometers (km); similarly, you move the decimal point four places to the right when converting 8.2 kilometers to decimeters.

km hm dam m dm cm mm

8.2000 km = 82000. dm

8.2 km = 82000 dm

Example 1.2.5

Convert 0.55 liters to centiliters.

Solution

Count two places from liters to centiliters.

kl hl dal l dl cl ml

In 0.55 l, move the decimal point two places to the right.

0.55 l = 055.cl

0.55 l = 55 cl

Answer: 0.55 liters = 55 centiliters

Try It 1.2.3

How many dekaliters are in 0.5 deciliters?

Answer

One deciliter is 100 times smaller than a dekaliter, so you move the decimal point two places to the left to convert 0.5 deciliters to 0.005 dekaliters.

Converting from Smaller to Larger Units

You can use similar processes when converting from smaller to larger units. When converting a larger unit to a smaller one, you multiply; when you convert a smaller unit to a larger one, you divide. Here is an example.

Example 1.2.6

Convert 739 centigrams to grams.

Solution

Identify locations of centigrams and grams.

kg	hg	dag	**g**	dg	**cg**	mg

Centigrams (cg) are smaller than grams (g), so you expect there to be less than 739 g in 739 cg.

Count the intermediate units, dividing by 10 as you go. Since you are going from a smaller unit to a larger unit, divide.

kg	hg	dag	**g**	dg	**cg**	mg
			←	← ← ←	←	
			÷10	÷10		

Since you are going from a smaller unit to a larger unit, divide.

Divide to find the number of grams in 739 centigrams.

$$739 \div 10 \div 10 = 7.39 \text{ g}$$

Answer: 739 centigrams = 7.39 grams

Notice that the shortcut method of counting prefixes and moving the decimal the same number of places also works here. Just make sure you are moving the decimal point in the correct direction for the conversion.

Example 1.2.7

Convert 205.5 milliliters to kiloliters.

Solution

Count six places from milliliters to kiloliters.

kl hl dal l dl cl ml

Milliliter is smaller than kiloliter, so you expect the number 205.5 to get smaller as you move up the metric chart.

In 205.5 ml, move the decimal point six places to the left.

205.5 ml = 0.0002055 kl

Answer: 205.5 milliliters = 0.0002055 kiloliters

Try It 1.2.4

Convert 3085 milligrams to grams.

Answer

One gram is 1000 times larger than a milligram, so you can move the decimal point in 3085 three places to the left to get 3.085 grams.

Factor Label Method

There is yet another method that you can use to convert metric measurements—the **factor label method (dimensional analysis)**. You used this method when you were converting measurement units within the U.S. customary system.

The factor label method works the same in the metric system; it relies on the use of unit fractions and the reducing of intermediate units. The table below shows some of the **unit equivalents** and **unit fractions** for length in the metric system. (You should notice that all of the unit fractions contain a factor of 10. Remember that the metric system is based on the notion that each unit is 10 times larger than the one that came before it.)

Also, notice that two new prefixes have been added here: mega- (which is very big) and micro- (which is very small). Mega is abbbreviated with the prefix capital "M" (since lower case "m" is milli} and micro is represented with the prefix of the greek letter "mu" written with the symbol μ

