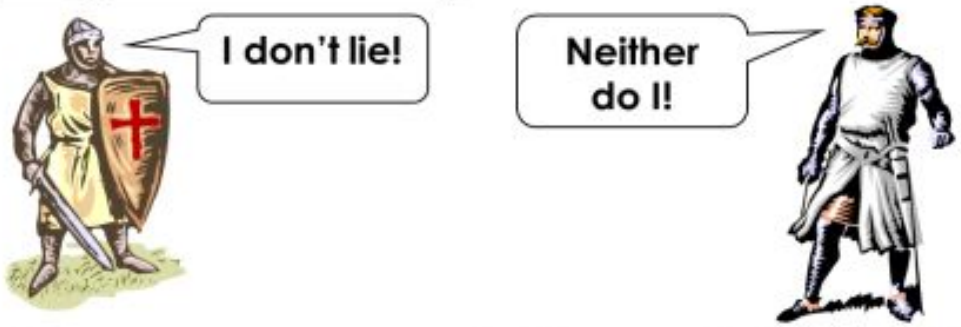
Boolean Logic

Logic Warm Up #1

Logic Warm Up



Suppose you are visiting an island with knights, who always tell the truth, and knaves, who always lie.

Question - Which statement is impossible for an islander to make?

1. **I am a knight or a knave**
2. **I am a knight**
3. **I am a knave**

Logic Warm Up #2

Third type of islander added: Spy can lie or tell the truth.

There is one spy, one knight, and one knave in this scenario

A says that C is a knave.
B says that A is a knight.
C says "I am the spy."

Which one is the spy, which one is the knight, which one is the knave? What can we rule out right away?

Third type of islander added: Spy can lie or tell the truth.

There is one spy, one knight, and one knave in this scenario

A says that C is a knave.

B says that A is a knight.

C says "I am the spy."

Answer:

C is a knave.

A is telling the truth, so A is a knight.

B is a spy.

LOGIC GATES

George Boole, (1815-1864)

- In the **1850s** George **Boole** developed a new form of algebra, now called Boolean algebra in his honour.
- Boolean equations use the **binary** number system to provide a very precise way of illustrating the logic of **computer chips**.
- Interesting fact: Boolean equations were **used long before computers or even electricity was invented**!

Did you know?

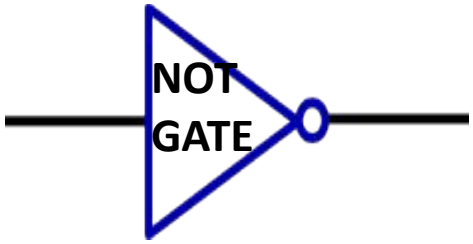
George Boole Inventor of the idea of logic gates. He was born in Lincoln, England and he was the son of a shoemaker in a low class family.

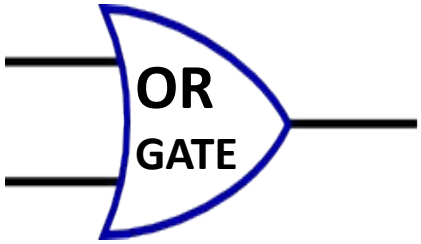
Review

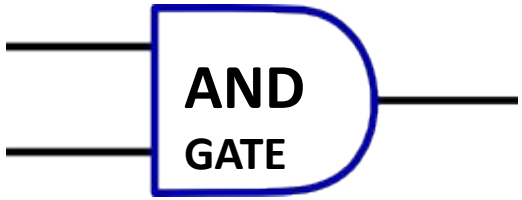
- 1 in the Binary System represents
  - ON or YES
- 0 in the Binary System represents
  - OFF or NO
- Boolean logic is a part of almost every aspect of COMPUTER ELECTRONICS
- Example: using the + while performing Google Searches

A logic gate is a digital circuit which either allows a signal to pass through it or to stop it.

There are seven basic logic gates: AND, OR, XOR, NOT, NAND, NOR, and XNOR.

