

How to make a computer

Last week, we learned that computers store numbers with a code called BINARY. A binary number is written with 1s and 0s, for example

110101

It's like a regular number, but instead of a 1s place, a 10s place, a 100s place, etc..., we have a 1s place, a 2s place, a 4s place, an 8s place, and so on. So:

1101 is $1 + 4 + 8 = 13$
8s 4s 2s 1s

Here are the binary numbers for some regular numbers:

REGULAR	BINARY
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000

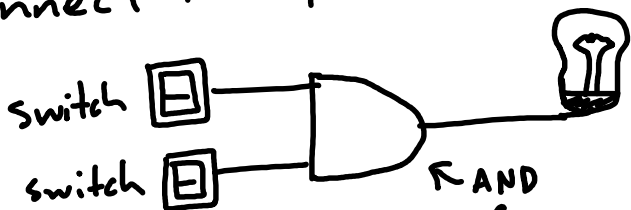
Can you figure out the binary number for 30?

What regular number does the binary number 11011 represent?

Today we'll see how computers do things like adding numbers.

On a computer, go to: logic.ly/demo

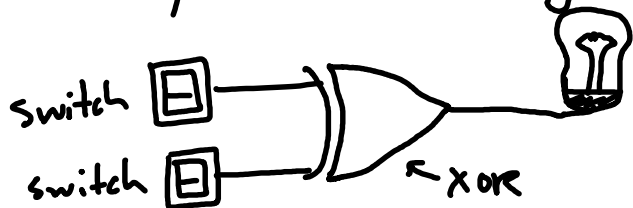
- ① Try connecting a toggle switch to a light bulb, and turn the switch on and off.
- ② Try to figure out what an AND gate does: Connect it up like this:



What happens in the following cases:

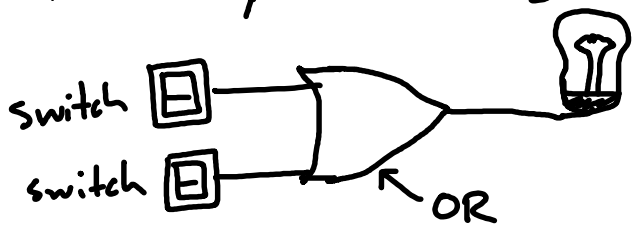
1st switch	2nd switch	light: on or off?
off	off	
off	on	
on	off	
on	on	

- ③ Now try the XOR gate:



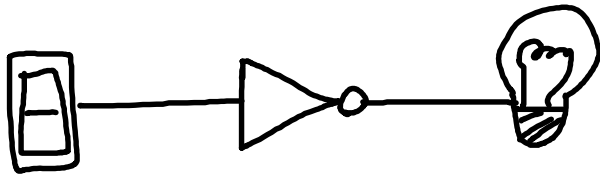
1st	2nd	Light?
off	off	
off	on	
on	off	
on	on	

- ④ Now try the OR gate:



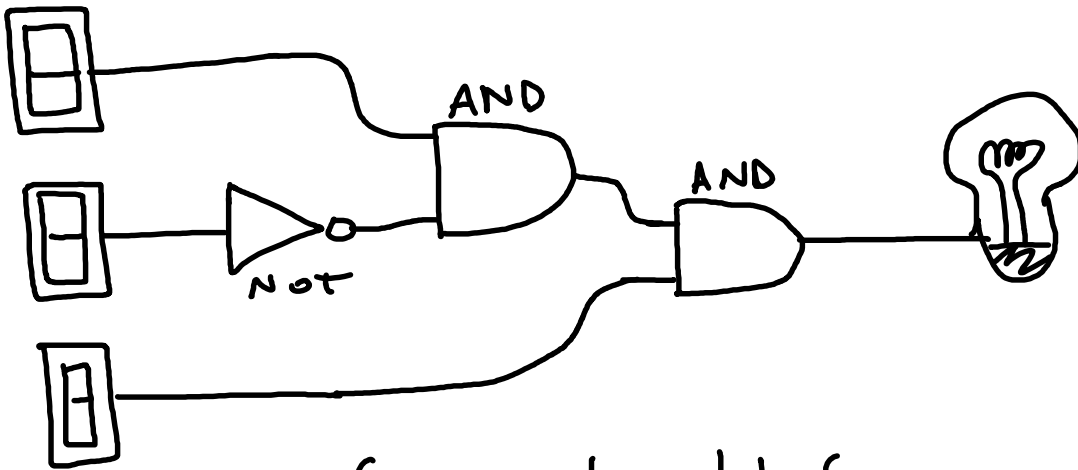
1st	2nd	Light?
off	off	
off	on	
on	off	
on	on	

⑤ How about the NOT gate?

