

CUSTOMARY SYSTEM OF MEASUREMENT

This unit is a review of the customary system of measurement. Topics discussed in this unit include conversions within the customary system and also between the customary and metric systems, measuring to the nearest sixteenth of an inch, converting temperatures between the Fahrenheit and Celsius systems, and examining applications of calculating elapsed time.

Measuring to the Nearest Sixteenth of an Inch

Customary and Metric Conversions

Customary Units of Area

Customary Units of Volume

Temperature

Time

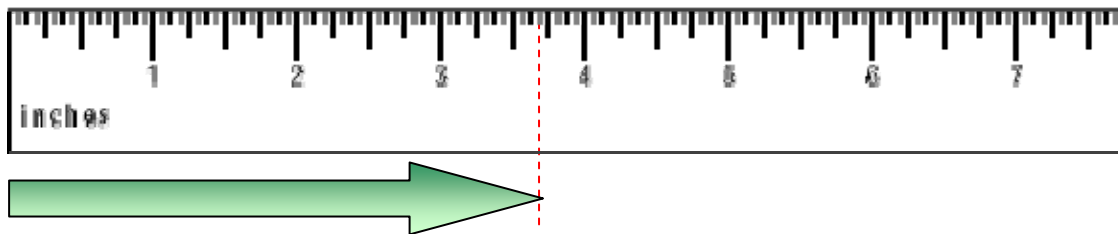
Measuring to the Nearest Sixteenth of an Inch

This ruler is divided into 16ths of an inch.

To measure to the nearest 16th, count the spaces from the beginning of one whole inch up to and including the mark of the measurement. Write the measurement in 16ths, and then reduce if possible.

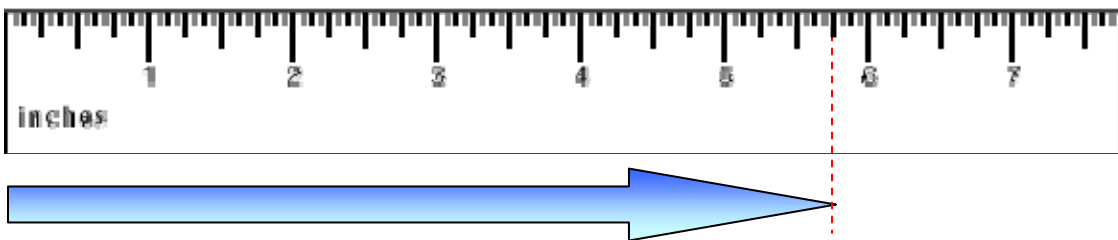


Example 1: How long is the arrow to the nearest 16th of an inch?



The arrow's tip falls on $\frac{11}{16}$ beyond 3 inches; therefore, the arrow's length is $3\frac{11}{16}$ inches.

Example 2: How long is the arrow to the nearest 16th of an inch?



The arrow's tip falls on $\frac{12}{16}$ beyond 5 inches; thus, the arrow's length is

$$5\frac{12}{16} \text{ inches which reduces to } 5\frac{3}{4}. \quad \left[5\frac{12}{16} \div \frac{4}{4} = 5\frac{3}{4} \right]$$

Customary and Metric Conversions

Units of Length	Customary Unit Equivalence	Metric Unit Equivalence
1 foot (ft)	12 inches (in)	30.48 cm
1 yard (yd)	3 ft or 36 in	0.91 m
1 mile (mi)	1760 yd or 5280 ft	1.61 km

Units of Weight	Customary Unit Equivalence	Metric Unit Equivalence
1 ounce (oz)		28.35 g
1 pound (lb)	16 ounces (oz)	0.45 kg
1 ton (T)	2000 lb	907.18 kg

Units of Capacity	Customary Unit Equivalence	Metric Unit Equivalence
1 fluid ounce (fl oz)		29.57 ml
1 cup (c)	8 fluid ounces (fl oz)	236.59 ml
1 pint (pt)	2 c	0.47 l
1 quart (qt)	2 pt	0.95 l
1 gallon (gal)	4 qt	3.79 l

Units of Time	
1 minute (min)	60 seconds (s)
1 hour (hr)	60 min
1 day (d)	24 hr
1 week (wk)	7 d
1 year (y)	52 wk, 12 months (mo), 365 d

Use these customary and metric equivalences to compute and make conversions

Express a Larger Unit as a Smaller Unit

To express a **larger unit as a smaller unit**, **MULTIPLY** the given measurement by the conversion factor.

