Breadboard Electronics

Starter Circuits

Introduction

This book was primarily created to supplement the Breadboard Electronics short videos that are available to view on YouTube and via BreadboardElectronics.co.uk.

You do not require the book to watch the videos or vice-versa, because they are both created with the same material.

However, this book was borne out of requests to have a hard copy of the video material to have something to refer to and maybe annotate, whilst offline.

About Breadboard Electronics

Breadboard Electronics is about encouraging people, young and old alike, to explore the world of electronics without the necessity to know the theory behind what is going on.

There are so many people that shy away from electronics because of the theory and mathematics required. Some people are 'just not good at sums', but they have ideas, they want to tinker, they want to 'have a go' at making something come alive.

Then there are those that are learning the theory at school or college and want to put what they have learnt into practise at home.

That's where we come in.

Our circuits and their accompanying videos are all tried and tested; we know that they work, so you can be assured that yours will too.

The Starter Kit

This book, although based on the videos, is also based on our Starter Kit that is available through our website BreadboardElectronics.co.uk.

The kit is comprised of various common components and if you have been tinkering for any amount of time you may already have most, if not all components.

The Starter Kit contains all of the components that are required to complete all of the circuits. The breadboard approach is so that you can make something, get it working, learn from it, then take it apart and re-use the components.

It does not contain thousands of components that you will own but probably never use, but it does contain what you need for all of our starter circuits, in an affordable way.

The complete list is:-

- 830 hole breadboard.
- Multimeter, leads and battery (tested before packaging).
- Battery holder for 4 x AA batteries (batteries not supplied).
- Resistors 5 of each 47Ω, 100Ω, 220Ω, 330Ω, 470Ω, 1kΩ, 2kΩ, 4.7kΩ, 9.1kΩ, 18kΩ, 47kΩ, 200kΩ, 470kΩ.
- Capacitors 5 of each 4.7µF e, 22 µF e, 47 µF e, 100 µF e, 470 µF e. (e = electrolytic)
- Capacitors 5 of each 1 µF, 100nF.
- Transistors 4 of each 2N3904 NPN, 2N3906 PNP.
- 2 X General purpose Diodes.
- 2 X Thermistors.
- 2 X Light Dependent Resistors.
- 2 X 555 Timer ICs.
- 1 X Op-Amp IC 4558 or 5532.
- 1 X Decade counter IC 4017.
- 5mm LEDs 10 of each Red, Yellow, Green.
- Trimmer potentiometers 1 X 1kΩ, 2 X 10kΩ, 2 X 100kΩ (different types/styles).
- 1 X Buzzer.
- 1 of each self-locking push switch, slide switch, small and large momentary switches.
- A bundle of 65 male to male jumper wires.
- And a 15 compartment box to hold your components.

Spares and add-ons can also be purchased through our website if required.

Contents

Video Links (to YouTube)

What is a breadboard?

Components

Project 1: Turn Led On: Hello World

Project 2: Turn LED on: Variable.

Project 3: Turn LED on: Variable.

Project 4: Toggle LEDs.

Project 5: Potential Divider.

Project 6: Potential Divider Extended.

Project 7: Transistor as a Switch.

Project 8: Transistor as a Switch with LDR.

Project 9: Transistor as a Switch with LDR part two.

Project 10: Transistor as a Switch – LED Dimmer.

Project 11: Transistor as a Switch – LED Dimmer part two.

Project 12: Simple Timer.

Project 13: Cats Eyes using an Astable Multivibrator.

Project 14: Transistor Astable.

Project 15: Timer with a 555 Integrated Circuit.

Project 16: Timer on Oscilloscope.

Project 17: Astable and Monostable.

Project 18: Gated 555 Timer.

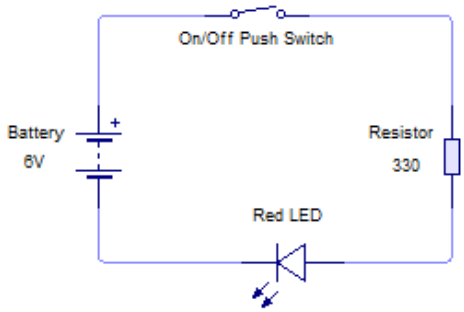
Project 19: Diminishing Frequency Astable.

Project 20: More Monostable: Delay Timer.

