Prealgebra Textbook

Second Edition

Chapter 6

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2012-2013

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Chapter 6

Ratio and Proportion

From the beginnings of the human race, we've long compared one quantity with another, a comparison that is called a *ratio* in mathematics. "Their tribe has twice as many cattle as ours" or "Two baskets of wheat cost 12 ducats" are examples of ratios that ring from distant times. Indeed, the concept of a *ratio* cannot be assigned to any one individual or class of individual. In his *History of Mathematics*, D. E. Smith writes:

> *It is rather profitless to speculate as to the domain in which the concept of ratio first appeared. The idea that one tribe is twice as large as another and the idea that one leather strap is only half as long as another both involve the notion of ratio; both are such as would develop early in the history of the race, and yet one has to do with ratio of numbers and the other with the ratio of geometric magnitudes. Indeed, when we come to the Greek writers we find Nicomachus including ratio in his arithmetic, Eudoxus in his geometry, and Theon of Smyrna in his chapter on music.*

Examples and applications of ratios are limitless: speed is a ratio that compares changes in distance with respect to time, acceleration is a ratio that compares changes in speed with respect to time, and percentages compare the part with the whole. We've already studied one classic ratio, the ratio of the circumference of a circle to its diameter, which gives us the definition of π.

One of the most famous ratios in history involves the division of a line segment AB into two segments AC and CB by selecting a point C on the segment AB.

The idea is to select a point C on the segment AB so that

$$\frac{AB}{AC} = \frac{AC}{CB}.$$

This ratio has a special name, the *Golden Ratio*, and has an exact value equal to $(1+\sqrt{5})/2$. The Golden Ratio has been known since the time of Euclid. Ancient and modern architects have long held that the most pleasing rectangular shape is the one whose ratio of length to width is equal to the Golden Ratio.

The comparison of two ratios, such as $AB/AC = AC/CB$, is called a *proportion*. Proportions are used in a number of practical ways. For example, if 5 cans of tomato sauce cost 2 dollars, we can find the number of cans that can be purchased with 10 dollars by comparing two ratios in a proportion:

$$\frac{5\,\text{cans of tomato sauce}}{2\,\text{dollars}} = \frac{x\,\text{cans of tomato sauce}}{10\,\text{dollars}}$$

Any discussion of ratio involves comparing two quantities, so the units of each quantity become extremely important. Two different systems of units are used when measuring length, capacity, and time: the *American* system of units and the *metric* system of units. In this chapter we will discuss both systems and explain how to convert quantities measured in one system to quantities measured in the other system.

Let's begin the journey.

6.1 Introduction to Ratios and Rates

We use *ratios* to compare two numeric quantities or quantities with the same units.

Ratio. A *ratio* is the quotient of two numerical quantities or two quantities with the same physical units.

For example, ancient Greek geometers believed that the most pleasing rectangle to the eye had length and width such that the ratio of length to width was a specific number, called the *Golden Ratio*, approximately equal to 1.6180339887.... Architects to this day use this ratio in their designs.

There are a number of equivalent ways of expressing ratios, three of which we will use in this text: fraction notation, "to" notation, and "colon" notation.

- 3/4 is a ratio, read as "the ratio of 3 to 4."
- 3 to 4 is a ratio, read as "the ratio of 3 to 4."
- 3:4 is a ratio, read as "the ratio of 3 to 4."

You Try It!

EXAMPLE 1. Express each of the following ratios as a fraction reduced to lowest terms: (a) 36 to 24, and (b) 0.12 : 0.18.

Express 0.12 : 0.3 as a fraction reduced to lowest terms.

Solution

(a) To express the ratio "36 to 24" as a fraction, place 36 over 24 and reduce.

$$\begin{aligned} \frac{36}{24} &= \frac{3 \cdot 12}{2 \cdot 12} && \text{Factor.} \\ &= \frac{3 \cdot \cancel{12}}{2 \cdot \cancel{12}} && \text{Cancel common factor.} \\ &= \frac{3}{2} \end{aligned}$$

Thus, the ratio 36 to 24 equals 3/2.

(b) To express the ratio "0.12:0.18" as a fraction, place 0.12 over 0.18 and reduce.

$$\frac{0.12}{0.18} = \frac{(0.12)(100)}{(0.18)(100)}$$ Multiply numerator and denominator by 100.

$$= \frac{12}{18}$$ Move each decimal 2 places right.

$$= \frac{2 \cdot 6}{3 \cdot 6}$$ Factor.

$$= \frac{2 \cdot \cancel{6}}{3 \cdot \cancel{6}}$$ Cancel.

$$= \frac{2}{3}$$

Thus, the ratio 0.12:0.18 equals 2/3.

Answer: 2/5

□

You Try It!

A rectangle has length $8\frac{1}{4}$ inches and width $3\frac{1}{2}$ inches. Express the ratio of length to width as a fraction reduced to lowest terms.

EXAMPLE 2. For the rectangle that follows, express the ratio of length to width as a fraction reduced to lowest terms.

Solution. The ratio length to width can be expressed as a fraction and reduced as follows.

$$\frac{\text{length}}{\text{width}} = \frac{3\frac{1}{4}\text{ ft}}{2\frac{1}{2}\text{ ft}}$$ Length to width as a fraction.

$$= \frac{3\frac{1}{4}\,\cancel{\text{ft}}}{2\frac{1}{2}\,\cancel{\text{ft}}}$$ Cancel common units.

$$= \frac{\frac{13}{4}}{\frac{5}{2}}$$ Mixed to improper fractions.

Invert and multiply, factor, and cancel common factors.

$$
\begin{aligned}
&= \frac{13}{4} \cdot \frac{2}{5} && \text{Invert and multiply.}\\
&= \frac{26}{20} && \text{Multiply numerators and denominators.}\\
&= \frac{13 \cdot 2}{10 \cdot 2} && \text{Factor numerator and denominator.}\\
&= \frac{13 \cdot \cancel{2}}{10 \cdot \cancel{2}} && \text{Cancel common factors.}\\
&= \frac{13}{10}
\end{aligned}
$$

Hence, the ratio length to width is 13/10. Answer: 33/14

□

Rates

We now introduce the concept of *rate*, a special type of ratio.

Rate. A *rate* is a quotient of two measurements with different units.

The physical interpretation of a rate in terms of its units is an important skill.

You Try It!

EXAMPLE 3. An automobile travels 224 miles on 12 gallons of gasoline. Express the ratio distance traveled to gas consumption as a fraction reduced to lowest terms. Write a short sentence explaining the physical significance of your solution. Include units in your description.

Lanny travels 180 kilometers on 14 liters of gasoline. Express the ratio distance traveled to gas consumption as a fraction reduced to lowest terms.

Solution. Place miles traveled over gallons of gasoline consumed and reduce.

$$
\begin{aligned}
\frac{224\,\text{mi}}{12\,\text{gal}} &= \frac{56 \cdot 4\,\text{mi}}{3 \cdot 4\,\text{gal}} && \text{Factor}\\
&= \frac{56 \cdot \cancel{4}\,\text{mi}}{3 \cdot \cancel{4}\,\text{gal}} && \text{Cancel common factor.}\\
&= \frac{56\,\text{mi}}{3\,\text{gal}}
\end{aligned}
$$

Thus, the rate is 56 miles to 3 gallons of gasoline. In plain-speak, this means that the automobile travels 56 miles on 3 gallons of gasoline.

Answer: 90/7 kilometers per litre.

□

Unit Rates

When making comparisons, it is helpful to have a rate in a form where the denominator is 1. Such rates are given a special name.

Unit Rate. A *unit rate* is a rate whose denominator is 1.

You Try It!

Jacob drives 120 kilometers in 3 hours. Find his average rate of speed.

EXAMPLE 4. Herman drives 120 miles in 4 hours. Find his average rate of speed.

Solution. Place the distance traveled over the time it takes to drive that distance.

$$\frac{120\,\text{miles}}{4\,\text{hours}} = \frac{30\,\text{miles}}{1\,\text{hour}} \qquad \text{Divide: } 120/4 = 30.$$
$$= 30\,\text{miles/hour}$$

Answer: 40 kilometers per hour.

Hence, Herman's average rate of speed is 30 miles per hour. □

You Try It!

Frannie works 5.5 hours and receives \$120 for her efforts. What is her hourly salary rate? Round your answer to the nearest penny.

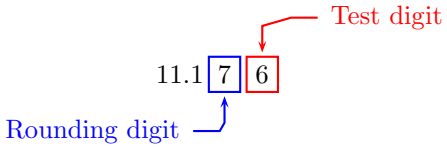
EXAMPLE 5. Aditya works 8.5 hours and receives \$95 for his efforts. What is his hourly salary rate?

Solution. Let's place money earned over hours worked to get the following rate:

$$\frac{95\,\text{dollars}}{8.5\,\text{hours}}$$

We will get a much better idea of Aditya's salary rate if we express the rate with a denominator of 1. To do so, divide. Push the decimal in the divisor to the far right, then move the decimal an equal number of places in the dividend. As we are dealing with dollars and cents, we will round our answer to the nearest hundredth.

$$\begin{array}{r} 11.176 \\ 85\overline{)950.000} \\ \underline{85} \\ 100 \\ \underline{85} \\ 15\,0 \\ \underline{8\,5} \\ 6\,50 \\ \underline{5\,95} \\ 550 \\ \underline{510} \\ 40 \end{array}$$



Because the test digit is greater than or equal to 5, we add 1 to the rounding digit and truncate; i.e., $95/8.5 \approx 11.18$. Hence,

$$\frac{95\,\text{dollars}}{8.5\,\text{hours}} = \frac{11.18\,\text{dollars}}{1\,\text{hour}} = 11.18\,\text{dollars/hour}.$$

Divide: $95/8.5 \approx 11.18$.

That is, his salary rate is 11.18 dollars per hour.

Answer: \$21.82 per hour

□

You Try It!

EXAMPLE 6. One automobile travels 422 miles on 15 gallons of gasoline. A second automobile travels 354 miles on 13 gallons of gasoline. Which automobile gets the better gas mileage?

Alicia works 8 hours and makes \$100. Connie works 10 hours and makes \$122. Which woman works at the larger hourly rate?

Solution. Decimal division (rounded to the nearest tenth) reveals the better gas mileage.

In the case of the first automobile, we get the following rate:

$$\frac{422\,\text{mi}}{15\,\text{gal}}$$

Divide.

$$\begin{array}{r} 28.13 \\ 15\overline{)422.00} \\ \underline{30} \\ 122 \\ \underline{120} \\ 2\,0 \\ \underline{1\,5} \\ 50 \\ \underline{45} \\ 5 \end{array}$$

To the nearest tenth, 28.1.

In the case of the second automobile, we get the following rate:

$$\frac{354\,\text{mi}}{13\,\text{gal}}$$

Divide.

$$\begin{array}{r} 27.23 \\ 13\overline{)354.00} \\ \underline{26} \\ 94 \\ \underline{91} \\ 3\,0 \\ \underline{2\,6} \\ 40 \\ \underline{39} \\ 1 \end{array}$$

To the nearest tenth, 27.2.

In the case of the first automobile, the mileage rate is 28.1 mi/1 gal, which can be read "28.1 miles per gallon." In the case of the second automobile, the mileage rate is 27.2 mi/1 gal, which can be read "27.2 miles per gallon." Therefore, the first automobile gets the better gas mileage.

Answer: Alicia

□

Exercises

In Exercises 1-24, express the given ratio as a fraction reduced to lowest terms.

1. 0.14 : 0.44

2. 0.74 : 0.2

3. 0.05 : 0.75

4. 0.78 : 0.4

5. 0.1 : 0.95

6. 0.93 : 0.39

7. $2\frac{2}{9} : 1\frac{1}{3}$

8. $3\frac{2}{3} : 2\frac{4}{9}$

9. 0.36 : 0.6

10. 0.58 : 0.42

11. 15 : 21

12. 77 : 121

13. $2\frac{8}{9} : 2\frac{2}{3}$

14. $1\frac{2}{3} : 3\frac{8}{9}$

15. $3\frac{8}{9} : 2\frac{1}{3}$

16. $1\frac{5}{9} : 1\frac{1}{3}$

17. $2\frac{5}{8} : 1\frac{3}{4}$

18. $2\frac{4}{9} : 1\frac{1}{3}$

19. 10 : 35

20. 132 : 84

21. 9 : 33

22. 35 : 10

23. 27 : 99

24. 12 : 28

25. One automobile travels 271.8 miles on 10.1 gallons of gasoline. A second automobile travels 257.9 miles on 11.1 gallons of gasoline. Which automobile gets the better gas mileage?

26. One automobile travels 202.9 miles on 13.9 gallons of gasoline. A second automobile travels 221.6 miles on 11.8 gallons of gasoline. Which automobile gets the better gas mileage?