Unit Equivalents	Conversion Factors	
1 meter = 1,000,000 micrometers	$\frac{1\text{ m}}{1,000,000\ \mu\text{m}}$	$\frac{1,000,000\ \mu\text{m}}{1\text{ m}}$
1 meter = 1000 millimeters	$\frac{1\text{ m}}{1000\text{ mm}}$	$\frac{1000\text{ mm}}{1\text{ m}}$
1 meter = 100 centimeters	$\frac{1\text{ m}}{100\text{ cm}}$	$\frac{100\text{ cm}}{1\text{ m}}$
1 meter = 10 decimeters	$\frac{1\text{ m}}{10\text{ dm}}$	$\frac{10\text{ dm}}{1\text{ m}}$
1 dekameter = 10 meters	$\frac{1\text{ dam}}{10\text{ m}}$	$\frac{10\text{ m}}{1\text{ dam}}$
1 hectometer = 100 meters	$\frac{1\text{ hm}}{100\text{ m}}$	$\frac{100\text{ m}}{1\text{ hm}}$
1 kilometer = 1000 meters	$\frac{1\text{ km}}{1000\text{ m}}$	$\frac{1000\text{ m}}{1\text{ km}}$
1 megameter = 1,000,000 meters	$\frac{1\text{ Mm}}{1,000,000\text{ m}}$	$\frac{1,000,000\text{ m}}{1\text{ Mm}}$

When applying the factor label method in the metric system, be sure to check that you are not skipping over any intermediate units of measurement.

Example 1.2.8

Convert 7225 centimeters to meters.

Solution

Meters is larger than centimeters, so you expect your answer to be less than 7225.

$$7225\text{ cm} = \_\_\_\_\_\text{m}$$

Using the factor label method, write 7225 cm as a fraction and use unit fractions to convert it to m.

$$\frac{7225\text{ cm}}{1}\cdot\frac{1\text{ m}}{100\text{ cm}} = \_\_\_\_\_\text{m}$$

Cancel similar units, multiply, and simplify.

$$\frac{7225}{1}\cdot\frac{1\text{ m}}{100} = \frac{7225}{100}\text{ m}$$

$$\frac{7225 \text{ m}}{100} = 72.25 \text{ m}$$

Answer: 7225 centimeters = 72.25 meters

Try It 1.2.5

Using whichever method you prefer, convert 32.5 kilometers to meters.

Answer

To find the number of meters in 32.5 kilometers, you can set up the following conversion: $\frac{32.5 \text{ kilometers}}{1} \cdot \frac{1000 \text{ meters}}{1 \text{ kilometer}} = \frac{32,500 \text{ meters}}{1}$. The kilometer units cancel, leaving the answer as 32,500 meters.

Now that you have seen how to convert among metric measurements in multiple ways, let's revisit the problem posed earlier.

Example 1.2.9

If you have a prescription for 5000 mg of medicine, and upon getting it filled, the dosage reads 5 g of medicine, did the pharmacist make a mistake?

Solution

Need to convert mg to g.

$$5000 \text{ mg} = \_\_\_\_\_ \text{g?}$$

$$\frac{5000 \text{ mg}}{1} \cdot \frac{1 \text{ g}}{1000 \text{ mg}} = \_\_\_\_\_ \text{g}$$

$$\frac{5000}{1} \cdot \frac{1 \text{ g}}{1000} = \_\_\_\_\_ \text{ g}$$

$$\frac{5000 \cdot 1 \text{ g}}{1 \cdot 1000} = \frac{5000 \text{ g}}{1000}$$

$$\frac{5000 \text{ g}}{1000} = 5 \text{ g}$$

Answer: 5 g = 5000 mg, so the pharmacist did not make a mistake.

Summary

To convert among units in the metric system, identify the unit that you have, the unit that you want to convert to, and then count the number of units between them. If you are going from a larger unit to a smaller unit, you multiply by 10 successively. If you are going from a smaller unit to a larger unit, you divide by 10 successively. The factor label method can also be applied to conversions within the metric system. To use the factor label method, you multiply the original measurement by unit fractions; this allows you to represent the original measurement in a different measurement unit.

Using Metric Conversions to Solve Problems

Introduction

Learning how to solve real-world problems using metric conversions is as important as learning how to do the conversions themselves. Mathematicians, scientists, nurses, and even athletes are often confronted with situations where they are presented with information using metric measurements, and must then make informed decisions based on that data.

To solve these problems effectively, you need to understand the context of a problem, perform conversions, and then check the reasonableness of your answer. Do all three of these steps and you will succeed in whatever measurement system you find yourself using.

