

# Probability

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### Probability

1. Which of the following is a true statement?

- A. With probability, smaller numbers indicate greater likelihood.
  - B. With probability, smaller numbers indicate equal likelihood.
  - C. With probability, larger numbers indicate greater likelihood.
  - D. With probability, larger numbers indicate equal likelihood.
- 

2. Which of the following is a true statement?

- A. A probability near 1 indicates an unlikely event.
  - B. A probability near 0 indicates a likely event.
  - C. A probability near 0 indicates an unlikely event.
  - D. A probability near  $\frac{1}{2}$  indicates a likely event.
- 

3. Fill in the blank.

A probability near \_\_\_\_ indicates an event that is neither unlikely nor likely.

- A. 0
  - B. 1
  - C.  $\frac{1}{2}$
  - D.  $\frac{1}{5}$
- 

4. Fill in the blank.

The probability of a chance event is a number between 0 and \_\_\_\_ that expresses the likelihood of the event occurring.

- A.  $\frac{1}{2}$
  - B. 1
  - C.  $\frac{1}{10}$
  - D. 100
- 

5. Noel is playing a game where he draws one playing card each out of two stacks of 5 cards. The table below shows all possible sums for the two numbers on the cards.

#### Sum of Two Cards

		Value of Card 1				
		3	6	7	9	11
Value of Card 2	1	4	7	8	10	12
	4	7	10	11	13	15
	6	9	12	13	15	17
	8	11	14	15	17	19
	12	15	18	19	21	23

Is Noel more likely to draw two cards with a sum that is a multiple of 3 or two cards with a sum that is greater than 13?

- Noel is more likely to draw two cards with a sum
  - A. that is greater than 13, because  $\frac{12}{25} > \frac{9}{25}$ .
  - B. that is a multiple of 3, because  $\frac{12}{25} < \frac{15}{25}$ .
  - C. that is greater than 13, because  $\frac{15}{25} > \frac{12}{25}$ .
  - D. Both are equally likely, because  $\frac{12}{25} = \frac{12}{25}$ .

6. Connie and Curtis are playing a game by rolling two number cubes with faces numbered 1 through 6. Connie gets a point when the sum of the two numbers face up on the cubes is an odd number, and Curtis gets a point when the sum of the two numbers is 7 or less. The table below shows all the possible sums for the two numbers face up on the cubes.

**Sum of Two Number Cubes**

		Cube 1					
		1	2	3	4	5	6
Cube 2	1	2	3	4	5	6	7
	2	3	4	5	6	7	8
	3	4	5	6	7	8	9
	4	5	6	7	8	9	10
	5	6	7	8	9	10	11
	6	7	8	9	10	11	12

Is Connie or Curtis more likely to get a point on the first roll?

- A. Connie is more likely to get a point, because  $\frac{24}{36} > \frac{21}{36}$ .
- B. They are equally likely to get a point, because  $\frac{21}{36} = \frac{21}{36}$ .
- C. Curtis is more likely to get a point, because  $\frac{21}{36} > \frac{18}{36}$ .
- D. Curtis is more likely to get a point, because  $\frac{21}{36} < \frac{24}{36}$ .

The probability of randomly selecting a name starting with the letter T from a bowl of 22 names is  $\frac{11}{22}$ .

7. Which of the following describes the likelihood of selecting a name starting with the letter T?

- A. unlikely
- B. likely
- C. neither unlikely nor likely

---

The probability of randomly selecting a green marble from a bag of 20 marbles is  $\frac{1}{20}$ .

8. Which of the following describes the likelihood of selecting a green marble?

- A. likely
- B. neither unlikely nor likely
- C. unlikely

---

9. Fred has a spinner that is split into four equal sections: red, blue, green, and yellow. Fred spun the spinner 548 times. Which of the following would be a good estimate of the number of times the spinner lands on the green section?

