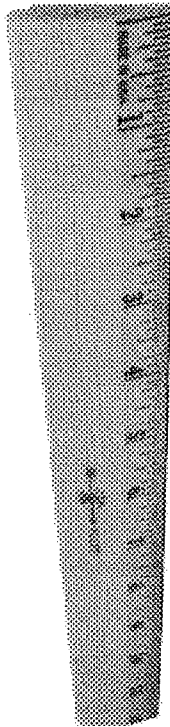


Measurement and Conversion



Objectives:

- 1)** Differentiate between US units of measurement and Metric units of measurement
- 2)** Convert from 1 measurement to another within the same system (simple conversions only)
- 3)** Convert from 1 measurement to another from US to metric; metric to US (simple conversions only)
- 4)** Know different categories of measurement (length, weight, and capacity/volume).

Instructor's supplemental notes for measurement and conversions. This topic can be taught with problem solving (Proportions). The instructor can provide a copy of this handout to students.

US and the Metric Systems: The US system is used primarily in the United States while the metric system is used world-wide. The conversion in the US system has no patterns while the metric system is based on the powers of tens.

In both systems, we can measure length (distance), weight (how heavy something is) and capacity/volume. Both systems have units for all types of measurement, but the metric system has a pattern that makes it easier to learn. However, it is important to understand the different types of units and measurements for each categories, how to convert from 1 unit to another within the same system as well as across systems. Simple proportions can be used to convert from 1 unit to another. It is important to have access to conversion facts. They are easy to look up through many different resources in the book, MyMathLab, and on the internet. Some common conversions are provided in this hand-out (This is not all inclusive).

Length (US system):

12 inches (in) = 1 foot (ft).

3 feet (ft) = 1 yard (yd)

5,280 ft = 1 mile

Example problem: Convert 36 inches to feet.

Solution: $\frac{12 \text{ in}}{1 \text{ ft}} = \frac{36 \text{ in}}{x \text{ ft}}$. Use cross multiplication to solve.

$12x = 36$. Divide both sides by 12. $x = 3 \text{ ft}$.

This means that 36 inches = 3 ft.

Example problem: Convert 6,000 ft to miles.

Solution: $\frac{5280 \text{ ft}}{1 \text{ mi}} = \frac{6000 \text{ ft}}{x \text{ mi}}$. Use cross multiplication to solve.

$5280x = 6000$. Divide both sides by 5,280.

$x = 25/22$ or 1.14 miles.

Instructor's supplemental notes for measurement and conversions. This topic can be taught with problem solving (Proportions). The instructor can provide a copy of this handout to students.

Weight (US system):

16 ounces (oz) = 1 pound (lb)

2,000 pounds (lbs) = 1 ton

Example problem: Convert 3 tons to pounds.

Solution: $\frac{1 \text{ ton}}{2000 \text{ lbs}} = \frac{3 \text{ tons}}{x \text{ lbs}}$. Use cross multiplication to solve.

$x = (2000)(3) = 6,000 \text{ lbs}$.

Capacity (US system):

8 fluid ounces (fl. oz) = 1 cup (c)

2 cups (c) = 1 pint (pt)

2 pints (pts) = 1 quart (qt)

4 quart (qts) = 1 gallon (gal)

Example problem: Jeff wants to buy 3 gallons of milk. However, the store only carries quarts of milk. How many quarts must he buy to have 3 gallons of milk?

Solution: $\frac{1 \text{ gal}}{4 \text{ qts}} = \frac{3 \text{ gal}}{x \text{ qts}}$.

Using cross multiplication, $x = 12$ quarts.

Metric system Prefixes: The prefix is a determination of conversion value. The prefix means the same thing for length, weight, or capacity.

Common prefix:

milli- (means 1/1000);

centi- (means 1/100);

kilo- (means 1,000)

Instructor's supplemental notes for measurement and conversions. This topic can be taught with problem solving (Proportions). The instructor can provide a copy of this handout to students.

Length: Meter is the unit of measurement.

$$1000 \text{ mm} = 1 \text{ m}$$

$$100 \text{ cm} = 1 \text{ m}$$

$$1000 \text{ m} = 1 \text{ km}$$

Example problem: Convert 500 cm to meters.

Solution: Simple proportions can still be used.

$$\frac{100 \text{ cm}}{1 \text{ m}} = \frac{500 \text{ cm}}{x \text{ m}}$$

Use cross-multiplication to solve: $x = 5 \text{ m}$.

