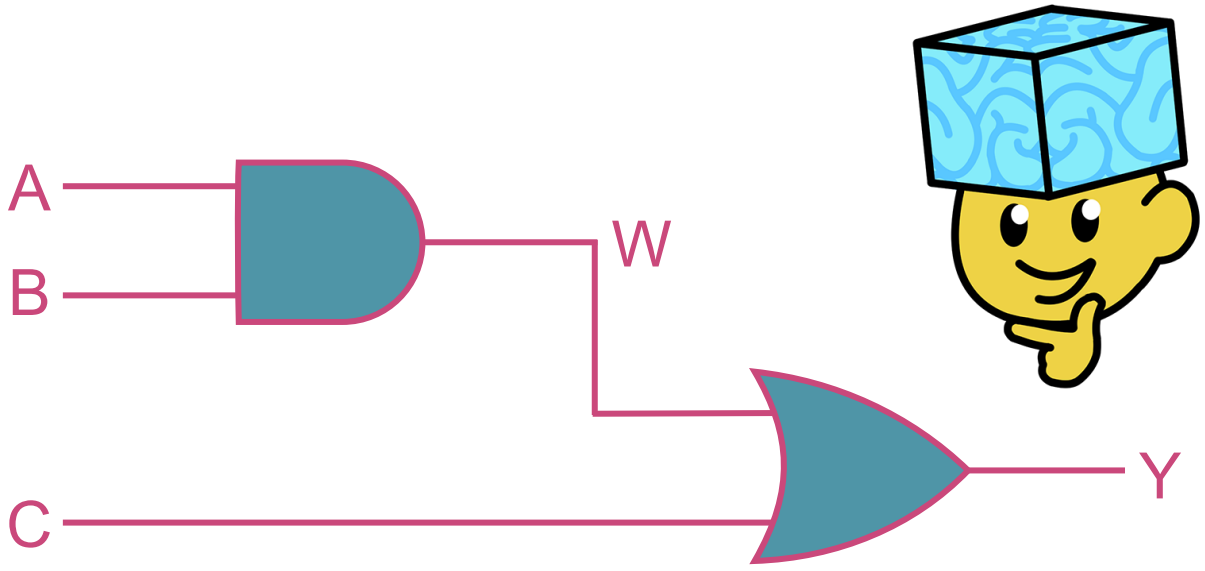
In this lesson we will look at how combinations of logic gates can be used to create logic circuits.

AFTER THIS LESSON, THE STUDENT SHOULD BE ABLE TO DO THE FOLLOWING:

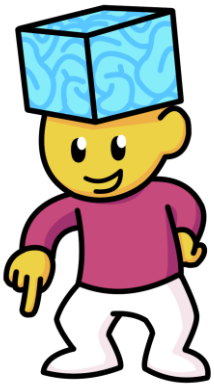
Combinational Logic Circuits

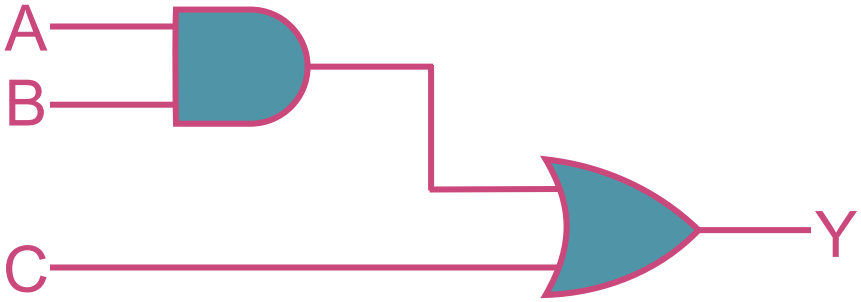
1. Combine multiple logic gates to create a logic circuit
2. Evaluate the output of two or more logic gates connected together
3. Create truth tables that shows all the outputs of logic circuits that are a combination of different types of logic gates.



COMBINATION LOGIC CIRCUITS

Combinational logic circuits are electronic circuits that are composed of two or more individual logic gates interconnected to produce outputs based on a combination of input values.





TRUTH TABLE			
INPUTS			OUTPUT
A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

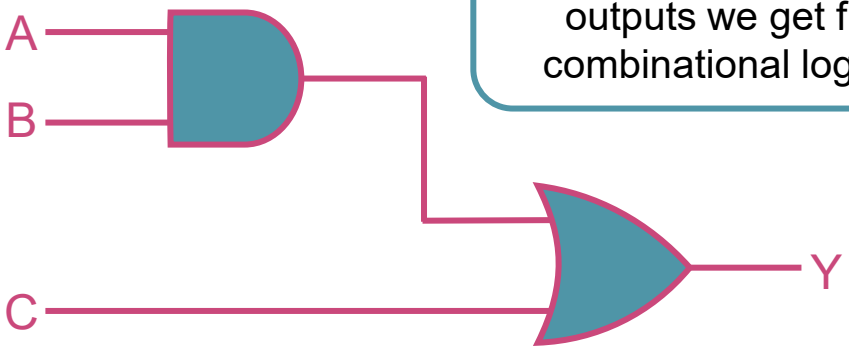
The behavior of combinational logic circuits can be described using a truth table, which lists all possible input combinations and their corresponding output values.

