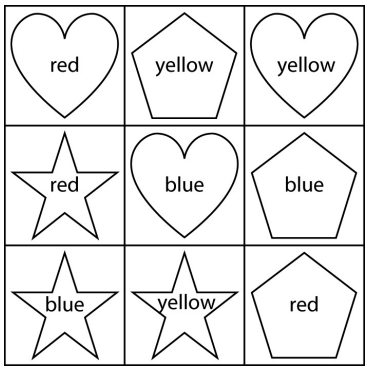
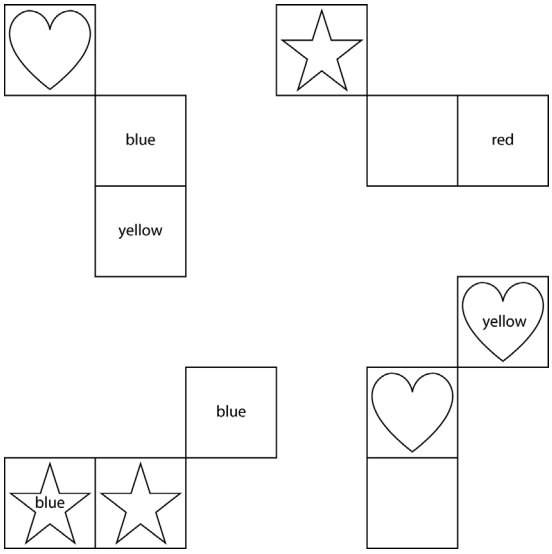
D. The solution is:



My clues are:



F. To make the puzzle easier, I could give more clues where both the colour and shape are given. Or, I could give the shapes in a diagonal, or a group of colours or shapes that would show one square in every row and column.
To make the puzzle harder, I could not give any clues with both the colour and the shape, or I could make the pieces smaller or without angles so there are more possibilities for their location in the 3 by 3 grid.

Lesson 3.6: The Inverse and the Contrapositive of Conditional Statements, page 214

1. a) Converse: If you are looking in a dictionary, then you will find *success* before *work*.
Inverse: If you do not find *success* before *work*, then you are not looking in a dictionary.
Contrapositive: If you are not looking in a dictionary, then you will not find *success* before *work*.
b) Converse: If you can drive, then you are over 16.
Inverse: If you are not over 16, then you cannot drive.
Contrapositive: If you cannot drive, then you are not over 16.
c) Converse: If the diagonals of a quadrilateral are perpendicular, then it is a square.
Inverse: If a quadrilateral is not a square, then its diagonals are not perpendicular.
Contrapositive: If the diagonals of a quadrilateral are not perpendicular, then it is not a square.
d) Converse: If $2n$ is an even number, then n is a natural number.
Inverse: If n is not a natural number, then $2n$ is not an even number.
Contrapositive: If $2n$ is not an even number, then n is not a natural number.
2. a) Converse: If an animal is a giraffe, then it has a long neck.
Contrapositive: If an animal is not a giraffe, then it does not have a long neck.
b) No. e.g., Ostriches and llamas have long necks, so the contrapositive is not true.

3. a) Converse: If a polygon is a pentagon, then it has five sides.
Inverse: If a polygon does not have five sides, then it is not a pentagon.
b) Since pentagons are the only shapes with 5 sides, both of these statements are true. They are logically equivalent.

4. a) I do not agree with Jeb. If $x^2 = 25$, then $x = 5$ or $x = -5$.
b) Converse: If $x = 5$, then $x^2 = 25$. This statement it true.
c) Inverse: If $x^2 \neq 25$, then $x \neq 5$. This statement is true.
d) Contrapositive: If $x \neq 5$, then $x^2 \neq 25$. This statement is not true, because x could equal -5, and x^2 would still equal 25.

5. a) i) The statement is true.
ii) Converse: If you are in Northwest Territories, then you are in Hay River.
The converse is false. You could be in another city or town in Northwest Territories, for example, Yellowknife.
iii) Inverse: If you are not in Hay River, then you are not in the Northwest Territories.
The inverse is false. You could be in Norman Wells, Northwest Territories for example.
iv) Contrapositive: If you are not in the Northwest Territories, then you are not in Hay River.
The contrapositive is true.
b) i) The statement is true. A puppy is either male or female.
ii) Converse: If a puppy is not female, then it is male.
The converse is true.
iii) Inverse: If a puppy is not male, then it is female.
The inverse is true.
iv) Contrapositive: If a puppy is female, then it is not male.
The contrapositive is true.
c) i) The statement is true.
ii) Converse: If the Edmonton Eskimos are number 1 in the west, then they won every game this season.

