This page is for

Teachers

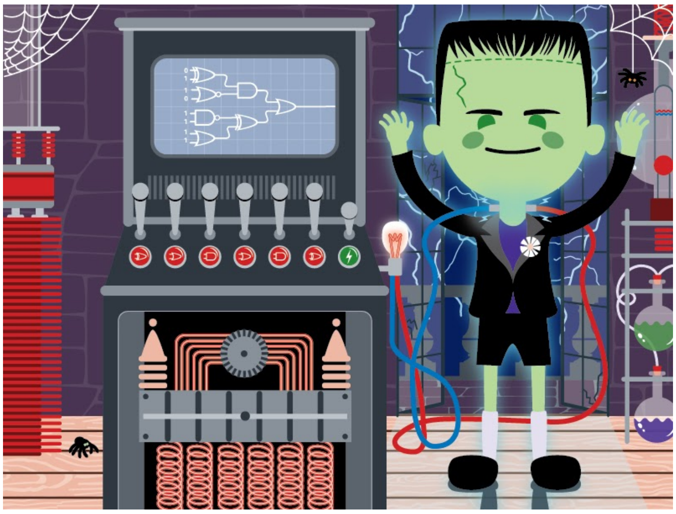
Parents and carers

Digital Technologies @ Home
Unplugged activities for students

This activity is for: Years 7-8

Logic gates

Trace logic gates following simple rules, to check if the light is on or off!



This activity teaches...

Logic gates are a representation of electronic circuit devices used in computers. Their inputs are binary, either on or off (or 1 or 0), and so is their output. Different logic gates have different rules that define how they work.

In this activity we'll learn the rules of logic gates, add logic gates together, and determine what their output will be based on their inputs.

This activity is aimed at lower secondary students and will take about 45 minutes to complete.

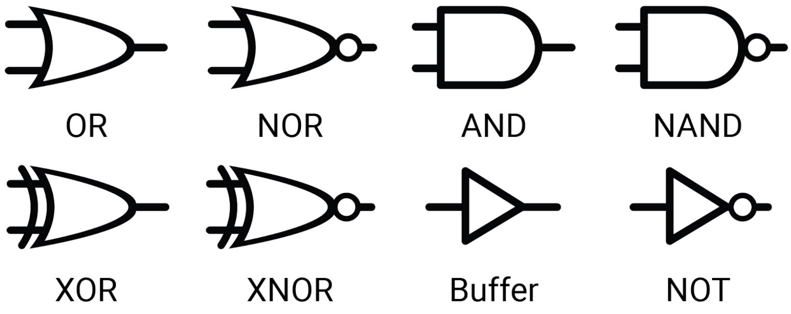
grok academy

This page is for

Students

Getting started with logic gates

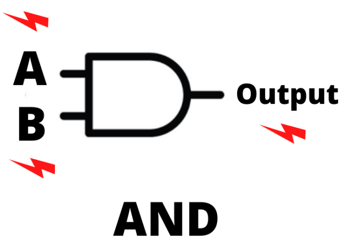
Logic gate symbols



Logic gates have inputs, and outputs with just two states. On, and off (or 1 and 0).

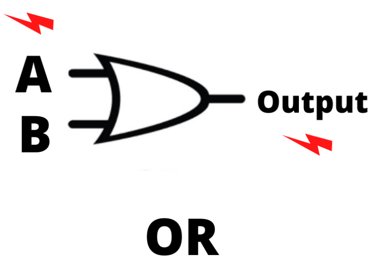
If an input is on, we say it has a value of 1. If an input is off, we say it has a value of 0.

This is an **AND** gate. It's output will be 1 (or **on**) if the top **and** bottom inputs (called A and B) on the left side have a value of 1 (or are **on**). We can also represent this gate with a truth table (on the right).



A	B	Out
0	0	0
0	1	0
1	0	0
1	1	1

This is an **OR** gate. It's output will be 1 if either the top **or** bottom input are 1. The truth table is shown on the right.



A	B	Out
0	0	0
0	1	1
1	0	1
1	1	1

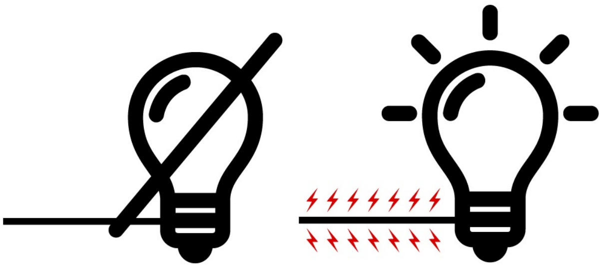
Logic Gates

Solve these questions! Will the light be on or off?

