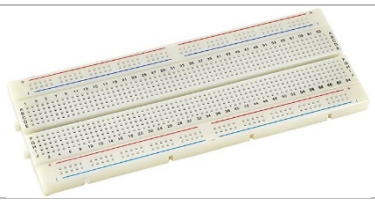
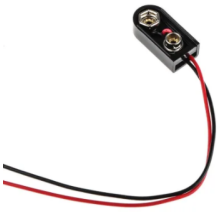
Electronic Dice Build Instructions

Parts List

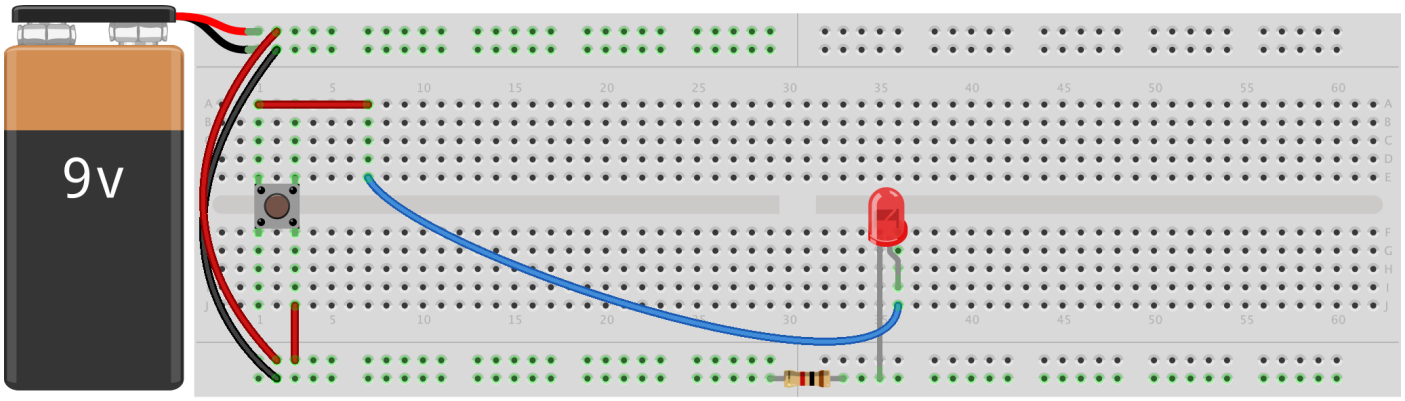
The following parts are required to build the electronic dice

Part	Quantity	
Breadboard	1	
9V Battery	1	
9V Battery Clip	1	
Push Button	1	
Jumper Wires	16	
555 Timer	1	
CD4017 Decade Counter	1	
Red LEDs	6	
1uF Capacitor	1	
1K Resistor	1	
10K Resistor	1	

Stage 1: Wire up the LED, Battery and Switch

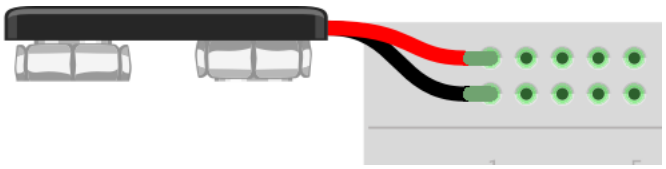
This circuit will light the LED when the button is pressed. It contains a button, a battery, a light-emitting diode (LED) and a resistor to reduce the 9 volts of current from the battery to about 2 volts.
The final circuit will look like this.

Please note that I have coloured the wires in the diagrams to make it a little clearer. You may not have the same colours of wires in your kit. Don't worry! The wire colours are not important.



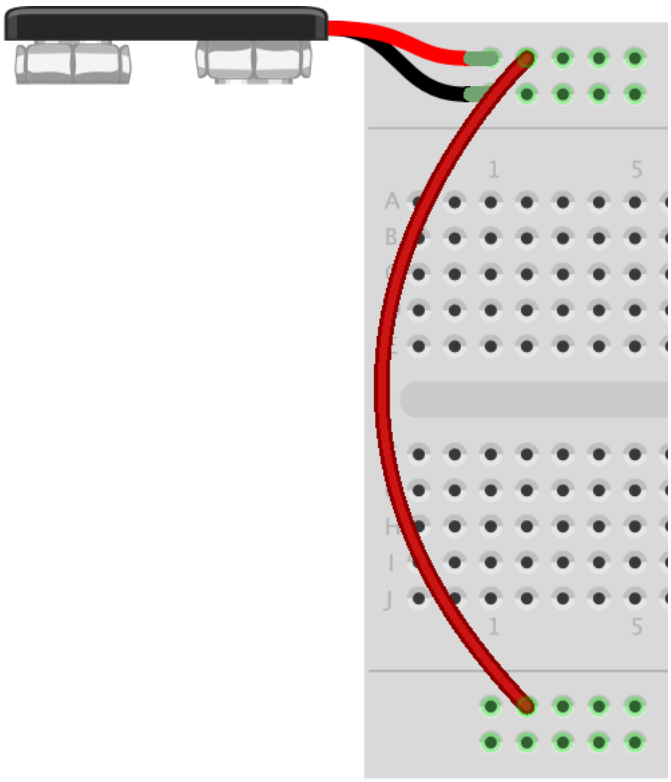
1. Add the battery

Make sure the battery wires are linked up with the red wire at the top. Do not connect the battery yet!

