

Explain It!

The Chess Club has 8 members. A new captain will be chosen by randomly selecting the name of one of the members. Leah and Luke both want to be captain. Leah says the chance that she will be chosen as captain is $\frac{1}{2}$ because she is either chosen for captain or she is not. Luke says the chance that he is chosen is $\frac{1}{8}$.



Lesson 9-4
Use Probability Models

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I can...
use probability models to find probabilities of events.

A. Construct Arguments Do you agree with Leah's statement? Use a mathematical argument to justify your answer.

B. Construct Arguments Do you agree with Luke's statement? Use a mathematical argument to justify your answer.

Focus on math practices
Look for Relationships How does the probability of Leah being chosen captain compare to the probability of Luke being chosen captain?

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Essential Question


How can a model be used to find the probability of an event?

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EXAMPLE 1 Develop a Probability Model

Mr. Campbell has a jar on his desk that contains 10 marbles. At the end of class, each student draws a marble from the jar without looking, notes its color, and then puts it back in the jar. If a student draws the red marble, the student gets a pass on that day's homework. How can the students determine the probability of drawing the red marble?



Model with Math How can you use a model to help you predict what color marble will be drawn?

Develop a *probability model* based on theoretical probability.

A **probability model** consists of:

- the *sample space*, and
- events within the sample space and their probabilities.

A **sample space** is the set of all possible outcomes. When a marble is drawn, there are 10 possible outcomes. Sample space, $S = \{R, G, G, G, P, P, P, P, P, P\}$

This is one way to represent the sample space.

R represents a red marble.
G represents a green marble.
P represents a purple marble.

List the three possible events and their probabilities.

- Drawing a red marble $P(R) = \frac{1}{10}$
- Drawing a green marble $P(G) = \frac{3}{10}$
- Drawing a purple marble $P(P) = \frac{6}{10}$

The students in Mr. Campbell's class can use a probability model to determine that the probability of drawing the red marble is $\frac{1}{10}$.

Try It!

Mr. Campbell decides that too many students are getting a pass on homework. He adds 10 yellow marbles to the jar. Tell whether each part of the probability model **does** or **does not** change.

The sample space change. Each event within the sample space change. The probability of each event change.

The new probability of drawing a red marble is $P(R) = \frac{1}{\text{input}}$.

Convince Me! How does a probability model help you predict how likely an event is to occur?

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EXAMPLE 2 Use a Probability Model to Evaluate a Situation

Ms. Stillman has a marble jar for the same purpose, but students do not know the number of marbles, or their colors. Each of 30 students draws a marble, notes its color, and then puts it back in the jar. Based on the results shown in the table, what can the students conclude about the probability of drawing a red marble?

Color	Red	Blue	Green
Number of Marbles Drawn	4	11	15

Develop a probability model based on experimental probability.

Sample space, $S = \{\text{red, blue, green}\}$

List the three possible events and their experimental probabilities.

- Drawing a red marble: $\frac{4}{30}$
- Drawing a blue marble: $\frac{11}{30}$
- Drawing a green marble: $\frac{15}{30}$

The sum of the probabilities of all the possible outcomes in the sample space of a probability model is equal to 1.

Based on this experimental probability, Ms. Stillman's students can conclude that the probability of drawing a red marble is about 13%.

EXAMPLE 3 Use a Probability Model to Make an Estimate

Ms. Stillman tells her students that the jar contains 100 marbles. Based on the table of marble colors after 60 draws, about how many marbles of each color are in the jar?

Color	Red	Blue	Orange	Green
Number of Marbles Drawn	7	20	1	32

Develop a probability model based on experimental probability.

Sample space, $S = \{\text{red, blue, orange, green}\}$

List the four possible events and their experimental probabilities.

- Drawing a red marble: $\frac{7}{60}$
- Drawing a blue marble: $\frac{20}{60}$
- Drawing an orange marble: $\frac{1}{60}$
- Drawing a green marble: $\frac{32}{60}$

Use proportional reasoning and the probability model to estimate the number of marbles of each color.

The estimated number of marbles in the jar is:

$$\frac{7}{60} = \frac{11.6}{100} \text{ or about 12 red marbles}$$

$$\frac{20}{60} = \frac{33.3}{100} \text{ or about 33 blue marbles}$$

$$\frac{1}{60} = \frac{1.6}{100} \text{ or about 2 orange marbles}$$

$$\frac{32}{60} = \frac{53.3}{100} \text{ or about 53 green marbles}$$

Try It!

