

Self-Review 5-4



Routine physical examinations are conducted annually as part of a health service program for General Concrete Inc. employees. It was discovered that 8% of the employees need corrective shoes, 15% need major dental work, and 3% need both corrective shoes and major dental work.

- What is the probability that an employee selected at random will need either corrective shoes or major dental work?
- Show this situation in the form of a Venn diagram.

Exercises

connect

- The events A and B are mutually exclusive. Suppose $P(A) = .30$ and $P(B) = .20$. What is the probability of either A or B occurring? What is the probability that neither A nor B will happen?
- The events X and Y are mutually exclusive. Suppose $P(X) = .05$ and $P(Y) = .02$. What is the probability of either X or Y occurring? What is the probability that neither X nor Y will happen?
- A study of 200 advertising firms revealed their income after taxes: 

Income after Taxes	Number of Firms
Under \$1 million	102
\$1 million to \$20 million	61
\$20 million or more	37

- What is the probability an advertising firm selected at random has under \$1 million in income after taxes?
 - What is the probability an advertising firm selected at random has either an income between \$1 million and \$20 million, or an income of \$20 million or more? What rule of probability was applied?
- The chair of the board of directors says, "There is a 50% chance this company will earn a profit, a 30% chance it will break even, and a 20% chance it will lose money next quarter."
 - Use an addition rule to find the probability the company will not lose money next quarter.
 - Use the complement rule to find the probability it will not lose money next quarter.
 - Suppose the probability you will get an A in this class is .25 and the probability you will get a B is .50. What is the probability your grade will be above a C ?
 - Two coins are tossed. If A is the event "two heads" and B is the event "two tails," are A and B mutually exclusive? Are they complements?
 - The probabilities of the events A and B are .20 and .30, respectively. The probability that both A and B occur is .15. What is the probability of either A or B occurring?
 - Let $P(X) = .55$ and $P(Y) = .35$. Assume the probability that they both occur is .20. What is the probability of either X or Y occurring?
 - Suppose the two events A and B are mutually exclusive. What is the probability of their joint occurrence?
 - A student is taking two courses, history and math. The probability the student will pass the history course is .60, and the probability of passing the math course is .70. The probability of passing both is .50. What is the probability of passing at least one?
 - A survey of grocery stores in the Southeast revealed 40% had a pharmacy, 50% had a floral shop, and 70% had a deli. Suppose 10% of the stores have all three departments, 30% have both a pharmacy and a deli, 25% have both a floral shop and deli, and 20% have both a pharmacy and floral shop.
 - What is the probability of selecting a store at random and finding it has both a pharmacy and a floral shop?
 - What is the probability of selecting a store at random and finding it has both a pharmacy and a deli?
 - Are the events "select a store with a deli" and "select a store with a pharmacy" mutually exclusive?

LO 5-5 Calculate probabilities rules of multi

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Exercises

- Some people are in favor of reducing federal taxes to increase consumer spending and others are against it. Two persons are selected and their opinions are recorded. Assuming no one is undecided, list the possible outcomes.
- A quality control inspector selects a part to be tested. The part is then declared acceptable, repairable, or scrapped. Then another part is tested. List the possible outcomes of this experiment regarding two parts.
- A survey of 34 students at the Wall College of Business showed the following majors:

Accounting	10
Finance	5
Economics	3
Management	6
Marketing	10

Suppose you select a student and observe his or her major.

- What is the probability he or she is a management major?
 - Which concept of probability did you use to make this estimate?
- A large company that must hire a new president prepares a final list of five candidates, all of whom are equally qualified. Two of these candidates are members of a minority group. To avoid bias in the selection of the candidate, the company decides to select the president by lottery.
 - What is the probability one of the minority candidates is hired?
 - Which concept of probability did you use to make this estimate?
 - In each of the following cases, indicate whether classical, empirical, or subjective probability is used.
 - A baseball player gets a hit in 30 out of 100 times at bat. The probability is .3 that he gets a hit in his next at bat.
 - A seven-member committee of students is formed to study environmental issues. What is the likelihood that any one of the seven is chosen as the spokesperson?
 - You purchase one of 5 million tickets sold for Lotto Canada. What is the likelihood you will win the \$1 million jackpot?
 - The probability of an earthquake in northern California in the next 10 years above 5.0 on the Richter Scale is .80.
 - A firm will promote two employees out of a group of six men and three women.
 - List the chances of this experiment if there is particular concern about gender equity.
 - Which concept of probability would you use to estimate these probabilities?
 - A sample of 40 oil industry executives was selected to test a questionnaire. One question about environmental issues required a yes or no answer.
 - What is the experiment?
 - List one possible event.
 - Ten of the 40 executives responded yes. Based on these sample responses, what is the probability that an oil industry executive will respond yes?
 - What concept of probability does this illustrate?
 - Are each of the possible outcomes equally likely and mutually exclusive?
 - A sample of 2,000 licensed drivers revealed the following number of speeding violations.

