

1.1**EXERCISES**

In Exercises 1–22, construct a Venn diagram to determine the validity of the given argument.

1. a. 1. All master photographers are artists.
2. Ansel Adams is a master photographer.
Therefore, Ansel Adams is an artist.
- b. 1. All master photographers are artists.
2. Ansel Adams is an artist.
Therefore, Ansel Adams is a master photographer.
2. a. 1. All Olympic gold medal winners are role models.
2. Michael Phelps is an Olympic gold medal winner.
Therefore, Michael Phelps is a role model.
- b. 1. All Olympic gold medal winners are role models.
2. Michael Phelps is a role model.
Therefore, Michael Phelps is an Olympic gold medal winner.
3. a. 1. All homeless people are unemployed.
2. Bill Gates is not a homeless person.
Therefore, Bill Gates is not unemployed.
- b. 1. All homeless people are unemployed.
2. Bill Gates is not unemployed.
Therefore, Bill Gates is not a homeless person.
4. a. 1. All professional wrestlers are actors.
2. Ralph Nader is not an actor.
Therefore, Ralph Nader is not a professional wrestler.
- b. 1. All professional wrestlers are actors.
2. Ralph Nader is not a professional wrestler.
Therefore, Ralph Nader is not an actor.
5. 1. All pesticides are harmful to the environment.
2. No fertilizer is a pesticide.
Therefore, no fertilizer is harmful to the environment.
6. 1. No one who can afford health insurance is unemployed.
2. All politicians can afford health insurance.
Therefore, no politician is unemployed.
7. 1. No vegetarian owns a gun.
2. All policemen own guns.
Therefore, no policeman is a vegetarian.

8. 1. No professor is a millionaire.
2. No millionaire is illiterate.
Therefore, no professor is illiterate.
9. 1. All poets are loners.
2. All loners are taxi drivers.
Therefore, all poets are taxi drivers.
10. 1. All forest rangers are environmentalists.
2. All forest rangers are storytellers.
Therefore, all environmentalists are storytellers.
11. 1. Real men don't eat quiche.
2. Clint Eastwood is a real man.
Therefore, Clint Eastwood doesn't eat quiche.
12. 1. Real men don't eat quiche.
2. Oscar Meyer eats quiche.
Therefore, Oscar Meyer isn't a real man.
13. 1. All roads lead to Rome.
2. Route 66 is a road.
Therefore, Route 66 leads to Rome.
14. 1. All smiling cats talk.
2. The Cheshire Cat smiles.
Therefore, the Cheshire Cat talks.
15. 1. Some animals are dangerous.
2. A tiger is an animal.
Therefore, a tiger is dangerous.
16. 1. Some professors wear glasses.
2. Mr. Einstein wears glasses.
Therefore, Mr. Einstein is a professor.
17. 1. Some women are police officers.
2. Some police officers ride motorcycles.
Therefore, some women ride motorcycles.
18. 1. All poets are eloquent.
2. Some poets are wine connoisseurs.
Therefore, some wine connoisseurs are eloquent.
19. 1. All squares are rectangles.
2. Some quadrilaterals are squares.
Therefore, some quadrilaterals are rectangles.
20. 1. All squares are rectangles.
2. Some quadrilaterals are rectangles.
Therefore, some quadrilaterals are squares.
21. 1. Some actors are not politicians.
2. Some politicians are not lawyers.
Therefore, no lawyers are actors.

- 22.** 1. Some mathematicians are not bankers.
2. No banker is a gambler.

Therefore, some mathematicians are gamblers.

In Exercises 23–32, identify the type of categorical proposition (universal affirmative, universal negative, particular affirmative, or particular negative) given in each premise and the conclusion of the following exercises.

- 23.** Exercise 7
24. Exercise 8
25. Exercise 9
26. Exercise 10
27. Exercise 19
28. Exercise 20
29. Exercise 21
30. Exercise 22
31. Classify each argument as deductive or inductive.
a. 1. My television set did not work two nights ago.
2. My television set did not work last night.
Therefore, my television set is broken.
b. 1. All electronic devices give their owners grief.
2. My television set is an electronic device.
Therefore, my television set gives me grief.
- 32.** Classify each argument as deductive or inductive.
a. 1. I ate a chili dog at Joe's and got indigestion.
2. I ate a chili dog at Ruby's and got indigestion.
Therefore, chili dogs give me indigestion.
b. 1. All spicy foods give me indigestion.
2. Chili dogs are spicy food.
Therefore, chili dogs give me indigestion.

In Exercises 33–42, fill in the blank with what is most likely to be the next number. Explain (using complete sentences) the pattern generated by your answer.

