No calculators are allowed. Please write clearly and carefully!

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1. Let \( p, q, r \) be the following propositions.

\[
p: \text{I am sick} \\
q: \text{I miss the exam} \\
r: \text{I pass the course}
\]

Express the following proposition an as English sentence.

\[
(p \land q) \lor (\neg q \land r)
\]

Answer: I am sick and miss the exam or I take the exam and pass the course.

Scratch Work:

2. State the converse and contrapositive of the following statement.

"If it snows tonight, I will have hot cocoa."

Converse: If I have hot cocoa, then it will snow tonight.

Contrapositive: If I don't have hot cocoa, then it doesn't snow tonight.
3. Use De Morgan’s laws to find the negation of the following statement.

“Jessica is young and strong.”

Answer: Jessica is old or weak

Scratch Work:

4. Use a truth table to verify that \( p \to q \) and \( \neg q \to \neg p \) are logically equivalent.

Answer:

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5. Let $S(x, y)$ be the statement “$x$ can sneak up on $y$,” where the domain $D$ consists of all living people. Express the following statement using quantifiers.

“There is no one who can sneak up on everybody.”

Answer: $\neg \exists x \forall y S(x, y)$

Scratch Work:

6. Translate the following statement into English and determine its truth value.

$\exists x \in \mathbb{Z} (x + 1 > 2x)$

Answer: There is an integer $x$ for which $x + 1 > 2x$. TRUE: $x = 0$ satisfies. $1 > 0$.

Scratch Work:
7. Let \( A = \{a, b, c\} \), \( B = \{m, n\} \), and \( C = \{0, 1\} \). Find \( C \times B \times A \).

Answer:
\[
\{(0, m, a), (0, n, a), (1, m, a), (1, n, a),
(0, m, b), (0, n, b), (1, m, b), (1, n, b),
(0, m, c), (0, n, c), (1, m, c), (1, n, c)\}
\]

8. Find the sets \( A \) and \( B \) if \( A - B = \{1, 4, 7, 9\} \), \( B - A = \{2, 8\} \), and \( A \cap B = \{3, 5, 6\} \).

Answer:
\[
A = \{1, 3, 4, 5, 6, 7, 9\}, \quad B = \{2, 3, 5, 6, 8\}
\]

Scratch Work:

9. Draw the Venn diagram for the following combination of the sets \( A \), \( B \), \( C \).

\[
A \cap (B \cup C)
\]

Answer:

[Diagram of Venn diagram with overlapping circles labeled A, B, C]