To reduce the number of homework passes, which color of marble should Ms. Stillman use as the pass on homework? Explain.

KEY CONCEPT

A probability model can help you evaluate a chance process and its outcomes. You can develop a model using theoretical or experimental probability. A probability model consists of the sample space of an action, events within the sample space, and probabilities associated with each event.

For rolling a number cube labeled from 1 through 6:

Sample space, $S = \{1, 2, 3, 4, 5, 6\}$

$$P(1) = \frac{1}{6} \quad P(4) = \frac{1}{6}$$

$$P(2) = \frac{1}{6} \quad P(5) = \frac{1}{6}$$

$$P(3) = \frac{1}{6} \quad P(6) = \frac{1}{6}$$



Do You Understand?

1. **Essential Question** How can a model be used to find the probability of an event?
2. **Construct Arguments** How can you check the sample space of a probability model?
3. **Reasoning** How does developing a probability model based on experimental probability help you evaluate a situation or make an estimate? Explain.

Do You Know How?

4. Develop a probability model for the spinner shown.
5. Mr. Henry has a basket full of fruit. He does not know how many pieces of fruit are in the basket or the types of fruit. Each of the 20 students in his class selects one piece of fruit from the basket without looking, notes its fruit type, and then puts it back in the basket. Based on the results shown in the table, what can the students conclude about the probability of selecting an apple?

Fruit	Apple	Orange	Pear
Number of Pieces of Fruit	5	2	13

$$P(\text{apple}) = \frac{5}{20} = \frac{1}{4}$$
6. The probability model based on experimental probability for randomly selecting a marble from a bag is $P(\text{green}) = \frac{11}{20}$, $P(\text{blue}) = \frac{11}{20}$, and $P(\text{white}) = \frac{1}{20}$. About how many marbles of each color are in the bag if there are 60 total marbles?

Name: _____

Practice & Problem Solving

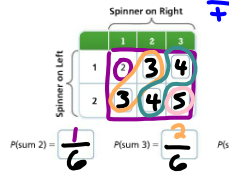
7. Murray spins the pointer of the spinner shown at the right.

a. What is the sample space for the probability model?



b. What is the probability of each event in the sample space?

8. Rafael spins the pointers of the two spinners shown at the right. Find the probability of each possible sum.



9. **Be Precise** An arts and crafts store has a crate that contains glass, wood, and brass beads. Friends take turns choosing a bead without looking, recording the bead type, and returning the bead to the crate. The table shows the results of 300 selections.

Choosing Beads	
Glass	60
Wood	96
Brass	144

a. Write a probability model for choosing a bead.

b. Based on the frequencies in the table, estimate the number of each type of bead that will be chosen if the friends select a total of 450 beads from the crate.

$P(G) = \frac{60}{300}$ $P(W) = \frac{96}{300}$ $P(B) = \frac{144}{300}$

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$$\frac{3}{450} \cdot \frac{60}{300} = \frac{G}{450} \cdot \frac{1}{1}$$

$$90 = G$$

10. A bag contains 14 green, 12 orange, and 19 purple tennis balls.

a. Create a probability model for choosing a tennis ball from the bag.

b. Suppose a tennis ball is randomly selected and then replaced 75 times. How many orange tennis balls do you expect? Explain.

11. Given that $P(\text{red pepper}) = \frac{3}{8}$, write another probability statement to complete the probability model of a random pepper selection from the box below.



12. **Higher Order Thinking** A survey asked 600 people for their favorite genre of book. The table shows the number of people who preferred four possible genres.

Genre	Number of People
Adventure	90
Comedy	102
Mystery	150
Romance	132

a. How many people surveyed responded with a genre that is not listed in the table?

b. Find the probabilities and complete a probability model to describe each response, including "other genre".

Assessment Practice

13. A box has 1 one-dollar bill, 2 five-dollar bills, 2 ten-dollar bills, and 1 twenty-dollar bill. A student selects one bill from the box at random.

PART A

Develop a probability model to compare the probability of selecting \$5 to the probability of selecting \$10. Explain.

PART B

How does the probability of selecting \$1 compare to the probability of selecting \$20? Explain.

$S = \{1, 1, 5, 5, 10, 10, 20\}$

$P(\$1) = \frac{3}{8}$

$P(\$5) = \frac{2}{8}$

$P(\$10) = \frac{2}{8}$

$P(\$20) = \frac{1}{8}$

