

7.2

Metric Units of Length

7.2 OBJECTIVES

1. Know the meaning of metric prefixes
2. Estimate metric units of length
3. Convert metric units of length

In Section 7.1 we studied the English system of measurement, which is used in the United States and a few other countries. Our work will now concentrate on the **metric system**, used throughout the rest of the world.

The metric system is based on one unit of length, the **meter (m)**. In the eighteenth century the meter was defined to be one ten-millionth of the distance from the north pole to the equator. Today the meter is scientifically defined in terms of a wavelength in the spectrum of krypton-86 gas.

One big advantage of the metric system is that you can convert from one unit to another by simply multiplying or dividing by powers of 10. This advantage and the need for uniformity throughout the world have led to legislation that will promote the use of the metric system in the United States.

Let's see how the metric system works. We will start with measures of length and compare a basic English unit, the yard, with the meter.

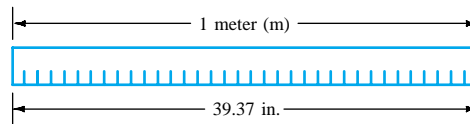
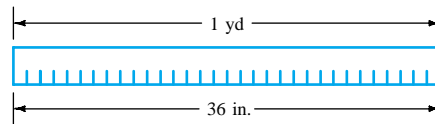
NOTE Even in the United States, the metric system is used in science, medicine, the automotive industry, the food industry, and many other areas.

NOTE The basic unit of length in the metric system is also spelled *metre* (the British spelling).

NOTE In the metric system, you don't have to worry about things like 12 in. to 1 foot, 5280 ft to 1 mile, and all that.

NOTE The meter is one of the basic units of the International System of Units (abbreviated SI). This is a standardization of the metric system agreed to by scientists in 1960.

NOTE There is a standard pattern of abbreviation in the metric system. We will introduce the abbreviation for each term as we go along. The abbreviation for meter is m (no period!).



As you can see, the meter is just slightly longer than the yard. It is used for measuring the same things you might measure in feet or yards. Look at Example 1 to get a feel for the size of the meter.

Example 1

Estimating Metric Length

A room might be 6 meters (6 m) long.

A building lot could be 30 m wide.

A fence is 2 m tall.



CHECK YOURSELF 1

Try to estimate the following lengths in meters.

- (a) A traffic lane is _____ m wide.
- (b) A small car is _____ m long.
- (c) You are _____ m tall.

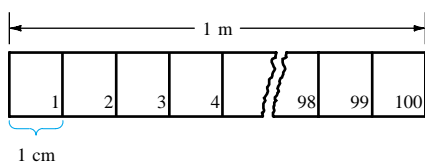
For other units of length, the meter is multiplied or divided by powers of 10. One commonly used unit is the **centimeter (cm)**.

Definitions: Comparing Centimeters (cm) to Meters (m)

$$1 \text{ centimeter (cm)} = \frac{1}{100} \text{ meter (m)}$$

NOTE The prefix “centi” means one hundredth. This should be no surprise. What is our cent? It is one hundredth of a dollar.

The drawing below relates the centimeter and the meter:



There are 100 cm in 1 m.

Just to give you an idea of the size of the centimeter, it is about the width of your little finger. There are about $2\frac{1}{2}$ cm to 1 in., and the unit is used to measure small objects. Look at Example 2 to get a feel for the length of a centimeter.

Example 2

Estimating Metric Length

A small paperback book is 10 cm wide.

A playing card is 8 cm long.

A ballpoint pen is 16 cm long.



CHECK YOURSELF 2

Try to estimate each of the following. Then use a metric ruler to check your guess.

- (a) This page is _____ cm long.
- (b) A dollar bill is _____ cm long.
- (c) The seat of the chair you are on is _____ cm from the floor.

To measure *very* small things, the **millimeter (mm)** is used. To give you an idea of its size, the millimeter is about the thickness of a new dime.

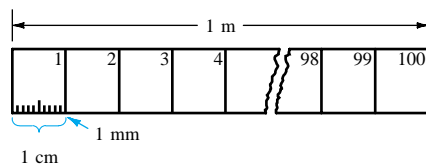
Definitions: Comparing Millimeters (mm) to Meters (m)

$$1 \text{ millimeter (mm)} = \frac{1}{1000} \text{ m}$$

NOTE The prefix “milli” means one thousandth.

The diagram below will help you see the relationships of the three units we have looked at.

NOTE Notice that there are 10 mm to 1 cm.



To get used to the millimeter, consider Example 3.

Example 3

Estimating Metric Length

Standard camera film is 35 mm wide.

A small paper clip is 5 mm wide.

Some cigarettes are 100 mm long.



CHECK YOURSELF 3

Try to estimate each of the following. Then use a metric ruler to check your guess.

- (a) Your pencil is _____ mm wide.
- (b) The tabletop you are working on is _____ mm thick.

The **kilometer (km)** is used to measure long distances. The kilometer is about six-tenths of a mile.

Definitions: Comparing Kilometers (km) to Meters (m)

1 kilometer (km) = 1000 m

NOTE The prefix “kilo” means 1000. You are already familiar with this. For instance, 1 kilowatt (kW) = 1000 watts (W).

