

# How to use fractions

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A series of measuring spoons, starting at  $\frac{1}{2}$  cup as the largest size. Photo: carol/Wikimedia. Photo: Saki's Pizza/Flickr.

A fraction is a number written as two numbers with a horizontal or slanted line between them. The value of the fraction is found by dividing the number above the line by the number below the line. Not only are fractions a simple tool for handling numbers in mathematics, but they are also used in daily life.

## Fundamental Mathematical Concepts And Terms

Every fraction has three parts: a horizontal or slanted line, a number above the line and a number below the line. The number above the line is the numerator. The number below the line is the denominator. For example, in the fraction  $\frac{3}{4}$  (also written  $\frac{3}{4}$ ), the numerator is 3 and the denominator is 4. The fraction  $\frac{3}{4}$  is one way of writing "3 divided by 4."

You can think of a fraction as a way to say how many portions. For example, if you slice 1 pizza into 8 equally sized parts, each piece is an eighth of a pizza, or  $\frac{1}{8}$  of a pizza. If you put 3 of these pieces on your plate, you have three-eighths of the pizza, since  $\frac{1}{8} + \frac{1}{8} + \frac{1}{8} = \frac{3}{8}$ .



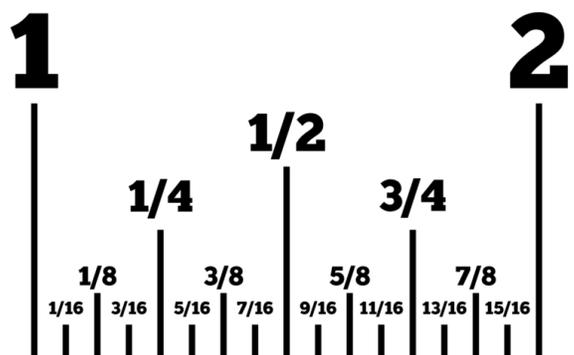
## Types Of Fractions

There are different kinds of fractions. A proper fraction is a fraction whose value is less than 1. An improper fraction is a fraction whose value is greater than or equal to 1. For example,  $\frac{3}{5}$  is a proper fraction, but  $\frac{5}{3}$  is an improper fraction. There is nothing mathematically wrong with an improper fraction. The only difference is that an improper fraction can be written as the sum of a whole number and a proper fraction. For example,  $\frac{5}{3}$  can be written as  $1 + \frac{2}{3}$ , since  $1 + \frac{2}{3} = \frac{3}{3} + \frac{2}{3} = \frac{5}{3}$ .

A unit fraction is any fraction with 1 in the numerator. This kind of fraction is so common that the English language has special words for the most familiar ones:  $\frac{1}{2}$  is a half,  $\frac{1}{3}$  is a third and  $\frac{1}{4}$  is a quarter.

Fractions are called equivalent if they stand for the same number. For example,  $\frac{4}{2}$  and  $\frac{8}{4}$  are equivalent because they both equal 2.

A lowest-terms fraction is a fraction with all common terms canceled out. A common term of two numbers is a number that divides evenly into both of them. For example, 2 is a common term of 4 and 16 because it goes twice into 4 and eight times into 16. For the fraction  $\frac{2}{16}$ , 2 is a common term of both the numerator and denominator. That means the fraction  $\frac{2}{16}$  is not a lowest-terms fraction. We can simplify  $\frac{2}{16}$  by dividing the numerator and the denominator by 2. That leaves us with  $\frac{1}{8}$ , a lowest-terms fraction.



A mixed fraction is made up of an integer plus a fraction, like  $1 + \frac{1}{2}$ . In cooking and carpentry (but never in mathematics), a mixed fraction is written without the "+" sign, as in  $1 \frac{1}{2}$ .

## Rules For Handling Fractions

To be useful, fractions must be added, subtracted, multiplied and divided by other numbers. The rules for how to do each of these things are given in Figure 1.