- A. 154
- B. 463
- C. 199
- D. 274

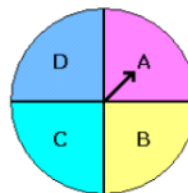
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10. Jordan flipped a coin 378 times. Which of the following would be a good estimate of the number of times the coin landed on heads?

- A. 289
- B. 114
- C. 328
- D. 174

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11.



If the spinner above is spun 80 times, predict the number of times the spinner would land on Section B.

- A. The spinner would land on Section B roughly 20 times, but probably not exactly 20 times.
- B. The spinner would land on Section B exactly 20 times.
- C. The spinner would land on Section B roughly 8 times, but probably not exactly 8 times.
- D. The spinner would land on Section B roughly 10 times.

12.



If the die above is rolled 180 times, predict the number of times it would land on an even number.

- A. The die would land on an even number roughly 90 times, but probably not exactly 90 times.
- B. The die would land on an even number roughly 60 times, but probably not exactly 60 times.
- C. The die would land on an even number roughly 45 times.
- D. The die would land on an even number exactly 90 times.

13. The possible outcomes for tossing a coin four times are shown below.

- |            |            |             |             |
|------------|------------|-------------|-------------|
| 1. T-T-T-T | 5. T-H-T-T | 9. H-T-T-T  | 13. H-H-T-T |
| 2. T-T-T-H | 6. T-H-T-H | 10. H-T-T-H | 14. H-H-T-H |
| 3. T-T-H-T | 7. T-H-H-T | 11. H-T-H-T | 15. H-H-H-T |
| 4. T-T-H-H | 8. T-H-H-H | 12. H-T-H-H | 16. H-H-H-H |
- Tails = T    Heads = H

If a coin is tossed four times, what is the probability of getting exactly 4 heads?

- A.  $\frac{1}{12}$
- B.  $\frac{1}{16}$
- C.  $\frac{1}{4}$
- D.  $\frac{1}{8}$

14. Nine cards with varying symbols, lowercase letters, capital letters, and numbers are placed in a paper bag. One card is drawn at random.



What is the probability of drawing a letter?

- A.  $\frac{5}{9}$
- B.  $\frac{1}{3}$
- C.  $\frac{4}{9}$
-

D.  $\frac{3}{10}$

15. Tyrone randomly drew pieces of paper numbered 10 through 50 out of a bowl. After he drew each piece of paper, he recorded the number, returned the piece of paper to the bowl, and then drew the next piece of paper. His results are recorded in the stem-and-leaf plot below.

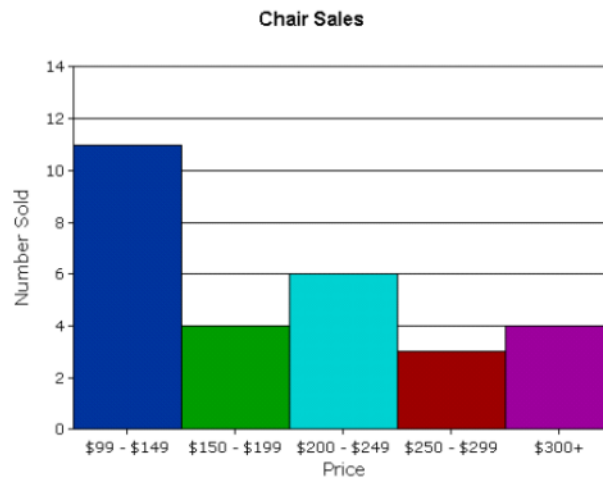
1	1	1	2	3	4	4	5	7	8			
2	0	1	2	2	2	3	4	6	8	9		
3	0	0	1	2	3	4	5	5	6	7	9	9
4	3	4	4	5	6	7	8	8	9			

Key: 1|6 represents 16

Based on the information in the stem-and-leaf plot, what is the experimental probability that a piece of paper randomly drawn from the bowl will have the number 35 written on it?

- A.  $\frac{1}{19}$
- B.  $\frac{1}{20}$
- C.  $\frac{1}{40}$
- D.  $\frac{1}{4}$

16. A furniture store recorded the number of dining table chairs that were sold in the last week in five different price ranges.

