**Example:** Leah places four white marbles and two black marbles in a bag. She plans to draw out one marble and then a second marble without replacing the first. What is the probability that both marbles will be white?

You can analyze the problem in this way.

For the first drawing, 4 out of 6 marbles are white. The probability that the first outcome is white is $\frac{4}{6}$, which reduces to $\frac{2}{3}$.

Now assume that the first marble is white.

For the second drawing, 3 out of the remaining 5 marbles are white. The probability that the second outcome is white is $\frac{3}{5}$.

Multiply to find the probability of both events: $\frac{2}{3} \times \frac{3}{5} = \frac{2}{5}$.

**Answer:** The probability of Leah’s drawing two white marbles is $\frac{2}{5}$, or 40%.

**SKILL PRACTICE**

Solve each problem. Express all answers in fraction form.

1. Three coins are tossed at the same time. What is the probability that all three coins will come up tails?

2. Dan and Stan are playing a card game. Of the seven cards Dan has in his hand, five are hearts. If Stan takes two cards from Dan’s hand without looking, what is the probability that both cards will be hearts?

Use the spinner below to solve items 3 to 5.

3. What is the chance of spinning a 2?

4. Sherry spins the spinner twice. What is the chance that she did not get a 4 on either spin?

5. Alan spins the spinner twice. What is the chance that the sum of the spins is 8?

6. Hasina has 4 bills in her wallet: a $1 bill, a $5 bill, a $10 bill, and a $20 bill. If she draws out two bills at random, what is the chance of her drawing out $30?

7. Of the 12 employees at Olympic Pharmacy, two will be chosen at random to work the night shift. Ana hopes she will not be chosen. The manager writes the employees’ names on cards and draws one out without looking. The first name drawn is Grant. What is the chance that Ana’s name will be next?

   (1) $\frac{1}{2}$
   (2) $\frac{1}{11}$
   (3) $\frac{1}{12}$
   (4) $\frac{1}{23}$
   (5) $\frac{1}{132}$

8. Two 6-sided dice are numbered from 1 to 6. If both dice are rolled and the two numbers added, there are 36 possible sums. Which of the following is a true statement? (Hint: Make a chart of all possible dice rolls.)

   (1) The chance of getting a sum of 2 is $\frac{1}{6}$.
   (2) The chance of rolling two 4s is $\frac{1}{12}$.
   (3) The chance of rolling two of the same number is $\frac{1}{2}$.
   (4) The chance of getting a sum of 6 is $\frac{1}{6}$.
   (5) The chance of getting a sum of 11 is $\frac{1}{18}$.

Answers and explanations start on page 327.
Since the number 1 represents a certain probability, the chance that an event will not happen is equal to 1 minus the probability that an event will occur. In this case, \(1 - \frac{1}{4} = \frac{3}{4}\), the probability that the marble will not be red.

**SKILL PRACTICE**

Solve each problem.

1. Three coins are tossed in the air. What is the chance that they will **not** all come up heads?

2. Ten items in a sale bin are priced:

   - $1
   - $1
   - $2
   - $2
   - $2
   - $2
   - $3
   - $3
   - $4
   - $4

   One item is chosen at random. What is the probability that the item costs either $1 or $2?

   - \(\frac{1}{5}\)
   - \(\frac{1}{10}\)
   - \(\frac{2}{5}\)

   (1) \(\frac{1}{5}\)
   (2) \(\frac{1}{10}\)
   (3) \(\frac{2}{5}\)
   (4) \(\frac{1}{2}\)
   (5) \(\frac{1}{3}\)

3. The spinner below is divided into eight equal sections.

   What is the probability of **not** spinning an odd number?

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**TECHNOLOGY Connection**

Many companies use contests to boost sales. Usually, the consumer has to find a certain bottlecap or game piece inside the product to win a prize. By law, companies must list the odds of winning a prize on the packaging or container.

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**Chunky Cookie Contest Rules and Odds**

**RULES:** Winning game pieces are randomly placed inside specially marked packages of Chunky Cookies. If you find a bag of cookies with a specially marked game piece inside, scratch off the cookie chunks on the game piece to find out how much you’ve won.