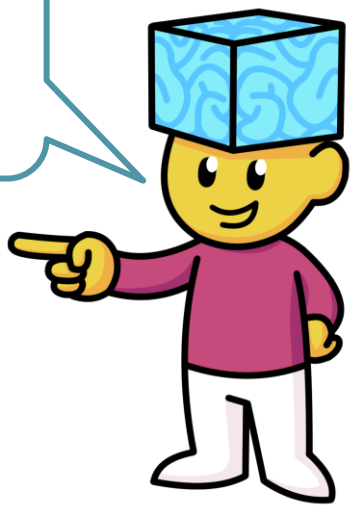
These logic circuits are the fundamental building blocks in the design of digital circuits and play a crucial role in modern computing and electronics.

COMBINING LOGIC GATES

All the logic gates we have learned about can be used to create combinational logic circuits. Logic gates can be mixed and matched as necessary in order to create a logic circuit that behaves in a very specific way.

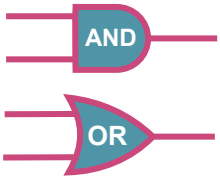
Example 1





STEP 1

Identify each kind of logic gate in the circuit.



There is one OR gate and one AND gate

STEP 2

Recall the truth table for each one of these logic gates individually.

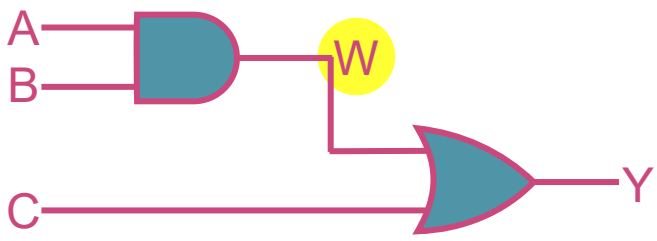
AND Gate		
Input		Output
A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

OR Gate		
Input		Output
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

The truth table for both gates will be used when working through the combinational logic circuit.

STEP 3

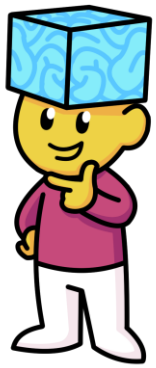
Create “stepping stones” that are both inputs and outputs used to determine the combined truth table for the overall logic circuit.



The “stepping stone” W is the *output* for the individual AND gate.

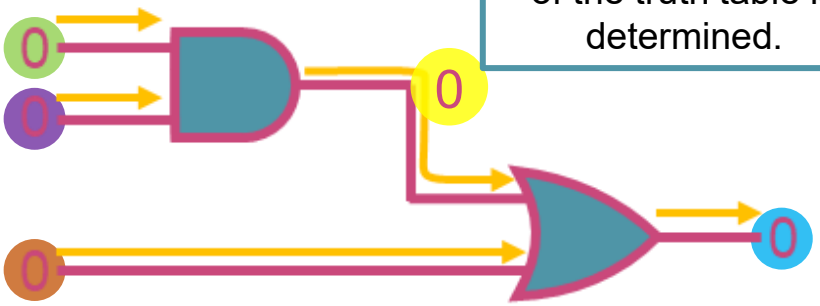
The “stepping stone” W is also an *input* for the individual OR gate.

AND Gate		
Input		Output
A	B	W
0	0	0
0	1	0
1	0	0
1	1	1



OR Gate		
“Stepping Stone”	Input	Output
W	C	Y
0	0	0
1	0	1
0	1	1
1	1	1

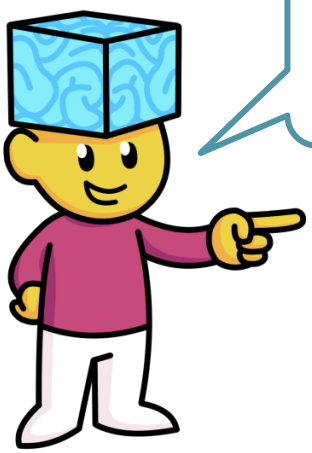
* We can see an example of how row 1 of the truth table is determined.



