

Logical Equivalences

Given any statement variables p , q , and r , a tautology \mathbf{t} , and a contradiction \mathbf{c} , the following logical equivalences hold:

1. **Commutative laws:** $p \wedge q \equiv q \wedge p$ $p \vee q \equiv q \vee p$
2. **Associative laws:** $(p \wedge q) \wedge r \equiv p \wedge (q \wedge r)$ $(p \vee q) \vee r \equiv p \vee (q \vee r)$
3. **Distributive laws:** $p \wedge (q \vee r) \equiv (p \wedge q) \vee (p \wedge r)$ $p \vee (q \wedge r) \equiv (p \vee q) \wedge (p \vee r)$
4. **Identity laws:** $p \wedge \mathbf{t} \equiv p$ $p \vee \mathbf{c} \equiv p$
 $\mathbf{t} \wedge p \equiv p$ $\mathbf{c} \vee p \equiv p$
5. **Negation laws:** $p \vee \sim p \equiv \mathbf{t}$ $p \wedge \sim p \equiv \mathbf{c}$
 $\sim p \vee p \equiv \mathbf{t}$ $\sim p \wedge p \equiv \mathbf{c}$
6. **Double negative law:** $\sim(\sim p) \equiv p$
7. **Idempotent laws:** $p \wedge p \equiv p$ $p \vee p \equiv p$
8. **Universal bound laws:** $p \vee \mathbf{t} \equiv \mathbf{t}$ $p \wedge \mathbf{c} \equiv \mathbf{c}$
 $\mathbf{t} \vee p \equiv \mathbf{t}$ $\mathbf{c} \wedge p \equiv \mathbf{c}$
9. **De Morgan's laws:** $\sim(p \wedge q) \equiv \sim p \vee \sim q$ $\sim(p \vee q) \equiv \sim p \wedge \sim q$
10. **Absorption laws:** $p \vee (p \wedge q) \equiv p$ $p \wedge (p \vee q) \equiv p$
11. **Negations of \mathbf{t} and \mathbf{c} :** $\sim \mathbf{t} \equiv \mathbf{c}$ $\sim \mathbf{c} \equiv \mathbf{t}$