The converse is false. To be number 1, they must win more games than the other western teams, but they do not have to win them all.
iii) Inverse: If the Edmonton Eskimos did not win every game this season, then they are not number 1 in the west.
The inverse is false. They may have won more games than the other western teams and would still be number 1.
iv) Contrapositive: If the Edmonton Eskimos are not number 1 in the west, then they did not win every game this season.
The contrapositive is true.
d) i) The statement is false. The integer could be 0. Zero is neither negative nor positive.
ii) Converse: If an integer is positive, then it is not negative.
The converse is true.
iii) Inverse: If an integer is negative, then it is not positive.
The inverse is true.
iv) Contrapositive: If an integer is not positive, then it is negative.
The contrapositive is false. The integer could be 0.

6.

	a)	**b)**	**c)**	**d)**
Conditional Statement	T	T	T	F
Inverse	F	T	F	T
Converse	F	T	F	T
Contrapositive	T	T	T	F

7. a) If the statement is true, the contrapositive is also true. If the statement is false, the contrapositive is also false.
b) If the inverse is true, the converse is also true. If the inverse is false, the converse is also false.
The pairs of statements are logically equivalent.

8. a) No, I cannot draw a conclusion about the conditional statement and its converse. There is no relationship between the two statements.
b) No, I cannot draw a conclusion about the inverse and the contrapositive. There is no relationship between the two statements.

9. a) Converse: If a polygon is a quadrilateral, then it is a square.
Inverse: If a polygon is not a square, then the polygon is not a quadrilateral.
Contrapositive: If a polygon is not a quadrilateral, then it is not a square.
b) The conditional statement is true. Every square is a quadrilateral by definition.
The converse is false. A counterexample is a parallelogram, which is not a square, but is a quadrilateral.
The inverse is false. A counterexample is a rectangle, which is a quadrilateral, but is not a square. The polygon could be a rectangle, which is not a square, but is a quadrilateral.
The contrapositive is true. If a polygon is not a quadrilateral, then it cannot be a square.

10. a) Converse: If a line has a y-intercept of 2, then the equation of this line is $y = 5x + 2$.
Inverse: If the equation of a line is not $y = 5x + 2$, then its y-intercept is not 2.
Contrapositive: If a line does not have a y-intercept of 2, then the equation of this line is not $y = 5x + 2$
b) The original statement is true, because the y-intercept of that line is 2.
The converse is not true. If a line has a y-intercept of 2, its equation could be $y = 2$, or infinitely other equations.
The inverse is also not true. A line could not have that equation, and still have a y-intercept of 2. For example, the equation $y = x + 2$ has a y-intercept of 2.
The contrapositive is true, because if a line does not have a y-intercept of 2, it cannot have that equation.

11. e.g., If a conditional statement, its inverse, its converse and its contrapositive are all true, I know the conditional statement is biconditional.

12. a) i) e.g., The statement is true. Pins can burst balloons.
ii) Converse: If a pin can burst the Moon, then the Moon is a balloon.
The converse is false. e.g., The Moon could be a soap bubble, for example.
iii) Inverse: If the Moon is not a balloon, then a pin cannot burst the Moon.
The inverse is false. e.g., Again, the Moon could be a soap bubble.
iv) Contrapositive: If a pin cannot burst the Moon, then the Moon is not a balloon. e.g., The contrapositive is true.
b) i) The statement is true. The negative of a negative number is a positive number.
ii) Converse: If $-x$ is a positive number, then x is a negative number.
The converse is true. The negative of a positive number is a negative number.
iii) Inverse: If x is not a negative number, then $-x$ is a not positive number. The inverse is true.
iv) Contrapositive: If $-x$ is not a positive number, then x is not a negative number. The contrapositive is true.
c) i) The statement is true.
ii) Converse: If a number is positive, then it is a perfect square. The converse is false. 3 is a positive number, but it is not a perfect square.
iii) Inverse: If a number is not a perfect square, then it is not positive. The inverse is false. 3 is not a perfect square, but it is positive.
iv) Contrapositive: If a number is not positive, then it is not a perfect square.
The contrapositive is true. Negative numbers cannot be perfect squares.