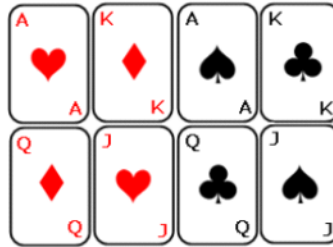


Based on the information in the graph, what is the experimental probability that the next chair sold will cost from \$250 to \$299?

- A.  $\frac{3}{28}$
-

- B.  $\frac{1}{7}$
- C.  $\frac{3}{14}$
- D.  $\frac{3}{25}$

17.



Devonte placed the cards shown above in a bag. He drew one card at a time from the bag. After each draw, the card was replaced.

The results of 20 draws are recorded in the table below.

Draw	Result	Draw	Result	Draw	Result	Draw	Result
1	black Q	6	black K	11	red J	16	red Q
2	red J	7	black J	12	red K	17	red K
3	red A	8	red Q	13	black A	18	red J
4	black Q	9	red K	14	red Q	19	black Q
5	red K	10	black A	15	red J	20	black A

What is the experimental probability of drawing a black card?

- A.  $\frac{1}{2}$
- B.  $\frac{7}{20}$
- C.  $\frac{3}{5}$
- D.  $\frac{2}{5}$

18. Waylon rolled a fair six-sided die 16 times, and recorded the results in the table below.

Roll	Result	Roll	Result	Roll	Result	Roll	Result
1	3	5	1	9	6	13	2
2	4	6	2	10	2	14	1
3	6	7	5	11	1	15	6
4	2	8	4	12	4	16	3

What is the experimental probability of rolling a 3?

- A.  $\frac{1}{16}$
- B.  $\frac{1}{6}$
- C.  $\frac{3}{16}$
- D.  $\frac{1}{8}$

19. Audra rolled a six-sided number cube with sides numbered 1 through 6 multiple times. Her results are shown below.

Side	Number of Times Rolled
1	
2	
3	
4	
5	
6	<del>    </del> <del>    </del>

Based on the data, what is the experimental probability that the next time Audra rolls the number cube, she will roll a 2?

- A.  $\frac{4}{25}$
- B.  $\frac{4}{21}$
- C.  $\frac{1}{2}$
- D.  $\frac{1}{25}$

20. Portia drew lollipops randomly from a bag one by one. After each draw, she recorded the flavor of the lollipop, then she returned the lollipop to the bag, and then she drew the next lollipop. Her results are recorded below.













Flavor	Number Drawn
cherry	
grape	<del>    </del>
blue raspberry	<del>    </del> <del>    </del>
sour apple	<del>    </del> <del>    </del>
orange	<del>    </del>

What is the experimental probability that a lollipop randomly drawn from the bag will be orange-flavored?



- A.  $\frac{11}{39}$
- B.  $\frac{2}{13}$
- C.  $\frac{14}{39}$
- D.  $\frac{7}{39}$

21. Seth and Chris are pulling cards from a deck of hearts, numbered 1(Ace) through 5. Their results are listed below.

Seth		Chris			
Pull	Card	Pull	Card	Pull	Card
1		1		5	
2		2		6	
3		3		7	
4		4		8	

Whose experimental probability is closer to the theoretical probability of pulling out a card with an even number on it?

- A. Neither
- B. Seth
- C. Chris
- D. They are the same.

22. Patricia and Courtney spun the spinner below. They recorded their results in the following tables.



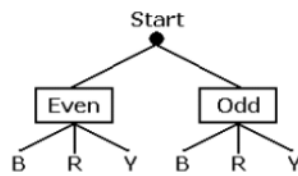
Patricia		Courtney	
Spin	Color	Spin	Color
1	Yellow	7	Red
2	Green	8	Green
3	Red	9	Blue
4	Yellow	10	Green
5	Blue	11	Yellow
6	Blue	12	Blue

If all the sections of the spinner were the same size, whose experimental probability was closest to the theoretical probability of the spinner landing on green?