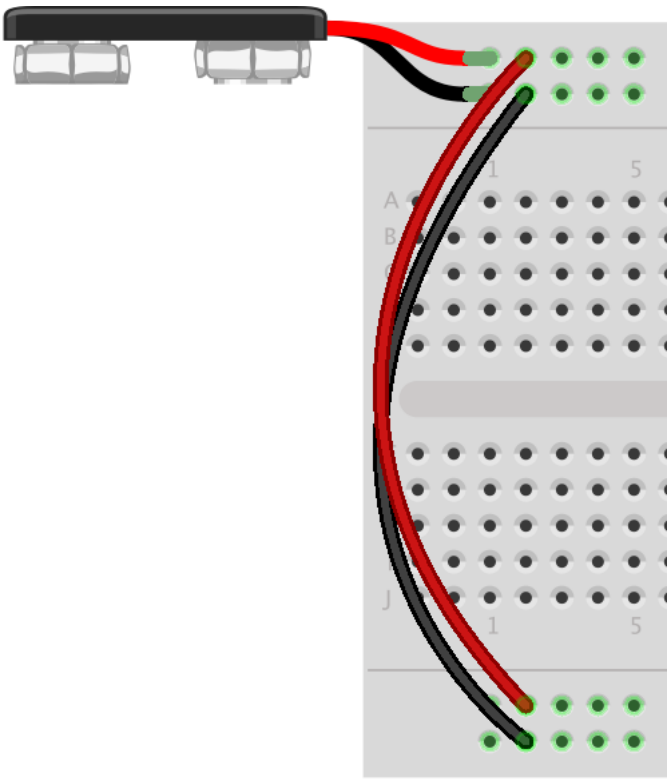


2. Connect the top and bottom of the breadboard

First add a wire from the top to the second row from the bottom as below



Then add a second wire from the second row from the top to the bottom as below

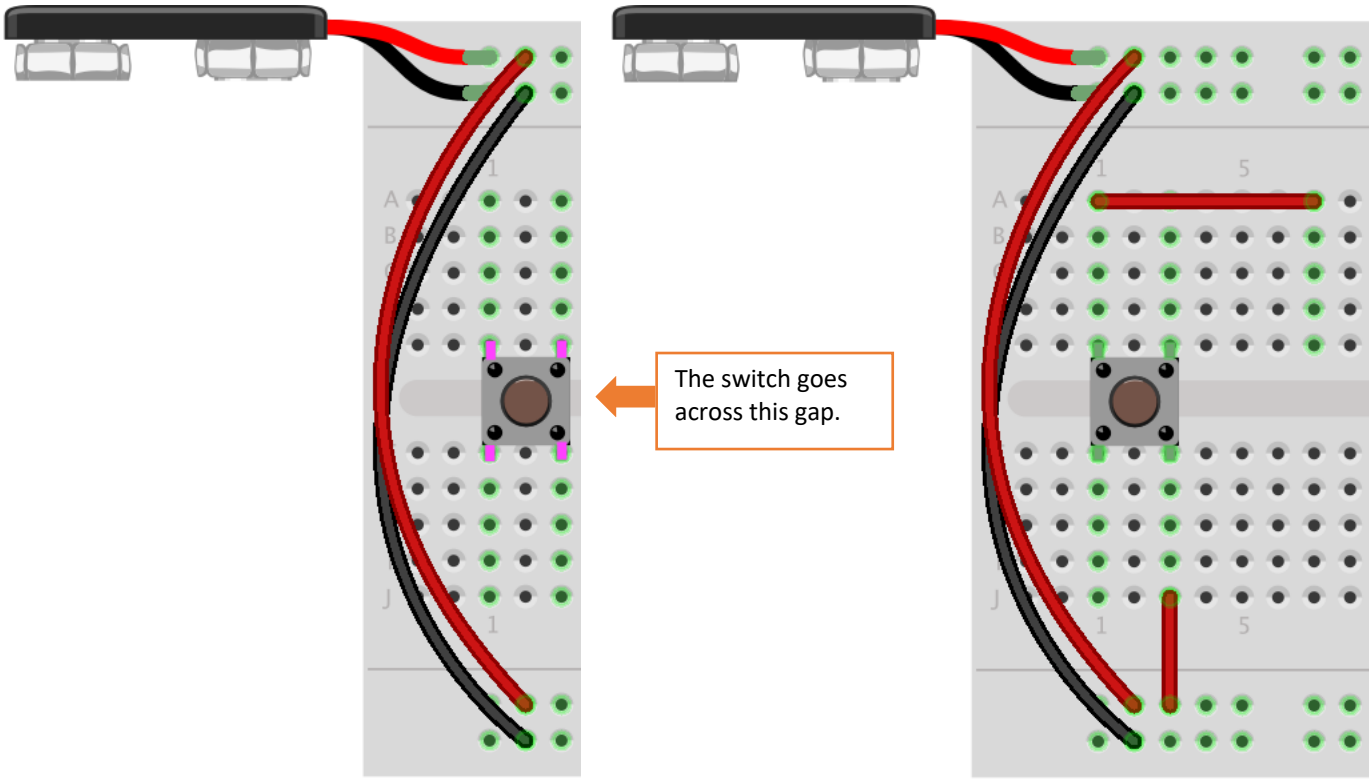


3. Add the button

The button goes across the gap that runs horizontally across the middle of the breadboard.