27. Todd is paid 183 dollars for 8.25 hours work. What is his hourly salary rate, rounded to the nearest penny?

28. David is paid 105 dollars for 8.5 hours work. What is his hourly salary rate, rounded to the nearest penny?

29. An automobile travels 140 miles in 4 hours. Find the average rate of speed.

30. An automobile travels 120 miles in 5 hours. Find the average rate of speed.

31. Judah is paid 187 dollars for 8 hours work. What is his hourly salary rate, rounded to the nearest penny?

32. Judah is paid 181 dollars for 8.75 hours work. What is his hourly salary rate, rounded to the nearest penny?

33. One automobile travels 234.2 miles on 10.8 gallons of gasoline. A second automobile travels 270.5 miles on 10.8 gallons of gasoline. Which automobile gets the better gas mileage?

34. One automobile travels 297.6 miles on 10.7 gallons of gasoline. A second automobile travels 298.1 miles on 12.6 gallons of gasoline. Which automobile gets the better gas mileage?

35. An automobile travels 180 miles in 5 hours. Find the average rate of speed.

36. An automobile travels 220 miles in 5 hours. Find the average rate of speed.

37. **Antarctic trek.** Seven women on a 562-mile Antarctic ski trek reached the South Pole 38 days after they began their adventure. What was the ladies' average rate of speed per day? Round your result to the nearest tenth of a mile. *Associated Press-Times-Standard 12/31/09 After 562-mile ski trek, seven women reach the South Pole.*

Answers

1. $\frac{7}{22}$

3. $\frac{1}{15}$

5. $\frac{2}{19}$

7. $\frac{5}{3}$

9. $\frac{3}{5}$

11. $\frac{5}{7}$

13. $\frac{13}{12}$

15. $\frac{5}{3}$

17. $\frac{3}{2}$

19. $\frac{2}{7}$

21. $\frac{3}{11}$

23. $\frac{3}{11}$

25. The first automobile has the better mileage per gallon.

27. 22.18 dollars/hr

29. 35 mi/hr

31. 23.38 dollars/hr

33. The second automobile has the better mileage per gallon.

35. 36 mi/hr

37. 14.8 miles per day

6.2 Introduction to Proportion

In Section 6.1, we introduced the concepts or ratio and rate. In this section, we equate these ratios in a construct called a *proportion*.

Proportions. A *proportion* is a statement that equates two ratios or rates.

For example, each of the equations

$$\frac{1}{3} = \frac{2}{6}, \qquad \frac{15\,\text{miles}}{2\,\text{hours}} = \frac{30\,\text{miles}}{4\,\text{hours}}, \qquad \text{and} \qquad \frac{a}{b} = \frac{c}{d}$$

compare two ratios or rates and is a proportion.

The proportion

$$\frac{1}{3} = \frac{2}{6}$$

is read "one is to three as two is to six." The four numbers that make up this proportion are called the *terms* of the proportion and are ordered in a natural manner.

$$\begin{array}{rl} \text{First term} \longrightarrow & \dfrac{1}{3} = \dfrac{2}{6} \longleftarrow \text{Third term} \\ \text{Second term} \longrightarrow & \dfrac{1}{3} = \dfrac{2}{6} \longleftarrow \text{Fourth term} \end{array}$$

Extremes and Means. The first and fourth terms are called the *extremes* of the proportion. The second and third terms are called the *means* of the proportion.

In the proportion

$$\frac{a}{b} = \frac{c}{d},$$

the terms a and d are the extremes; the terms b and c are the means.

$$\frac{\boxed{a}}{b} = \frac{c}{\boxed{d}} \quad \textit{extremes} \qquad\qquad a \;\boxed{=}\; \frac{\boxed{c}}{d} \quad \textit{means}$$

If we multiply both sides of the proportion by the common denominator,

$$bd\left(\frac{a}{b}\right) = bd\left(\frac{c}{d}\right)$$

then cancel,

$$\cancel{b}d\left(\frac{a}{\cancel{b}}\right) = b\cancel{d}\left(\frac{c}{\cancel{d}}\right)$$

we get the following result.

$$ad = bc$$

This leads to the following observation.

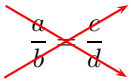
Product of Extremes and Means. In the proportion

$$\frac{a}{b} = \frac{c}{d}$$

the product of the means equals the product of the extremes. That is,

$$ad = bc.$$

We can get an equivalent result using a technique called *cross multiplication.*



Product of means $= bc$

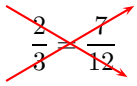
Product of extremes $= ad$

You Try It!

EXAMPLE 1. Which of the following is a valid proportion: (a) $\frac{2}{3} = \frac{7}{12}$, or (b) $\frac{4}{9} = \frac{12}{27}$.

Solution.

(a) Cross multiply



Product of means

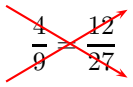
Product of extremes

to get

$$24 = 21.$$

Hence, the product of the extremes does not equal the product of the means, so $2/3 = 7/12$ is **not** a valid proportion.

(b) Cross multiply



Product of means

Product of extremes

to get

$$108 = 108.$$

Hence, the product of the extremes equals the product of the means, so $4/9 = 12/27$ **is** a valid proportion.

Is the following a valid proportion?

$$\frac{4}{3} = \frac{16}{11}$$

Answer: No

□

Solving Proportions

We already have all the tools needed to solve proportions. Let's begin with the first example.

You Try It!

Solve the proportion for n:

$$\frac{2}{3} = \frac{n}{9}$$

EXAMPLE 2. Solve the proportion for x: $\frac{3}{4} = \frac{x}{12}$.

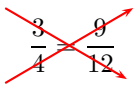
Solution. Cross multiply, then solve the resulting equation.

$$\begin{aligned}
\frac{3}{4} &= \frac{x}{12} && \text{Original proportion.}\\
4 \cdot x &= 3 \cdot 12 && \text{Products of means and extremes are equal.}\\
4x &= 36 && \text{Simplify.}\\
\frac{4x}{4} &= \frac{36}{4} && \text{Divide both sides by 4.}\\
x &= 9 && \text{Simplify.}
\end{aligned}$$

Check. Substitute 9 for x into the original proportion and check.

$$\begin{aligned}
\frac{3}{4} &= \frac{x}{12} && \text{Original proportion.}\\
\frac{3}{4} &= \frac{9}{12} && \text{Substitute 9 for } x.
\end{aligned}$$

Cross multiply.



Product of means = 36

Product of extremes = 36

Answer: 6

Thus, the solution 9 checks. □

You Try It!

Solve the proportion for m:

$$\frac{9}{6} = \frac{m}{4}$$

EXAMPLE 3. Solve the proportion for n: $\frac{3}{2} = \frac{24}{n}$.

Solution. Cross multiply, then solve the resulting equation.

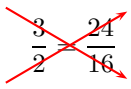
$$\begin{aligned}
\frac{3}{2} &= \frac{24}{n} && \text{Original proportion.}\\
3 \cdot n &= 2 \cdot 24 && \text{Products of means and extremes are equal.}\\
3n &= 48 && \text{Simplify.}\\
\frac{3n}{3} &= \frac{48}{3} && \text{Divide both sides by 3.}\\
n &= 16 && \text{Simplify.}
\end{aligned}$$

Check. Substitute 16 for n into the original proportion and check.

$$\frac{3}{2} = \frac{24}{n}$$ Original proportion.

$$\frac{3}{2} = \frac{24}{16}$$ Substitute 16 for n.

Cross multiply.



Product of means = 48

Product of extremes = 48

Thus, the solution 16 checks.

Answer: 6

□

You Try It!

EXAMPLE 4. Solve the proportion for x: $\frac{2x+1}{15} = \frac{1}{3}$.

Solve the proportion for y:

$$\frac{6+2y}{18} = \frac{8}{9}$$

Solution. Cross multiply, then solve the resulting equation.

$$\frac{2x+1}{15} = \frac{1}{3}$$ Original proportion.

$$3(2x+1) = 15(1)$$ Products of means and extremes are equal.

$$6x+3 = 15$$ On the left, distribute. On the right, multiply.

$$6x+3-3 = 15-3$$ Subtract 3 from both sides.

$$6x = 12$$ Simplify.

$$\frac{6x}{6} = \frac{12}{6}$$ Divide both sides by 6.

$$x = 2$$ Simplify both sides.

Check. We'll leave it to our readers to check this solution.

Answer: 5

□

Applications

A number of practical applications involve solving a proportion.

You Try It!

EXAMPLE 5. If 5 oranges cost \$1.15, what will be the cost for 15 oranges (assuming an equal rate)?

If 7 apples cost \$3.15, how much will 10 apples cost (assuming an equal rate)?

Solution. Let x represent the cost for 15 oranges. Assuming the rate for 5 oranges at \$1.15 equals the rate for 15 oranges at an unknown cost x, we set up the following proportion.

$$\frac{5}{1.15} = \frac{15}{x}$$

Cross multiply

$$\frac{5}{1.15} = \frac{15}{x}$$

Product of means $= (1.15)(15)$

Product of extremes $= 5x$

to get

$$5x = 17.25.$$

Solve for x.

$$\frac{5x}{5} = \frac{17.25}{5}$$
$$x = 3.45$$

Answer: \$4.50

Thus, 15 oranges cost \$3.45. □

Checking Units is Extremely Important. When setting up a proportion, check to make sure that both numerators have the same units and both denominators have the same units.

For example, in Example 5, both numerators have "oranges" as units and both denominators have "dollars" as units.

$$\begin{array}{rcl} \text{Oranges} \longrightarrow & \frac{5}{1.15} = \frac{15}{x} & \longleftarrow \text{Oranges} \\ \text{Dollars} \longrightarrow & & \longleftarrow \text{Dollars} \end{array}$$

This proportion is set up correctly, because both numerators have the same units and both denominators have the same units.

On the other hand, if we had set the proportion up incorrectly as follows,

$$\begin{array}{rcl} \text{Oranges} \longrightarrow & \frac{5}{1.15} = \frac{x}{15} & \longleftarrow \text{Dollars} \\ \text{Dollars} \longrightarrow & & \longleftarrow \text{Oranges} \end{array}$$

a quick check of the units reveals the error; i.e., the numerators have different units and the denominators have different units. *Checking units helps us avoid errors!*

You Try It!

EXAMPLE 6. Dylan and David are planning a backpacking trip in Yosemite National Park. On their map, the legend indicates that 1.2 centimeters represents 2 miles. How long is their trip if the route measures 10.6 centimeters on the map? Round your answer to the nearest tenth of a mile.

Eloise and Susannah are planning a trip is Sequoia National Park. On their map, 3 inches represents 50 miles. How long is their trip if the route measures $4\frac{1}{2}$ inches on the map?

Solution. Let's set up the proportion with units.

$$\frac{1.2\,\text{cm}}{2\,\text{mi}} = \frac{10.6\,\text{cm}}{x\,\text{mi}}$$

Note how including the units aids in the setup of the proportion. Now, let's drop the units and solve for x.

$$\begin{aligned}
\frac{1.2}{2} &= \frac{10.6}{x} && \text{Original proportion.}\\
1.2x &= (2)(10.6) && \text{Cross multiply.}\\
1.2x &= 21.2 && \text{Simplify right-hand side.}\\
\frac{1.2x}{1.2} &= \frac{21.2}{1.2} && \text{Divide both sides by 1.2.}\\
x &\approx 17.66 && \text{On the right: Divide.}
\end{aligned}$$

We carried the division on the right one decimal place past the tenths place. The rounding digit is a 6 and the following test digit is a 6. Add 1 to the rounding digit and truncate.

To the nearest tenth of a mile, the backpacking route is approximately 17.7 miles.

Answer: 75 miles

□

You Try It!

EXAMPLE 7. A recipe making 2 dozen cookies requires $1\frac{3}{4}$ cups of flour, among other ingredients. If the baker wishes to make twice that number of cookies, how much flour is required?

Dough for 3 pizzas requires $8\frac{1}{2}$ cups of flour. If the baker wishes to make 9 pizzas, how many cups of flour are required?

Solution. Twice 2 dozen is 4 dozen cookies. Let x represent the amount of flour needed for 4 dozen cookies. Assuming an equal rate for 2 dozen cookies (2 dozen requires $1\frac{3}{4}$ cups of flour), we set up the following proportion. Again, using units helps us craft the correct proportion.

$$\frac{2\,\text{dozen}}{1\frac{3}{4}\,\text{cups}} = \frac{4\,\text{dozen}}{x\,\text{cups}}$$

Note how including the units aids in the setup of the proportion. Now, let's drop the units and solve for x.

$$\begin{aligned}
\frac{2}{1\frac{3}{4}} &= \frac{4}{x} && \text{Original proportion.}\\
2x &= 1\frac{3}{4}\cdot 4 && \text{Cross multiply.}\\
2x &= \frac{7}{4}\cdot 4 && \text{Change to improper fraction.}\\
2x &= 7 && \text{Multiply.}
\end{aligned}$$

Divide both sides of the equation by 2 and finish.

$$\frac{2x}{2} = \frac{7}{2} \qquad \text{Divide both sides by 2.}$$
$$x = \frac{7}{2}$$

Change the improper fraction to a mixed fraction. Thus, it will take $3\frac{1}{2}$ cups of flour to make 4 dozen cookies.

