1. a conditional statement and its contrapositive, as well as the converse and inverse of a conditional statement

2. If you are an athlete, then you play soccer; This statement is false, but the other 3 are true.

3. If a polygon is a pentagon, then it has five sides.

4. If two lines form vertical angles, then they intersect.

5. If you run, then you are fast.

6. If you like math, then you like science.

7. If $x = 2$, then $9x + 5 = 23$.

8. If today is Friday, then tomorrow is the weekend.

9. If you are in a band, then you play the drums.

10. If two angles are right angles, then they are supplementary.

11. If you are registered, then you are allowed to vote.

12. If two angles are complementary, then their measures sum to 90°.

13. The sky is not blue.

14. The lake is not cold.

15. The ball is pink.

16. The dog is a Lab.

17. conditional: If two angles are supplementary, then the measures of the angles sum to 180°; true

converse: If the measures of two angles sum to 180°, then they are supplementary; true

inverse: If the two angles are not supplementary, then their measures do not sum to 180°; true

contrapositive: If the measures of two angles do not sum to 180°, then they are not supplementary; true

18. conditional: If you are in math class, then you are in Geometry; false

converse: If you are in Geometry, then you are in math class; true

inverse: If you are not in math class, then you are not in Geometry; true

contrapositive: If you are not in Geometry, then you are not in math class; false

19. conditional: If you do your math homework, then you will do well on the test; false

converse: If you do well on the test, then you did your math homework; false

inverse: If you do not do your math homework, then you will not do well on the test; false

contrapositive: If you do not do well on the test, then you did not do your math homework; false

20. conditional: If you are not an only child, then you have a sibling; true

converse: If you have a sibling, then you are not an only child; true

inverse: If you are an only child, then you do not have a sibling; true

contrapositive: If you do not have a sibling, then you are an only child; true

21. conditional: If it does not snow, then I will run outside; false

converse: If I run outside, then it is not snowing; true

inverse: If it snows, then I will not run outside; true

contrapositive: If I do not run outside, then it is snowing; false

22. conditional: If the Sun is out, then it is daytime; true
converse: If it is daytime, then the Sun is out; false
inverse: If the Sun is not out, then it is not daytime; false
contrapositive: If it is not daytime, then the Sun is not out; true

23. conditional: If $3x - 7 = 20$, then $x = 9$; true
converse: If $x = 9$, then $3x - 7 = 20$; true
inverse: If $3x - 7 \neq 20$, then $x \neq 9$; true
contrapositive: If $x \neq 9$, then $3x - 7 \neq 20$; true

24. conditional: If it is Valentine's Day, then it is February; true
converse: If it is February, then it is Valentine's Day; false
inverse: If it is not Valentine's Day, then it is not February; false
contrapositive: If it is not February, then it is not Valentine's Day; true

25. true; By definition of right angle, the measure of the right angle shown is 90°.

26. true; If intersecting lines form a right angle, then they are perpendicular.

27. true; If angles form a linear pair, then the sum of the measures of their angles is 180°.

28. false; The midpoint cannot be assumed unless $\overline{AM}$ and $\overline{MB}$ are marked as congruent.

29. A point is the midpoint of a segment if and only if it is the point that divides the segment into two congruent segments.

30. Two angles are vertical angles if and only if their sides form two pairs of opposite rays.

31. Two angles are adjacent angles if and only if they share a common vertex and side, but have no common interior points.

32. Two angles are supplementary angles if and only if the sum of their measures is 180°.

33. A polygon has three sides if and only if it is a triangle.

34. A polygon is a quadrilateral if and only if it has four sides.

35. An angle is a right angle if and only if it measures 90°.

36. An angle has a measure between 90° and 180° if and only if it is obtuse.

37. Taking four English courses is a requirement regardless of how many courses the student takes total, and the courses do not have to be taken simultaneously; If students are in high school, then they will take four English courses before they graduate.

