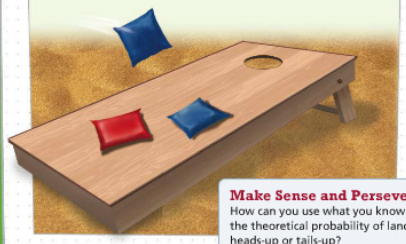
Lesson 7-7
Simulate Compound Events

Go Online | PearsonRealize.com

I can...
simulate a compound event to approximate its probability.

Solve & Discuss It!

Jillian lands the beanbag in the hole in about half of her attempts in a beanbag toss game. How can she predict the number of times she will get the beanbag in the hole in her next 5 attempts using a coin toss?



Make Sense and Persevere
How can you use what you know about the theoretical probability of landing heads-up or tails-up?

Focus on math practices

Use Appropriate Tools When might it be useful to model a scenario with a coin or other tool?

397

Essential Question How can you use simulations to determine the probability of events?

EXAMPLE 1 Simulate a Probability Situation Using a Spinner

Scan for Multimedia

Nikki is planning a hike for the end of the week. She really does not want to hike if it is raining the whole time, but is okay if it is cloudy. Based on the weather forecast, should she postpone the hike?

Model with Math How can you use a model to represent the situation?

STEP 1 Develop a probability model for rain on a given day.

Sample space, S = {rain, no rain}

List the two possible events and their probabilities.

$P(\text{rain}) = 40\%$, or $\frac{4}{10}$

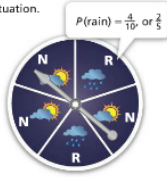
$P(\text{no rain}) = 1 - \frac{4}{10}$

$= \frac{6}{10}$

The sum of the probabilities of the outcomes in a probability model is 1.
$P(\text{rain}) + P(\text{no rain}) = 1$

STEP 2 Design a *simulation* using a spinner. A **simulation** is a model of a real-world situation that can be used to find probabilities. The spinner has outcomes and probabilities that match the real-world situation.

$P(\text{rain}) = \frac{4}{10}$, or $\frac{2}{5}$



STEP 3 Run the simulation.

Spin the spinner 3 times—once for each day—and record the results.

Trial 1: R, N, N

Conduct additional trials.

Trial 2: N, R, N
Trial 3: R, R, N
Trial 4: N, N, N
Trial 5: R, N, N

Based on this simulation, Nikki should expect rain on one day of the three days.

She should not postpone her hike.

Try It!

There is a 50% chance that a volleyball team will win any one of its four remaining games this year. A spinner with 2 equal sections numbered 1 (win) and 2 (loss) is used to simulate the probability that the team will win exactly two of its last four games. The results of the simulation are shown below.

1221 1121 2211 2121 2221 2212 1122 1111 1222 1112

Out of 10 trials, there are ____ favorable outcomes. Based on the simulation, the probability that the team will win exactly 2 of its last 4 games is ____.

Convince Me! Does the probability that the team will win two games change when "exactly" is replaced with "at least"? Explain.

Go Online | PearsonRealize.com

EXAMPLE 2 Simulate a Probability Situation Using a Coin

The Hornets and the Tigers will play a 5-game series, with the winner of 3 games named the state volleyball champion. The two teams are evenly matched. Use a simulation to find the probability that the Hornets will win the 5-game series.

STEP 1 Develop a probability model.

Sample space, S = {Hornets win, Tigers win}

List the events and their probabilities.
P(Hornets win) = 50%
P(Tigers win) = 50%

STEP 2 Design a simulation using a coin. The outcomes and probabilities of flipping a coin can be matched with those of the game.

Heads (H) = Hornets win
Tails (T) = Tigers win

STEP 3 Run the simulation. For each trial, flip the coin 5 times to represent the 5 games.

Trial 1: H, H, T, H, T – The Hornets win.
Trial 2: T, T, H, H, T – The Tigers win.
Trial 3: H, T, H, H, T – The Hornets win.
Trial 4: T, H, T, H, T – The Tigers win.
Trial 5: H, H, T, H, T – The Hornets win.
Trial 6: T, H, T, H, H – The Hornets win.
Trial 7: H, T, T, T, T – The Tigers win.

STEP 4 Find the probability.

Based on 7 trials of the simulation, the probability that the Hornets will win the series is $\frac{4}{7}$.

EXAMPLE 3 Simulate a Probability Situation with a Random Number Generator

An energy bar company is printing equal quantities of 6 different collectible cards. The company will randomly package one card inside the wrapper of each energy bar. What is the probability that all 6 collectible cards will be packaged in a box of 10 energy bars?

Use a random number generator to simulate the situation.
The numbers 1 through 6 represent each of the trading cards.

Each trial has 10 numbers to represent the 10 bars.

Trial 1: 4, 4, 6, 3, 5, 6, 1, 6, 6, 1 – Not a full set of cards
Trial 2: 1, 1, 1, 2, 1, 3, 5, 5, 2, 6 – Not a full set of cards
Trial 3: 6, 1, 2, 1, 6, 2, 3, 1, 4, 5 – Full set of cards
Trial 4: 3, 4, 3, 1, 6, 3, 2, 4, 1, 6 – Not a full set of cards
Trial 5: 5, 6, 1, 5, 4, 5, 6, 1, 4, 2 – Not a full set of cards
Trial 6: 2, 1, 3, 2, 5, 5, 2, 4, 3, 4 – Not a full set of cards
Trial 7: 3, 6, 1, 5, 6, 3, 5, 1, 2, 5 – Not a full set of cards
Trial 8: 5, 6, 4, 5, 6, 3, 6, 2, 4, 5 – Not a full set of cards

1 out of 8 trials result in a full set of cards.

