

Lesson 53

NAME:

Theoretical and Experimental Probability



Start by navigating to the Online Lesson for instructions.

Objectives

- ✓ Calculate theoretical probability.
- ✓ Calculate experimental probability.
- ✓ Analyze probabilities to make fair decisions.

Why?

Probability can help determine how likely something is to happen. Whether you realize it or not, probability is used to predict the weather, determine the best route to take, or play a game.



Warm Up

Name the total number of events (possible outcomes).

- 1) A coin
- 2) A spinner with sections labeled A, B, C, D, E, F, G, H
- 3) A number cube (die)
- 4) A standard deck of cards
- 5) Suits in a standard deck of cards
- 6) Cards in one suit in a standard deck of cards



To continue, return to the Online Lesson.



Explore



Theoretical Probability

▶ Fill in the notes as you watch the video in the Online Lesson.

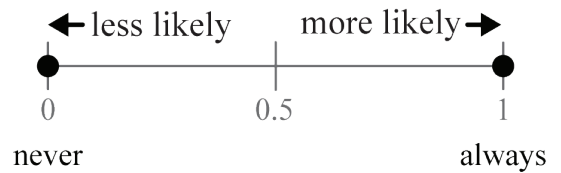
- Probability is a _____ of how likely an event is to occur.
 - It is always a number _____.

- Depending on the problem, probability will be written as:

- _____
- _____
- _____

- A probability of zero (0%) means the event will _____.
- A probability of one (100%) means the event will _____.

- The closer a probability is to zero, _____



- The closer the probability is to one, _____

Vocabulary	Example
The _____ is a list of all possible outcomes.	Sides of a number cube: {1, 2, 3, 4, 5, 6}
An _____ is the favorable result or set of favorable results of a probability experiment. $P(E)$	Rolling an even number on a number cube $P(\text{even})$
An _____ is the result of a probability experiment.	Rolling a 2 on a number cube
A _____ to an event is all of the events that are not the event. $P(\text{not } E) = 1 - P(E)$ or $P(E')$	The odd numbers are a complement to the evens on a number cube. $P(\text{not even})$ or $P(\text{odd})$

- All the events in the sample space have _____.
- _____ is the *expected* probability using math and logical reasoning.

- Theoretical probability is the _____ of favored, or desired, outcomes to the total number of possible outcomes.

$$P(\text{favorable event}) = \frac{\text{favorable outcome}}{\text{total possible outcomes}}$$

Example 1

▶ Complete the example as you watch the video in the Online Lesson.

A bag contains seven red, eight yellow, five blue, six white, and four purple marbles. Determine the probability.

Plan

Calculate the total number of outcomes
Determine $P(\text{favorable event})$

- A) Red
- B) White
- C) Blue
- D) Yellow or Purple

Example 2

▶ Complete the example as you watch the video in the Online Lesson.

A security system requires a 5-digit code with no repeating numbers. If the digits 0 through 9 are allowed, what is the probability that a randomly generated code will contain the digits 1, 2, and 3 in that exact order, but the other two digits can be any other numbers (also in any order)?

Total number of codes:

Codes allowed:

_____ must be a 1 _____ must be a 2 _____ must be a 3 _____ not 1, 2, 3 _____ not 1, 2, 3 ? = 42 Possibilities

Example 3

▶ Complete the example as you watch the video in the Online Lesson.

The diagram shows all possible pairs when two dice are rolled. Find the probability of each outcome to the nearest whole percent.

A) P(sum of 10)

1	1	2	1	3	1	4	1	5	1	6	1
1	2	2	2	3	2	4	2	5	2	6	2
1	3	2	3	3	3	4	3	5	3	6	3
1	4	2	4	3	4	4	4	5	4	6	4
1	5	2	5	3	5	4	5	5	5	6	5
1	6	2	6	3	6	4	6	5	6	6	6

B) P(both even)

C) P(not doubles)

D) Explain which event is most likely to occur from problems A through C.

Rolling _____ is the event most likely to occur because _____, which is closest to 100%.

Checkpoint: Theoretical Probability

Determine the probability for each of the outcomes.

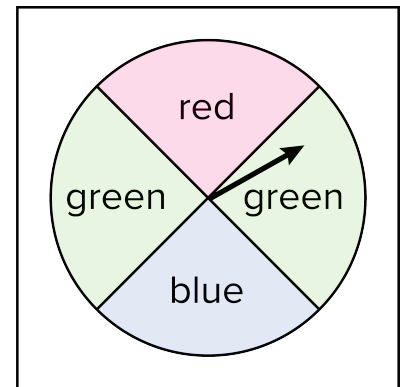
Spinning an arrow that stops on:

A) Green:

B) Red:

C) Not blue:

D) White:



To continue, return to the Online Lesson.

Experimental Probability

 Fill in the notes as you watch the video in the Online Lesson.