<table>
<thead>
<tr>
<th>Prize</th>
<th>Number of Winning Pieces</th>
<th>Estimated Odds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grand Prize—$1000</td>
<td>250</td>
<td>1:36,000</td>
</tr>
<tr>
<td>First Prize—$500</td>
<td>500</td>
<td>1:18,000</td>
</tr>
<tr>
<td>Second Prize—$100</td>
<td>1,000</td>
<td>1:9,000</td>
</tr>
<tr>
<td>Third Prize—Case of Cookies</td>
<td>3,000</td>
<td>1:3,000</td>
</tr>
<tr>
<td>Fourth Prize—Bag of Cookies</td>
<td>2,250,000</td>
<td>1:4</td>
</tr>
</tbody>
</table>

For example, if you buy a bag of Chunky Cookies, you have a 1-in-4, or 25%, chance of winning fourth prize, another bag of cookies. As you can see, more valuable prizes are more difficult to win.

**If you bought 500 bags of cookies, about how many would have a game piece winning fourth prize? About how much harder is it to win $500 than to win $100?**

Answers and explanations start on page 327.
14. Carla is helping her daughter with a math problem: There are 4 men with 4 hats. The hats are put into a big box. What is the probability that, without looking, each man will pick out his own hat?

(1) \(\frac{1}{256}\)
(2) \(\frac{1}{4}\)
(3) \(\frac{1}{24}\)
(4) \(\frac{1}{4}\)
(5) Not enough information is given.

15. Avion Bird Club monitors bird migration. One day 100 birds fly by the watch station: 65 are ducks and 35 are geese. Which of the following expressions best represents how to calculate the probability that a passing bird is a goose?

(1) \(\frac{35}{65}\)
(2) \(\frac{35}{100}\)
(3) \(\frac{65}{100}\)
(4) \(\frac{(65-35)}{100}\)
(5) \(\frac{(35+65)}{100}\)

17. With one roll of a six-sided die, what is the probability that Joel will not roll a three or a six?

(1) 5 in 6
(2) 2 in 3
(3) 1 in 2
(4) 1 in 3
(5) 1 in 6

18. The Altadena Food Bank sent 15 jars of spaghetti sauce and 20 jars of tomatoes to a shelter. What is the probability that the first jar the cook pulls out of the carton will be a jar of spaghetti sauce?

(1) \(\frac{15}{20}\)
(2) \(\frac{1}{35}\)
(3) \(\frac{5}{35}\)
(4) \(\frac{3}{4}\)
(5) \(\frac{7}{7}\)

19. In a garment plant, 5% of the shirts sewn do not pass inspection and must be sold as seconds. An inspector has 200 shirts to inspect. What is the chance that a shirt chosen at random will not pass inspection?

(1) 1 in 200
(2) 1 in 40
(3) 1 in 20
(4) 1 in 10
(5) 1 in 5

20. Ian tells Ruth that he will buy her lunch if she draws one of the four aces on the first pick from a deck of 52 cards. What are the chances that Ian will have to buy Ruth lunch?

(1) 1 in 52
(2) 3 in 52
(3) 1 in 13
(4) 2 in 13
(5) 12 in 13
3. The students may be making progress. Even though the test scores have declined, the margin of error for the test results is plus or minus 4%. Depending on the ability of the test to accurately measure performance, students’ reading ability for 1997 may have been as low as 80% and their reading ability for 1999 may have been as high as 86%. The teachers would be wise to give their observations at least as much weight as the test scores.

4. Yes Considering the margin of error, math performance for 1997 could have been as high as 80%, and math performance for 1999 may have been as low as 82%. Even considering the possibility of error, the scores show an increase of at least 2 percentage points.

Skill Practice, page 235
1. \( \frac{4}{10} = \frac{2}{5} \), or 25%
2. \( \frac{3}{10} \) Add the number of blue and green outcomes, and place the sum over 40: 12 + 4 = 16, and \( \frac{16}{40} = \frac{2}{5} \), or 30%.
3. \( \frac{5}{8} \) You can either count the spins that are not black, or count black and subtract from 40: 40 - 15 = 25, and \( \frac{25}{40} = \frac{5}{8} \), or 60%.
4. Your sections may be in a different order, but each color should take up about the same fraction of the total circle as shown to right.

Skill Practice, page 237
1. (3) \( \frac{3}{10} \) Count the combinations that contain neither C nor F. Then write a ratio comparing that number to 20, the number of possible combinations: \( \frac{3}{20} = \frac{3}{10} \), or 30%.
2. \( \frac{18}{50} \) or 28% There are 36 possible dice rolls. Remember that the combination 2 and 3 is different than 3 and 2, even though the sums are the same. Count the number of rolls that total more than 8, and compare to 36, the number of possible rolls: \( \frac{20}{36} = \frac{5}{9} \), or about 28%.
3. \( \frac{100}{3} \) or 1% Write a probability ratio and reduce: \( \frac{300}{300} = \frac{100}{300} \), or 1%.