Answer: $25\frac{1}{2}$ cups

□

Exercises

In Exercises 1-12, which of the following is a true proportion?

1. $\frac{9}{7}=\frac{27}{21}$, $\frac{4}{3}=\frac{9}{7}$, $\frac{7}{2}=\frac{8}{9}$, $\frac{4}{8}=\frac{9}{6}$

2. $\frac{6}{7}=\frac{18}{21}$, $\frac{2}{3}=\frac{8}{6}$, $\frac{4}{3}=\frac{3}{2}$, $\frac{8}{9}=\frac{3}{8}$

3. $\frac{7}{6}=\frac{28}{24}$, $\frac{5}{6}=\frac{5}{4}$, $\frac{9}{5}=\frac{7}{3}$, $\frac{9}{2}=\frac{8}{9}$

4. $\frac{7}{6}=\frac{2}{8}$, $\frac{4}{5}=\frac{5}{7}$, $\frac{3}{4}=\frac{15}{20}$, $\frac{8}{4}=\frac{8}{7}$

5. $\frac{6}{5}=\frac{24}{20}$, $\frac{7}{3}=\frac{2}{4}$, $\frac{2}{4}=\frac{2}{6}$, $\frac{5}{2}=\frac{2}{8}$

6. $\frac{9}{8}=\frac{4}{3}$, $\frac{5}{7}=\frac{10}{14}$, $\frac{8}{6}=\frac{5}{4}$, $\frac{8}{5}=\frac{2}{6}$

7. $\frac{3}{5}=\frac{2}{8}$, $\frac{3}{7}=\frac{6}{14}$, $\frac{5}{6}=\frac{2}{4}$, $\frac{7}{4}=\frac{5}{9}$

8. $\frac{7}{3}=\frac{7}{6}$, $\frac{4}{7}=\frac{8}{14}$, $\frac{5}{3}=\frac{7}{8}$, $\frac{5}{7}=\frac{6}{9}$

9. $\frac{5}{4}=\frac{25}{20}$, $\frac{9}{3}=\frac{9}{6}$, $\frac{7}{4}=\frac{3}{6}$, $\frac{3}{5}=\frac{9}{4}$

10. $\frac{7}{6}=\frac{6}{9}$, $\frac{7}{3}=\frac{2}{5}$, $\frac{6}{7}=\frac{30}{35}$, $\frac{4}{7}=\frac{2}{8}$

11. $\frac{9}{7}=\frac{4}{3}$, $\frac{9}{4}=\frac{7}{9}$, $\frac{3}{5}=\frac{6}{10}$, $\frac{3}{9}=\frac{9}{5}$

12. $\frac{4}{3}=\frac{8}{7}$, $\frac{2}{6}=\frac{5}{8}$, $\frac{7}{2}=\frac{3}{6}$, $\frac{9}{4}=\frac{36}{16}$

In Exercises 13-36, solve the given proportion.

13. $\frac{17}{3}=\frac{x}{18}$

14. $\frac{16}{5}=\frac{x}{20}$

15. $\frac{6x+10}{6}=\frac{11}{3}$

16. $\frac{4x+8}{12}=\frac{5}{3}$

17. $\frac{17}{9}=\frac{x}{18}$

18. $\frac{8}{9}=\frac{x}{18}$

19. $\frac{11}{2}=\frac{x}{8}$

20. $\frac{11}{4}=\frac{x}{8}$

21. $\frac{7x+15}{15}=\frac{10}{3}$

22. $\frac{7x+3}{8}=\frac{5}{4}$

23. $\frac{11}{2}=\frac{x}{10}$

24. $\frac{19}{6}=\frac{x}{18}$

25. $\frac{5x+8}{12}=\frac{2}{3}$

26. $\frac{3x+12}{6}=\frac{3}{2}$

27. $\frac{2}{15}=\frac{24}{x}$

28. $\frac{7}{8}=\frac{14}{x}$

29. $\frac{3}{16}=\frac{6}{x}$

30. $\frac{4}{21}=\frac{12}{x}$

31. $\frac{5}{22}=\frac{20}{x}$

32. $\frac{3}{22}=\frac{21}{x}$

33. $\frac{2x+10}{6}=\frac{14}{3}$

34. $\dfrac{2x+9}{9} = \dfrac{13}{3}$

35. $\dfrac{7}{2} = \dfrac{21}{x}$

36. $\dfrac{2}{15} = \dfrac{18}{x}$

---

37. If 13 dog bones cost \$1.97, what will be the cost for 7 dog bones (assuming an equal rate)? Round your answer to the nearest penny.

38. If 2 watermelons cost \$3.89, what will be the cost for 11 watermelons (assuming an equal rate)? Round your answer to the nearest penny.

39. If 7 bananas cost \$2.55, what will be the cost for 14 bananas (assuming an equal rate)? Round your answer to the nearest penny.

40. If 2 apples cost \$2.05, what will be the cost for 8 apples (assuming an equal rate)? Round your answer to the nearest penny.

41. If 13 oranges cost \$3.61, what will be the cost for 11 oranges (assuming an equal rate)? Round your answer to the nearest penny.

42. If 3 watermelons cost \$1.05, what will be the cost for 9 watermelons (assuming an equal rate)? Round your answer to the nearest penny.

43. If 3 dog bones cost \$1.23, what will be the cost for 13 dog bones (assuming an equal rate)? Round your answer to the nearest penny.

44. If 3 watermelons cost \$4.41, what will be the cost for 7 watermelons (assuming an equal rate)? Round your answer to the nearest penny.

45. If 3 apples cost \$3.24, what will be the cost for 13 apples (assuming an equal rate)? Round your answer to the nearest penny.

46. If 6 apples cost \$3.43, what will be the cost for 7 apples (assuming an equal rate)? Round your answer to the nearest penny.

47. If 4 dog bones cost \$1.03, what will be the cost for 8 dog bones (assuming an equal rate)? Round your answer to the nearest penny.

48. If 4 oranges cost \$4.28, what will be the cost for 3 oranges (assuming an equal rate)? Round your answer to the nearest penny.

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49. **Two rolls.** In Haiti, two flat rolls cost 5 gourdes, about 12 cents. How many cents would 20 rolls cost? *Associated Press-Times-Standard 02/18/10 Haiti's earthquake camps turning into shanty towns.*

50. **Turbines.** As proposed, the Shell Wind Energy project consists of 25 ridge-top turbines that can generate up to 50 megawatts, or enough to supply electricity to about 1,000 homes. Estimate the number of ridge-top turbines that would be needed to supply electricity to 70,000 homes, the approximate number of properties in Humboldt County, CA. *John Driscoll Times-Standard 12/24/09 Wind power project goes under analysis.*

51. **Dumptrucks.** U.S. Highway 199 had a landslide where as much as 3,000 cubic yards of material fell on the road, reportedly requiring about 200 large dumptrucks to remove. Only a week earlier, 40,000 cubic yards of material fell on Highway 96. Estimate the number of dumptrucks needed for that slide rounded to the nearest whole number. *Associated Press-Times-Standard 03/09/10 Another highway closed by slide.*

52. **Timber sales.** Alaska's 26,000 square mile Tongass National Forest plan allows for timber sales of up to 267 million board-feet per year – enough for nearly 27,000 two-bedroom homes, but demand for timber is far short of that. Less than 25 million board-feet was logged in the forest in 2009. Forest Service officials have said they hope to increase logging in the Tongass to about 100 million board-feet per year. *Associated Press-Times-Standard 02/18/10 Industry loses lawsuit over logging in Alaska.*

i) Estimate the number of 2-bedroom homes that 25 million board-feet of timber would build.

ii) How many 2-bedroom homes would 100 million board-feet of timber build?

53. **Costly spill.** In Australia, penalties on ships causing oil spills are approximately $1.75 million Australian dollars, equivalent to about $1.64 million US dollars. After an oil tanker was grounded onto a coral reef, Australian officials are considering raising the fine to $10 million Australian dollars. What will the new fine be in US dollars? Round your answer to the nearest hundredth of a million dollars. *Associated Press-Times-Standard 04/13/10 Ship that leaked oil on Great Barrier Reef removed.*

Answers

1. $\frac{9}{7} = \frac{27}{21}$ is a proportion

3. $\frac{7}{6} = \frac{28}{24}$ is a proportion

5. $\frac{6}{5} = \frac{24}{20}$ is a proportion

7. $\frac{3}{7} = \frac{6}{14}$ is a proportion

9. $\frac{5}{4} = \frac{25}{20}$ is a proportion

11. $\frac{3}{5} = \frac{6}{10}$ is a proportion

13. 102

15. 2

17. 34

19. 44

21. 5

23. 55

25. 0

27. 180

29. 32

31. 88

33. 9

35. 6

37. $1.06

39. \$5.10

41. \$3.05

43. \$5.33

45. \$14.04

47. \$2.06

49. \$0.48

51. $2,667$ loads

53. \$9.37 million US dollars

6.3 Unit Conversion: American System

In this section we will develop a technique for converting units used in the American system. We begin with a discussion of common measurements of length in the United States.

Units of Length

The most common units of length are the inch, foot, yard, and mile. Our focus will be on the technique used to convert from one unit of length to another.

American Units of Length. Facts relating common units of length.

$$1\,\text{foot (ft)} = 12\,\text{inches (in)} \qquad 1\,\text{yard (yd)} = 3\,\text{feet (ft)}$$
$$1\,\text{mile (mi)} = 5280\,\text{feet (ft)}$$

Take for example, the fact that there are 3 feet in 1 yard, which can be stated as an equation, using the common abbreviations for feet (ft) and yards (yd).

$$3\,\text{ft} = 1\,\text{yd}$$

If we divide both sides of the equation by 3 ft,

$$\frac{3\,\text{ft}}{3\,\text{ft}} = \frac{1\,\text{yd}}{3\,\text{ft}},$$

or equivalently,

$$1 = \frac{1\,\text{yd}}{3\,\text{ft}}.$$

The key observation is the fact that the ratio $1\,\text{yd}/3\,\text{ft}$ equals the number 1. Consequently, multiplying by the "conversion factor" $1\,\text{yd}/3\,\text{ft}$ is equivalent to multiplying by 1. This can be used to change a measurement in feet to yards.

You Try It!

EXAMPLE 1. Change 36 feet to yards.

Change 81 feet to yards.

Solution. Multiply by the conversion factor 1 yd/3 ft.

$$\begin{aligned} 36\,\text{ft} &= 36\,\text{ft} \cdot 1 && \text{Multiplicative Identity Property.} \\ &= 36\,\text{ft} \cdot \frac{1\,\text{yd}}{3\,\text{ft}} && \text{Replace 1 with 1 yd/3 ft.} \\ &= 36\,\cancel{\text{ft}} \cdot \frac{1\,\text{yd}}{3\,\cancel{\text{ft}}} && \text{Cancel common unit.} \\ &= \frac{36 \cdot 1}{3}\,\text{yd} && \text{Multiply fractions.} \\ &= \frac{36}{3}\,\text{yd} && \text{Simplify.} \\ &= 12\,\text{yd} && \text{Divide.} \end{aligned}$$

Answer: 27 yards

Hence, 36 feet equals 12 yards. □

On the other hand, we can start again with

$$3\,\text{ft} = 1\,\text{yd}$$

and divide both sides of the equation by 1 yd.

$$\frac{3\,\text{ft}}{1\,\text{yd}} = \frac{1\,\text{yd}}{1\,\text{yd}}$$

This gives the conversion factor

$$\frac{3\,\text{ft}}{1\,\text{yd}} = 1.$$

The key observation is the fact that the ratio 3 ft/1 yd equals the number 1. Consequently, multiplying by the "conversion factor" 3 ft/1 yd is equivalent to multiplying by 1. This can be used to change a measurement in yards to feet.

You Try It!

Change 15 yards to feet.

EXAMPLE 2. Change 18 yards to feet.

Solution. Multiply by the conversion factor 3 ft/1 yd.

$$\begin{aligned} 18\,\text{yd} &= 18\,\text{yd} \cdot 1 && \text{Multiplicative Identity Property.} \\ &= 18\,\text{yd} \cdot \frac{3\,\text{ft}}{1\,\text{yd}} && \text{Replace 1 with 3 ft/1 yd.} \\ &= 18\,\cancel{\text{yd}} \cdot \frac{3\,\text{ft}}{1\,\cancel{\text{yd}}} && \text{Cancel common unit.} \\ &= \frac{18 \cdot 3}{1}\,\text{ft} && \text{Multiply fractions.} \\ &= 54\,\text{ft} && \text{Simplify.} \end{aligned}$$

Hence, 18 yards equals 54 feet. Answer: 45 feet

□

Another common comparison is the fact that there are 12 inches in 1 foot. This can be represented as an equation using the common abbreviation for inches (in) and feet (ft).

$$12\,\text{in} = 1\,\text{ft}$$

Dividing both sides by 12 in

$$\frac{12\,\text{in}}{12\,\text{in}} = \frac{1\,\text{ft}}{12\,\text{in}},$$

yields the conversion factor

$$1 = \frac{1\,\text{ft}}{12\,\text{in}}.$$

The key observation is the fact that the ratio 1 ft/12 in equals the number 1. Consequently, multiplying by the "conversion factor" 1 ft/12 in is equivalent to multiplying by 1. This can be used to change a measurement in inches to feet.

