

## 9.1 Exercises

### Concept Check

**Fill-in-the-Blank.** Complete each sentence using information found in this section.

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1. In an experiment, a \_\_\_\_\_ is a repetition of the same procedure.
2. In a random experiment, there is one distinct \_\_\_\_\_ for each trial of the experiment.
3. Empirical probability of an event is calculated by finding the ratio of the number of \_\_\_\_\_ in which a specific event occurs to the total number of \_\_\_\_\_.
4. The law of \_\_\_\_\_ numbers says that the \_\_\_\_\_ the number of trials an experiment has, the closer the empirical probability will be to the actual probability.
5. Classical probability of an event is calculated by finding the ratio of the number of \_\_\_\_\_ in the event to the total number of outcomes in the \_\_\_\_\_.
6. A \_\_\_\_\_ diagram can be used to organize outcomes in a systematic manner.

**True/False.** Determine whether each statement is true or false. If a statement is false, explain how it can be changed so the statement will be true. (**Note:** There may be more than one acceptable change.)

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7. In an experiment where a coin is tossed several times, the trials are a head or a tail.
8. In an experiment where a standard die is rolled, the sample space would be  $S = \{1, 2, 3, 4, 5, 6\}$ .
9. An empirical probability is a probability that is determined by observing a random experiment.
10. Classical probability can be measured as a simple proportion: the number of trials in an experiment divided by the number of outcomes in the sample space.

### Practice

For each situation, explain whether each condition of a random experiment is met. See Examples 1 through 4.

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1. You draw a card from a well-shuffled deck of 52 cards and observe if the card is a jack.
2. A bag contains three red balls, four green balls, and three blue balls. You pull two balls from the bag and observe if their colors are the same.

3. You roll a 6-sided die and observe whether the number rolled is less than seven.
4. You roll two dice and observe the sum of the numbers on the upper-most surfaces.
5. A spinner with the numbers 1 through 8 is spun and the outcome is observed.
6. A quality inspector takes 20 details from the last batch of parts made on a machine and observes the number of defects.
7. You select a piece of candy from bowl of candy that contains only butterscotch discs.
8. A researcher selects seven mice for the experiment and observes the number of mice that have lost weight.

Find the probability for each situation. Round your answers to the nearest thousandth, if necessary. See Examples 5 and 6.

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9. A football team won 24 of 44 games.
  - a. Determine the empirical probability that the team will win the next game.
  - b. Determine the empirical probability that the team will not win the next game.
10. A bakery sells all of the fruitcakes they make on 16 days out of 30.
  - a. What is the empirical probability that the bakery will sell all of the fruitcakes tomorrow?
  - b. What is the empirical probability that the bakery will not sell all of the fruitcakes tomorrow?
11. An archer hits the target 18 times out of 20.
  - a. What is the empirical probability that he will miss the next shot?
  - b. What is the empirical probability that he will hit the next shot?
12. Of the 56 donuts tasted by a group of friends, 21 had caramel filling.
  - a. What is the empirical probability that the next donut they try will not have caramel filling?
  - b. What is the empirical probability that the next donut they try will have a caramel filling?
13. You asked 54 people whether they like Hawaiian pizza and found that 18 of them like Hawaiian pizza. What is the empirical probability that the next person you ask does not like Hawaiian pizza?
14. Fourteen employees in a company of 105 people got a bonus last month. Determine the empirical probability of getting a bonus at this company.

15. Of this year's graduates at a local university, 190 found a full-time job and 110 are still searching for one. Determine the empirical probability of finding a full-time job for a graduate of this university.
16. A new video watched by one thousand people got 190 likes and 70 dislikes. What is the empirical probability that the next viewer will neither like nor dislike the video?
17. A mobile phone company conducted a survey of 280 new customers to determine whether they were interested in using mobile internet hotspot. Using the results from the following table, determine the empirical probability that a new customer will be interested in mobile internet hotspot.

Interested	Not Interested
156	124

18. A research center tests a new medicine for headache on 300 patients. The results of the study are shown in the following table.

Decreased Pain	Increased Pain	No Effect
230	6	64

What is the empirical probability that the medicine will decrease a patient's pain?

19. A candidate's team conducts a telephone survey of 1000 people to find out if they intend to vote for the team's candidate. The results were as follows.

Votes for the Team's Candidate	Votes for a Different Candidate	Undecided
365	521	114

- a. What is the empirical probability that a person will vote for the team's candidate?
- b. What is the empirical probability that a person has already decided how he or she will vote?
20. A survey was conducted to identify the number of children in 74 local families. The following table shows the results.

Number of Children	0	1	2	3	More than 3
Number of Families	12	32	19	8	3

- a. What is the empirical probability that a family has one child?
- b. What is the empirical probability that a family has more than one child?

For each experiment, determine the empirical probability of each outcome. Round your answer to the nearest thousandth, if necessary. See Example 7.

