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2. Let $Q(x,y)$ denote the statement "x is the capital of y". What are these truth values?

  i. $Q($"Hangzhou", "Zhejiang"$)$

  ii. $Q($"Shenzhen", "Guangdong"$)$

  iii. $Q($"Qingdao", "Shandong"$)$

  iv. $Q($"Yinchuan", "Ningxia"$)$

A: i. iv. are truth values.

4. Use truth tables to verify these equivalences.

i) $p \wedge T \equiv p$

Truth table:

P	$p \wedge T$
T	T
F	F

ii) $p \vee F \equiv p$

Truth table:

P	$p \vee F$
T	T
F	F

iii) $p \wedge F \equiv F$

Truth table:

P	$p \wedge F$
T	F
F	F

iv) $p \vee T \equiv T$

Truth table:

P	$p \vee T$
T	T
F	T

v) $p \vee p \equiv p$

Truth table:

P	$p \vee p$
T	T
F	F

vi) $p \wedge p \equiv p$

Truth table:

P	$p \wedge p$
T	T
F	F

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6. Use truth tables to verify the commutative laws.

i) $p \land q \equiv q \land p$

Truth table:

P	q	$p \land q$	$q \land p$
T	T	T	T
T	F	F	F
F	T	F	F
F	F	F	F

ii) $p \lor q \equiv q \lor p$

Truth table:

P	q	$p \lor q$	$q \lor p$
T	T	T	T
T	F	T	T
F	T	T	T.
F	F	F	F

8. Use a truth table to verify the distributive law.

$$p \land (q \lor r) \equiv (p \land q) \lor (p \land r)$$

Truth table:

P	q	r	$q \lor r$	$p \land q$	$p \land r$	$p \land (q \lor r)$	$(p \land q) \lor (p \land r)$
T	T	T	T	T	T	T	T
T	T	F	T	T	F	T	T
T	T	F	T	T	T	T	T
T	F	F	F	F	F	F	F
F	T	T	T	F	F	F	F
F	T	F	T	F	F	F	F
F	F	T	T	F	F	F	F
F	F	F	F	F	F	F	F

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10. Show that each of these implications is a tautology by using truth tables.

i) $(p \wedge q) \to p$

Truth table:

P	q	$p \wedge q$	$(p \wedge q) \to p$
T	T	T	T
T	F	F	T
F	T	F	T
F	F	F	T

ii) $p \to (p \vee q)$

Truth table:

P	q	$(p \vee q)$	$p \to (p \vee q)$
T	T	T	T
T	F	T	T
F	T	T	T
F	F	F	T

iii) $\neg p \to (p \to q)$

Truth table:

P	q	$\neg p$	$p \to q$	$\neg p \to (p \to q)$
T	T	F	T	T
T	F	F	F	T
F	T	T	T	T
F	F	T	T	T

iv) $(p \wedge q) \to (p \to q)$

Truth table:

P	q	$p \wedge q$	$p \to q$	$(p \wedge q) \to (p \to q)$
T	T	T	T	T
T	F	F	F	T
F	T	F	T	T
F	F	F	T	T

v) $\neg(p \to q) \to p$

Truth table:

P	q	$p \to q$	$\neg(p \to q)$	$\neg(p \to q) \to p$
T	T	T	F	T
T	F	F	T	T
F	T	T	F	T
F	F	T	F	T

vi) $\neg(p \to q) \to \neg q$

Truth table:

P	q	$p \to q$	$\neg(p \to q)$	$\neg q$	$\neg(p \to q) \to \neg q$
T	T	T	F	F	T
T	F	F	T	T	T
F	T	T	F	F	T
F	F	T	F	T	T