

MEASUREMENT AND GEOMETRY: THE METRIC SYSTEM OF MEASUREMENT*

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Abstract

This module is from Fundamentals of Mathematics by Denny Burzynski and Wade Ellis, Jr. This module discusses the Metric System of measurement. By the end of the module students should be more familiar with some of the advantages of the base ten number system, know the prefixes of the metric measures, be familiar with the metric system of measurement and be able to convert from one unit of measure in the metric system to another unit of measure

1 Section Overview

- The Advantages of the Base Ten Number System
- Prefixes
- Conversion from One Unit to Another Unit
- Conversion Table

2 The Advantages of the Base Ten Number System

The metric system of measurement takes advantage of our base ten number system. The advantage of the metric system over the United States system is that in the metric system it is possible to convert from one unit of measure to another simply by multiplying or dividing the given number by a power of 10. This means we can make a conversion simply by moving the decimal point to the right or the left.

3 Prefixes

Common units of measure in the metric system are the meter (for length), the liter (for volume), and the gram (for mass). To each of the units can be attached a prefix. The **metric prefixes** along with their meaning are listed below.

Metric Prefixes

kilo — thousand

deci — tenth

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hecto — hundred
centi — hundredth
deka — ten
milli — thousandth

For example, if length is being measured,

1 kilometer is equivalent to 1000 meters.
 1 centimeter is equivalent to one hundredth of a meter.
 1 millimeter is equivalent to one thousandth of a meter.

4 Conversion from One Unit to Another Unit

Let's note three characteristics of the metric system that occur in the metric table of measurements.

1. In each category, the prefixes are the same.
2. We can move from a *larger to a smaller* unit of measure by moving the decimal point to the *right*.
3. We can move from a *smaller to a larger unit* of measure by moving the decimal point to the *left*.

The following table provides a summary of the relationship between the basic unit of measure (meter, gram, liter) and each prefix, and how many places the decimal point is moved and in what direction.

kilo hecto deka unit deci centi milli

Basic Unit to Prefix		Move the Decimal Point
unit to deka	1 to 10	1 place to the left
unit to hector	1 to 100	2 places to the left
unit to kilo	1 to 1,000	3 places to the left
unit to deci	1 to 0.1	1 place to the right
unit to centi	1 to 0.01	2 places to the right
unit to milli	1 to 0.001	3 places to the right

Table 1

5 Conversion Table

Listed below, in the unit conversion table, are some of the common metric units of measure.

Unit Conversion Table			
	1 kilometer (km)	=	1,000 × 1 m
	1,000 meters (<i>m</i>)		
<i>continued on next page</i>			

Length

	1 hectometer (hm) = 100 meters	=	$100 \times 1 \text{ m}$
	1 dekameter (dam) = 10 meters	=	$10 \times 1 \text{ m}$
	1 meter (m)		$1 \times 1 \text{ m}$
	1 decimeter (dm) = $\frac{1}{10}$ meter		$.1 \times 1 \text{ m}$
	1 centimeter (cm) = $\frac{1}{100}$ meter		$.01 \times 1 \text{ m}$
	1 millimeter (mm) = $\frac{1}{1,000}$ meter	=	$.001 \times 1 \text{ m}$
Mass	1 kilogram (kg) = 1,000 grams (g)	=	$1,000 \times 1 \text{ g}$
	1 hectogram (hg) = 100 grams		$100 \times 1 \text{ g}$
	1 dekagram (dag) = 10 grams		$10 \times 1 \text{ g}$
	1 gram (g)		$1 \times 1 \text{ g}$
	1 decigram (dg) = $\frac{1}{10}$ gram		$.1 \times 1 \text{ g}$
	1 centigram (cg) = $\frac{1}{100}$ gram		$.01 \times 1 \text{ g}$
	1 milligram (mg) = $\frac{1}{1,000}$ gram	=	$.001 \times 1 \text{ g}$
Volume	1 kiloliter (kL) = 1,000 liters (L)	=	$1,000 \times 1 \text{ L}$
	1 hectoliter (hL) = 100 liters		$100 \times 1 \text{ L}$
	1 dekaliter (daL) = 10 liters		$10 \times 1 \text{ L}$
	1 liter (L)		$1 \times 1 \text{ L}$
	1 deciliter (dL) = $\frac{1}{10}$ liter		$.1 \times 1 \text{ L}$
	1 centiliter (cL) = $\frac{1}{100}$ liter		$.01 \times 1 \text{ L}$
	1 milliliter (mL) = $\frac{1}{1,000}$ liter		$.001 \times 1 \text{ L}$
Time	Same as the United States system		

