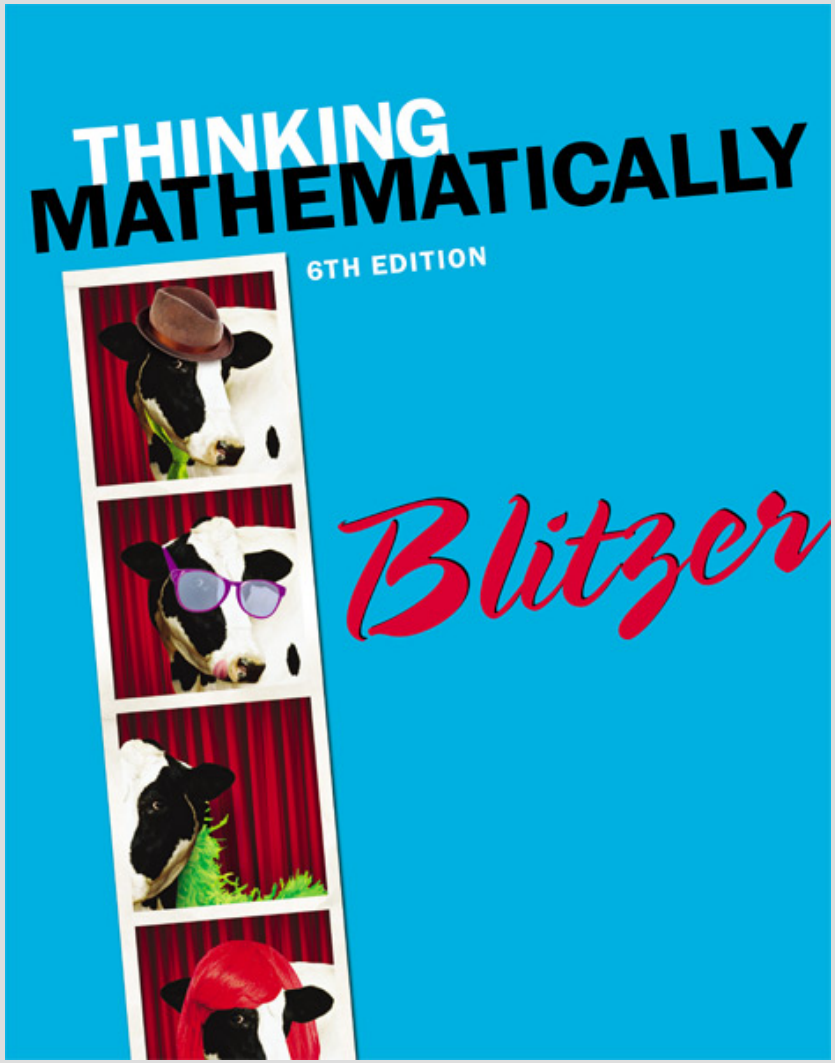
CHAPTER 9

Measurement



9.3

Measuring Weight and Temperature

Objectives

1. Apply metric prefixes to units of weight.
2. Convert units of weight within the metric system.
3. Use relationships between volume and weight within the metric system.
4. Use dimensional analysis to change units of weight to and from the metric system.
5. Understand temperature scales.

Weight and Mass

Weight

The measure of the gravitational pull on an object.

Mass

The measure of the quantity of matter in an object, determined by its molecular structure.

Note: In this section we will treat mass and weight as equivalent and refer strictly to weight.

Units of Weight

UNITS OF WEIGHT: THE ENGLISH SYSTEM

$$16 \text{ ounces (oz)} = 1 \text{ pound (lb)}$$

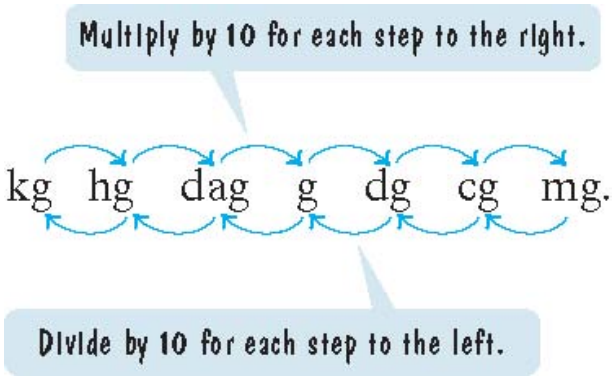
$$2000 \text{ pounds (lb)} = 1 \text{ ton (T)}$$

Units of Weight

The Metric System

Symbol	Unit	Meaning
kg	kilogram	1000 grams
hg	hectogram	100 grams
dag	dekagram	10 grams
g	gram	1 gram
dg	decigram	0.1 gram
cg	centigram	0.01 gram
mg	milligram	0.001 gram

Example: Changing Units of Weight Within the Metric System



Convert 950 mg to g.