Science Connection, page 237
The possible pairings are \( R_1R_3 \), \( R_1R_5 \), \( R_3R_5 \), and \( R_5R_2 \). One out of the four offspring will be white.

Skill Practice, page 239
1. \( \frac{8}{8} \) For each coin, the probability that the toss will come up tails is \( \frac{1}{2} \). Multiply to find the combined probability: \( \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = \frac{1}{8} \).
2. \( \frac{21}{25} \) Before a card is drawn, 5 out of 7 cards are hearts. Assume the first card is a heart. Of the cards that are left, 4 out of 6 are hearts. Multiply the two probabilities: \( \frac{5}{7} \times \frac{4}{6} = \frac{20}{42} = \frac{10}{21} \).

3. \( \frac{1}{4} \) Of the 8 equal sections, 2 are labeled “2,” and \( \frac{1}{4} \) reduces to \( \frac{1}{8} \).
4. \( \frac{25}{64} \) On either spin, there is a \( \frac{5}{8} \) chance of not spinning 4. Multiply: \( \frac{5}{8} \times \frac{5}{8} = \frac{25}{64} \).
5. \( \frac{9}{64} \) The only way to get a sum of 8 in two spins is by spinning two 4s. The question is really asking, “What is the probability of spinning two 4s?” On any spin, the probability of spinning a 4 is \( \frac{1}{8} \). Multiply: \( \frac{1}{8} \times \frac{1}{8} = \frac{9}{64} \).
6. \( \frac{1}{6} \) Hasina needs to draw the $20 and $10 bills in order to end up with $30. The possibility of getting either the $20 or $10 bill on the first draw is \( \frac{2}{16} \), or \( \frac{1}{8} \). Assume she gets either of those bills. The chance of drawing out the other on the second draw is \( \frac{1}{15} \). Multiply: \( \frac{1}{8} \times \frac{1}{15} = \frac{1}{6} \).
7. (2) \( \frac{6}{11} \) After Grant’s name is drawn, 11 cards are left, and only one is Anna’s.
8. (5) The chance of getting a sum of 11 is \( \frac{1}{18} \). Out of the 36 possible combinations, there are only two that total 11: 5 + 6 and 6 + 5. Two out of 36 reduces to \( \frac{1}{18} \).

Technology Connection, page 241
About \( \frac{1}{4} \) of the 300 bags would have a fourth-place game piece: \( \frac{1}{4} \times 500 = 125 \). It is about twice as hard (half as likely) to win $500 as to win $100, since 1:18,000 is half the frequency of 1:9,000.

GED Practice, pages 242–244
1. (3) \( \frac{4}{3} \) one dime among four coins has a 1-in-4 chance of being randomly chosen: \( \frac{1}{4} \).
2. (3) Wearhouse Focus on the data in the “Medium” column, rounding the statistics: 2(30 + 10 + 20) = 120. Since Wearhouse sold 120 medium-sized sweaters, it sold about twice as many as the other stores combined. You can also use number sense. The store that sold twice as many as all the others combined would have to be the store with the greatest sales of that size.
3. (5) 1 in 6 The chance of getting a collector’s card is \( \frac{5000}{20,000} \), which reduces to \( \frac{1}{4} \).
4. (3) \( \frac{22}{25} \) Note that you want the chance of Lee picking an orange that is not starting to rot. Find the probability of \( 25 - 3 \) fresh oranges among a total of 25 oranges: \( \frac{22}{25} = \frac{22}{25} \).
5. (2) 2% Waldo has 8 chances out of 400 for the winning ticket, so he has 2 chances out of 100, or a 2% probability of holding the winning ticket.

6. (5) The ratio of blue tokens to white tokens is probably 3:1. Mike can predict its contents. By sampling the contents of the bag, he can see that there are probably more blue tokens than white tokens in the bag, eliminating choices (1) through (4). Since the ratio of blue to white tokens during the experiment is 9:3, which reduces to 3:1, Mike can conclude that the ratio of tokens in the bag is probably 3:1.

7. (2) There are 40 tiles in the box, and 10 are red. Thus, \( \frac{10}{40} \) of the tiles are red, which reduces to \( \frac{1}{4} \).

8. (5) \( \frac{5}{8} \) There are 25 tiles that are either red or white, so 25 out of 40 tiles are red or white. The chance of drawing a red or white tile is \( \frac{25}{40} \), which reduces to \( \frac{5}{8} \).