21. A football referee is testing a new coin that he intends to use in the next season. The results of 182 tosses are shown in the following table.

Outcome	Tails	Heads
<b>Number of Observations</b>	89	93

22. A convenience store manager wants to compare the popularity of the different berry jams they sell. She records the last 150 purchases, getting the following results.

Outcome	Strawberry	Raspberry	Cherry
<b>Number of Observations</b>	65	30	55

23. A manufacturer tests a new 4-sided die for fairness. The results of 400 throws are as follows.

Outcome	1	2	3	4
<b>Number of Observations</b>	98	105	107	90

24. The developers of a random number generator want to test their application. They set the generator to produce 1000 random integers from 0 to 9 and obtain the following frequencies.

Outcome	0	1	2	3	4	5	6	7	8	9
<b>Number of Observations</b>	110	90	100	110	120	90	80	100	90	110

Find the indicated probability. Round your answer to the nearest ten thousandth, if necessary. See Examples 8 through 10.

25. A 4-sided die is rolled once. Let  $E$  be the event of observing a 3. What is  $P(E)$ ?
26. A card is drawn from a standard deck of 52 cards.
- Let  $E$  be the event of drawing a card of a red suit (red suits are diamonds and hearts). What is  $P(E)$ ?
  - Let  $E$  be the event of drawing a queen of a red suit. What is  $P(E)$ ?
27. An application generates a random number from 1 to 9.
- Let  $E$  be the event of getting an odd number. What is  $P(E)$ ?
  - Let  $E$  be the event of getting an even number. What is  $P(E)$ ?
28. A 6-sided die is rolled twice. Let  $E$  be the event of rolling the same number on two throws of the die. What is  $P(E)$ ?

29. A coin was tossed three times. The sample space consists of 8 outcomes,  $\{HHH, HHT, HTH, HTT, THH, THT, TTH, TTT\}$ . Let  $E$  be the event of getting three tails. What is  $P(E)$ ?
30. An application generates a random number from 1 through 100. Let  $E$  be the event of observing a number greater than 30. What is  $P(E)$ ?
31. Twelve students expressed the desire to take the position of a class president. Let  $E$  be the event that the youngest student wins. What is  $P(E)$ ?
32. Thirty men and forty women participate in a lottery. Let  $E$  be the event that a woman wins. What is  $P(E)$ ?
33. Eight-hundred people participate in a marathon. Six of them are your friends. Let  $E$  be the event that the winner is one of your friends. What is  $P(E)$ ?
34. A bag contains 15 chocolate, 7 mint, and 11 caramel candies. You randomly choose a piece candy from the bag. Let  $E$  be the event that candy drawn from the bag is chocolate. What is  $P(E)$ ?
35. Four coins are tossed simultaneously. The sample space is  $\{HHHH, HHHT, HHTH, HTHH, THHH, HHTT, HTHT, HTTH, THTH, TTHH, THHT, HTTT, THTT, TTHT, TTHH, TTTT\}$
- Let  $E$  be the event of getting exactly two heads. What is  $P(E)$ ?
  - Let  $E$  be the event of getting one or four tails. What is  $P(E)$ ?
36. A 20-sided die is rolled.
- Let  $E$  be the event of the number being no less than 4. What is  $P(E)$ ?
  - Let  $E$  be the event of the number being even. What is  $P(E)$ ?

Solve and round your answer to the nearest thousandth, if necessary. See Example 11.

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37. Two 6-sided dice are rolled.
- Draw a tree diagram for the possible outcomes of this experiment.
  - Determine the probability of getting two different numbers.
38. Two 4-sided dice are rolled, and we observe the sum of the numbers.
- Draw a tree diagram for the possible outcomes of this experiment.
  - Determine the probability of the sum being greater than 4.
39. In a family of tennis players, a brother has equal chances to win or lose when playing against his sister. Consider they play four matches.
- Draw a tree diagram for the possible outcomes of this experiment.
  - Determine the probability of the sister winning at least three matches.

40. Two people play rock-paper-scissors. In this game, rock beats scissors, scissors beats paper, and papers beats rock.
  - a. Draw a tree diagram for the possible outcomes of this experiment.
  - b. Determine the probability of the first player winning.
41. Consider we choose a random number from 3 to 7 and then a random even number from 2 to 8.
  - a. Draw a tree diagram for the possible outcomes of this experiment.
  - b. Determine the probability of the first and second numbers being the same.
42. Five managers should gather for the company meeting. Each of them has equal chances to arrive on time (T) or to be late (L).
  - a. Draw a tree diagram for the possible outcomes of this experiment.
  - b. Determine the probability that exactly three managers will arrive on time.

## Writing & Thinking

43. Give at least two examples of random experiments.
44. In your own words, explain the difference between empirical probability and classical probability.
45. After tossing a fair coin 1000 times, we got 510 tails and 490 heads. Is the actual probability of observing a tail is greater than the probability of observing a head?
46. When can you use a tree diagram to calculate probability?