Solution:

To convert from mg to g, we start at mg and move three steps to the left.

kg hg dag g dg cg mg.

Hence we move the decimal point three places to the left:

$$950 \text{ mg} = 0.950 \text{ g}.$$

Volume and Weight in the Metric System

One kilogram of water has a volume of 1 liter.

$$1000\ \text{cm}^3 = 1\ \text{dm}^3 = 1\ \text{L} = 1\ \text{kg}$$

Volume and Weight of Water in the Metric System

Volume		Capacity		Weight
$1\ \text{cm}^3$	=	1 mL	=	1g
$1\ \text{dm}^3 = 1000\ \text{cm}^3$	=	1L	=	1kg
$1\ \text{m}^3$	=	1kL	=	1000 kg = 1t

Example: Volume and Weight in the Metric System

An aquarium holds 0.25m^3 of water. How much does the water weigh?

Solution:

We use the fact that 1 m^3 of water = 1000 kg of water to set up our unit fraction:

$$\frac{1000 \text{ kg}}{1 \text{ m}^3}$$

$$0.25 \text{ m}^3 = \frac{0.25 \cancel{\text{m}^3}}{1} \cdot \frac{1000 \text{ kg}}{1 \cancel{\text{m}^3}} = 250 \text{ kg}$$

Weight: English and Metric Equivalents

1 ounce (oz) $\approx$ 28 grams (g)
1 pound (lb) $\approx$ 0.45 kilogram (kg)
1 ton (T) $\approx$ 0.9 tonne (t)

Example: Using Dimensional Analysis

Convert 160 pounds to kilograms

Solution:

Use a unit fraction with kilograms in the numerator and pounds in the denominator.

$$\frac{0.45 \text{ kg}}{1 \text{ lb}}$$

Thus,

$$160 \text{ lb} = \frac{160 \text{ lb}}{1} \cdot \frac{0.45 \text{ kg}}{1 \text{ lb}} = 160(0.45) \text{ kg} = 72 \text{ kg}.$$

Measuring Temperature

Fahrenheit temperature scale

Water freezes at 32 degrees (32º F)

Water boils at 212 degrees (212 ºF)

Celsius temperature

Water freezes at 0 degrees (0º C)

Water boils at 100 degrees (100º C)

Converting Temperatures

From Celsius to Fahrenheit

$$F = \frac{9}{5}C + 32$$

or

$$F = 1.8\,C + 32$$

From Fahrenheit to Celsius

$$C = \frac{5}{9}(F - 32)$$

Example: Converting from Celsius to Fahrenheit

The bills from your European vacation have you feeling a bit feverish, so you decide to take your temperature.

The thermometer reads 37ºC.

Should you panic?

Solution:

Use the formula:

$$F = \frac{9}{5}C + 32$$

Substitute in 37 for C to find the value of F.

$$F = \frac{9}{5}(37) + 32 = 66.6 + 32 = 98.6$$

Your temperature is 98.6º F, which is normal!

Example: Converting from Fahrenheit to Celsius

The temperature on a warm spring day is 77ºF.

Find the equivalent temperature in Celsius.

Solution:

Use the formula:

$$C = \frac{5}{9}(F - 32)$$

Substitute 77 for F:

$$C = \frac{5}{9}(77 - 32) = \frac{5}{9}(45) = 25$$

Thus, 77º F is equivalent to 25º C.

Kelvin Temperature Scale

Absolute zero is the coldest possible temperature, at which there is no heat and molecules stop moving.

0 K is −273.15° C or absolute zero.

373.15 K is the boiling point of water.

From Celsius to Kelvin

$K = C + 273.15$

From Kelvin to Celsius

$C = K - 273.15$

Comparing the Three Temperature Scales