Weight: Grams is the unit of measurement.

$$1000 \text{ mg} = 1 \text{ g}$$

$$100 \text{ cg} = 1 \text{ g}$$

$$1000 \text{ g} = 1 \text{ kg}$$

Notice the pattern is still the same. km stands for kilometer while kg stands for kilograms. The conversion is the same rate (1000 m = 1 km; 1000 g = 1 kg). This pattern makes the metric system easier to learn and use. However, in the United States, we are more used to the our system since our system is what we learn in school and is used all around. We see speed limits in miles per hour rather than kilometers per hour.

Example problem: Convert 5000 g to kg.

Solution:

$$\frac{1000 \text{ g}}{1 \text{ kg}} = \frac{5000 \text{ g}}{x \text{ kg}}$$

Use cross-multiplication to solve: $x = 5 \text{ kg}$.

Instructor's supplemental notes for measurement and conversions. This topic can be taught with problem solving (Proportions). The instructor can provide a copy of this handout to students.

Capacity: Liters is the unit of measurement.

$$1000 \text{ mL} = 1 \text{ L}$$

$$100 \text{ cL} = 1 \text{ L}$$

$$1000 \text{ L} = 1 \text{ kL}$$

Example problem: Convert 2000 mL to liters.

Solution: Simple proportions can still be used.

$$\frac{1000 \text{ mL}}{1 \text{ L}} = \frac{2000 \text{ mL}}{x \text{ L}}$$

Use cross-multiplication to solve: $x = 2 \text{ L}$.

Conversions between systems:

	US to Metric	Metric to US
Units of length	1 mile \approx 1.61 kilometer 1 yard \approx 0.914 meters 1 foot \approx 0.305 meters 1 inch = 2.54 centimeters	1 kilometer \approx 0.62 miles 1 meter \approx 3.28 feet 1 meter \approx 1.09 yards 1 centimeter \approx 0.394 inch
Units of weight	1 pound \approx 0.454 kilogram 1 ounce = 28.35 grams	1 kilogram \approx 2.2 pounds 1 gram \approx 0.0353 ounce
Units of volume/capacity	1 gallon \approx 3.79 liters 1 quart \approx 0.946 liters	1 liter \approx 0.264 gallon 1 liter \approx 1.06 quarts

Note: This conversion table is from MyMathLab. These conversion rates should be used for MML.

Example problem: The speed limit on Kirkman Road is 50 mph. Convert this to km/h.

Solution: This problem requires the conversion of 50 miles to kilometers.

A simple proportion can be used. The conversion to use is 1 mile \approx 1.61 km.

$$\frac{1 \text{ mi}}{1.61 \text{ km}} = \frac{50 \text{ mi}}{x \text{ km}}; x \approx 80.5 \text{ km} \quad \rightarrow \quad 50 \text{ mph} \approx 80.5 \text{ km/h.}$$

Instructor's supplemental notes for measurement and conversions. This topic can be taught with problem solving (Proportions). The instructor can provide a copy of this handout to students.

Sample Practice problem (MyMathLab):

- 1)** Convert 13 ft to m (*Round to the nearest hundredth*).

- 2)** Convert 17 in to cm (*Round to the nearest hundredth*).

- 3)** Convert 62 mi to km (*Round to the nearest hundredth*).

- 4)** Convert 14.7 cm to in (*Round to the nearest hundredth*).

- 5)** Convert 1400 m to ft (*Round to the nearest hundredth*).

- 6)** Convert 7 km to mi (*Round to 1 decimal place as needed*).

- 7)** Convert 45 L to gal (*Round to 2 decimal places as needed*).

- 8)** Convert 3.4 L to qt (*Round to the nearest hundredth*).

- 9)** A wire that is 14 mm long is how many inches wide? (*Round to the nearest hundredth*).

- 10)** There are 342 g of cereal in a family-size box of raisin bran. The box contains 6 servings. How many ounces is 1 serving? (*Round to 2 decimal places as needed*).

