Squishy Logic

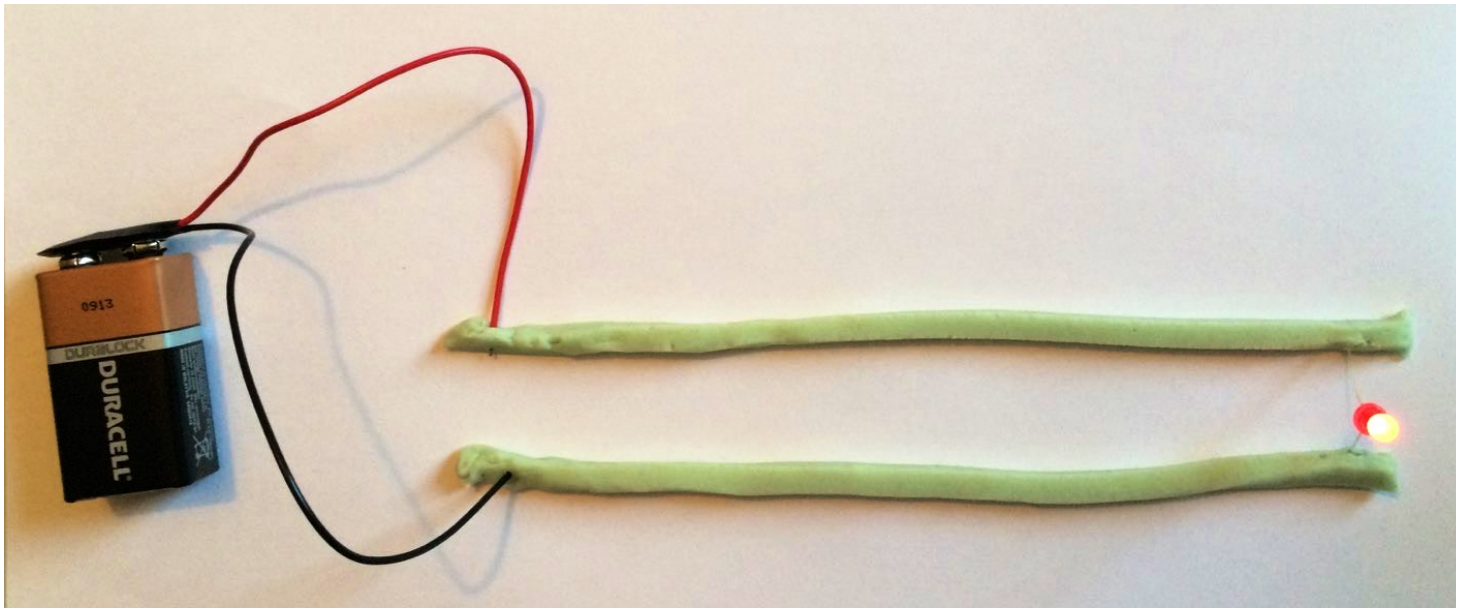
@SteveBattle

Squishy Circuits

- “Squishy circuits are a project from the Playful Learning Lab at the University of St. Thomas. The goal of the project is to design tools and activities which allow kids of all ages to create circuits and explore electronics using play dough.”

- http://courseweb.stthomas.edu/apthomas/SquishyCircuits/

Building a circuit



- 9V Battery (PP3).
- Light Emitting Diode (LED)
- The longer anode connects to +9V (red).
- The shorter *cathode* connects to 0V (black).
- The play dough is a *resistor*. Please don't connect the LED directly to the battery as this will release the magic smoke (bad).

Conductive Dough Recipe

Makes approximately 500g play-dough

- 1 cup water
- 1½ cups of flour
- ¼ cup of salt
- 3 tbsp. Cream of Tartar or 9 tbsp. lemon juice
- 1 tbsp. vegetable oil
- food colouring

Source: http://courseweb.stthomas.edu/apthomas/SquishyCircuits/conductiveDough.htm

Squish-tronics

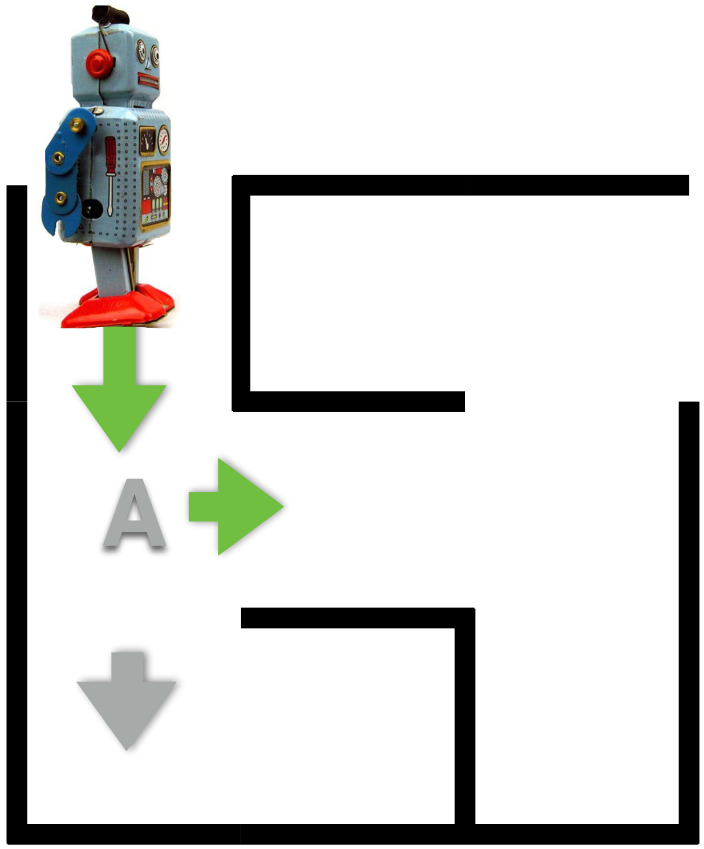
Our mission is to rescue the squishbot from a maze. At each junction the robot's *squish-tronic* brain receives input and it has to make a decision to turn left or right.

