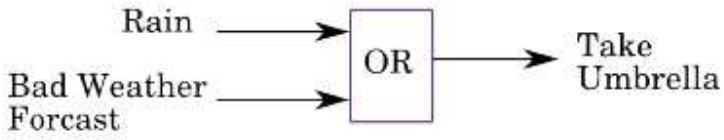
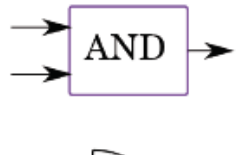
A/L ICT. BOOLEAN ALGEBRA & LOGIC GATES

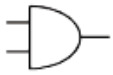
Boolean algebra, as developed in 1854 by George Boole in his book An Investigation of the Laws of Thought. Boolean algebra is the algebra of truth values 0 and 1. *The operations are usually taken to be conjunction, disjunction, and negation, with constants 0 and 1. Applications include mathematical logic, digital logic, computer programming, set theory, and statistics.*

Boolean algebra is used to design digital circuits. Boolean
A circuit is designed by connecting AND, OR, NOT gates together.
Gates can be composed into complex circuits of electronic devices.

"I will take an umbrella with me if it is raining or the weather forecast is bad AND not take the car"	
(Take Umbrella) = (NOT (Take Car)) AND ((Bad Forecast) OR (Raining))	

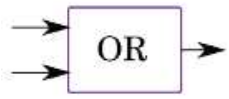
Basic Gates used in Circuit Design

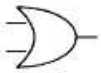




AND ·

A	B	R
0	0	0
0	1	0
1	0	0
1	1	1



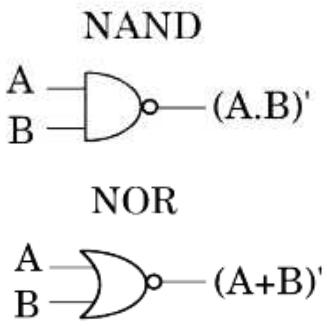


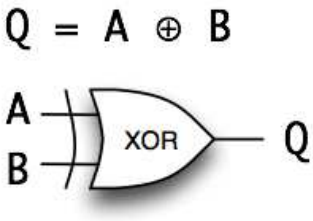
OR +

A	B	R
0	0	0
0	1	1
1	0	1
1	1	1

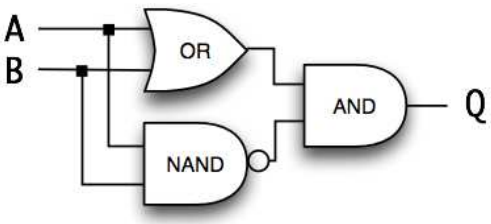
NOT ′

A	R
0	1
1	0





A	B	XOR
0	0	0
0	1	1
1	0	1
1	1	0



Boolean Rules to know …

Basic Boolean algebraic identities

Additive	Multiplicative
$A + 0 = A$	$0A = 0$
$A + 1 = 1$	$1A = A$
$A + A = A$	$AA = A$
$A + \overline{A} = 1$	$A\overline{A} = 0$

Basic Boolean algebraic properties

Additive	Multiplicative
$A + B = B + A$	$AB = BA$
$A + (B + C) = (A + B) + C$	$A(BC) = (AB)C$
$A(B + C) = AB + AC$	

Useful Boolean rules for simplification

$$A + AB = A$$

$$A + \overline{A}B = A + B$$

$$(A + B)(A + C) = A + BC$$

De Morgan's Law

$$\overline{A \cdot B} = \overline{A} + \overline{B}$$

$$\overline{A + B} = \overline{A} \cdot \overline{B}$$

http://en.wikipedia.org/wiki/Augustus_De_Morgan

Boolean Arithmetic

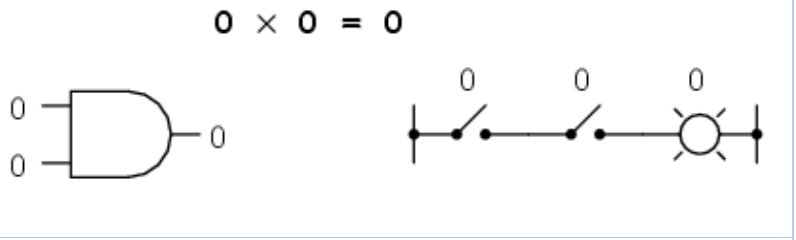
Fundamentals of addition:

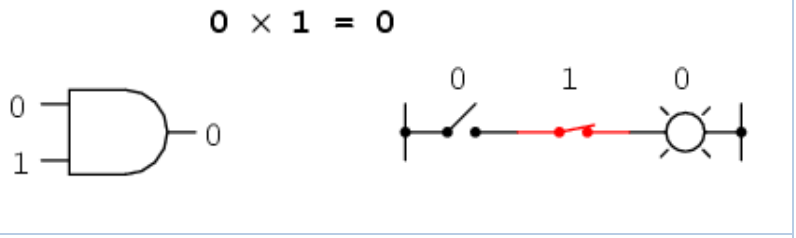
0 + 0 = 0 0 + 1 = 1 1 + 0 = 1 1 + 1 = 1	0 + 1 + 1 = 1 1 + 1 + 1 = 1 0 + 1 + 1 + 1 = 1 1 + 0 + 1 + 1 + 1 = 1	*No matter how much we add 1s the output is 1*

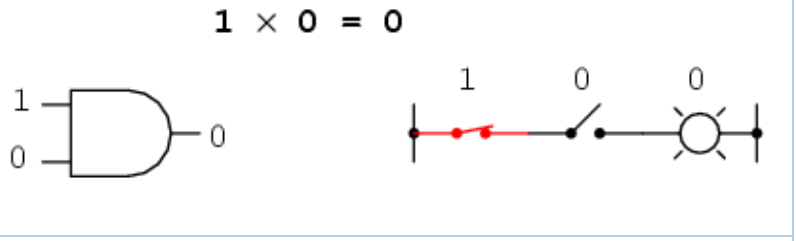
Multiplications work like this

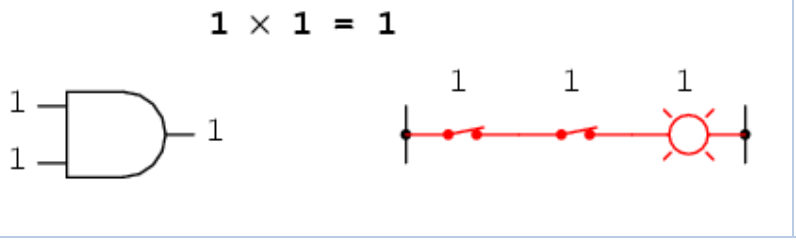
0 × 0 = 0 0 × 1 = 0 1 × 0 = 0 1 × 1 = 1	*There is no subtraction or division in Boolean algebra.*