Based on 8 trials of the simulation, the probability that all 6 cards will be packaged in a box of 10 energy bars is $\frac{1}{8}$, or 12.5%.

Try It!

In a tennis tournament, 25% of Sarah's serves were aces. Design a simulation to predict how many aces you expect Sarah to serve out of 50 serves.

KEY CONCEPT

A simulation is a model of a real-world situation that can be used to predict results or outcomes when the actual event is difficult to perform or record.

A simulation uses a tool, such as a spinner, number cube, coin, or random number generator, for which outcomes have the same probabilities as the actual event.

A greater number of trials will usually give results that are closer to the theoretical probability of the actual event.

Do You Understand?

1. **Essential Question** How can you use simulations to determine the probability of events?

2. **Look for Relationships** What is the connection between the tool used to simulate an event and the probability of the actual event?

3. Why are the results of simulations usually close to the probabilities of their related events?

Do You Know How?

4. Carl hits the target 50% of the time he throws a ball at it. Carl uses a coin to simulate his next three pitches. He assigns H for a hit and T for a miss. The results of 12 trials are shown below.

HHH HTH TTH HTT THT THH
HHT HTT HTH HTT TTH THT

Based on the results, what is the probability that Carl will hit the target with exactly two of his next three throws?

$\frac{5}{12} = 0.41\overline{6}$

41.6666...%

$\approx 42\%$

5. On average, Margo scores a goal for her field hockey team every 2 out of 3 shots. Margo uses a number cube to simulate her next three shots. She assigns 1 to 4 as "goals" and 5 and 6 as "missed shots." Why does this assignment of numbers on the number cube make it a valid simulation?

Name: _____

Practice & Problem Solving

Scan for Assistance

0 1 2 3 4 5 6 7 8 9

NOT

Leveled Practice In 6 and 7, estimate the probability for each event.

6. Molly makes 70% of her free throws. The random numbers below represent 20 trials of a simulation of two free throws, using the numbers 0 through 9.

38	38	21	50	64
71	66	42	47	90
80	92	29	98	27
87	89	89	93	03

Let the numbers from ___ to ___ represent a successful free throw.

Let the numbers from ___ to ___ represent a missed free throw.

Based on the simulated results, the probability that Molly makes both free throws is ___, or ___%.

7. Survey results state that 80% of people enjoy going to the beach. The random numbers below represent 10 trials of a simulation of asking two people if they enjoy going to the beach, using the numbers 0 through 9 for their responses.

80/100 = 8 out of 10

86	54	22	09	40
53	07	65	56	15

Let the numbers from 0 to 7 represent people who enjoy going to the beach.

Let the numbers 8 to 9 represent people who do not enjoy going to the beach.

Based on the simulated results, the probability that exactly one of two people enjoys going to the beach is 2/10, or 20%.

only one # 0-7

2·10 / 10·10 = 20/100 = 20%

8. In Stacia's town, 60% of registered people vote regularly. A spinner with equal-sized sections numbered 0 to 9 can be used to represent those who do and do not vote.

a. What numbers can be assigned to represent those who do vote and those who do not vote?

b. Based on the simulated results below, what is the probability that at least one person out of three does not vote?

380	799	331	205	851
182	117	768	715	410

9. Inspection of items at a company shows that an item has a 50% chance of being defective. A spinner with equal-sized sections numbered 0 to 9 can be used to simulate the event that the next 2 items inspected are defective.

a. How would you assign numbers to represent the defective and non-defective items?

b. Based on the simulated results below, what is the probability that the next 2 items are defective?

88	92	87	70	49
44	43	55	32	12

10. Julie used a number cube to simulate a flower seed sprouting, for which the success rate is 50%. She used even numbers to represent success and odd numbers to represent failure. The results of 8 trials that simulate the sprouting of five seeds are shown below.

31534	35635	43631	35633
25143	25643	64133	53113

Based on the simulated results, what is the probability that none of the next five flower seeds will sprout successfully?

11. **Construct Arguments** How is the difference between the simulated probability and the theoretical probability of an actual event related to the number of simulated trials conducted?

12. **Higher Order Thinking** Suppose Arun has an 80% chance of winning a game. For a simulation, the numbers 0 to 7 represent winning, and the numbers 8 and 9 represent losing. Write three different trial results that show 5 wins in a row out of 6 games played.

Assessment Practice

13. About 50% of the people surveyed in a certain county work for a small business. A random number generator was used to simulate the results of the next four people surveyed.

The numbers 0 to 4 represent people who work for a small business, and the numbers 5 to 9 represent people who do not work for a small business.

6411	0501	7582	0403	3074
7383	5250	2235	0803	3750
7694	9225	7121	4493	7596
8223	1288	8121	7652	3154

PART A

Based on the simulated results shown above, what is the probability that at least one of the next four people surveyed works for a small business?

PART B

How would the design of the simulation change if the percent of people who work for a small business was 70%?