- **Input:** The switch can be ON or OFF.
  - Representing **true/false** or **1/0.**

- **Output:** The LED lamp can be ON or OFF
  - Representing a **left** or **right** turn.

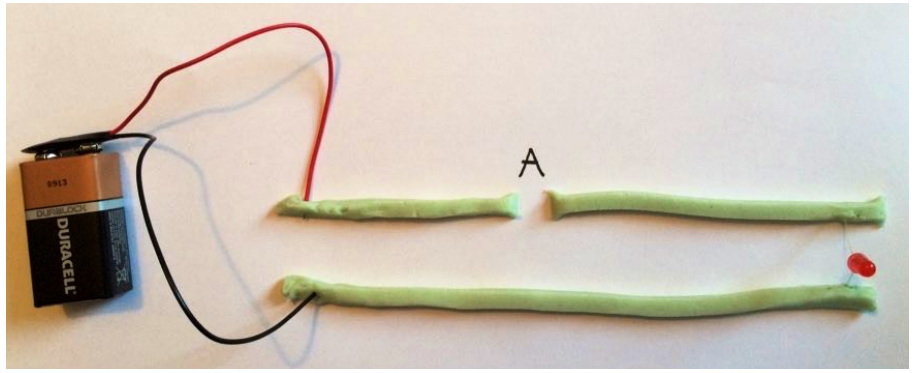
First Challenge

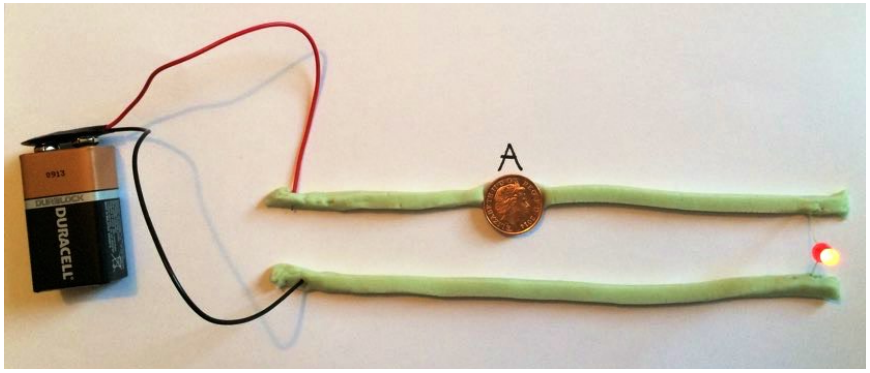
- At the first junction the robot sees a sign ‘A’ on the wall.
- Instruct the robot to turn left (LED ON) if it sees input **A**.



Making a switch

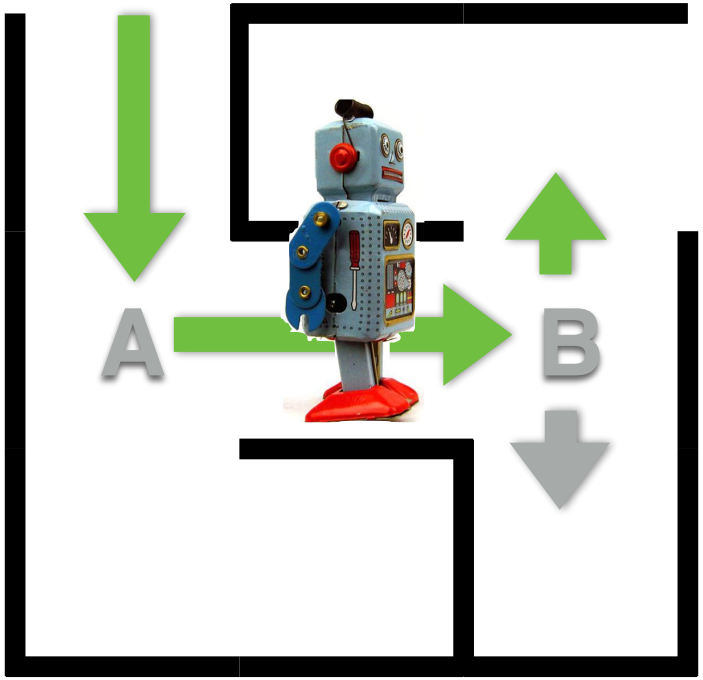
- Cut a gap to break the circuit.
- Place a penny across the gap to make a switch.