- 33.** 3, 8, 13, 18, _____
34. 10, 11, 13, 16, _____
35. 0, 2, 6, 12, _____
36. 1, 2, 5, 10, _____
37. 1, 4, 9, 16, _____
38. 1, 8, 27, 64, _____
39. 2, 3, 5, 7, 11, _____
40. 1, 1, 2, 3, 5, _____
41. 5, 8, 11, 2, _____
42. 12, 5, 10, 3, _____

In Exercises 43–46, fill in the blanks with what are most likely to be the next letters. Explain (using complete sentences) the pattern generated by your answers.

- 43.** O, T, T, F, _____, _____
44. T, F, S, E, _____, _____
45. F, S, S, M, _____, _____
46. J, F, M, A, _____, _____

In Exercises 47–58, explain the general rule or pattern used to assign the given letter to the given word. Fill in the blank with the letter that fits the pattern.

- 47.**

circle	square	trapezoid	octagon	rectangle
c	s	t	o	_____

48.

circle	square	trapezoid	octagon	rectangle
i	u	a	o	_____

49.

circle	square	trapezoid	octagon	rectangle
j	v	b	p	_____

50.

circle	square	trapezoid	octagon	rectangle
c	r	p	g	_____

51.

banana	strawberry	asparagus	eggplant	orange
b	z	t	u	_____

52.

banana	strawberry	asparagus	eggplant	orange
y	r	g	p	_____

- 53.** Find two different numbers that could be used to fill in the blank.

$$1, 4, 7, 10, \underline{\hspace{1cm}}$$

Explain the pattern generated by each of your answers.

- 54.** Find five different numbers that could be used to fill in the blank.

$$7, 14, 21, 28, \underline{\hspace{1cm}}$$

Explain the pattern generated by each of your answers.

- 55.** Example 1 utilized the Quadratic Formula. Verify that

$$x = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

is a solution of the equation $ax^2 + bx + c = 0$.

HINT: Substitute the fraction for x in $ax^2 + bx + c$ and simplify.

Therefore, the statement “Obeying the law is sufficient for not being arrested” can be rephrased as follows:

“**If** a person obeys the law, **then** the person is ***not*** arrested.”

Statement p
is the antecedent.

The negation of statement q
is the consequent.

The given compound statement can be expressed as $p \rightarrow \sim q$.

We have seen that a statement is a sentence that is either true or false and that connecting two or more statements forms a compound statement. Figure 1.32 summarizes the logical connectives and symbols that were introduced in this section. The various connectives have been defined; we can now proceed in our analysis of the conditions under which a compound statement is true. This analysis is carried out in the next section.

Statement	Symbol	Read as ...
negation	$\sim p$	not p
conjunction	$p \wedge q$	p and q
disjunction	$p \vee q$	p or q
conditional (implication)	$p \rightarrow q$	if p , then q all p are q p is sufficient for q q is necessary for p

Figure 1.32 Logical connectives.

1.2 EXERCISES

- Which of the following are statements? Why or why not?
 - George Washington was the first president of the United States.
 - Abraham Lincoln was the second president of the United States.
 - Who was the first vice president of the United States?
 - Abraham Lincoln was the best president.
- Which of the following are statements? Why or why not?
 - $3 + 5 = 6$
 - Solve the equation $2x + 5 = 3$.
 - $x^2 + 1 = 0$ has no solution.
 - $x^2 - 1 = (x + 1)(x - 1)$
 - Is $\sqrt{2}$ a rational number?
- Determine which pairs of statements are negations of each other.
 - All of the fruits are red.
 - None of the fruits is red.
 - Some of the fruits are red.
 - Some of the fruits are not red.
- Determine which pairs of statements are negations of each other.
 - Some of the beverages contain caffeine.
 - Some of the beverages do not contain caffeine.
 - None of the beverages contain caffeine.
 - All of the beverages contain caffeine.
- Write a sentence that represents the negation of each statement.
 - Her dress is not red.
 - Some computers are priced under \$100.
 - All dogs are four-legged animals.
 - No sleeping bag is waterproof.
- Write a sentence that represents the negation of each statement.
 - She is not a vegetarian.
 - Some elephants are pink.