You Try It!

EXAMPLE 3. Change 24 inches to feet. Change 48 inches to feet.

Solution. Multiply by the conversion factor 1 ft/12 in.

$$\begin{aligned} 24\,\text{in} &= 24\,\text{in} \cdot 1 && \text{Multiplicative Identity Property.} \\ &= 24\,\text{in} \cdot \frac{1\,\text{ft}}{12\,\text{in}} && \text{Replace 1 with 1 ft/12 in.} \\ &= 24\,\cancel{\text{in}} \cdot \frac{1\,\text{ft}}{12\,\cancel{\text{in}}} && \text{Cancel common unit.} \\ &= \frac{24 \cdot 1}{12}\,\text{ft} && \text{Multiply fractions.} \\ &= 2\,\text{ft} && \text{Simplify.} \end{aligned}$$

Hence, 24 inches equals 2 feet. Answer: 4 feet

□

We provide a summary of conversion factors for units of length in Table 6.1.

Convert	Conversion Factor	Convert	Conversion Factor
feet to inches	12 in/1 ft	inches to feet	1 ft/12 in
yards to feet	3 ft/1 yd	feet to yards	1 yd/3 ft
miles to feet	5280 ft/1 mi	feet to miles	1 mi/5280 ft

Table 6.1: Conversion factors for units of length.

Some conversions require more than one application of a conversion factor.

You Try It!

Change 8 yards to inches.

EXAMPLE 4. Change 4 yards to inches.

Solution. We multiply by a chain of conversion factors, the first to change yards to feet, the second to change feet to inches.

$$\begin{aligned} 4\,\text{yd} &= 4\,\text{yd} \cdot \frac{3\,\text{ft}}{1\,\text{yd}} \cdot \frac{12\,\text{in}}{1\,\text{ft}} && \text{Multiply by conversion factors.} \\ &= 4\,\cancel{\text{yd}} \cdot \frac{3\,\cancel{\text{ft}}}{1\,\cancel{\text{yd}}} \cdot \frac{12\,\text{in}}{1\,\cancel{\text{ft}}} && \text{Cancel common units.} \\ &= \frac{4 \cdot 3 \cdot 12}{1 \cdot 1}\,\text{in} && \text{Multiply fractions.} \\ &= 144\,\text{in} && \text{Simplify.} \end{aligned}$$

Answer: 288 inches

Hence, 4 yards equals 144 inches. □

You Try It!

Change 5 miles to yards.

EXAMPLE 5. Change 2 miles to yards.

Solution. We multiply by a chain of conversion factors, the first to change miles to feet, the second to change feet to yards.

$$\begin{aligned} 2\,\text{mi} &= 2\,\text{mi} \cdot \frac{5280\,\text{ft}}{1\,\text{mi}} \cdot \frac{1\,\text{yd}}{3\,\text{ft}} && \text{Multiply by conversion factors.} \\ &= 2\,\cancel{\text{mi}} \cdot \frac{5280\,\cancel{\text{ft}}}{1\,\cancel{\text{mi}}} \cdot \frac{1\,\text{yd}}{3\,\cancel{\text{ft}}} && \text{Cancel common units.} \\ &= \frac{2 \cdot 5280 \cdot 1}{1 \cdot 3}\,\text{yd} && \text{Multiply fractions.} \\ &= 3520\,\text{yd} && \text{Simplify.} \end{aligned}$$

Answer: 8,800 yards

Hence, 2 miles equals 3,520 yards. □

Units of Weight

The most common units of weight are the ounce, pound, and ton. Our focus will remain on how to convert from one unit to another.

American Units of Weight. Facts relating common units of weight.

$$1\,\text{pound (lb)} = 16\,\text{ounces (oz)} \qquad 1\,\text{ton} = 2000\,\text{pounds (lb)}$$

The above facts lead to the conversion factors in Table 6.2.

Convert	Conversion Factor	Convert	Conversion Factor
pounds to ounces	$16\,\text{oz}/1\,\text{lb}$	ounces to pounds	$1\,\text{lb}/16\,\text{oz}$
tons to pounds	$2000\,\text{lb}/1\,\text{ton}$	pounds to tons	$1\,\text{ton}/2000\,\text{lb}$

Table 6.2: Conversion factors for units of weight.

You Try It!

EXAMPLE 6. Change $2\frac{1}{2}$ pounds to ounces.

Change $6\frac{1}{4}$ pounds to ounces.

Solution. Multiply by the appropriate conversion factor.

$$\begin{aligned} 2\frac{1}{2}\,\text{lb} &= 2\frac{1}{2}\,\text{lb}\cdot\frac{16\,\text{oz}}{1\,\text{lb}} && \text{Multiply by conversion factor.}\\ &= 2\frac{1}{2}\,\cancel{\text{lb}}\cdot\frac{16\,\text{oz}}{1\,\cancel{\text{lb}}} && \text{Cancel common units.}\\ &= \left(2\frac{1}{2}\cdot 16\right)\text{oz} && \text{Multiply fractions.}\\ &= \left(\frac{5}{2}\cdot 16\right)\text{oz} && \text{Mixed to improper fraction.}\\ &= \frac{80}{2}\,\text{oz} && \text{Multiply.}\\ &= 40\,\text{oz} && \text{Divide.} \end{aligned}$$

Hence, $2\frac{1}{2}$ pounds equals 40 ounces.

Answer: 100 ounces

□

You Try It!

EXAMPLE 7. Change 3.2 tons to ounces.

Change 4.1 tons to ounces.

Solution. This exercise requires multiplying by a chain of conversion factors.

$$\begin{aligned} 3.2\,\text{ton} &= 3.2\,\text{ton}\cdot\frac{2000\,\text{lb}}{1\,\text{ton}}\cdot\frac{16\,\text{oz}}{1\,\text{lb}} && \text{Multiply by conversion factors.}\\ &= 3.2\,\cancel{\text{ton}}\cdot\frac{2000\,\cancel{\text{lb}}}{1\,\cancel{\text{ton}}}\cdot\frac{16\,\text{oz}}{1\,\cancel{\text{lb}}} && \text{Cancel common units.}\\ &= \frac{3.2\cdot 2000\cdot 16}{1\cdot 1}\,\text{oz} && \text{Multiply fractions.}\\ &= 102,400\,\text{oz} && \text{Simplify.} \end{aligned}$$

Hence, 3.2 tons equals 102,400 ounces.

Answer: 128,000 ounces

□

Units of Volume

The most common units of volume are fluid ounces, cups, pints, quarts, and gallons. We will focus on converting from one unit to another.

American Units of Volume. Facts relating common units of volume.

$1\,\text{cup (c)} = 8\,\text{fluid ounces (fl oz)}$ $\qquad$ $1\,\text{pint (pt)} = 2\,\text{cups (c)}$

$1\,\text{quart (qt)} = 2\,\text{pints (pt)}$ $\qquad$ $1\,\text{gallon (gal)} = 4\,\text{quarts (qt)}$

These facts lead to the conversion factors listed in Table 6.3.

Convert	Conversion Factor	Convert	Conversion Factor
cups to ounces	$8\,\text{fl oz}/1\ \text{c}$	ounces to cups	$1\,\text{c}/8\,\text{fl oz}$
pints to cups	$2\,\text{c}/1\,\text{pt}$	cups to pints	$1\,\text{pt}/2\,\text{c}$
quarts to pints	$2\,\text{pt}/1\,\text{qt}$	pints to quarts	$1\,\text{qt}/2\,\text{pt}$
gallons to quarts	$4\,\text{qt}/1\,\text{gal}$	quarts to gallons	$1\,\text{gal}/4\,\text{qt}$

Table 6.3: Conversion factors for units of volume.

You Try It!

Change 3.2 gallons to pints.

EXAMPLE 8. Change 5.6 gallons to pints.

Solution. This exercise requires multiplying by a chain of conversion factors.

$$5.6\,\text{gal} = 5.6\,\text{gal} \cdot \frac{4\,\text{qt}}{1\,\text{gal}} \cdot \frac{2\,\text{pt}}{1\,\text{qt}} \qquad \text{Multiply by conversion factors.}$$

$$= 5.6\,\cancel{\text{gal}} \cdot \frac{4\,\cancel{\text{qt}}}{1\,\cancel{\text{gal}}} \cdot \frac{2\,\text{pt}}{1\,\cancel{\text{qt}}} \qquad \text{Cancel common units.}$$

$$= \frac{5.6 \cdot 4 \cdot 2}{1 \cdot 1}\,\text{pt} \qquad \text{Multiply fractions.}$$

$$= 44.8\,\text{pt} \qquad \text{Simiplify.}$$

Answer: 25.6 pints

Hence, 5.6 gallons equals 44.8 pints. □

Units of Time

The most common units of time are seconds, minutes, hours, days, and years.

American Units of Time. Facts relating common units of time.

$1\,\text{minute (min)} = 60\,\text{seconds (s)}$ $\qquad$ $1\,\text{hour (hr)} = 60\,\text{minutes (min)}$

$1\,\text{day (day)} = 24\,\text{hours (hr)}$ $\qquad$ $1\,\text{year (yr)} = 365\,\text{days (day)}$

These facts lead to the conversion factors in Table 6.4.

Convert	Conversion Factor	Convert	Conversion Factor
minutes to seconds	$60\,\text{s}/1\,\text{min}$	seconds to minutes	$1\,\text{min}/60\,\text{s}$
hours to minutes	$60\,\text{min}/1\,\text{hr}$	minutes to hours	$1\,\text{hr}/60\,\text{min}$
days to hours	$24\,\text{hr}/1\,\text{day}$	hours to days	$1\,\text{day}/24\,\text{hr}$
years to days	$365\,\text{day}/1\,\text{yr}$	days to years	$1\,\text{yr}/365\,\text{day}$

Table 6.4: Conversion factors for units of time.

You Try It!

EXAMPLE 9. How many seconds in a year?

How many seconds in a day?

Solution. A chain of conversion factors is needed.

$$1\,\text{yr} = 1\,\text{yr} \cdot \frac{365\,\text{day}}{1\,\text{yr}} \cdot \frac{24\,\text{hr}}{1\,\text{day}} \cdot \frac{60\,\text{min}}{1\,\text{hr}} \cdot \frac{60\,\text{s}}{1\,\text{min}} \qquad \text{Conversion factors.}$$

$$= 1\,\cancel{\text{yr}} \cdot \frac{365\,\cancel{\text{day}}}{1\,\cancel{\text{yr}}} \cdot \frac{24\,\cancel{\text{hr}}}{1\,\cancel{\text{day}}} \cdot \frac{60\,\cancel{\text{min}}}{1\,\cancel{\text{hr}}} \cdot \frac{60\,\text{s}}{1\,\cancel{\text{min}}} \qquad \text{Cancel common units.}$$

$$= \frac{1 \cdot 365 \cdot 24 \cdot 60 \cdot 60}{1 \cdot 1 \cdot 1 \cdot 1}\,\text{s} \qquad \text{Multiply fractions.}$$

$$= 31,536,000\,\text{s} \qquad \text{Simplify.}$$

Thus, 1 year equals 31,536,000 seconds.

Answer: 86,400 seconds

□

Converting Units of Speed

Ever wonder how fast a baseball is moving?

You Try It!

EXAMPLE 10. A professional pitcher can throw a baseball at 95 miles per hour. How fast is this in feet per second? Round your answer to the nearest foot per second.

A women's softball pitcher can throw her fastball at 60 miles per hour. How fast is this in feet per second? Round your answer to the nearest foot per second.

Solution. There are 5280 feet in a mile, 60 minutes in an hour, and 60 seconds in a minute.

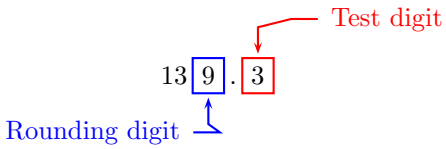
$$95\,\frac{\text{mi}}{\text{h}} \approx 95\,\frac{\text{mi}}{\text{h}} \cdot \frac{5280\,\text{ft}}{1\,\text{mi}} \cdot \frac{1\,\text{h}}{60\,\text{min}} \cdot \frac{1\,\text{min}}{60\,\text{s}} \qquad \text{Conversion factors.}$$

$$\approx 95\,\frac{\cancel{\text{mi}}}{\cancel{\text{h}}} \cdot \frac{5280\,\text{ft}}{1\,\cancel{\text{mi}}} \cdot \frac{1\,\cancel{\text{h}}}{60\,\cancel{\text{min}}} \cdot \frac{1\,\cancel{\text{min}}}{60\,\text{s}} \qquad \text{Cancel common units.}$$

$$\approx \frac{95 \cdot 5280 \cdot 1 \cdot 1}{1 \cdot 60 \cdot 60}\,\frac{\text{ft}}{\text{s}} \qquad \text{Multiply fractions.}$$

$$\approx 139.3\,\frac{\text{ft}}{\text{s}} \qquad \text{Multiply and divide.}$$

To round to the nearest foot per second, identify the rounding and test digits.



