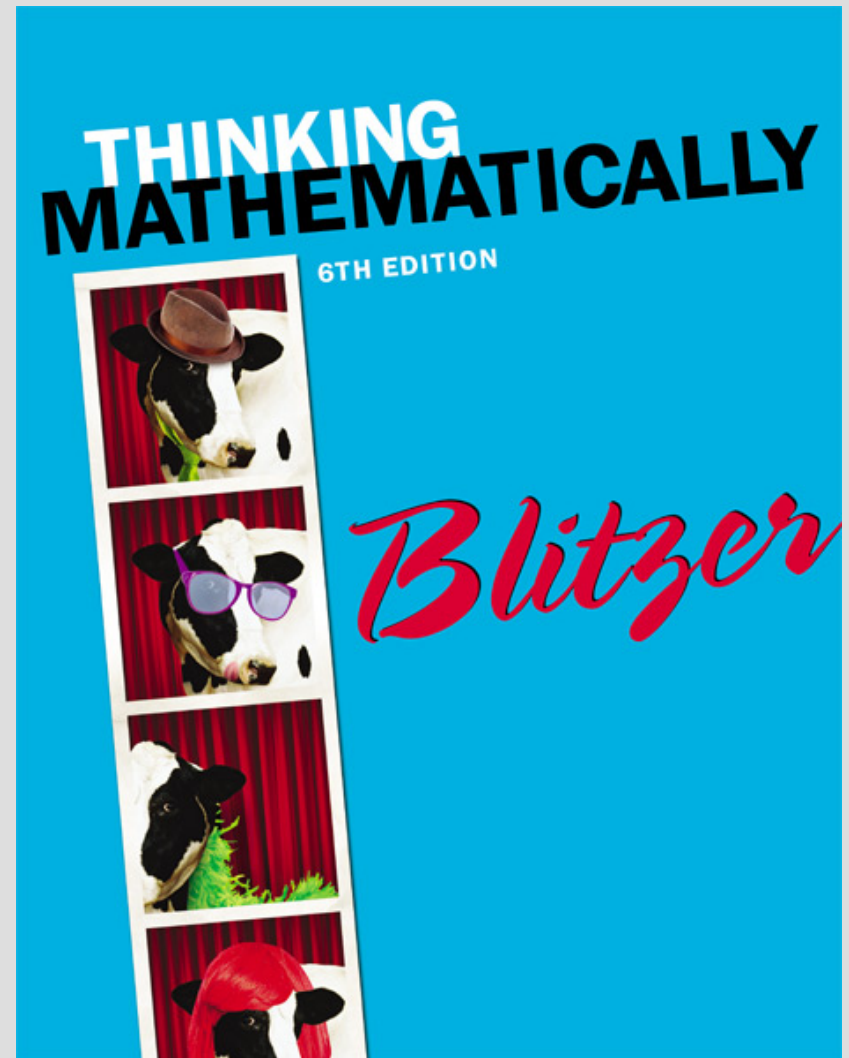


CHAPTER 9

Measurement



9.1

Measuring Length; The Metric System

Objectives

1. Use dimensional analysis to change units of measurement.
2. Understand and use metric prefixes.
3. Convert units within the metric system.
4. Use dimensional analysis to change to and from the metric system.

Length

Linear Units of Measure: The English System

$$12 \text{ inches (in.)} = 1 \text{ foot (ft)}$$

$$3 \text{ feet} = 1 \text{ yard (yd)}$$

$$36 \text{ inches} = 1 \text{ yard}$$

$$5280 \text{ feet} = 1 \text{ mile (mi)}$$

Unit Fractions contain different units and the value of the unit is 1. Here are some unit fractions:

$$\frac{12 \text{ in.}}{1 \text{ ft}} \quad \frac{1 \text{ ft}}{12 \text{ in.}} \quad \frac{3 \text{ ft}}{1 \text{ yd}} \quad \frac{1 \text{ yd}}{3 \text{ ft}} \quad \frac{5280 \text{ ft}}{1 \text{ mi}} \quad \frac{1 \text{ mi}}{5280 \text{ ft}}$$

Dimensional Analysis

To convert a measurement to a different unit, multiply by the unit fraction (or by unit fractions). The given unit of measurement should appear in the denominator of the unit fraction so that this unit cancels upon multiplication. The unit measurement that needs to be introduced should appear in the numerator of the fraction so that this unit will be retained upon multiplication.