Table 2

Distinction Between Mass and Weight

There is a distinction between mass and weight. The **weight** of a body is related to gravity whereas the mass of a body is not. For example, your weight on the earth is different than it is on the moon, but your mass is the same in both places. **Mass** is a measure of a body's resistance to motion. The more massive a body, the more resistant it is to motion. Also, more massive bodies weigh more than less massive bodies.

Converting Metric Units

To convert from one metric unit to another metric unit:

1. Determine the location of the original number on the metric scale (pictured in each of the following examples).
2. Move the decimal point of the original number in the same direction and same number of places as is necessary to move to the metric unit you wish to go to.

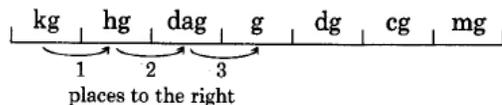
We can also convert from one metric unit to another using unit fractions. Both methods are shown in Example 1 of Section 5.1 (Sample Set A).

5.1 Sample Set A

Example 1

Convert 3 kilograms to grams.

- (a) 3 kg can be written as 3.0 kg. Then,



$$3.0 \text{ kg} = \underbrace{3\,000}_{1\,2\,3} \text{ g}$$

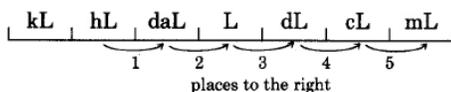
Thus, $3\text{kg} = 3,000 \text{ g}$.

- (b) We can also use unit fractions to make this conversion. Since we are converting to grams, and $1,000 \text{ g} = 1 \text{ kg}$, we choose the unit fraction $\frac{1,000 \text{ g}}{1 \text{ kg}}$ since grams is in the numerator.

$$\begin{aligned} 3 \text{ kg} &= 3 \text{ kg} \cdot \frac{1,000 \text{ g}}{1 \text{ kg}} \\ &= 3 \overline{) \text{kg}} \cdot \frac{1,000 \text{ g}}{1 \overline{) \text{kg}}} \\ &= 3 \cdot 1,000 \text{ g} \\ &= 3,000 \text{ g} \end{aligned}$$

Example 2

Convert 67.2 hectoliters to milliliters.

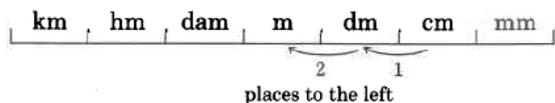


$$67.2 \text{ hL} = \underbrace{67\,20000}_{1\,2\,3\,4\,5} \text{ mL}$$

Thus, $67.2 \text{ hL} = 6,720,000 \text{ mL}$.

Example 3

Convert 100.07 centimeters to meters.

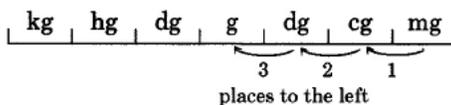


$$100.07 \text{ cm} = \underbrace{1,0007}_{2\,1} \text{ m}$$

Thus, $100.07 \text{ cm} = 1.0007 \text{ m}$.

Example 4

Convert 0.16 milligrams to grams.



$$0.16 \text{ mg} = \underbrace{0,00016}_{3\,2\,1} \text{ g}$$

Thus, $0.16 \text{ mg} = 0.00016 \text{ g}$.