Because the test digit is less than 5, leave the rounding digit alone and truncate. Thus, to the nearest foot per second, the speed is approximately 139 feet per second.

Whew! Since the batter stands at home plate, which is about 60 feet from where the pitch is delivered, the batter has less than 1/2 a second to react to the pitch!

Answer: 88 feet per second

□

Exercises

1. Change 8 yards to feet.

2. Change 60 yards to feet.

3. Change 261 feet to yards.

4. Change 126 feet to yards.

5. Change 235 inches to yards. Round your answer to the nearest tenth of a yard.

6. Change 244 inches to yards. Round your answer to the nearest tenth of a yard.

7. Change 141 feet to yards.

8. Change 78 feet to yards.

9. Change 2.8 miles to feet.

10. Change 4.9 miles to feet.

11. Change 104 inches to yards. Round your answer to the nearest tenth of a yard.

12. Change 101 inches to yards. Round your answer to the nearest tenth of a yard.

13. Change 168,372 inches to miles, correct to the nearest tenth of a mile.

14. Change 198,550 inches to miles, correct to the nearest tenth of a mile.

15. Change 82 feet to inches.

16. Change 80 feet to inches.

17. Change 2.9 yards to inches. Round your answer to the nearest inch.

18. Change 4.5 yards to inches. Round your answer to the nearest inch.

19. Change 25,756 feet to miles. Round your answer to the nearest tenth of a mile.

20. Change 19,257 feet to miles. Round your answer to the nearest tenth of a mile.

21. Change 5 yards to feet.

22. Change 20 yards to feet.

23. Change 169,312 inches to miles, correct to the nearest tenth of a mile.

24. Change 162,211 inches to miles, correct to the nearest tenth of a mile.

25. Change 1.5 yards to inches. Round your answer to the nearest inch.

26. Change 2.1 yards to inches. Round your answer to the nearest inch.

27. Change 360 inches to feet.

28. Change 768 inches to feet.

29. Change 48 inches to feet.

30. Change 528 inches to feet.

31. Change 15,363 feet to miles. Round your answer to the nearest tenth of a mile.

32. Change 8,540 feet to miles. Round your answer to the nearest tenth of a mile.

33. Change 1.7 miles to inches.

34. Change 4.7 miles to inches.

35. Change 3.1 miles to inches.

36. Change 1.8 miles to inches.

37. Change 3.6 miles to feet.

38. Change 3.1 miles to feet.

39. Change 18 feet to inches.

40. Change 33 feet to inches.

41. Change $5\frac{1}{8}$ pounds to ounces.

42. Change $3\frac{1}{16}$ pounds to ounces.

43. Change 2.4 tons to ounces.

44. Change 3.4 tons to ounces.

45. Change 34 ounces to pounds. Express your answer as a fraction reduced to lowest terms.

46. Change 78 ounces to pounds. Express your answer as a fraction reduced to lowest terms.

47. Change 2.2 tons to pounds.

48. Change 4.8 tons to pounds.

49. Change 70 ounces to pounds. Express your answer as a fraction reduced to lowest terms.

50. Change 20 ounces to pounds. Express your answer as a fraction reduced to lowest terms.

51. Change 9,560 pounds to tons. Round your answer to the nearest tenth of a ton.

52. Change 9,499 pounds to tons. Round your answer to the nearest tenth of a ton.

53. Change $2\frac{1}{2}$ pounds to ounces.

54. Change $7\frac{1}{16}$ pounds to ounces.

55. Change 5.9 tons to pounds.

56. Change 2.1 tons to pounds.

57. Change 2.5 tons to ounces.

58. Change 5.3 tons to ounces.

59. Change 8,111 pounds to tons. Round your answer to the nearest tenth of a ton.

60. Change 8,273 pounds to tons. Round your answer to the nearest tenth of a ton.

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61. Change 4.5625 pints to fluid ounces.

62. Change 2.9375 pints to fluid ounces.

63. Change 32 fluid ounces to pints.

64. Change 160 fluid ounces to pints.

65. Change 3.7 gallons to pints.

66. Change 2.4 gallons to pints.

67. Change 216 pints to gallons.

68. Change 96 pints to gallons.

69. Change 544 fluid ounces to pints.

70. Change 432 fluid ounces to pints.

71. Change 112 pints to gallons.

72. Change 200 pints to gallons.

73. Change 7.7 gallons to pints.

74. Change 5.7 gallons to pints.

75. Change 3.875 pints to fluid ounces.

76. Change 3 pints to fluid ounces.

---

77. Change 7.8 years to hours.

78. Change 4.7 years to hours.

79. Change 7.6 years to hours.

80. Change 6.6 years to hours.

81. Change 4,025,005 seconds to days. Round your answer to the nearest tenth of a day.

82. Change 4,672,133 seconds to days. Round your answer to the nearest tenth of a day.

83. Change 37,668 hours to years.

84. Change 40,296 hours to years.

85. Change 22,776 hours to years.

86. Change 29,784 hours to years.

87. Change 96 days to seconds.

88. Change 50 days to seconds.

89. Change 40 days to seconds.

90. Change 10 days to seconds.

91. Change 3,750,580 seconds to days. Round your answer to the nearest tenth of a day.

92. Change 4,493,469 seconds to days. Round your answer to the nearest tenth of a day.

---

93. Change 367 feet per second to miles per hour. Round your answer to the nearest mile per hour.

94. Change 354 feet per second to miles per hour. Round your answer to the nearest mile per hour.

95. Change 442 feet per second to miles per hour. Round your answer to the nearest mile per hour.

96. Change 388 feet per second to miles per hour. Round your answer to the nearest mile per hour.

97. Change 30 miles per hour to feet per second. Round your answer to the nearest foot per second.

98. Change 99 miles per hour to feet per second. Round your answer to the nearest foot per second.

99. Change 106 miles per hour to feet per second. Round your answer to the nearest foot per second.

100. Change 119 miles per hour to feet per second. Round your answer to the nearest foot per second.

---

101. **Strong man.** Famed strongman Joe Rollino, who was still bending quarters with his fingers at age 104, once lifted $3,200$ pounds at Coney Island Amusement Park. How many tons did Joe lift that day? *Associated Press-Times-Standard 01/12/10 NYC amusement park strongman, 104, killed by van.*

102. **Earth day.** The amount of time it takes the Earth to rotate once around its axis is one day. How many seconds is that?

103. **Water break.** "The average age of Washington, DC's water pipes is 76 years, and they are not alone. Every two minutes, somewhere in the country, a pipe breaks." How many pipes break each year in the US? *New York Times 03/14/10 Saving U.S. water and sewer systems could be costly.*

Answers

1. 24 feet

3. 87 yards

5. 6.5 yards

7. 47 yards

9. 14,784 feet

11. 2.9 yards

13. 2.7 miles

15. 984 inches

17. 104 inches

19. 4.9 miles

21. 15 feet

23. 2.7 miles

25. 54 inches

27. 30 feet

29. 4 feet

31. 2.9 miles

33. 107,712 inches

35. 196,416 inches

37. 19,008 feet

39. 216 inches

41. 82 ounces

43. 76,800 ounces

45. $2\frac{1}{8}$ pounds

47. 4,400 pounds

49. $4\frac{3}{8}$ pounds

51. 4.8 tons

53. 40 ounces

55. 11,800 pounds

57. 80,000 ounces

59. 4.1 tons

61. 73 fluid ounces

63. 2 pints

65. 29.6 pints

67. 27 gallons

69. 34 pints

71. 14 gallons

73. 61.6 pints

75. 62 fluid ounces

77. 68,328 hours

79. 66,576 hours

81. 46.6 days

83. 4.3 years

85. 2.6 years

87. 8,294,400 seconds

89. 3,456,000 seconds

91. 43.4 days

93. 250 mi/hr

95. 301 mi/hr

97. 44 ft/s

99. 155 ft/s

101. 1.6 tons

103. $262,800$

6.4 Unit Conversion: Metric System

The metric system of units is the standard system of units preferred by scientists. It is based on the base ten number system and its decimal format is more friendly to users of this system.

There is a common set of prefixes adopted by the metric system to indicate a power of ten to apply to the base unit.

Metric System Prefixes. This is a list of standard prefixes for the metric system and their meanings.

deka = 10	deci = 1/10
hecto = 100	centi = 1/100
kilo = 1000	milli = 1/1000

Thus, for example, a decameter is 10 meters, a hectoliter is 100 liters, and a kilogram is 1000 grams. Similarly, a decimeter is 1/10 of a meter, a centiliter is 1/100 of a liter, and a milligram is 1/1000 of a gram.

Units of Length

The standard measure of length in the metric system is the meter.

> *Historically, the meter was defined by the French Academy of Sciences as the length between two marks on a platinum-iridium bar, which was designed to represent 110,000,000 of the distance from the equator to the north pole through Paris. In 1983, it was redefined by the International Bureau of Weights and Measures (BIPM) as the distance travelled by light in free space in 1299,792,458 of a second. (Wikipedia)*

We can apply the standard prefixes to get the following result.

Metric Units of Length. These units of length are used in the metric system.

Unit Length	Unit Abbreviation
1 kilometer = 1000 meters	km
1 hectometer = 100 meters	hm
1 dekameter = 10 meters	dam
1 meter	m
1 decimeter = $\frac{1}{10}$ meter	dm
1 centimeter = $\frac{1}{100}$ meter	cm
1 millimeter = $\frac{1}{1000}$ meter	mm

We can use these facts to build conversion factors as we did in Section 6.3. For example, because

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

we can divide both sides by 1000 m to produce the conversion factor

$$1 = \frac{1\,\text{km}}{1000\,\text{m}}.$$

This conversion factor can help change meters into kilometers.

Before using this conversion factor in an example, we repeat here the rules for multiplying and dividing by powers of ten. We will be making heavy use of these rules in this section.

Multiplying and Dividing by Powers of Ten.

- Multiplying a decimal number by 10^n will move the decimal point n places to the right. For example, $3.2567 \cdot 10^2 = 3.2567 \cdot 100 = 325.67$.
- Dividing a decimal number by 10^n will move the decimal point n places to the left. For example, $3.2567/10^2 = 3.2567/100 = 0.032567$.

And now the example.

You Try It!

Change 1,156 meters to kilometers.

EXAMPLE 1. Change 2,326 meters to kilometers.

Solution. Multiply by the conversion factor 1 km/1000 m.

$$\begin{aligned} 2326\,\text{m} &= 2326\,\text{m} \cdot \frac{1\,\text{km}}{1000\,\text{m}} && \text{Apply conversion factor.} \\ &= 2326\,\cancel{\text{m}} \cdot \frac{1\,\text{km}}{1000\,\cancel{\text{m}}} && \text{Cancel common units.} \\ &= \frac{2326 \cdot 1}{1000}\,\text{km} && \text{Multiply fractions.} \\ &= 2.326\,\text{km} && \text{Simplify.} \end{aligned}$$

In the last step, note that dividing by 1000 moves the decimal point three places to the left. Thus, 2326 meters is equal to 2.326 kilometers.

Alternate Solution. A second solution depends upon the fact that multiplying or dividing by a power of ten will move the decimal point right or left a number of places equal to the number of zeros present in the multiplier or divisor. Thus, as we saw above, dividing by 1000 moved the decimal point 3 places to the left.

Suppose that we arrange the metric units of length in order, from largest to smallest, as shown below.

Note that we must move 3 places left to move from the meters (m) abbreviation to the kilometers (km) abbreviation. In like manner, if we write 2,326 meters as 2,326.0 meters, then we can convert to kilometers by moving the decimal 3 places to the left.

$$2,326.0\,\text{m} = 2.236\,0\,\text{km} = 2.326\,\text{km}$$

Answer: 1.156 kilometers

□

You Try It!

EXAMPLE 2. Change 537 centimeters to meters.

Change 276 centimeters to meters.

Solution. We know that

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

or multiplying both sides of this result by 100,

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

Dividing both sides of this last result by 100 cm, we obtain the conversion factor 1 m/100 cm.

$$\begin{aligned} 537\,\text{cm} &= 537\,\text{cm} \cdot \frac{1\,\text{m}}{100\,\text{cm}} && \text{Apply conversion factor.} \\ &= 537\,\cancel{\text{cm}} \cdot \frac{1\,\text{m}}{100\,\cancel{\text{cm}}} && \text{Cancel common units.} \\ &= \frac{537 \cdot 1}{100}\,\text{m} && \text{Multiply fractions.} \\ &= 5.37\,\text{m} \end{aligned}$$

In the last step, note that dividing by 100 moves the decimal point two places to the left.

Alternately, we can set up our ordered list of units.

Note that we must move 2 places left to move from the centimeters (cm) abbreviation to the meters (m) abbreviation. In like manner, if we write 537 centimeters as 537.0 centimeters, then we can convert to meters by moving the decimal 2 places to the left.

$$537.0\,\text{cm} = 5.37\,0\,\text{m} = 5.37\,\text{m}$$

Answer: 2.76 meters

□

Sometimes more than one conversion factor is needed.

