# 9-5 Simulating Compound Events

## What You'll Learn

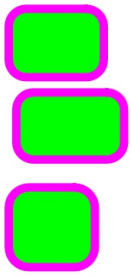
CONTENT STANDARDS 7.SP.8.c

To design and use simulations to estimate the probability of compound events

**New Vocabulary** simulation, trial

## Check Skills You'll Need

A box contains 4 white candles and 5 blue candles. You take one candle at random and then take a second candle without replacing the first one. Find the probability of each event.



2. Both candles are white.
3. Both candles are blue.
4. The first candle is white, and the second candle is blue.

## Why Learn This?

You can estimate the probability of compound events to help you determine how much you would need to spend to win a prize.

Recall that a **simulation** is a model used to estimate the probability of an event. Each **trial** of a simulation results in an outcome.

## EXAMPLE 1 Designing a Simulation

A cereal company marks $\frac{1}{6}$ of its box lids with stars. If a customer gets a star, he or she wins a prize. Design a simulation for estimating the probability that a customer will need to buy at least 3 boxes to win a prize.

**Step 1** Choose a simulation tool.

$\frac{1}{6}$ of the boxes are marked with stars, so use a tool that has 6 equally likely outcomes.

A number cube would be appropriate.

**Step 2** Decide which outcomes are favorable.

$\frac{1}{6}$ of the outcomes should represent a box with a star.

Let rolling a 1 represent a box with a star. Let rolling any other number represent a box without a star.

**Step 3** Describe a trial.

For each trial, roll the number cube until you get a 1. Keep track of the number of times you roll the cube. This number represents the number of boxes the customer must buy to win a prize.

## Examples

**1 Designing a Simulation** A laundry company inserts a coupon for one free box of detergent inside $\frac{1}{5}$ of its detergent boxes. Design a simulation that can be used to estimate the probability that a customer will need to buy at least 3 boxes to get a coupon.

**Step 1** Choose a simulation tool.

$\frac{1}{5}$ of the boxes include coupons, so use a tool that has 5 equally likely outcomes. A five-section spinner would be appropriate.

**Step 2** Decide which outcomes are favorable.

$\frac{1}{5}$ of the outcomes should represent a box with a coupon.

Let spinning a 1 represent a box with a coupon.

**Step 3** Describe a trial.

For each trial, spin until you get a 1. Keep track of the number of times you spin the spinner. This number represents the number of boxes the customer must buy to get a coupon for a free box.

## EXAMPLE 2 Using a Simulation to Estimate Probability

Perform 20 trials of the simulation you designed in Example 1. Then estimate the probability that a customer will need to buy at least 3 cereal boxes to win a prize.

The table shows the results of 20 trials of the simulation. Of the 20 trials, 14 resulted in 3 or more boxes.

The probability that a customer will need to buy at least 3 boxes to win a prize is $\frac{14}{20}$, or $\frac{7}{10}$.

| Boxes Needed to Win Prize | Frequency |
|---|---|
| 1 | 𝍸 |
| 2 | 𝍸 |
| 3 or more | 𝍸 𝍸 𝍸 |

**2 Using a Simulation to Estimate Probability** Perform 20 trials of the simulation you designed in Example 1. Then estimate the probability that a customer will need to buy at least 3 boxes of detergent to get a coupon.

The table shows the results of 20 trials of the simulation. Of the 20 trials, 15 resulted in 3 or more boxes. So, the experimental probability that a customer will need to buy at least 3 boxes to get a coupon is approximately $\frac{15}{20}$, or $\frac{3}{4}$.

| Boxes Needed to Get a Coupon | Frequency |
|---|---|
| 1 | 𝍸 |
| 2 | I |
| 3 or more | 𝍸 𝍸 𝍸 |

## EXAMPLE 3 Using Random Digits as a Simulation Tool

**Journalism** In an election, 52% of voters chose Mayor Garner. Use random digits as a simulation tool to estimate the probability that a reporter will ask more than 2 voters before finding one who voted for Garner.

52% of voters, or $\frac{52}{100}$, chose Garner.

Use a simulation tool with 100 equally likely outcomes. You can use 2-digit random numbers from 00 to 99.

52 of the possible outcomes should represent voters for Garner. Use the numbers 00 to 51.

Each row of random numbers at the right represents one trial.

If either or both numbers are between 00 and 51, the reporter will need to ask 1 or 2 voters.

If neither number is between 00 and 51, the reporter will need to ask more than 2 voters.

Out of 10 trials, 3 resulted in more than 2 voters being asked.