Answer Key:

1) 3.96 m

2) 43.18 cm

3) 99.78 km

4) 5.79 in

5) 4593.18 ft

6) 4.3 mi

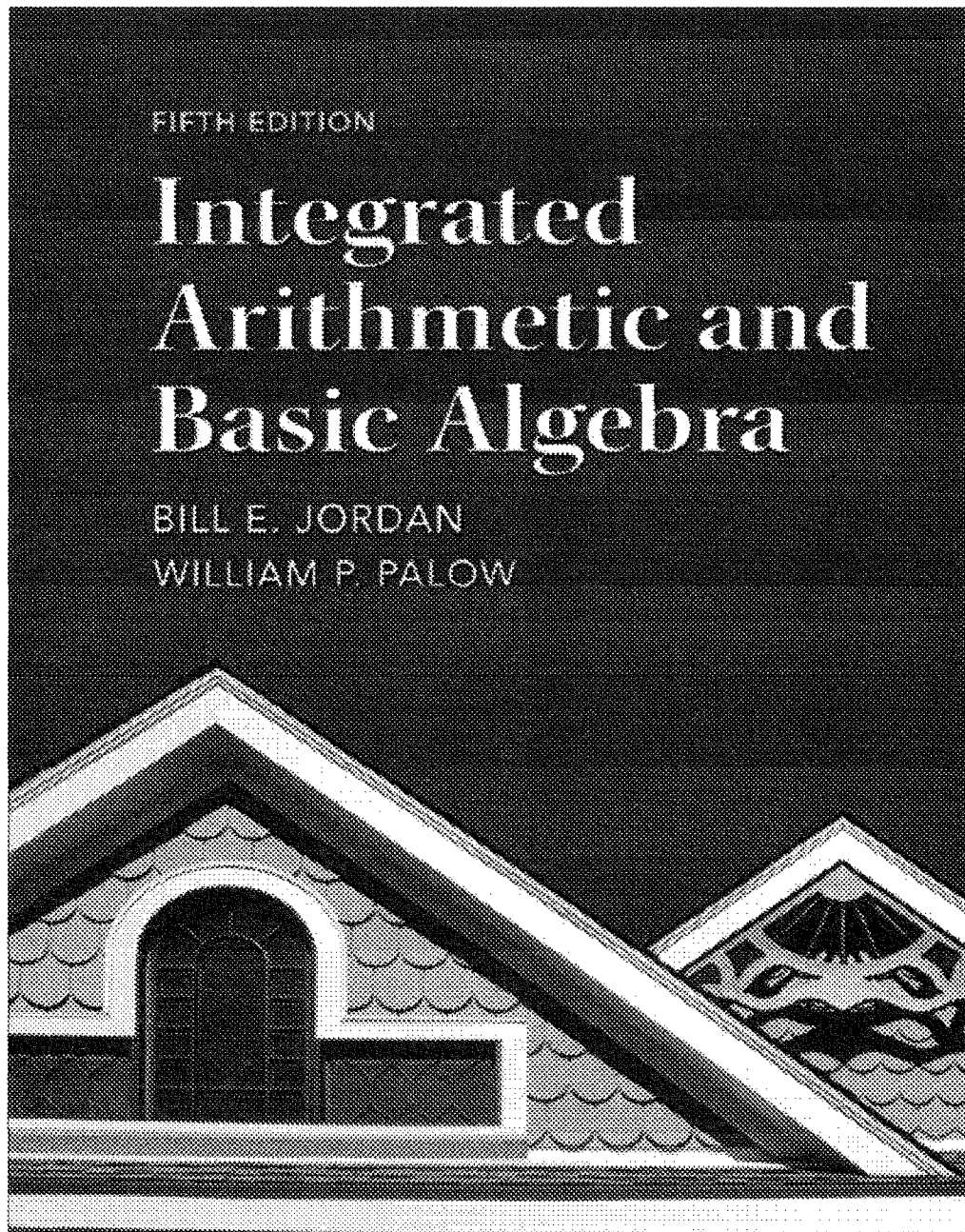
7) 11.89 gal

8) 3.59 qt

9) 0.55 in

10) 2.01 oz (1 serving)

The following is an excerpt from:



Jordan, B.E., Palow, W.P. (2013). *Integrated arithmetic and basic algebra: 5th edition*. CH R: Section R.7
– Linear measurement in the American and Metric System. Pg. 62 – 66. Copyright: Pearson

Section
R.7Linear Measurement in the American
and Metric Systems**OBJECTIVES** When you complete this section, you will be able to:

1. Convert linear units within the American system of measurement.
2. Convert linear units within the metric system of measurement.

PREREQUISITE SKILLS Before beginning this section, you should be able to:

- a. Multiply and divide decimals (Section R.6).
- b. Multiply by fractions whose numerator or denominator is one. (Section R.4).

GETTING READY FOR SECTION R.7

Perform each indicated operation.

