

1. Prove the following using a deductive proof. Justify each step. Show all substitutions used to derive appropriate instances of the rules.

a. $p \vee q \Rightarrow r, \neg q \Rightarrow \neg s, s \mid\text{-} q \wedge r$

b. $p \Rightarrow (q \Rightarrow r), r \Rightarrow s, p \wedge q \mid\text{-} s \vee u$

2. Prove the following using a deductive proof. Justify each step, but you need not show the substitution used to derive the appropriate instance of the laws. You may use commuted and generalized versions of the rules that involve \wedge and \vee .

$$p \wedge \neg q \wedge r, q \vee s \vee t, s \Rightarrow u, t \Rightarrow v \mid\text{-} v \vee u$$

3. Use conditional proof to prove the following.

$$p \wedge q \Rightarrow r \vee s, p \vee t, \neg t \wedge \neg s \mid\text{-} q \Rightarrow r$$

4. Use indirect proof to prove the following.

$$p \vee \neg q, r \Rightarrow p \vee q, r \mid\text{-} p$$