1. Is the following a tautology? Justify your answer.
   $(\neg q \to \neg p) \to ((\neg q \to p) \to q)$

2. Show using truth table that the following equivalence holds.
   $(p \leftrightarrow q) \equiv (\neg p \leftrightarrow \neg q)$

3. Let α and β be two formulas in propositional logic. Is it true that $(\alpha \vee \beta)$ is a tautology iff one of them is a tautology?

4. Show using truth table that the following equivalence holds.
   $(p \to (q \to r)) \equiv ((p \wedge q) \to r)$

5. Find three formula α, β, and γ such that $(\alpha \wedge \beta \wedge \gamma)$ is unsatisfiable and such that the conjunction of any pair of them is satisfiable.

6. Prove that a disjunction of literals $l_1, l_2, \ldots, l_m$, i.e. $(l_1 \vee l_2 \ldots \vee l_m)$, is valid if and only if there are two literals l_i and l_j, $1 \leq i, j \leq m$, such that l_i is $\neg l_j$.

7. Is the following statement true? Justify your answer.
   If $\alpha \to \beta$ is a tautology and α is a tautology, then β is a tautology.

8. Consider the propositions $(p \to (q \to q))$ and $((p \to q) \to q)$. One of these is a tautology; one of them is not. Which is which? Prove your answer.

9. Either Lily attended the meeting or Lily was not invited. If the boss wanted Lily at the meeting, then she was invited. Lily did not attend the meeting. If the boss did not want Lily at the meeting, and she was not invited, then she is going to be fired. Argue that Lily is going to be fired.

10. Is the following statement true? Justify your answer.
    If $\alpha \to \beta$ is satisfiable and α is satisfiable, then β is satisfiable.