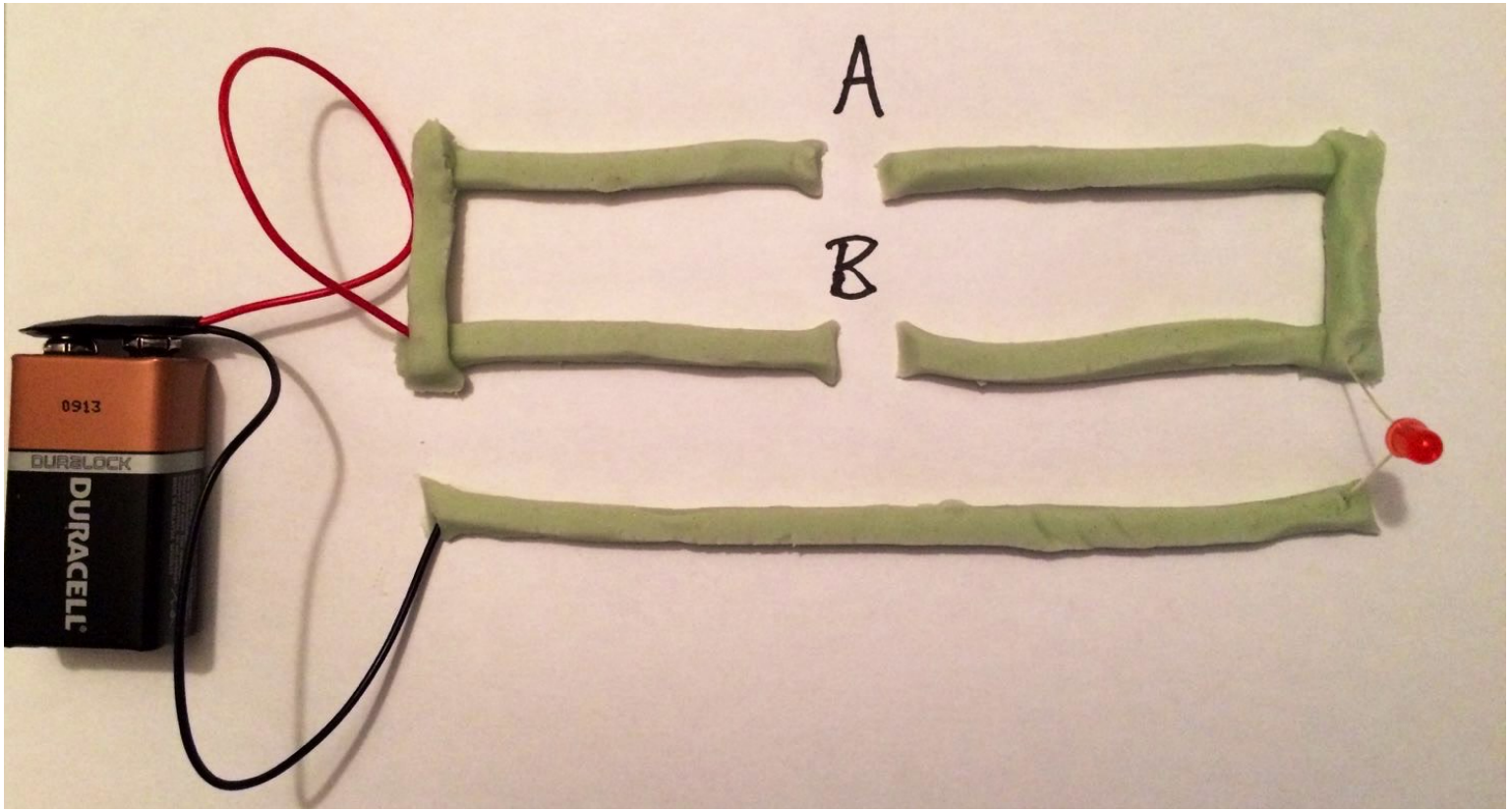
Second Challenge

- At the second junction the robot sees the sign ‘B’ on the wall.
- Instruct the robot to turn left (LED ON) if it sees either input **A, B.**