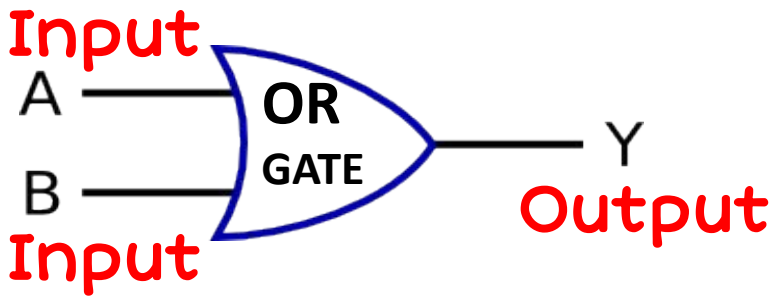




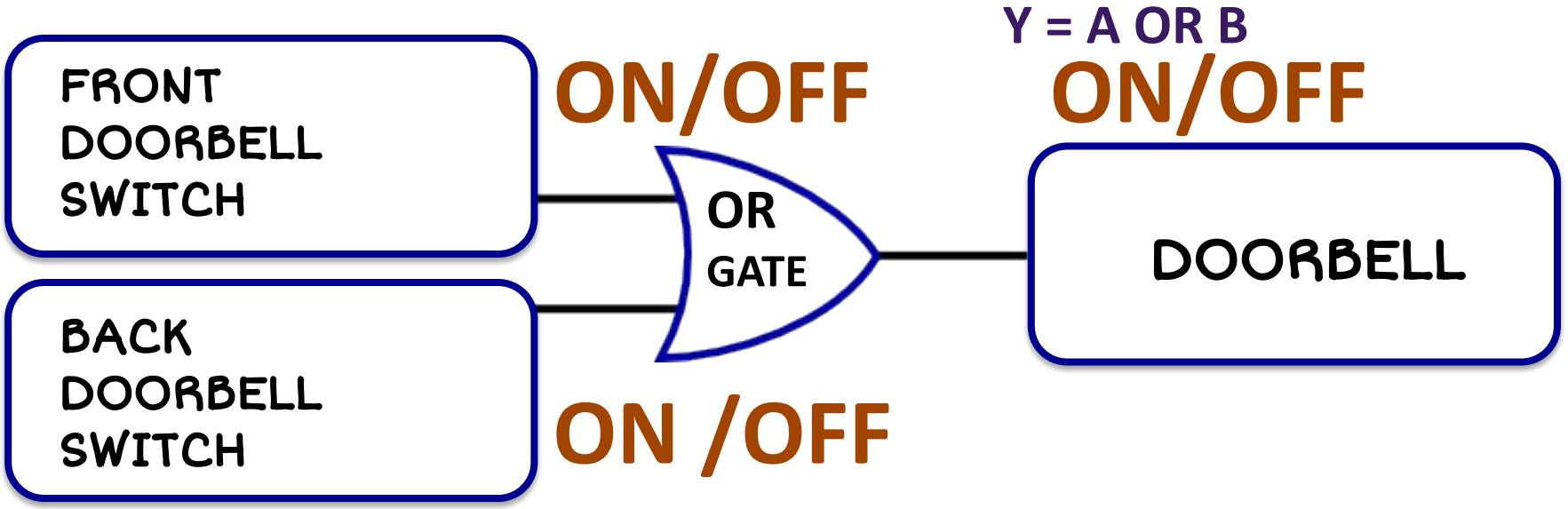


Did you know?

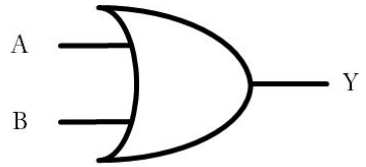
Logic gates allow the computer to do things such as add, divide, multiply, do simple yes and no reasoning in certain situations along with other things.



An OR gate can have two or more inputs.
The output will be positive (True) if at least one input is true.

