Measurement

Understanding Measurement

The **customary system**, or English system of measurement, is used in the United States. Most countries in the rest of the world use the **metric system**. Different types of measurement and common units used in both systems are listed below.

Type of Measurement	Commonly Used Units of Measure	
	Customary System	**Metric System**
Length The distance from one end to the other. Includes height, width, and depth.	inches, feet, yards, miles	millimeters, centimeters, kilometers Meters are the basic unit.
Weight/Mass How heavy something is. In the metric system, the term *mass* is used instead of *weight*.	ounces, pounds, tons	milligrams, centigrams, kilograms Grams are the basic unit.
Capacity The amount of matter something can hold	pints, quarts, gallons, fluid ounces	milliliters, centiliters, kiloliters Liters are the basic unit.
Volume The amount of space something occupies	cubic inches, cubic feet, cubic yards, cubic miles	cubic meters/millimeters, centimeters, kilometers
Area The size of a surface	square inches, square feet, square yards, square miles	square meters/millimeters, centimeters, kilometers
Temperature A measure of heat	degrees Fahrenheit (°F)	degrees Celsius (°C)

PRACTICE

Identify the type of measurement that would be used for the situation. Then circle the units that might be used to measure it. The first one has been done for you.

1.	coffee poured in a restaurant	capacity	pounds	(gallons)	yards
2.	distance between two cities	_____	miles	degrees	pints
3.	size of a lawn	_____	miles	quarts	square feet
4.	amount of gasoline a tank holds	_____	pounds	gallons	degrees
5.	amount of cheese to buy	_____	degrees	quarts	ounces
6.	setting the oven to bake a cake	_____	ounces	degrees	pints
7.	distance a person swims	_____	yards	ounces	square feet
8.	number of boxes that will fit in the closet	_____	cubic feet	degrees	square feet

Choosing an Appropriate Unit of Measure

You would not measure the distance between New York and Florida in inches, nor would you use an eyedropper to fill a swimming pool. The information below relates units of measure with familiar objects. It can help you decide the best unit to use.

Customary Units	Metric Units
Weight pencil ≈ 1 ounce package of hot dogs ≈ 1 pound automobile ≈ about 1 ton	**Mass** sewing needle ≈ 1 milligram paper clip ≈ 1 gram 6 apples ≈ 1 kilogram
Length small paper clip ≈ 1 inch man's foot ≈ 1 foot height of a doorknob ≈ 1 yard	**Length** thickness of a dime ≈ 1 millimeter width of your baby finger ≈ 1 centimeter length of a baseball bat ≈ 1 meter
Capacity coffee cup ≈ 1 cup tall bottle of soda ≈ 1 quart large bottle of milk ≈ 1 gallon	**Capacity** medicine dropper ≈ 1 milliliter tall bottle of soda ≈ 1 liter 5 bathtubs of water ≈ 1 kiloliter

Note: ≈ means *approximately equal to*

PRACTICE

Circle the better unit to measure each one.

1. the mass of a wristwatch
   A grams
   B kilograms

2. the weight of a bicycle
   C ounces
   D pounds

3. the amount of water in a fish tank
   E milliliters
   F liters

4. the height of a tall building
   G feet
   H yards

5. the width of a picture
   A centimeters
   B kilometers

Circle the most reasonable estimate.

6. the weight of a bag of popcorn
   F 6 oz **H** 60 oz
   G 6 lb **J** 60 lb

7. the amount of water to fill a bathtub
   A 1.3 L **C** 13 L
   B 130 L **D** 1,300 L

8. the height of a refrigerator
   F $5\frac{1}{2}$ in. **H** $5\frac{1}{2}$ ft
   G $5\frac{1}{2}$ yd **J** $5\frac{1}{2}$ mi

9. the length of a room
   A 10 mm **C** 10 m
   B 10 cm **D** 10 km

Converting Units Within the Customary System

The same length can be described in different units. For example, a person might say she is 60 inches tall, or she might say she is 5 feet tall. To **convert**, or change, from one unit to another, as from inches to feet, or from cups to pints, you need to know the exchange rate between the units. Common equivalent measures within the customary system are shown below.

Length	Weight	Capacity
12 inches (in.) = 1 foot (ft)	16 ounces (oz) = 1 pound (lb)	8 fluid ounces (fl oz) = 1 cup (c)
3 feet = 1 yard (yd)	2,000 pounds = 1 ton (T)	2 cups = 1 pint (pt)
36 inches = 1 yard		2 pints = 1 quart (qt)
5,280 feet = 1 mile (mi)		4 quarts = 1 gallon (gal)

Time	
60 seconds (sec) = 1 minute (min)	365 days = 1 year (yr)
60 minutes = 1 hour (hr)	4 weeks = 1 month (mo)
24 hours = 1 day (d)	12 months = 1 year
7 days = 1 week (wk)	52 weeks = 1 year

One way to convert units is to use multiplication or division.

- Multiply to convert larger units to smaller units.

Example 2 ft = _____ in.

- Identify the exchange rate. 1 ft = 12 in.
- Multiply each foot by 12. $2 \times 12 = 24$

2 ft = 24 in.

- Divide to convert smaller units to larger units.

Example 14 wks = _____ mo

- Identify the exchange rate. 4 wks = 1 mo
- Divide the number of weeks by 4. $14 \div 4 = 3$ R2

3 R2 represents 3 months and 2 weeks. The remainder can also be written as $\frac{2}{4}$ or $\frac{1}{2}$.

14 wks = 3 months 2 weeks or $3\frac{1}{2}$ months

PRACTICE

Multiply or divide to convert each measurement.

1. 7 T = _____ lb
2. 45 ft = _____ yd
3. 72 in. = _____ ft
4. 8 c = _____ pt
5. 8 oz = _____ lb
6. 240 min = _____ hr
7. 91 d = _____ wk
8. 2 ft = _____ yd
9. 1 wk = _____ hr
10. 12 pt = _____ qt

Another way to convert units is to set up a proportion.