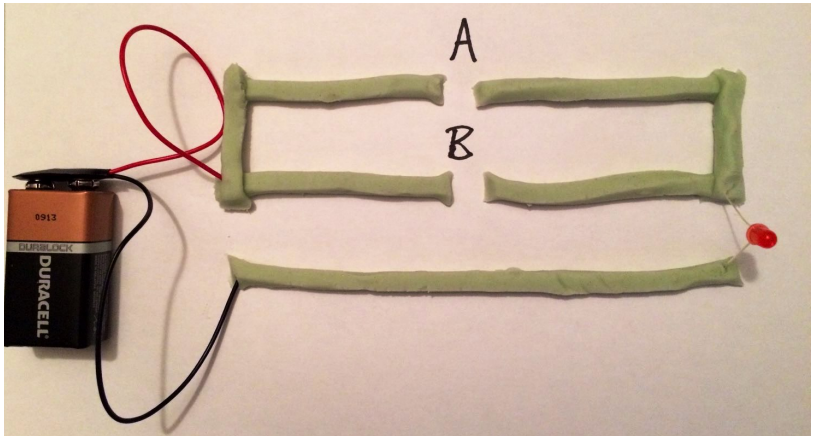
Turn left if:
A or B

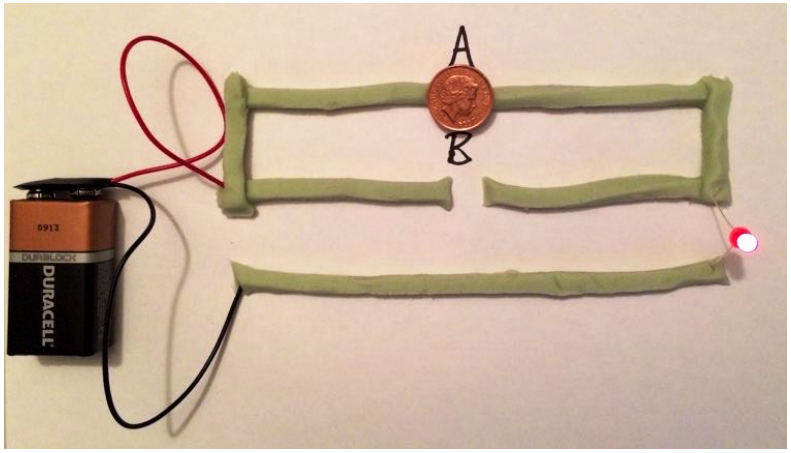
Logical OR

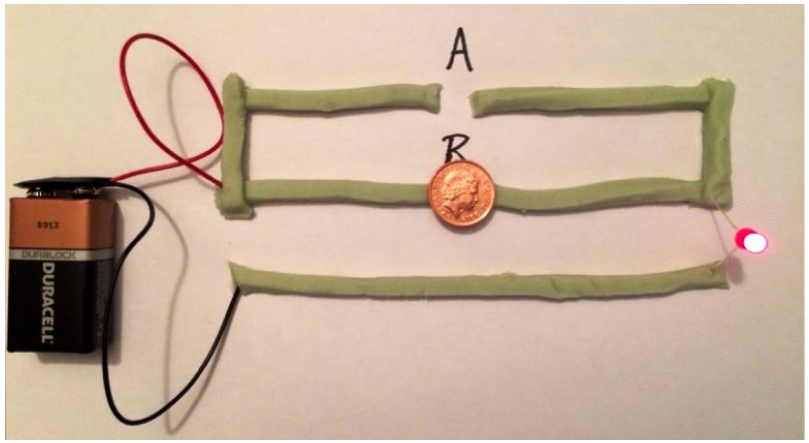


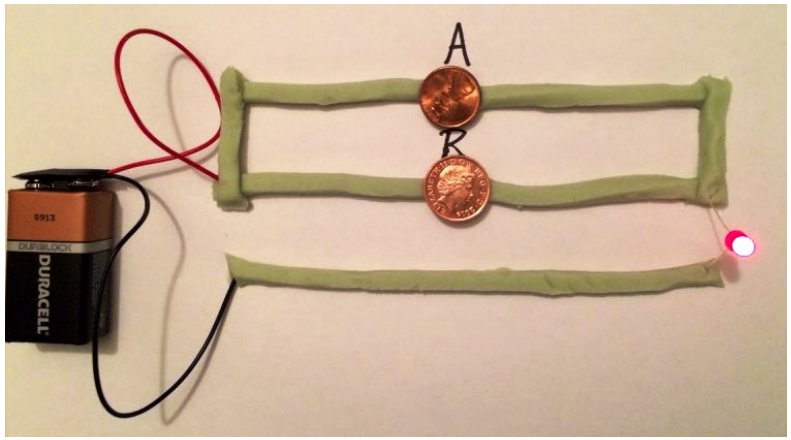
- The electrical current can follow either path.
- The switches are in parallel.