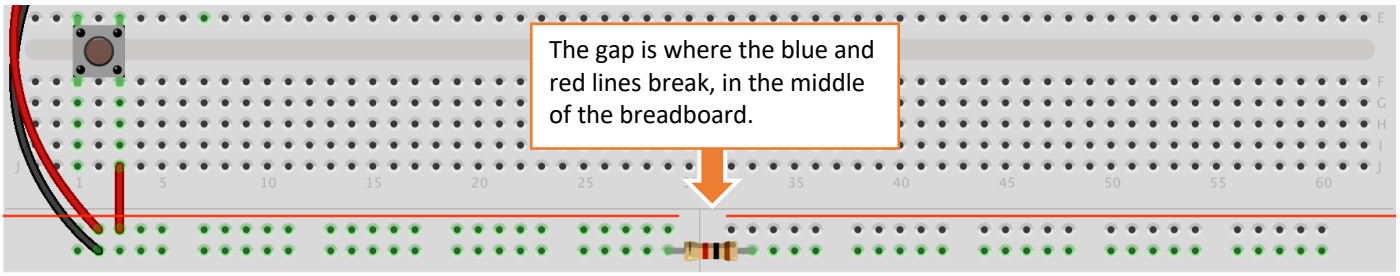
Make sure that the pins of the button are in the holes just above the gap and just below the gap.

Then link up the two wire to the button as below.



4. Add the resistor

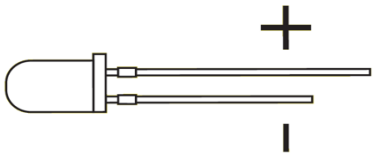
The resistor goes across another gap in the board, this time at the bottom.



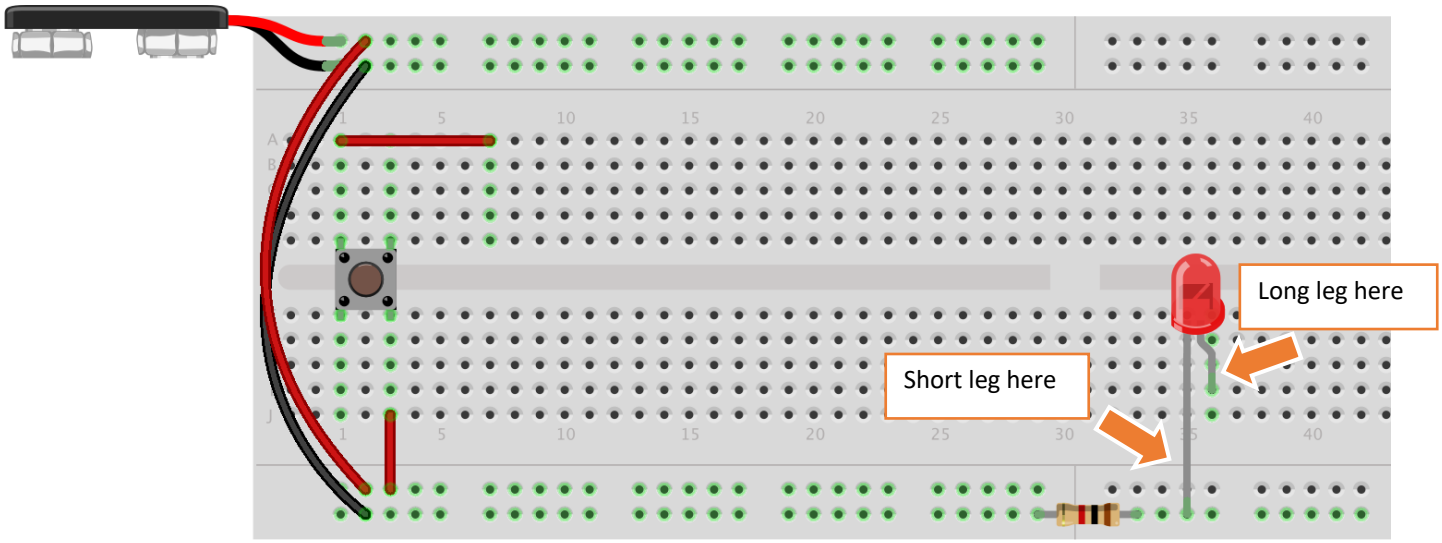
5. Add the LED

LEDs have a polarity, which means that if you wire them in backwards, they do not work.

The + terminal can be identified by its slightly longer leg.



