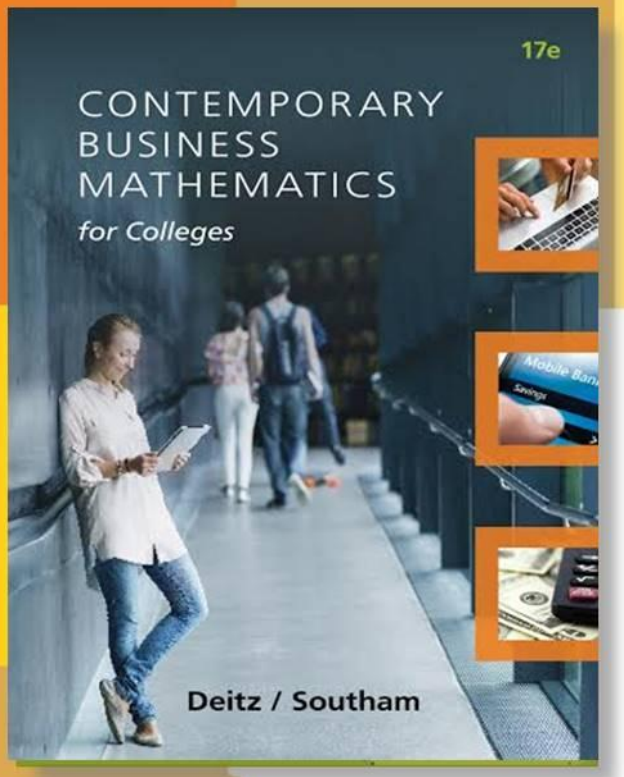

4

International System of Units (SI): *The Metric System*

Prepared by Johnny Howard

Learning Objectives

By studying this chapter and completing all assignments you will be able to:

Learning Objective 1 Recognize and apply the basic elements of the International System of Units (SI) commonly known as "the metric system."

Learning Objective 2 Understand the SI measurements for length and be able to convert between the US and SI systems.

Learning Objective 3 Understand the SI measurements for volume and be able to convert between the US and SI systems.

Learning Objective 4 Understand the SI measurements for weight and be able to convert between the US and SI systems.

Basic Elements of the International System of Units (SI)

- The measuring system used in the United States is commonly referred to as the "traditional," or the "US Traditional," system.
- The measuring system used in other parts of the world is called the *International System of Units* (abbreviated *SI*) or the *metric system*.
- Metric units most widely used are:
  - *meter* (m) — a measure of length
  - *liter* (L) — a measure of liquid capacity (volume)
  - *gram* (g) — a measure of weight (mass)

DECIMAL (METRIC) SYSTEM: Prefixes and Symbols

Number	US Term	Metric Prefix	Symbol
1,000,000,000	Billion	giga	G
1,000,000	Million	mega	M
1,000	Thousand	kilo	k
100	Hundred	hector	h
10	Ten	deka	da
1	One	(no prefix)	
1/10	One tenth	deci	d
1/100	One hundredth	centi	c
1/1000	One thousandth	milli	m
1/1,000,000	One millionth	micro	u
1/1,000,000,000	One billionth	nano	n

The Measurement of Length

- The meter (m) is the base unit of the metric measure of length. Some of the multiples of the meter are:

kilometer (km)	=	1000 meters
hectometer (hm)	=	100 meters
dekameter (dam)	=	10 meters
meter (m)	=	1 meter
decimeter (dm)	=	0.1 meter
centimeter (cm)	=	0.01 meter
millimeter (mm)	=	0.001 meter

EXAMPLE B

To change from meters to kilometers (smaller to larger) the steps are:

6 000 meters (m) $\div$ 10 = 600 dekameters (dam)
600 dekameters (dam) $\div$ 10 = 60 hectometers (hm)
60 hectometers (hm) $\div$ 10 = 6 kilometers (km)

To change from meters to millimeters (larger to smaller) the steps are:

6 meters (m) $\times$ 10 = 60 decimeters (dm)
60 decimeters (dm) $\times$ 10 = 600 centimeters (cm)
600 centimeters (cm) $\times$ 10 = 6 000 millimeters (mm)

Conversion Tables for Measurement of Length (Approximate)

Metric SI to Traditional US

1 kilometer	(km)	=	0.621 mile
1 kilometer	(km)	=	3,280.840 feet
1 hecktometer	(hm)	=	328.084 feet
1 dekameter	(dam)	=	32.808 feet
1 meter	(m)	=	39.370 inches
1 meter	(m)	=	3.281 feet
1 meter	(m)	=	1.094 yards
1 decimeter	(dm)	=	3.937 inches
1 centimeter	(cm)	=	0.393 inches
1 millimeter	(mm)	=	0.039 inches