A or B





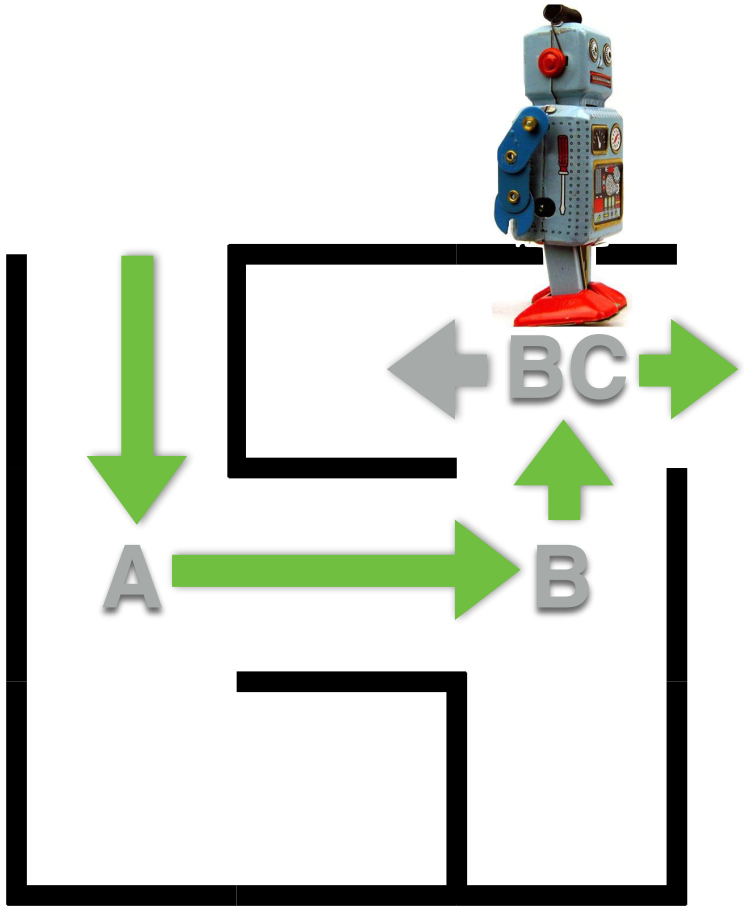




Truth table: A or B

A	B	A∨B
0	0	0
0	1	1
1	0	1
1	1	1

Third Challenge

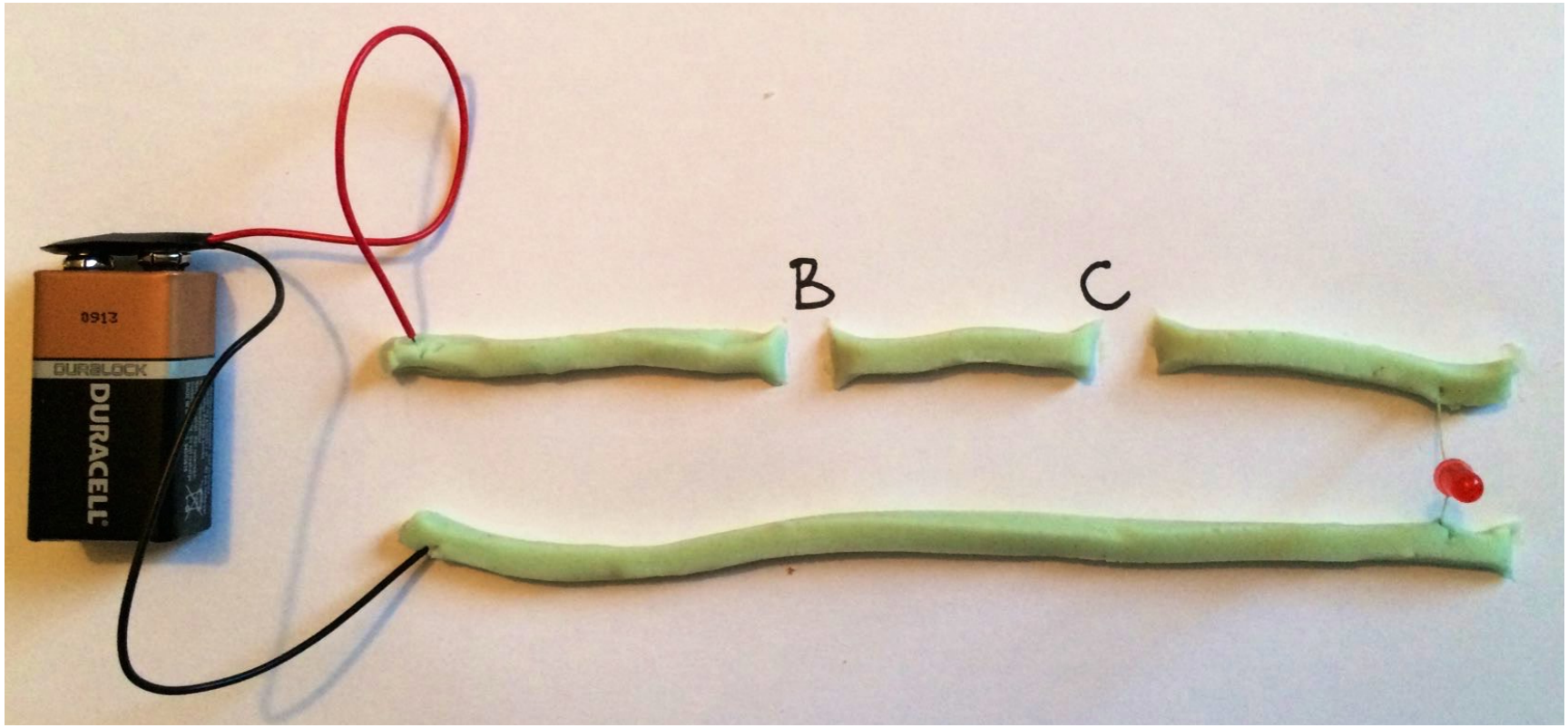


Turn left if
(A or B) and $\overline{C}$

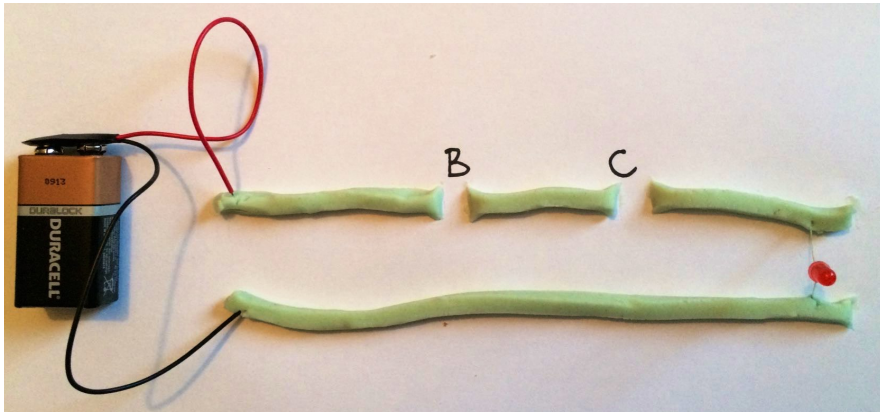
- At the third junction the robot sees the sign ‘BC’ on the wall.
- Whereas before B switches the LED ON, in conjunction with C it must be OFF.