- A. Neither
- B. Courtney
- C. They are the same.
- D. Patricia

23. Everett is rolling a block with the numbers 1, 2, 3, 4, 5, and 6 on it. Finley is drawing one disk from a basket of three disks: one blue, one red, and one yellow.

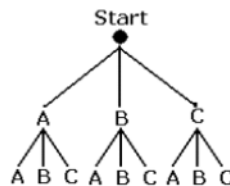
What is the probability that Everett and Finley end up with an even number and a blue disk?



- A.  $\frac{1}{6}$
- B.  $\frac{1}{3}$
- C.  $\frac{1}{6}$
- D.  $\frac{1}{5}$

24. Dorian has two bags. Each bag has the letters A, B, and C written on little pieces of paper inside of it. He draws one letter from each bag.

What is the probability that he draws out a vowel and a consonant?



- A.  $\frac{1}{9}$
- B.  $\frac{2}{9}$
- C.  $\frac{4}{9}$
- D.  $\frac{1}{2}$

25. Fred is going to flip one coin four times and record whether it lands on heads or tails for each flip. The list below shows the possible outcomes for each of the four flips.

H H H H	H H H T	H H T T	H T T T
T H H H	T T H H	T T T H	T T T T
H T H T	T H T H	T H H T	H T T H
H H T H	T T H T	T H T T	H T H H

What is the probability of flipping two tails and two heads?

- A.  $\frac{1}{2}$
- B.  $\frac{3}{8}$
- C.  $\frac{3}{4}$
- D.  $\frac{3}{16}$

26. A game requires each player to spin a spinner with four equal sections and roll a die numbered 1 through 6. The sections on the spinner are colored red, blue, green, or yellow. The table below shows all the outcomes of one spin and one roll.

Outcomes	1	2	3	4	5	6
Red	R, 1	R, 2	R, 3	R, 4	R, 5	R, 6
Blue	B, 1	B, 2	B, 3	B, 4	B, 5	B, 6
Green	G, 1	G, 2	G, 3	G, 4	G, 5	G, 6
Yellow	Y, 1	Y, 2	Y, 3	Y, 4	Y, 5	Y, 6

What is the probability of landing on green or yellow and rolling an even number?

- A.  $\frac{1}{2}$
- B.  $\frac{1}{8}$
- C.  $\frac{1}{6}$
- D.  $\frac{1}{4}$

27. Emilio has 4 red buttons, 1 green button, and 2 black buttons in a jar. Which list shows all the possible unique outcomes if Emilio chooses 3 buttons at one time from his jar?

**Button Outcomes**

red	red	red
red	red	green
red	red	black
black	black	red
black	black	green
red	green	black

**W.**

**Button Outcomes**

red	red	green
red	red	black
black	black	red
black	black	green
red	green	black

**X.**

**Button Outcomes**

red	red	red
red	red	green
red	green	green
red	red	black
black	black	red
black	black	green
red	green	black

**Y.**

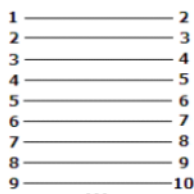
**Button Outcomes**

red	red	green
red	red	black
red	green	black

**Z.**

- A. W
- B. X
- C. Y
- D. Z

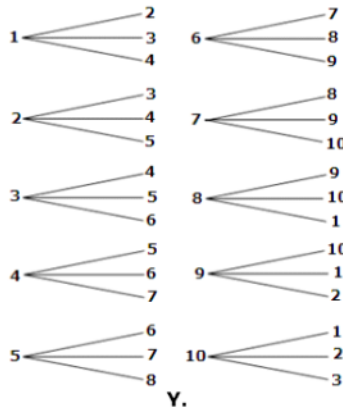
**28.** There are 10 contestants left in a television competition where the contestants complete weekly challenges. For the next challenge, each contestant will be paired with one of the other contestants. Which diagram shows all the possible combinations of the contestants?