Example 4 shows how to get used to the kilometer.

Estimating Metric Length

The distance from New York to Boston is 325 km.

A popular distance for road races is 10 km.

Now that you have seen the four commonly used units of length in the metric system, you can review with the following Check Yourself exercise.

**CHECK YOURSELF 4**

Choose the most reasonable measure in each of the following statements.

- (a) The width of a doorway: 50 mm, 1 m, or 50 cm.
- (b) The length of your pencil: 20 m, 20 mm, or 20 cm.
- (c) The distance from your house to school: 500 km, 5 km, or 50 m.
- (d) The height of a basketball center: 2.2 m, 22 m, or 22 cm.
- (e) The width of a matchbook: 30 cm, 30 mm, or 3 mm.

NOTE Of course, this is easy. All we need to do is move the decimal point to the right or left the required number of places. Again, that's the big advantage of the metric system.

As we said earlier, to convert units of measure within the metric system, all we have to do is multiply or divide by the appropriate power of 10.

Definitions: Converting Metric Measurements to Smaller Units

To convert to a *smaller* unit of measure, we *multiply* by a power of 10, moving the decimal point *to the right*.

NOTE The *smaller* the unit, the *more* units it takes, so *multiply*.

Example 5**Converting Metric Length**

5.2 m = 520 cm	Multiply by 100 to convert from meters to centimeters.
8 km = 8000 m	Multiply by 1000.
6.5 m = 6500 mm	Multiply by 1000.
2.5 cm = 25 mm	Multiply by 10.

**CHECK YOURSELF 5**

Complete the following. Remember, you don't need to do any calculation. Just move the decimal point the appropriate number of places, and write the answer.

- (a) 3 km = _____ m
- (b) 4.5 m = _____ cm
- (c) 1.2 m = _____ mm
- (d) 6.5 cm = _____ mm

Definitions: Converting Metric Measurements to Larger Units

To convert to a *larger* unit of measure, we *divide* by a power of 10, moving the decimal point *to the left*.

NOTE The *larger* the unit, the *fewer* units it takes, so *divide*.

Example 6**Converting Metric Length**

43 mm = 4.3 cm Divide by 10.

3000 m = 3 km Divide by 1000.

450 cm = 4.5 m Divide by 100.

**CHECK YOURSELF 6**

Complete the following statements.

(a) 750 cm = _____ m

(b) 5000 m = _____ km

(c) 78 mm = _____ cm

(d) 3500 mm = _____ m

We have introduced all the commonly used units of linear measure in the metric system. There are other prefixes that can be used to form other linear measures. The prefix “deci” means $\frac{1}{10}$, “deka” means times 10, and “hecto” means times 100. Their use is illustrated in the following table.

Definitions: Using Metric Prefixes

1 millimeter (mm) = $\frac{1}{1000}$ m

1 centimeter (cm) = $\frac{1}{100}$ m

1 decimeter (dm) = $\frac{1}{10}$ m

1 meter (m)

1 dekameter (dam) = 10 m

1 hectometer (hm) = 100 m

1 kilometer (km) = 1000 m

You may find the following chart helpful when converting between metric units.

To convert to larger units move the decimal point to the left.

mm	cm	dm	m	dam	hm	km
0.001 m	0.01 m	0.1 m	1 m	10 m	100 m	1000 m

To convert to smaller units move the decimal point to the right.

To convert between metric units, just move the decimal point to the left or right the number of places indicated by the chart.

Example 7**Converting Between Metric Lengths**

(a) $800 \text{ cm} = ? \text{ m}$

To convert from centimeters to meters, you can see from the chart that you must move the decimal point *two places to the left*.

$800 \text{ cm} = 8.00 \text{ m} = 8 \text{ m}$

(b) $500 \text{ m} = ? \text{ km}$

To convert from meters to kilometers, move the decimal point *three places to the left*.

$500 \text{ m} = .500 \text{ km} = 0.5 \text{ km}$

(c) $6 \text{ m} = ? \text{ mm}$

To convert from meters to millimeters, move the decimal point *three places to the right*.

$6 \text{ m} = 6000. \text{ mm}$

**CHECK YOURSELF 7**

Complete each statement.

(a) $300 \text{ cm} = \underline{\hspace{2cm}} \text{ m}$

(b) $370 \text{ mm} = \underline{\hspace{2cm}} \text{ m}$

(c) $4500 \text{ m} = \underline{\hspace{2cm}} \text{ km}$

CHECK YOURSELF ANSWERS

- (a)** About 3 m; **(b)** perhaps 5 m; **(c)** You are probably between 1.5 and 2 m tall.
- (a)** About 28 cm; **(b)** almost 16 cm; **(c)** about 45 cm
- (a)** About 8 mm; **(b)** probably between 25 and 30 mm
- (a)** 1 m; **(b)** 20 cm; **(c)** 5 km; **(d)** 2.2 m; **(e)** 30 mm
- (a)** 3000 m; **(b)** 450 cm; **(c)** 1200 mm; **(d)** 65 mm
- (a)** 7.5 m; **(b)** 5 km; **(c)** 7.8 cm; **(d)** 3.5 m **7.** **(a)** 3 m; **(b)** 0.37 m; **(c)** 4.5 km



Exercises

Name _____

Section _____ Date _____

Choose the most reasonable measure.

