EXAMPLE 11 Independent Events in a Family

The picture in the margin shows a family that has had nine girls in a row. Find the probability of this occurrence.

Solution If two or more events are independent, we can find the probability of them all occurring by multiplying their probabilities. The probability of a baby girl is $\frac{1}{2}$, so the probability of nine girls in a row is $\frac{1}{2}$ used as a factor nine times.

$$P(\text{nine girls in a row}) = \frac{1}{2}\cdot\frac{1}{2}\cdot\frac{1}{2}\cdot\frac{1}{2}\cdot\frac{1}{2}\cdot\frac{1}{2}\cdot\frac{1}{2}\cdot\frac{1}{2}\cdot\frac{1}{2}$$
$$= \left(\frac{1}{2}\right)^9 = \frac{1}{512}$$

The probability of a run of nine girls in a row is $\frac{1}{512}$. (If another child is born into the family, this event is independent of the other nine, and the probability of a girl is still $\frac{1}{2}$.)

Check Point 11 Find the probability of a family having four boys in a row.

Exercise Set 11.7

Practice and Application Exercises

The table shows the distribution, by marital status and gender, of the 212.5 million Americans ages 18 or older. Use the data in the table to solve Exercises 1–10.

Marital Status of the United States Population, Ages 18 or Older, in Millions

	Never Married	Married	Widowed	Divorced	Total
Male	28.6	62.1	2.7	9.0	102.4
Female	23.3	62.8	11.3	12.7	110.1
Total	51.9	124.9	14.0	21.7	212.5

Total male: 28.6 + 62.1 + 2.7 + 9.0 = 102.4

Total female: 23.3 + 62.8 + 11.3 + 12.7 = 110.1

Total never married: 28.6 + 23.3 = 51.9

Total widowed: 2.7 + 11.3 = 14.0

Total adult population: 102.4 + 110.1 = 212.5

Total married: 62.1 + 62.8 = 124.9

Total divorced: 9.0 + 12.7 = 21.7

Source: U.S. Census Bureau

If one person is randomly selected from the population described in the table, find the probability, to the nearest hundredth, that the person

1. is divorced.
2. has never been married.
3. is female.
4. is male.
5. is a widowed male.
6. is a widowed female.
7. Among those who are divorced, find the probability of selecting a woman.
8. Among those who are divorced, find the probability of selecting a man.
9. Among adult men, find the probability of selecting a married person.
10. Among adult women, find the probability of selecting a married person.

In Exercises 11–16, a die is rolled. Find the probability of getting

11. a 4.
12. a 5.
13. an odd number.
14. a number greater than 3.
15. a number greater than 4.
16. a number greater than 7.

In Exercises 17–20, you are dealt one card from a standard 52-card deck. Find the probability of being dealt

17. a queen.
18. a diamond.
19. a picture card.
20. a card greater than 3 and less than 7.

In Exercises 21–22, a fair coin is tossed two times in succession. The sample space of equally likely outcomes is $\{HH, HT, TH, TT\}$. Find the probability of getting

21. two heads.
22. the same outcome on each toss.

In Exercises 23–24, you select a family with three children. If M represents a male child and F a female child, the sample space of equally likely outcomes is $\{MMM, MMF, MFM, MFF, FMM, FMF, FFM, FFF\}$. Find the probability of selecting a family with

23. at least one male child.
24. at least two female children.

In Exercises 25–26, a single die is rolled twice. The 36 equally likely outcomes are shown as follows:

		Second Roll					
		⚀	⚁	⚂	⚃	⚄	⚅
First Roll	⚀	(1,1)	(1,2)	(1,3)	(1,4)	(1,5)	(1,6)
	⚁	(2,1)	(2,2)	(2,3)	(2,4)	(2,5)	(2,6)
	⚂	(3,1)	(3,2)	(3,3)	(3,4)	(3,5)	(3,6)
	⚃	(4,1)	(4,2)	(4,3)	(4,4)	(4,5)	(4,6)
	⚄	(5,1)	(5,2)	(5,3)	(5,4)	(5,5)	(5,6)
	⚅	(6,1)	(6,2)	(6,3)	(6,4)	(6,5)	(6,6)

Find the probability of getting

25. two numbers whose sum is 4.

