5.24 Investment advisors agree that near-retirees, defined as people aged 55 to 65, should have balanced portfolios. Most advisors suggest that the near-retirees have no more than 50% of their investments in stocks. However, during the huge decline in the stock market in 2008, 22% of near-retirees had 90% or more of their investments in stocks (P. Regnier, "What I Learned from the Crash," *Money*, May 2009, p. 114). Suppose you have a random sample of 10 people who would have been labeled as near-retirees in 2008. What is the probability that during 2008

a. zero had 90% or more of their investment in stocks?
b. exactly one had 90% or more of his or her investment in stocks?
c. two or fewer had 90% or more of their investment in stocks?
d. three or more had 90% or more of their investment in stocks?

5.25 When a customer places an order with Rudy's On-Line Office Supplies, a computerized accounting information system (AIS) automatically checks to see if the customer has exceeded his or her credit limit. Past records indicate that the probability of customers exceeding their credit limit is 0.05. Suppose that, on a given day, 20 customers place orders. Assume that the number of customers that the AIS detects as having exceeded their credit limit is distributed as a binomial random variable.

a. What are the mean and standard deviation of the number of customers exceeding their credit limits?
b. What is the probability that zero customers will exceed their limits?
c. What is the probability that one customer will exceed his or her limit?
d. What is the probability that two or more customers will exceed their limits?

SELF Test **5.26** In Example 5.4 on page 175, you and two friends decided to go to Wendy's. Now, suppose that instead you go to Popeye's, which last month filled approximately 84% of orders correctly. What is the probability that

a. all three orders will be filled correctly?
b. none of the three will be filled correctly?
c. at least two of the three will be filled correctly?
d. What are the mean and standard deviation of the binomial distribution used in (a) through (c)? Interpret these values.

5.27 In Example 5.4 on page 175, you and two friends decided to go to Wendy's. Now, suppose that instead you go to McDonald's, which last month filled approximately 94.5% of the orders correctly. What is the probability that

a. all three orders will be filled correctly?
b. none of the three will be filled correctly?
c. at least two of the three will be filled correctly?
d. What are the mean and standard deviation of the binomial distribution used in (a) through (c)? Interpret these values.
e. Compare the result of (a)–(d) with those of Popeye's in Problem 5.26 and Wendy's in Example 5.4 on page 175.

5.4 Poisson Distribution

Many studies are based on counts of the times a particular event occurs in a given *area of opportunity*. An **area of opportunity** is a continuous unit or interval of time, volume, or any physical area in which there can be more than one occurrence of an event. Examples of variables that follow the Poisson distribution are the surface defects on a new refrigerator, the number of network failures in a day, the number of people arriving at a bank, and the number of fleas on the body of a dog. You can use the **Poisson distribution** to calculate probabilities in situations such as these if the following properties hold:

- You are interested in counting the number of times a particular event occurs in a given area of opportunity. The area of opportunity is defined by time, length, surface area, and so forth.
- The probability that an event occurs in a given area of opportunity is the same for all the areas of opportunity.
- The number of events that occur in one area of opportunity is independent of the number of events that occur in any other area of opportunity.
- The probability that two or more events will occur in an area of opportunity approaches zero as the area of opportunity becomes smaller.

Consider the number of customers arriving during the lunch hour at a bank located in the central business district in a large city. You are interested in the number of customers that arrive each minute. Does this situation match the four properties of the Poisson distribution given earlier? First, the *event* of interest is a customer arriving, and the *given area of opportunity* is defined as a 1-minute interval. Will zero customers arrive, one customer arrive, two customers arrive, and so on? Second, it is reasonable to assume that the probability that a customer arrives

Problems for Section 5.4

LEARNING THE BASICS

5.28 Assume a Poisson distribution.

a. If $\lambda = 2.5$, find $P(X = 2)$.
b. If $\lambda = 8.0$, find $P(X = 8)$.
c. If $\lambda = 0.5$, find $P(X = 1)$.
d. If $\lambda = 3.7$, find $P(X = 0)$.

5.29 Assume a Poisson distribution.

a. If $\lambda = 2.0$, find $P(X \geq 2)$.
b. If $\lambda = 8.0$, find $P(X \geq 3)$.
c. If $\lambda = 0.5$, find $P(X \leq 1)$.
d. If $\lambda = 4.0$, find $P(X \geq 1)$.
e. If $\lambda = 5.0$, find $P(X \leq 3)$.

5.30 Assume a Poisson distribution with $\lambda = 5.0$. What is the probability that

a. $X = 1$?
b. $X < 1$?
c. $X > 1$?
d. $X \leq 1$?

APPLYING THE CONCEPTS

5.31 Assume that the number of network errors experienced in a day on a local area network (LAN) is distributed as a Poisson random variable. The mean number of network errors experienced in a day is 2.4. What is the probability that in any given day

a. zero network errors will occur?
b. exactly one network error will occur?
c. two or more network errors will occur?
d. fewer than three network errors will occur?

SELF Test **5.32** The quality control manager of Marilyn's Cookies is inspecting a batch of chocolate-chip cookies that has just been baked. If the production process is in control, the mean number of chip parts per cookie is 6.0. What is the probability that in any particular cookie being inspected

a. fewer than five chip parts will be found?
b. exactly five chip parts will be found?
c. five or more chip parts will be found?
d. either four or five chip parts will be found?

5.33 Refer to Problem 5.32. How many cookies in a batch of 100 should the manager expect to discard if company policy requires that all chocolate-chip cookies sold have at least four chocolate-chip parts?

5.34 The U.S. Department of Transportation maintains statistics for mishandled bags per 1,000 airline passengers. In 2007, airlines had mishandled 7 bags per 1,000 passengers (data extracted from R. Yu, "Airline Performance Nears 20 Year Low," *USA Today*, April 8, 2008, p. B1). What is the probability that in the next 1,000 passengers, airlines will have

a. no mishandled bags?
b. at least one mishandled bag?
c. at least two mishandled bags?

5.35 The U.S. Department of Trans
tistics for consumer complaints per
gers. In 2007, consumer complaints
passengers (data extracted from R. Y
Nears 20 Year Low," *USA Today*, Ap
is the probability that in the next 1(
will be

a. no complaints?
b. at least one complaint?
c. at least two complaints?

5.36 Based on past experience, it i
ber of flaws per foot in rolls of g
Poisson distribution with a mean
paper (0.2 flaw per foot). What is th

a. 1-foot roll, there will be at least
b. 12-foot roll, there will be at least
c. 50-foot roll, there will be more
and fewer than or equal to 15 fla

5.37 J.D. Power and Associates c
various statistics concerning car qu
score measures the number of pro
For 2009 model cars, Ford had 1.0
Dodge had 1.34 problems per car
Power Forward with Gains in Qual
June 23, 2009, p. 3B). Let the rand
the number of problems with a new

a. What assumptions must be mad
tributed as a Poisson random var
tions reasonable?

Making the assumptions as in (a),
Ford, what is the probability that th

b. zero problems?
c. two or fewer problems?
d. Give an operational definition
operational definition importan
quality score?

5.38 Refer to Problem 5.37. I
Dodge, what is the probability tha

a. zero problems?
b. two or fewer problems?
c. Compare your answers in (a) an
in Problem 5.37 (b) and (c).

5.39 Refer to Problem 5.37. Anot
Moves Up in Quality Survey," *U*
p. 3B) reported that in 2008, Ford
and Dodge had 1.41 problems p
2008 Ford, what is the probability

a. zero problems?
b. two or fewer problems?
c. Compare your answers in (a) a
Ford in Problem 5.37 (b) and (