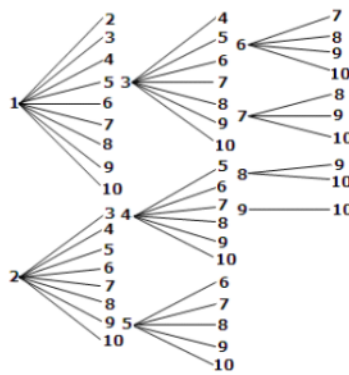
**W.**



**X.**



**Y.**



**Z.**

- A. W
- B. Y
- C. X
- D. Z

29. Kasey is ordering prints of some digital photos. She needs to decide the size, finish, and color for her prints. The photo options are shown below.

Size	Finish	Color
4 in × 6 in (1)	matte (M)	color (C)
5 in × 7 in (2)	glossy (G)	black and white (B)
8 in × 10 in (3)		
11 in × 14 in (4)		

Which of the following lists all the possible outcomes for choosing a size, finish, and color for the prints?

1, M, C	2, M, C	3, M, C	4, M, C
1, M, B	2, M, B	3, M, B	4, M, B
1, G, C	2, G, C	3, G, C	4, B, C
1, G, B	2, G, B	3, G, B	4, C, B

W.

1, M, C	2, M, C	3, M, C	4, M, C
1, M, B	2, M, B	3, M, B	4, M, B
1, G, C	2, G, C	3, G, C	4, G, C
1, G, B	2, G, B	3, G, B	4, G, B

X.

1, M, C	2, M, C	3, G, C	4, M, C
1, M, B	2, M, B	3, G, B	4, M, B
1, G, C	2, G, C	3, G, C	4, G, C
1, G, B	2, G, B	3, G, B	4, G, B

Y.

1, M, C	2, M, C	3, M, C	4, M, G
1, M, B	2, M, B	3, M, B	4, M, B
1, G, C	2, G, C	3, G, C	4, G, M
1, G, B	2, G, B	3, G, B	4, G, B

Z.

- A. Z
- B. X
- C. Y
- D. W

30. Rolando tossed a coin 4 times.

Which of the following is a list of all the possible outcomes with 2 or 3 heads?

HHTT	TTHH
HTHT	TTHH
HTTH	HTHH
THHT	HHTT
THTH	HHHT

W.

HHTT	TTHH
HTHT	TTHH
HTTH	HTHT
THHT	HHTH
THTH	HHHT

X.

HHTT	TTHH
HTHT	TTHH
HTTH	HTHH
THHT	HHTH
THTH	HHHH

Y.

HHTT	TTHH
HTHT	TTHH
HTTH	HTHH
THHT	HHTH
THTH	HHHT

Z.

- A. W
- B. X
- C. Z
- D. Y

## Answers

1. C
2. C
3. C

- 4. B
- 5. A
- 6. C
- 7. C
- 8. C
- 9. A
- 10. D
- 11. A
- 12. A
- 13. B
- 14. B
- 15. B
- 16. A
- 17. D
- 18. D
- 19. A
- 20. B
- 21. C
- 22. D
- 23. C
- 24. C
- 25. B
- 26. D
- 27. A
- 28. D
- 29. B
- 30. C

## Explanations

1. The probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring.

The closer a probability is to 0, the lesser the likelihood of the event occurring. The closer a probability is to 1, the greater the likelihood of the event occurring.

Therefore, **with probability, larger numbers indicate greater likelihood.**

2. The probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring.

The closer a probability is to 0, the lesser the likelihood of the event occurring. The closer a probability is to 1, the greater the likelihood of the event occurring.

Therefore, **a probability near 0 indicates an unlikely event.**

3. The probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring.

The closer a probability is to 0, the lesser the likelihood of the event occurring. The closer a probability is to 1, the greater the likelihood of the event occurring.