d) i) The statement is true.
ii) Converse: If a number can be expressed as a fraction, then it can be expressed as a terminating decimal.
The converse is false. For example, $\frac{1}{3}$, written as a decimal, is 0.333… This is a repeating decimal.
iii) Inverse: If a number cannot be expressed as a terminating decimal then it cannot be expressed as a fraction.
The inverse is false. For example, 0.333… is a repeating decimal. It is also $\frac{1}{3}$.
iv) Contrapositive: If a number cannot be expressed as a fraction, then it cannot be expressed as a terminating decimal. The contrapositive is true.
e) i) This statement is true
ii) Converse: If a graph is a parabola, then the equation of this parabola is $f(x) = 5x^2 + 10x + 3$.
This statement is false, because there are many parabolas that do not have that equation, such as $f(x) = x^2$.
iii) Inverse: If the equation of a function is not $f(x) = 5x^2 + 10x + 3$, then its graph is not a parabola.
This statement is false. For example, a function can have the equation $f(x) = x^2$, yet it is a parabola.
iv) Contrapositive: If a graph is not a parabola, then the equation of this parabola is not $f(x) = 5x^2 + 10x + 3$.
This statement is true, because only a parabola can have that equation.
f) i) This statement is false. For example, –1 is an integer, but not a whole number.
ii) Converse: If a number is a whole number, than it is an integer.
This statement is true,
iii) Inverse: If a number is not an integer, than it is not a whole number.
This statement is true.
iv) Contrapositive: If a number is not a whole number, than it is not an integer.
This statement is false, for example –1 is not a whole number, but it is an integer.

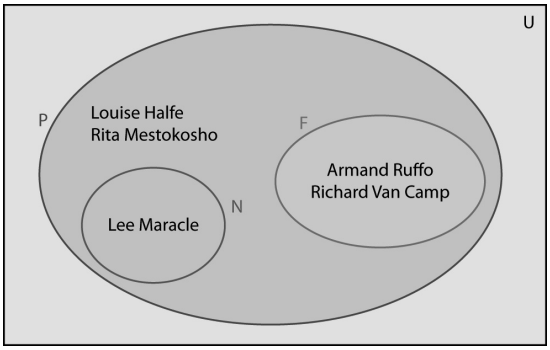
13. a) e.g., The contrapositive assumes as its hypothesis that the original conclusion is false, which means that the original hypothesis must also not be true. If the original hypothesis is not true, then the conditional statement must be false.
b) e.g., The converse of a conditional statement is formed by stating the conclusion before the hypothesis. The inverse is formed by negating the hypothesis and conclusion of a conditional statement. Since negating both parts of the statement is the same as reversing them, the converse and inverse are logically equivalent. The inverse of a statement is the contrapositive of the statement's converse.

14. e.g., **a)** Conditional statement: If you are tall, then you like chocolate.
Contrapositive statement: If you do not like chocolate, then you are not tall.
Counterexample: I am tall and do not like chocolate. Both the conditional statement and the contrapositive are false.
b) Conditional statement: If a traffic light is green, it is not red. Contrapositive: If a traffic light is red, it is not green. Both the conditional statement and the contrapositive are true.

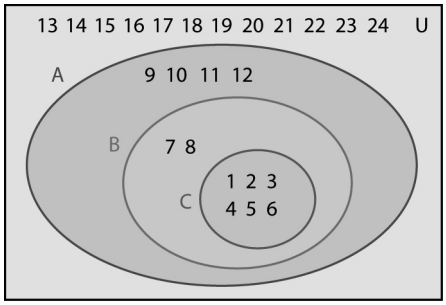
15. e.g., **a)** Conditional statement: If it is Saturday, then it is the weekend.
Inverse: If it is not Saturday, then it is not the weekend. The inverse is false. Counterexample: it could be Sunday and be the weekend.
Converse: If it is the weekend, then it is Saturday. The converse is false. Counterexample: it could be the weekend and be Sunday.
b) Conditional statement: If a polygon has six sides, then it is a hexagon.
Inverse: If a polygon does not have six sides, then it is not a hexagon. The inverse is true by definition.
Converse: If a polygon is a hexagon, then it has six sides. The converse is true by definition.

Chapter Self-Test, page 217

1. Let U represent the universal set of writers. Let P represent the set of poets. Let N represent the set of novelists, and let F represent the set of fiction writers.
Subset fiction writer, F = {Armand Ruffo, Richard Van Camp}



2. a)



Set C is inside set A, therefore $C \subset A$.
b) A = {1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12}
B = {1, 2, 3, 4, 5, 6, 7, 8}
$A \cup B$ = {1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12}