This page is for Students

For these questions, we'll ask if the light is on or off.

The light is on if there is power getting to it through the wire, and it's off if there isn't.

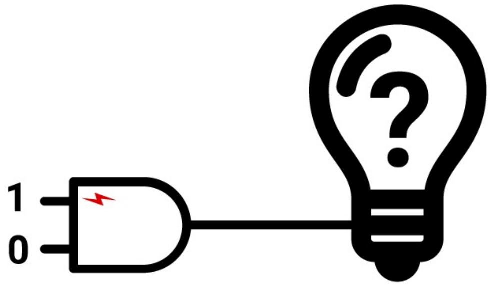


Off On!

The tricky bit is, we're going to send the power through the logic gates before it gets to the light.

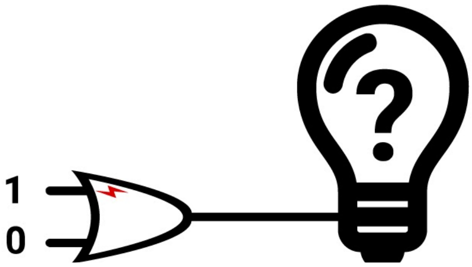
Question 1

Will this light be on or off?



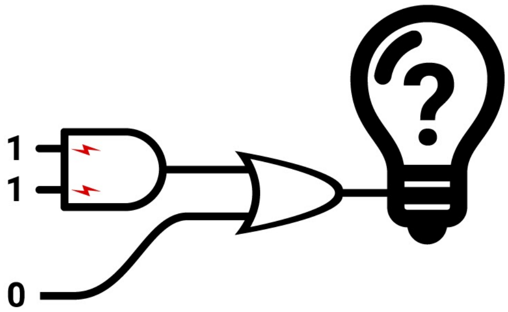
Question 2

Will the light be on or off?



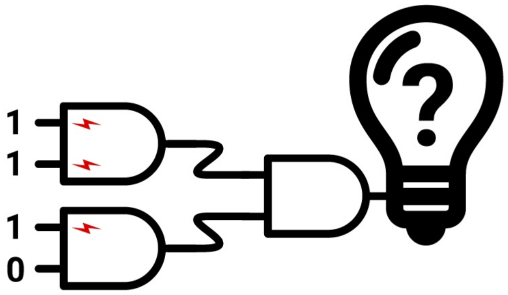
Question 3

Will the light be on or off?



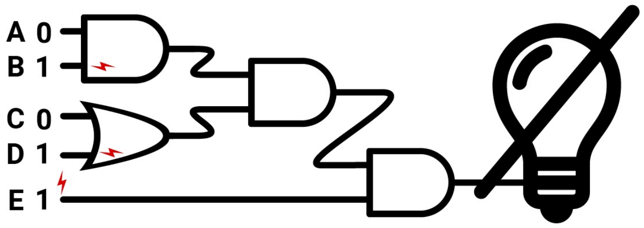
Question 4

Will the light be on or off?



Question 5

This light is off. Which switch do we need to flip to turn it on? A, or C?



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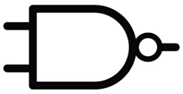
Students

New Logic Gates!

This is called a NAND gate. It's output will be 1 if both the top and bottom inputs are **not** 1. You can think of it as an AND gate, with the output reversed. That's why we call it a NAND gate, **N**ot **AND** gate.

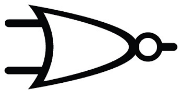


NAND

We can also represent this with a truth table:

A	B	Out
0	0	1
0	1	1
1	0	1
1	1	0

This is an NOR gate. It's output will be 1 if neither the top **or** bottom input are 1.



NOR

We can also represent this with a truth table:

A	B	Out
0	0	1
0	1	0
1	0	0
1	1	0

Let's try some problems with these new gates.

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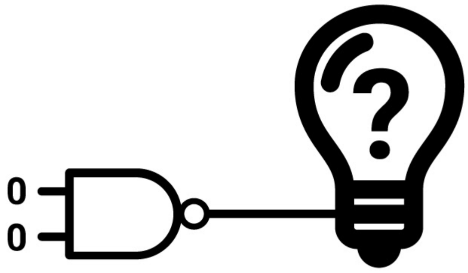
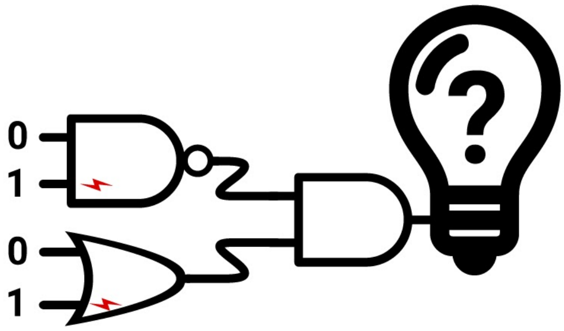
Students