US Traditional to Metric SI

1 inch	=	2.540 centimeters (cm)
1 foot	=	0.305 meter (m)
1 yard	=	0.914 meter (m)
1 mile	=	1.609 kilometers (km)

EXAMPLES C and D

Convert 20 meters to yards.
Using the conversion table, note that 1 meter equals 1.094 yards.
Multiply: 20 × 1.094 = 21.88 (yards)

What is the speed limit in miles per hour on a highway where there is a sign that reads “80 kilometers”?
From the conversion table: 1 kilometer equals 0.621 miles.
Multiply: 80 × 0.621 = 49.68 mph
(Note: The 49.68 mph calculation is routinely rounded to 50 mph.)

Volume and Capacity Measures

- Volume and Capacity
  - –Simply mean “how much something holds.”
  - –Are used interchangeably to refer to cubic units of capacity.
- Liter is the basic metric unit for liquid capacity.
  - –The symbol for liter is the capital letter “L” in order to avoid confusion with the number 1.

SI Measurements for Volume

kiloliter	(kL)	=	1 000 liters
hectoliter	(hL)	=	100 liters
dekaliter	(daL)	=	10 liters
liter	(L)	=	1 liter
deciliter	(dL)	=	0.1 liter
centiliter	(cL)	=	0.01 liter
milliliter	(mL)	=	0.001 liter

COMPARISON OF US AND SI SYSTEMS
MEASUREMENT OF CAPACITY

Metric SI to Traditional US

1 kiloliter	kL	=	264,178	gallons
1 hectoliter	hL	=	26,418	gallons
1 dekaliter	daL	=	2,642	gallons
1 liter	L	=	2.113	pints
	L	=	1.057	quarts
	L	=	0.264	gallon
1 deciliter	dL	=	0.211	pint
1 centiliter	cL	=	0.338	ounce
1 milliliter	mL	=	0.034	ounce

US Traditional to Metric SI

1 cup	=	0.237 liter	(L)
1 pint	=	0.473 liter	(L)
1 quart	=	0.946 liter	(L)
1 gallon	=	3.785 liter	(L)
1 ounce	=	29.573 milliliters	(mL)

EXAMPLE F

Five liters equal how many quarts?
1 liter equals 1.057 quarts. $5 \times 1.057 = 5.285$ quarts

Seven quarts equal how many liters?
1 quart equals 0.946 liter. $7 \times 0.946 = 6.622$ liters

How many liters are there in four gallons?
1 gallon equals 3.785 liters. $4 \times 3.785 = 15.14$ liters

How many gallons are there in 12 liters?
1 liter = 0.264 gallons. $12 \times 0.264 = 3.168$ gallons

COMPARISON OF US AND SI SYSTEMS
MEASUREMENT OF WEIGHT

Metric SI to Traditional US

1 metric ton	t	=	1.102 short tons
1 metric ton	t	=	2,204.623 pounds
1 kilogram	kg	=	2.205 pounds
1 kilogram	kg	=	35.274 ounces
1 hectogram	hg	=	3.527 ounces
1 dekagram	dag	=	0.353 ounces
1 gram	g	=	0.035 ounce
1 decigram	dg	=	1.543 grains
1 centigram	cg	=	0.154 grain
1 milligram	mg	=	0.015 grain

Traditional US to Metric SI

1 grain	=	0.065	gram	g
1 ounce	=	28.349	gram	g
1 pound	=	453.592	gram	g
1 pound	=	0.453	kilogram	kg
1 short ton	=	0.907	metric ton	t

Assignment 4.1: International System of Units (SI) and Capacity

A

1. Fill in the missing information: (10 points, 1 point each answer)

Prefix	Symbol	Value
kilo	k	1 000
centi	c	0.01
deci	d	0.1
deka	da	10
milli	m	0.001

2. The meter is the base unit of the measure of length. Provide the missing information: (5 points, 1 point each)

a. 1 kilometer = 1 000 meters
b. 0.001 meter = 1 millimeter
c. 1 dekameter = 10 meters
d. 4 meters = 40 decimeters
e. 240 millimeters = 24 centimeters