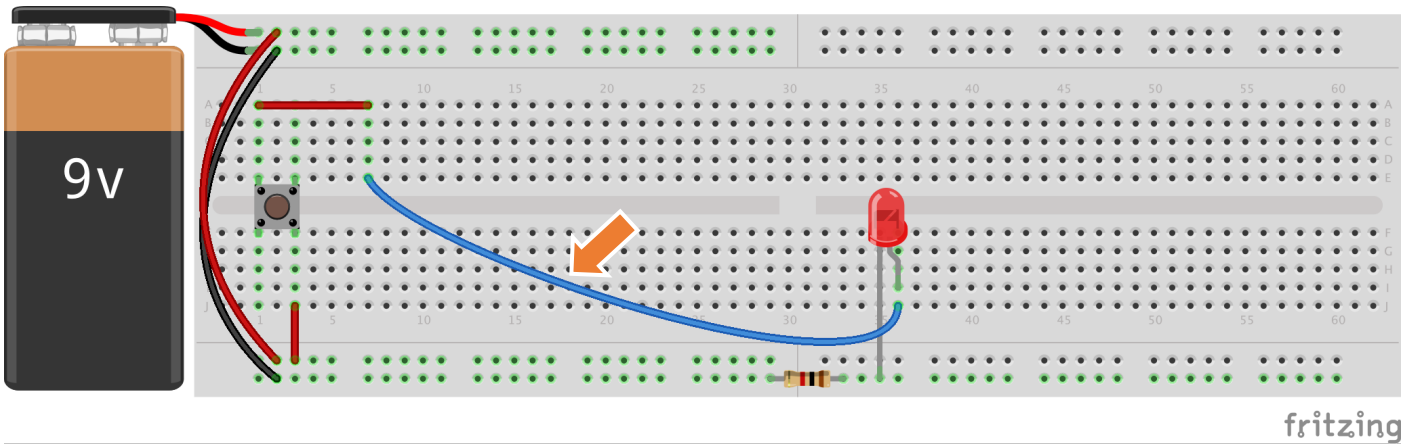
You will need to bend the longer leg a little so that it can connect a few pins up on the breadboard. The shorter negative terminal is going to connect to the blue (-) power rail.
The diagram does make the shorter leg look longer, it's just the way that it is drawn.



6. Link the LED up to the switch and connect the battery.

Add a wire as indicated from the switch to the anode of the LED. Check the wiring, then connect up the battery to test.

Please make sure that you connect the battery up to the connector correctly. If you are not sure, please ask your parents for help. If the battery is connected up backwards, it may damage the circuit.



If you press the button now, the LED should light up.

If the LED does not light up, please check:

1. The battery is connected correctly.
2. All of the wires and components on the breadboard are in the right holes.
3. The shorter wire of the LED is in the bottom row

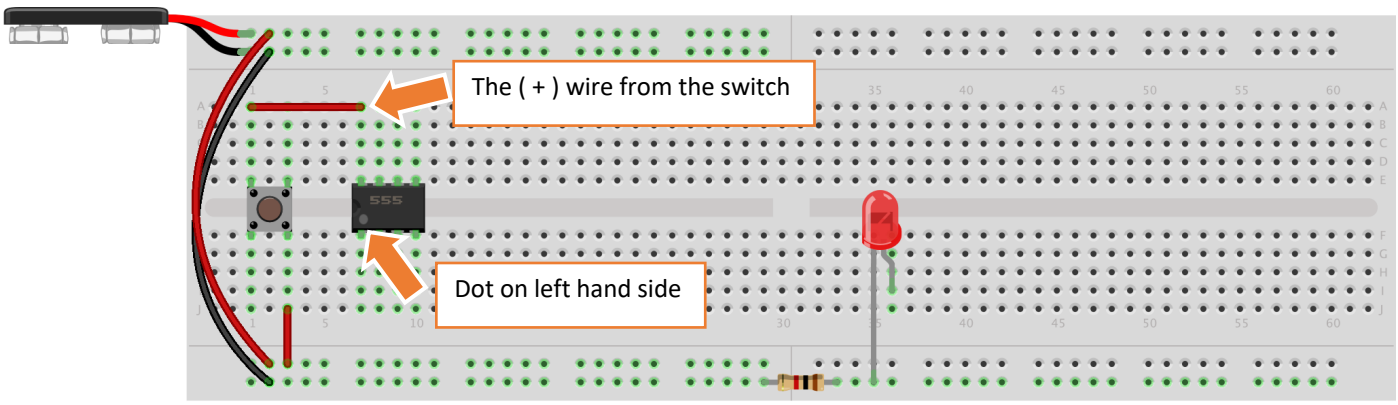
Stage 2: Wire up the 555 Timer

This stage adds the 555 Timer chip to the circuit.

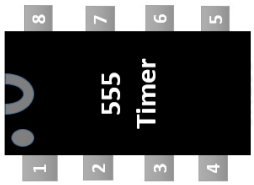
1. Add the chip to the breadboard

The 555 Timer is the small chip with 8 legs.
First, disconnect the battery, and then remove the wire that connects the LED to the switch.

Plug the 555 Timer into the breadboard making sure that the engraved dot on the chip is on the left-hand side, and the top-left leg is in the same row of holes as the red wire from the switch. The legs on the chip may need to be bent in ever so slightly in order to fit in the breadboard holes



The dot indicates where pin (or leg) 1 of the chip is.