38. The inverse was used instead of the converse; If I bring an umbrella, then it is raining.

39.

p	q	$\sim p$	$\sim p \rightarrow q$
T	T	F	T
T	F	F	T
F	T	T	T
F	F	T	F

40.

p	q	$\sim q$	$\sim q \rightarrow p$
T	T	F	T
T	F	T	T
F	T	F	T
F	F	T	F

41.

p	q	$\sim p$	$\sim q$	$\sim p \rightarrow \sim q$	$\sim(\sim p \rightarrow \sim q)$
T	T	F	F	T	F
T	F	F	T	T	F
F	T	T	F	F	T
F	F	T	T	T	F

42.

p	q	$\sim q$	$p \rightarrow \sim q$	$\sim(p \rightarrow \sim q)$
T	T	F	F	T
T	F	T	T	F
F	T	F	T	F
F	F	T	T	F

43.

p	q	$\sim p$	$q \rightarrow \sim p$
T	T	F	F
T	F	F	T
F	T	T	T
F	F	T	T

44.

p	q	$q \rightarrow p$	$\sim(q \rightarrow p)$
T	T	T	F
T	F	T	F
F	T	F	T
F	F	T	F

45. **a.** If a rock is igneous, then it is formed from the cooling of molten rock; If a rock is sedimentary, then it is formed from pieces of other rocks; If a rock is metamorphic, then it is formed by changing temperature, pressure, or chemistry.

b. If a rock is formed from the cooling of molten rock, then it is igneous; true; All rocks formed from cooling molten rock are called igneous.

If a rock is formed from pieces of other rocks, then it is sedimentary; true; All rocks formed from pieces of other rocks are called sedimentary.

If a rock is formed by changing temperature, pressure, or chemistry, then it is metamorphic; true; All rocks formed by changing temperature, pressure, or chemistry are called metamorphic.

c. *Sample answer:* If a rock is not sedimentary, then it was not formed from pieces of other rocks; This is the inverse of one of the conditional statements in part (a). So, the converse of this statement will be the contrapositive of the conditional statement. Because the contrapositive is equivalent to the conditional statement and the conditional statement was true, the contrapositive will also be true.

46. your sister; It is possible to go to the mall without buying a shirt. So, the converse is not true.

47. no; The contrapositive is equivalent to the original conditional statement. In order to write a conditional statement as a true biconditional statement, you must know that the converse (or inverse) is true.

48. inverse; $p \rightarrow q$; $\sim p \rightarrow \sim q$

49. If you tell the truth, then you don't have to remember anything.

50. If you expect things of yourself, then you can do them.

51. If one is lucky, then a solitary fantasy can totally transform one million realities.

52. If you are happy, then you will make others happy too.

53. no; "If $x^2 - 10 = x + 2$, then $x = 4$" is a false statement because $x = -3$ is also possible. The converse, however, of the original conditional statement is true. In order for a biconditional statement to be true, both the conditional statement and its converse must be true.

54. **a.** *Sample answer:* If a natural arch is the largest in the United States, then it is the Landscape Arch. If a natural arch is the Landscape Arch, then it spans 290 feet.

b. contrapositive: If a natural arch is not the Landscape Arch, then it is not the largest in the United States. If a natural arch does not span 290 feet, then it is not the Landscape Arch.

c. converse: If a natural arch is the Landscape Arch, then it is the largest in the United States. inverse: If a natural arch is not the largest in the United States, then it is not the Landscape Arch; Both of these statements are true because there is only one arch that fits both criteria.

converse: If a natural arch spans 290 feet, then it is the Landscape Arch. inverse: If a natural arch is not the Landscape Arch, then it does not span 290 feet; Both of these statements are false because it is possible for a natural arch in another country to span 290 feet.

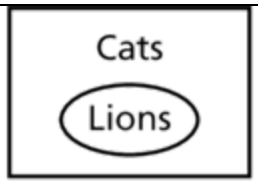
55. A

56. *Sample answer:* If today is Monday, then tomorrow is Tuesday; If the measure of an angle is 85°, then it is obtuse; If today is sunny, then I will go for a walk.