9. (4) Add 20 red tiles. For the chance of drawing red to be 50%, half of the tiles in the box must be red. There are already 15 white and 15 blue, for a total of 30 nonred tiles. Adding 20 red to the 10 red already in the box would increase the total tiles in the box to 60, and the total red tiles to 30. 30 red tiles out of 60 would be 50% red.

10. (4) \( \frac{2}{5} \) There are two possible chances to pick a red candy out of nine remaining candies. Be sure to subtract the one chosen candy from the original number of candies in the jar.

11. (3) \( \frac{1}{6} \) \( \times \frac{1}{5} \frac{2}{5} \times \frac{2}{5} = \frac{1}{5} \). Each spin has the same chance of being an “A,” a one-in-six probability. Since this is a dependent event (spinning one “A” after the other), the ratios are multiplied: \( \frac{1}{6} \times \frac{1}{5} \).

12. (2) 83\% To win a prize, Karen will have to spin “B” on her second spin, a probability of 1 in 6. Her chance of not spinning “B” is 5 in 6, or \( \frac{5}{6} \), which equals 83\%.

13. (1) 1470 to 1530 The number of voters who said yes to the proposition was 1500. The survey’s margin of error is 2% (plus or minus two percentage points of 1500, which is 30 voters), making the range 1500 minus 30 to 1500 plus 30, or 1470 to 1530.

14. (3) \( \frac{3}{24} \) The probability that the first man will get the right hat is \( \frac{1}{4} \). Now 3 men and 3 hats are left. The probability that the second man who tries will get his own hat is \( \frac{1}{3} \). The probability for the third man is \( \frac{1}{2} \). Of course, if the first three men get their own hats, then the fourth or last man must get his hat, the only hat left. The total probability is found by multiplying all these events together.

15. (2) \( \frac{35}{100} \) This set-up solution can be read, “There are 35 out of 100 chances that the bird is a goose.” Notice that the answer choices were not reduced in this case.

16. (4) 66\% Eight of the 12 sections are labeled with numbers less than 5 (1, 2, 3, or 4): \( \frac{8}{12} = \frac{2}{3} \), which is a 66\% chance.

17. (2) 2 in 3 Rethink the problem: Four of the six faces are not 3 or 6, so the probability is 4 in 6. Reduce to 2 in 3.

18. (5) \( \frac{3}{7} \) There are 15 chances out of 35 that a jar of spaghetti sauce will be chosen: \( \frac{15}{35} = \frac{3}{7} \).

19. (3) 1 in 20 If 5\% of the shirts do not pass inspection, then 5 out of 100, or 1 out of 20, do not pass.

20. (3) 1 in 13 The chances of picking any one of the 4 aces are 4 in 52, or 1 in 13.

Alternate Math Formats, pages 245–246

21. \( $104 \) \( 2 \times 4 \times $13 = $104 \)

22. \( $11.20 \) \( \frac{(39 + 8 + 31 + 15 + 13)}{3} = $11.20 \)

23. 35 Put the weights in order and find the middle value.

24. \( \frac{1}{4} \) There are 1000 cards in all. The chance of drawing a Dodger card is 250 out of 1000, or 1 in 4.

25. \( \frac{3}{4} \) There are 4 red sections and 2 white sections, so the number of favorable outcomes is 6. The chance of drawing either of the colors is 6 out of 8, or \( \frac{3}{4} \).

26. 83° Add the temperatures and divide the total by 6, the number of measurements taken.

27. Any value between $150 and $200 would be correct. Note that the points on the graph form a line. Mentally connect the points and determine where the line would cross the 4-hour mark. If you gridded in a value between 150 and 200, consider your answer correct.

28. Any value between 70 and 80 would be correct. Each year the enrollment increases by about 20\%. A good estimate for Year 6 is an enrollment of 78 players, an increase of 20\% from Year 5. Consider an answer between 70 and 80 correct.

29. Any value between 75 and 80 would be correct. As the price per family ticket increases, the number of tickets sold decreases. Mentally draw a line through the existing points. If the ticket price is raised to $30, the number of tickets sold will probably be between 75 and 80.

PROGRAM 38: INTRODUCTION TO ALGEBRA

Skill Practice, page 253

1. 6 6. 0

2. -47 7. 30

3. -15 8. 3

4. -8 9. 11 \( \frac{3}{7} \)

5. 51 10. 3.7