There are 8 problems worth a total of 40 points.

1. (4 points) Let $R$ stand for the statement "it is raining," $S$ stand for the statement "it is snowing," and $C$ stand for the statement "the game has been canceled." Express the following sentence as a logical formula.

If the game has been canceled, then either it is raining or it is snowing.

2. (6 points) Construct a truth table for the formula $(P \land \neg Q) \rightarrow R$.

3. (6 points) Use the laws of logic stated in the text to prove that the formulas $(P \lor \neg R) \land (Q \lor \neg R)$ and $\neg((\neg(P \land Q)) \land R)$ are equivalent.

Use one law at a time and state the name of the law you are using in each step.

4. (5 points) Find a formula which uses only the connectives $\land$, $\lor$ and $\neg$ which is equivalent to $P \rightarrow (Q \rightarrow R)$.

5. (4 points) Draw a Venn diagram for the sets $A$, $B$, and $C$, and shade in the region on diagram which corresponds to $(A \cup B) \setminus (C \setminus B)$.

6. (5 points) Let $P$, $Q$, $R$ represent the statements $x \in A$, $x \in B$, $x \in C$, respectively. Express the statement $x \in A \cap (B \setminus C)$ as a logical formula in terms of $P$, $Q$, $R$.

7. (5 points) Negate the following statement and then reexpress the result as a positive statement.

$$\exists x \forall y [y > x \rightarrow \exists z (z^2 + 5z = y)]$$

8. (5 points) Let $I$ be the index set $\{1, 2, 3\}$. For each $i \in I$, let

$$A_i = \{i, i + 1, i + 2, i + 5\}.$$

List the elements of the following sets:

\[ \bigcup_{i \in I} A_i \]
\[ \bigcap_{i \in I} A_i \]