Understanding Context and Performing Conversions

The first step in solving any real-world problem is to understand its context. This will help you figure out what kinds of solutions are reasonable (and the problem itself may give you clues about what types of conversions are necessary). Here is an example.

Example 1.2.10

In the Summer Olympic Games, athletes compete in races of the following lengths: 100 meters, 200 meters, 400 meters, 800 meters, 1500 meters, 5000 meters and 10,000 meters. If a runner were to run in all these races, how many kilometers would he run?

Solution

To figure out how many kilometers he would run, you need to first add all of the lengths of the races together and *then* convert that measurement to kilometers.

$$10000\text{ m} + 5000\text{ m} + 1500\text{ m} + 800\text{ m} + 400\text{ m} + 200\text{ m} + 100\text{ m} = 18000\text{ m}$$

Use the factor label method and unit fractions to convert from meters to kilometers.

$$\frac{18000\text{ m}}{1} \cdot \frac{1\text{ km}}{1000\text{ m}} = \_\_\_\_\_\text{ km}$$

Cancel, multiply, and solve.

$$\frac{18000}{1} \cdot \frac{1\text{ km}}{1000} = \frac{18000\text{ km}}{1000}$$

$$\frac{18000\text{ km}}{1000} = 18\text{ km}$$

Answer: The runner would run 18 kilometers.

This may not be likely to happen (a runner would have to be quite an athlete to compete in all of these races) but it is an interesting question to consider. The problem required you to find the total distance that the runner would run (in kilometers). The example showed how to add the distances, in meters, and then convert that number to kilometers.

An example with a different context, but still requiring conversions, is shown below.

Example 1.2.11

One bottle holds 295 dl while another one holds 28,000 ml. What is the difference in capacity between the two bottles?

Solution

The two measurements are in different units. You can convert both units to liters and then compare them

$$295\text{ dl} = \_\_\_\_\_\text{l}$$

$$28000\text{ ml} = \_\_\_\_\_\text{l}$$

Convert dl to liters.

$$\frac{295\text{ dl}}{1} \cdot \frac{1\text{ l}}{10\text{ dl}} = \_\_\_\_\_\text{l}$$

Cancel common units and multiply.

$$\frac{295}{1} \cdot \frac{1\text{ l}}{10} = \_\_\_\_\_\text{l}$$

295 dl = 29.5 liters.

$$\frac{295\text{ l}}{10} = 29.5\text{ l}$$

Convert ml to liters.

$$\frac{28000\text{ ml}}{1} \cdot \frac{1\text{ l}}{1000\text{ ml}} = \_\_\_\_\_\text{l}$$

$$\frac{28000}{1} \cdot \frac{1\,\text{l}}{1000} = \frac{28000\,\text{l}}{1000}$$

28,000 ml = 28 liters

$$\frac{28000\,\text{l}}{1000} = 28\,\text{l}$$

The question asks for “difference in capacity” between the bottles.

$$29.5 \text{ liters} - 28 \text{ liters} = 1.5 \text{ liters}$$

Answer: There is a difference in capacity of 1.5 liters between the two bottles.

This problem asked for the difference between two quantities. The easiest way to find this is to convert one quantity so that both quantities are measured in the same unit, and then subtract one from the other. Here you could have also chosen to convert both numbers to deciliters or both numbers to milliliters instead of liters.

Try It 1.2.6

One boxer weighs in at 85 kg. He is 80 dag heavier than his opponent. How much does his opponent weigh?

Answer

His opponent weights 84.2 kg since $80 \text{ dekagrams} = 0.8 \text{ kilograms}$, and $85 - 0.8 = 84.2$.

Checking your Conversions

Sometimes it is a good idea to check your conversions using a second method. This usually helps you catch any errors that you may make, such as using the wrong unit fractions or moving the decimal point the wrong way.