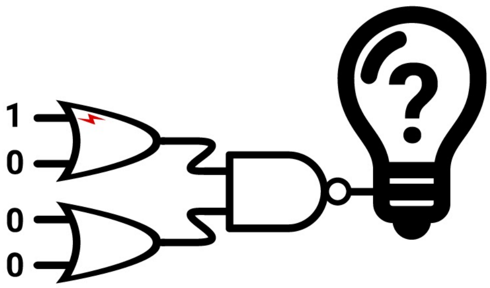
Question 6
Will the light be on or off?



Question 7
Will the light be on or off?



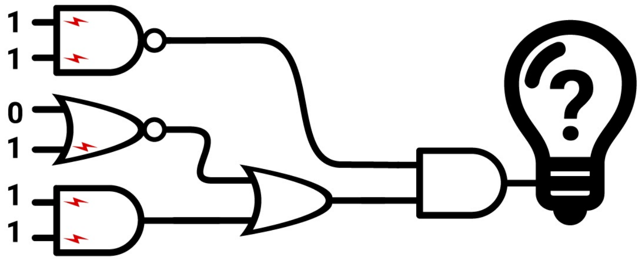
Question 8
Will the light be on or off?



What's the minimum number of switches that can be turned on for this light to be on? _____

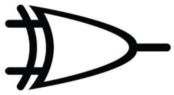
The maximum? _____

Question 9
Will the light be on or off?



XOR and XNOR gates

This is an exclusive OR gate, or XOR gate. It’s output will be 1 if either the top **or** bottom inputs are 1, but not both.

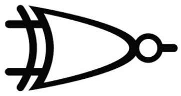


XOR

We can also represent this with a truth table:

A	**B**	**Out**
0	0	0
0	1	1
1	0	1
1	1	0

This is an XNOR gate, or exclusive not or. It’s output will be 1 if the output of an XOR gate would be 0.



XNOR

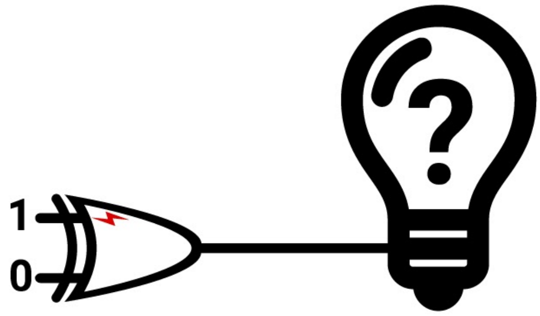
We can also represent this with a truth table:

A	**B**	**Out**
0	0	1
0	1	0
1	0	0
1	1	1

Let’s try some problems with these new gates.

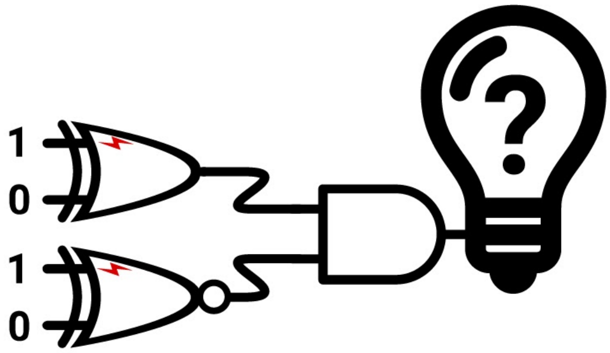
Question 10

Will the light be on or off?



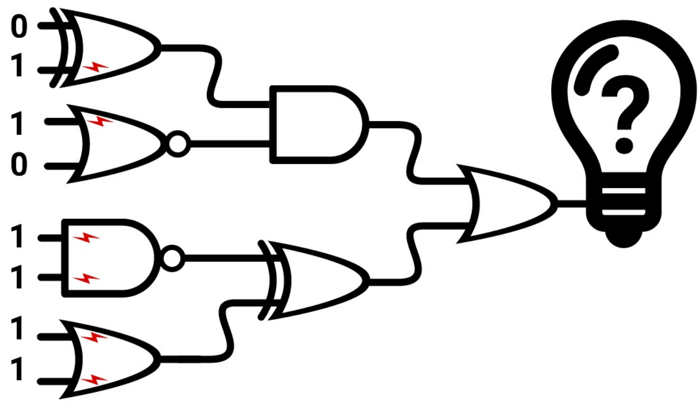
Question 11

Will the light be on or off?