Example 1: How many ounces (oz) are in 7 pounds (lb)?

$$1 \text{ lb} = 16 \text{ oz} \quad \text{-conversion factor}$$

$$7 \times 16 = 112 \quad \text{-large unit to small unit, multiply}$$

There are 112 ounces in 7 pounds.

Example 2: How many inches are in 5 feet 4 inches?

$$1 \text{ ft} = 12 \text{ in} \quad \text{-conversion factor}$$

$$5 \times 12 = 60 + 4 = 64 \quad \text{-multiply to convert the feet to inches, and then add on the inches given}$$



There are 64 inches in 5 feet 4 inches.

Express a Smaller Unit as a Larger Unit

To express a **smaller unit as a larger unit**, **DIVIDE** the given measurement by the conversion factor.

Example 3: How many gallons (gal) are equal to 18 quarts (qt)?



$$1 \text{ gal} = 4 \text{ qt}$$

-conversion factor

$$18 \div 4 = 4 \frac{1}{2}$$

-large unit to small
unit, divide

$$\left(\begin{array}{r} 4 \frac{2}{4} = 4 \frac{1}{2} \\ 4 \overline{)18} \\ \underline{16} \\ 2 \end{array} \right)$$

There are 4 1/2 gallons in 18 quarts.

Example 4: Add and express the answer in simplest terms.

$$\begin{array}{r} 5 \text{ feet } 7 \text{ inches} \\ + 2 \text{ feet } 8 \text{ inches} \\ \hline 7 \text{ feet } 15 \text{ inches} \end{array}$$

Simplify
→
1 ft = 12 in

$$\begin{array}{r} 7 \text{ feet } \left(15 \text{ inches} \right) \\ 7 \text{ feet } + \left(12 \text{ inches} + 3 \text{ inches} \right) \\ \left(7 \text{ feet } + 1 \text{ foot} \right) + 3 \text{ inches} \\ 8 \text{ feet } + 3 \text{ inches} \end{array}$$

The sum of 5 feet 7 inches and 2 feet 8 inches is 8 feet 3 inches.

Example 5: Subtract and borrow, if needed.

$$\begin{array}{r} 6 \text{ hours } 22 \text{ minutes} \\ - 3 \text{ hours } 45 \text{ minutes} \\ \hline \end{array}$$



Since 22 is smaller than 45, borrow one hour (60 min).

$$\begin{array}{r} \overset{5}{\cancel{6}} \text{ hours } \quad \overset{82}{\cancel{22}} \text{ minutes} \quad \left[22 \text{ min} + 60 \text{ min} = 82 \text{ min} \right] \\ - 3 \text{ hours } \quad 45 \text{ minutes} \\ \hline 2 \text{ hours } \quad 37 \text{ minutes} \end{array}$$

The difference is 2 hours and 37 minutes.

Customary Units of Area

Use the table of customary units of area to find equivalent areas in solving the problems that follow.

Unit	Abbreviation	Customary Unit Equivalence	Metric Unit Equivalence
square mile	sq mi or mi ²	1 sq mi = 640 acres 1 sq mi = 102,400 rd ²	
acre		1 acre = 4840 yd ² 1 acre = 43,560 ft ²	1 acre = 0.407 hectares
square rod	sq rd or rd ²	1 sq rd = 30.25 yd ² 1 sq rd = 0.006 acres	
square yard	sq yd or yd ²	1 sq yd = 1296 in ² 1 sq yd = 9 ft ²	1 sq yd = 0.836 square meters
square foot	sq ft or ft ²	1 sq ft = 144 in ² 1 sq ft = 0.111 yd ²	
square inch	sq in or in ²	1 sq in = 0.007 ft ² 1 sq in = 0.00077 yd ²	1 sq in = 6.4516 sq cm