### Real-Life Applications

#### Cooking And Baking

Fractions are important for cooking and baking. Cups and teaspoons are often measured in fractions. A cook must often know at least how to add and multiply fractions to use a recipe. Recipes are only given for a certain amount. If you want to make more or less, you have to divide or multiply the fractions in the instructions. Say, for example, that a cookie recipe calls for  $2\frac{2}{3}$  cups of flour and you want to make three times as much. How much flour do you need to measure?

Operation	Rule	Example
Multiply a fraction by an integer, $n$	$n \frac{a}{b} = \frac{na}{b}$	$4 \times \frac{3}{5} = \frac{4 \times 3}{5} = \frac{12}{5}$
Divide a fraction by an integer, $n$	$\frac{a}{b} \div n = \frac{a}{bn}$	$\frac{1}{2} \div 4 = \frac{1}{2 \times 4} = \frac{1}{8}$
Multiply fractions	$\frac{a}{b} \times \frac{c}{d} = \frac{ac}{bd}$	$\frac{1}{3} \times \frac{4}{5} = \frac{1 \times 4}{3 \times 5} = \frac{4}{15}$
Divide fractions	$\frac{a}{b} \div \frac{c}{d} = \frac{a}{b} \times \frac{d}{c} = \frac{ad}{bc}$	$\frac{1}{3} \div \frac{4}{5} = \frac{1}{3} \times \frac{5}{4} = \frac{5}{12}$
Add fractions	$\frac{a}{b} + \frac{c}{d} = \frac{ad + bc}{bd}$	$\frac{2}{9} + \frac{1}{7} = \frac{2 \times 7 + 1 \times 9}{9 \times 7} = \frac{23}{63}$
Subtract fractions	$\frac{a}{b} - \frac{c}{d} = \frac{ad - bc}{bd}$	$\frac{2}{9} - \frac{1}{7} = \frac{2 \times 7 - 1 \times 9}{9 \times 7} = \frac{5}{63}$

One way to figure this out is to write the mixed number  $2\frac{2}{3}$  as a fraction. First, note that  $2 = \frac{6}{3}$ . To add fractions with the same denominator, you just add the numerators, so  $2\frac{2}{3} = \frac{6}{3} + \frac{2}{3} = \frac{8}{3}$ . To triple the amount of flour, you multiply  $\frac{8}{3}$  cups by 3, which is  $2\frac{2}{3}$ .

You can get out your  $\frac{1}{3}$ -cup measure and measure 24 times, but that is a lot of work. Instead, you can reduce  $2\frac{2}{3}$ . Reducing the fraction shows that  $2\frac{2}{3} = 8$ . Therefore, you can measure eight times with your 1-cup measure.

#### Radioactive Waste

Nuclear waste gives off radiation, which may cause disease and kill living things. Only over very long periods will radioactive waste slowly become harmless as it breaks down naturally into other elements. How quickly a substance loses its radioactivity is expressed as a fraction. This fraction is called the "half-life" of the substance. The half-life of a substance is the time it takes for the substance to lose  $\frac{1}{2}$  of its radioactivity. For the element plutonium, which is found in most nuclear waste, the half-life is about 24,000 years. That is, no matter how much plutonium you start out with, after 24,000 years you will have half as much plutonium left.

By multiplying fractions, it is possible to answer some questions about how much radioactive waste will remain after a certain time. For instance, after two half-lives, how much plutonium will be left? This is the same as asking what is a half of a half, which is the same as multiplying  $\frac{1}{2}$  times itself:  $1 \times \frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$ . So if you start with 1 pound of plutonium, you will have  $\frac{1}{4}$  pound after two half-lives. This can be carried on for as many steps as we like.

## Fractions And Rhythm

Fractions are also used in music. In Western music, the time-values of notes are named after fractions: besides the whole note, which lasts one full beat, there is the half-note, which lasts only half a beat, and the quarter note, eighth note, sixteenth note and so on. Notice that these fractions —  $\frac{1}{2}$ ,  $\frac{1}{4}$ ,  $\frac{1}{8}$ ,  $\frac{1}{16}$  — all have multiples of 2 in the denominator. In fact, each fraction in the series is the previous fraction times  $\frac{1}{2}$ . That is, each standard type of note lasts  $\frac{1}{2}$  as long as the next-longest type.