Project 1: Turn Led On: Hello World

Parts.
6v power supply
Breadboard
Momentary switch
330R resistor
Red LED
Connecting wires

Note: The 330R resistor will allow for different colour LEDs without destroying them.
To be more accurate (if you know the values for the LED) use Ohms Law.
Or you can check on this web site
http://www.ohmslawcalculator.com/led-resistor-calculator



We are not here to teach you Ohms Law or where to apply it, or even maths.
Actually, we are not here to teach you anything.

We are here to give you the opportunity to practice, experiment with, and consolidate, what you have already been learning, in a cost effective manner.

If you are studying electronics at School or College then I am certain that the math is being taught there.

There is so much good information already on the Internet explaining this subject that we decided very early on, not to add more to the confusion.

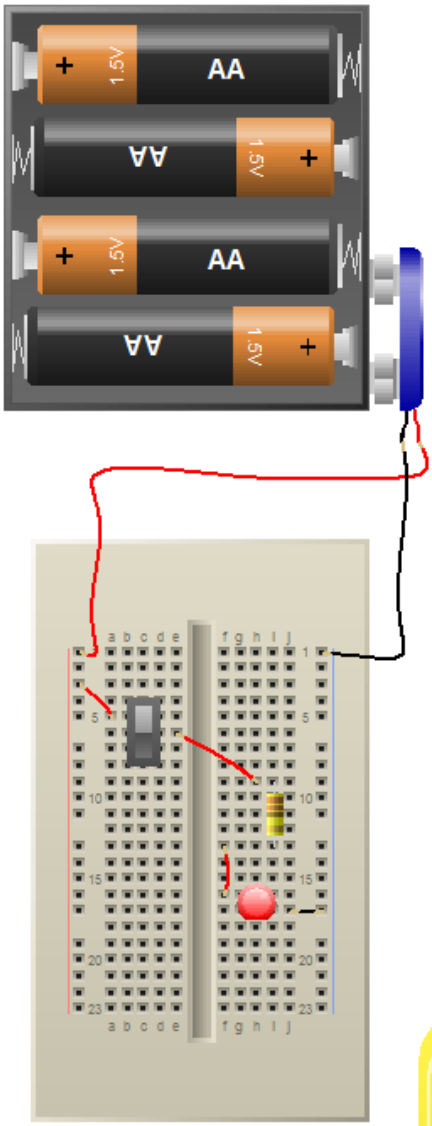
In our presentations and videos of the circuits, all we give is a brief explanation of what it is for and maybe a few tips and pointers on the way.
The rest is up to you, play with the circuit, change it slightly, alter the values of resistors (or add a variable resistor) and capacitors to see what the result may be.
Sometimes there may be a dramatic change, sometimes no change, but by experimentation you will learn more quickly and if you need to do the math on the way, then that will help consolidate that too.

Unfortunately, what we cannot stop is you destroying some of your components through experimentation.
But, just knowing that they can be destroyed is a good thing because it will make you think about your circuit.

If you know that your transistor can only handle 3 volt, don't expect it to work after shoving 12 volt through it.
Different LEDs can range between 2.5 and 3.5 volts, so use your multimeter before plugging your LED in.

Sometimes a resistors colours can be difficult to see, or you are not yet confident to convert from colour to number, so use your multimeter as an easy way to find the value of a resistor.

If you do not know what a component can handle, then I suggest that an Internet search for the datasheet for that component will help.
Datasheets can seem a bit of a minefield, but you do not need to know everything there is to know about a particular transistor, just key bits of information, like its maximum ratings.
After looking at a few datasheets, the task will become a lot easier.



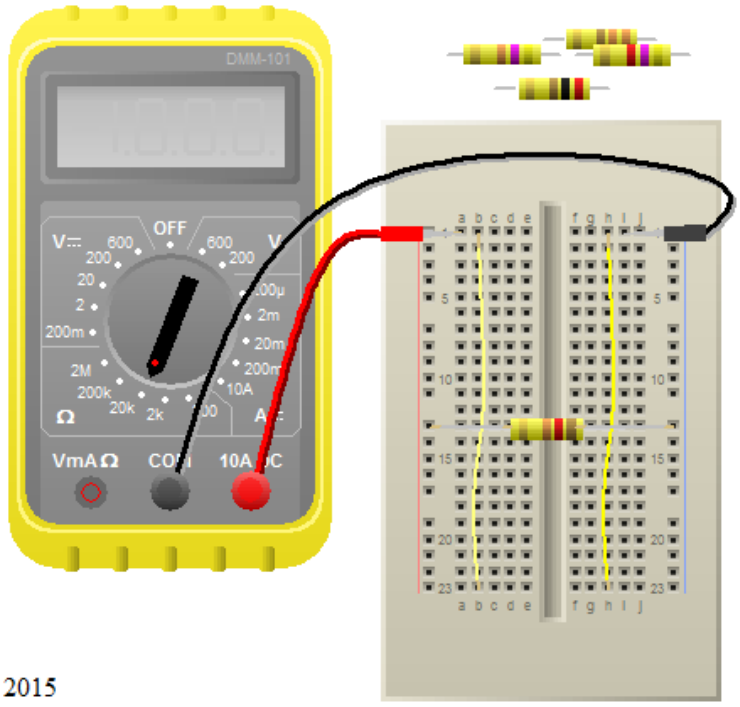
Parts.
6v power supply
Breadboard
Momentary switch
330R resistor
Red LED
Connecting wires

