Chapter 13: Probability and Data Analysis
13.1 Finding Probability and Odds

Probability -

2 Types of Probability

Theoretical probability = \[
\frac{\text{Number of favorable outcomes}}{\text{Total number of outcomes}}
\]  
(what the results “should” be based on the laws of probability)

Experimental probability = \[
\frac{\text{Number of successes}}{\text{Number of trials}}
\]  
(if you carry out an experiment and record the actual results)

Example 1

You roll a number cube (dice). What is the theoretical probability that you will roll:

a) an odd number

b) an even number

c) a number less than 5

d) a number greater than 1

e) a number less than 8
**Example 2**  
*Find a theoretical probability*

**T-SHIRTS** You and your friends designed T-shirts with silk screened emblems, and you are selling the T-shirts to raise money. The table below shows the number of T-shirts you have in each design. A student chooses a T-shirt at random. What is the probability that the student chooses a red T-shirt?

<table>
<thead>
<tr>
<th></th>
<th>Gold emblem</th>
<th>Silver emblem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green T-shirt</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Red T-shirt</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

2. **T-SHIRTS** In Example 2, what is the probability that the student chooses a T-shirt with a gold emblem?

**Example 3**  
*Standardized Test Practice*

Each section of the spinner shown has the same area. The spinner was spun 20 times. The table shows the results. For which color is the experimental probability of stopping on the color the same as the theoretical probability?

<table>
<thead>
<tr>
<th>Spinner Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
</tr>
<tr>
<td>5</td>
</tr>
</tbody>
</table>

**A** Red  
**B** Green  
**C** Blue  
**D** Yellow
**ODDS** The odds of an event compare the number of favorable and unfavorable outcomes when all outcomes are equally likely.

\[
\text{Odds in favor} = \frac{\text{Number of favorable outcomes}}{\text{Number of unfavorable outcomes}}
\]

\[
\text{Odds against} = \frac{\text{Number of unfavorable outcomes}}{\text{Number of favorable outcomes}}
\]

---

**Example 4** Find the odds

**SPINNER** In Example 3, find the odds against stopping on green.

In Example 3, what are the odds in favor of stopping on blue?

Example:

The probability of rain tonight is .6 (60%)

Find the odds for rain:________

Find the odds against rain:________
PROBABILITY AND ODDS  In Exercises 7–13, refer to the spinner shown. The spinner is divided into sections with the same area.

7. What is the probability that the spinner stops on a multiple of 3?

8. ERROR ANALYSIS  Describe and correct the error in finding the probability of stopping on a multiple of 9.

\[
\frac{\text{Number of favorable outcomes}}{\text{Total number of outcomes}} = \frac{2}{10} = \frac{1}{5} \times \]

9. You spin the spinner 30 times. It stops on 12 three times. What is the experimental probability of stopping on 12?

10. You spin the spinner 10 times. It stops on an even number 6 times. What is the experimental probability of stopping on an even number?

11. What are the odds in favor of stopping on a multiple of 4?

12. What are the odds against stopping on a number less than 12?

14. ★ MULTIPLE CHOICE  The odds in favor of an event are 5 : 8. What are the odds against the event?

   A  3 : 8  
   B  8 : 3  
   C  5 : 8  
   D  8 : 5

15. ★ OPEN–ENDED  Describe a real-world event whose probability is 0. Describe another real-world event whose probability is 1.

16. ★ MULTIPLE CHOICE  According to a meteorologist, there is a 40% chance that it will rain today. What are the odds in favor of rain?

   A  2 : 5  
   B  2 : 3  
   C  3 : 2  
   D  4 : 1
20. **SURVEY** A survey asked a total of 600 students (100 male students and 100 female students who were 11, 13, and 15 years old) about their exercise habits. The table shows the numbers of students who said they exercise 2 hours or more each week.

<table>
<thead>
<tr>
<th></th>
<th>11 years</th>
<th>13 years</th>
<th>15 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>53</td>
<td>57</td>
<td>51</td>
</tr>
<tr>
<td>Male</td>
<td>65</td>
<td>68</td>
<td>67</td>
</tr>
</tbody>
</table>

a. What is the probability that a randomly selected female student who participated in this survey exercises 2 hours or more each week?

b. What is the probability that a randomly selected 15-year-old student who participated in this survey exercises 2 hours or more each week?

c. What is the probability that a randomly selected student who participated in this survey exercises 2 hours or more each week?
You roll a number cube. What is the probability that you will roll a number less than 5?

1. \(P(5)\)  
2. \(P(\text{odd number})\)  
3. \(P(\text{even number})\)

4. \(P(\text{not 5})\)  
5. \(P(\text{less than 5})\)  
6. \(P(\text{greater than 5})\)

7. \(P(\text{multiple of 5})\)  
8. \(P(\text{less than 15})\)  
9. \(P(\text{prime number})\)

You choose a marble at random from a bag containing 2 red marbles, 4 green marbles, and 3 blue marbles. Find the odds.

12. odds in favor of red  
13. odds in favor of blue

14. odds against green  
15. odds against red

16. odds in favor of green  
17. odds against blue

18. You roll a number cube. What are the odds that you will roll an even number?
13.1 Practice (continued)

Theoretical and Experimental Probability

One hundred twenty randomly selected students at Roosevelt High School were asked to name their favorite sport. The results are shown in the table. Find the experimental probability that a student selected at random makes the given response.