- c. All candy promotes tooth decay.
d. No lunch is free.
7. Using the symbolic representations
p: The lyrics are controversial.
q: The performance is banned.
express the following compound statements in symbolic form.
- The lyrics are controversial, and the performance is banned.
 - If the lyrics are not controversial, the performance is not banned.
 - It is not the case that the lyrics are controversial or the performance is banned.
 - The lyrics are controversial, and the performance is not banned.
 - Having controversial lyrics is sufficient for banning a performance.
 - Noncontroversial lyrics are necessary for not banning a performance.
8. Using the symbolic representations
p: The food is spicy.
q: The food is aromatic.
express the following compound statements in symbolic form.
- The food is aromatic and spicy.
 - If the food isn't spicy, it isn't aromatic.
 - The food is spicy, and it isn't aromatic.
 - The food isn't spicy or aromatic.
 - Being nonaromatic is sufficient for food to be nonspicy.
 - Being spicy is necessary for food to be aromatic.
9. Using the symbolic representations
p: A person plays the guitar.
q: A person rides a motorcycle.
r: A person wears a leather jacket.
express the following compound statements in symbolic form.
- If a person plays the guitar or rides a motorcycle, then the person wears a leather jacket.
 - A person plays the guitar, rides a motorcycle, and wears a leather jacket.
 - A person wears a leather jacket and doesn't play the guitar or ride a motorcycle.
 - All motorcycle riders wear leather jackets.
 - Not wearing a leather jacket is sufficient for not playing the guitar or riding a motorcycle.
 - Riding a motorcycle or playing the guitar is necessary for wearing a leather jacket.
10. Using the symbolic representations
p: The car costs \$70,000.
q: The car goes 140 mph.

- r*: The car is red.
express the following compound statements in symbolic form.
- All red cars go 140 mph.
 - The car is red, goes 140 mph, and does not cost \$70,000.
 - If the car does not cost \$70,000, it does not go 140 mph.
 - The car is red and it does not go 140 mph or cost \$70,000.
 - Being able to go 140 mph is sufficient for a car to cost \$70,000 or be red.
 - Not being red is necessary for a car to cost \$70,000 and not go 140 mph.
- In Exercises 11–34, translate the sentence into symbolic form. Be sure to define each letter you use. (More than one answer is possible.)*
- All squares are rectangles.
 - All people born in the United States are American citizens.
 - No square is a triangle.
 - No convicted felon is eligible to vote.
 - All whole numbers are even or odd.
 - All muscle cars from the Sixties are polluters.
 - No whole number is greater than 3 and less than 4.
 - No electric-powered car is a polluter.
 - Being an orthodontist is sufficient for being a dentist.
 - Being an author is sufficient for being literate.
 - Knowing Morse code is necessary for operating a telegraph.
 - Knowing CPR is necessary for being a paramedic.
 - Being a monkey is sufficient for not being an ape.
 - Being a chimpanzee is sufficient for not being a monkey.
 - Not being a monkey is necessary for being an ape.
 - Not being a chimpanzee is necessary for being a monkey.
 - I do not sleep soundly if I drink coffee or eat chocolate.
 - I sleep soundly if I do not drink coffee or eat chocolate.
 - Your check is not accepted if you do not have a driver's license or a credit card.
 - Your check is accepted if you have a driver's license or a credit card.
 - If you drink and drive, you are fined or you go to jail.
 - If you are rich and famous, you have many friends and enemies.
 - You get a refund or a store credit if the product is defective.

34. The streets are slippery if it is raining or snowing.
35. Using the symbolic representations
 p : I am an environmentalist.
 q : I recycle my aluminum cans.
 express the following in words.
 a. $p \wedge q$ b. $p \rightarrow q$
 c. $\sim q \rightarrow \sim p$ d. $q \vee \sim p$
36. Using the symbolic representations
 p : I am innocent.
 q : I have an alibi.
 express the following in words.
 a. $p \wedge q$ b. $p \rightarrow q$
 c. $\sim q \rightarrow \sim p$ d. $q \vee \sim p$
37. Using the symbolic representations
 p : I am an environmentalist.
 q : I recycle my aluminum cans.
 r : I recycle my newspapers.
 express the following in words.
 a. $(q \vee r) \rightarrow p$ b. $\sim p \rightarrow \sim(q \vee r)$
 c. $(q \wedge r) \vee \sim p$ d. $(r \wedge \sim q) \rightarrow \sim p$
38. Using the symbolic representations
 p : I am innocent.
 q : I have an alibi.
 r : I go to jail.
 express the following in words.
 a. $(p \vee q) \rightarrow \sim r$ b. $(p \wedge \sim q) \rightarrow r$
 c. $(\sim p \wedge q) \vee r$ d. $(p \wedge r) \rightarrow \sim q$
39. Which statement, #1 or #2, is more appropriate? Explain why.
 Statement #1: “Cold weather is necessary for it to snow.”
 Statement #2: “Cold weather is sufficient for it to snow.”
40. Which statement, #1 or #2, is more appropriate? Explain why.
 Statement #1: “Being cloudy is necessary for it to rain.”
 Statement #2: “Being cloudy is sufficient for it to rain.”
41. Which statement, #1 or #2, is more appropriate? Explain why.
 Statement #1: “Having 31 days in a month is necessary for it not to be February.”
 Statement #2: “Having 31 days in a month is sufficient for it not to be February.”
42. Which statement, #1 or #2, is more appropriate? Explain why.
 Statement #1: “Being the Fourth of July is necessary for the U.S. Post Office to be closed.”
 Statement #2: “Being the Fourth of July is sufficient for the U.S. Post Office to be closed.”



