→ Logical Equivalence

- Two statements A and B are called logically equivalent if and only if $\boxed{A \leftrightarrow B}$ is a tautology.
- Logical equivalence can be denoted by $\Leftrightarrow$ or $\equiv$.
- The two statement A and B can also be concluded to be logically equivalent if both the compound propositions have the same truth table ie the truth value of both the propositions should be same for the same combination of inputs.

Eg:- Show that $(P \wedge T) \equiv P$.

$(P \wedge T)$	P
T	T
F	F

Q) Prove the following using truth table:

$$p \vee (q \wedge r) \equiv (p \vee q) \wedge (p \vee r)$$

→ Tautology:

A compound proposition that is always true for all possible truth values of its variables.

Eg:

p	$\sim p$	$p \vee \sim p$
T	F	T
F	T	T

→ Contradiction

A compound proposition that is always false for all possible values of its variables.

Eg :-

p	~p	p∧~p
T	F	F
F	T	F

→ Contingency

A proposition that is neither a tautology nor a contradiction.

p	q	p∨q
T	T	T
T	F	T
F	T	T
F	F	F

Q) Check whether $p \rightarrow (p \vee q)$ is a tautology or not?

→ Derived Implication

(a) Contrapositive : $\neg Q \rightarrow \neg P$

(b) Converse : $Q \rightarrow P$

(c) Inverse : $\neg P \rightarrow \neg Q$

These are some compound propositions related to $P \rightarrow Q$ where P and Q are any two propositions.