Therefore, since  $\frac{1}{2}$  is halfway between 0 and 1, **a probability near  $\frac{1}{2}$  indicates an event that is neither unlikely nor likely.**

4. The probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring.

First, find the probability that Noel draws two cards with a sum that is a multiple of 3. The table shows that there are 9 sums that are a multiple of 3.

So, the probability that Noel draws two cards with a sum that is a multiple of 3 is  $\frac{9}{25}$ .

Next, find the probability that Noel draws two cards with a sum that is greater than 13. The table shows that there are 12 sums that are greater than 13.

So, the probability that Noel draws two cards with a sum that is greater than 13 is  $\frac{12}{25}$ .

Therefore, Noel is more likely to draw two cards with a sum  
5. that is greater than 13, because  $\frac{12}{25} > \frac{9}{25}$ .

First, find the probability that Connie gets a point on the first roll. The table shows that there are 18 rolls where the sum of the two numbers is odd.

So, the probability that Connie gets a point on the first roll is  $\frac{18}{36}$ .

Next, find the probability that Curtis gets a point on the first roll. The table shows that there are 21 rolls where the sum of the two numbers is 7 or less.

So, the probability that Curtis gets a point on the first roll is  $\frac{21}{36}$ .

Therefore, Curtis is more likely to get a point, because  
6.  $\frac{21}{36} > \frac{18}{36}$ .

Since the probability is equal to  $\frac{1}{2}$ , it is the same distance from both 0 and 1. Therefore, the likelihood of selecting a name  
7. starting with the letter T is neither unlikely nor likely.

Since the probability is closer to 0 than it is to  $\frac{1}{2}$ , the  
8. likelihood of selecting a green marble is unlikely.

9. Fred spun the spinner 548 times.

Each time the spinner was spun, the chance of it landing on green was  $\frac{1}{4}$ .

So, the spinner could have landed on green  $\frac{1}{4} \times 548$ , or 137 times.  
The answer that is closest to 137 would be the best estimate.

Therefore, **154** is the best estimate for the number of times the spinner landed on green.

10. Jordan flipped the coin 378 times.

Each time the coin is flipped, the chance of it landing on heads is  $\frac{1}{2}$ .

So, the coin could have landed on heads  $\frac{1}{2} \times 378$ , or 189 times.  
The answer that is closest to 189 would be the best estimate.

Therefore, **174** is the best estimate for the number of times the coin landed on heads.

11. Notice that all four sections on the spinner are equal, so it has a probability of landing on Section B 1 time out of every 4 spins.

In order to predict the number of times the spinner would land on Section B if it was spun 80 times, set up a proportion and solve.

$$\begin{aligned}\frac{1}{4} &= \frac{x}{80} \\ 4x &= 80 \\ x &= 20\end{aligned}$$

However, since predicting a relative frequency is an estimate instead of an exact value, **the spinner would land on Section B roughly 20 times, but probably not exactly 20 times.**

12. There are 6 sides to the die with each numbered 1 through 6. Three of the sides have an even number, such as 2, 4, and 6, so the number of times the die would land on an even number is 3 times out of 6, or 1 out of 2.

In order to predict the number of times the die would land on an even number if it were rolled 180 times, set up a proportion and solve.

$$\begin{aligned}\frac{1}{2} &= \frac{x}{180} \\ 2x &= 180 \\ x &= 90\end{aligned}$$

However, since predicting a relative frequency is an estimate instead of an exact value, **the die would land on an even number roughly 90 times, but probably not exactly 90 times.**

Only one of the sixteen possible outcomes has exactly 4 heads.

H-H-H-H

13. So, the probability of getting exactly 4 heads is  $\frac{1}{16}$ .

Three out of 9 cards have a letter.

$$\frac{3}{9} = \frac{1}{3}$$

14. Therefore, the probability of drawing a letter is  $\frac{1}{3}$ .

15. First, find the total number of pieces of paper drawn from the bowl by finding the total number of entries in the stem-and-leaf plot.

There are 40 numbers recorded in the stem-and-leaf plot, and two of the entries are 35.