AND gate: *(Serial Switches)*







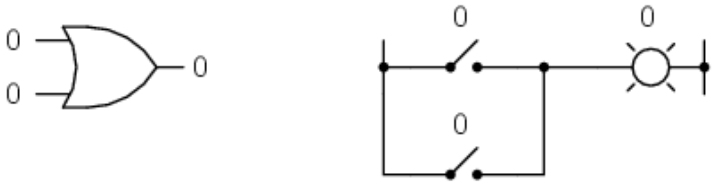


AND ·

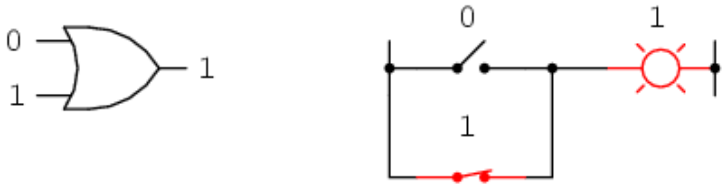
A	B	R
0	0	0
0	1	0
1	0	0
1	1	1

OR gate: *(parallel switches)*

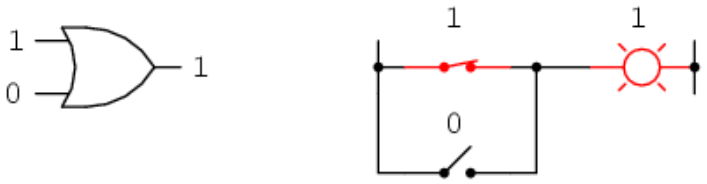
0 + 0 = 0



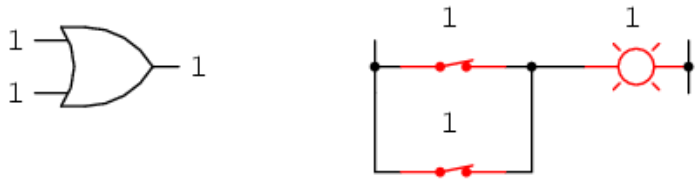
0 + 1 = 1



1 + 0 = 1



1 + 1 = 1



OR +

A	B	R
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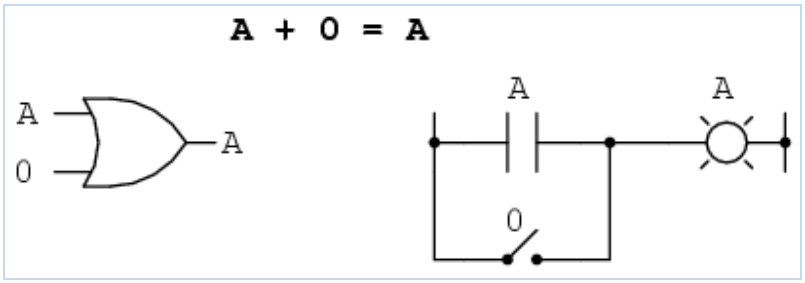
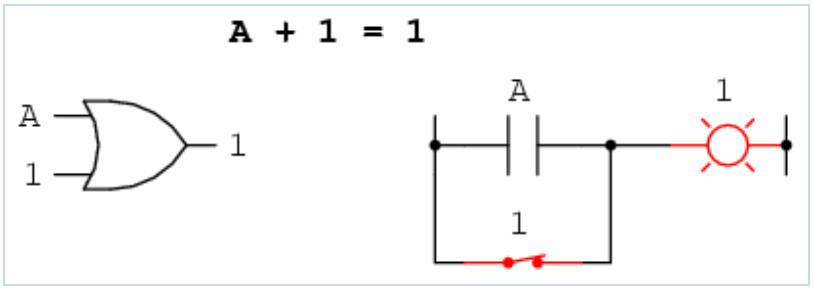
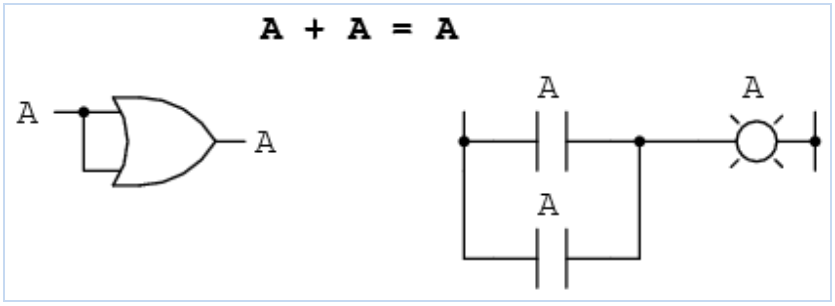
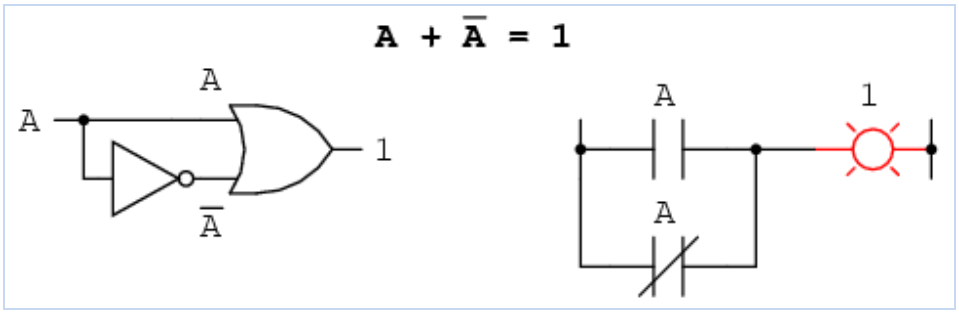
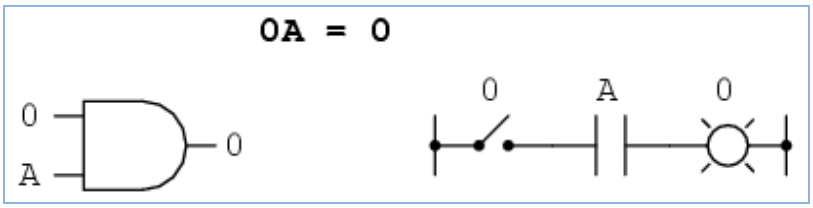
OR gates …

