Inverse, Converse, and Contrapositive of Conditional Statements

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Name: _____ Date: _____ Score: / 10

Learning Objectives

- Write the negation of a given statement
- Identify the hypothesis and conclusion of a conditional statement
- Form the converse, inverse, and contrapositive of a conditional statement
- Identify logically equivalent statements and determine truth values

For each item, write the requested statement and determine whether it is true or false.

1. Write the negation of the statement: 'A square has four sides.'

p : A square has four sides.

Answer: _____

2. Identify the hypothesis and conclusion of the conditional statement: 'If two angles are vertical, then they are congruent.'

$p \rightarrow q$

Answer: _____

3. Write the converse of the conditional: 'If a polygon is a triangle, then it has three sides.'

$p \rightarrow q \Rightarrow q \rightarrow p$

Answer: _____

4. Write the inverse of the conditional: 'If an angle measures 90 degrees, then it is a right angle.'

$p \rightarrow q \Rightarrow \sim p \rightarrow \sim q$

Answer: _____

5. Write the contrapositive of the conditional: 'If two lines are parallel, then they do not intersect.'

$p \rightarrow q \Rightarrow \sim q \rightarrow \sim p$

Answer: _____

6. Determine whether the converse of the following true statement is true or false: 'If a figure is a square, then it is a rectangle.'

$q \rightarrow p$

Answer: _____

7. Identify which pair of statements is logically equivalent for any conditional statement.

(a) $p \rightarrow q$ and $q \rightarrow p$ (b) $p \rightarrow q$ and $\sim q \rightarrow \sim p$

Answer: _____

8. The converse and the inverse of a conditional are also logically equivalent. Write the converse and inverse of: 'If it is raining, then the ground is wet.'

$q \rightarrow p$ and $\sim p \rightarrow \sim q$

Answer: _____

9. Given the statement 'If an animal is a dog, then it is a mammal,' write all three related conditionals: converse, inverse, and contrapositive.

$p \rightarrow q$

Answer: _____

10. Determine the truth value of each related statement of: 'If two angles form a linear pair, then they are supplementary.' Classify the conditional, converse, inverse, and contrapositive as true or false.

$p \rightarrow q,\ q \rightarrow p,\ \sim p \rightarrow \sim q,\ \sim q \rightarrow \sim p$

Answer: _____

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ANSWER KEY & SOLUTIONS

This worksheet covers negation of statements, conditional (if-then) statements, identifying hypothesis and conclusion, forming the converse, inverse, and contrapositive, recognizing logically equivalent statements (conditional with contrapositive, converse with inverse), and applying these to geometric examples.

Solutions

1. Write the negation of the statement: 'A square has four sides.'

p : A square has four sides.

→ *Identify the original statement p.*
→ *Place 'not' or 'does not' to negate the verb of the statement.*
→ *The negation reverses the truth value of the original statement.*

Answer: $\sim p$: A square does not have four sides.

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2. Identify the hypothesis and conclusion of the conditional statement: 'If two angles are vertical, then they are congruent.'

$p \rightarrow q$

→ *In an if-then statement, the part following 'if' is the hypothesis.*
→ *The part following 'then' is the conclusion.*
→ *Therefore the hypothesis is 'two angles are vertical' and the conclusion is 'they are congruent.'*

Answer: Hypothesis: two angles are vertical; Conclusion: they are congruent

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3. Write the converse of the conditional: 'If a polygon is a triangle, then it has three sides.'

$p \rightarrow q \Rightarrow q \rightarrow p$

→ *The converse is formed by interchanging the hypothesis and conclusion.*
→ *Swap 'a polygon is a triangle' with 'it has three sides.'*
→ *Write the new conditional in if-then form.*

Answer: If a polygon has three sides, then it is a triangle.

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4. Write the inverse of the conditional: 'If an angle measures 90 degrees, then it is a right angle.'

$p \rightarrow q \Rightarrow \sim p \rightarrow \sim q$

→ *The inverse is formed by negating both the hypothesis and the conclusion.*
→ *Negate 'an angle measures 90 degrees' to 'an angle does not measure 90 degrees.'*
→ *Negate 'it is a right angle' to 'it is not a right angle.'*
→ *Combine into a new if-then statement.*

Answer: If an angle does not measure 90 degrees, then it is not a right angle.

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5. Write the contrapositive of the conditional: 'If two lines are parallel, then they do not intersect.'

$p \rightarrow q \Rightarrow \sim q \rightarrow \sim p$

→ *The contrapositive is formed by interchanging and negating both the hypothesis and conclusion.*
→ *Negate the conclusion 'they do not intersect' to 'they intersect' and place it first.*
→ *Negate the hypothesis 'two lines are parallel' to 'two lines are not parallel' and place it last.*

Answer: If two lines intersect, then they are not parallel.

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6. Determine whether the converse of the following true statement is true or false: 'If a figure is a square, then it is a rectangle.'

$q \to p$

→ *Form the converse by swapping the hypothesis and conclusion.*
→ *Test the converse: a rectangle does not have to have four equal sides.*
→ *Because there exists a counterexample, the converse is false.*

Answer: Converse: If a figure is a rectangle, then it is a square. (False)

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7. Identify which pair of statements is logically equivalent for any conditional statement.

(a) $p \to q$ and $q \to p$ (b) $p \to q$ and $\sim q \to \sim p$

→ *A conditional statement and its contrapositive always have the same truth value.*
→ *A conditional and its converse may have different truth values, so they are not equivalent.*
→ *Therefore option (b), the conditional and its contrapositive, are logically equivalent.*

Answer: (b) The conditional and its contrapositive are logically equivalent.

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8. The converse and the inverse of a conditional are also logically equivalent. Write the converse and inverse of: 'If it is raining, then the ground is wet.'

$q \to p$ and $\sim p \to \sim q$

→ *Form the converse by switching the hypothesis and conclusion.*
→ *Form the inverse by negating both the hypothesis and the conclusion.*
→ *Both statements share the same truth value, confirming the equivalence of converse and inverse.*

Answer: Converse: If the ground is wet, then it is raining. Inverse: If it is not raining, then the ground is not wet.

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9. Given the statement 'If an animal is a dog, then it is a mammal,' write all three related conditionals: converse, inverse, and contrapositive.

$p \to q$

→ *Form the converse by interchanging the hypothesis and conclusion.*
→ *Form the inverse by negating both the hypothesis and the conclusion.*
→ *Form the contrapositive by interchanging and negating both parts.*

Answer: Converse: If an animal is a mammal, then it is a dog. Inverse: If an animal is not a dog, then it is not a mammal. Contrapositive: If an animal is not a mammal, then it is not a dog.

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10. Determine the truth value of each related statement of: 'If two angles form a linear pair, then they are supplementary.' Classify the conditional, converse, inverse, and contrapositive as true or false.

$p \to q,\ q \to p,\ \sim p \to \sim q,\ \sim q \to \sim p$

→ *A linear pair always sums to 180 degrees, so the conditional is true.*
→ *Two supplementary angles do not have to form a linear pair, so the converse is false.*
→ *If two angles do not form a linear pair, they may still be supplementary, so the inverse is false.*
→ *Since the conditional and contrapositive are logically equivalent, the contrapositive is true.*

Answer: Conditional: True; Converse: False; Inverse: False; Contrapositive: True