26. two numbers whose sum is 6.

27. To play the California lottery, a person has to select 6 out of 51 numbers, paying $1 for each six-number selection. If you pick six numbers that are the same as the ones drawn by the lottery, you win mountains of money. What is the probability that a person with one combination of six numbers will win? What is the probability of winning if 100 different lottery tickets are purchased?

28. A state lottery is designed so that a player chooses six numbers from 1 to 30 on one lottery ticket. What is the probability that a player with one lottery ticket will win? What is the probability of winning if 100 different lottery tickets are purchased?

Exercises 29–30 involve a deck of 52 cards. If necessary, refer to the picture of a deck of cards, **Figure 11.11** *on page 1035.*

29. A poker hand consists of five cards.

a. Find the total number of possible five-card poker hands.

b. A diamond flush is a five-card hand consisting of all diamonds. Find the number of possible diamond flushes.

c. Find the probability of being dealt a diamond flush.

30. If you are dealt 3 cards from a shuffled deck of 52 cards, find the probability that all 3 cards are picture cards.

The table shows the educational attainment of the U.S. population, ages 25 and over. Use the data in the table, expressed in millions, to solve Exercises 31–36.

Educational Attainment, in Millions, of the United States Population, Ages 25 and Over

	Less Than 4 Years High School	4 Years High School Only	Some College [Less than 4 years]	4 Years College [or More]	Total
Male	14	25	20	23	82
Female	15	31	24	22	92
Total	29	56	44	45	174

Source: U.S. Census Bureau

Find the probability, expressed as a simplified fraction, that a randomly selected American, aged 25 or over,

31. has not completed four years (or more) of college.

32. has not completed four years of high school.

33. has completed four years of high school only or less than four years of college.

34. has completed less than four years of high school or four years of high school only.

35. has completed four years of high school only or is a man.

36. has completed four years of high school only or is a woman.

In Exercises 37–42, you are dealt one card from a 52-card deck. Find the probability that

37. you are not dealt a king.

38. you are not dealt a picture card.

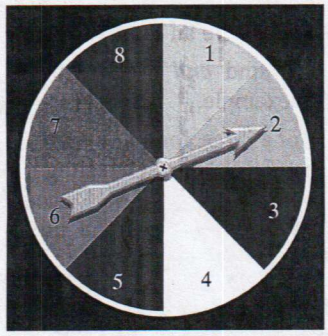
39. you are dealt a 2 or a 3.

40. you are dealt a red 7 or a black 8.

41. you are dealt a 7 or a red card.

42. you are dealt a 5 or a black card.

In Exercises 43–44, it is equally probable that the pointer on the spinner shown will land on any one of the eight regions, numbered 1 through 8. If the pointer lands on a borderline, spin again.



Find the probability that the pointer will stop on

43. an odd number or a number less than 6.

44. an odd number or a number greater than 3.

Use this information to solve Exercises 45–46. The mathematics department of a college has 8 male professors, 11 female professors, 14 male teaching assistants, and 7 female teaching assistants. If a person is selected at random from the group, find the probability that the selected person is

45. a professor or a male.

46. a professor or a female.

In Exercises 47–50, a single die is rolled twice. Find the probability of rolling

47. a 2 the first time and a 3 the second time.

48. a 5 the first time and a 1 the second time.

49. an even number the first time and a number greater than 2 the second time.

50. an odd number the first time and a number less than 3 the second time.

51. If you toss a fair coin six times, what is the probability of getting all heads?

52. If you toss a fair coin seven times, what is the probability of getting all tails?

53. The probability that South Florida will be hit by a major hurricane (category 4 or 5) in any single year is $\frac{1}{16}$.
(*Source:* National Hurricane Center)

a. What is the probability that South Florida will be hit by a major hurricane two years in a row?

b. What is the probability that South Florida will be hit by a major hurricane in three consecutive years?

c. What is the probability that South Florida will not be hit by a major hurricane in the next ten years?

d. What is the probability that South Florida will be hit by a major hurricane at least once in the next ten years?