Note: The 330R resistor will allow for different colour LEDs. To be more accurate (if you know the values of the LED) use Ohms Law. For accuracy you can check on this web site
http://www.ohmslawcalculator.com/led-resistor-calculator

Resistor testing:

If you are like me and have dodgy eyesight, or not quite confident enough to convert colour bands of a resistor into a value, then the setup below can make life a little easier.
I find that after a few hours of expermentation, I have a large number of resistors loose in a pile and this is how I check their values.

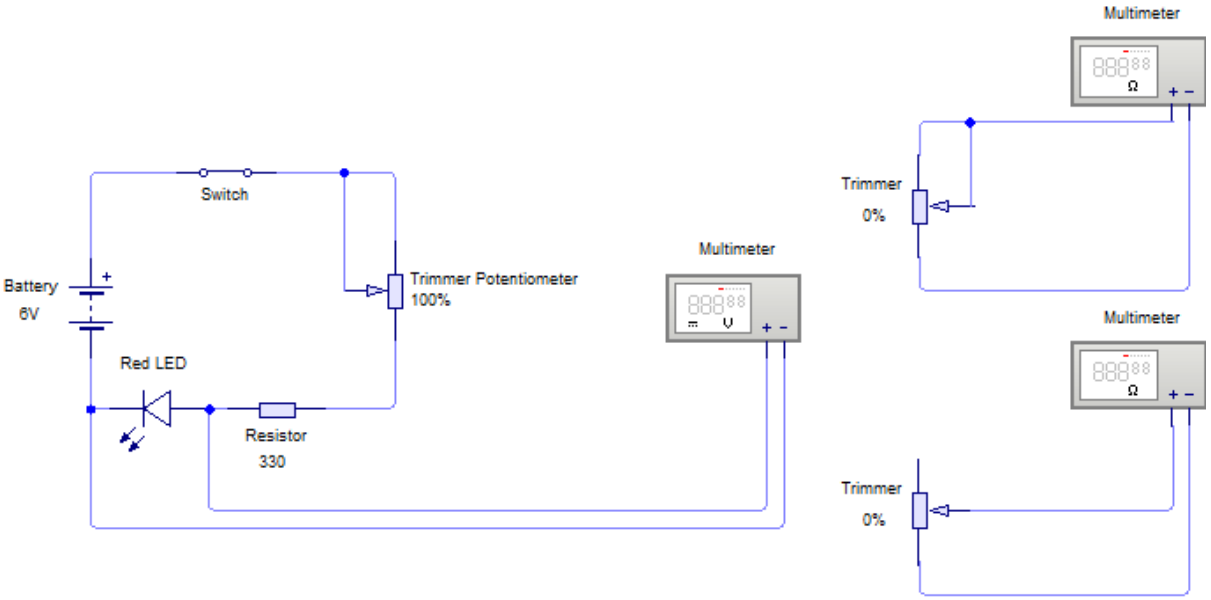
On a spare breadboard, I attach two **bare** wires of reasonable length. Show here in yellow.
Attach your multimeter to the ends. Now just rest your resistor accross the bare leads and read the value on the multimeter.