Example 6 yd = _____ ft

- Write a ratio with the exchange rate of yards to feet. $\frac{\text{yd}}{\text{ft}}$ $\frac{1}{3}$
- Write an equal ratio to create a proportion.
  Use the amount you want to convert for the second ratio.
  Let a variable represent the amount you do not know. $\frac{\text{yd}}{\text{ft}}$ $\frac{1}{3} = \frac{6}{n}$
- Find cross products and solve for the missing number. $1 \times n = 3 \times 6$

Since the variable represents feet, the 18 is 18 feet. $n = 18$

6 yd = 18 ft

Sometimes more than one step is needed. For example, to get from gallons to cups, you can first go from gallons to quarts, and then from quarts to cups.

Example 2 gal = _____ c gallons to quarts → quarts to cups

- Set up a proportion. $\frac{\text{gal}}{\text{qt}}$ $\frac{1}{4} = \frac{2}{n}$ $\frac{\text{qt}}{\text{c}}$ $\frac{1}{4} = \frac{8}{n}$
- Cross multiply. $1 \times n = 2 \times 4$, $n = 8$ $1 \times n = 4 \times 8$, $n = 32$
- Solve. 2 gal = 8 qt → 8 qt = 32 c

2 gal = 32 c

PRACTICE

Use a proportion to convert each measurement.

11. 5 yd = _____ ft
12. 3 T = _____ lb
13. 6 in. = _____ ft
14. 36 fl oz = _____ c
15. 4 yd = _____ in.
16. 18 in. = _____ ft
17. 6 hr = _____ sec
18. 245 d = _____ wk
19. 6 lb = _____ oz
20. 1 ft = _____ yd
21. 3 qt = _____ pt
22. 250 lb = _____ T

Converting Units Within the Metric System

The metric system is based on groups of ten. This system is easy to use because it works very much like our decimal system.

In the metric system the basic unit of length is the meter (m), the basic unit of mass is the gram (g), and the basic unit of capacity is the liter (L). Amounts that are greater than or less than a basic unit are identified with prefixes. The same prefixes are used with each type of unit.

- Prefixes for amounts less than the basic unit:
  deci (d) = one tenth of the basic unit
  cent (c) = one one-hundredth of the basic unit
  milli (m) = one one-thousandth of the basic unit

- Prefixes for amounts greater than the basic unit:
  deka (dk) = ten units
  hecto (h) = one hundred units
  kilo (k) = one thousand units

1,000	100	10	1	0.1	0.01	0.001
kilo (k)	hecto (h)	deka (dk)	basic unit	deci (d)	centi (c)	milli (m)
km	hm	dkm	meter (m)	dm	cm	mm
kL	hL	dkL	liter (L)	dL	cL	mL
kg	hg	dkg	gram (g)	dg	cg	mg

Just as in the customary system, to convert units within the metric system you need to know the conversion or exchange rates. For example, 1 kilogram = 1,000 g.

PRACTICE

Write the equivalent for each metric measure.

1. 1 m = _____ cm
2. 1 km = _____ m
3. 100 cg = _____ g
4. 100 cL = _____ L
5. 1 hg = _____ g
6. 1 kL = _____ L
7. 10 cm = _____ dm
8. 1 m = _____ mm
9. 1,000 g = _____ kg

You can use proportions to convert metric units.

Example 85 cg = _____ g

- Set up a ratio using the basic exchange rate.

$$\frac{\text{cg}}{\text{g}} \quad \frac{100}{1}$$

- Write a proportion.
  Use a variable for the amount you need to find.

$$\frac{\text{cg}}{\text{g}} \quad \frac{100}{1} = \frac{85}{n}$$

- Cross multiply.

$$100 \times n = 85$$

- Divide by 100 on both sides of the equal sign.

$$\frac{{}^{1}\cancel{100}n}{\cancel{100}_{1}} = \frac{85}{100}$$

Cancel on the left side.

- Write the fraction as a decimal. Metric units are always written as decimals.

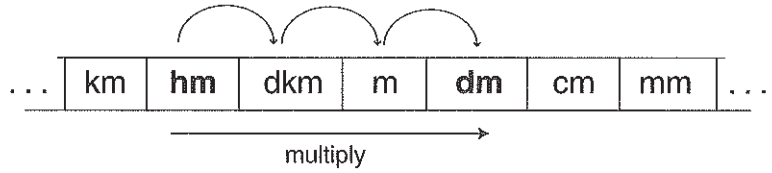
$$\frac{85}{100} = 0.85$$

85 cg = 0.85 g

Another way to convert is to use multiplication or division. A place-value chart can help.

- Multiply to convert larger units to smaller units.

Example 5 hm = _____ dm

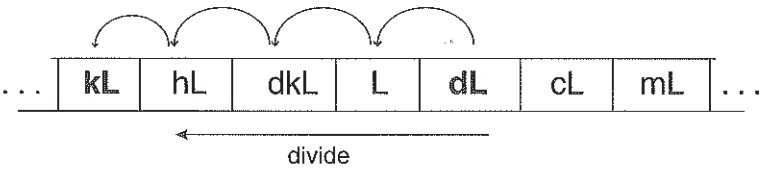


- Find **hecto**meters in the chart. **Deci**meters are three columns to the right. Each column represents a power of 10; 3 columns is 10 × 10 × 10 or 1,000.
- Multiply the number of hectometers by 1,000. 5 × 1,000 = 5,000

5 hm = 5,000 dm

- Divide to convert smaller units to larger units.

Example 14 dL = _____ kL



- Find **deci**liters column in the chart. **Kilo**liters are four columns to the left. Each column represents a power of 10; 4 columns is 10 × 10 × 10 × 10 or 10,000.
- Divide the number of deciliters by 10,000. 14 ÷ 10,000 = 0.0014

Remember that in the metric system, units are always expressed as decimals.

14 dL = 0.0014 kL

PRACTICE

Convert each measurement to the unit indicated.

1. 500 g = _____ mg
2. 1 km = _____ cm
3. 2,000 mL = _____ L
4. 25 cg = _____ mg
5. 37 dL = _____ L
6. 125 hm = _____ m
7. 10 mL = _____ L
8. 4 kg = _____ dkg
9. 30 cm = _____ m
10. 250 dkg = _____ g

Adding and Subtracting Units of Measure

You will often need to convert units to regroup before you can add or subtract. You may also need to convert units to simplify an answer.