So, two out of 40 pieces of paper drawn had the number 35 written on them.

Therefore, the experimental probability that the piece of paper will have 35 on it is  $\frac{2}{40} = \frac{1}{20}$ .

16. First, find the total number of dining table chairs that were sold in the last week by adding the number of chairs sold in each price range.

$$11 + 4 + 6 + 3 + 4 = 28$$

Three out of the 28 chairs sold were in the \$250 to \$299 price range.

Therefore, the experimental probability that the next chair sold costs from \$250 to \$299 is  $\frac{3}{28}$ .



17. To determine the experimental probability, find the ratio of the number of times Devonte drew a black card to the total number of draws.

Devonte drew a black card eight times out of 20 draws.

$$\begin{aligned} P(\text{drawing a black card}) &= \frac{8}{20} \\ &= \frac{2}{5} \end{aligned}$$

18. To determine the experimental probability, find the ratio of the number of times Waylon rolled a 3 to the total number of rolls.

Waylon rolled a 3 two times out of 16 rolls.

$$\begin{aligned} P(\text{rolling a 3}) &= \frac{2}{16} \\ &= \frac{1}{8} \end{aligned}$$

19. First, find the total number of times Audra rolled the number cube by adding the number of times Audra rolled each number.

$$1 + 4 + 2 + 3 + 2 + 13 = 25$$

Audra rolled a 2 four out of twenty-five times.

Therefore, the experimental probability that Audra will roll a 2 is  $\frac{4}{25}$ .

20. First, find the total number of lollipops Portia drew by adding the total number of times each flavor was drawn.

$$1 + 7 + 14 + 11 + 6 = 39$$

Portia drew an orange-flavored lollipop six out of thirty-nine times.

Therefore, the experimental probability that the next lollipop drawn will be orange-flavored is  $\frac{6}{39} = \frac{2}{13}$ .

There are 5 numbers in the deck, with only two even numbered cards, 2 and 4. Each card has an equal chance of being pulled.

So, the theoretical probability of pulling an even numbered card is  $\frac{2}{5}$ .

Seth did not pull any cards with even numbers on them. Chris did pull cards with even numbers on them.

Therefore, Chris has an experimental probability closer to the

21. theoretical probability of pulling out a card with an even number on it.

There are 4 colors on the spinner. Each color has an equal chance of being landed on.

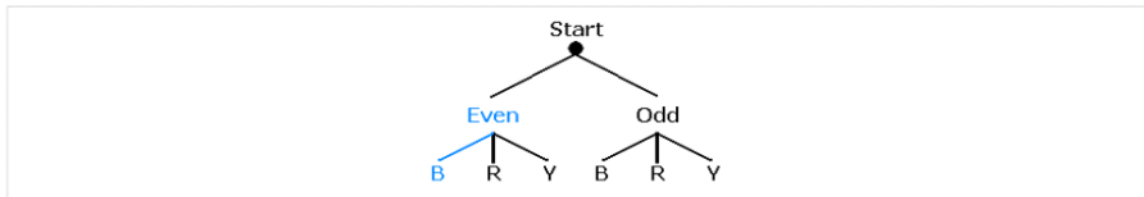
So, the theoretical probability of the spinner landing on green is  $\frac{1}{4}$ .

Patricia's experimental probability was  $\frac{3}{12}$ , or  $\frac{1}{4}$ .

Courtney's experimental probability was  $\frac{0}{6}$ .

Therefore, Patricia had an experimental probability closer to the theoretical probability of the spinner landing on green.

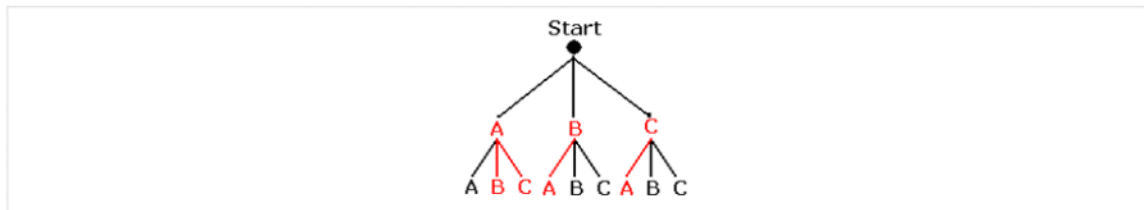
23. Use the probability tree to determine the answer. Find each branch that has both an even number and a blue disk.