You Try It!

Change 13.5 dekameters to centimeters.

EXAMPLE 3. Change 10.2 dekameters to centimeters.

Solution. We have two facts:

- 1 dam=10 m, which yields the conversion factor 10 m/1 dam.
- 1 cm=(1/100) m or 100 cm=1 m, which yields the conversion factor 100 cm/1 m.

$$\begin{aligned} 10.2\,\text{dam} &= 10.2\,\text{dam} \cdot \frac{10\,\text{m}}{1\,\text{dam}} \cdot \frac{100\,\text{cm}}{1\,\text{m}} && \text{Apply conversion factors.} \\ &= 10.2\,\cancel{\text{dam}} \cdot \frac{10\,\cancel{\text{m}}}{1\,\cancel{\text{dam}}} \cdot \frac{100\,\text{cm}}{1\,\cancel{\text{m}}} && \text{Cancel common units.} \\ &= \frac{10.2 \cdot 10 \cdot 100}{1 \cdot 1}\,\text{cm} && \text{Multiply fractions.} \\ &= 10,200\,\text{cm} \end{aligned}$$

In the last step, note that multiplying by 10, then by 100, moves the decimal point three places to the right.

Alternately, we can set up our ordered list of units.

km hm dam m dm cm mm

Note that we must move 3 places right to move from the dekameters (dam) abbreviation to the centimeters (cm) abbreviation. In like manner, we can convert 10.2 dekameters to centimeters by moving the decimal 3 places to the right.

$$10.2\,\text{dam} = 10\,200\,\text{cm} = 10,200\,\text{cm}$$

Answer: 13,500 centimeters

□

Units of Mass

The fundamental unit of mass in the metric system is called a *gram*. Originally, it was defined to be equal to one cubic centimeter of water measured at the temperature of melting ice. Now it is simply defined as 1/1000 of a kilogram, which is defined by a physical prototype preserved by the International Bureau of Weights and Measures (Wikipedia). The mass of an object is not the same as an object's weight, but rather a resistance to motion when an external force is applied.

The same metric system prefixes apply.

Metric Units of Mass. These units of mass are used in the metric system.

Unit of Mass	Unit Abbreviation
1 kilogram = 1000 grams	kg
1 hectogram = 100 grams	hg
1 dekagram = 10 grams	dag
1 gram	g
1 decigram = $\frac{1}{10}$ gram	dg
1 centigram = $\frac{1}{100}$ gram	cg
1 milligram = $\frac{1}{1000}$ gram	mg

You Try It!

EXAMPLE 4. Convert 0.025 dekagrams to milligrams.

Convert 0.05 dekagrams to milligrams.

Solution. We'll use two conversion factors:

- 1 dag=10 g, which yields the conversion factor 10 g/1 dag.
- 1 mg=(1/1000) g, which yields the conversion factor 1000 mg/1 g.

$$0.025\,\text{dag} = 0.025\,\text{dag} \cdot \frac{10\,\text{g}}{1\,\text{dag}} \cdot \frac{1000\,\text{mg}}{1\,\text{g}} \qquad \text{Apply conversion factors.}$$

$$= 0.025\,\cancel{\text{dag}} \cdot \frac{10\,\cancel{\text{g}}}{1\,\cancel{\text{dag}}} \cdot \frac{1000\,\text{mg}}{1\,\cancel{\text{g}}} \qquad \text{Cancel common units.}$$

$$= \frac{0.025 \cdot 10 \cdot 1000}{1 \cdot 1}\,\text{mg} \qquad \text{Multiply fractions.}$$

$$= 250\,\text{mg}$$

Alternately, we can set up our ordered list of units.

kg hg dag g dg cg mg

Note that we must move 4 places right to move from the dekagrams (dag) abbreviation to the milligrams (mg) abbreviation. In like manner, we can convert 0.025 dekagrams to milligrams by moving the decimal 4 places to the right.

$$0.0250\,\text{dag} = 0\,0250.\,\text{mg} = 250\,\text{mg}$$

Answer: 500 milligrams

□

Units of Volume

The fundamental unit of volume in the metric system is called a *litre*. Originally, one litre was defined as the volume of one kilogram of water measured at 4° C at 760 millimeters of mercury (Wikipedia). Currently, 1 litre is defined as 1 cubic decimeter (imagine a cube with each edge 1/10 of a meter).

The same metric system prefixes apply.

Metric Units of Volume. These units of volume are used in the metric system.

Unit of Volume	Unit Abbreviation
1 kilolitre = 1000 litres	kL
1 hectolitre = 100 litres	hL
1 dekalitre = 10 litres	daL
1 litre	L
1 decilitre = $\frac{1}{10}$ litre	dL
1 centilitre = $\frac{1}{100}$ litre	cL
1 millilitre = $\frac{1}{1000}$ litre	mL

You Try It!

Convert 5,763 millilitres to dekalitres.

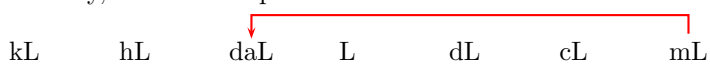
EXAMPLE 5. Convert 11,725 millilitres to dekalitres.

Solution. We'll use two conversion factors:

- 1 daL=10 L, which yields the conversion factor 1 daL/10 L.
- 1 mL=(1/1000) L, which yields the conversion factor 1 L/1000 mL.

$$\begin{aligned} 11,725\,\text{mL} &= 11,725\,\text{mL} \cdot \frac{1\,\text{L}}{1000\,\text{mL}} \cdot \frac{1\,\text{daL}}{10\,\text{L}} && \text{Apply conversion factors.} \\ &= 11,725\,\cancel{\text{mL}} \cdot \frac{1\,\cancel{\text{L}}}{1000\,\cancel{\text{mL}}} \cdot \frac{1\,\text{daL}}{10\,\cancel{\text{L}}} && \text{Cancel common units.} \\ &= \frac{11,725 \cdot 1 \cdot 1}{1000 \cdot 10}\,\text{daL} && \text{Multiply fractions.} \\ &= 1.1725\,\text{daL} \end{aligned}$$

Alternately, we can set up our ordered list of units.



Note that we must move 4 places left to move from the millitres (mL) abbreviation to the dekalitres (daL) abbreviation. In like manner, we can convert 11,725 millilitres to dekalitres by moving the decimal 4 places to the left.

$$11,725.0\,\text{mL} = 1.1725\,0\,\text{daL} = 1.1725\,\text{daL}$$

Answer: 0.5763 dekalitres

□

Exercises

1. What is the meaning of the metric system prefix centi?

2. What is the meaning of the metric system prefix deka?

3. What is the meaning of the metric system prefix hecto?

4. What is the meaning of the metric system prefix kilo?

5. What is the meaning of the metric system prefix deci?

6. What is the meaning of the metric system prefix milli?

7. What is the meaning of the metric system abbreviation mg?

8. What is the meaning of the metric system abbreviation g?

9. What is the meaning of the metric system abbreviation m?

10. What is the meaning of the metric system abbreviation km?

11. What is the meaning of the metric system abbreviation kL?

12. What is the meaning of the metric system abbreviation daL?

13. What is the meaning of the metric system abbreviation hm?

14. What is the meaning of the metric system abbreviation dm?

15. What is the meaning of the metric system abbreviation dam?

16. What is the meaning of the metric system abbreviation cm?

17. What is the meaning of the metric system abbreviation dL?

18. What is the meaning of the metric system abbreviation L?

19. What is the meaning of the metric system abbreviation hg?

20. What is the meaning of the metric system abbreviation kg?

21. What is the meaning of the metric system abbreviation dg?

22. What is the meaning of the metric system abbreviation dag?

23. What is the meaning of the metric system abbreviation hL?

24. What is the meaning of the metric system abbreviation cL?

25. Change 5,490 millimeters to meters.

26. Change 8,528 millimeters to meters.

27. Change 64 meters to millimeters.

28. Change 65 meters to millimeters.

29. Change 4,571 millimeters to meters.

30. Change 8,209 millimeters to meters.

31. Change 15 meters to centimeters.

32. Change 12 meters to centimeters.

33. Change 569 centimeters to meters.

34. Change 380 centimeters to meters.

35. Change 79 meters to centimeters.

36. Change 60 meters to centimeters.

37. Change 7.6 kilometers to meters.

38. Change 4.9 kilometers to meters.

39. Change 861 centimeters to meters.

40. Change 427 centimeters to meters.

41. Change 4,826 meters to kilometers.

42. Change 1,929 meters to kilometers.

43. Change 4,724 meters to kilometers.

44. Change 1,629 meters to kilometers.

45. Change 6.5 kilometers to meters.

46. Change 7.9 kilometers to meters.

47. Change 17 meters to millimeters.

48. Change 53 meters to millimeters.

---

49. Change 512 milligrams to centigrams.

50. Change 516 milligrams to centigrams.

51. Change 541 milligrams to centigrams.

52. Change 223 milligrams to centigrams.

53. Change 70 grams to centigrams.

54. Change 76 grams to centigrams.

55. Change 53 centigrams to milligrams.

56. Change 30 centigrams to milligrams.

57. Change 83 kilograms to grams.

58. Change 70 kilograms to grams.

59. Change 8,196 grams to kilograms.

60. Change 6,693 grams to kilograms.

61. Change 564 centigrams to grams.

62. Change 884 centigrams to grams.

63. Change 38 grams to centigrams.

64. Change 88 grams to centigrams.

65. Change 77 centigrams to milligrams.

66. Change 61 centigrams to milligrams.

67. Change 5,337 grams to kilograms.

68. Change 4,002 grams to kilograms.

69. Change 15 kilograms to grams.

70. Change 45 kilograms to grams.

71. Change 833 centigrams to grams.

72. Change 247 centigrams to grams.

---

73. Change 619,560 centilitres to kilolitres.

74. Change 678,962 centilitres to kilolitres.

75. Change 15.2 litres to millilitres.

76. Change 9.7 litres to millilitres.

77. Change 10,850 centilitres to litres.

78. Change 15,198 centilitres to litres.

79. Change 10.7 litres to millilitres.

80. Change 17.3 litres to millilitres.

81. Change 15,665 millilitres to litres.

82. Change 12,157 millilitres to litres.

83. Change 6.3 kilolitres to centilitres.

84. Change 8.3 kilolitres to centilitres.

85. Change 4.5 kilolitres to centilitres.

86. Change 6.2 kilolitres to centilitres.

87. Change 10.6 litres to centilitres.

88. Change 16.6 litres to centilitres.

89. Change 14,383 centilitres to litres.

90. Change 11,557 centilitres to litres.

91. Change 9.9 litres to centilitres.

92. Change 19.5 litres to centilitres.

93. Change 407,331 centilitres to kilolitres.

94. Change 827,348 centilitres to kilolitres.

95. Change 14,968 millilitres to litres.

96. Change 18,439 millilitres to litres.

Answers

1. 1/100

3. 100

5. 1/10

7. milligram

9. meter

11. kilolitre or kiloliter

13. hectometer

15. dekameter

17. decilitre or deciliter

19. hectogram

21. decigram

23. hectolitre or hectoliter

25. 5.49 meters

27. 64,000 millimeters

29. 4.571 meters

31. 1,500 centimeters

33. 5.69 meters

35. 7,900 centimeters

37. 7,600 meters

39. 8.61 meters

41. 4.826 kilometers

43. 4.724 kilometers

45. 6,500 meters

47. 17,000 millimeters

49. 51.2 centigrams

51. 54.1 centigrams

53. 7,000 centigrams

55. 530 milligrams

57. 83,000 grams

59. 8.196 kilograms

61. 5.64 grams

63. 3,800 centigrams

65. 770 milligrams

67. 5.337 kilograms

69. 15,000 grams

71. 8.33 grams

73. 6.1956 kilolitres

75. 15,200 millilitres

77. 108.5 litres

79. 10,700 millilitres

81. 15.665 litres

83. 630,000 centilitres

85. 450,000 centilitres

87. 1,060 centilitres

89. 143.83 litres

91. 990 centilitres

93. 4.07331 kilolitres

95. 14.968 litres

6.5 American Units to Metric Units and Vice-Versa

We often need to convert from the American system of units to the metric system of units or vice-versa (imagine traveling to a European country using the metric system). That will be our focus in this section.