- _____ is the probability that results when an experiment has been completed.
- The experimental probability _____ the theoretical probability.
- _____ the experiment is completed, the more likely it is that the experimental probability, or the results, will _____ with the theoretical probability.
- It is recommended that an experiment be performed _____ to provide enough data to _____ expected values (theoretical) to actual values (experimental).

Example 4

 Complete the example as you watch the video in the Online Lesson.

A probability experiment was conducted in which a coin was flipped to see how it landed, heads up or tails up. The data was recorded in a table.

A) What is the experimental probability of landing tails up?

Coin Flips	
	
Heads	Tails
22	28

B) What is the expected value for flipping a coin?

C) Are the experimental and theoretical probabilities equal? Explain why or why not.

_____. This experiment _____ the theoretical probability because _____.

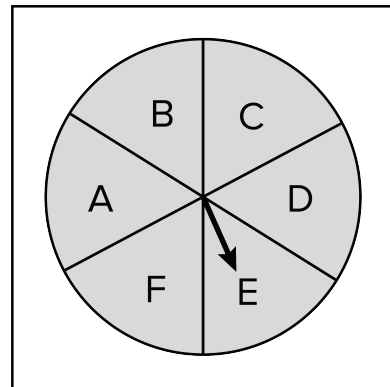
_____.

Example 5

▶ Complete the example as you watch the video in the Online Lesson.

A spinner contains wedges of equal size labeled with a letter. The tally chart shows the experiment's results.

Spin	Tally
A	40
B	60
C	32
D	40
E	48
F	20



- A)** What is the theoretical probability of the arrow stopping on any wedge? Explain.
- B)** From the tally chart, what spins are the most and least likely to occur?
- C)** Based on the results, is the spinner fair? Explain.

Checkpoint: Experimental Probability

Why is it necessary to repeat a probability experiment multiple times?

What is the suggested minimum number of times for an experiment to be performed?



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 **Practice 1**

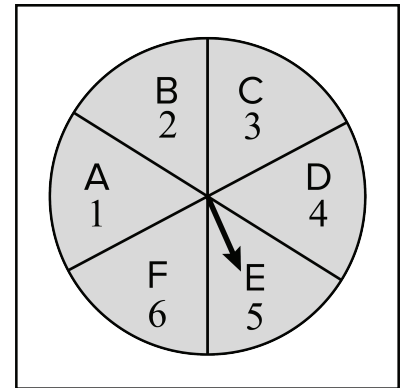
Complete problems on a separate sheet of paper.

Fill in the blank with a word or phrase.

- 1) All probabilities will be a number ranging from _____.
- 2) It is recommended that an experiment be performed at least _____ so that the theoretical and experimental probabilities get closer to one another.

For problems 3–6, use the spinner.

- 3) $P(A)$
- 4) $P(3)$
- 5) The arrow was spun twice. Determine the probability of stopping on a sum of seven.
- 6) Determine the probability of the arrow stopping *not* on B or D.



For problems 7–8, use the following scenario.

Jennie wrote each letter of her name on a piece of paper and placed them in a bag.

- 7) Without looking, Jennie's friend Maria selected one piece from the bag. What is the probability that Maria will take out an 'e' or 'n'?
- 8) What is the probability that Maria will take out a consonant?
- 9) Two crayons are drawn from a box containing four blue and six red crayons. What is the probability that both will be blue?
- 10) A bag contains cards labeled with the numbers 3, 4, 5, 6, and 7. One at a time, one card is randomly selected from the bag. What is the probability that the cards drawn in order will represent a number that is greater than 7000?

For problems 11–15, use the frequency chart.

Ali had a bag of 30 beads, six of each color: {red, white, blue, yellow, black}. The frequency chart shows her results after drawing a bead and then replacing it.

- 11) Find experimental probabilities for each bead color.
- 12) What is the most likely bead (event) to be selected according to the experiment? Explain.
- 13) What is the least likely bead (event) to be selected according to the experiment? Explain.
- 14) Determine the theoretical probability of each bead as a decimal.
- 15) Explain if the beads were drawn fairly by comparing the experimental and theoretical probabilities.
- 16) Kylin has a drawer containing five pairs of yellow socks, two pairs of blue socks, and three pairs of red socks. Explain which color of socks Kylin should expect when one pair is randomly selected.
- 17) West's shelf has a selection of books: three are by Tolkien, one by C.S. Lewis, and the two remaining are by Jane Austen. If West chooses a book at random, a book by which author is least likely to be picked? Explain.

Bead	Tally
Red	24
White	19
Blue	20
Yellow	20
Black	17

For problems 18–20, state if the event is likely, unlikely, will always happen, or will never happen. Explain.

- 18) Wren flips a fair coin three times. What is the likelihood of the flips resulting in heads every time?
- 19) Shae is flipping a fair coin. What is the likelihood of getting heads or tails on the first flip?
- 20) Raphael is rolling a 9-sided die numbered 1 through 9. What is the likelihood of rolling a two-digit number?