1. $2.4 \cdot 12$

2. $6.28 \cdot 100$

3. $5.78 \div 10$

4. $763 \div 100$

Multiply the following:

5. $8 \cdot \frac{12}{1}$

6. $216 \cdot \frac{1}{36}$

7. $10,560 \cdot \frac{1}{5280}$

8. $3.4 \cdot \frac{36}{1}$

OBJECTIVE A Converting linear units within the American system of measurement

In the American system of linear measure, the units are inch, foot, yard, rod, furlong, and mile. The rod and furlong are not often used in everyday situations and will not be discussed here. We often abbreviate the names of the units. We abbreviate inch as "in.," foot as "ft.," yard as "yd.," and mile as "mi.," It is possible to measure the length of an object and get different numerical answers because we used different units. In order to change from one unit of measure to another, we must know the conversion factors. The conversion factors for the American system are given in the following table:

Conversion Factors: American System of Linear Measure

1 ft = 12 in.

1 yd = 3 ft

1 yd = 36 in.

1 mi = 5280 ft

1 mi = 1760 yd

There are several methods for converting from one unit to another. One method used extensively in the sciences and is the method that we will use. It is called the **unit-cancellation, unit analysis, or factor-label method**. When using this method we multiply the expression to be converted by the ratio of the conversion factors which the numerator is the unit into which we wish to convert and the denominator is the unit from which we are converting. For example, if we want to convert a given number of feet to inches, we multiply the given number of feet by the ratio $\frac{12 \text{ in.}}{1 \text{ ft}}$. Then "cancel" the units. The word *cancel* is often used to indicate division, but will not be used so much in this book.

Example 1 Convert the following into the indicated unit:

a. $4 \text{ ft} = \underline{\hspace{2cm}} \text{ in.}$ Multiply 4 ft by the ratio $\frac{12 \text{ in.}}{1 \text{ ft}}$.

$$4 \text{ ft} \cdot \frac{12 \text{ in.}}{1 \text{ ft}} = \text{Divide the ft.}$$

$$4 \text{ ft} \cdot \frac{12 \text{ in.}}{1 \text{ ft}} = 12 \text{ in.} + 1 = 12 \text{ in.}$$

$$4 \cdot 12 \text{ in.} = \text{Multiply.}$$

$$48 \text{ in.} \quad \text{Therefore, } 4 \text{ ft} = 48 \text{ in.}$$

c. $2.4 \text{ mi} = \underline{\hspace{2cm}} \text{ ft}$ Multiply 2.4 mi by $\frac{5280 \text{ ft}}{1 \text{ mi}}$.

$$2.4 \text{ mi} \cdot \frac{5280 \text{ ft}}{1 \text{ mi}} = \text{Divide the mi.}$$

$$2.4 \text{ mi} \cdot \frac{5280 \text{ ft}}{1 \text{ mi}} = 5280 \text{ ft} + 1 = 5280 \text{ ft.}$$

$$2.4 \cdot 5280 \text{ ft} = \text{Multiply.}$$

$$12,672 \text{ ft} \quad \text{Therefore, } 2.4 \text{ mi} = 12,672 \text{ ft.}$$

b. $72 \text{ in.} = \underline{\hspace{2cm}} \text{ yd}$ Multiply 72 in. by $\frac{1 \text{ yd}}{36 \text{ in.}}$.

$$72 \text{ in.} \cdot \frac{1 \text{ yd}}{36 \text{ in.}} = \text{Divide the in.}$$

$$72 \text{ in.} \cdot \frac{1 \text{ yd}}{36 \text{ in.}} = \text{Think of 72 as } \frac{72}{1}.$$

$$\frac{72}{1} \cdot \frac{1 \text{ yd}}{36} = \text{Multiply.}$$

$$\frac{72 \text{ yd}}{36} = \text{Divide 72 by 36.}$$

$$72 \div 36 = 2.$$

$$2 \text{ yd} \quad \text{Therefore, } 72 \text{ in.} = 2 \text{ yd.}$$

PRACTICE EXERCISE 1

Convert each of the following to the indicated unit:

a. $4 \text{ yd} = \underline{\hspace{2cm}} \text{ ft}$

b. $48 \text{ in.} = \underline{\hspace{2cm}} \text{ ft}$

c. $3 \text{ ft} = \underline{\hspace{2cm}} \text{ in.}$

d. $15,840 \text{ ft} = \underline{\hspace{2cm}}$

If you need more practice, do the following Additional Practice Exercises.