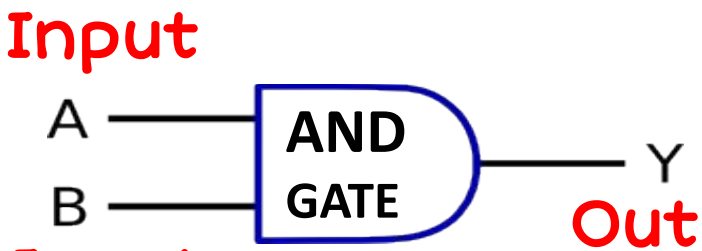


OR



A	B	Y (Output)
0	0	0
0	1	1
1	0	1
1	1	1

If either input is 1 (YES) the output is 1 (YES).



An AND gate can have two or more inputs.
The output will be positive (true) when both inputs (the input one AND the input two) are positive (true).

PERSON SENSOR

ON/OFF

ON SWITCH FOR ALARM

ON /OFF

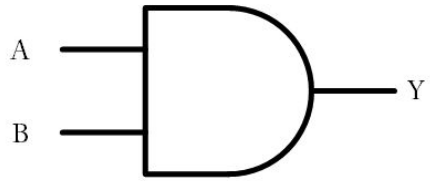
AND GATE

Y = A AND B

ON/OFF

BURGLAR ALARM

AND



A	B	Y (Output)
0	0	0
0	1	0
1	0	0
1	1	1

Both inputs must be 1(YES) to get a 1(YES) as output.

TO ADD MORE SENSORS TO ALARM

BEDROOM SENSOR

FRONT ROOM SENSOR

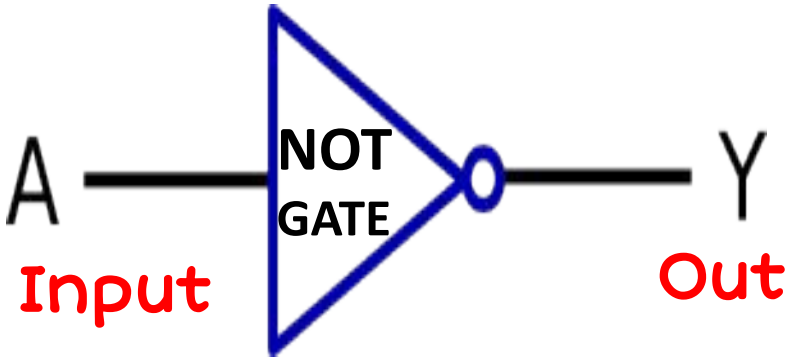
OR GATE

ON SWITCH FOR ALARM

AND GATE

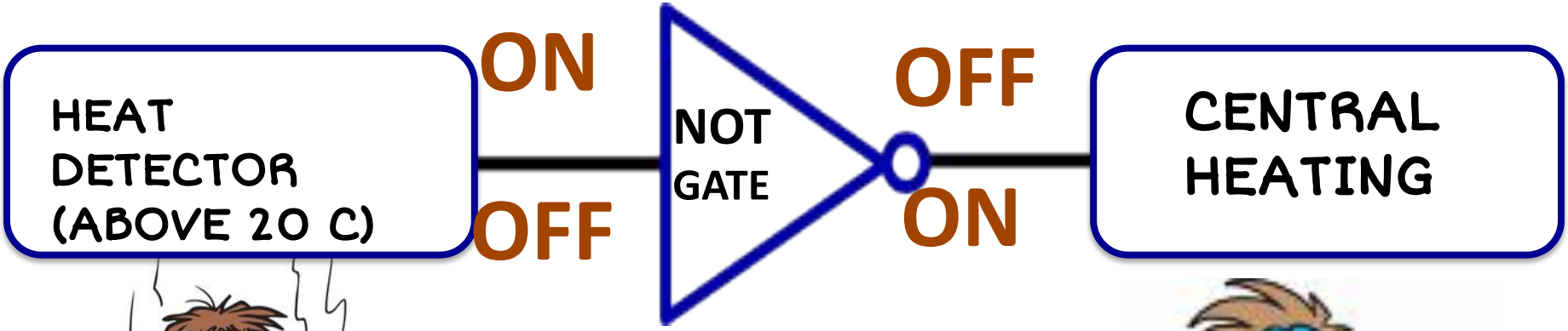
ON or OFF ?

