

The difference between two quantities is best characterized by a percentage.

*Example #1*

Let's say you're expecting some potatoes. Unfortunately, the punks at the potato company delivered 4 fewer potatoes than you were expecting! How angry should you be?

Well, if you were expecting 4 potatoes, then you should be very angry. If you were expecting 2500 potatoes, then maybe you should let it slide.

If you were expecting 4 potatoes, then they were off by 100% -- a huge error on their part!

If you were expecting 2500 potatoes, and they only produced 2496 potatoes, then they were only off by  $4 / 2500 = 0.0016 = 0.16\%$ . A margin of error of 0.2% is probably more than you can expect when sorting & counting thousands of potatoes.

*Formula #1*

The “% difference” between expected and actual quantities can be expressed as follows:

$$\% \text{ difference} = | \text{expected} - \text{actual} | / \text{expected}$$

Note that the absolute value sign ensures that the % difference is always positive.

*Practice*

Calculate the % difference between the actual and expected values below.

1. You were expecting 100 potatoes but only received 95.
2. You were expecting a force of 20 N but only measured 18 N.
3. You were expecting a mass of 1800.00 kg but measured 1798.58 kg.

*Example #2*

Sometimes it isn't clear what is 'expected' and what is not. Say you and a friend were both weighing your dog. Your friend measured 35.5 lbs, you measured 36.2 lbs. In this case there is no 'expected' value – both values have equal validity. In this case, the formula changes slightly:

*Formula #2*

The “% difference” between two equivalent values can be expressed as follows:

$$\% \text{ difference} = | \text{value \#1} - \text{value \#2} | / \text{AVERAGE}$$

Where AVERAGE is the average of value #1 and value #2. (Some people divide by the smaller of the two so the % difference is maximized. We won't bother with that, but you should know that happens from time to time.)

*Practice*

Calculate the % difference between the experiments below.

1. You counted 305 SAT exams but your partner counted 304 exams.
2. You predict a force of  $8 \times 10^{-5}$  N but your buddy predicts a force of  $5 \times 10^{-5}$  N.
3. You say there are 15 sunny days a year at SI but your friend argues there are 16 sunny days a year at SI.

*Further practice*

It is worth learning how to do % differences in your head. They can be a very quick way of determining how well an experiment is going DURING the experiment (rather than after, when all the equipment is put away.)

TRY THESE IN YOUR HEAD before checking with a calculator.

1. You predicted 10 N but measured 11 N.
2. You predicted 100 kg but measured 118 kg.
3. You predicted 20 kg but measured 19 kg.
4. Your bill at the Stinking Rose was \$80 but you put down \$96.
5. You got a 95 on the exam and your partner got a 105.
6. You're 5'6" tall and your boyfriend is 6'0" tall.

*Rational Error Analysis*

Let's say you predicted a speed for an air track in the lab of 5.0 m/s and you measured 5.5 m/s, for a % difference of 10%. You write that this 10% error is due to friction. Why might your teacher take issue with you 'explaining away' this 10% error with friction? What might be a better explanation?