Musical notes use fractions to show duration. Image from public domain.

Music also has rests. These marks tell you how long to be silent. Just as there are notes with various values, there are rest symbols with various time values — whole, half, quarter and eighth rests.

## Quiz

- 1 Which sentence from the article supports the idea that some fractions that look different may have the same value?
- (A) For example, in the fraction  $\frac{3}{4}$  (also written  $\frac{3}{4}$ ), the numerator is 3 and the denominator is 4.
  - (B) For example, if you slice 1 pizza into 8 equally sized parts, each piece is an eighth of a pizza, or  $\frac{1}{8}$  of a pizza.
  - (C) For example,  $\frac{4}{2}$  and  $\frac{8}{4}$  are equivalent because they both equal 2.
  - (D) For example, 2 is a common term of 4 and 16 because it goes twice into 4 and eight times into 16.
- 2 Which sentence in the section "Cooking And Baking" BEST supports the conclusion that people with jobs in the restaurant business need to know fractions?
- (A) Fractions are important for cooking and baking.
  - (B) Cups and teaspoons are often measured in fractions.
  - (C) A cook must often know at least how to add and multiply fractions to use a recipe.
  - (D) If you want to make more or less, you have to divide or multiply the fractions in the instructions.
- 3 Which sentence from the section "Radioactive Waste" BEST introduces "half-life" to the reader?
- (A) Only over very long periods will radioactive waste slowly become harmless as it breaks down naturally into other elements.
  - (B) How quickly a substance loses its radioactivity is expressed as a fraction.
  - (C) For the element plutonium, which is found in most nuclear waste, the half-life is about 24,000 years.
  - (D) That is, no matter how much plutonium you start out with, after 24,000 years you will have half as much plutonium left.

- 4 Which sentence introduces fractions as a part of a whole in the article?
- (A) A fraction is a number written as two numbers with a horizontal or slanted line between them.
  - (B) Every fraction has three parts: a horizontal or slanted line, a number above the line and a number below the line.
  - (C) You can think of a fraction as a way to say how many portions.
  - (D) A lowest-terms fraction is a fraction with all common terms canceled out.

## Answer Key

- 1 Which sentence from the article supports the idea that some fractions that look different may have the same value?
- (A) For example, in the fraction  $\frac{3}{4}$  (also written  $\frac{3}{4}$ ), the numerator is 3 and the denominator is 4.
  - (B) For example, if you slice 1 pizza into 8 equally sized parts, each piece is an eighth of a pizza, or  $\frac{1}{8}$  of a pizza.
  - (C) **For example,  $\frac{4}{2}$  and  $\frac{8}{4}$  are equivalent because they both equal 2.**
  - (D) For example, 2 is a common term of 4 and 16 because it goes twice into 4 and eight times into 16.
- 2 Which sentence in the section "Cooking And Baking" BEST supports the conclusion that people with jobs in the restaurant business need to know fractions?
- (A) Fractions are important for cooking and baking.
  - (B) Cups and teaspoons are often measured in fractions.
  - (C) **A cook must often know at least how to add and multiply fractions to use a recipe.**
  - (D) If you want to make more or less, you have to divide or multiply the fractions in the instructions.
- 3 Which sentence from the section "Radioactive Waste" BEST introduces "half-life" to the reader?
- (A) Only over very long periods will radioactive waste slowly become harmless as it breaks down naturally into other elements.
  - (B) **How quickly a substance loses its radioactivity is expressed as a fraction.**
  - (C) For the element plutonium, which is found in most nuclear waste, the half-life is about 24,000 years.
  - (D) That is, no matter how much plutonium you start out with, after 24,000 years you will have half as much plutonium left.

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  - (D) A lowest-terms fraction is a fraction with all common terms canceled out.