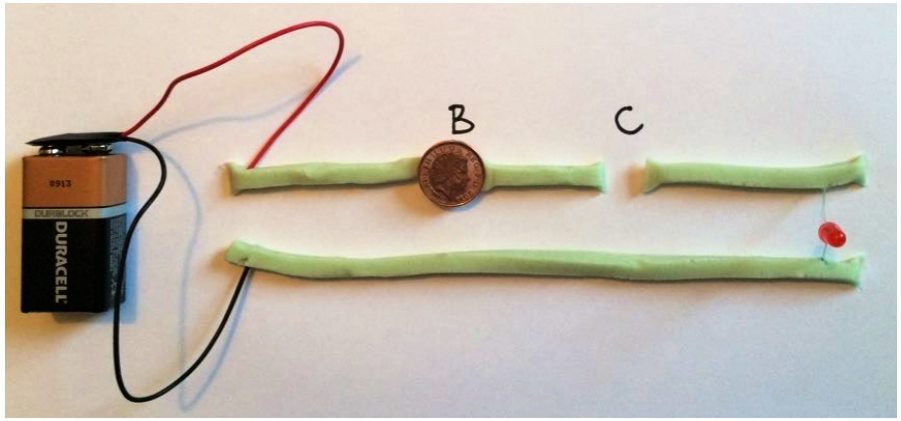
Logical AND

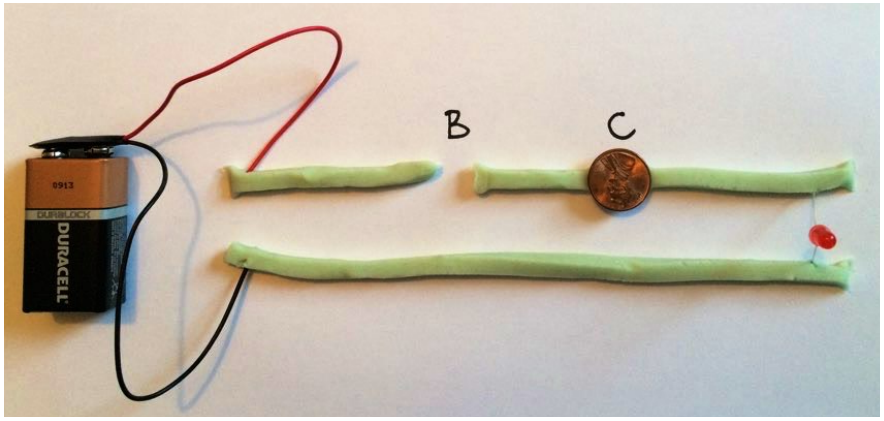
- First of all - look at B AND C.
- The switches B, C are in series.