When working in the metric system, use the basic conversion rates based on tens.

Example Subtract 37 cm from 5 m.

$$\begin{array}{r} 5\text{ m} \\ -\ 37\text{ cm} \\ \hline \end{array}$$

Think: 1 m = 100 cm

$$\begin{array}{r} {}^{4}\cancel{5}\text{ m } 100\text{ cm} \\ -\ 37\text{ cm} \\ \hline 4\text{ m } 63\text{ cm} \end{array}$$

When working in the customary system, be sure to check the conversion rates. They are different for each type of measurement.

Examples Add 2 ft 8 in. + 3 ft 7 in.

$$\begin{array}{r} 2\text{ ft } 8\text{ in.} \\ +\ 3\text{ ft } 7\text{ in.} \\ \hline 5\text{ ft } 15\text{ in.} \end{array}$$

Think: 12 in. = 1 ft 5 ft 15 in. = 6 ft 3 in.

Think: 3 ft = 1 yd, 6 ft = 2 yd 6 ft 3 in. = 2 yd 3 in.

2 ft 8 in. + 3 ft 7 in. = 2 yd 3 in.

Subtract 1 gal − 3 qts.

$$\begin{array}{r} 1\text{ gal} \\ -\ 3\text{ qt} \\ \hline \end{array}$$

Think: 1 gal = 4 qt

$$\begin{array}{r} {}^{0}\cancel{1\text{ gal}}\ 4\text{ qt} \\ -\ 3\text{ qt} \\ \hline 1\text{ qt} \end{array}$$

1 gal − 3 qt = 1 qt

PRACTICE

Add. Convert to greater units in the answer when possible.

1. $\begin{array}{r} 4\text{ ft } 8\text{ in.} \\ +\ 1\text{ ft } 6\text{ in.} \\ \hline \end{array}$

2. $\begin{array}{r} 2\text{ yd } 1\text{ ft} \\ +\ 4\text{ ft} \\ \hline \end{array}$

3. $\begin{array}{r} 1\text{ lb } 9\text{ oz} \\ +\ 8\text{ oz} \\ \hline \end{array}$

4. $\begin{array}{r} 3\text{ qt } 1\text{ c} \\ +\ 3\text{ c} \\ \hline \end{array}$

5. $\begin{array}{r} 350\text{ mL} \\ +\ 875\text{ mL} \\ \hline \end{array}$

6. $\begin{array}{r} 2\text{ ft } 6\text{ in.} \\ +\ 9\text{ in.} \\ \hline \end{array}$

7. $\begin{array}{r} 4\text{ fl oz} \\ +\ 7\text{ fl oz} \\ \hline \end{array}$

Subtract.

8. $\begin{array}{r} 5\text{ ft } 8\text{ in.} \\ -\ 1\text{ ft } 10\text{ in.} \\ \hline \end{array}$

9. $\begin{array}{r} 3\text{ yd } 2\text{ ft} \\ -\ 1\text{ ft } 5\text{ in.} \\ \hline \end{array}$

10. $\begin{array}{r} 22\text{ cg} \\ -\ 35\text{ mg} \\ \hline \end{array}$

11. $\begin{array}{r} 1\text{ lb } 2\text{ oz} \\ -\ 7\text{ oz} \\ \hline \end{array}$

12. $\begin{array}{r} 2\text{ qt} \\ -\ 1\text{ pt} \\ \hline \end{array}$

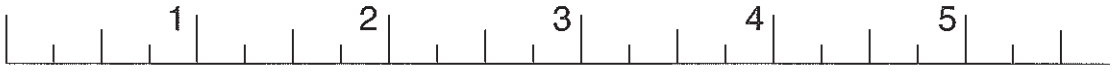
13. $\begin{array}{r} 3\text{ km} \\ -\ 150\text{ m} \\ \hline \end{array}$

14. $\begin{array}{r} 1\text{ yr} \\ -\ 5\text{ mo} \\ \hline \end{array}$

15. $\begin{array}{r} 1\text{ T} \\ -\ 550\text{ lb} \\ \hline \end{array}$

Reading a Scale

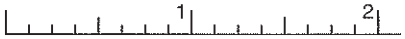
A number line on a measurement tool such as a ruler or thermometer is called a **scale**. The line is divided equally into units that are marked with numbers. Often, the spaces between the units are divided into fractional units with small lines called **tick marks**.



To find the value represented by tick marks, count the number of spaces created between each pair of numbers on the scale. The numbers on the number line above are 1 unit apart. The longer tick marks between the numbers divide the space into two equal parts, so the longer mark represents $\frac{1}{2}$ of a unit. The spaces are also divided into four equal parts with shorter tick marks that represent $\frac{1}{4}$ of a unit. Note that the $\frac{1}{2}$ mark is also the $\frac{2}{4}$ mark.

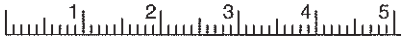
PRACTICE

For Questions 1–4, circle the value of the unit represented by each tick mark between the numbers.

1. 

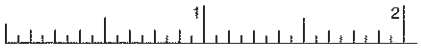
A $\frac{1}{4}$ C $\frac{1}{6}$

B $\frac{1}{8}$ D $\frac{1}{10}$

2. 

F $\frac{1}{8}$ H $\frac{1}{10}$

G $\frac{1}{12}$ J $\frac{1}{16}$

3. 

A $\frac{1}{10}$ C $\frac{1}{12}$

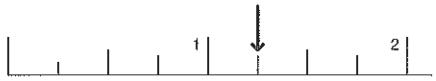
B $\frac{1}{16}$ D $\frac{1}{20}$

4. 

F $\frac{1}{6}$ H $\frac{1}{3}$

G $\frac{1}{2}$ J $\frac{1}{4}$

Circle the value represented by the pointer.

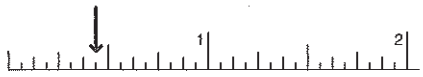
5. 

A 1

B $1\frac{1}{4}$

C $1\frac{1}{2}$

D $1\frac{2}{3}$

6. 