TRUTH TABLE			
INPUTS			OUTPUT
A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

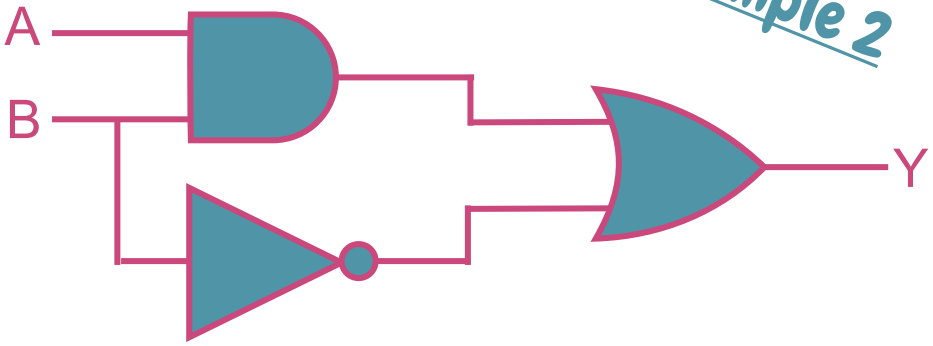
STEP 4

Create the combined truth table for the overall logic circuit. All the combinations for the inputs A, B, C and the outputs for Y are listed.



Let's look another combinational logic circuit and determine the outputs step-by-step.

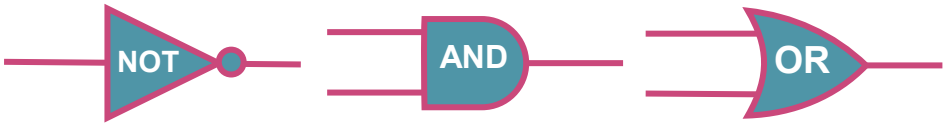
Example 2



STEP 1

Identify each kind of logic gate in the circuit.

There is one AND gate, one NOT gate, and one OR gate.



STEP 2

Recall the truth table for each one of these logic gates individually.

The truth table for all three gates will be used when working through the combinational logic circuit.

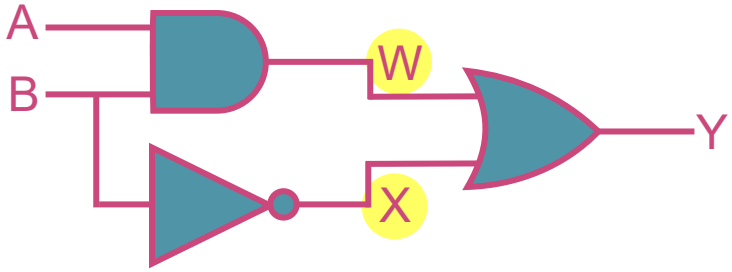
AND Gate		
Input		Output
A	**B**	**Y**
0	0	0
0	1	0
1	0	0
1	1	1

NOT Gate	
Input	Output
A	**Y**
0	1
1	0

OR Gate		
Input		Output
A	**B**	**Y**
0	0	0
0	1	1
1	0	1
1	1	1

STEP 3

Create “stepping stones” that are both inputs and outputs used to determine the combined truth table for the overall logic circuit.



The “stepping stone” W is the *output* for the individual AND gate.

The “stepping stone” X is the *output* for the individual NOT gate.

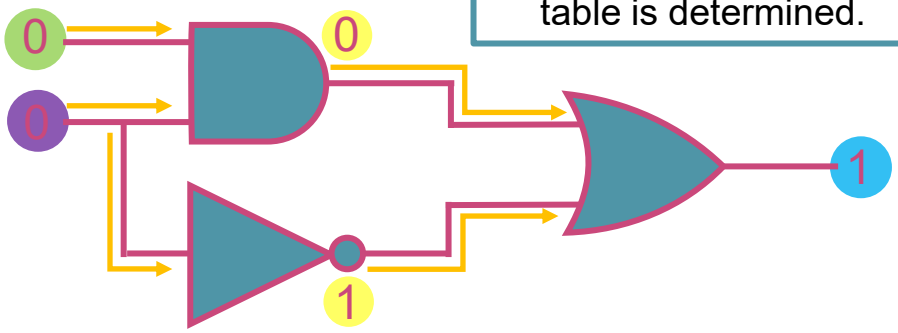
The “stepping stones” W and X are also both the *inputs* for the individual OR gate.

AND Gate		
Input		Output
A	**B**	**W**
0	0	0
0	1	0
1	0	0
1	1	1

NOT Gate	
Input	Output
B	**X**
0	1
1	0

OR Gate		
“Stepping Stones”		Output
W	**X**	**Y**
0	0	0
0	1	1
1	0	1
1	1	1

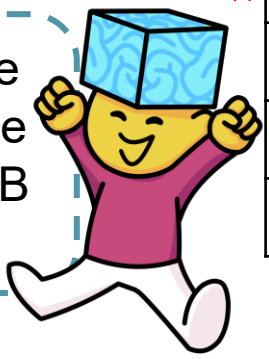
* We can see an example of how row 1 of the truth table is determined.



TRUTH TABLE		
INPUTS		OUTPUT
A	B	Y
0	0	1
0	1	0
1	0	1
1	1	1

STEP 4

Create the combined truth table for the overall logic circuit. All the combinations for the inputs A & B and the output for Y are listed.



TRY THIS!

Determine the outputs from these combinational logic circuits. Use the previous examples as a step-by-step guide to identify each of the logic gates used, create “stepping stones”, and write a truth table for each of the combinational logic circuits.