Additional Practice Exercise 1 Convert each of the following to the indicated unit:

a. $180 \text{ in.} = \underline{\hspace{2cm}} \text{ yd}$

b. $2 \text{ yd} = \underline{\hspace{2cm}} \text{ ft}$

c. $1.2 \text{ mi} = \underline{\hspace{2cm}} \text{ ft}$

d. $36 \text{ ft} = \underline{\hspace{2cm}} \text{ yd}$

OBJECTIVE B Converting linear units within the metric system of measurement

One of the greatest advantages of the metric system is that conversions from one unit of measure to another are accomplished by powers of 10. When multiplying or dividing by a power of 10, we simply move the decimal point the appropriate number of places. Study the following for a pattern that gives the number of places the decimal point is moved when multiplying or dividing by a power of 10:

Example 2 Find the following products:

a. $2.763 \times 100 = 276.3$ Decimal point moved right two places.

$43.91 \times 1000 = 43,910$ Decimal point moved right three places.

$0.0062 \times 10 = 0.062$ Decimal point moved right one place.

$0.000123 \times 10,000 = 1.23$ Decimal point moved right four places.

b. $467.91 \div 10 = 46.791$ Decimal point moved left one place.

$5.78 \div 1000 = 0.00578$ Decimal point moved left three places.

$0.0142 \div 100 = 0.000142$ Decimal point moved left two places.

$100.02 \div 10,000 = 0.010002$ Decimal point moved left four places.

Based on the preceding example, we make the following observations:

Multiplication and Division by Powers of 10

- a. When multiplying by a power of 10, move the decimal point to the right the same number of places as there are zeroes in the power of 10.
- b. When dividing by a power of 10, move the decimal point to the left the same number of places as there are zeroes in the power of 10.

The basic unit of linear measure in the metric system is the meter, which is abbreviated as "m." The basic unit is then prefixed by one of the following, which tell how many meters or what part of a meter the unit is measuring:

Partial List of Metric Prefixes

- | | |
|--------------------------------------|---|
| kilo- (k) = 1000 units | |
| hecto- (h) = 100 units | centi- (c) = $\frac{1}{100}$ of a unit |
| deca- (dk or da) = 10 units | |
| deci- (d) = $\frac{1}{10}$ of a unit | milli- (m) = $\frac{1}{1000}$ of a unit |

Consequently, "km" means kilometer and equals 1000 meters, "dm" means decimeter and equals $\frac{1}{10}$ of a meter, and "mm" means millimeter and equals $\frac{1}{1000}$ of a meter. The most commonly used units are the kilometer, which is used in the way the mile is used in the American system; the meter, which is used in the way feet or yards are used in the American system; and the centimeter and millimeter, which are used in the way the inch is used in the American system.

Conversions within the metric system can be done by the factor-label method, but there is a much easier way. Since the metric system is based on powers of 10, and multiplying or dividing by powers of 10 simply moves the decimal point, all we have to do is determine how many places and in which direction to move the decimal point. One way of doing this is to use the accompanying diagram. The units on the line correspond to place values in our base-10 number system.



Using the preceding diagram, we convert within the metric system as follows.

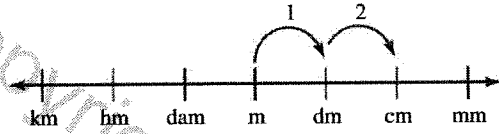
Procedure: Converting Within the Metric System

1. Locate the unit given and count the number of places, left or right, to the unit into which you are converting.
2. Move the decimal point the number of place values and in the same direction as found in step 1.

Example 3 Convert each of the following into the indicated unit:

a. $3.6 \text{ m} = \underline{\hspace{2cm}} \text{ cm}$

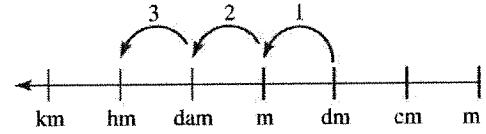
Solution



Since cm is two units to the right of m, move the decimal point two places to the right. Therefore, $3.6 \text{ m} = 360 \text{ cm}$.

b. $7354 \text{ dm} = \underline{\hspace{2cm}} \text{ hm}$

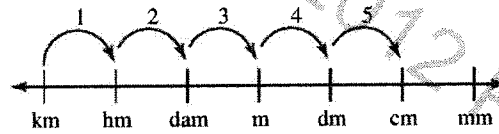
Solution



Since hm is three units to the left of dm, move the decimal places to the left. Therefore, $7354 \text{ dm} = 7.354 \text{ hm}$.

