11.1 Using Normal Distributions
For use with Exploration 11.1

Essential Question   In a normal distribution, about what percent of the data lies within one, two, and three standard deviations of the mean?

Recall that the standard deviation $\sigma$ of a numerical data set is given by

$$\sigma = \sqrt{\frac{(x_1 - \mu)^2 + (x_2 - \mu)^2 + \cdots + (x_n - \mu)^2}{n}}$$

where $n$ is the number of values in the data set and $\mu$ is the mean of the data set.

1 EXPLORATION: Analyzing a Normal Distribution

Work with a partner. In many naturally occurring data sets, the histogram of the data is bell-shaped. In statistics, such data sets are said to have a normal distribution. For the normal distribution shown below, estimate the percent of the data that lies within one, two, and three standard deviations of the mean. Each square on the grid represents 1%.
11.1 Using Normal Distributions (continued)

**EXPLORATION: Analyzing a Data Set**

**Work with a partner.** A famous data set was collected in Scotland in the mid-1800s. It contains the chest sizes (in inches) of 5738 men in the Scottish Militia. Do the data fit a normal distribution? Explain.

<table>
<thead>
<tr>
<th>Chest size (inches)</th>
<th>Number of men</th>
</tr>
</thead>
<tbody>
<tr>
<td>33</td>
<td>3</td>
</tr>
<tr>
<td>34</td>
<td>18</td>
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<tr>
<td>35</td>
<td>81</td>
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<td>36</td>
<td>185</td>
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<tr>
<td>37</td>
<td>420</td>
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<tr>
<td>38</td>
<td>749</td>
</tr>
<tr>
<td>39</td>
<td>1073</td>
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<tr>
<td>40</td>
<td>1079</td>
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<tr>
<td>41</td>
<td>934</td>
</tr>
<tr>
<td>42</td>
<td>658</td>
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<tr>
<td>43</td>
<td>370</td>
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<td>50</td>
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<td>46</td>
<td>21</td>
</tr>
<tr>
<td>47</td>
<td>4</td>
</tr>
<tr>
<td>48</td>
<td>1</td>
</tr>
</tbody>
</table>

**Communicate Your Answer**

3. In a normal distribution, about what percent of the data lies within one, two, and three standard deviations of the mean?

4. Use the Internet or some other reference to find another data set that is normally distributed. Display your data in a histogram.
11.1 Notetaking with Vocabulary
For use after Lesson 11.1

In your own words, write the meaning of each vocabulary term.

normal distribution

normal curve

standard normal distribution

z-score

Core Concepts
Areas Under a Normal Curve

A normal distribution with mean $\mu$ and standard deviation $\sigma$ has these properties.

- The total area under the related normal curve is 1.
- About 68% of the area lies within 1 standard deviation of the mean.
- About 95% of the area lies within 2 standard deviations of the mean.
- About 99.7% of the area lies within 3 standard deviations of the mean.

Notes:
11.1 Notetaking with Vocabulary (continued)

Extra Practice

In Exercises 1–6, a normal distribution has mean $\mu$ and standard deviation $\sigma$. Find the indicated probability for a randomly selected $x$-value from the distribution.

1. $P(x \leq \mu - 2\sigma)$
2. $P(x \geq \mu - 3\sigma)$

3. $P(x \leq \mu + 2\sigma)$
4. $P(x \geq \mu + 3\sigma)$

5. $P(\mu - \sigma \leq x \leq \mu + 3\sigma)$
6. $P(\mu - 2\sigma \leq x \leq \mu + \sigma)$

7. The scores for a math course test are normally distributed with a mean of 61 and a standard deviation of 11. The test scores range from 0 to 100.

a. About what percent of the students taking the test have scores between 72 and 83?

b. About what percent of the students taking the test have scores less than 50?
8. The temperatures of a city are normally distributed over the course of a year. The mean temperature is 55.2°F and the standard deviation is 6.3°F. A day is randomly chosen.

   a. What is the probability that the chosen day is 45°F or cooler?

   b. What is the probability that the chosen day is cooler than 32.5°F?

   c. What is the probability that the chosen day is between 32.5°F and 45°F?

   d. What is the probability that the chosen day is 60°F or warmer?

In Exercises 9 and 10, determine whether the histogram has a normal distribution.

9. Number of Visitors at a Science Center

10. Height of Sunflowers