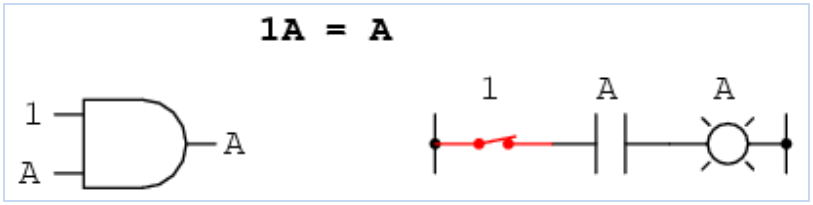


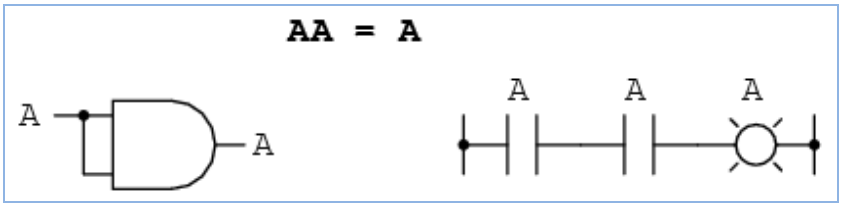


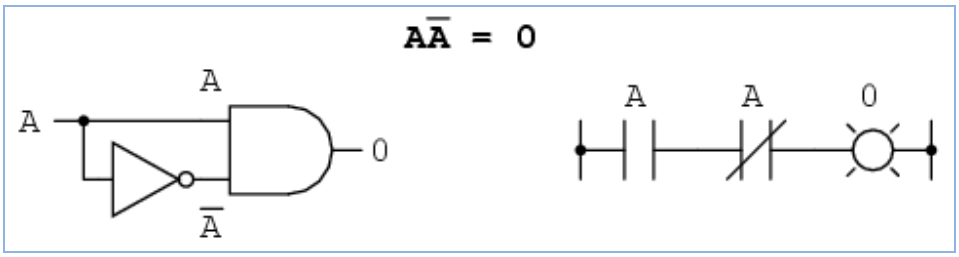












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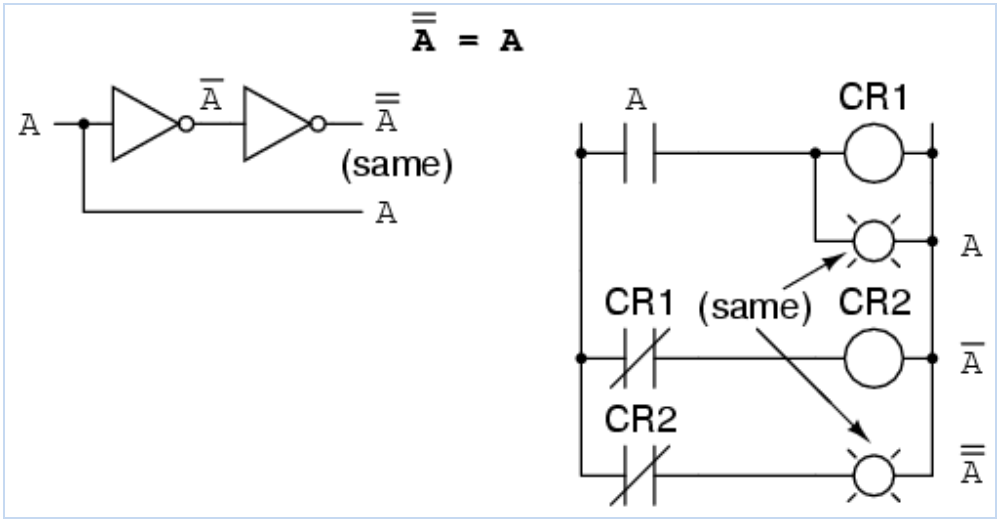

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