BURGLAR ALARM

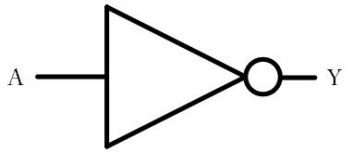


A NOT gate (inverter) has only one input.
It reverses the logic state.

Y = NOT A



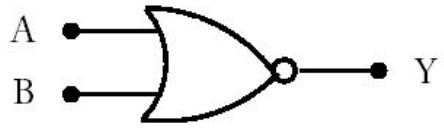
NOT



A	Y (Output)
0	1
1	0

Output is opposite of input.

NOR



A	B	Y (Output)
0	0	1
0	1	0
1	0	0
1	1	0

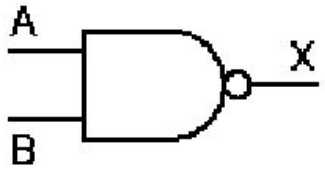
For a value of 1(YES) – both inputs need to be 0(NO).
(OPPOSITE OF OR)

XOR

A	B	Y (Output)
0	0	0
0	1	1
1	0	1
1	1	0

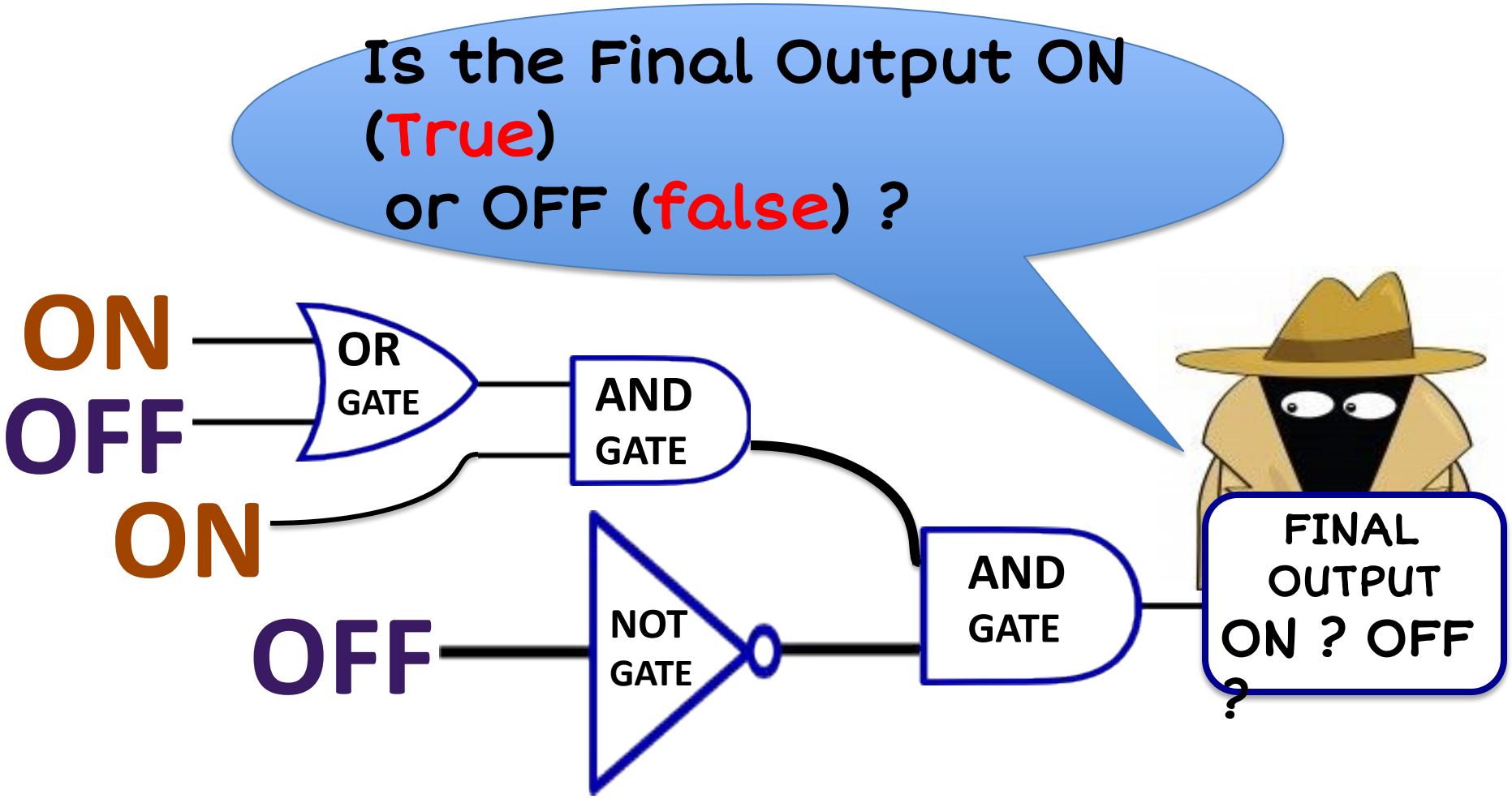
Only one input can be 1(YES) to have a 1(YES) output.