F $\frac{1}{2}$

G $\frac{5}{8}$

H $\frac{3}{4}$

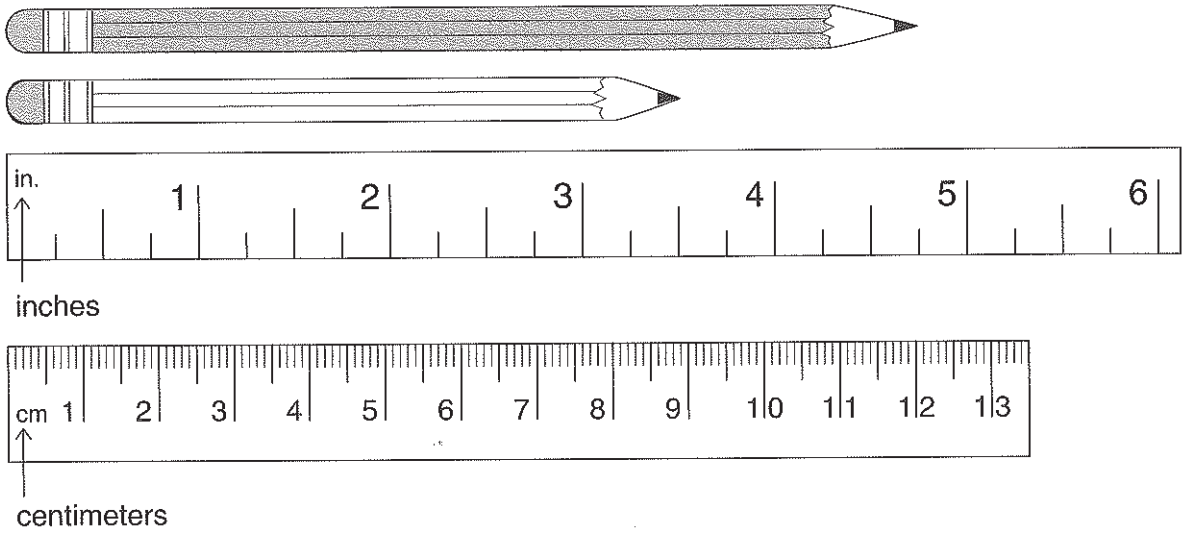
J $\frac{7}{16}$

Using a Ruler

Rulers, meter sticks, yardsticks, and tape measures use scales to measure length.

Inches are used in the customary system. The space between each inch (in.) may be divided into halves, fourths, eighths, or sixteenths. The longest tick marks will be for inches; $\frac{1}{2}$-inch marks are a little shorter, $\frac{1}{4}$-inch marks shorter still, and so on. The inch ruler below has marks that represent inch, $\frac{1}{2}$-inch, and $\frac{1}{4}$-inch units.

Metric rulers use centimeters. The space between each centimeter (cm) is divided into 10 equal spaces. The tick marks between centimeters represents millimeters (mm).



PRACTICE

Use the rulers above to answer each of the following questions.

1. Which represents the greater length?
   A 1 in. **B** 2 cm

2. About how many centimeters are equal to 1 inch?
   F 2 **G** $2\frac{1}{2}$

3. What is the smallest unit of measure shown on the inch ruler above?
   A $\frac{1}{8}$ in. **C** $\frac{1}{4}$ in.
   B $\frac{1}{2}$ in. **D** 1 in.

4. What is the length of the longer pencil?
   F $3\frac{3}{4}$ in. **H** $4\frac{1}{4}$ in.
   G $4\frac{2}{4}$ in. **J** $4\frac{3}{4}$ in.

5. What is the length of the shorter pencil?
   A $3\frac{1}{2}$ cm **C** $4\frac{3}{4}$ cm
   B 9 cm **D** 12 cm

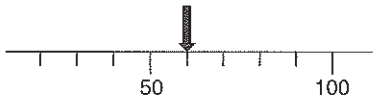
6. Which best describes the difference in length between the two pencils?
   F between $\frac{1}{4}$ inch and $\frac{1}{2}$ inch
   G between $\frac{1}{2}$ inch and 1 inch
   H between 1 inch and $1\frac{1}{2}$ inches
   J between $1\frac{1}{2}$ inches and 2 inches

Reading a Scale That Skips Numbers

Sometimes a scale skips numbers. For example, thermometers and bathroom scales are usually labeled in tens: 10, 20, 30, 40, and so on. On such scales, the tick marks represent whole numbers, not fractions. Follow these steps to figure out what the tick marks represent.

- Find the difference between two neighboring numbers on the scale.
- Count the number of spaces between the two numbers.
- Divide the difference between the numbers by the number of spaces.

Example Find the reading on this scale.

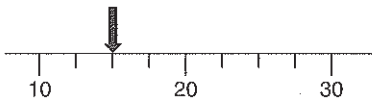


The difference between 50 and 100 is 50.
There are 5 spaces between the numbers.
$50 \div 5 = 10$. Each tick mark represents 10 units.

The reading on the scale is $50 + 10$, or 60 units.

Sometimes you can use judgement to read the scale.

Example Find the reading on this scale.

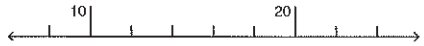


The pointer on the scale is about halfway between 10 and 20.
15 is halfway between 10 and 20.

The reading on this scale is about 15.

PRACTICE

Identify the value represented by each tick mark for Questions 1–4.

1. 

The space between 10 and 20 is divided into 5 equal spaces.
Each tick mark represents _____

2. 

The space between 20 and 40 is divided into 10 equal spaces.
Each tick mark represents _____

3. The space between 60 and 80 is divided into 5 equal spaces.
Each tick mark represents _____

4. The space between 0 and 50 is divided into 5 equal spaces.
Each tick mark represents _____

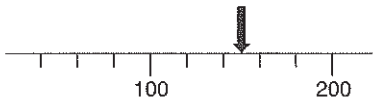
Give the reading described.

5. The pointer is halfway between 20 and 30. _____

6. The pointer is halfway between 50 and 100. _____

7. The pointer is $\frac{1}{4}$ of the way between 0 and 20. _____

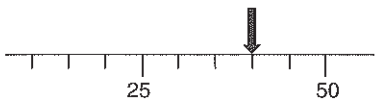
8. The pointer is $\frac{3}{4}$ of the way between 0 and 20. _____

9. 