Example: Using Dimensional Analysis to Change Units of Measurement.

Convert:

a. 40 inches to feet

Solution:

$$40 \text{ in.} = \frac{40 \cancel{\text{in.}}}{1} \cdot \frac{1 \text{ ft}}{12 \cancel{\text{in.}}} = \frac{40 \text{ ft}}{12} = 3\frac{1}{3} \text{ or } 3.\bar{3} \text{ ft}$$

b. 13,200 feet to miles

Solution:

$$13,200 \text{ ft} = \frac{13,200 \cancel{\text{ft}}}{1} \cdot \frac{1 \text{ mi}}{5280 \cancel{\text{ft}}} = \frac{13,200 \text{ mi}}{5,280} = 2.5 \text{ mi.}$$

Length and the Metric System

Used in most industrialized countries

Based on powers of ten.

Commonly used Metric Prefixes

Prefix	Symbol	Meaning
kilo	k	$1000 \times$ base unit
hecto	h	$100 \times$ base unit
deka	da	$10 \times$ base unit
deci	d	$1/10$ of base unit
centi	c	$1/100$ of base unit
milli	m	$1/1000$ of base unit

Commonly Used Units of Linear Measure in the Metric System

The basic unit for linear measure in the metric system is the meter.

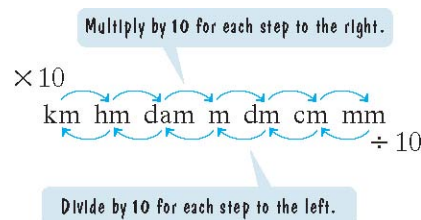
Symbol	Unit	Meaning
km	kilometer	1000 meters
hm	hectometer	100 meters
dam	dekameter	10 meters
m	meter	1 meter
dm	decimeter	0.1 meter
cm	centimeter	0.01 meter
mm	millimeter	0.001 meter

Changing Units Within the Metric System

To change from larger units to smaller units involves multiplying by ten.

To change from smaller units to larger units involves dividing by ten.

Metric units for length from largest to smallest



Example: Changing Units Within the Metric System


Convert 504.7 meters to kilometers.

Solution:

To convert from meters to kilometers, start at meters and move three steps to the left to obtain kilometers:

km hm dam m dm cm mm


Hence we move the decimal point 3 places to the left.

$$504.7 \text{ m} = 0.5047 \text{ km.}$$


Example continued

Convert 27 meters to centimeters


Solution:

To convert from meters to centimeters, start at meters and move two steps to the right to obtain centimeters:

km hm dam m dm cm mm.



Hence we move the decimal point 2 places to the right.

$$27 \text{ m} = 2700 \text{ cm.}$$


Using Dimensional Analysis to Change To and From the Metric System

Approximate English and Metric Equivalents

1 inch (in.) = 2.54 centimeters (cm)
1 foot (ft) = 30.48 centimeters (cm)
1 yard (yd) = 0.9 meter (m)
1 mile (mi) = 1.6 kilometers (km)

These conversions are exact.

These conversions are approximate.

Example: Using Dimensional Analysis to Change to and from the Metric System

Convert 125 miles to kilometers

Solution:

Use the unit fraction: $\frac{1.6 \text{ km}}{1 \text{ mi}}$

$$125 \text{ miles} = \frac{125 \text{ mi}}{1} \cdot \frac{1.6 \text{ km}}{1 \text{ mi}} = 125(1.6) \text{ km} = 200 \text{ km}$$

Example continued

Convert 26,800 millimeters to inches.

Solution:

From the table we see that

$$26,800 \text{ mm} = 2680.0 \text{ cm}$$

Use the unit fraction: $\frac{1 \text{ in.}}{2.54 \text{ cm}}$

$$\begin{aligned} 26,800 \text{ mm} &= 2680 \text{ cm} \\ &= \frac{2680 \cancel{\text{ cm}}}{1} \cdot \frac{1 \text{ in.}}{2.54 \cancel{\text{ cm}}} = \frac{2680}{2.54} \text{ in.} \approx 1055 \text{ in.} \end{aligned}$$