Question 12

Will the light be on or off?



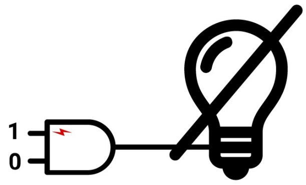
Answer key

Choose if you want to print this for your kids
or keep it to yourself!

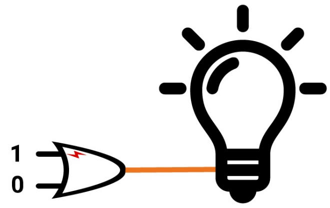
This page is for

Parents
and carers

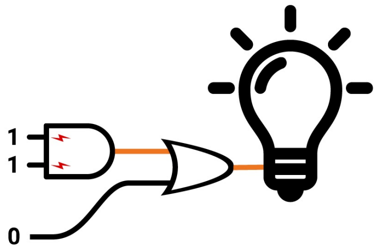
1: Off



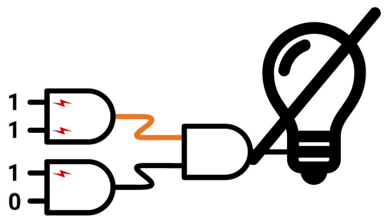
2: On



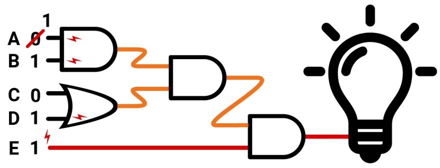
3: On



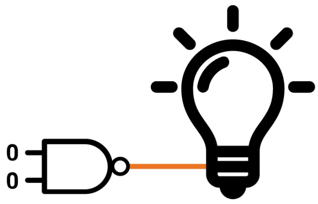
4: Off



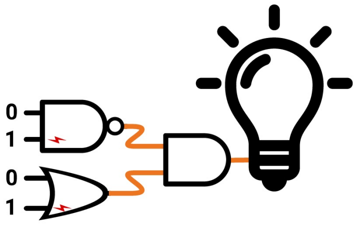
5: Flip A to turn it on



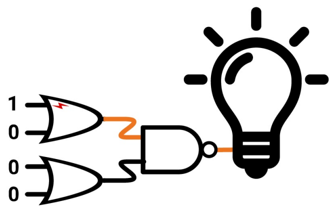
6: On



7: On

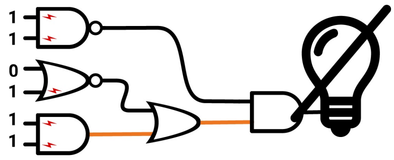


8: On

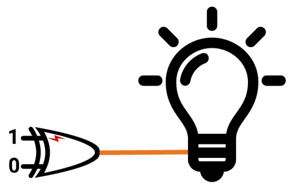


Minimum on switches: 0
Maximum on switches: 2

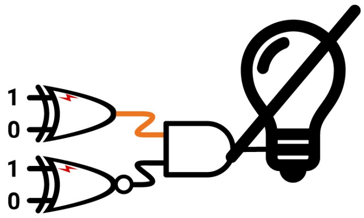
9: Off



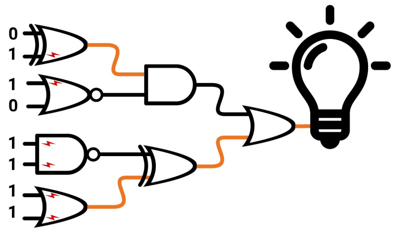
10: On



11: Off



12: On



This page is for

Teachers

Want more?

Here are some further activities, online resources, assessment ideas and curriculum references.

Adapting this activity

Older students can go on to learn about DeMorgan's theorem, which lets you transform a set of logic gates into equivalent gates, and boolean algebra, which is used in computing.

Keep the conversation going

- How does the number of logic gates used relate to the number of inputs?
- Can you think of a way to build a physical logic gate? Think water, or marbles. Some people have even made them using lego!

Keep learning

For High School students interested in learning about how computers communicate with encrypted messages, try this course: cmp.ac/crypto

For teachers creating a portfolio of learning or considering this task for assessment

Students can draw a truth table for a circuit of logic gates, rather than just one.

Is there any way to lessen the number of gates needed while getting the same result?

Linking it back to the Australian Curriculum: Digital Technologies

Algorithms
Design, modify and follow simple algorithms involving sequences of steps, branching, and iteration (repetition) (ACTDIP019 - see cmp.ac/algorithms)

Refer to aca.edu.au/curriculum for more curriculum information.