Project 2: Turn LED on: Variable

Parts.
6v power supply
Breadboard
Momentary switch
330R resistor (just in case)
100kR variable resistor (potentiometer)
Red LED
Connecting wires

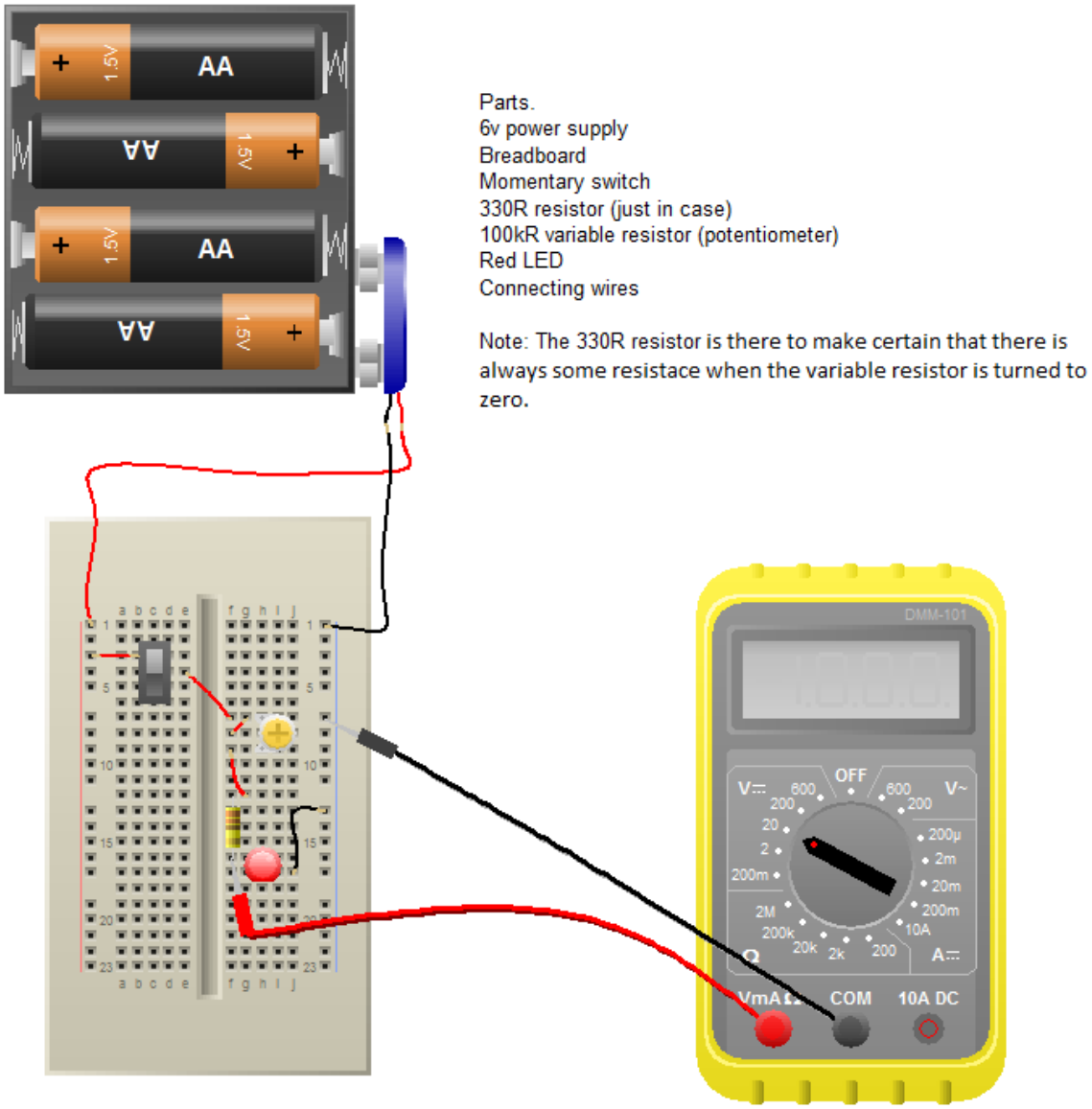
Note: The 330R resistor is there to make certain that there is always some resistace when the variable resistor is turned to zero.



This circuit is very similar to Project 1, and we have left the 330 ohm resistor in place to protect the LED. The addition of the variable resistor or potentiometer (pot) is to show how an LEDs brightness can be changed.

The multimeter is there in the main circuit diagram to measure the voltage across the LED.
If you changed the resistor for a 200 ohm one, the voltage across the LED will be increased when the pot is at its minimum resistance. At approximately 3.2 volts you would be right in thinking that this was just about the limit for an LED.

The circuits on the right are solely there to show you how to view the resistance of a pot.
The result of both circuits is the same.