3. Convert 120 meters to: (5 points, 1 point each)

a. centimeters 12 000
b. kilometers 0.120
c. millimeters 120 000

Convert 25 kilometers to:

d. meters 25 000
e. millimeters 25 000 000

4. Convert the following lengths to the metric or traditional equivalent units. (10 points, 2 points each)

a. 50 miles per hour to kilometers per hour: 80.450 kmph
$1.609 \times 50 = 80.450$ kmph

b. 5 meters to feet: 16.405 feet
$3.281 \times 5 = 16.405$ feet

c. 100-meter track event to yards: 109.4 yards
$100 \times 1.094 = 109.4$ yards

d. 12-inch ruler to centimeters: 30.48 cm
$2.54 \times 12 = 30.48$ cm

e. 300-yard roll of tape to meters: 274.2 m
$300 \times 0.914 = 274.2$ m

Assignment 4.1: International System of Units (SI) and Capacity

B

5. A building is 180 feet high.

a. What metric unit would most likely be used to express its height? meters

b. How high is it in metric units? 54.9 m 1 foot = 0.305 meters × 180 = 54.9 m

6. Iona Valdez plans to build a house on a lot 80 feet wide and 120 feet deep.

a. How many meters wide is the lot? 24.4 m 80 feet × 0.305 = 24.4 m

b. How many meters deep is the lot? 36.6 m 120 feet × 0.305 = 36.6 m

7. If you were to change the highway speed limit signs from miles to kilometers, how would the following read? (Round to nearest km/h)

a. 55 miles per hour: 88 km/h 1.609 × 55 = 88.495 or 88 km/h

b. 35 miles per hour: 56 km/h 1.609 × 35 = 56.315 or 56 km/h

8. The height of a basketball player is 183 cm. How tall is this in feet? 6 feet

1 m = 3.281 feet 1 cm = 3.281 × 0.01 = 0.03281 feet 0.03281 × 183 = 6.004

or

1 cm = 3.281 × 0.01 = 0.033 0.033 × 183 = 6.04

Assignment 4.1: International System of Units (SI) and Capacity

C

10. The liter is the basic unit of the measure of capacity and volume. Provide the missing information:

a. 0.01 liter = 1 cL

b. 10 kiloliters = 1 000 daL

c. 12 liters = 12 000 mL

d. 750 milliliters = 0.75 L

e. 42 hectoliters = 4.2 kL

11. Which measure probably would be used to express the capacity of the following:

	Metric Name and Symbol
a. Large water tank	kiloliter (kL)
b. Quart of orange juice	liter (L)
c. Teaspoon of medicine	milliliter (mL)
d. Gallon of gasoline	liter (L)
e. Swimming pool	kiloliter (kL)

12. Convert the following capacities to the equivalents of metric or traditional units:

a. 7 gallons = 26.495 liters

$7 \times 3.785 = 26.495$ L

b. 6 liters = 12.678 pints

$6 \times 2.113 = 12.678$ pints

c. 32 ounces = 946.336 milliliters

$32 \times 29.573 = 946.336$ mL

d. $2\frac{1}{2}$ cups = 0.5925 liters

$0.237 \times 2.5 = 0.5925$ L

e. 12 liters = 12.684 quarts

$12 \times 1.057 = 12.684$ quarts

Assignment 4.2: International System of Units (SI) Measurement of Capacity and Weight

A **Round final answer to two decimal places.**

1. What will be the price of 3 784 mL of milk that sells for $1.19 per quart? $4.76

   29.573 mL per ounce 29.573 × 32 (ounces per quart) = 946 mL per qt.
   3 784 mL ÷ 946 mL = 4 quarts 4 × $1.19 = $4.76

2. Mike Mackie used 105 liters of gasoline when he drove from Chicago to New York, a distance of 1 210 kilometers.

   a. What was the average number of kilometers per liter? 11.52 km per liter 1 210 km ÷ 105 L = 11.52 km per L

   b. What was the average number of miles per gallon? 27.11 miles per gallon

      1 km = 0.621 miles × 1 210 = 751.41 miles 1 L = 0.264 gal. × 105 = 27.72 gallons
      751.41 ÷ 27.72 = 27.11 miles per gallon

3. If an automatic dishwasher used 9 gallons of water, what is the equivalent number of liters?

   34.065 L 9 gallons × 3.785 = 34.065 L

Assignment 4.2: International System of Units (SI) Measurement of Capacity and Weight

A **Round final answer to two decimal places. (cont'd)**

4. The labels on many food products state the volume in both ounces and liters.

a. How many milliliters are in a 12-ounce can of tomato juice? 354.88 (or 355) mL

29.573 × 12 = 354.88 (or 355) mL

b. What is the volume in liters of 1 quart, 14 ounces of grapefruit juice? 1.36 L

1 qt. = 0.946 L 1 oz. = 29.573 mL or 0.029573 L 14 oz. × 0.029573 = 0.414022 L

0.946 L + 0.414022 L = 1.360022 L or 1.36 L

or

14 × 0.03 = 0.42 0.946 L + 0.42 L = 1.366 or 1.36

5. A carton containing 1 liter of milk sells for 62¢, while a carton containing 5 deciliters is priced at 37¢. How much is saved by buying a carton containing 1 liter rather than two cartons containing 5 deciliters each?