Example 1: Set up a proportion to convert the following measurement of area.

$$5 \text{ square yards} = \underline{\quad ? \quad} \text{ square feet}$$

From the conversion chart ... $1 \text{ yd}^2 = 9 \text{ ft}^2$

square yard	sq yd or yd^2	$1 \text{ sq yd} = 1296 \text{ in}^2$ $1 \text{ sq yd} = 9 \text{ ft}^2$	$1 \text{ sq yd} =$ $0.836 \text{ square meters}$
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Set up a proportion comparing square yards to square feet.

$$\frac{\text{yd}^2}{\text{ft}^2} \rightarrow \frac{1 \text{ yd}^2}{9 \text{ ft}^2} = \frac{5 \text{ yd}^2}{? \text{ ft}^2}$$

$$\frac{1}{9} = \frac{5}{x}$$

Cross multiply

$$(1)x = 9(5)$$

Simplify

$$x = 45$$

Five square yards equal 45 square feet.

Example 2: Set up a proportion to convert the following measurement of area.

$$14,520 \text{ square yards} = \underline{\quad ? \quad} \text{ acres}$$

acre	1 acre = 4840 yd ² 1 acre = 43,560 ft ²	1 acre = 0.407 hectares
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From the conversion chart ... 1 acre = 4840 yd²

Set up a proportion comparing acres to square yards.

$$\frac{\text{acre}}{\text{yd}^2} \rightarrow \frac{1 \text{ acre}}{4840 \text{ yd}^2} = \frac{? \text{ acres}}{14,520 \text{ yd}^2}$$

$$\begin{array}{l} \frac{1}{4840} = \frac{x}{14520} \\ (4840)x = 1(14520) \quad \text{Cross multiply} \\ 4840x = 14520 \quad \text{Simplify} \\ \frac{4840x}{4840} = \frac{14520}{4840} \quad \text{Divide both sides by 4840} \\ 1x = 3 \quad \text{Simplify (1x = x)} \\ x = 3 \end{array}$$

Three acres equal 14,520 square yards.

Example 3: Set up a proportion to convert the following measurement of area.

$$72 \text{ square inches} = \underline{\quad ? \quad} \text{ square feet}$$

From the conversion chart ... $1 \text{ ft}^2 = 144 \text{ in}^2$

square foot	sq ft or ft ²	$1 \text{ sq ft} = 144 \text{ in}^2$ $1 \text{ sq ft} = 0.111 \text{ yd}^2$
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Set up a proportion comparing square feet to square inches.

$$\frac{\text{ft}^2}{\text{in}^2} \rightarrow \frac{1 \text{ ft}^2}{144 \text{ in}^2} = \frac{? \text{ ft}^2}{72 \text{ in}^2}$$

$$\frac{1}{144} = \frac{x}{72}$$

$$(144)x = 1(72)$$

$$144x = 72$$

$$\frac{144x}{144} = \frac{72}{144}$$

$$1x = \frac{72}{144}$$

$$x = \frac{1}{2}$$

Cross multiply

Simplify

Divide both sides by 144

Simplify $\left(\frac{72 \div 72}{144 \div 72} = \frac{1}{2} \right)$

Seventy-two square inches equal one-half of a square foot.

Customary Units of Volume

Use the table of customary units of capacity to find an equivalent measure of capacity in solving the problem that follows.

Unit	Abbreviation	Customary Unit Equivalence	Metric Unit Equivalence
cubic yard	cu yd or yd^3	$1 \text{ cu yd} = 27 \text{ ft}^3$ $1 \text{ cu yd} = 46,656 \text{ in}^3$	$1 \text{ cu yd} = 0.7646$ cubic meter
cubic foot	cu ft or ft^3	$1 \text{ cu ft} = 1728 \text{ in}^3$ $1 \text{ cu ft} = 0.0370 \text{ yd}^3$	
cubic inch	cu in or in^3	$1 \text{ cu in} = 0.00058 \text{ ft}^3$ $1 \text{ cu in} = 0.000021 \text{ yd}^3$	$1 \text{ cu in} = 16.39$ millimeters