Parts.
6v power supply
Breadboard
Momentary switch
330R resistor (just in case)
100kR variable resistor (potentiometer)
Red LED
Connecting wires

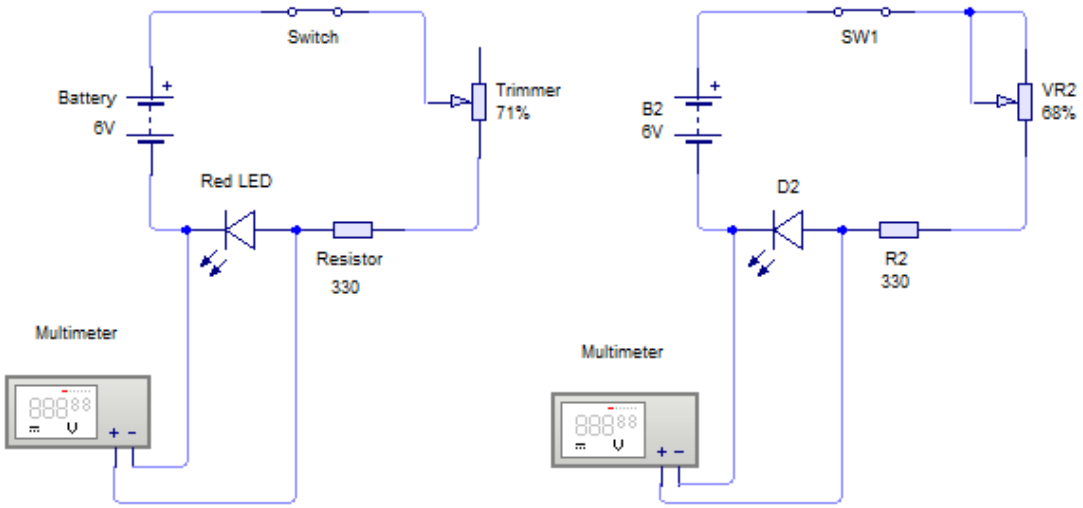
Note: The 330R resistor is there to make certain that there is always some resistace when the variable resistor is turned to zero.

Project 3: Turn LED on: Variable

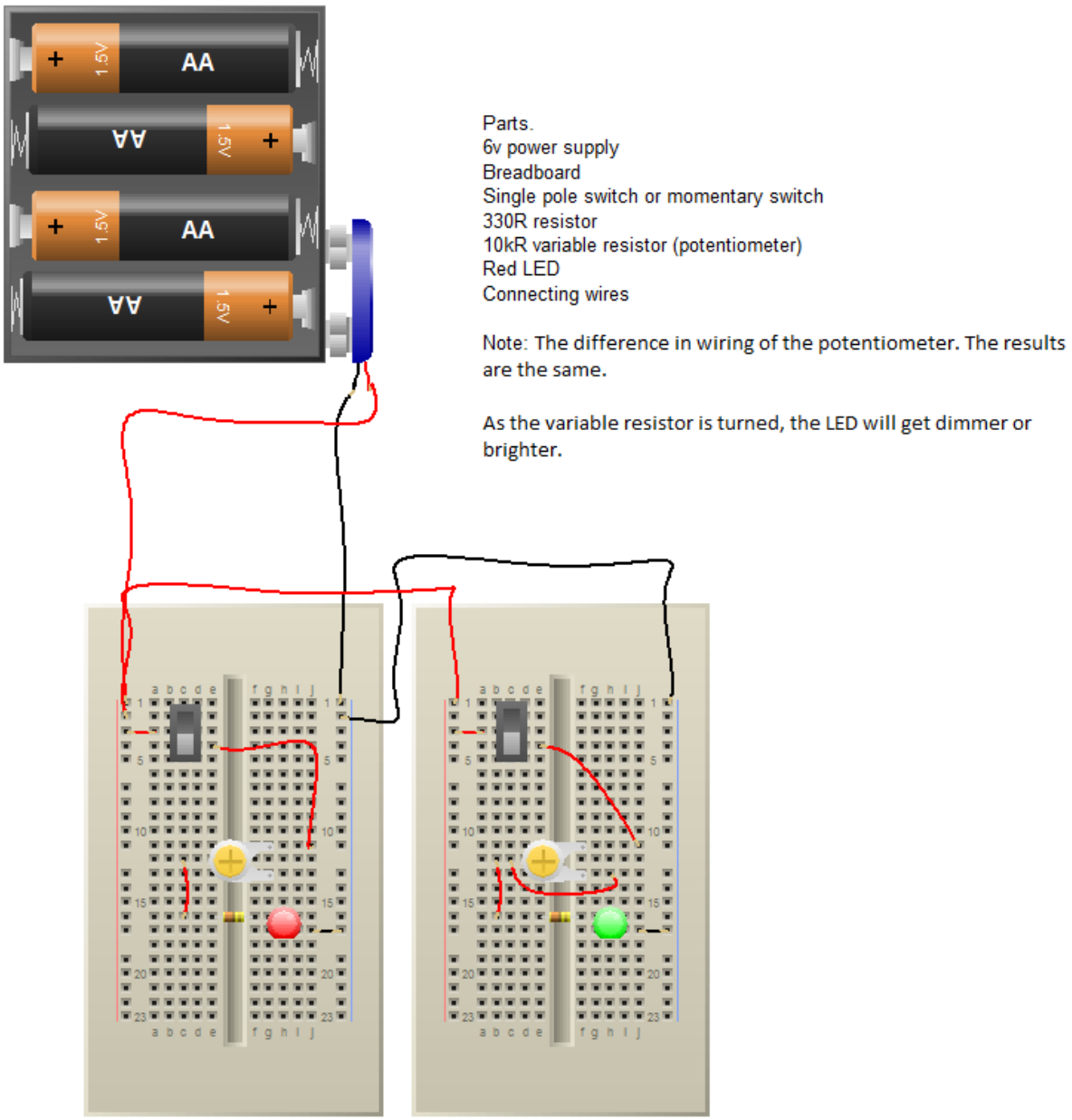
Parts.
6v power supply
Breadboard
Single pole switch or momentary switch
330R resistor
10kR variable resistor (potentiometer)
Red LED
Connecting wires