Example 1.2.12

A two-liter bottle contains 87 centiliters of oil and 4.1 deciliters of water. How much more liquid is needed to fill the bottle?

Solution

You are looking for the amount of liquid needed to fill the bottle. Convert both measurements to liters and then solve the problem.

$$87\,\text{cl} + 4.1\,\text{dl} + \_\_\_\_\_ = 2\,\text{l}$$

Convert 87 cl to liters.

$$87\,\text{cl} = \_\_\_\_\_\,\text{l}$$

$$\frac{87\,\text{cl}}{1} \cdot \frac{1\,\text{l}}{100\,\text{cl}} = \_\_\_\_\_\,\text{l}$$

$$\frac{87}{1} \cdot \frac{1\,\text{l}}{100} = \frac{87\,\text{l}}{100}$$

$$\frac{87\,\text{l}}{100} = 0.87\,\text{l}$$

Convert 4.1 dl to liters

$$4.1\,\text{dl} = \_\_\_\_\_\,\text{l}$$

$$\frac{4.1\,\text{dl}}{1} \cdot \frac{1\,\text{l}}{10\,\text{dl}} = \_\_\_\_\_\,\text{l}$$

$$\frac{4.1}{1} \cdot \frac{1\,\text{l}}{10} = \frac{4.1\,\text{l}}{10}$$

$$\frac{4.1\,\text{l}}{10} = 0.41\,\text{l}$$

Subtract to find how much more liquid is needed to fill the bottle.

$$87 \text{ cl} + 4.1 \text{ dl} + \_\_\_\_\_ = 2 \text{ l}$$

$$0.87 \text{ liter} + 0.41 \text{ liter} + \_\_\_\_\_ = 2 \text{ liters}$$

$$2 \text{ liters} - 0.87 \text{ liter} - 0.41 \text{ liter} = 0.72 \text{ liter}$$

Answer: The amount of liquid needed to fill the bottle is 0.72 liter.

Having come up with the answer, you could also check your conversions using the quicker “move the decimal” method, shown below.

Example 1.2.13

A two-liter bottle contains 87 centiliters of oil and 4.1 deciliters of water. How much more liquid is needed to fill the bottle?

Solution

You are looking for the amount of liquid needed to fill the bottle. Convert both measurements to liters and then solve the problem.

$$87 \text{ cl} + 4.1 \text{ dl} + \_\_\_\_\_ = 2 \text{ l}$$

Convert 87 cl to liters.

$$87 \text{ cl} = \_\_\_\_\_ \text{l}$$

On the chart, l is two places to the left of cl.

kl hl dal **l** dl **cl** ml

Move the decimal point two places to the left in 87 cl.

.87. cl

87 cl = 0.87 l

Convert 4.1 dl to liters.

$$4.1 \text{ dl} = \_\_\_\_\_ \text{l}$$

On the chart, l is one place to the left of dl.

kl hl dal **l dl** cl ml

Move the decimal point one place to the left in 4.1 dl.

.4.1 dl

4.1 dl = 0.41 l

Subtract to find how much more liquid is needed to fill the bottle.

$$87 \text{ cl} + 4.1 \text{ dl} + \_\_\_\_\_ = 2 \text{ l}$$

$$0.87 \text{ liter} + 0.41 \text{ liter} + \_\_\_\_\_ = 2 \text{ liters}$$

$$2 \text{ liters} - 0.87 \text{ liter} - 0.41 \text{ liter} = 0.72 \text{ liter}$$

Answer: The amount of liquid needed to fill the bottle is 0.72 liter.

The initial answer checks out—0.72 liter of liquid is needed to fill the bottle. Checking one conversion with another method is a good practice for catching any errors in scale.

Summary

Understanding the context of real-life application problems is important. Look for words within the problem that help you identify what operations are needed, and then apply the correct unit conversions. Checking your final answer by using another conversion

method (such as the “move the decimal” method, if you have used the factor label method to solve the problem) can cut down on errors in your calculations.
