Expressing Error as a Percentage

Let's use percentages to describe situations that involve error.

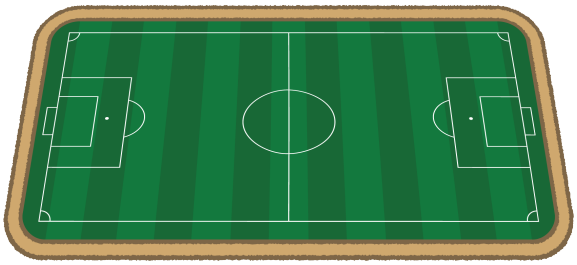
11.1 Math Talk: What Percentage?

Find each percentage mentally.

- 3 is what percent of 6?
- 3 is what percent of 12?
- 3 is what percent of 120?
- 3 is what percent of 600?

11.2 Measuring a Soccer Field

A soccer field is 120 yards long. Han uses a 30-foot-long tape measure to measure the length of the field and gets a measurement of 376 feet 6 inches.



1. What is the amount of the error?

2. Express the error as a percentage of the actual length of the field. Explain or show your reasoning.

3. What are some possible causes for this error?

11.3 Plants, Bicycles, and Crowds

1. Instructions to care for a plant say to water it with $\frac{3}{4}$ cup of water every day. The plant has been getting 25% too much water. How much water has the plant been getting?

2. The pressure on a bicycle tire is 63 psi. This is 5% higher than what the manual says is the correct pressure. What is the correct pressure?

3. The crowd at a sporting event is estimated to be 3,000 people. The exact attendance is 2,486 people. What is the **percent error**?

Are you ready for more?

A micrometer is an instrument that can measure lengths to the nearest micron. (A micron is a millionth of a meter.) Would this instrument be useful for measuring any of the following things? If so, what would the largest percent error be?

1. the thickness of an eyelash, which is typically about 0.1 millimeter

2. the diameter of a red blood cell, which is typically about 8 microns

3. the diameter of a hydrogen atom, which is about 100 picometers (a picometer is a trillionth of a meter).

11.4 Saw Mill

1. A saw mill cuts boards that are 16 feet long. After they are cut, the boards are inspected and rejected if the length has a percent error of 1.5% or more.

   a. List some board lengths that should be accepted.

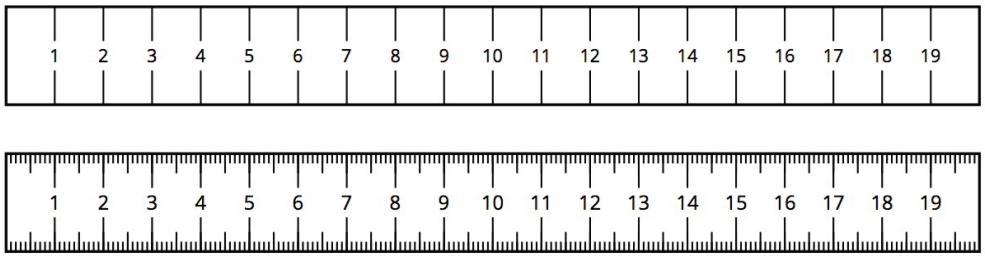
   b. List some board lengths that should be rejected.

2. The saw mill also cuts boards that are 10, 12, and 14 feet long. An inspector rejects a board that is 2.3 inches too long. What was the intended length of the board?

Lesson 11 Summary

When we use a ruler or measuring tape to measure a length, we can get a measurement that is different from the actual length. This could be because we positioned the ruler incorrectly, or it could be because the ruler is not very precise. There is always at least a small difference between the actual length and a measured length, even if it is a microscopic difference!

Here are two rulers with different markings.



The second ruler is marked in millimeters, so it is easier to get a measurement to the nearest tenth of a centimeter with this ruler than with the first. For example, a line that is actually 6.2 cm long might be measured to be 6 cm long by the first ruler because we measure to the nearest centimeter.

The **measurement error** is the positive difference between the measurement and the actual value. Measurement error is often expressed as a percentage of the actual value. We always use a positive number to express measurement error and, when appropriate, use words to describe whether the measurement is greater than or less than the actual value.

For example, if we get 6 cm when we measure a line that is actually 6.2 cm long, then the measurement error is 0.2 cm, or about 3.2%, because $0.2 \div 6.2 \approx 0.032$.

Percent error can be used to describe any situation where there is a correct value and an incorrect value, and we want to describe the relative difference between them. For example, if a milk carton is supposed to contain 16 fluid ounces, and it only contains 15 fluid ounces:

- The measurement error is 1 oz.
- The percent error is 6.25% because $1 \div 16 = 0.0625$.

We can also use percent error when talking about estimates. For example, a teacher estimates there are about 600 students at their school. If there are actually 625 students, then the percent error for this estimate is 4%, because $625 - 600 = 25$ and $25 \div 625 = 0.04$.