_____

10. 

_____

11. 

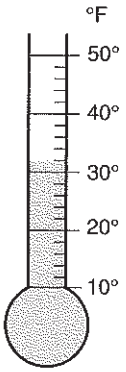
_____

Measuring Temperature

A **thermometer** uses a scale to measure temperature. In the customary system, temperature is measured in **degrees Fahrenheit** (°F). The metric system uses **degrees Celsius** (°C). Look for one of those two symbols on a thermometer to tell you which units are used.

PRACTICE

Use this thermometer for Questions 1–4.



1. Circle the unit this thermometer uses

   degrees Celsius

   degrees Fahrenheit

2. What temperature is shown on the thermometer? _____

3. Is 20°F colder or warmer than the temperature shown above? _____

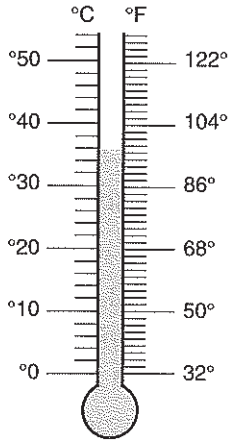
4. Water freezes at the temperature shown above. Which of these would be the best setting for your freezer?

   A 45°F **C** 56°F
   B 37°F **D** 5°F

5. Which of these would be the best setting for the refrigerator?

   F 50°F **H** 30°F
   G 37°F **J** 20°F

This thermometer shows both degrees Celsius and degrees Fahrenheit. Use it for Questions 6–9.



6. Circle the unit that is larger.

   1°C 1°F

7. How many degrees does each tick mark on the above scales represent?

   _____ °C _____ °F

8. What temperature is shown on the thermometer?

   about _____ °C about _____ °F

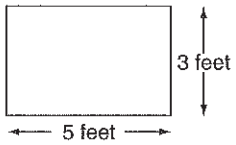
9. Which of these represents the hottest temperature?

   A 104°F **C** 40°C
   B 50°C **D** 86°F

Finding Perimeter

Perimeter is the distance around the outside of a closed figure. To find the perimeter, add the lengths of the sides to find the total. The letter P is used to represent perimeter.

Examples



- Find the length of each side. Opposite sides of a rectangle are equal.

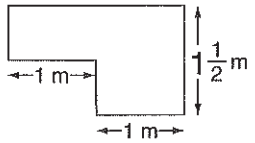
  bottom = 5 ft top = 5 ft

  right side = 3 ft left side = 3 ft

- Add.

  $P = 5 + 5 + 3 + 3 = 16$

  $P = 16$ ft



- Find the length of each side.

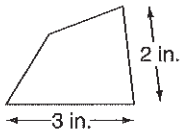
  2 "bottoms" = 2 m top = 2 m

  right side = $1\frac{1}{2}$ m 2 left sides = $1\frac{1}{2}$ m

- Add.

  $P = 2 + 2 + 1\frac{1}{2} + 1\frac{1}{2} = 7$ m

  $P = 7$ m



There is not enough information to calculate the perimeter of this figure.

PRACTICE

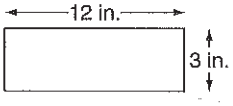
Find the perimeter of each shape. *Hint:* The symbol " is an abbreviation for inches and the symbol ' is an abbreviation for feet.

1. a rectangular room 12 feet long and 5 feet wide

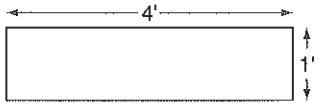
   $P =$ _____

2. 

   $P =$ _____

3. 

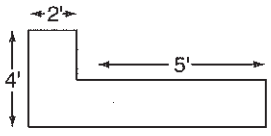
   $P =$ _____

4. 

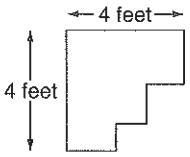
   $P =$ _____

5. a square that measures 2 cm on each side

   $P =$ _____

6. 

   $P =$ _____

7. 

   $P =$ _____

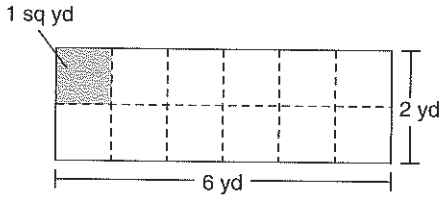
8. The perimeter of a rectangle is 20 cm. The top and bottom are each 8 cm long. What is the length of each side of the rectangle?

   _____

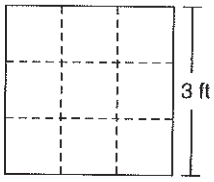
Finding Area

Area is the size of a surface and is usually measured in square units such as square feet (ft^2), square yards (yd^2), square meters (m^2), and so on. One way to find area is to count the number of squares inside a shape. The letter A is used to represent area.

Examples



This rectangle is divided into squares that measure 1 yard on each side. Each small square is 1 sq yd, or 1 yd^2.
$A = 12\ yd^2$



Each side of the square is divided into foot-long sections to create 9 smaller squares inside the shape. Each smaller square is 1 sq ft, or 1 ft^2.
$A = 9\ ft^2$

A shortcut to finding the area of a square or a rectangle is to multiply *length* × *width*. However, the length and width must be the same unit of measure.

- For the rectangle on the left, $A = l \times w = 2\ yd \times 6\ yd = 12\ yd^2$.
- For the square on the right, $A = l \times w = 3\ ft \times 3\ ft = 9\ ft^2$.

PRACTICE

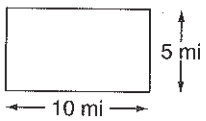
Find the area of each shape below. Be sure to give your answers in square units.

1. a rectangular tile that is 6 cm long and 6 cm wide

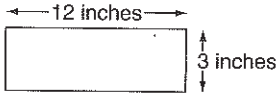
   $A =$ _____

2. a rectangle whose sides measure 2 mm, 4 mm, 2 mm, and 4 mm

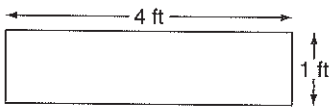
   $A =$ _____

3. 