Answer the following questions using complete sentences and your own words.

■ CONCEPT QUESTIONS

43. What is a negation? Include an example.
44. What is a conjunction? Include an example.
45. What is a disjunction? Include an example.
46. What is a conditional? Include an example.
47. What is an antecedent? Include an example.
48. What is a consequent? Include an example.
49. What is a sufficient condition? Include an example.
50. What is a necessary condition? Include an example.
51. What is the difference between the *inclusive or* and the *exclusive or*? Include an example.
52. What is the negation of a universal affirmative statement? Include an example.
53. What is the negation of a particular affirmative statement? Include an example.
54. Create a sentence that is a self-contradiction, or paradox, as in part (e) of Example 1.



Answer the following questions using complete sentences and your own words.

■ HISTORY QUESTIONS

55. In what academic field did Gottfried Leibniz receive his degrees? Why is the study of logic important in this field?
56. Who developed a formal system of logic based on syllogistic arguments?
57. What is meant by *characteristica universalis*? Who proposed this theory?

■ THE NEXT LEVEL



The following questions are modeled after those found on standardized entrance exams.

Exercises 58–62 refer to the following: A culinary institute has a small restaurant in which the students prepare various dishes. The menu changes daily, and during a specific week, the following dishes are to be prepared: moussaka, pilaf, quiche, ratatouille, stroganoff, and teriyaki. During the week, the restaurant does not prepare any other kind of dish. The selection of dishes the restaurant offers is consistent with the following conditions:

- If the restaurant offers pilaf, then it does not offer ratatouille.
- If the restaurant does not offer stroganoff, then it offers pilaf.

1.3 EXERCISES

In Exercises 1–20, construct a truth table for the symbolic expressions.

1. $p \vee \sim q$
2. $p \wedge \sim q$
3. $p \vee \sim p$
4. $p \wedge \sim p$
5. $p \rightarrow \sim q$
6. $\sim p \rightarrow q$
7. $\sim q \rightarrow \sim p$
8. $\sim p \rightarrow \sim q$
9. $(p \vee q) \rightarrow \sim p$
10. $(p \wedge q) \rightarrow \sim q$
11. $(p \vee q) \rightarrow (p \wedge q)$
12. $(p \wedge q) \rightarrow (p \vee q)$
13. $p \wedge \sim(q \vee r)$
14. $p \vee \sim(q \vee r)$
15. $p \vee (\sim q \wedge r)$
16. $\sim p \vee \sim(q \wedge r)$
17. $(\sim r \vee p) \rightarrow (q \wedge p)$
18. $(q \wedge p) \rightarrow (\sim r \vee p)$
19. $(p \vee r) \rightarrow (q \wedge \sim r)$
20. $(p \wedge r) \rightarrow (q \vee \sim r)$

In Exercises 21–40, translate the compound statement into symbolic form and then construct the truth table for the expression.

21. If it is raining, then the streets are wet.
22. If the lyrics are not controversial, the performance is not banned.
23. The water supply is rationed if it does not rain.
24. The country is in trouble if he is elected.
25. All squares are rectangles.
26. All muscle cars from the Sixties are polluters.
27. No square is a triangle.
28. No electric-powered car is a polluter.
29. Being a monkey is sufficient for not being an ape.
30. Being a chimpanzee is sufficient for not being a monkey.
31. Not being a monkey is necessary for being an ape.
32. Not being a chimpanzee is necessary for being a monkey.
33. Your check is accepted if you have a driver's license or a credit card.
34. You get a refund or a store credit if the product is defective.
35. If leaded gasoline is used, the catalytic converter is damaged and the air is polluted.

36. If he does not go to jail, he is innocent or has an alibi.
37. I have a college degree and I do not have a job or own a house.
38. I surf the Internet and I make purchases and do not pay sales tax.
39. If Proposition A passes and Proposition B does not, jobs are lost or new taxes are imposed.
40. If Proposition A does not pass and the legislature raises taxes, the quality of education is lowered and unemployment rises.

