Logic Gates: AND, OR, NOT (Inverter)

Using AND

An AND gate can have more than two inputs

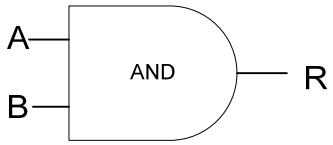
- If at least one input is a 0, then the output is a 0.
- When all inputs are 1, the output is a 1.

All of these symbols are equivalent:
A AND B ➔ A ∧ B ➔ A · B ➔ AB

Truth Table (AND)

A	B	A·B
0	0	0
0	1	0
1	0	0
1	1	1

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



Using OR

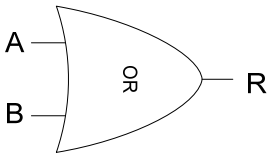
An OR gate can have more than two inputs

- If at least one input is a 1, then the output is a 1.
- If **all** the inputs are 0, the output is a 0.

All of these symbols are equivalent
A OR B ➔ A V B ➔ A+ B
Truth Table (OR)

A	B	A+B
0	0	0
0	1	1
1	0	1
1	1	1

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



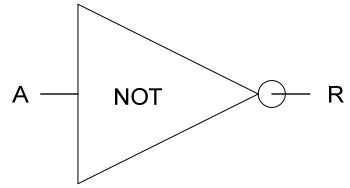
Using NOT (Invert)

All of these symbols are equivalent

NOT ➔ ~ ➔ $\bar{}$

Truth Table (NOT)

C	~C = R
0	1
1	0



Sample Examples:

1) R = ~AC + B

3 Variables (A, B, C)
3 initial columns
8 rows to include all possibilities

Question:
If A= 0, B= 1, C=1 What is R?
R = 1

A	B	C	~A
0	0	1	1
0	0	0	1
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

A	B	C	~A	~A·C
0	0	0	1	0
0	0	1	1	1
0	1	0	1	0
0	1	1	1	1
1	0	0	0	0
1	0	1	0	0
1	1	0	0	0
1	1	1	0	0

A	B	C	~A	~A·C	~AC+B
0	0	1	0	0	0
0	0	1	1	1	1
0	1	0	1	0	1
0	1	1	1	1	1
1	0	0	0	0	0
1	0	1	0	0	0
1	1	0	0	0	1
1	1	1	0	0	1

2) R = (A+C)(~C+A)

A	C	~C	A+C	~C+A	R
0	0	1			
0	1	0			
1	0	1			
1	1	0			

A	C	~C	A+C	~C+A	R
0	0	1	0		
0	1	0	1		
1	0	1	1		
1	1	0	1		

A	C	~C	A+C	~C+A	R
0	0	1	0	1	
0	1	0	1	0	
1	0	1	1	1	
1	1	0	1	1	

A	C	~C	A+C	~C+A	R = (A+C)(~C+A)
0	0	1	0	1	0
0	1	0	1	0	0
1	0	1	1	1	1
1	1	0	1	1	1

Try these Examples:

Remember, the dot (·) will only be included if critical
Two letters next to each other AB = A· B which means AND

Note: Order of operations matters
The order is: Parenthesis ()
NOT~
AND · ex: AB or A·B
OR + ex: A+B

1) R = ~A + ~BC If A = 0, B = 1, C = 1, then what is R?

2) R = ~A · ~B + A If A = 1, B = 0, then what is R?

3) R = ~A · (~B + A) If A = 1, B = 0, then what is R?
Be careful question 2 and 3 are not the same. Order of operations matters.

4) R= (~B + C)A If A = 0, B = 1, C = 1 then what is R?
Order of operations matters here.

5) R = ((A+~B)(B+C)) If A = 1, B = 1, C = 0 then what is R?
Order of operations matters here.

Solutions:

1) R = ~A + ~BC **If A = 0, B = 1, C = 1, then what is R?**
R = 1

A	B	C	~A	~B	~BC	~A + ~BC
0	0	0	1	1	0	1
0	0	1	1	1	1	1
0	1	0	1	0	0	1
0	**1**	**1**	**1**	**0**	**0**	**1**
1	0	0	0	1	0	0
1	0	1	0	1	1	1
1	1	0	0	0	0	0
1	1	1	0	0	0	0

2) R = ~A · ~B + A **If A = 1, B = 0, then what is R?**
R = 1

A	B	~A	~B	~A · ~B	~A · ~B + A
0	0	1	1	1	1
0	1	1	0	0	0
1	**0**	**0**	**1**	**0**	**1**
1	1	0	0	0	1

3) R = ~A · (~B + A) **If A = 1, B = 0, then what is R?**
R = 0

A	B	~A	~B	(~B + A)	~A · (~B + A)
0	0	1	1	1	1
0	1	1	0	0	0
1	**0**	**0**	**1**	**1**	**0**
1	1	0	0	1	0

4) R= (~B + C)A **If A = 0, B = 1, C = 1 then what is R?**
R = 0

A	B	C	~B	(~B+C)	(~B + C)A
0	0	0	1	1	0
0	0	1	1	1	0
0	1	0	0	0	0
0	**1**	**1**	**0**	**1**	**0**
1	0	0	1	1	1
1	0	1	1	1	1
1	1	0	0	0	0
1	1	1	0	1	1

5) R = ((A+~B)(B+C)) If A = 1, B = 1, C = 0 then what is R?
R = 1

A	B	C	~B	(A+ ~B)	(B+C)	((A+ ~B)(B+C))
0	0	0	1	1	0	0
0	0	1	1	1	1	1
0	1	0	0	0	1	0
0	1	1	0	0	1	0
1	0	0	1	1	0	0
1	0	1	1	1	1	1
1	**1**	**0**	**0**	**1**	**1**	**1**
1	1	1	0	1	1	1