   $A =$ _____

4. 

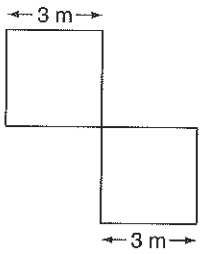
   $A =$ _____

5. 

   $A =$ _____

6. a square that measures 2 cm on each side

   $A =$ _____

7. 

   $A =$ _____

   (*Hint:* The area is *not* that of a 6 m × 6 m square.)

8. The area of a square is 25 square inches. How long is each side of the square?

   _____

Reading Time

We use clocks and watches to measure units of time such as seconds, minutes, and hours. Digital clocks (Figure A) show hours separated from minutes with a colon. Analog clocks (Figure B) have hands that move around a face. It is important to be able to read both types of clocks.

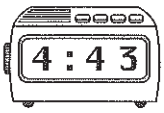


Figure A


Figure B

- With a digital clock, read the number left of the colon (:) as the hour, and the number at the right of the colon as minutes. The digital clock above would be read *4:43* (four forty-three), which means 43 minutes *after* 4 o'clock, or 43 minutes *past* 4 o'clock.
- With an analog clock, you can read the time as minutes after the last hour, or as minutes before the next hour. The clock in Figure B can be read as 4:43. It can also be read as 17 minutes *before* 5, or 17 minutes *to* 5. Notice that 43 minutes (after) + 17 minutes (before) = 60 minutes or 1 hour.

15 minutes = $\frac{1}{4}$ hour or a quarter of an hour

30 minutes = $\frac{1}{2}$ hour or half of an hour

45 minutes = $\frac{3}{4}$ hour or 3 quarters of an hour

PRACTICE

Circle the correct answer.

1. What time is shown on the clock? There are two correct answers.

A 4:30
B half past five
C half past four
D 5:30

2. What time is shown on the clock? There are two correct answers.

F 20 minutes to 9
G 8 minutes to 9
H 8 minutes past 8
J 8:40

3. What time will the clock show in 15 minutes?

A 2:15
B 2:20
C 2:25
D 3:30

4. What time will the clock show in 30 minutes?

F 15 minutes to 3
G 25 minutes before 3
H 35 minutes before 3
J 35 minutes after 3

Fill in the blank to convert each amount of time shown.

5. $\frac{1}{2}$ hour = _____ min
6. 2 hours = _____ min
7. $\frac{1}{3}$ hour = _____ min
8. 2 days = _____ hr
9. $1\frac{1}{2}$ hours = _____ min
10. $\frac{3}{4}$ hour = _____ min

Calculating Time

When you know how long a task will take, you can figure out what time to start the task in order to finish by a certain time. You can also figure out what time you will finish the task if you start it at a certain time. You can use a clock face to help with that.

Examples

You have an appointment at 10:00. It takes 1 hour and 15 minutes to travel. What time should you start out?

Since you need a time *before* 10:00, count back from 10:00.

- Count the hours. Start at 10:00. 1 hour before 10:00 is 9:00.
- Count the minutes. Start at 9:00. 15 minutes before 9:00 is 8:45.

You should start out at 8:45.

Eric starts work at 8:45. He works for 7 hours and 45 minutes. What time does he finish work?

Since the time will be *after* 8:45, count forward.

- Count the hours. Start at 8:45. 7 hours after 8:45 is 3:45.
- Count the minutes. Start at 3:45. 45 minutes after 3:45 is 4:30.

Eric finishes work at 4:30.

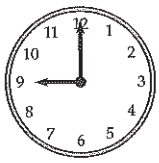
PRACTICE

Write the time asked for in each problem.

1. What is the time exactly 5 hours before 2:00?

_____

2. What is the time exactly 6 hours after 9:00?



_____

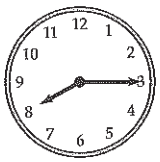
3. It will take 6 hours to make bread. You plan to eat at 5:00. By what time should you start making the bread?

_____

4. It will take 50 minutes to drive to your mother's house. You leave at 3:30. When will you arrive?

_____

5. Gregory volunteers at a shelter. He spent $5\frac{1}{2}$ hours there on Tuesday. If he started at 8:15 A.M., what time did he leave?



_____

6. When Sabrina checked her watch, it was 3:30. She had been reading for 1 hour and 45 minutes. What time did she start reading?

_____

Finding Elapsed Time

The amount of time that passes between the beginning of a task or event and its end is called **elapsed time**. To find elapsed time, find the difference between the starting time and the ending time. You can use a clock face to help you find elapsed time. Keep in mind that 12:00 midnight starts the A.M. or morning hours; 12:00 noon starts the P.M. or afternoon hours.

Examples

Sheeri's train is scheduled to leave the station at 9:45 A.M.
The train should arrive at her stop at 1:30 P.M.
How long will Sheeri be on the train?

- Count the hours.
  Start at 9:45. Count complete hours.
  From 9:45 to 12:45 is 3 hours.
- Count the minutes.
  Start at 12:45. Count the number of minutes until 1:30.
  From 12:45 to 1:30 is 45 minutes.

Sheeri will be on the train for 3 hours and 45 minutes.

Note: Another way to find the answer would be to count the hours from 9:45 to 1:45, and then subtract the number of minutes as you count back from 1:45 to 1:30.

PRACTICE

Find the elapsed time for each situation.

1. Start time: 6:20 A.M.
   Stop time: 11:25 A.M.
   Elapsed time: _____

2. Start time: 10:30 A.M.
   Stop time: 2:15 P.M.
   Elapsed time: _____

3. The decorating committee began putting up decorations for the party at 3:20 P.M. It was 7:45 P.M. when they finished. How long did it take the committee to finish the job? _____

4. Renaldo and Carl finished painting the bedroom at 3:20 P.M. They had started painting at 9:15 that morning. How long did it take them to paint the bedroom? _____

5. Gretchen said she would meet Falon at 2:15 that afternoon, but she got stuck in traffic and didn't show up until 3:05. How late was Gretchen? _____

6. Warren started typing his report at 8:30 A.M. and didn't finish until 2:50 that afternoon. How long did it take him to finish the report? _____

Adding and Subtracting Time

When you add or subtract amounts of time, you need to add or subtract like units. You may need to convert units. Remember, 60 minutes = 1 hour.