Example: Set up a proportion to convert the following measurement of capacity.

$$8 \text{ cubic yards} = \underline{\quad ? \quad} \text{ cubic feet}$$

cubic yard	cu yd or yd ³	1 cu yd = 27 ft ³ 1 cu yd = 46,656 in ³	1 cu yd = 0.7646 cubic meter
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From the conversion chart ... 1 cubic yard = 27 ft³

Set up a proportion comparing cubic yards to cubic feet.

$$\frac{\text{yd}^3}{\text{ft}^3} \rightarrow \frac{1 \text{ yd}^3}{27 \text{ ft}^3} = \frac{8 \text{ yd}^3}{? \text{ ft}^3}$$

$$\frac{1}{27} = \frac{8}{x}$$

$$(1)x = 27(8)$$

$$x = 216$$

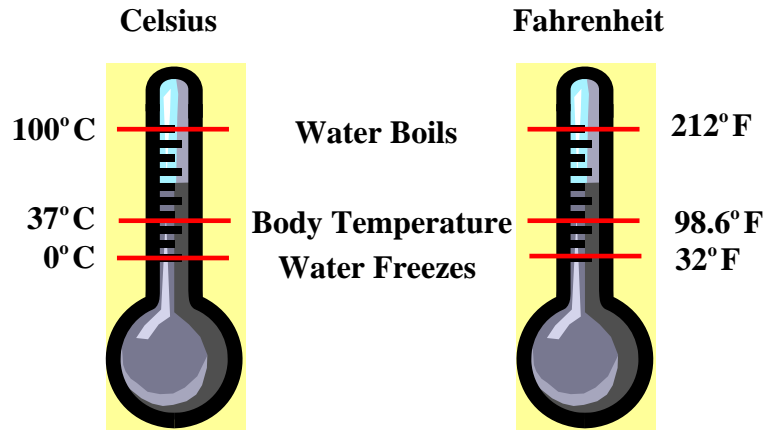
Cross multiply

Simplify

Eight cubic yards equal 216 cubic feet.

Temperature

Temperature is commonly measured in Celsius (C) degrees or Fahrenheit (F) degrees. A comparison of a Celsius thermometer and a Fahrenheit thermometer are shown below.



The following formulas can be used to convert from one temperature scale to the other, and vice versa.

- **Celsius to Fahrenheit:** $F = \frac{9}{5} \times C + 32$
- **Fahrenheit to Celsius:** $C = \frac{5}{9} \times (F - 32)$

Example 1: Sheila and her friends went to Daytona Beach for spring break. Sheila sent a post card to her parents and told them that the temperature was averaging about 25° C throughout the day. What was the equivalent temperature in Fahrenheit degrees?

Convert from Celsius to Fahrenheit:



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

$$F = \frac{9}{5} \times 25 + 32$$

Replace C with 25

$$F = \frac{9}{\cancel{5}} \times \frac{\cancel{25}^5}{1} + 32$$

Cancel by 5

$$F = \frac{9 \times 5}{1 \times 1} + 32$$

Simplify

$$F = \frac{45}{1} + 32$$

Simplify

$$F = 45 + 32$$

Simplify

$$F = 77^\circ$$

Add

Twenty-five degrees Celsius equals 77 degrees Fahrenheit.

Example 2: On a cold winter day, the Fahrenheit thermometer registered 20° F. What was temperature on the Celsius thermometer?



Convert from Fahrenheit to Celsius:

➡ $C = \frac{5}{9}(F - 32)$

$C = \frac{5}{9}(20 - 32)$ Replace F with 20

$C = \frac{5}{9}(-12)$ Subtract
 ($20 - 32 = 20 + -32 = -12$)

$C = \frac{5}{9} \times \frac{-12}{1}$ Prepare to multiply

$C = \frac{5}{\cancel{9}^3} \times \frac{\cancel{-12}^{-4}}{1}$ Cancel the 9 and -12 by 3

$C = \frac{5 \times -4}{3 \times 1}$ Simplify

$C = \frac{-20}{3}$ Multiply

$C \approx -7^\circ$ Divide $\left(\begin{array}{r} 6.6 \\ 3 \overline{)20.0} \\ \underline{18} \\ 20 \\ \underline{18} \\ 2 \end{array} \right)$

The Celsius scale registered approximately -7 degrees when the temperature was 20 degrees Fahrenheit.