In Exercises 41–50, construct a truth table to determine whether the statements in each pair are equivalent.

41. The streets are wet or it is not raining.
If it is raining, then the streets are wet.
42. The streets are wet or it is not raining.
If the streets are not wet, then it is not raining.
43. He has a high school diploma or he is unemployed.
If he does not have a high school diploma, then he is unemployed.
44. She is unemployed or she does not have a high school diploma.
If she is employed, then she does not have a high school diploma.
45. If handguns are outlawed, then outlaws have handguns.
If outlaws have handguns, then handguns are outlawed.
46. If interest rates continue to fall, then I can afford to buy a house.
If interest rates do not continue to fall, then I cannot afford to buy a house.
47. If the spotted owl is on the endangered species list, then lumber jobs are lost.
If lumber jobs are not lost, then the spotted owl is not on the endangered species list.
48. If I drink decaffeinated coffee, then I do not stay awake.
If I do stay awake, then I do not drink decaffeinated coffee.
49. The plaintiff is innocent or the insurance company does not settle out of court.
The insurance company settles out of court and the plaintiff is not innocent.
50. The plaintiff is not innocent and the insurance company settles out of court.
It is not the case that the plaintiff is innocent or the insurance company does not settle out of court.

In Exercises 51–54, construct truth tables to determine which pairs of statements are equivalent.

51. i. Knowing Morse code is sufficient for operating a telegraph.

- ii. Knowing Morse code is necessary for operating a telegraph.
 - iii. Not knowing Morse code is sufficient for not operating a telegraph.
 - iv. Not knowing Morse code is necessary for not operating a telegraph.
52. i. Knowing CPR is necessary for being a paramedic.
- ii. Knowing CPR is sufficient for being a paramedic.
 - iii. Not knowing CPR is necessary for not being a paramedic.
 - iv. Not knowing CPR is sufficient for not being a paramedic.
53. i. The water being cold is necessary for not going swimming.
- ii. The water not being cold is necessary for going swimming.
 - iii. The water being cold is sufficient for not going swimming.
 - iv. The water not being cold is sufficient for going swimming.
54. i. The sky not being clear is sufficient for it to be raining.
- ii. The sky being clear is sufficient for it not to be raining.
 - iii. The sky not being clear is necessary for it to be raining.
 - iv. The sky being clear is necessary for it not to be raining.
55. Using truth tables, verify De Morgan's Law
 $\sim(p \wedge q) \equiv \sim p \vee \sim q$
56. Using truth tables, verify De Morgan's Law
 $\sim(p \vee q) \equiv \sim p \wedge \sim q$

In Exercises 57–68, write the statement in symbolic form, construct the negation of the expression (in simplified symbolic form), and express the negation in words.

57. I have a college degree and I am not employed.
 58. It is snowing and classes are canceled.

- 59. The television set is broken or there is a power outage.
- 60. The freeway is under construction or I do not ride the bus.
- 61. If the building contains asbestos, the original contractor is responsible.
- 62. If the legislation is approved, the public is uninformed.
- 63. The First Amendment has been violated if the lyrics are censored.
- 64. Your driver's license is taken away if you do not obey the laws.
- 65. Rainy weather is sufficient for not washing my car.
- 66. Drinking caffeinated coffee is sufficient for not sleeping.
- 67. Not talking is necessary for listening.
- 68. Not eating dessert is necessary for being on a diet.



Answer the following questions using complete sentences and your own words.

CONCEPT QUESTIONS

- 69. a. Under what conditions is a disjunction true?
 b. Under what conditions is a disjunction false?
- 70. a. Under what conditions is a conjunction true?
 b. Under what conditions is a conjunction false?
- 71. a. Under what conditions is a conditional true?
 b. Under what conditions is a conditional false?
- 72. a. Under what conditions is a negation true?
 b. Under what conditions is a negation false?
- 73. What are equivalent expressions?
- 74. What is a truth table?
- 75. When constructing a truth table, how do you determine how many rows to create?



Answer the following questions using complete sentences and your own words.

HISTORY QUESTIONS

- 76. Who is considered "the father of symbolic logic"?
- 77. Boolean algebra is a combination of logic and mathematics. What is it used for?

1.4

MORE ON CONDITIONALS

OBJECTIVES

- Create the converse, inverse, and contrapositive of a conditional statement
- Determine equivalent variations of a conditional statement
- Interpret "only if" statements
- Interpret a biconditional statement