10-4 The Binomial Distribution

Determine whether each experiment is a binomial experiment or can be reduced to a binomial experiment. If so, describe a trial, determine the random variable, and state n, p, and q.

1. A study finds that 58% of people have pets. You ask 100 people how many pets they have.

2. You roll a die 15 times and find the sum of all of the rolls.

3. A poll found that 72% of students plan on going to the homecoming dance. You ask 30 students if they are going to the homecoming dance.

4. Conduct a binomial experiment to determine the probability of drawing an ace or a king from a deck of cards. Then compare the experimental and theoretical probabilities of the experiment.

5. **GAMES** Aiden has earned five spins of the wheel. He will receive a prize each time the spinner lands on WIN. What is the probability that he receives three prizes?

A 4.2%
B 5.8%
C 7.1%
D 8.8%

6. **CCSS PRECISION** A poll at Steve's high school was taken to see if students are in favor of spending class money to expand the junior-senior parking lot. Steve surveyed 6 random students from the population.

Expand the Parking Lot	
favor	85%
oppose	15%

a. Determine the probabilities associated with the number of students that Steve asked who are in favor of expanding the parking lot by calculating the probability distribution.
b. What is the probability that no more than 2 people are in favor of expanding the parking lot?
c. How many students should Steve expect to find who are in favor of expanding the parking lot?

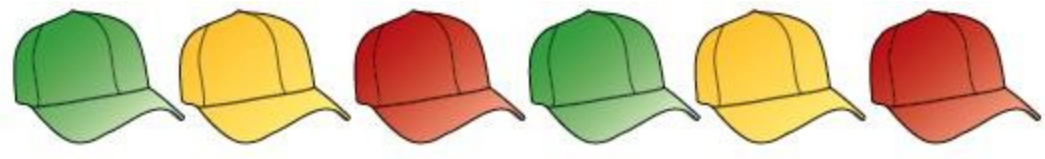
Determine whether each experiment is a binomial experiment or can be reduced to a binomial experiment. If so, describe a trial, determine the random variable, and state n, p, and q.

7. There is a 35% chance that it rains each day in a given month. You record the number of days that it rains for that month.

8. A survey found that on a scale of 1 to 10, a movie received a 7.8 rating. A movie theater employee asks 200 patrons to rate the movie on a scale of 1 to 10.

10-4 The Binomial Distribution

9. A ball is hidden under one of the hats shown below. A hat is chosen, one at a time, until the ball is found.



10. **DICE** Conduct a binomial experiment to determine the probability of rolling a 7 with two dice. Then compare the experimental and theoretical probabilities of the experiment.

11. **MARBLES** Conduct a binomial experiment to determine the probability of pulling a red marble from the bag. Then compare the experimental and theoretical probabilities of the experiment.

12. **SPINNER** Conduct a binomial experiment to determine the probability of the spinner stopping on an even number. Then compare the experimental and theoretical probabilities of the experiment.

13. **CARDS** Conduct a binomial experiment to determine the probability of drawing a face card out of a standard deck of cards. Then compare the experimental and theoretical probabilities of the experiment.

14. **PERSONAL MEDIA PLAYERS** According to a recent survey, 85% of high school students own a personal media player. What is the probability that 6 out of 10 random high school students own a personal media player?

15. **CARS** According to a recent survey, 92% of high school seniors drive their own car. What is the probability that 10 out of 12 random high school students drive their own car?

16. **SENIOR PROM** According to a recent survey, 25% of high school upperclassmen think that the junior-senior prom is the most important event of the school year. What is the probability that 3 out of 15 random high school upperclassmen think this way?

17. **FOOTBALL** A certain football team has won 75.7% of their games. Find the probability that they win 7 of their next 12 games.

18. **GARDENING** Peter is planting 24 irises in his front yard. The flowers he bought were a combination of two varieties, blue and white. The flowers are not blooming yet, but Peter knows that the probability of having a blue flower is 75%. What is the probability that 20 of the flowers will be blue?

19. **FOOTBALL** A field goal kicker is accurate 75% of the time from within 35 yards. What is the probability that he makes exactly 7 of his next 10 kicks from within 35 yards?

Range (yd)	Accuracy (%)
0–35	75
35–45	62
45+	20

20. **BABIES** Mr. and Mrs. Davis are planning to have 3 children. The probability of each child being a boy is 50%. What is the probability that they will have 2 boys?

21. **CCSS SENSE-MAKING** According to a recent survey, 52% of high school students own a laptop. Ten random students are chosen.
    a. Determine the probabilities associated with the number of students that own a laptop by calculating the probability distribution.
    b. What is the probability that at least 8 of the 10 students own a laptop?
    c. How many students should you expect to own a laptop?

22. **ATHLETICS** A survey was taken to see the percent of students that participate in sports for their school. Six random students are chosen.

Student Athletics	
0 sports	20%
1 sport	55%
2 sports	20%
3+ sports	5%

    a. Determine the probabilities associated with the number of students playing in at least one sport by calculating the probability distribution.
    b. What is the probability that no more than 2 of the students participated in a sport?
    c. How many students should you expect to have participated in at least one sport?

23. **CCSS MODELING** An online poll showed that 57% of adults still own vinyl records. Moe surveyed 8 random adults from the population.
    a. Determine the probabilities associated with the number of adults that still own vinyl records by calculating the probability distribution.
    b. What is the probability that no less than 6 of the people surveyed still own vinyl records?
    c. How many people should Moe expect to still own vinyl records?

A binomial distribution has a 60% rate of success. There are 18 trials.