Converting Units of Length

One meter is slightly longer than one yard. Indeed,

$$1\,\text{m} \approx 1.0936\,\text{yd}.$$

If we divide both sides of this equation by 1.0936, then

$$\frac{1\,\text{m}}{1.0936} \approx \frac{1.0936\,\text{yd}}{1.0936}$$
$$0.9144\,\text{m} \approx 1\,\text{yd}$$

Further conversions can be made. For example, to change meters to feet, we make the following conversions.

$$1\,\text{m} \approx 1\,\text{m} \cdot \frac{1\,\text{yd}}{0.9144\text{m}} \cdot \frac{3\,\text{ft}}{1\,\text{yd}} \qquad \text{Apply conversion factors.}$$
$$\approx 1\,\cancel{\text{m}} \cdot \frac{1\,\cancel{\text{yd}}}{0.9144\cancel{\text{m}}} \cdot \frac{3\,\text{ft}}{1\,\cancel{\text{yd}}} \qquad \text{Cancel common units.}$$
$$\approx \frac{1 \cdot 1 \cdot 3}{0.9144 \cdot 1}\,\text{ft} \qquad \text{Multiply fractions.}$$
$$\approx 3.2808\,\text{ft}$$

Table 6.5 shows some of the most common conversions between American units of length and metric units of length.

American to Metric	Metric to American
$1\,\text{in} \approx 2.54\,\text{cm}$	$1\,\text{cm} \approx 0.3937\,\text{in}$
$1\,\text{ft} \approx 0.3048\,\text{m}$	$1\,\text{m} \approx 3.2808\,\text{ft}$
$1\,\text{yd} \approx 0.9144\,\text{m}$	$1\,\text{m} \approx 1.0936\,\text{yd}$
$1\,\text{mi} \approx 1.6093\,\text{km}$	$1\,\text{km} \approx 0.6214\,\text{mi}$

Table 6.5: Length conversions: American — Metric.

You Try It!

Change 227 miles to kilometers. Round to the nearest tenth of a kilometer.

EXAMPLE 1. A car's speedometer shows that a family has currently traveled 154 miles in route to their vacation destination. Convert this distance to kilometers.

Solution. Choose $1\,\text{mi} = 1.6093\,\text{km}$ from Table 6.5.

$$\begin{aligned} 154\,\text{mi} &\approx 154\,\text{mi} \cdot \frac{1.6093\,\text{km}}{1\,\text{mi}} && \text{Apply conversion factor.} \\ &\approx 154\,\cancel{\text{mi}} \cdot \frac{1.6093\,\text{km}}{1\,\cancel{\text{mi}}} && \text{Cancel common units.} \\ &\approx \frac{154 \cdot 1.6093}{1}\,\text{km} && \text{Multiply fractions.} \\ &\approx 247.8\,\text{km} \end{aligned}$$

Hence, 154 miles is approximately 247.8 kilometers.

Alternate Solution. Note that this would work equally well if we chose $1\,\text{km} \approx 0.6214\,\text{mi}$ from Table 6.5.

$$\begin{aligned} 154\,\text{mi} &\approx 154\,\text{mi} \cdot \frac{1\,\text{km}}{0.6214\,\text{mi}} && \text{Apply conversion factor.} \\ &\approx 154\,\cancel{\text{mi}} \cdot \frac{1\,\text{km}}{0.6214\,\cancel{\text{mi}}} && \text{Cancel common units.} \\ &\approx \frac{154 \cdot 1}{0.6214}\,\text{km} && \text{Multiply fractions.} \\ &\approx 247.8\,\text{km} \end{aligned}$$

Answer: 365.3 kilometers

□

Converting Units of Weight and Mass

It is known that

$$1\,\text{kg} \approx 2.2\,\text{lb}.$$

Dividing both sides of this equation by 2.2,

$$\begin{aligned} \frac{1\,\text{kg}}{2.2} &\approx \frac{2.2\,\text{lb}}{2.2} \\ 0.454\,\text{kg} &\approx 1\,\text{lb} \end{aligned}$$

A summary of the more common conversion factors regarding mass and weight are given in Table 6.6.

American to Metric	Metric to American
$1\,\text{oz} \approx 28.35\,\text{g}$	$1\,\text{g} \approx 0.035\,\text{oz}$
$1\,\text{lb} \approx 0.454\,\text{kg}$	$1\,\text{kg} \approx 2.2\,\text{lb}$

Table 6.6: Mass—Weight conversions: American — Metric.

You Try It!

Change 5.7 kilograms to ounces. Round to the nearest ounce.

EXAMPLE 2. Change 2.3 kilograms to ounces.

Solution. One kilogram weighs 2.2 pounds and there are 16 ounces in a pound.

$$\begin{aligned} 2.3\,\text{kg} &\approx 2.3\,\text{kg} \cdot \frac{2.2\,\text{lb}}{1\,\text{kg}} \cdot \frac{16\,\text{oz}}{1\,\text{lb}} && \text{Apply conversion factors.} \\ &\approx 2.3\,\cancel{\text{kg}} \cdot \frac{2.2\,\cancel{\text{lb}}}{1\,\cancel{\text{kg}}} \cdot \frac{16\,\text{oz}}{1\,\cancel{\text{lb}}} && \text{Cancel common units.} \\ &\approx \frac{2.3 \cdot 2.2 \cdot 16}{1 \cdot 1}\,\text{oz} && \text{Multiply fractions.} \\ &\approx 80.96\,\text{oz} \end{aligned}$$

Hence, 2.3 kilograms weighs 80.96 ounces.

Alternate Solution. Another approach uses the facts that 1 kilogram equals 1000 grams and 1 ounce equals 28.35 grams.

$$\begin{aligned} 2.3\,\text{kg} &\approx 2.3\,\text{kg} \cdot \frac{1000\,\text{g}}{1\,\text{kg}} \cdot \frac{1\,\text{oz}}{28.35\,\text{g}} && \text{Apply conversion factors.} \\ &\approx 2.3\,\cancel{\text{kg}} \cdot \frac{1000\,\cancel{\text{g}}}{1\,\cancel{\text{kg}}} \cdot \frac{1\,\text{oz}}{28.35\,\cancel{\text{g}}} && \text{Cancel common units.} \\ &\approx \frac{2.3 \cdot 1000 \cdot 1}{1 \cdot 28.35}\,\text{oz} && \text{Multiply fractions.} \\ &\approx 81.13\,\text{oz} \end{aligned}$$

Roundoff Error. Why the discrepancy in answers? This difference in approximations is due to something called *round-off error*. Indeed, in the first calculation, we used a conversion factor that is rounded to the nearest tenth; i.e., $1\,\text{kg} \approx 2.2\,\text{lb}$. If we use a more accurate conversion factor to change kilograms to pounds, namely $1\,\text{kg} \approx 2.2046\,\text{lb}$, we get the following result.

$$\begin{aligned} 2.3\,\text{kg} &\approx 2.3\,\text{kg} \cdot \frac{2.2046\,\text{lb}}{1\,\text{kg}} \cdot \frac{16\,\text{oz}}{1\,\text{lb}} && \text{Apply conversion factors.} \\ &\approx 2.3\,\cancel{\text{kg}} \cdot \frac{2.2046\,\cancel{\text{lb}}}{1\,\cancel{\text{kg}}} \cdot \frac{16\,\text{oz}}{1\,\cancel{\text{lb}}} && \text{Cancel common units.} \\ &\approx \frac{2.3 \cdot 2.2046 \cdot 16}{1 \cdot 1}\,\text{oz} && \text{Multiply fractions.} \\ &\approx 81.13\,\text{oz} \end{aligned}$$

Answer: 201 ounces

Note that this result is in better agreement with the second result above.

□

Important Observation. To obtain better approximations, you need to use a conversion factor that is more accurate. Any time you feel you need more accuracy, you might try an online conversion utility, such as the one at:

http://www.france-property-and-information.com/metric_conversion_table.htm

Converting Units of Volume

It is known that

$$1\,\text{qt} \approx 0.946\,\text{L}.$$

Dividing both sides of this equation by 0.946,

$$1\,\text{L} \approx 1.06\,\text{qt}.$$

Again, these conversion factors for volume have been well worked out by scientists. The more common conversion factors for volume are shown in Table 6.7.

American to Metric	Metric to American
$1\,\text{fl oz} \approx 0.030\,\text{L}$	$1\,\text{L} \approx 33.8\,\text{fl oz}$
$1\,\text{pt} \approx 0.473\,\text{L}$	$1\,\text{L} \approx 2.1\,\text{pt}$
$1\,\text{qt} \approx 0.946\,\text{L}$	$1\,\text{L} \approx 1.06\,\text{qt}$
$1\,\text{gal} \approx 3.785\,\text{L}$	$1\,\text{L} \approx 0.264\,\text{gal}$

Table 6.7: Volume conversions: American — Metric.

You Try It!

EXAMPLE 3. Change 2.5 dekalitres to gallons.

Solution. Recall that $1\,\text{daL} = 10\,\text{L}$ and $1\,\text{L} = 0.264\,\text{gal}$.

$$\begin{aligned} 2.5\,\text{daL} &\approx 2.5\,\text{daL} \cdot \frac{10\,\text{L}}{1\,\text{daL}} \cdot \frac{0.264\,\text{gal}}{1\,\text{L}} && \text{Apply conversion factors.} \\ &\approx 2.5\,\cancel{\text{daL}} \cdot \frac{10\,\cancel{\text{L}}}{1\,\cancel{\text{daL}}} \cdot \frac{0.264\,\text{gal}}{1\,\cancel{\text{L}}} && \text{Cancel common units.} \\ &\approx \frac{2.5 \cdot 10 \cdot 0.264}{1 \cdot 1}\,\text{gal} && \text{Multiply fractions.} \\ &\approx 6.6\,\text{gal} \end{aligned}$$

Hence, 2.5 dekalitres is approximately equal to 6.6 gallons.

Change 3.2 dekalitres to gallons.Round your answer to the nearest tenth of a gallon.

Answer: 0.8 gallons

□

Converting Units of Speed

Modern speedometers often show a car's speed in both miles per hour and kilometers per hour.

You Try It!

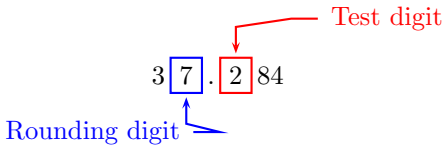
A car's speedometer registers 45 kilometers per hour. Change this speed to miles per hour. Round your answer to the nearest mile per hour.

EXAMPLE 4. A car's speedometer is showing it speeding along at 60 kilometers per hour. How fast is it traveling in miles per hour? Round your answer to the nearest mile per hour.

Solution. From Table 6.5, $1\,\text{km} \approx 0.6214\,\text{mi}$.

$$\begin{aligned} 60\,\frac{\text{km}}{\text{h}} &\approx 60\,\frac{\text{km}}{\text{h}} \cdot \frac{0.6214\,\text{mi}}{1\,\text{km}} && \text{Apply conversion factor.} \\ &\approx 60\,\frac{\cancel{\text{km}}}{\text{h}} \cdot \frac{0.6214\,\text{mi}}{1\,\cancel{\text{km}}} && \text{Cancel common units.} \\ &\approx \frac{60 \cdot 0.6214}{1}\,\frac{\text{mi}}{\text{h}} && \text{Multiply fractions.} \\ &\approx 37.284\,\frac{\text{mi}}{\text{h}} \end{aligned}$$

To round to the nearest mile per hour, identify the rounding and test digits.



Because the test digit is less than 5, leave the rounding digit alone and truncate. Thus, to the nearest mile per hour, the speed is approximately 37 miles per hour.

