| Example 10 | Rounding Probabilities |

- The probability of 0.9017094017 (from Example 7) has ten significant digits (9017094017), and it can be rounded to three significant digits as 0.902.

- The probability of 1/3 can be left as a fraction or rounded to 0.333. (Do *not* round to 0.3.)

- The probability of 2/8 (from Example 4) can be expressed as 1/4 or 0.25; because 0.25 is exact, there's no need to express it with three significant digits as 0.250.

The mathematical expression of probability as a number between 0 and 1 is fundamental and common in statistical procedures, and we will use it throughout the remainder of this text. A typical computer output, for example, may include a "*P*-value" expression such as "significance less than 0.001." We will discuss the meaning of *P*-values later, but they are essentially probabilities of the type discussed in this section. For now, you should recognize that a probability of 0.001 (equivalent to 1/1000) corresponds to an event so rare that it occurs an average of only once in a thousand trials. Example 12 involves the interpretation of such a small probability value.

Interpreting Probabilities: *Unlikely* Events and *Unusual* Events

We can consider an event with a small probability (such as 0.05 or less) to be *unlikely*. But we often need to determine when an event consists of an *unusually high* number of outcomes of a particular type or an *unusually low* number of such outcomes. An event has a number of particular outcomes that is unusually low or unusually high if that number is *extreme* in the sense that it is far from the number that we typically expect. The following definitions are not standard with universal use, but they are very helpful in interpreting probability values and developing concepts used extensively in later chapters.

> **DEFINITIONS** An event is **unlikely** if its probability is very small, such as 0.05 or less. (See Figure 4-2.) An event has an **unusually low number** of outcomes of a particular type or an **unusually high number** of those outcomes if that number is far from what we typically expect.

Unlikely: Small probability (such as 0.05 or less)

Unusual: Extreme result (number of outcomes of a particular type is far below or far above the typical values)

By associating "unusual" with *extreme* outcomes, we are consistent with the range rule of thumb (Section 3-3) and the use of *z* scores for identifying unusual values (Section 3-4).

| Example 11 | Unlikely/Unlikely |

a. When a fair coin is tossed 1000 times, the result consists of exactly 500 heads. The probability of getting exactly 500 heads in 1000 tosses is 0.0252. Is this result unlikely? Is 500 heads unusually low or unusually high?

b. When a fair coin is tossed 1000 times, the result consists of 10 heads. Is this result unlikely? Is 10 heads unusually low or unusually high?

How Many Shuffles?

After conducting extensive research, Harvard mathematician Persi Diaconis found that it takes seven shuffles of a deck of cards to get a complete mixture. The mixture is complete in the sense that all possible arrangements are equally likely. More than seven shuffles will not have a significant effect, and fewer than seven are not enough. Casino dealers rarely shuffle as often as seven times, so the decks are not completely mixed. Some expert card players have been able to take advantage of the incomplete mixtures that result from fewer than seven shuffles.