Logic Gates and their Equivalents

in IB Studies

p	T	T	F	F		NOT	OR	NOR	XOR	XNOR	AND	NAND	XAND	XNAND	Implication	Contrapos.	Non impl.	Contrapos.
q	T	F	T	F		¬	v	↓	$\underline{\vee}$	$\underline{\downarrow}$	^	↑	$\underline{\wedge}$	$\underline{\uparrow}$	→			
0	T	T	T	T	tautology			¬(p ↓ ¬p)				¬p ↑ p						
1	T	T	T	F	OR		p v q	¬(p ↓ q)				¬p ↑ ¬q			¬p → q	¬q → p		
2	T	T	F	T	implication		p v ¬q	¬(p ↓ ¬q)				¬p ↑ q			¬p → ¬q	q → p		
3	T	T	F	F	p amplifier			¬p ↓ ¬p				¬(p ↑ p)						
4	T	F	T	T	implication		¬p v q	¬(¬p ↓ q)				p ↑ ¬q			p → q	¬q → ¬p		
5	T	F	T	F	q amplifier			¬q ↓ ¬q				¬(q ↑ q)						
6	T	F	F	T	XNOR[†]			#?	¬p $\underline{\vee}$ q	p $\underline{\downarrow}$ q		#?	p $\underline{\wedge}$ q	¬p $\underline{\uparrow}$ q				
7	T	F	F	F	AND			¬p ↓ ¬q			p ^ q	¬(p ↑ q)					p \ ¬q	q \ ¬p
8	F	T	T	T	NAND		¬p v ¬q	¬(¬p ↓ ¬q)				p ↑ q			p → ¬q	q → ¬p		
9	F	T	T	F	XOR			#?	p $\underline{\vee}$ q	¬p $\underline{\downarrow}$ q		#?	¬p $\underline{\wedge}$ q	p $\underline{\uparrow}$ q				
10	F	T	F	T	q inverter	¬q		q ↓ q				q ↑ q						
11	F	T	F	F	non impl.			¬p ↓ q			p ^ ~q	¬(p ↑ ¬q)					p \ q	¬q \ ¬p
12	F	F	T	T	p inverter	¬p		p ↓ p				p ↑ p						
13	F	F	T	F	non impl.			p ↓ ¬q			~p ^ q	¬(¬p ↑ q)					¬p \ ¬q	q \ p
14	F	F	F	T	NOR			p ↓ q			~p ^ ~q	¬(¬p ↑ ¬q)					¬p \ q	¬q \ p
15	F	F	F	F	denial			p ↓ q				¬(¬p ↑ p)						
								Peirce's Arrow	XNAND	XAND ↔ Equiv.		Sheffer's Arrow	XNOR	XOR Non equiv.			\ diff	\ diff

[†]same as ↔

p and q can be exchanged

Don't forget de Morgan's rules.

The **XNAND** gate is functionally identical to the **XOR** gate.

The **XAND** gate is functionally identical to Equivalence.

The **NOR** and **NAND** gates are **functionally complete**.

Machines 6 and 9 require slightly more complex arrangements.

Can you construct the four missing expressions marked '#?' ? HINT Draw Venn diagram.

Mr. G investigated **XNAND** and **XAND** in 2001 and defined the symbols $\underline{\wedge}$ and $\underline{\uparrow}$

Pointless fact - the computer on Apollo 11 was constructed entirely of NOR gates.

Logically p ⇒ q is defined by ¬p v q {the Switcheroo rule - named after R.R. Switcheroo}

p implies q means if you've got p then you must have q but q is independent of p.

p only if q	*rainbows occur only if it's raining*
q is a <u>necessary</u> condition for p	*rain is a necessary condition for rainbows*
p is a <u>sufficient</u> condition for q	*a rainbow is a sufficient condition for rain*
q if p	*it's raining if you have a rainbow*

Contrapositive combines inverse and converse so logically equivalent to original statement.