Time

Units of time are the same in customary and metric systems. The most common units of time are shown below.

Units of Time	
1 day (d)	= 24 hours (h)
1 hour (h)	= 60 minutes (min)
1 minute (min)	= 60 seconds (s)

To convert units of time, determine if the change is from *larger to smaller* units or *smaller to larger* units.

- *Multiply* to express larger units as smaller units.
- *Divide* to express smaller units as larger units.

Example 1: Change $6\frac{1}{2}$ hours to minutes.

1 hour (h)	= 60 minutes (min)
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hours \Rightarrow minutes

larger \Rightarrow smaller

Therefore, MULTIPLY by 60.

$$6\frac{1}{2} \times 60 = 6.5 \times 60 = 390$$

Four and one-half hours equal 390 minutes.

Example 2: Change 585 seconds to minutes.

1 minute (min)	= 60 seconds (s)
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seconds \Rightarrow minutes

smaller \Rightarrow larger

Therefore, DIVIDE by 60.

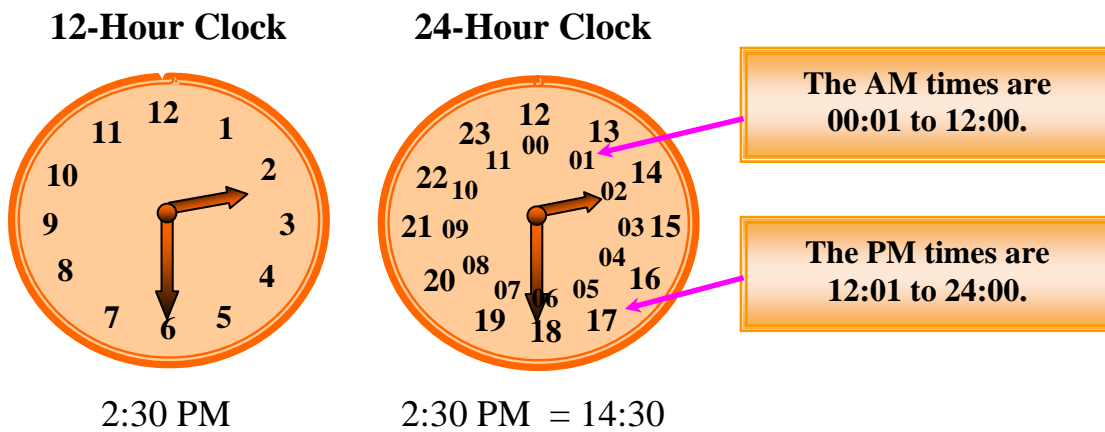
$$585 \div 60 = \begin{array}{r} 9.75 \\ 60 \overline{)585.00} \\ \underline{540} \\ 450 \\ \underline{420} \\ 300 \\ \underline{300} \\ 0 \end{array} = 9.75 \text{ or } 9\frac{3}{4}$$

Five hundred eight-five seconds equal $9\frac{3}{4}$ minutes.

Calculating elapsed time is used in everyday job settings such as clocking in and out for a day's work or planning a schedule for the workday. Finding hours worked from time cards is similar to finding elapsed time.

One way to find elapsed time is using 24-hour notation. This method is useful because no adjustments are needed for AM and PM changes in the same 24-hour day.

The illustration below compares a 12-hour clock to a 24-hour clock. The morning times are 00:01 to 12:00 noon. The afternoon times are 12:01 to 24:00 midnight.



Example 1: Change 8:30 PM to 24-hour notation.

