1. Prove by induction that \( n! \geq 2^n \) for all natural numbers \( n \geq 4 \).
2. Prove that \((p \to (q \land \neg q)) \to \neg p\) is a tautology.
3. Negate the statement \((\exists y)[p(y) \land (\forall x)[\neg q(x) \to r(x)]]\). Simplify.
4. Prove that any interval in \( \mathbb{R} \) is a set. You may assume \( \mathbb{R} \) is a set.
   Hint: you may need to look at some cases.
5. Prove or disprove \((\forall A)[B \in \mathcal{P}(A)] \Rightarrow B = \emptyset\).
6. Prove or disprove \((A \cup C) \times (B \cup D) \subseteq (A \times B) \cup (C \times D)\).