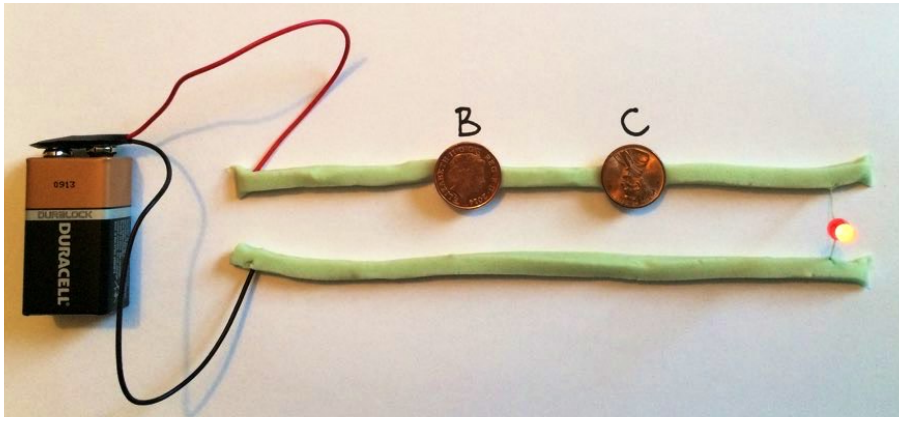


B and C





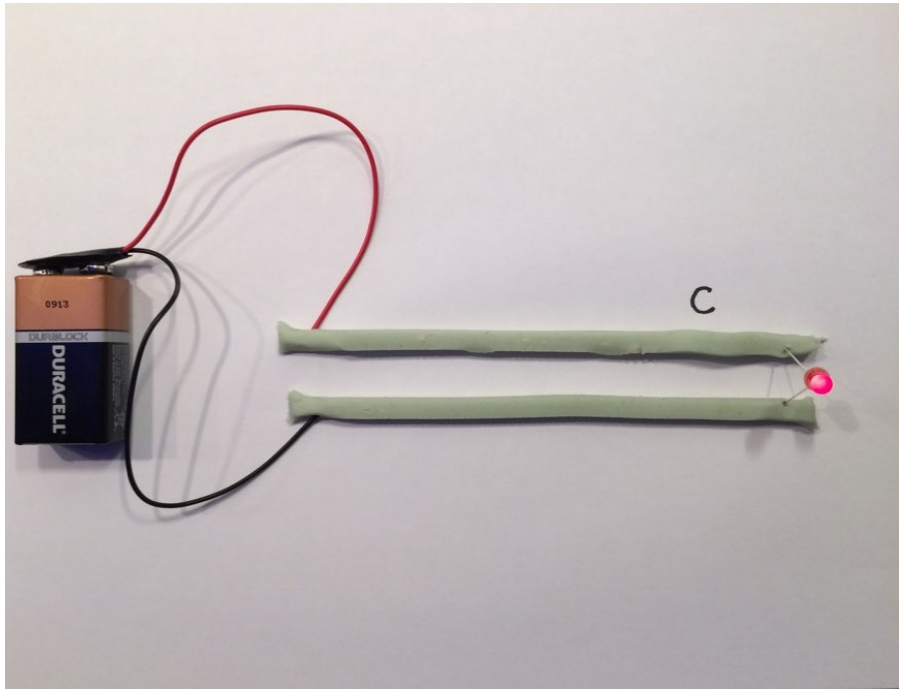


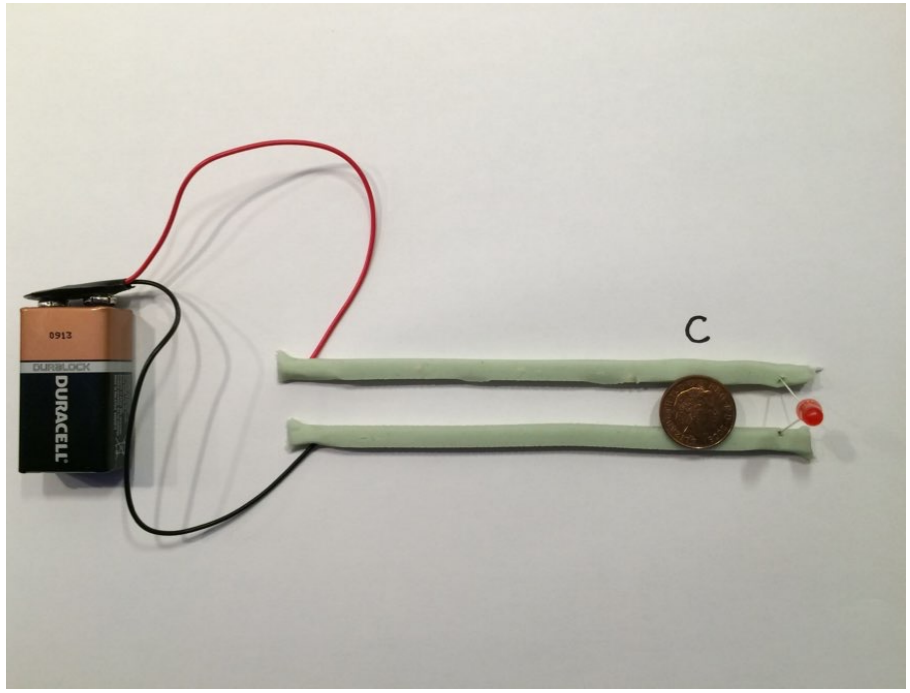


Truth table: A and B

B	C	B∧C
0	0	0
0	1	0
1	0	0
1	1	1

Not C, $\overline{C}$



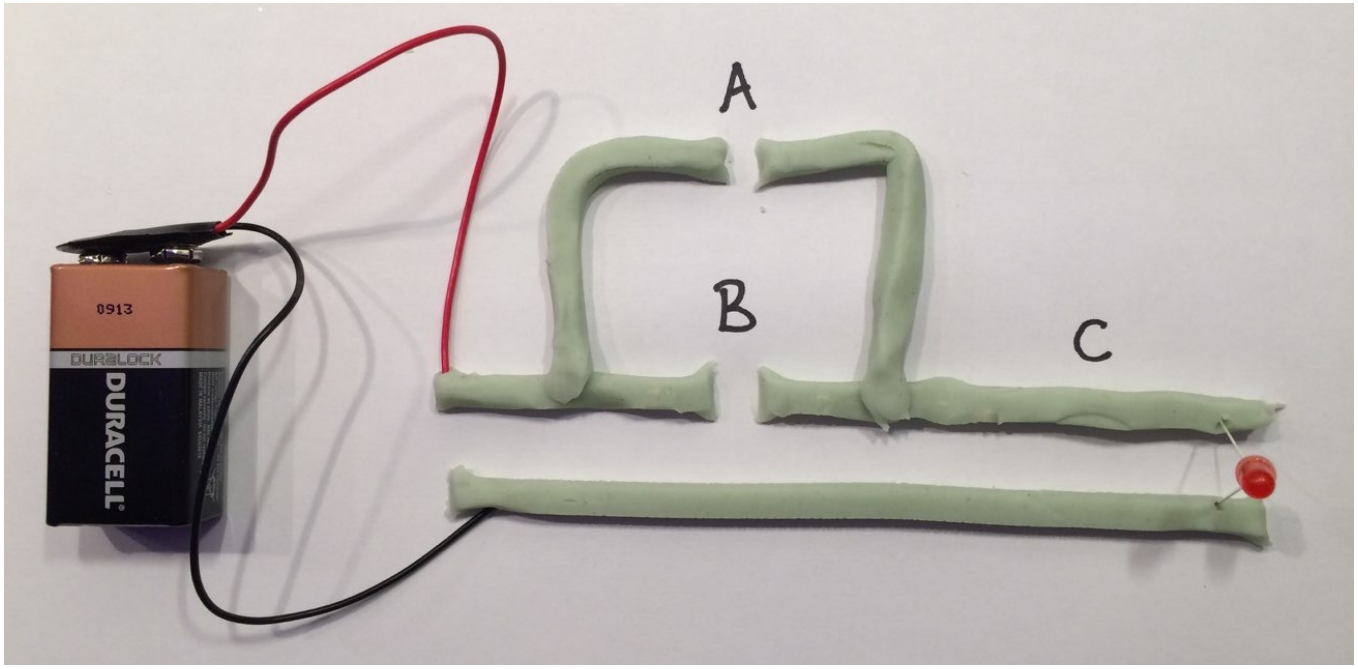


- Electricity tries to take the easy path. The penny is very conductive.
- Adding the penny pulls the circuit down to ground. The play dough is a resistor so this is not a short-circuit. **Never** short-circuit a battery.

