use every data value, such as the standard deviation. To keep our round-off rules as consistent and as simple as possible, we will round the range using the same round-off rule for all measures of variation discussed in this section.

Round-Off Rule for Measures of Variation

When rounding the value of a measure of variation, carry one more decimal place than is present in the original set of data.

Example 1 Range

Find the range of these numbers of chocolate chips: 22, 22, 26, 24. (These are the first four chip counts for the Chips Ahoy cookies.)

Solution

The range is found by subtracting the lowest value from the largest value, so we get

$$\text{range} = (\text{maximum value}) - (\text{minimum value}) = 26 - 22 = 4.0$$

The result is shown with one more decimal place than is present in the original data values. We conclude that the range is 4.0 chocolate chips.

Standard Deviation of a Sample

The *standard deviation* is the measure of variation most commonly used in statistics.

DEFINITION The **standard deviation** of a set of sample values, denoted by s, is a measure of how much data values deviate away from the mean. It is calculated by using Formula 3-4 or 3-5. Formula 3-5 is just a different version of Formula 3-4, so both formulas are algebraically the same.

Formula 3-4

$$s = \sqrt{\frac{\Sigma (x - \bar{x})^2}{n - 1}}$$ sample standard deviation

Formula 3-5

$$s = \sqrt{\frac{n(\Sigma x^2) - (\Sigma x)^2}{n(n - 1)}}$$ shortcut formula for sample standard deviation (formula used by calculators and computer programs)

Later in this section we describe the reasoning behind these formulas, but for now we recommend that you use Formula 3-4 for an example or two, and then learn how to find standard deviation values using your calculator and by using a software program. (Most scientific calculators are designed so that you can enter a list of values and automatically get the standard deviation.) The following properties are consequences of the way in which the standard deviation is defined.

Important Properties of Standard Deviation

- The standard deviation is a measure of how much data values deviate away from the *mean*.

What the Median Is Not

Harvard biologist Stephen Jay Gould wrote, "The Median Isn't the Message." In it, he describes how he learned that he had abdominal mesothelioma, a form of cancer. He went to the library to learn more, and he was shocked to find that mesothelioma was incurable, with a median survival time of only *eight months* after it was discovered. Gould wrote this: "I suspect that most people, without training in statistics, would read such a statement as 'I will probably be dead in eight months' the very conclusion that must be avoided, since it isn't so, and since attitude (in fighting the cancer) matters so much." Gould went on to carefully interpret the value of the median. He knew that his chance of living longer than the median was good because he was young, his cancer was diagnosed early, and he would get the best medical treatment. He also reasoned that some could live much longer than eight months, and he saw no reason why he could not be in that group. Armed with this thoughtful interpretation of the median and a strong positive attitude, Gould lived for *20 years* after his diagnosis. He died of another cancer not related to the mesothelioma.