Note: The difference in wiring of the potentiometer. The results are the same.

As the variable resistor is turned, the LED will get dimmer or brighter.



These two curcuits show what was presented in Project 2 where we explained the use of a pot and the differences between the way in which the pot is wired.



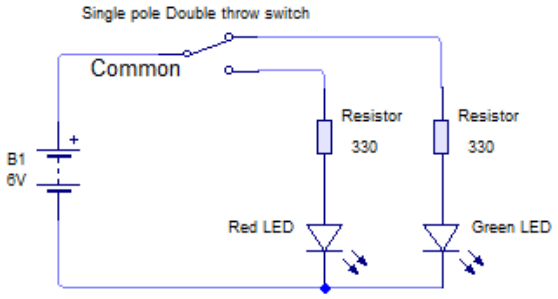
Parts.
6v power supply
Breadboard
Single pole switch or momentary switch
330R resistor
10kR variable resistor (potentiometer)
Red LED
Connecting wires

Note: The difference in wiring of the potentiometer. The results are the same.

As the variable resistor is turned, the LED will get dimmer or brighter.

Project 4: Toggle LEDs

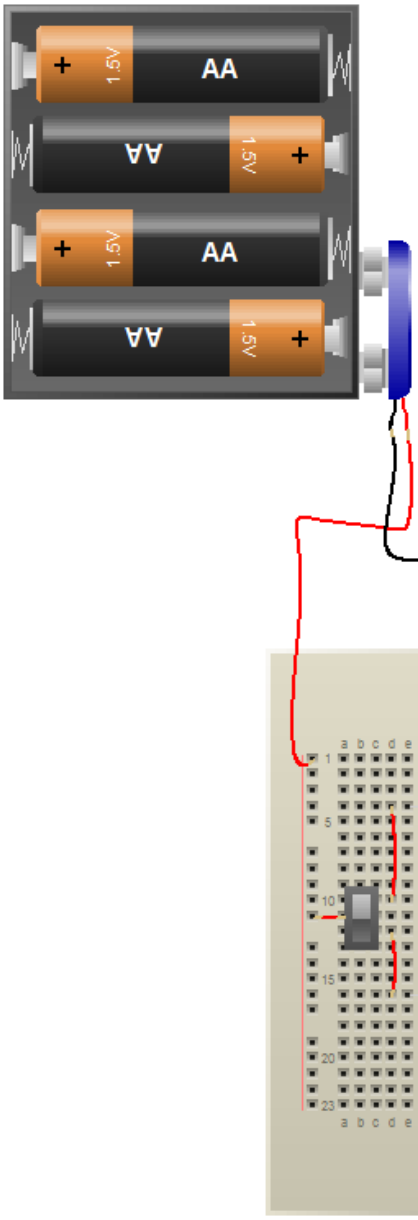
Parts.
6v power supply
Breadboard
Single pole double throw (SPDT) switch
2 X 330R resistors
1 X Red and 1 X green LEDs
Connecting wires



Single pole Double throw switch:
Normally known as SPDT.
More often, a switch with three legs, with the middle one being the common and internally toggling between the other two.