Truth table: not C

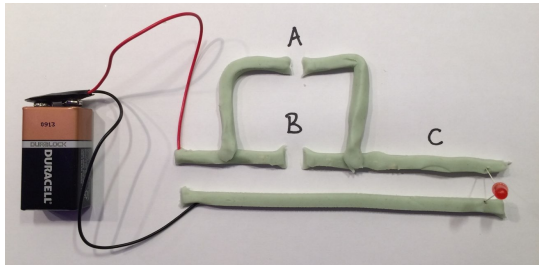
C	$\bar{C}$
0	1
1	0

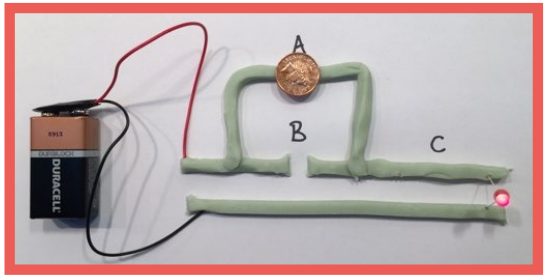
(A or B) and $\overline{C}$



- This combines the parallel circuit (A or B) with the negation (not) of C.

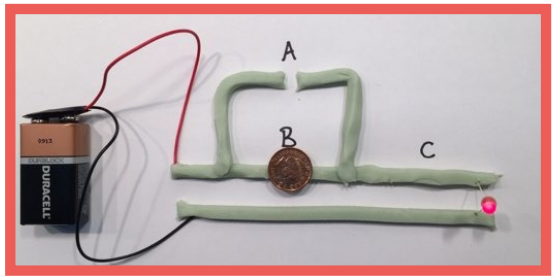
(A or B) and $\overline{C}$

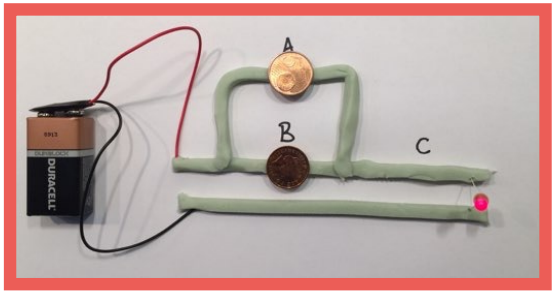


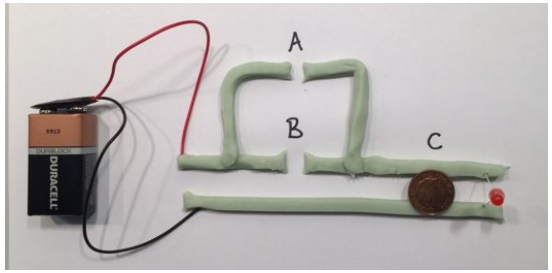


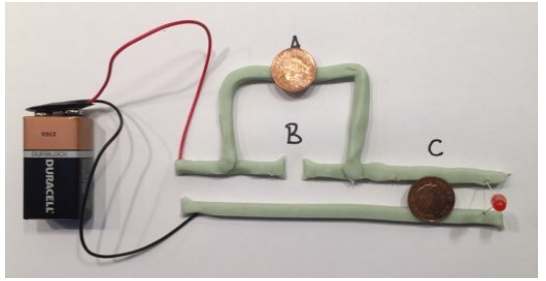
Turn left at the 1st junction.

Turn left at the 2nd junction.

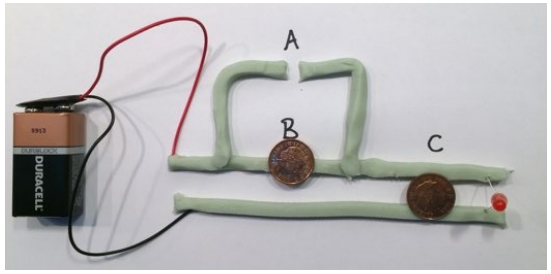


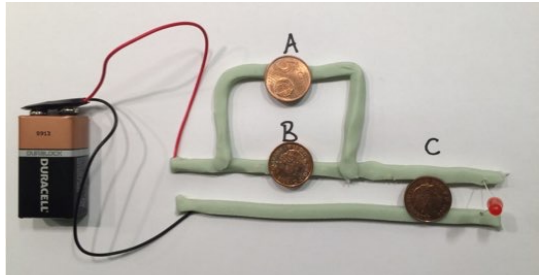






Turn right at the 3rd junction.





Truth table: (A or B) and $\overline{C}$

A	B	C	A∨B	$\overline{C}$	(A∨B)∧$\overline{C}$
0	0	0	0	1	0
0	0	1	0	0	0
0	1	0	1	1	1
0	1	1	1	0	0
1	0	0	1	1	1
1	0	1	1	0	0
1	1	0	1	1	1
1	1	1	1	0	0

- *Electrical logic circuits were first described by Claude Shannon, the creator of information theory, in 1937, "A Symbolic Analysis of Relay and Switching Circuits."*

  http://blog.stevebattle.me