<table>
<thead>
<tr>
<th>Favorite Sport Survey</th>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basketball</td>
<td>30</td>
</tr>
<tr>
<td>Baseball</td>
<td>22</td>
</tr>
<tr>
<td>Football</td>
<td>34</td>
</tr>
<tr>
<td>Soccer</td>
<td>20</td>
</tr>
<tr>
<td>Other</td>
<td>14</td>
</tr>
</tbody>
</table>

19. \( P(\text{basketball}) \)

20. \( P(\text{soccer}) \)

21. \( P(\text{baseball}) \)

22. \( P(\text{football}) \)

23. A meteorologist says that the probability of rain today is 35%. What is the probability that it will not rain?

24. Hank usually makes 11 out of every 20 of his free throws. What is the probability that he will miss his next free throw?

25. There are 250 freshmen at Central High School. You survey 50 randomly selected freshmen and find that 35 plan to go to the school party on Friday. How many freshmen are likely to be at the party?

26. The Widget Company randomly selects its widgets and checks for defects. If 5 of the 300 selected widgets are defective, how many defective widgets would you expect in the 1500 widgets manufactured today?
Practice A

Find the number of possible outcomes in the sample space. Then list the possible outcomes.
1. A bag contains 5 red cards numbered 1–5 and 5 white cards numbered 1–5. You choose a card at random.
2. A bag contains 3 red cards numbered 1–3 and 4 white cards numbered 1–4. You choose a card at random.
3. You toss three coins.
   - You roll a number cube and toss two coins.

In Exercises 5–12, refer to the spinner shown. The spinner is divided into sections with the same area.
5. What is the probability that the spinner stops on an odd number?
6. What is the probability that the spinner stops on an even number?
7. What is the probability that the spinner stops on a multiple of 3?
8. You spin the spinner 36 times. It stops on 8 four times. What is the experimental probability of stopping on 8?
9. You spin the spinner 20 times. It stops on 1 twice. What is the experimental probability of stopping on 1?
10. You spin the spinner 24 times. It stops on 3 six times. What is the experimental probability of stopping on 3?
11. What are the odds in favor of stopping on 14?
12. What are the odds against stopping on a multiple of 3?
13. Favorite Subjects A survey asked a total of 180 students in the senior class about their favorite class subjects. The table shows the results of the survey.

<table>
<thead>
<tr>
<th>Subject</th>
<th>English</th>
<th>Social studies</th>
<th>Science</th>
<th>Math</th>
<th>Gym</th>
<th>Foreign language</th>
<th>No preference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of students</td>
<td>26</td>
<td>33</td>
<td>42</td>
<td>30</td>
<td>9</td>
<td>15</td>
<td>25</td>
</tr>
</tbody>
</table>

a. What is the probability that a randomly selected student who participated in this survey chose foreign language as his or her favorite subject?
b. What is the probability that a randomly selected student who participated in this survey chose English as his or her favorite subject?
c. What is the probability that a randomly selected student who participated in this survey chose science or math as his or her favorite subject?
**Practice B**

Find the number of possible outcomes in the sample space. Then list the possible outcomes.

1. A bag contains 6 blue cards numbered 1–6 and 6 red cards numbered 1–8. You choose a card at random.
2. You roll one 4-sided number cube and toss two coins.
3. You roll two 6-sided number cubes.

In Exercises 4–9, refer to the spinner shown. The spinner is divided into sections with the same area.

4. What is the probability that the spinner stops on an even number?
5. What is the probability that the spinner stops on an odd number?
6. You spin the spinner 24 times. It stops on 27 twice. What is the experimental probability of stopping on 27?
7. You spin the spinner 30 times. It stops on a multiple of 3 five times. What is the experimental probability of stopping on a multiple of 3?
8. What are the odds in favor of stopping on a multiple of 4?
9. What are the odds against stopping on a multiple of 6?

10. **Favorite Spectator Sport**  A survey asked a total of 180 students in your school about their favorite spectator sports. The table shows the results of the survey.

<table>
<thead>
<tr>
<th>Sport</th>
<th>Basketball</th>
<th>Soccer</th>
<th>Football</th>
<th>Baseball</th>
<th>Volleyball</th>
<th>Wrestling</th>
<th>Hockey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of students</td>
<td>40</td>
<td>20</td>
<td>45</td>
<td>20</td>
<td>16</td>
<td>18</td>
<td>21</td>
</tr>
</tbody>
</table>

a. What is the probability that a randomly selected student who participated in this survey chose football as his or her favorite spectator sport?
b. What is the probability that a randomly selected student who participated in this survey chose wrestling or hockey as his or her favorite spectator sport?
c. What are the odds in favor of a randomly selected student who participated in this survey choosing basketball as his or her favorite spectator sport?

11. **Movies** A local movie theater did a survey of students to determine their favorite types of movies. The circle graph shows the results of the survey.

a. What is the probability that a randomly selected student chose science fiction as his or her favorite type of movie?
b. What is the probability that a randomly selected student chose drama or comedy as his or her favorite type of movie?