1. The height of a ceiling
 - (a) 25 m
 - (b) 2.5 m
 - (c) 25 cm
2. The diameter of a quarter
 - (a) 24 mm
 - (b) 2.4 mm
 - (c) 24 cm
3. The height of a kitchen counter
 - (a) 9 m
 - (b) 9 cm
 - (c) 90 cm
4. The diagonal measure of a television screen
 - (a) 50 mm
 - (b) 50 cm
 - (c) 5 m
5. The height of a two-story building
 - (a) 7 m
 - (b) 70 m
 - (c) 70 cm
6. An hour's drive on a freeway
 - (a) 9 km
 - (b) 90 m
 - (c) 90 km
7. The width of a roll of cellophane tape
 - (a) 1.27 mm
 - (b) 12.7 mm
 - (c) 12.7 cm
8. The width of a sheet of typing paper
 - (a) 21.6 cm
 - (b) 21.6 mm
 - (c) 2.16 cm
9. The thickness of window glass
 - (a) 5 mm
 - (b) 5 cm
 - (c) 50 mm
10. The height of a refrigerator
 - (a) 16 m
 - (b) 16 cm
 - (c) 160 cm
11. The length of a ballpoint pen
 - (a) 16 mm
 - (b) 16 m
 - (c) 16 cm
12. The width of a hand-held calculator key
 - (a) 1.2 mm
 - (b) 12 mm
 - (c) 12 cm

Complete each statement, using a metric unit of length.

13. A playing card is 6 _____ wide.
14. The diameter of a penny is 19 _____.

ANSWERS

1. _____
2. _____
3. _____
4. _____
5. _____
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7. _____
8. _____
9. _____
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12. _____
13. _____
14. _____

ANSWERS

15. _____
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17. _____
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32. _____
33. _____
34. _____
35. _____
36. _____
37. _____
38. _____
39. _____
40. _____

15. A doorway is 2 _____ high.

16. A table knife is 22 _____ long.

17. A basketball court is 28 _____ long.

18. A commercial jet flies 800 _____ per hour.

19. The width of a nail file is 12 _____ .

20. The distance from New York to Washington, D.C., is 360 _____ .

21. A recreation room is 6 _____ long.

22. A ruler is 22 _____ wide.

23. A long-distance run is 35 _____ .

24. A paperback book is 11 _____ wide.

Complete each statement.

25. 3000 mm = _____ m

26. 150 cm = _____ m

27. 8 m = _____ cm

28. 77 mm = _____ cm

29. 250 km = _____ cm

30. 500 cm = _____ m

31. 25 cm = _____ mm

32. 150 mm = _____ m

33. 7000 m = _____ km

34. 9 m = _____ cm

35. 8 cm = _____ mm

36. 45 cm = _____ mm

37. 5 km = _____ m

38. 4000 m = _____ km

39. 5 m = _____ mm

40. 7 km = _____ m

Use a metric ruler to measure the necessary dimensions, and complete the statements.

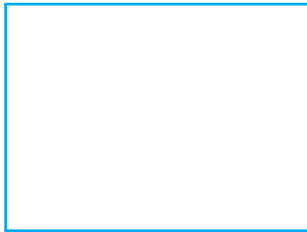
41. The perimeter of the parallelogram is _____ cm.



42. The perimeter of the triangle is _____ mm.

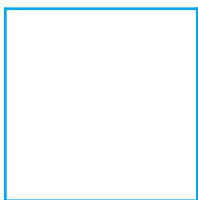


43. The perimeter of the rectangle below is _____ cm.



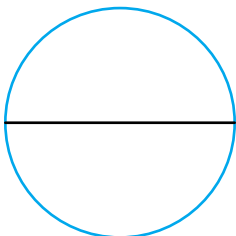
44. Its area is _____ cm^2 .

45. The perimeter of the square below is _____ mm.



46. The area of the square in exercise 45 is _____ mm^2 .

47. The circumference of the circle below is _____ mm.



41. _____

42. _____

43. _____

44. _____

45. _____

46. _____

47. _____

ANSWERS

48.



49.



50.

48. The area of the circle in exercise 47 is _____ mm^2 .

49. (a) Determine the world record speed for both men and women in meters per second (m/s) for the following events: 100-, 400-, 1500-, and 5000-m run. The record times can be found at <http://planet100.com/trak.htm>

(b) Rank all the speeds obtained in order from fastest to slowest.



50. What units in the metric system would you use to measure each of the following quantities?



(a) Distance from Los Angeles to New York

(b) Your waist measurement

(c) Width of a hair

(d) Your height

Answers

1. (b) 3. (c) 5. (a) 7. (b) 9. (a) 11. (c) 13. cm
15. m 17. m 19. mm 21. m 23. km 25. 3 27. 800
29. 25,000,000 31. 250 33. 7 35. 80 37. 5000 39. 5000
41. 12 43. 14 45. 100 47. 94.2 49.