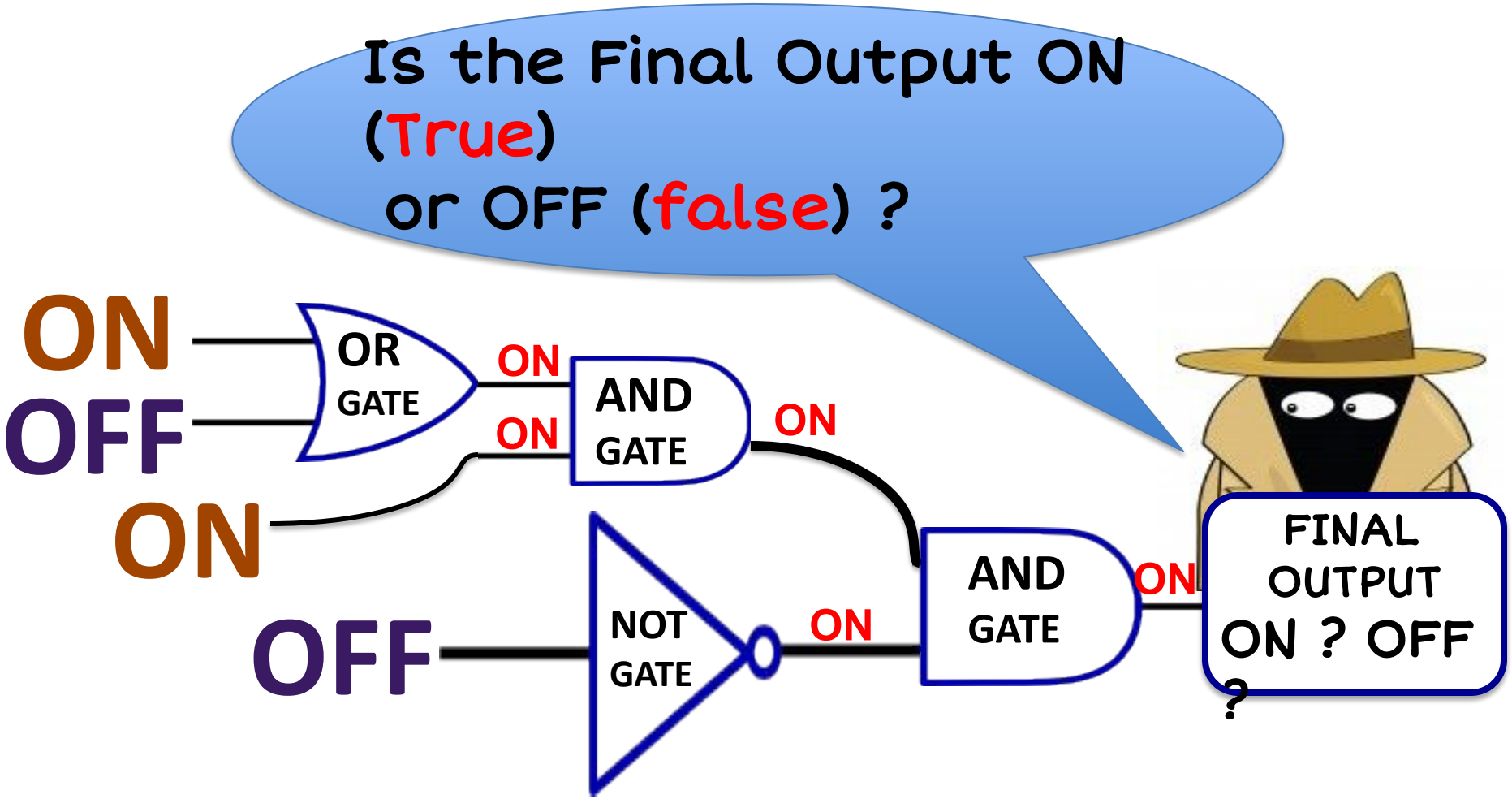
NAND



A	B	Y (Output)
0	0	1
0	1	1
1	0	1
1	1	0

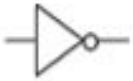
If both inputs are 1(YES) output is 0(NO).
OPPOSITE OF AND!!


Is the Final Output ON (True) or OFF (false) ?
ON
OFF
ON
OFF
OR GATE
AND GATE
NOT GATE
AND GATE
FINAL OUTPUT ON ? OFF ?


Is the Final Output ON (True) or OFF (false) ?
ON
OFF
ON
OFF
OR GATE
ON
ON
AND GATE
ON
NOT GATE
ON
AND GATE
ON
FINAL OUTPUT ON ? OFF ?

ANSWER: ON

Boolean Expressions

Gate	Symbol	Operator
and		●
or		+
not		-
nand		$\overline{\bullet}$
nor		$\overline{+}$
xor		⊕