Examples

$$\begin{array}{rr} 1 \text{ hour} & 15 \text{ minutes} \\ + \ 2 \text{ hours} & 50 \text{ minutes} \\ \hline 3 \text{ hours} & 65 \text{ minutes} \end{array}$$

Simplify the answer.
- Convert 60 minutes to 1 hour.
  65 min = 1 hr 5 min
- Add.
  3 hr + 1 hr + 5 min

  3 hr 65 min = 4 hr 5 min

$$\begin{array}{rr} {}^{2}\cancel{3} \text{ hours} & {}^{70}\cancel{10} \text{ minutes} \\ - & 45 \text{ minutes} \\ \hline 2 \text{ hours} & 25 \text{ minutes} \end{array}$$

Regroup to subtract.
- Convert 1 hour to 60 minutes.
- Add. 60 min + 10 min = 70 min
- Subtract.

PRACTICE

Add or subtract. Regroup to convert minutes to hours or hours to minutes as needed.

1. $\begin{array}{rr} 1 \text{ hour} & 15 \text{ minutes} \\ + \ 4 \text{ hours} & 30 \text{ minutes} \\ \hline \end{array}$

2. $\begin{array}{rr} 45 \text{ minutes} \\ + \ 45 \text{ minutes} \\ \hline \end{array}$

3. $\begin{array}{rr} 3 \text{ hours} & 35 \text{ minutes} \\ + \ 2 \text{ hours} & 45 \text{ minutes} \\ \hline \end{array}$

4. $\begin{array}{rr} 5 \text{ hours} & 10 \text{ minutes} \\ + \ 3 \text{ hours} & 50 \text{ minutes} \\ \hline \end{array}$

5. $\begin{array}{rr} 1 \text{ hour} & 15 \text{ minutes} \\ + \ 3 \text{ hours} & 39 \text{ minutes} \\ & 30 \text{ minutes} \\ \hline \end{array}$

6. $\begin{array}{rr} 4 \text{ hours} \\ - \ 1 \text{ hour} & 25 \text{ minutes} \\ \hline \end{array}$

7. $\begin{array}{rr} 5 \text{ hours} & 10 \text{ minutes} \\ - \ 2 \text{ hours} & 20 \text{ minutes} \\ \hline \end{array}$

8. $\begin{array}{rr} 6 \text{ hours} & 15 \text{ minutes} \\ - \ 3 \text{ hours} & 40 \text{ minutes} \\ \hline \end{array}$

9. $\begin{array}{rr} 1 \text{ hour} & 30 \text{ minutes} \\ - & 45 \text{ minutes} \\ \hline \end{array}$

10. $\begin{array}{rr} 4 \text{ hours} & 12 \text{ minutes} \\ - \ 2 \text{ hours} & 27 \text{ minutes} \\ \hline \end{array}$

Measurement Skills Checkup

Circle the letter for the correct answer to each problem.

1. What time will the clock show in 20 minutes?

A 2:20
B 2:55
C 3:20
D 3:05

2. A pork chop weighs 8 ounces. What fraction of a pound is that?

F $\frac{1}{4}$
G $\frac{1}{3}$
H $\frac{1}{2}$
J $\frac{1}{5}$

3. Which is the most reasonable estimate of the height of a door?

A 7 inches
B 70 inches
C 700 inches
D 7,000 inches

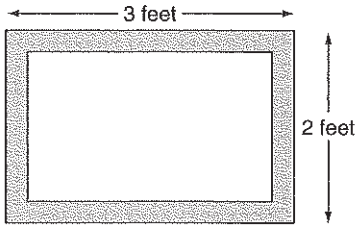
4. You want to make a $\frac{1}{4}$-pound hamburger. How many ounces of hamburger do you need?

F 10 oz
G 25 oz
H 4 oz
J 40 oz

5. Maya leaves her children with the babysitter at 6:50 P.M. She returns at 8:45 P.M. How long are her children with the babysitter?

A 1 hour and 55 minutes
B 1 hour and 5 minutes
C 2 hours and 5 minutes
D 3 hours and 5 minutes

This diagram shows plans for a picture frame. Study the diagram. Then do Numbers 6–8.



6. What is the perimeter along the outside edge of this picture frame?

F 5 ft
G 6 ft
H 10 ft
J 8 ft

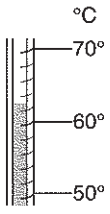
7. What is the area of the framed picture?

A 6 sq ft
B 5 sq ft
C 10 sq ft
D 8 sq ft

8. It takes about 25 minutes to cut the materials for this frame. It takes another 45 minutes to put them together. How long does it take to make the frame?

F 1 hour and 10 minutes
G 1 hour and 7 minutes
H 1 hour and 20 minutes
J $1\frac{1}{2}$ hours

9. What temperature is shown on this thermometer?



A 65°C
B 63°C
C $1\frac{1}{2}$°C
D 66°C

Measurement Skills Checkup (continued)

10. Which unit would be used to measure the weight of a business letter?

F pounds
G liters
H kilograms
J ounces

11. Byung plans to spend 20 minutes exercising on a stair machine. He starts at 4:52. When will he finish?

A 5:12
B 4:72
C 5:02
D 5:07

12. Rochelle buys 20 feet of fence for her garden. She plans to use all 20 feet to outline one square flower bed. How long will each side of the flower bed be?

F 10 feet
G 5 feet
H 4 feet
J 3 feet

13. You want to buy 8 ounces of peas. They cost $1.00 per pound. How much will you pay?

A $1
B $2
C $0.50
D $0.80

14. Which measure is equal to 1 kL?

F 1,000 cL
G 1,000 mL
H 1,000 dL
J 1,000 L

15. Grace has a ribbon that is 3 feet long. She needs to use 32 inches to trim her hem. How much ribbon will she have left over?

A 10 inches
B 8 inches
C 4 inches
D 2 inches

16. A train trip from Forest to Central takes 40 minutes. Continuing on the train from Central to the zoo takes another 50 minutes. How long is the ride from Forest all the way to the zoo?