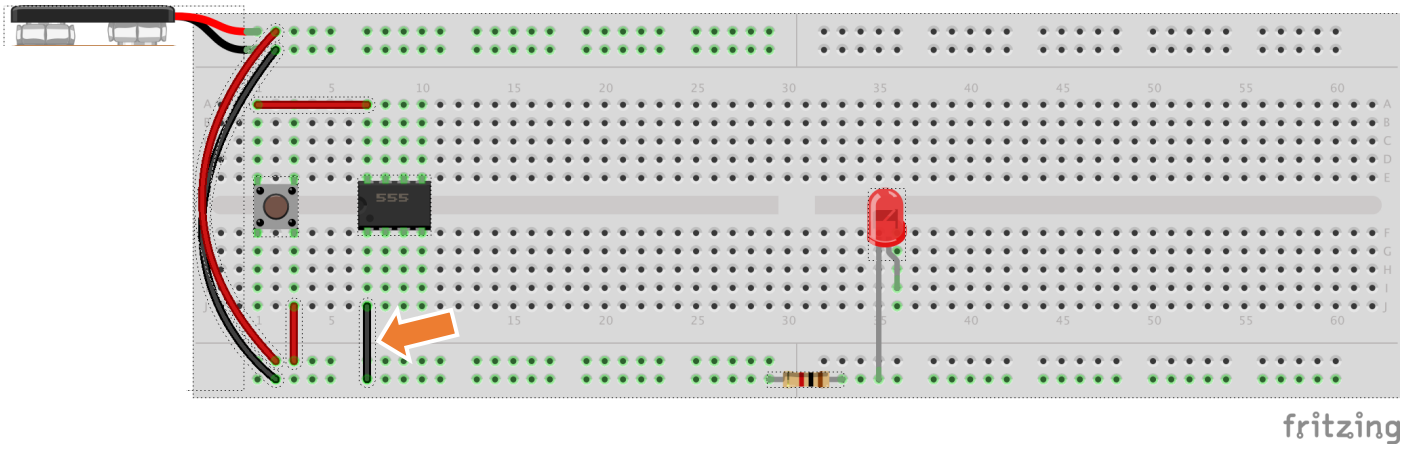


Pin 1: Ground (or -)
Pin 2: Trigger
Pin 3: Output
Pin 4: Reset
Pin 5: Control
Pin 6: Threshold
Pin 7: Discharge
Pin 8: Vcc (or +)

Chip pins are usually numbered from the bottom, left to right, then from the top, right to left.

2. Add power to the chip

To complete the power circuit to the chip, pin 1 needs to be connected to blue (-) power rail.
The (+) power wire is already in place; the red wire connecting the switch to pin 8.

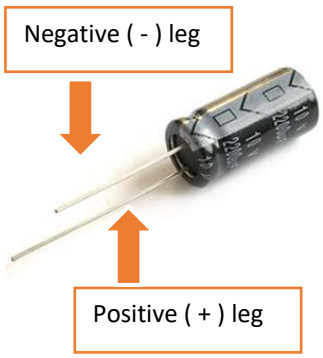


Add a wire from pin 1 as indicated to the blue (-) power rail at the bottom of the board.

3. Connect up the 555 timer

The timer is set up in this circuit to generate a regular voltage pulse. It is like a very fast ticking clock, and in electronics it is common to call this a clock signal or clock pulse. In order to do that, we have to connect a capacitor and a resistor to the 555 timer to set the frequency (or how fast we want those pulses), and connect a couple of pins so that the 555 timer will do this more than once.

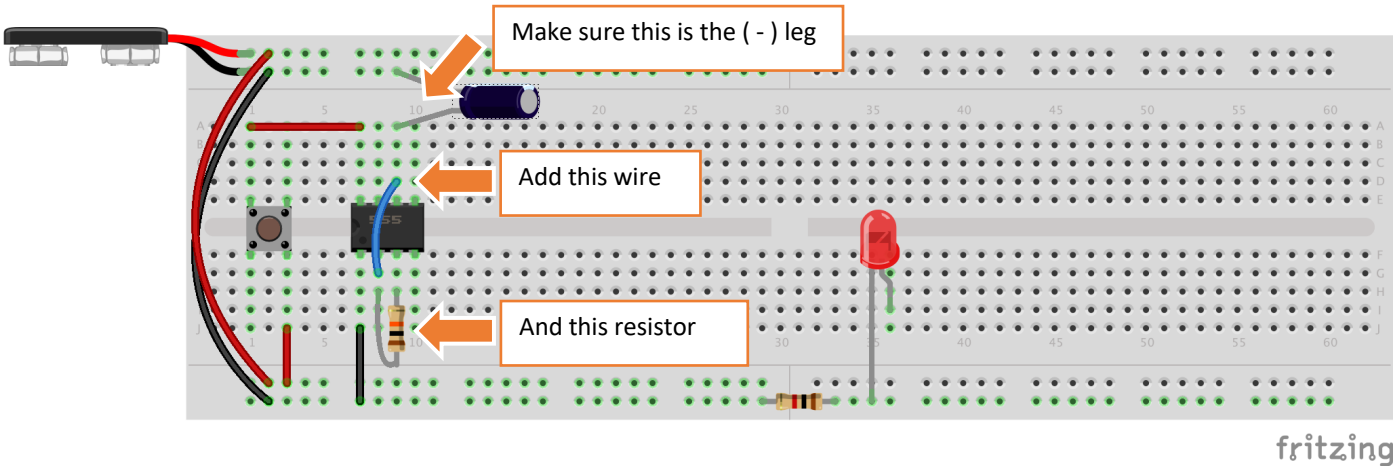
Connect the 10K resistor so that one leg is connected to pin 2 of the 555 timer, and the other is connected to pin 3, and use a short wire to connect pin 2 of the 555 timer to pin 6.



Now connect the 1uF capacitor. Electrolytic capacitors have a polarity, like a battery. It is important that they are connected the right way otherwise the circuit may not work, and it will eventually damage the capacitor.