$AND \quad Y = A \cdot B$

$OR \quad Y = A + B$

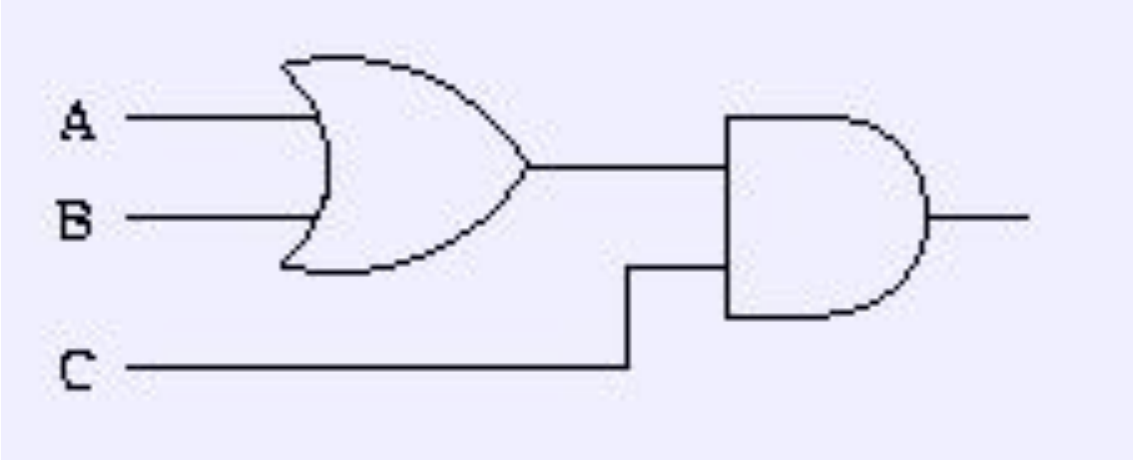
$NOT \quad Y = \overline{A}$

$NOR \quad Y = \overline{A + B}$

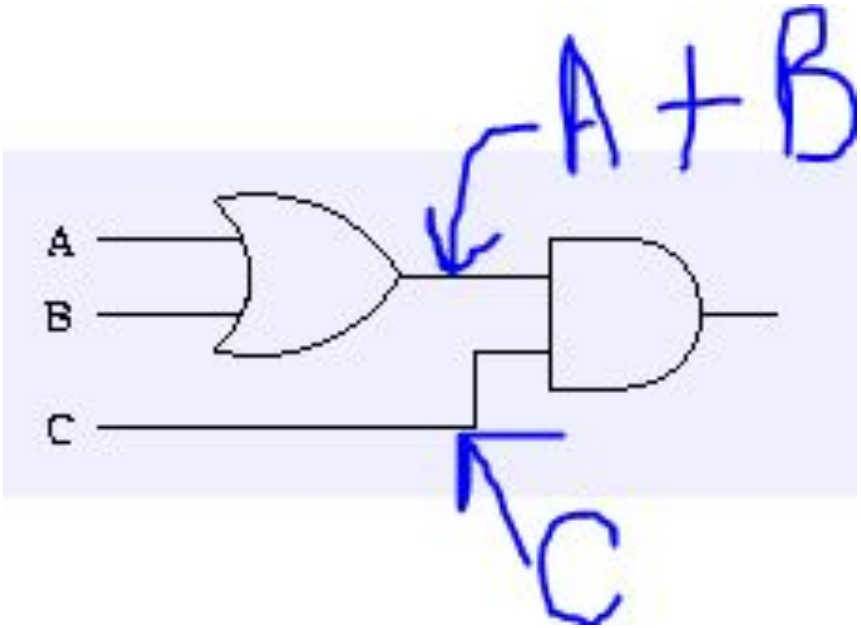