To change a PM time to 24-hour notation, add on 12 hours to the 12-hour notation.

$$\begin{array}{r}
 8:20 \text{ PM} \quad \rightarrow \quad 8:20 \text{ PM} \\
 \underline{12:00} \quad \leftarrow \text{Add 12 hours} \\
 20:20
 \end{array}$$

The 24-hour notation for 8:20 PM is 20:20.

Example 2: Change 5:30 AM to 24-hour notation.

All that is needed to express a morning time to 24-hour notation is to fill in the first place with a zero for single digit hours.

$$5:30 \text{ AM} \rightarrow 05:30$$

*Notice that the AM notation is not used in 24-hour clock time.

The 24-hour notation for 5:30 AM is 05:30.

Example 3: Change 13:00 to 12-hour notation.

Since 13:00 is greater than 12:00, subtract away 12 hours.

$$\begin{array}{r} 13:00 \quad \rightarrow \quad 13:00 \\ - \underline{12:00} \quad \leftarrow \text{Subtract 12 hours} \\ \hline 1:00 \end{array}$$

Since 13:00 falls in the 12:01 to 24:00 range, we know it is PM.

The 12-hour notation for 13:00 is 1:00 PM.

Example 4: Change the following 24-hour notation times to 12-hour notation: (a) 07:00, (b) 11:00.

All that is needed to express a morning 24-hour time to 12-hour notation is to drop first place zero for single digit hours and add on AM.

$$07:00 \rightarrow 7:00 \text{ AM}$$

$$11:15 \rightarrow 11:15 \text{ AM}$$

The 12-hour notation for 07:00 is 7:00 AM.

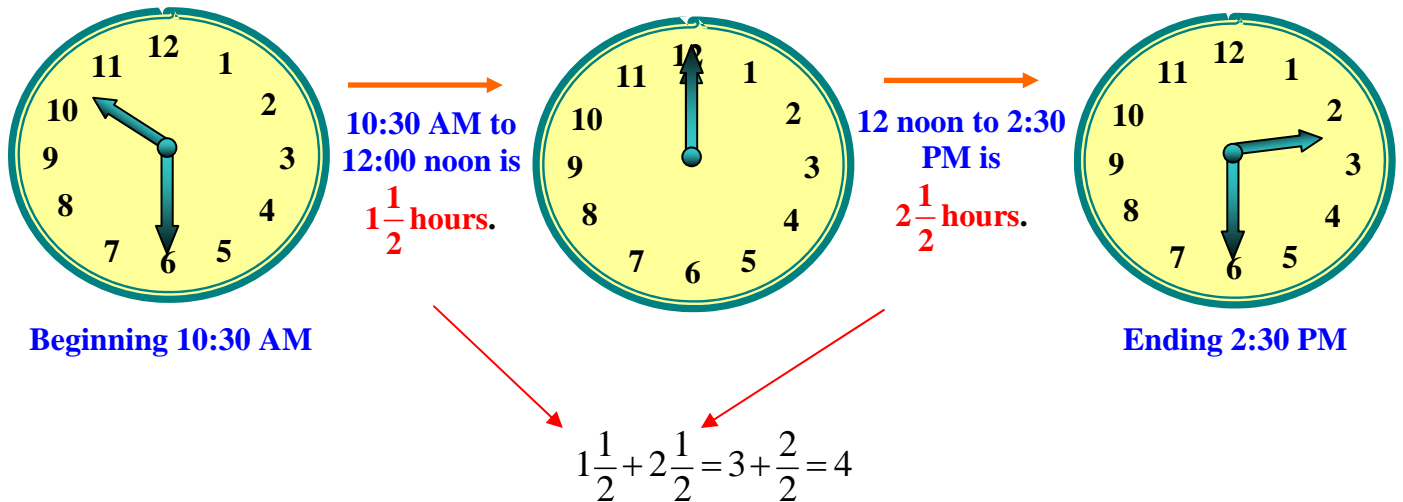
The 12-hour notation for 11:15 is 11:15 AM.

Elapsed Time

Elapsed time is the amount of time that passes from one time to another.

Note: Remember to watch for AM and PM changes when determining elapsed time.

Example 5: Find the elapsed time from 10:30 AM to 2:30 PM



The time elapsed is 4 hours.