24. What is the probability that there will be at least 12 successes?

25. What is the probability that there will be 12 failures?

26. What is the expected number of successes?

27. **DECISION MAKING** Six roommates randomly select someone to wash the dishes each day.
    a. What is the probability that the same person has to wash the dishes 3 times in a given week?
    b. What method can the roommates use to select who washes the dishes each day?

28. **DECISION MAKING** A committee of five people randomly selects someone to take the notes of each meeting.
    a. What is the probability that a person takes notes less than twice in 10 meetings?
    b. What method can the committee use to select the notetaker each meeting?
    c. If the method described in part b results in the same person being notetaker for nine straight meetings, would this result cause you to question the method

Each binomial distribution has n trials and p probability of success. Determine the most likely number of successes.

29. $n = 8, p = 0.6$

30. $n = 10, p = 0.4$

31. $n = 6, p = 0.8$

32. $n = 12, p = 0.55$

33. $n = 9, p = 0.75$

34. $n = 11, p = 0.35$

35. **SWEEPSTAKES** A beverage company is having a sweepstakes. The probability of winning selected prizes is shown below. If Ernesto purchases 8 beverages, what is the probability that he wins at least one prize?

Odds of Winning	
beverage	1 in 10
CD	1 in 200
hat	1 in 250
MP3 player	1 in 20,000
car	1 in 25,000,000

Each binomial distribution has n trials and p probability of success. Determine the probability of s successes

36. $n = 8, p = 0.3, s \geq 2$

37. $n = 10, p = 0.2, s > 2$

38. $n = 6, p = 0.6, s \leq 4$

39. $n = 9, p = 0.25, s \leq 5$

40. $n = 10, p = 0.75, s \geq 8$

41. $n = 12, p = 0.1, s < 3$

42. **CHALLENGE** A poll of students determined that 88% wanted to go to college. Eight random students are chosen. The probability that at least x students want to go to college is about 0.752 or 75.2%. Solve for x.

43. **WRITING IN MATH** What should you consider when using a binomial distribution to make a decision?

44. **OPEN ENDED** Describe a real-world setting within your school or community activities that seems to fit a binomial distribution. Identify the key components of your setting that connect to binomial distributions.

45. **WRITING IN MATH** Describe how binomial distributions are connected to Pascal's triangle.

46. **WRITING IN MATH** Explain the relationship between a binomial experiment and a binomial distribution.

47. **EXTENDED RESPONSE** Carly is taking a 10-question multiple-choice test in which each question has four choices. If she guesses on each question, what is the probability that she will get
    a. 7 questions correct?
    b. 9 questions correct?
    c. 0 questions correct?
    d. 3 questions correct?

48. What is the maximum point of the graph of the equation $y = -2x^2 + 16x + 5$?
    A (–4, –59)
    B (–4, –91)
    C (4, 37)
    D (4, 101)

49. **GEOMETRY** On a number line, point X has coordinate –8 and point Y has coordinate 4. Point P is $\frac{2}{3}$ of the way from X to Y. What is the coordinate of P?
    F –4
    G –2
    H 0
    J 2

50. **SAT/ACT** The cost of 4 CDs is d dollars. At this rate, what is the cost, in dollars, of 36 CDs?
    A $9d$
    B $144d$
    C $\frac{9d}{4}$
    D $\frac{d}{36}$
    E $\frac{36}{d}$

Identify the random variable in each distribution, and classify it as *discrete* or *continuous*. Explain your reasoning.

51. the number of customers at an amusement park

52. the running time of a movie

53. the number of hot dogs sold at a sporting event

54. the distance between two cities

55. **FINANCIAL LITERACY** The prices of entrees offered by a restaurant are shown.

Prices (dollars)			
11.25	14.75	9.00	17.25
19.75	9.75	20.25	15.50
16.50	21.50	10.25	22.75
12.75	18.50	23.00	13.50

a. Use a graphing calculator to create a box-and-whisker plot. Then describe the shape of the distribution.
b. Describe the center and spread of the data using either the mean and standard deviation or the five-number summary. Justify your choice.

Find the missing value for each arithmetic sequence.

56. $a_5 = 12,\ a_{16} = 133,\ d = ?$

57. $a_9 = -34,\ a_{22} = 44,\ d = ?$

58. $a_4 = 18,\ a_n = 95,\ d = 7,\ n = ?$

59. $a_8 = ?,\ a_{19} = 31,\ d = 8$

60. $a_6 = ?,\ a_{20} = 64,\ d = 7$

61. $a_7 = -28,\ a_n = 76,\ d = 8,\ n = ?$

62. **ASTRONOMY** The table shows the closest and farthest distances of Venus and Jupiter from the center of the Sun in millions of miles.

Planet	Closest	Farthest
Venus	66.8	67.7
Jupiter	460.1	507.4

a. Write an equation for the orbit of each planet. Assuming that the center of the orbit is the origin and the center of the Sun is a focus that lies on the x-axis.
b. Which planet has an orbit that is closer to a circle?

Write an equivalent exponential or logarithmic function.

63. $e^{-x} = 5$

64. $e^2 = 6x$

65. $\ln e = 1$

66. $\ln 5.2 = x$

67. $e^{x+1} = 9$

68. $e^{-1} = x^2$

69. $\ln \frac{7}{3} = 2x$

70. $\ln e^{x} = 3$

71. **MUSIC** Tina owns 11 pop, 6 country, 16 rock, and 7 rap CDs. Find each probability if she randomly selects 4 CDs.
    a. P(2 rock)
    b. P(1 rap)
    c. P(1 rock and 2 country)