There is only 1 branch with both an even number and a blue disk out of a total of 6 branches.

Therefore, the probability is  $\frac{1}{6}$ .

24. Use the probability tree to determine the answer. Find each branch that has both a vowel and a consonant.



There are 4 branches with both a vowel and a consonant out of a total of 9 branches.

Therefore, the probability is  $\frac{4}{9}$ .

25. There are 6 out of 16 outcomes that show two heads and two tails.

H H H H	H H H T	H H T T	H T T T
T H H H	T T H H	T T T H	T T T T
H T H T	T H T H	T H H T	H T T H
H H T H	T T H T	T H T T	H T H H

So, the probability of flipping two heads and two tails is  $\frac{6}{16}$ , or  $\frac{3}{8}$ .

26. Looking at the outcomes in the table, there are 6 out of 24 outcomes that are yellow or green paired with an even number.

Outcomes	1	2	3	4	5	6

Red	R, 1	R, 2	R, 3	R, 4	R, 5	R, 6
Blue	B, 1	B, 2	B, 3	B, 4	B, 5	B, 6
Green	G, 1	G, 2	G, 3	G, 4	G, 5	G, 6
Yellow	Y, 1	Y, 2	Y, 3	Y, 4	Y, 5	Y, 6

So, the probability of landing on green or yellow and rolling an even number is  $\frac{6}{24}$ , or  $\frac{1}{4}$ .

27. There are 4 red buttons in Emilio's jar, so one possible outcome is that he chooses 3 red buttons. He can also choose 2 red buttons and 1 green button or 2 red buttons and 1 black button.

There are 2 black buttons in Emilio's jar, so two other possible outcomes are that he chooses 2 black buttons and 1 red button or 2 black buttons and 1 green button.

He can also choose 1 red button, 1 green button, and 1 black button.

Therefore, the possible unique outcomes if Emilio chooses 3 buttons at a time from his jar are shown in list **W**.

28. The first contestant can be paired with any of the other contestants.

The second contestant can be paired with any of the other contestants except for the first contestant, because he or she already has selected a partner.

This pattern continues until all the contestants have selected a partner.

Therefore, the diagram **Z** shows all the possible combinations of the contestants.

29. Start by finding all the possible outcomes for the finish and the color. Pair each finish, matte (M) and glossy (G), with each color option, color (C) and black and white (B).

- M, C
- M, B
- G, C
- G, B

Since there are 4 choices for sizes and 4 choices for finish and color, there are  $4 \times 4 = 16$  possible outcomes. Pair each finish and color option with each size to find all 16 possible outcomes.

The complete list of all possible outcomes is shown below.

1, M, C	2, M, C	3, M, C	4, M, C
1, M, B	2, M, B	3, M, B	4, M, B
1, G, C	2, G, C	3, G, C	4, G, C
1, G, B	2, G, B	3, G, B	4, G, B

30. Start by finding all the possible outcomes for a coin tossed 4 times. Since each toss has two possible outcomes, the total number of possible outcomes is  $2 \times 2 \times 2 \times 2 = 16$ .

List all the possible outcomes, starting with 0 heads. Continue listing all the possible outcomes with 1 head, 2 heads, 3 heads, and 4 heads.

All 16 of the possible outcomes are shown below. The possible outcomes that have 2 or 3 heads are highlighted.

TTTT	TTTH	TTHT	TTHH
HTTT	HHTT	HTHT	HTTH
THTT	HTHT	TTHH	HHHT
TTHT	HTTH	TTHH	HHHH