57. If today is February 28, then tomorrow is March 1.

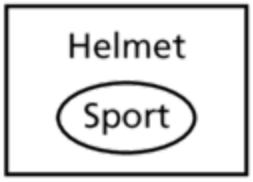
58. *Sample answer:* If a student is in the jazz band, then he or she is in the band. If a student is in chorus, then he or she is not in the band. If a student is in chorus, then he or she is a musician.

59. a.



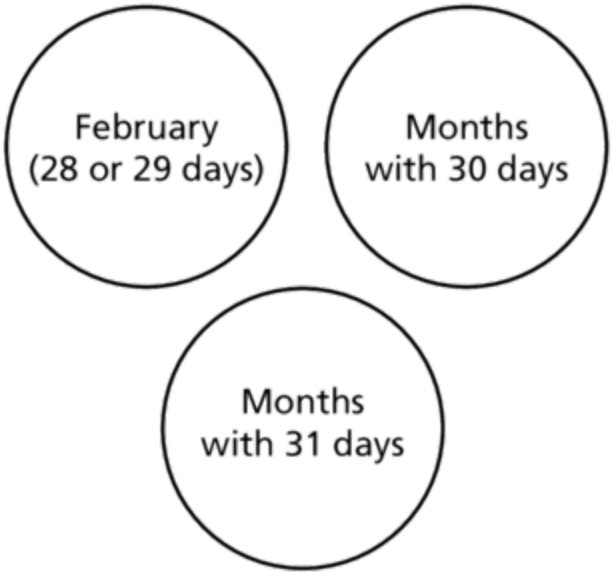
If you see a cat, then you went to the zoo to see a lion; The original statement is true, because a lion is a type of cat, but the converse is false, because you could see a cat without going to the zoo.

b.



If you wear a helmet, then you play a sport; Both the original statement and the converse are false, because not all sports require helmets and sometimes helmets are worn for activities that are not considered a sport, such as construction work.

c.



If this month is not February, then it has 31 days; The original statement is true, because February never has 31 days, but the converse is false, because a month that is not February could have 30 days.

60. **a.** true (as long as $x \neq y$)

b. If the mean of the data is between x and y, then x and y are the least and greatest values in your data set. This converse is false, because x and y could be any two values in the set as long as one is higher and one is lower than the mean.

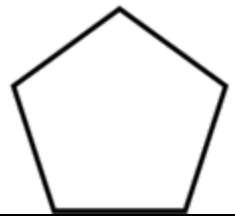
c. mode; The mean is always a calculated value that is not necessarily equal to any of the data values, and the median is a calculated value when there are an even number of data values. The mode is the data value with the greatest frequency, so it is always a data value.

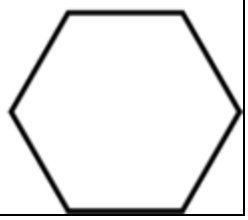
61. *Sample answer:* If they are vegetarians, then they do not eat hamburgers.

62. By definition of a linear pair, $\angle 1$ and $\angle 2$ are supplementary. So, if $m\angle 1 = 90°$, then $m\angle 2 = 90°$. Also, by definition of a linear pair, $\angle 2$ and $\angle 3$ are supplementary. So, if $m\angle 2 = 90°$, then $m\angle 3 = 90°$. Finally, by definition of a linear pair, $\angle 3$ and $\angle 4$ are supplementary. So, if $m\angle 3 = 90°$, then $m\angle 4 = 90°$.

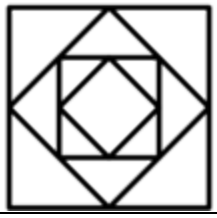
63. *Sample answer:* slogan: "This treadmill is a fat-burning machine!" conditional statement: If you use this treadmill, then you will burn fat quickly.

64. add a side;





65. add a square that connects the midpoints of the previously added square;



66. add 2; 9, 11

67. add 11; 56, 67

68. multiply by $\frac{2}{3}$; $\frac{32}{81}$, $\frac{64}{243}$

69. 1^2, 2^2, 3^2, . . .; 25, 36