Answer: 28 miles per hour

□

Exercises

1. Use the conversion 1 in = 2.54 cm to convert 68 inches to centimeters, rounded to the nearest tenth of a centimeter.

2. Use the conversion 1 in = 2.54 cm to convert 42 inches to centimeters, rounded to the nearest tenth of a centimeter.

3. Use the conversion 1 in = 2.54 cm to convert 44 centimeters to inches, rounded to the nearest tenth of a inch.

4. Use the conversion 1 in = 2.54 cm to convert 22 centimeters to inches, rounded to the nearest tenth of a inch.

5. Use the conversion 1 mi = 1.6093 km to convert 79 miles to kilometers, rounded to the nearest tenth of a kilometer.

6. Use the conversion 1 mi = 1.6093 km to convert 39 miles to kilometers, rounded to the nearest tenth of a kilometer.

7. Use the conversion 1 yd = 0.9144 m to convert 1489 centimeters to yards, rounded to the nearest tenth of a yard.

8. Use the conversion 1 yd = 0.9144 m to convert 1522 centimeters to yards, rounded to the nearest tenth of a yard.

9. Use the conversion 1 yd = 0.9144 m to convert 28 yards to centimeters, rounded to the nearest tenth of a centimeter.

10. Use the conversion 1 yd = 0.9144 m to convert 34 yards to centimeters, rounded to the nearest tenth of a centimeter.

11. Use the conversion 1 m = 3.2808 ft to convert 8.6 meters to inches, rounded to the nearest tenth of a inch.

12. Use the conversion 1 m = 3.2808 ft to convert 8.3 meters to inches, rounded to the nearest tenth of a inch.

13. Use the conversion 1 in = 2.54 cm to convert 60 inches to centimeters, rounded to the nearest tenth of a centimeter.

14. Use the conversion 1 in = 2.54 cm to convert 75 inches to centimeters, rounded to the nearest tenth of a centimeter.

15. Use the conversion 1 m = 3.2808 ft to convert 208 inches to meters, rounded to the nearest tenth of a inch.

16. Use the conversion 1 m = 3.2808 ft to convert 228 inches to meters, rounded to the nearest tenth of a inch.

17. Use the conversion 1 m = 1.0936 yd to convert 20 yards to meters, rounded to the nearest tenth of a meter.

18. Use the conversion 1 m = 1.0936 yd to convert 44 yards to meters, rounded to the nearest tenth of a meter.

19. Use the conversion 1 mi = 1.6093 km to convert 29 miles to kilometers, rounded to the nearest tenth of a kilometer.

20. Use the conversion 1 mi = 1.6093 km to convert 15 miles to kilometers, rounded to the nearest tenth of a kilometer.

21. Use the conversion 1 m = 1.0936 yd to convert 8.2 meters to yards, rounded to the nearest tenth of a yard.

22. Use the conversion 1 m = 1.0936 yd to convert 6.9 meters to yards, rounded to the nearest tenth of a yard.

23. Use the conversion 1 mi = 1.6093 km to convert 4.9 kilometers to miles, rounded to the nearest tenth of a mile.

24. Use the conversion 1 mi = 1.6093 km to convert 4.2 kilometers to miles, rounded to the nearest tenth of a mile.

25. Use the conversion 1 m = 1.0936 yd to convert 25 yards to meters, rounded to the nearest tenth of a meter.

26. Use the conversion 1 m = 1.0936 yd to convert 2 yards to meters, rounded to the nearest tenth of a meter.

27. Use the conversion 1 in = 2.54 cm to convert 47 centimeters to inches, rounded to the nearest tenth of a inch.

28. Use the conversion 1 in = 2.54 cm to convert 19 centimeters to inches, rounded to the nearest tenth of a inch.

29. Use the conversion 1 mi = 1.6093 km to convert 8.3 kilometers to miles, rounded to the nearest tenth of a mile.

30. Use the conversion 1 mi = 1.6093 km to convert 4.8 kilometers to miles, rounded to the nearest tenth of a mile.

31. Use the conversion 1 yd = 0.9144 m to convert 41 yards to centimeters, rounded to the nearest tenth of a centimeter.

32. Use the conversion 1 yd = 0.9144 m to convert 20 yards to centimeters, rounded to the nearest tenth of a centimeter.

33. Use the conversion 1 m = 3.2808 ft to convert 3.7 meters to inches, rounded to the nearest tenth of a inch.

34. Use the conversion 1 m = 3.2808 ft to convert 7.9 meters to inches, rounded to the nearest tenth of a inch.

35. Use the conversion 1 yd = 0.9144 m to convert 1323 centimeters to yards, rounded to the nearest tenth of a yard.

36. Use the conversion 1 yd = 0.9144 m to convert 1715 centimeters to yards, rounded to the nearest tenth of a yard.

37. Use the conversion 1 m = 1.0936 yd to convert 8.4 meters to yards, rounded to the nearest tenth of a yard.

38. Use the conversion 1 m = 1.0936 yd to convert 7.3 meters to yards, rounded to the nearest tenth of a yard.

39. Use the conversion 1 m = 3.2808 ft to convert 289 inches to meters, rounded to the nearest tenth of a inch.

40. Use the conversion 1 m = 3.2808 ft to convert 251 inches to meters, rounded to the nearest tenth of a inch.

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41. Use the conversion 1 kg = 2.2 lb to convert 15.8 kilograms to pounds, rounded to the nearest tenth of a pound.

42. Use the conversion 1 kg = 2.2 lb to convert 19.4 kilograms to pounds, rounded to the nearest tenth of a pound.

43. Use the conversion 1 oz = 28.35 g to convert 35 ounces to grams, rounded to the nearest tenth of a gram.

44. Use the conversion 1 oz = 28.35 g to convert 33 ounces to grams, rounded to the nearest tenth of a gram.

45. Use the conversion 1 kg = 2.2 lb to convert 2.48 kilograms to ounces, rounded to the nearest tenth of a ounce.

46. Use the conversion 1 kg = 2.2 lb to convert 3.74 kilograms to ounces, rounded to the nearest tenth of a ounce.

47. Use the conversion 1 kg = 2.2 lb to convert 2.35 kilograms to ounces, rounded to the nearest tenth of a ounce.

48. Use the conversion 1 kg = 2.2 lb to convert 3.57 kilograms to ounces, rounded to the nearest tenth of a ounce.

49. Use the conversion 1 kg = 2.2 lb to convert 15 pounds to kilograms, rounded to the nearest tenth of a kilogram.

50. Use the conversion 1 kg = 2.2 lb to convert 27 pounds to kilograms, rounded to the nearest tenth of a kilogram.

51. Use the conversion 1 kg = 2.2 lb to convert 10.4 kilograms to pounds, rounded to the nearest tenth of a pound.

52. Use the conversion 1 kg = 2.2 lb to convert 17.7 kilograms to pounds, rounded to the nearest tenth of a pound.

53. Use the conversion 1 kg = 2.2 lb to convert 352 ounces to kilograms, rounded to the nearest tenth of a kilogram.

54. Use the conversion 1 kg = 2.2 lb to convert 326 ounces to kilograms, rounded to the nearest tenth of a kilogram.

55. Use the conversion 1 oz = 28.35 g to convert 96 grams to ounces, rounded to the nearest tenth of a ounce.

56. Use the conversion 1 oz = 28.35 g to convert 100 grams to ounces, rounded to the nearest tenth of a ounce.

57. Use the conversion 1 oz = 28.35 g to convert 14 ounces to grams, rounded to the nearest tenth of a gram.

58. Use the conversion 1 oz = 28.35 g to convert 29 ounces to grams, rounded to the nearest tenth of a gram.

59. Use the conversion 1 kg = 2.2 lb to convert 54 pounds to kilograms, rounded to the nearest tenth of a kilogram.

60. Use the conversion 1 kg = 2.2 lb to convert 82 pounds to kilograms, rounded to the nearest tenth of a kilogram.

61. Use the conversion 1 oz = 28.35 g to convert 92 grams to ounces, rounded to the nearest tenth of a ounce.

62. Use the conversion 1 oz = 28.35 g to convert 103 grams to ounces, rounded to the nearest tenth of a ounce.

63. Use the conversion 1 kg = 2.2 lb to convert 388 ounces to kilograms, rounded to the nearest tenth of a kilogram.

64. Use the conversion 1 kg = 2.2 lb to convert 395 ounces to kilograms, rounded to the nearest tenth of a kilogram.

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65. Use the conversion 1 qt = 0.946 L to convert 55.1 litres to quarts, rounded to the nearest tenth of a quart.

66. Use the conversion 1 qt = 0.946 L to convert 50.3 litres to quarts, rounded to the nearest tenth of a quart.

67. Use the conversion 1 L = 33.8 fl oz to convert 72073 fluid ounces to kilolitres, rounded to the nearest tenth of a kilolitre.

68. Use the conversion 1 L = 33.8 fl oz to convert 56279 fluid ounces to kilolitres, rounded to the nearest tenth of a kilolitre.

69. Use the conversion 1 L = 33.8 fl oz to convert 2.5 kilolitres to fluid ounces.

70. Use the conversion 1 L = 33.8 fl oz to convert 4.5 kilolitres to fluid ounces.

71. Use the conversion 1 qt = 0.946 L to convert 24 quarts to litres, rounded to the nearest tenth of a litre.

72. Use the conversion 1 qt = 0.946 L to convert 21 quarts to litres, rounded to the nearest tenth of a litre.

73. Use the conversion 1 qt = 0.946 L to convert 30 quarts to litres, rounded to the nearest tenth of a litre.

74. Use the conversion 1 qt = 0.946 L to convert 22 quarts to litres, rounded to the nearest tenth of a litre.

75. Use the conversion 1 gal = 3.785 L to convert 11.8 gallons to litres, rounded to the nearest tenth of a litre.

76. Use the conversion 1 gal = 3.785 L to convert 13.5 gallons to litres, rounded to the nearest tenth of a litre.

77. Use the conversion 1 gal = 3.785 L to convert 50.5 litres to gallons, rounded to the nearest tenth of a gallon.

78. Use the conversion 1 gal = 3.785 L to convert 55.9 litres to gallons, rounded to the nearest tenth of a gallon.

79. Use the conversion 1 L = 33.8 fl oz to convert 8.3 kilolitres to fluid ounces.

80. Use the conversion 1 L = 33.8 fl oz to convert 5.3 kilolitres to fluid ounces.

81. Use the conversion 1 qt = 0.946 L to convert 42.4 litres to quarts, rounded to the nearest tenth of a quart.

82. Use the conversion 1 qt = 0.946 L to convert 55.4 litres to quarts, rounded to the nearest tenth of a quart.

83. Use the conversion 1 gal = 3.785 L to convert 17.2 gallons to litres, rounded to the nearest tenth of a litre.

84. Use the conversion 1 gal = 3.785 L to convert 19.6 gallons to litres, rounded to the nearest tenth of a litre.

85. Use the conversion 1 L = 33.8 fl oz to convert 51274 fluid ounces to kilolitres, rounded to the nearest tenth of a kilolitre.

86. Use the conversion 1 L = 33.8 fl oz to convert 82164 fluid ounces to kilolitres, rounded to the nearest tenth of a kilolitre.

87. Use the conversion 1 gal = 3.785 L to convert 55.6 litres to gallons, rounded to the nearest tenth of a gallon.

88. Use the conversion 1 gal = 3.785 L to convert 59.2 litres to gallons, rounded to the nearest tenth of a gallon.

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89. Change 60 miles per hour to kilometers per hour. Round your answer to the nearest kilometer per hour.

90. Change 56 miles per hour to kilometers per hour. Round your answer to the nearest kilometer per hour.

91. Change 77 miles per hour to kilometers per hour. Round your answer to the nearest kilometer per hour.

92. Change 57 miles per hour to kilometers per hour. Round your answer to the nearest kilometer per hour.

93. Change 42 kilometers per hour to miles per hour. Round your answer to the nearest mile per hour.

94. Change 56 kilometers per hour to miles per hour. Round your answer to the nearest mile per hour.

95. Change 62 kilometers per hour to miles per hour. Round your answer to the nearest mile per hour.

96. Change 63 kilometers per hour to miles per hour. Round your answer to the nearest mile per hour.

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97. **Tallest tower.** The world's tallest tower in Dubai has 160 floors at a height of 2,717 feet. Convert the height of the tower to the nearest tenth of a meter. *Associated Press-Times-Standard 02/09/10 World's tallest tower closed a month after opening.*

98. **High peaks.** For the first time, foreigners will be allowed to climb nearly 100 high-altitude Himalayan peaks on the Indian side of Kashmir, peaks ranging from 9,840 feet to nearly 26,246 feet. Convert the highest of the peaks to the nearest tenth of a meter. *Associated Press-Times-Standard 04/11/10 India opens Himalayan peaks to foreigners.*

99. **Ancient find.** In the southern Egyptian town of Luxor, a 3,400-year-old 4-meter statue of Thoth, the ancient Egyptian god of Wisdom and Magic, was unearthed. Convert the height of the statue to the nearest tenth of a foot. *Associated Press-Times-Standard 03/17/10 3,400-year-old statues unearthed in Egypt.*

100. **Arctic wind.** Blizzard condition winds in the Arctic blew 80 miles per hour. Find the wind speed to the nearest kilometer per hour. *Associated Press-Times-Standard 12/31/09 After 562-mile ski trek, seven women reach the South Pole.*

101. **Solar plane.** The Solar Impulse lifted off from a military airport at a speed no faster than 28 miles per hour. Convert the speed of the solar-powered plane to the nearest kilometer per hour. *Associated Press-Times-Standard 04/09/10 Solar-powered plane makes successful maiden flight.*

Answers

1. 172.7 centimeters

3. 17.3 inches

5. 127.1 kilometers

7. 16.3 yards

9. 2560.3 centimeters

11. 338.6 inches

13. 152.4 centimeters

15. 5.3 meters

17. 18.3 meters

19. 46.7 kilometers

21. 9.0 yards

23. 3.0 miles

25. 22.9 meters

27. 18.5 inches

29. 5.2 miles

31. 3749.0 centimeters

33. 145.7 inches

35. 14.5 yards

37. 9.2 yards

39. 7.3 meters

41. 34.8 pounds

43. 992.3 grams

45. 87.3 ounces

47. 82.7 ounces

49. 6.8 kilograms

51. 22.9 pounds

53. 10.0 kilograms

55. 3.4 ounces

57. 396.9 grams

59. 24.5 kilograms

61. 3.2 ounces

63. 11.0 kilograms

65. 58.2 quarts

67. 2.1 kilolitres

69. 84500 ounces

71. 22.7 litres

73. 28.4 litres

75. 44.7 litres

77. 13.3 gallons

79. 280540 ounces

81. 44.8 quarts

83. 65.1 litres

85. 1.5 kilolitres

87. 14.7 gallons

89. 97 km/hr

91. 124 km/hr

93. 26 mi/hr

95. 39 mi/hr

97. 828.2 meters

99. 13.1 feet

101. 45 km/hr

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