$NAND \quad Y = \overline{A \cdot B}$

$XOR \quad Y = A \oplus B$

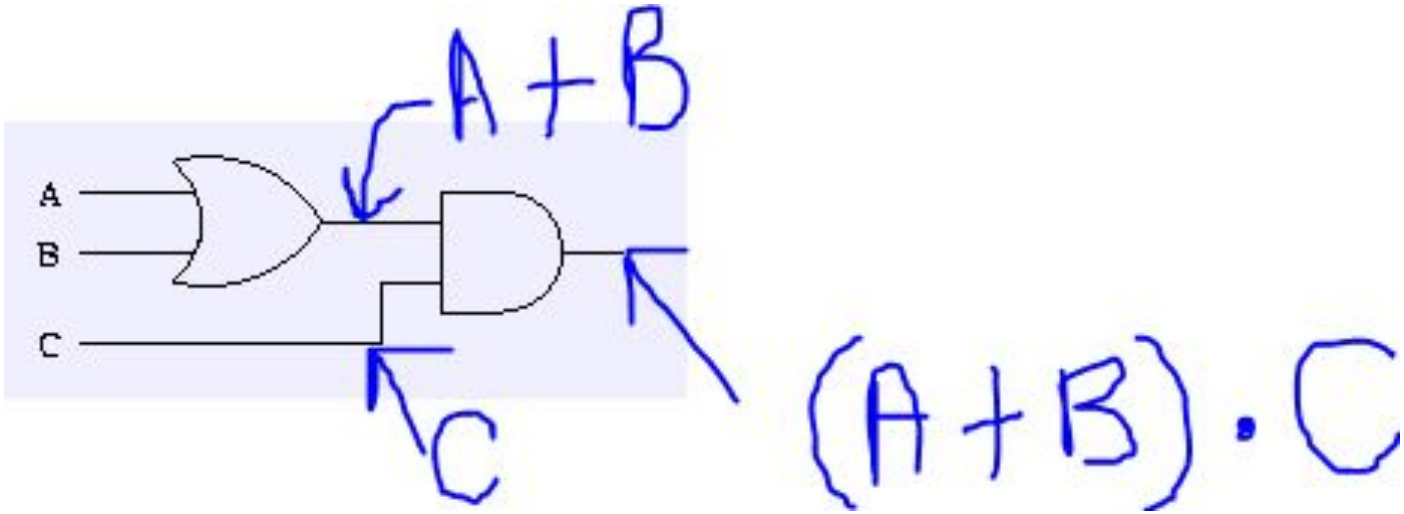
Boolean Algebra Example:



Boolean Algebra Example:



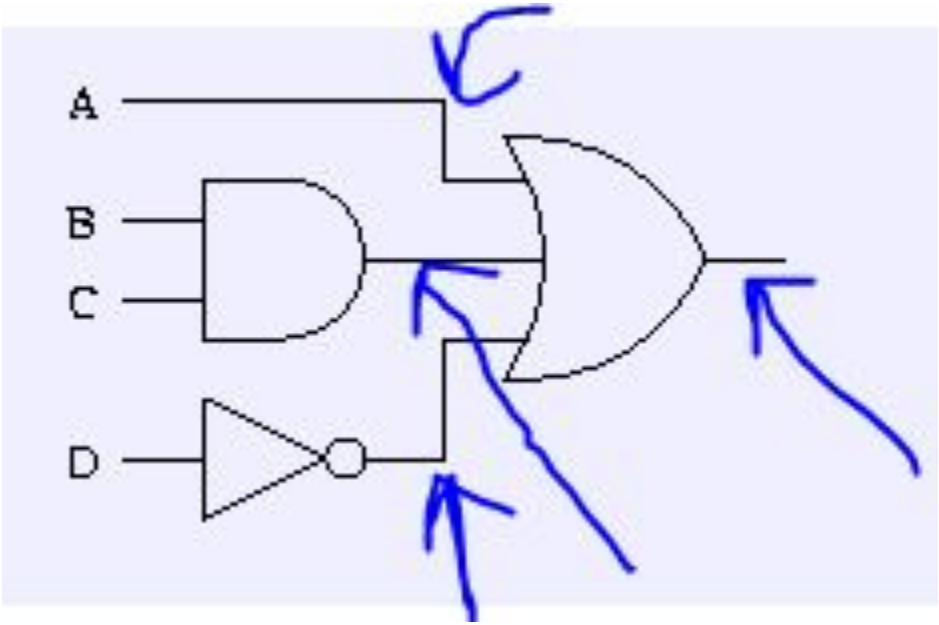
Boolean Algebra Example:



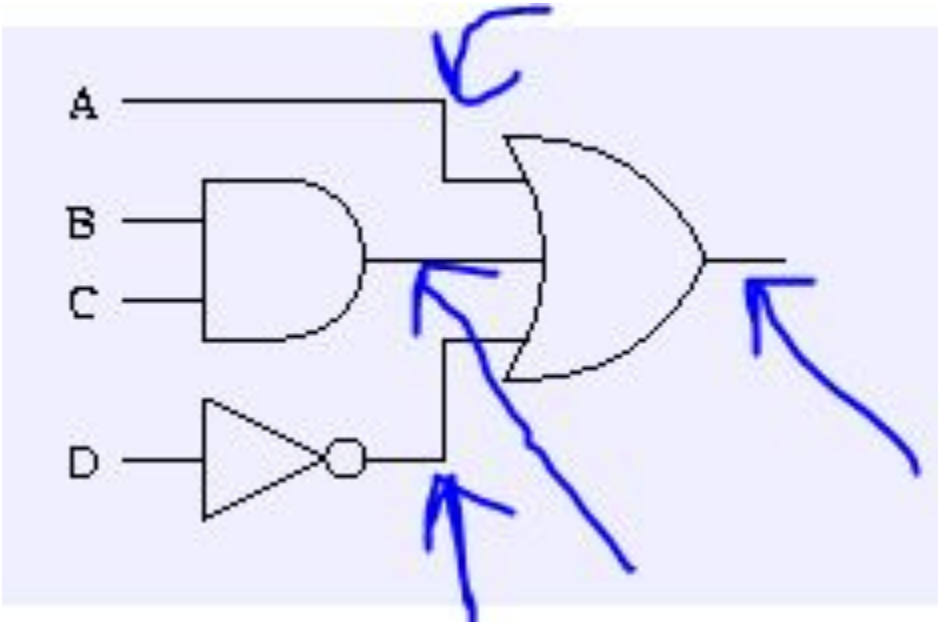
Your answer here would be:

(A + B)C

Try this one:



Try this one:



Answer: A + (BC) + D’

**The ‘ means NOT but when you write it on paper, you will use a horizontal bar

Question #	Answer: ON or OFF?
1	Off
2	On
3	Off
4	On
5	Off
6	On
7	On
8	Off
9	Off
10	On