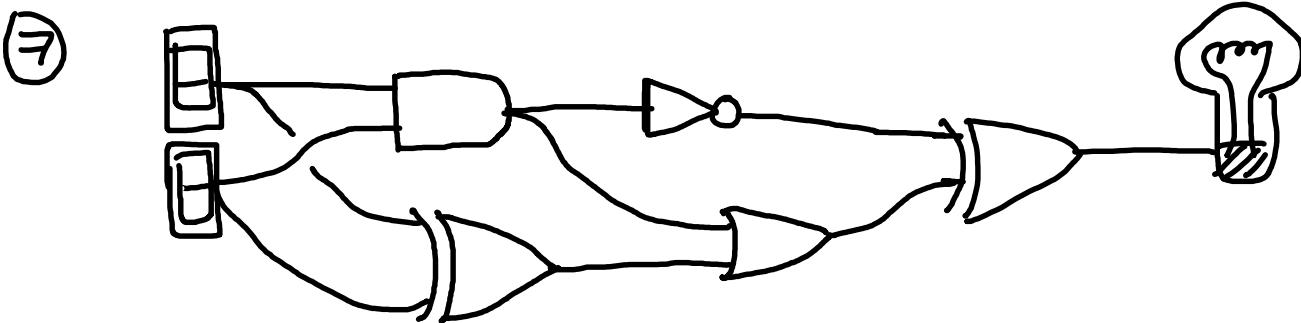


switch	light?
on	
off	

⑥ Which switches do we need to turn on to turn the bulb on?



See if you can figure it out before you try it!



Can you figure out what this will do? Build it to see if you are right.

top switch	bottom switch	bulb
on	on	
on	off	
off	on	
off	off	

⑧ Now let's build an adder. For one digit binary numbers, we have

$$0 + 0 = 0$$

$$0 + 1 = 1$$

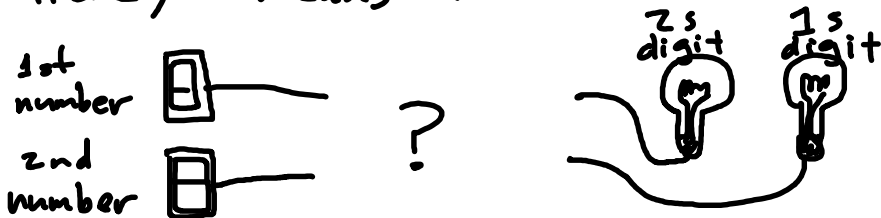
$$1 + 0 = 1$$

$$1 + 1 = 10$$

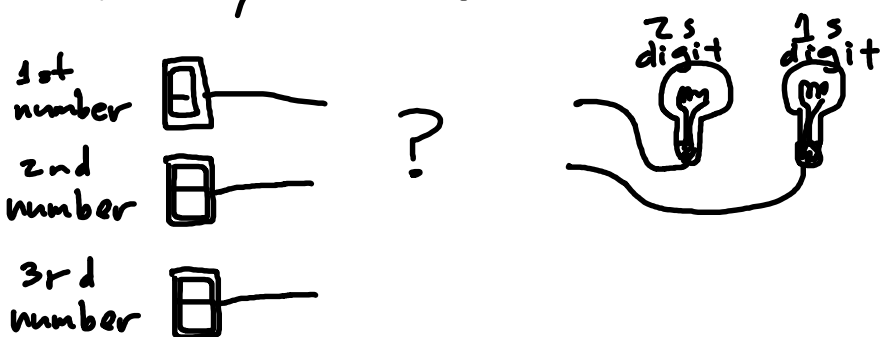
Try to make a circuit with 2 switches as the "inputs" and 2 light bulbs as the 2 digits of the "output" so that we get:

1st switch	2nd switch	1st bulb	2nd bulb
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

Here, 0 means off and 1 means on.



⑨ Now, see if you can make an adder that adds 3 1 digit binary numbers



Here's what you want:

switches:	bulbs:
all off	off - off
one on	off - on
two on	on - off
three on	on - on

The bulbs show a binary number that counts how many switches are on. This is a tricky one. Good luck!