Number of Violations	Number of Drivers
0	1,910
1	46
2	18
3	12
4	9
5 or more	5
Total	2,000

- What is the experiment?
- List one possible event.

LO 5-3 Calculate probabilities using the rules of addition.

Example



- c. What is the probability that a particular driver had exactly two speeding violations?
- d. What concept of probability does this illustrate?
9. Bank of America customers select their own three-digit personal identification number (PIN) for use at ATMs.
 - a. Think of this as an experiment and list four possible outcomes.
 - b. What is the probability Mr. Jones and Mrs. Smith select the same PIN?
 - c. Which concept of probability did you use to answer (b)?
10. An investor buys 100 shares of AT&T stock and records its price change daily.
 - a. List several possible events for this experiment.
 - b. Estimate the probability for each event you described in (a).
 - c. Which concept of probability did you use in (b)?

5.4 Some Rules for Computing Probabilities

Now that we have defined probability and described the different approaches to probability, we turn our attention to computing the probability of two or more events by applying rules of addition and multiplication.

Rules of Addition

There are two rules of addition, the special rule of addition and the general rule of addition. We begin with the special rule of addition.

LO 5-3 Calculate probabilities using the rules of addition.

Special Rule of Addition To apply the **special rule of addition**, the events must be *mutually exclusive*. Recall that mutually exclusive means that when one event occurs, none of the other events can occur at the same time. An illustration of mutually exclusive events in the die-tossing experiment is the events "a number 4 or larger" and "a number 2 or smaller." If the outcome is in the first group {4, 5, and 6}, then it cannot also be in the second group {1 and 2}. Another illustration is a product coming off the assembly line cannot be defective and satisfactory at the same time.

If two events A and B are mutually exclusive, the special rule of addition states that the probability of one or the other event's occurring equals the sum of their probabilities. This rule is expressed in the following formula:

SPECIAL RULE OF ADDITION

$$P(A \text{ or } B) = P(A) + P(B)$$

[5-2]

For three mutually exclusive events designated A , B , and C , the rule is written:

$$P(A \text{ or } B \text{ or } C) = P(A) + P(B) + P(C)$$

An example will help to show the details.

Example



A machine fills plastic bags with a mixture of beans, broccoli, and other vegetables. Most of the bags contain the correct weight, but because of the variation in the size of the beans and other vegetables, a package might be underweight or overweight. A check of 4,000 packages filled in the past month revealed:

Weight	Event	Number of Packages	Probability of Occurrence
Underweight	A	100	.025
Satisfactory	B	3,600	.900
Overweight	C	300	.075
		4,000	1.000

100
4,000

Exercises

connect

23. Suppose $P(A) = .40$ and $P(B|A) = .30$. What is the joint probability of A and B?
24. Suppose $P(X_1) = .75$ and $P(Y_2|X_1) = .40$. What is the joint probability of X_1 and Y_2 ?
25. A local bank reports that 80% of its customers maintain a checking account, 60% have a savings account, and 50% have both. If a customer is chosen at random, what is the probability the customer has either a checking or a savings account? What is the probability the customer does not have either a checking or a savings account?
26. All Seasons Plumbing has two service trucks that frequently need repair. If the probability the first truck is available is .75, the probability the second truck is available is .50, and the probability that both trucks are available is .30, what is the probability neither truck is available?
27. Refer to the following table. 

Second Event	First Event			Total
	A_1	A_2	A_3	
B_1	2	1	3	6
B_2	1	2	1	4
Total	3	3	4	10

- a. Determine $P(A_1)$.
- b. Determine $P(B_1|A_2)$.
- c. Determine $P(B_2 \text{ and } A_3)$.
28. Three defective electric toothbrushes were accidentally shipped to a drugstore by Clean-brush Products along with 17 nondefective ones.
- a. What is the probability the first two electric toothbrushes sold will be returned to the drugstore because they are defective?
- b. What is the probability the first two electric toothbrushes sold will not be defective?
29. Each salesperson at Puchett, Sheets, and Hogan Insurance Agency is rated either below average, average, or above average with respect to sales ability. Each salesperson is also rated with respect to his or her potential for advancement—either fair, good, or excellent. These traits for the 500 salespeople were cross-classified into the following table. 

Sales Ability	Potential for Advancement		
	Fair	Good	Excellent
Below average	16	12	22
Average	45	60	45
Above average	93	72	135

- a. What is this table called?
- b. What is the probability a salesperson selected at random will have above average sales ability and excellent potential for advancement?
- c. Construct a tree diagram showing all the probabilities, conditional probabilities, and joint probabilities.
30. An investor owns three common stocks. Each stock, independent of the others, has equally likely chances of (1) increasing in value, (2) decreasing in value, or (3) remaining the same value. List the possible outcomes of this experiment. Estimate the probability at least two of the stocks increase in value.
31. David Akers is the field goal kicker for the Philadelphia Eagles of the National Football League. During the 2010 season, he attempted 38 field goals and made 32 of the attempts. A summary of his field goal outcomes by distance is shown on the next page.