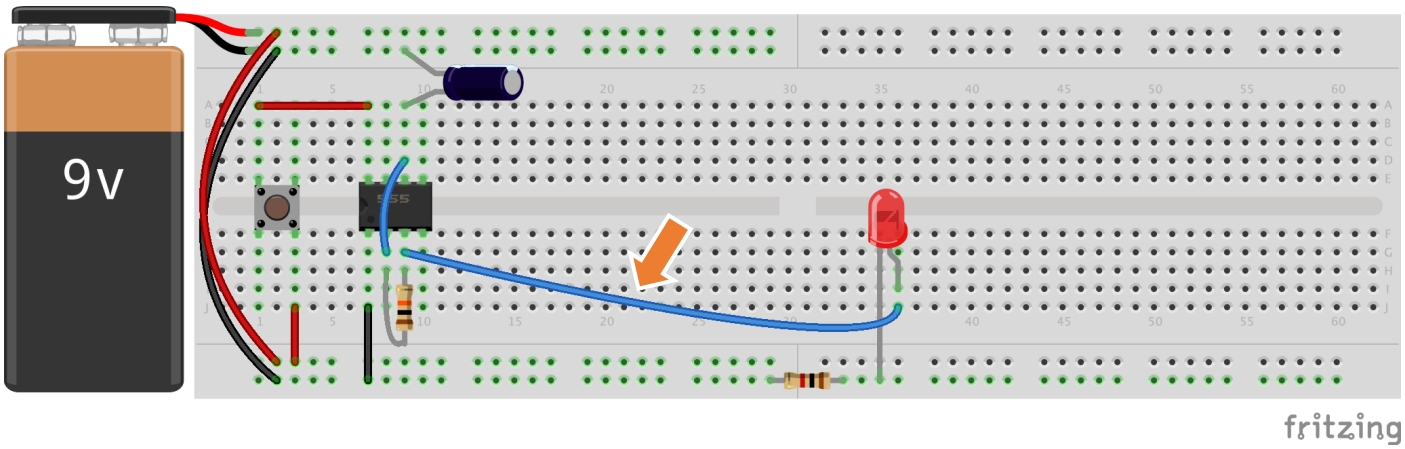
The negative leg is usually the shorter of the two legs, and is also on the same side as a distinct stripe with (-) signs printed on the capacitor body.

Connect the capacitor on the breadboard so that the positive leg is connected to pin 5 of the 555 timer, and the negative leg is connected to the blue (-) power rail.



4. Connect up the LED

Connect the final wire between pin 3 of the 555 timer and the anode of the LED.



Check the wiring, connect the battery and test by pressing the button. Note that the LED will light up. It is actually flashing but is too fast to see with the naked eye. You may be able to check it is flashing by viewing it in a webcam or camera phone.

If the LED does not light up, disconnect the battery and check your wiring.

Stage 3: Wire up the 4017 Decade Counter

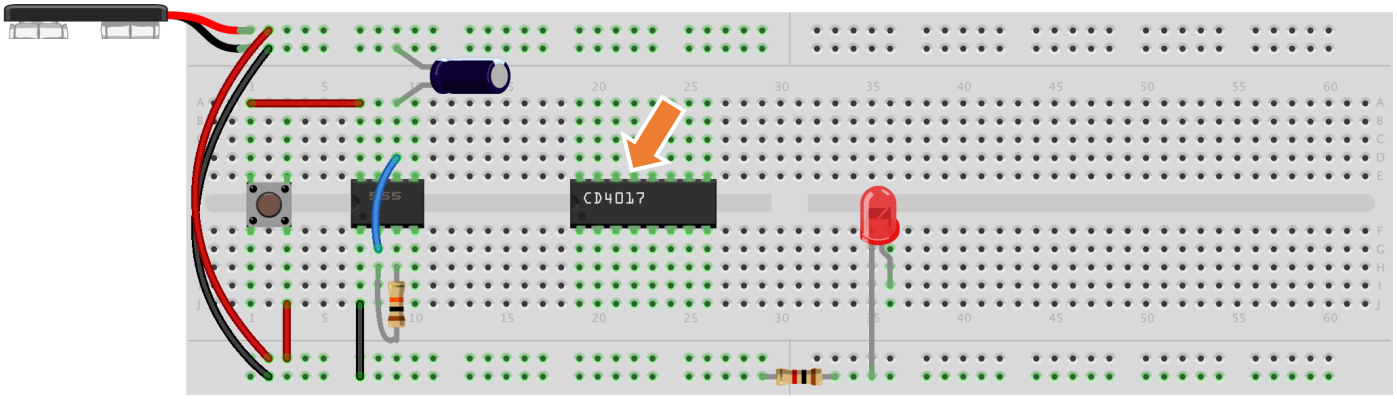
The final stage adds the 4017 Decade Counter to the circuit, and the remaining 5 LEDs. A decade counter is a chip that will count a decade (from 0 to 9).

1. Add the chip to the breadboard

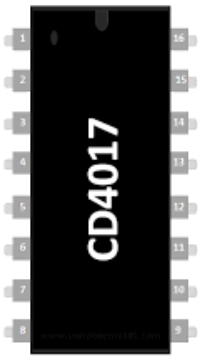
The 4017 Decade Counter is the longer chip with 16 legs.

First, disconnect the battery and remove the wire that connects the 555 Timer to the LED.

Plug the 4017 Timer into the breadboard making sure that the notch on the chip is on the left-hand side. Place it as indicated on the breadboard. The legs on the chip may need to be bent in ever so slightly in order to fit in the breadboard holes



The notch indicates where pin (or leg) 1 of the chip is.