5.2 Practice Set A

- Exercise 1** *(Solution on p. 7.)*
Convert 411 kilograms to grams.
- Exercise 2** *(Solution on p. 7.)*
Convert 5.626 liters to centiliters.
- Exercise 3** *(Solution on p. 7.)*
Convert 80 milliliters to kiloliters.
- Exercise 4** *(Solution on p. 7.)*
Convert 150 milligrams to centigrams.
- Exercise 5** *(Solution on p. 7.)*
Convert 2.5 centimeters to meters.

6 Exercises

Make each conversion.

- Exercise 6** *(Solution on p. 7.)*
87 m to cm
- Exercise 7**
905 L to mL
- Exercise 8** *(Solution on p. 7.)*
16,005 mg to g
- Exercise 9**
48.66 L to dL
- Exercise 10** *(Solution on p. 7.)*
11.161 kL to L
- Exercise 11**
521.85 cm to mm
- Exercise 12** *(Solution on p. 7.)*
1.26 dag to dg
- Exercise 13**
99.04 dam to cm
- Exercise 14** *(Solution on p. 7.)*
0.51 kL to daL
- Exercise 15**
0.17 kL to daL
- Exercise 16** *(Solution on p. 7.)*
0.05 m to dm
- Exercise 17**
0.001 km to mm
- Exercise 18** *(Solution on p. 7.)*
8.106 hg to cg
- Exercise 19**
17.0186 kL to mL

Exercise 20 (Solution on p. 7.)
3 cm to m

Exercise 21
9 mm to m

Exercise 22 (Solution on p. 7.)
4 g to mg

Exercise 23
2 L to kL

Exercise 24 (Solution on p. 7.)
6 kg to mg

Exercise 25
7 daL to mL

6.1 Exercises for Review

Exercise 26 (Solution on p. 7.)
(here¹) Find the value of $\frac{5}{8} - \frac{1}{3} + \frac{3}{4}$.

Exercise 27
(here²) Solve the proportion: $\frac{9}{x} = \frac{27}{60}$.

Exercise 28 (Solution on p. 7.)
(here³) Use the method of rounding to estimate the sum: $8,226 + 4,118$.

Exercise 29
(here⁴) Use the clustering method to estimate the sum: $87 + 121 + 118 + 91 + 92$.

Exercise 30 (Solution on p. 7.)
(here⁵) Convert 3 in. to yd.

¹"Addition and Subtraction of Fractions, Comparing Fractions, and Complex Fractions: Addition and Subtraction of Fractions with Unlike Denominators" <<http://legacy.cnx.org/content/m34935/latest/>>

²"Ratios and Rates: Proportions" <<http://legacy.cnx.org/content/m34981/latest/>>

³"Techniques of Estimation: Estimation by Rounding" <<http://legacy.cnx.org/content/m35011/latest/>>

⁴"Techniques of Estimation: Estimation by Clustering" <<http://legacy.cnx.org/content/m35012/latest/>>

⁵"Measurement and Geometry: Measurement and the United States System" <<http://legacy.cnx.org/content/m35018/latest/>>

Solutions to Exercises in this Module

Solution to Exercise (p. 5)

411,000 g

Solution to Exercise (p. 5)

562.6 cL

Solution to Exercise (p. 5)

0.00008 kL

Solution to Exercise (p. 5)

15 cg

Solution to Exercise (p. 5)

0.025 m

Solution to Exercise (p. 5)

8,700 cm

Solution to Exercise (p. 5)

16.005 g

Solution to Exercise (p. 5)

11,161 L

Solution to Exercise (p. 5)

126 dg

Solution to Exercise (p. 5)

5.1 daL

Solution to Exercise (p. 5)

0.5 dm

Solution to Exercise (p. 5)

81,060 cg

Solution to Exercise (p. 6)

0.03 m

Solution to Exercise (p. 6)

4,000 mg

Solution to Exercise (p. 6)

6,000,000 mg

Solution to Exercise (p. 6)

$\frac{25}{24} = 1\frac{1}{24}$

Solution to Exercise (p. 6)

12,300 (12,344)

Solution to Exercise (p. 6)

0.08 $\bar{3}$ yard