A simple circuit using a double pole switch to either have one LED on or the other.
You could use this as a 'keep Out' or 'Enter' signal on your bedroom door or the fridge, or, if the switch was a micro switch, it could be used in a model railway to determine the passing of a train.

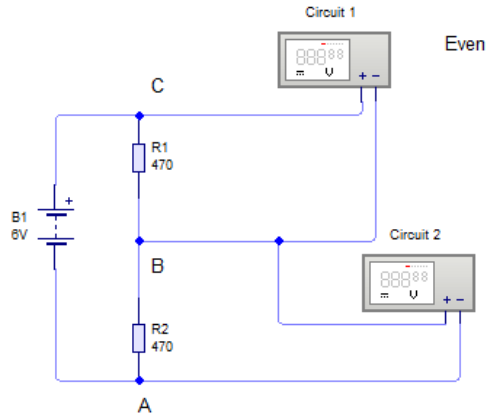
Again, a very simple circuit but could have a practical use in a number of places, limited only by imagination.



Parts.
6v power supply
Breadboard
Single pole double throw (SPDT) switch
2 X 330R resistors
1 X Red and 1 X green LEDs
Connecting wires

Project 5: Potential Divider

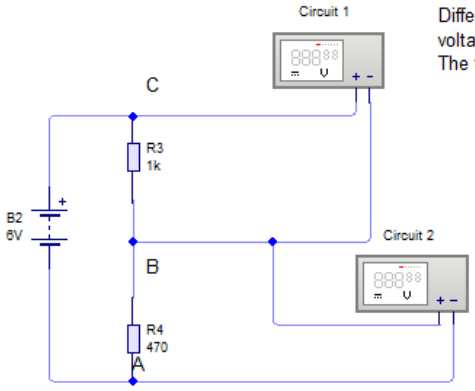
Parts.
6v power supply
Breadboard
3 X 470R resistors
1 X 1kR resistor
Connecting wires



Even resistance, even voltage

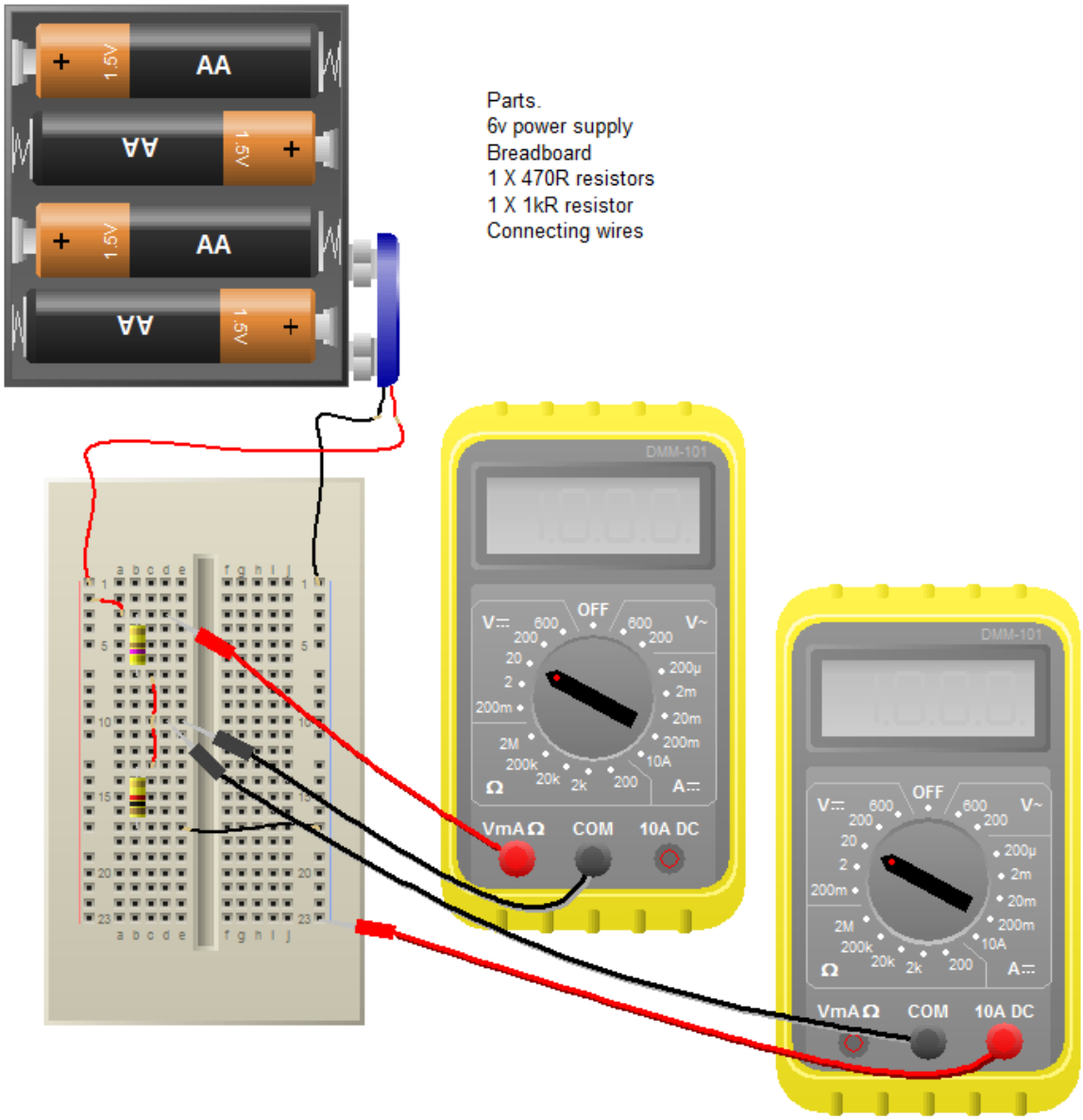
Potential dividers have a great number of applications in electronics.
At their most basic, they can be used to reduce a voltage to a useable level.
Say you had a 9v battery and not a 6v one for these projects. You could create a potential divider to get the 6v that you needed by u.sing a 1K and a 2K resistor