So, the probability that a reporter will have to ask more than 2 voters before finding one who voted for Garner is approximately $\frac{3}{10}$.

| Random Numbers | Outcome |
|---|---|
| 06 82 | ← 1 voter |
| 80 17 | ← 2 voters |
| 87 65 | ← > 2 voters |
| 96 96 | ← > 2 voters |
| 60 68 | ← > 2 voters |
| 47 39 | ← 1 voter |
| 40 31 | ← 1 voter |
| 66 17 | ← 2 voters |
| 30 33 | ← 1 voter |
| 20 68 | ← 1 voter |

**3 Using Random Digits as a Simulation Tool** In an election, 43% of voters chose Governor Smith. Use random digits as a simulation tool to estimate the probability that a journalist will have to interview more than 2 voters before finding one who voted for Smith.

43% of voters, or $\frac{\boxed{43}}{100}$, chose Smith.

Use a simulation tool with 100 equally likely outcomes. You can use 2-digit random numbers from 0 to 99.

$\boxed{43}$ of the possible outcomes should represent votes for Smith. Use the numbers 00 to 42.

Each row of random numbers represents one trial.

If either or both numbers are between 00 and $\boxed{42}$, the journalist will need to interview 1 or 2 voters.

If neither number is between 00 and $\boxed{42}$, the journalist will need to interview more than 2 voters.

Out of 10 trials, $\boxed{4}$ resulted in more than 2 voters being interviewed. So, the probability that a journalist will have to interview more than 2 voters before finding one who voted for Smith is approximately $\frac{\boxed{4}}{10}$, or $\frac{\boxed{2}}{\boxed{5}}$.

| Random Numbers | | Outcome |
|---|---|---|
| 02 | 85 | ← 1 or 2 voters |
| 70 | 13 | ← 1 or 2 voters |
| 97 | 56 | ← 2 or more voters |
| 32 | 24 | ← 1 or 2 voters |
| 60 | 58 | ← 2 or more voters |
| 41 | 30 | ← 1 or 2 voters |
| 29 | 12 | ← 1 or 2 voters |
| 62 | 83 | ← 2 or more voters |
| 54 | 78 | ← 2 or more voters |
| 20 | 18 | ← 1 or 2 voters |

## Quick Check

**1.** One-fourth of the deer in a population has a certain disease. Design a simulation for estimating the probability that a scientist will need to test no more than 3 deer before finding one with the disease.

**2.** Perform 20 trials of the simulation in Quick Check 1. Estimate the probability that a scientist will need to test no more than 3 deer before finding one that has the disease.

**3. Medicine** In the U.S., 42% of blood donors have type A blood. Use the random numbers at the right as a tool to estimate the probability that it will take at least 4 donors to find one with type A blood.

**Medicine**

| | | | |
|---|---|---|---|
| 91 | 04 | 81 | 49 |
| 72 | 45 | 45 | 96 |
| 54 | 93 | 14 | 81 |
| 70 | 28 | 66 | 00 |
| 67 | 37 | 29 | 45 |
| 33 | 77 | 57 | 22 |
| 58 | 84 | 14 | 80 |
| 49 | 45 | 20 | 59 |
| 78 | 05 | 88 | 88 |
| 21 | 83 | 16 | 98 |

## Vocabulary

A simulation is a model used to _____

Each trial of a simulation results in _____

Name _____ Class _____ Date _____

# 9-5 • Guided Problem Solving

GPS **Student Page 338, Exercise 9:**

**Consumer Math** A restaurant gives out a scratch-off ticket with each purchase of a $5 meal deal. Two thirds of the tickets are winners. Design a simulation and perform 20 trials to estimate the probability that a customer will need to spend at least $15 to get a winning ticket.

## *Understand*

1. What are you being asked to do?

_____

_____

2. What will you use to find the answer?

_____

_____

## *Plan and Carry Out*

3. What fraction shows the amount of tickets that win? _____

4. What simulation tool would work best with this fraction? _____

5. How many meals will $15 buy? _____

6. Let 1 and 2 represent winning tickets. Perform 20 trials. Complete the frequency table. _____

| Meals Bought to Get Winning Ticket | Frequency |
|---|---|
| 1 | |
| 2 | |
| 3 or more | |

7. What is the probability that a customer will need to spend at least $15 to get a winning ticket?

_____

## *Check*

8. How can you check your answer?

_____

## Solve Another Problem

9. A sporting goods store holds a drawing for new merchandise. Each purchase of $20 or more gives a customer one entry into the drawing. Three fourths of the entries win a prize. Design a simulation and perform 20 trials to estimate the probability that a customer will need to spend at least $60 to win a prize.

_____

_____