c. $0.0178 \text{ km} = \underline{\hspace{2cm}} \text{ cm}$

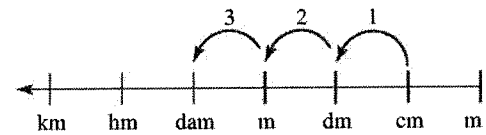
Solution



Since cm is five units to the right of km, move the decimal point five places to the right. Therefore, $0.0178 \text{ km} = 1780 \text{ cm}$. Note: It was necessary to write a 0 after the 8 in order to be able to move the decimal point five places.

d. $9.3 \text{ cm} = \underline{\hspace{2cm}} \text{ dam}$

Solution



Since dam is three units to the left of cm, move the decimal three places to the left. Therefore, $9.3 \text{ cm} = 0.0093 \text{ dam}$. Note: It was necessary to write two 0s before the 9 in order to be able to move the decimal point three places.

PRACTICE EXERCISE 3

Convert each of the following to the indicated unit:

a. $76.323 \text{ dam} = \underline{\hspace{2cm}} \text{ dm}$

b. $5824 \text{ m} = \underline{\hspace{2cm}} \text{ hm}$

c. $2.45 \text{ km} = \underline{\hspace{2cm}} \text{ dm}$

d. $2.9 \text{ cm} = \underline{\hspace{2cm}} \text{ dam}$

If you need more practice, do the following Additional Practice Exercises.

Additional Practice Exercise 3 Convert each of the following to the indicated unit:

a. $4.478 \text{ hm} = \underline{\hspace{2cm}} \text{ m}$

b. $8345 \text{ dm} = \underline{\hspace{2cm}} \text{ km}$

c. $6.2 \text{ hm} = \underline{\hspace{2cm}} \text{ dm}$

d. $0.063 \text{ cm} = \underline{\hspace{2cm}} \text{ dm}$

For Extra Help

Exercise Set R.7 MyMathLab®

Convert the following to the indicated unit. (See Example 1.)

1. $2 \text{ ft} = \underline{\hspace{2cm}} \text{ in.}$

2. $36 \text{ in.} = \underline{\hspace{2cm}} \text{ ft}$

3. $9 \text{ ft} = \underline{\hspace{2cm}} \text{ yd}$

4. $4 \text{ yd} = \underline{\hspace{2cm}}$

5. $5 \text{ mi} = \underline{\hspace{2cm}} \text{ ft}$

6. $15,840 \text{ ft} = \underline{\hspace{2cm}} \text{ mi}$

7. $2 \text{ mi} = \underline{\hspace{2cm}} \text{ yd}$

8. $3520 \text{ yd} = \underline{\hspace{2cm}}$

9. 60 in. = _____ ft 10. 8 ft = _____ in. 11. 24 ft = _____ yd 12. 15 yd = _____ ft
 13. 288 in. = _____ yd 14. 4.5 yd = _____ in. 15. 255 yd = _____ ft 16. 324 in. = _____ yd
 17. 5.25 mi = _____ yd 18. 2.5 yd = _____ in. 19. 31,680 ft = _____ mi 20. 7040 yd = _____ mi

Convert the following to the indicated unit. (See Example 3.)

21. 3 hm = _____ m 22. 500 m = _____ hm 23. 400 mm = _____ dm 24. 15 dm = _____ m
 25. 8 dam = _____ cm 26. 12,000 cm = _____ dam 27. 1.4 km = _____ m 28. 500 m = _____ km
 29. .7 m = _____ mm 30. 80 mm = _____ m 31. 458 dm = _____ dam 32. 56 dam = _____ km
 33. 10,000 m = _____ km 34. 7.89 km = _____ m 35. 8.4 dm = _____ m 36. 6.97 hm = _____ km
 37. .009 km = _____ m 38. 8.3 m = _____ mm 39. 16.2 dm = _____ hm 40. .005 m = _____ km

Challenge Exercises (41–48)

Convert the following to the indicated unit. (See Examples 1 and 3.)

41. 540 in. = _____ yd 42. 243 yd = _____ in. 43. 6.7 mi = _____ ft
 44. 18.75 yd = _____ in. 45. 5280 mm = _____ km 46. .0046 hm = _____ cm
 47. .0000001 m = _____ mm 48. 8903 km = _____ dm

Writing Exercises (49–51)

49. List the conversion factors in the American system for measuring weight. 50. List the conversion factors in the American system for measuring dry volume.
 51. List the conversion factors in the American system for measuring liquid volume.