12¢ One 1-L carton costs 62¢ One 5-dL carton costs 37¢; Two 5-dL cartons cost 74¢ 74¢ − 62¢ = 12¢ saving

Assignment 4.2: International System of Units (SI) Measurement of Capacity and Weight

B **Round final answer to two decimal places. (cont'd)**

6. The kilogram is considered the basic unit of the measurement of weight (mass). Provide the missing information: (*1 point each*)

a. 1 gram = 0.001 kg

b. 150 kilograms = 15 000 dag

c. 300 milligrams = 3 dg

d. 26 hectograms = 2 600 g

e. 280 centigrams = 2.8 g

7. Which measure probably would be used to express the weight of the following: (*2 points each*)

	Metric Name and Symbol
a. A student's weight	kilogram (kg)
b. A can of pepper	gram (g)
c. A truckload of iron	metric ton (t)
d. A turkey	kilogram (kg)
e. One aspirin tablet	milligram (mg)

8. Convert the following weights to the equivalent metric or traditional units: (*2 points each*)

a. 482 grams of beans = 16.87 ounces $482 \times 0.035 = 16.87$ ounces

b. 12,125 pounds of coal = 5.5 metric tons $12{,}125 \div 2{,}204.623 = 5.4998$ or 5.5 t

c. 5 kilograms of meat = 11.025 pounds $2.205 \times 5 = 11.025$ pounds

d. 5 ounces of soap = 141.745 grams $5 \times 28.349 = 141.745$ g

e. 0.500 milligrams of medicine = 0.0075 grain $0.500 \times 0.015 = 0.0075$ grain

Assignment 4.2: International System of Units (SI) Measurement of Capacity and Weight

C **Round final answer to two decimal places. (cont'd)**

9. A five-pound bag of sugar sells for $1.66. A 16-ounce box sells for 53¢. What is the cost per kilogram for the large bag and the small box?

Large bag: $0.73 per kg

Small box: $1.17 per kg 16 ounces = 1 pound = 0.453 kg 5 lbs. × 0.453 = 2.265 kg

$1.66 ÷ 2.265 = $0.73289 or $0.73 $0.53 ÷ 0.453 = $1.16998 or $1.17

10. It costs $0.46 for the first ounce (or fraction thereof) and $0.40 for each additional ounce (or fraction thereof) to mail a letter in the United States. How much will the postage be on a letter weighing 80 grams? $1.25 1 gram = 0.035 ounce 80 g × 0.035 = 2.8 or 3 ounces $0.46 (1st oz.) + 80¢ (2 oz.) = $1.26

11. A canning factory packs corn in a small size can weighing $8\frac{3}{4}$ ounces. The cans are packed 48 cans to a carton. What is the metric weight of the carton? 11 906 g or 11.906 kg

$8\frac{3}{4}$ × 28.349 (g per oz.) = 248.05 g per can 248.05 g × 48 = 11 906 grams or 11.906 kg

Assignment 4.2: International System of Units (SI) Measurement of Capacity and Weight

C **Round final answer to two decimal places. (cont'd)**

12. What would be the weight in grams of the following items:

a. $2\frac{1}{2}$ pounds of coffee = 1 134 grams 1 pound = 453.592 grams 2.5 lbs. × 453.592 = 1,133.98 g or 1 134 g

b. 5 pounds, 8 ounces of dog biscuits = 2 495 grams

5 lbs. × 453.592 = 2 267.96 g 8 oz. × 28.349 = 226.792 g

2 267.96 + 226.792 = 2 494.752 g or 2 495 g Alternate: 5.5 lb. × 453.592 = 2 494.756 g

c. $5\frac{1}{4}$ ounces of cookies = 149 grams 1 oz. = 28.349 g 5.25 ounces × 28.349 = 148.8323 or 149 g

13. What metric measure would you use to express the following:

a. The amount of water necessary to fill a 2-gallon bucket liter

b. The weight of a football player kilogram

c. A can of corn gram

d. A 2-ounce bottle of cologne milliliter

e. A small candy bar gram