Pin 1: Output 5
Pin 2: Output 1
Pin 3: Output 0
Pin 4: Output 2
Pin 5: Output 6
Pin 6: Output 7
Pin 7: Output 3
Pin 8: Ground (or -)

Pin 9: Output 8
Pin 10: Output 4
Pin 11: Output 9
Pin 12: Carry Out
Pin 13: Enable
Pin 14: Clock
Pin 15: Reset
Pin 16: Vcc (or +)

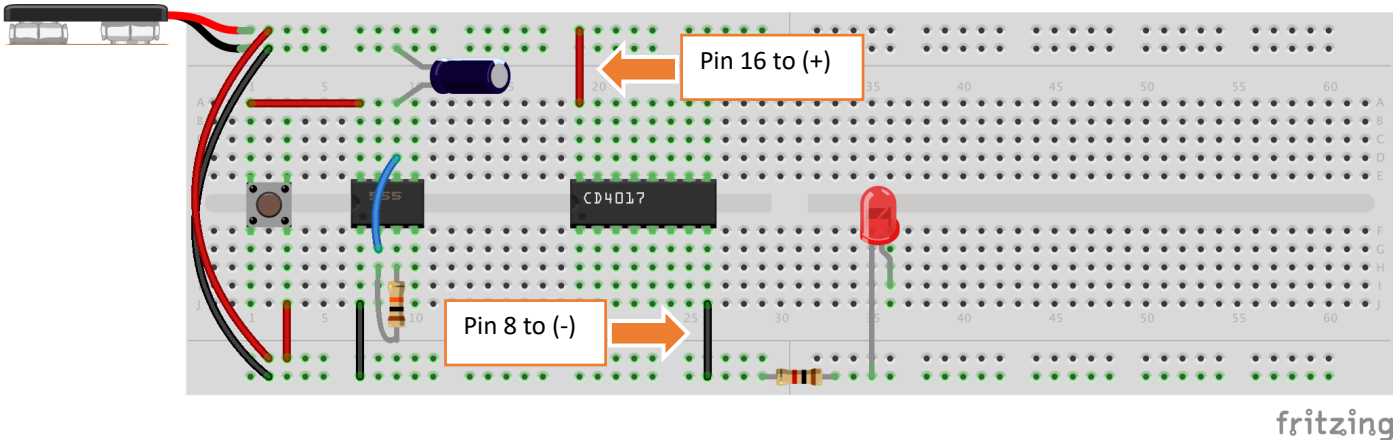
Remember, chip pins are usually numbered from the bottom, left to right, then from the top, right to left.

As the chip counts, it will apply power to just 1 of the outputs.

It will count every time it gets a pulse on pin 14 (Clock).

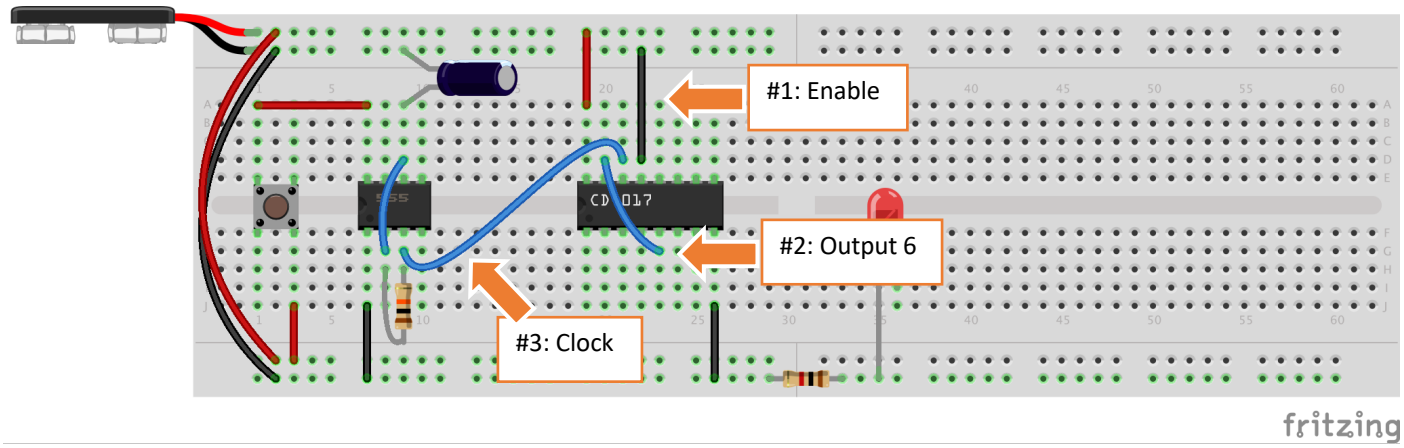
2. Add power to the chip

Connect pin 8 to (-) and pin 16 to (+)



3. Connect up the 4017 Decade Counter

We now need to add three more more wires:



Wire #1:

Connect Pin 13 (enable) to the (-) power rail.

This is a control pin to enable or disable the chip. This is 'active low', so needs to be 'pulled low', in other words connected to (-) to enable the chip.

Wire #2:

Connect Pin 5 (output 6) to Pin 15 (reset).

This is another control pin to reset to chip back to '0' when a voltage is applied to it. Wiring it up to output 6 will make it count from 0 to 5.