F 1 hour and 10 minutes
G 1 hour and 20 minutes
H 1 hour and 30 minutes
J 1 hour and 40 minutes

17. Which of these is the best tool for finding out if a refrigerator will fit through a doorway?

A calendar
B thermometer
C ruler
D clock

18. Which of the following would be a comfortable temperature for your bath water? (Body temperature ≈ 98° F)

F 20°F
G 50°F
H 100°F
J 200°F

19. Here are the dimensions of three rectangular fields.

Field A: 50 feet by 20 feet
Field B: 30 feet by 30 feet
Field C: 30 feet by 40 feet

Which field has the greatest area?

A Field A
B Field B
C Field C
D They all have the same area.

20. Which is the most reasonable estimate for the weight of a kitten?

F 5 oz
G 5 lb
H 5 T
J 5 g

4. G
5. $n + 24$
6. $n + 6$
7. $n - 7$
8. $\frac{n}{2}$ or $\times \frac{1}{2} n$
9. $n + 8$
10. $6 \times n$
11. $\frac{13}{n}$ or $13 \div n$
12. $n - 6$
13. $14 \times n$
14. $n + 10$

Page 118

15. $r + \$20$
16. $\frac{p}{4}$ or $p \div 4$
17. $n - \$450$
18. $3 \times c$
19. $d + m$
20. $4 \times k$
21. $28 - d$
22. $6 - f$
23. $y - 7$
24. $172 - x$

Page 119

1. D
2. F
3. A
4. H
5. C
6. 10
7. 8
8. 13
9. 5
10. 25
11. 4
12. 9
13. 17
14. 8

Page 120

1. B
2. J
3. G
4. $24 - 7 = x$
5. $9{,}000 + x = 12{,}000$
6. $7 + 3 = x$

Page 121

1. 8
2. 25
3. 15
4. 25
5. 39
6. 40
7. 15
8. 103

Algebra Skills Checkup

Pages 122–123

1. D
2. H
3. A
4. F
5. B
6. F
7. D
8. H
9. B
10. F
11. C
12. F
13. D
14. J
15. B
16. H
17. C
18. H
19. D
20. G

Measurement

Page 124

2. length, miles
3. area, square feet
4. capacity, gallons
5. weight, ounces
6. temperature, degrees
7. length, yards
8. volume, cubic feet

Page 125

1. A
2. D
3. F
4. H
5. A
6. F
7. B
8. H
9. C

Page 126

1. 14,000 lbs
2. 15 yd
3. 6 ft
4. 4 pt
5. $\frac{1}{2}$ lb
6. 4 hr
7. 13 wk
8. $\frac{2}{3}$ yd
9. 168 hr
10. 6 qt

Page 127

11. 15 ft
12. 6,000 lb
13. $\frac{1}{2}$ ft
14. $4\frac{1}{2}$ C
15. 144 in.
16. $1\frac{1}{2}$ ft
17. 21,600 sec
18. 35 wks
19. 96 oz
20. $\frac{1}{3}$ yd
21. 6 pt
22. $\frac{1}{8}$ T

Page 128

1. 100 cm
2. 1,000 m
3. 1 g
4. 1 L
5. 100 g
6. 1,000 L
7. 1 dm
8. 1,000 mm
9. 1 kg

Page 129

1. 500,000 mg
2. 100,000 cm
3. 2 L
4. 250 mg
5. 3.7 L
6. 12,500 m
7. 0.01 L
8. 400 dkg
9. 0.3 m
10. 2,500 g

Page 130

1. 6 ft 2 in.
2. 3 yd 2 ft
3. 2 lb 1 oz
4. 4 qt
5. 1 L 225 mL or 1.225 L
6. 3 ft 3 in.
7. 11 fl oz
8. 3 ft 10 in.
9. 3 yd 7 in.
10. 18 cg 5 mg or 18.5 cg
11. 11 oz
12. 1 qt 1 pt
13. 1 km 859 m or 1.859 km
14. 7 mo
15. 1,450 lb

Page 131

1. B
2. H
3. B
4. F
5. B
6. J

Page 132

1. A
2. G
3. C
4. J
5. B
6. H

Page 133

1. 2
2. 2
3. 4
4. 10
5. 25
6. 75
7. 5
8. 15
9. 150
10. 95
11. 40

Page 134

1. degrees Fahrenheit
2. 32ºF
3. colder
4. D
5. G
6. 1ºC
7. 2ºC, 2ºF
8. 36ºC, 96ºF
9. B

Page 135

1. 34 ft
2. 30 mi
3. 30 in.
4. 10'
5. 8 cm
6. 22'
7. 16 ft
8. 2 cm

Page 136

1. 36 cm^2
2. 8 mm^2
3. 50 mi^2
4. 36 in^2
5. 4 ft^2
6. 4 cm^2
7. 18 m^2
8. 5 in.

Page 137

1. A, C
2. F, J
3. C
4. J
5. 30 min
6. 120 min
7. 20 min
8. 48 hrs
9. 90 min
10. 45 min

Page 138

1. 9:00
2. 3:00
3. 11:00
4. 4:20
5. 1:45
6. 1:45

Page 139

1. 5 hr 5 min
2. 3 hrs 45 min
3. 4 hrs 25 min
4. 6 hrs 5 min
5. 50 min
6. 6 hrs 20 min

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1. 5 hrs 45 min
2. 1 hr 30 min
3. 6 hrs 20 min
4. 9 hrs
5. 5 hrs 24 min
6. 2 hrs 35 min
7. 2 hrs 50 min
8. 2 hrs 35 min
9. 45 min
10. 1 hr 45 min

Measurement Skills Checkup

Pages 141–142

1. D
2. H
3. B
4. H
5. A
6. H
7. A
8. F
9. B
10. J
11. A
12. G
13. C
14. J
15. C
16. H
17. C
18. H
19. C
20. G

Geometry

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1. ray *ST*
2. line segment *GH* or *HG*
3. line *KL* or *LK*
4. line *XY* or *YX*
5. ray *MN*
6. line segment *EF* or *FE*

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1. C
2. F
3. D
4. H
5. A
6. F

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1. B, E, F, G, H
2. A, C, D
3. F, H