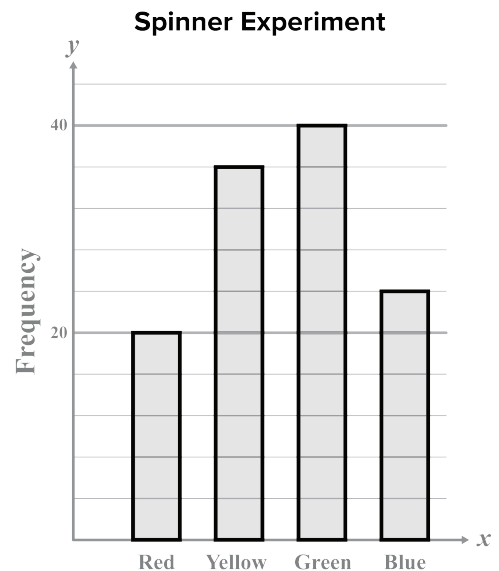


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 **Mastery Check** **Show What You Know**

A bar graph was created to track the number of spins for an experiment.

- A)** Determine the probability as a percent for each color on a spinner using the bar graph.



- B)** Looking at the outcomes from the experiment, what color(s) do you expect to occur? Explain.

- C)** Draw and label a spinner with *six* wedges that represent the experiment.

- D)** Estimate the probability as a percentage for each color of the spinner you drew in part C.

 **Say What You Know**

In your own words, talk about what you have learned using the objectives for this lesson and your work on this page.



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 **Practice 2**

Complete problems on a separate sheet of paper.

- 1) Why is the probability of any event between zero and one?
- 2) What is the complement of an event?

For problems 3–6, use the following scenario.

A bag contains the numbers 1 through 9 written on equal-sized pieces of paper.

- 3) $P(5)$
- 4) $P(\text{even})$
- 5) $P(\text{odd})$
- 6) $P(\text{multiple of } 3)$

For problems 7–10, two fair six-sided dice were rolled.

- 7) Determine the probability of rolling a sum of 11.
- 8) Determine the probability of rolling a sum less than 5.
- 9) Determine the probability of rolling a sum greater than 12.
- 10) Determine the probability of rolling an even sum.

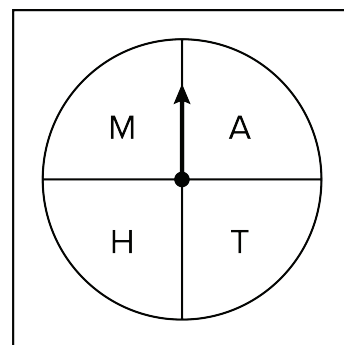
For problems 11–12, determine probabilities of a standard deck of cards.

- 11) Determine the probability of drawing a card with a two on it.
- 12) Determine the probability of selecting a face card (jack, queen, king).

For problems 13–18, the spinner was used in an experiment. The results were recorded in the tally chart.

- 13) Find the experimental probability as a decimal for each letter on the spinner.
- 14) Determine the most likely letter (event) to occur according to the chart.
- 15) Determine the least likely letter (event) to occur according to the chart.

Letter	Tally
M	65
A	39
T	28
H	68



- 16) Using the spinner, estimate the theoretical probability for stopping on each letter. Explain.
- 17) Does the image of the spinner match the information from the experiment? Explain.

For problems 18–20, state if the event is likely, unlikely, will always happen, or will never happen. Explain.

Reese bought a multi-flavor box of oatmeal and randomly selected a flavor. The flavors include six apple cinnamon, eight blueberry, eight strawberry, and two plain oatmeal packets.

- 18)** Reese selects an apple cinnamon packet.
- 19)** Reese selects a banana packet.
- 20)** Reese selects a blueberry or a strawberry packet.



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Multiple Choice

- _____ 11) A sample of 842 residents of Center County were randomly surveyed about the number of miles to the closest gas station from their homes. Of those surveyed, 64.5% responded “fewer than ten miles from their home.” Find the margin of error to the nearest percentage that most likely contains the population parameter.
- A) It is likely that between 61% and 68% of Center County residents have a gas station fewer than ten miles from their home.
- B) It is likely that between 32% and 39% of Center County residents have a gas station fewer than ten miles from their home.
- C) It is likely that between 62% and 68% of Center County residents have a gas station fewer than ten miles from their home.
- D) Cannot be determined.
- _____ 12) Select the equation that is NOT a polynomial function
- A) $f(x) = -3x^5 + 0.5x^4 + \pi x - e$
- B) $g(x) = x^{\frac{1}{3}} \left(x^9 - \frac{9}{5}x^6 \right)$
- C) $h(x) = (12 - xi)(x^2 + 5)$
- D) $j(x) = 3x \left(x - \frac{4}{5} \right) + \sqrt{6}$

Problem	1	2	3	4	5	6	7	8	9	10	11	12
Origin	L51	L51	L52	L52	L31	L32	L32	L31	L39	L50	L49	L33

L = Lesson in this level, A1 = Algebra 1: Principles of Secondary Mathematics



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