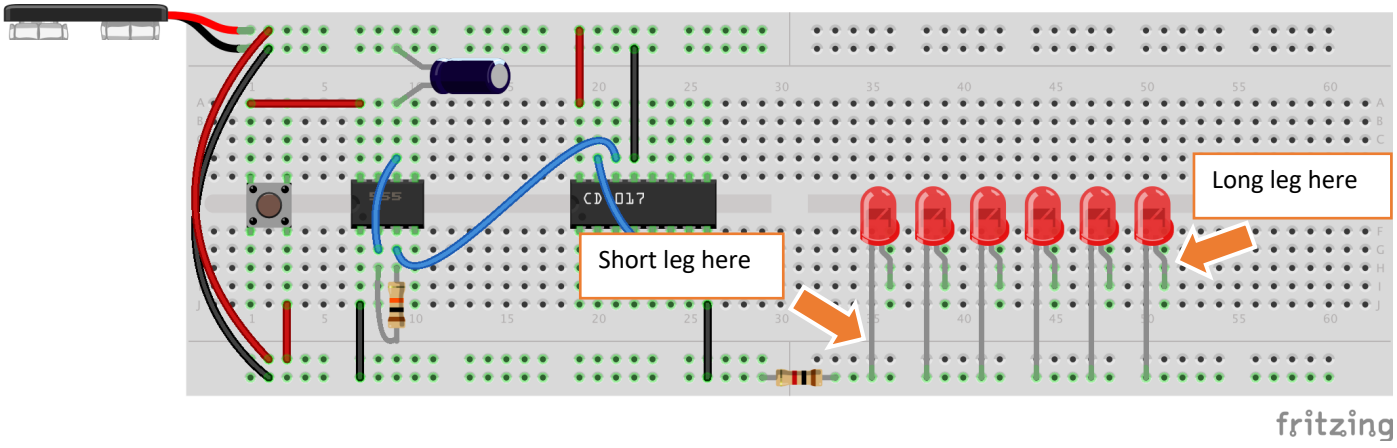
Wire #3:

This connects the pin 3 (output) of the 555 timer to pin 14 (clock input) of the decade counter.

Every time the decade counter gets a tick (pulse) from the 555 timer output, it will count by applying a voltage to the next output pin in sequence. If it gets to 9, or is reset, it will start at 0 again.

4. Put the remaining LEDs on the board

Remember about polarity; bend the long leg and put the short leg on (-). Space them apart every 2 or 3 holes.

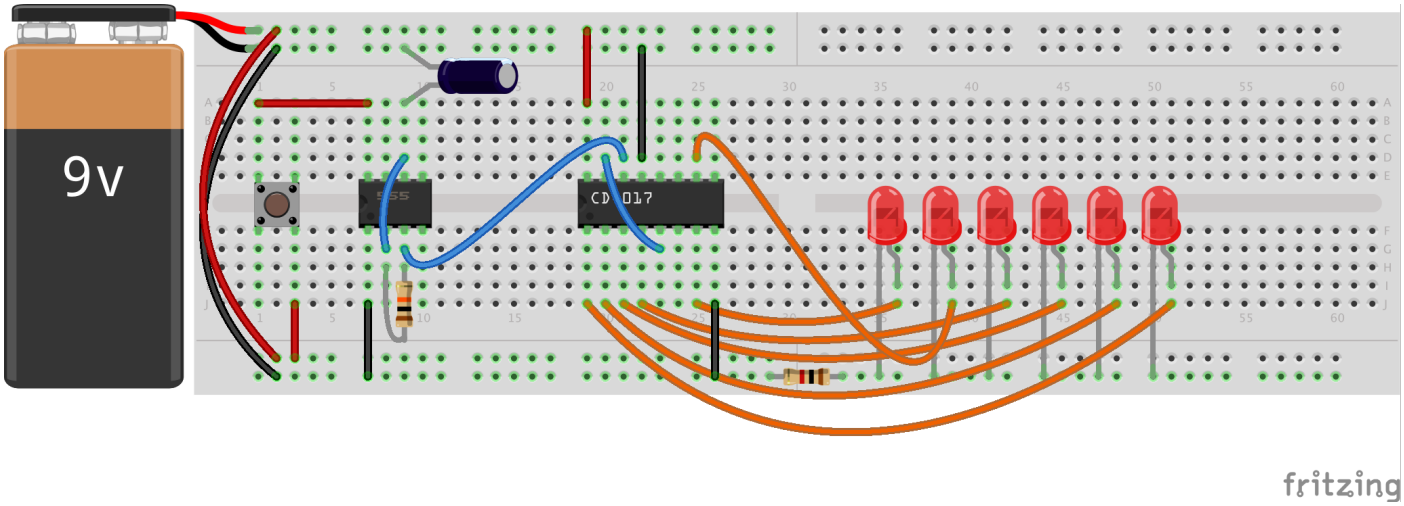


5. Wire up the LEDs and test

The anodes of the LEDs are wired up directly to the following pins of the 4017

- LED 1 is connected to Pin 7
- LED 2 is connected to Pin 10
- LED 3 is connected to Pin 4
- LED 4 is connected to Pin 3
- LED 5 is connected to Pin 2
- LED 6 is connected to Pin 1

As long as you only connect the LEDs to Pins 1,2,3,4,7 and 10 it doesn't particularly matter which LED each of those pins connects to.



Finally, to test the completed circuit.

Check the wiring, connect the battery and test by pressing the button. The LEDs should flash whilst the button is held. When the button is released, one of the LEDs should remain lit.

The LED that remains lit is your dice throw, so the first LED is like throwing a '1' and the last LED is like throwing a '6'.

If the LEDs do not flash, disconnect the battery and check your wiring.

If it works, congratulations! You've just built an electronic dice.

Important: Please don't forget to disconnect the battery when not in use; the circuit will eventually flatten it if left plugged in.