US Customary Units of Length

Converting measurements of length in the US system

A measurement includes both a number and a unit of length.

Examples:	Measurement	Number	Unit of Length
	3 ft	3	ft (feet)
	10 mi	10	mi (miles)
	12 yd	12	yd (yards)

A few equivalences between units of length in the US Customary system include:

Examples	12 inches	=	1 foot
	3 feet	=	1 yard
	36 inches	=	1 yard
	5,280 feet	=	1 mile

These equivalences can be used to form conversion rates (fractions) to change from one unit to another. When forming these conversion rates, the units that we want to end with will go on the top and the units we want to convert will go on the bottom of our fraction.

Example: Suppose we want to convert 27 feet into yards.

First we look to see if we have an equivalence between *feet* and *yards.* We know that 3 feet is the same as 1 yard, so we will setup our conversion rate using these two measurements.

We start with our given measurement **27 *feet*** and then multiply it by our conversion rate (in the form of a fraction), which will be made up from the equivalence between feet and yards.

When setting up the conversion rate, the unit of measurement that we want to convert to goes in the numerator and the unit of measurement we are converting from goes in the denominator.

$$27 \, feet \; \times \; \frac{1 \, yard}{3 \, feet}$$

We can now eliminate the units "feet" and perform the multiplication

$$\frac{27 \, yards}{3}$$

Reducing the fraction will provide us with the answer in the desired unit of measurement

$$9 \, yards$$

Arithmetic Operations with Measurements of Length

We can also write measurements of length using more than one unit.

    Example: Suppose we know that a piece of rope is 50 inches long, but we want to express the length of the rope using both feet and inches.

    To convert 50 inches into both feet and inches we must use the equivalence that exists between feet and inches (1 ft = 12 in).

    We will divide the given measurement of 50 inches by 12 in standard long division format

$$\begin{array}{r} 4 \quad \leftarrow \text{ our measurement in feet} \\ 12\overline{)50} \\ \underline{48} \\ 2 \quad \leftarrow \text{ our measurement in inches} \end{array}$$

    So 50 inches is equal to 4 feet 2 inches.

We can also add measurements together. We must first group the measurements by their units and then combine the like measurements together.

    Example: Find the sum of 4 ft 4 in and 1 ft 11 in.

    First we will group measurements

$$\begin{array}{rcl} & 4\,ft & 4\,in \\ + & 1\,ft & 11\,in \\ \hline \end{array}$$

    Now we combine our like units

$$\begin{array}{rcl} & 4\,ft & 4\,in \\ + & 1\,ft & 11\,in \\ \hline & 5\,ft & 15\,in \end{array}$$

    Since we know that 12 in = 1 ft, we can simplify the answer by subtracting 12 from the number of inches and adding 1 to the number of feet.

$$\begin{array}{rcl} & 4\,ft & 4\,in \\ + & 1\,ft & 11\,in \\ \hline & 5\,ft & 15\,in \\ +1 & & -12 \end{array}$$

    Performing the addition and subtraction we get the answer of 6 ft 3 in.

We use the same process when we are subtracting measurements.

Example: Subtract 9 ft 6 in minus 3 ft 8 in.

First we group the measurements

$$
\begin{array}{r r}
9\,ft & 6\,in \\
-\quad 3\,ft & 8\,in \\
\hline
\end{array}
$$

In this example, we do not have enough inches to perform the subtraction as written since 6 inches is less than 8 inches. We must first use our conversion rate of 12 in = 1 ft to take 1 foot away from the 9 feet and add 12 inches to the 6 inches.

$$
\begin{array}{r r}
9\,ft & 6\,in \\
-\quad 3\,ft & 8\,in \\
\hline
\end{array}
\quad \rightarrow \quad
\begin{array}{r r}
8\,ft & 18\,in \\
-\quad 3\,ft & 8\,in \\
\hline
\end{array}
$$

Now we can perform the subtraction and get the answer

$$
\begin{array}{r r}
8\,ft & 18\,in \\
-\quad 3\,ft & 8\,in \\
\hline
5\,ft & 10\,in \\
\end{array}
$$

There may also be times when you will have to find the quotient involving measurements with more than one unit.

Example: Find the quotient of 5 ft 4 in and 2.

Here what we want to do is divide "5 ft 4 in" by "2". To do this, we will setup our problem using long division with "5 ft 4 in" as the dividend and "2" as the divisor.

$$
2\overline{)5\,ft \quad 4in}
$$

First we will divide the 2 into the 5 ft.

$$
\begin{array}{r}
2 \\
2\overline{)5\,ft \quad 4\,in} \\
\underline{4} \\
1
\end{array}
$$

We are left with a remainder of 1 ft. Using our conversion rate 1 ft = 12 in, we can add 12 to 4 inches to get rid of the remainder of 1 foot.

$$
\begin{array}{r}
2 \\
2\overline{)5\,ft\quad 4\,in} \\
\underline{4} \\
1 \rightarrow 12 \\
\underline{16\,in}
\end{array}
$$

Now, we can finish the division by dividing 2 into the 16 inches.

$$
\begin{array}{r}
2\,ft\quad 8\,in \\
2\overline{)5\,ft\quad 4\,in} \\
\underline{4} \\
1 \rightarrow 12 \\
16\,in \\
\underline{16}
\end{array}
$$

The answer is 2 ft 8 in.