Voltage at CB (V_{out}) = Voltage at C (V_{in}) X R2 / (R1 + R2)
Therefore V_{out} = 6 X 470 / (470 + 470) = 3v



Different resistance, different voltage drop.
The total is still 6volt

Voltage at CB (V_{out}) = Voltage at C (V_{in}) X R3 / (R3 + R4)
Therefore V_{out} = 6 X 470 / (470 + 100) = 1.92v
and at BA, V_{out} = 6 X 1000 / (470 + 100) = 4.08v

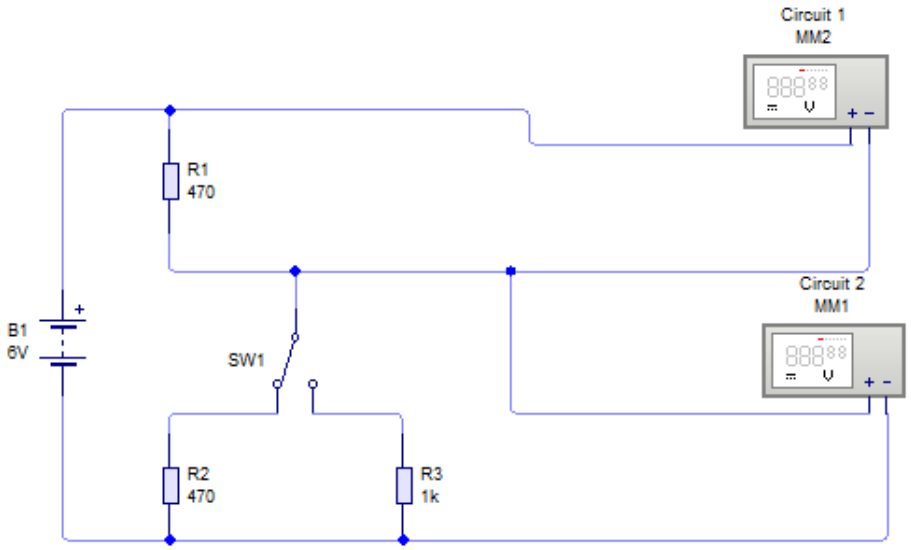


Parts.
6v power supply
Breadboard
1 X 470R resistors
1 X 1kR resistor
Connecting wires

Placing a multimeter as shown above will display the two different values.
Changing the values of the two resistors will produce different readings.
If you replace the fixed resistors with trimmers then you will be able to create any required value needed for your circuit (based on the input power of course)

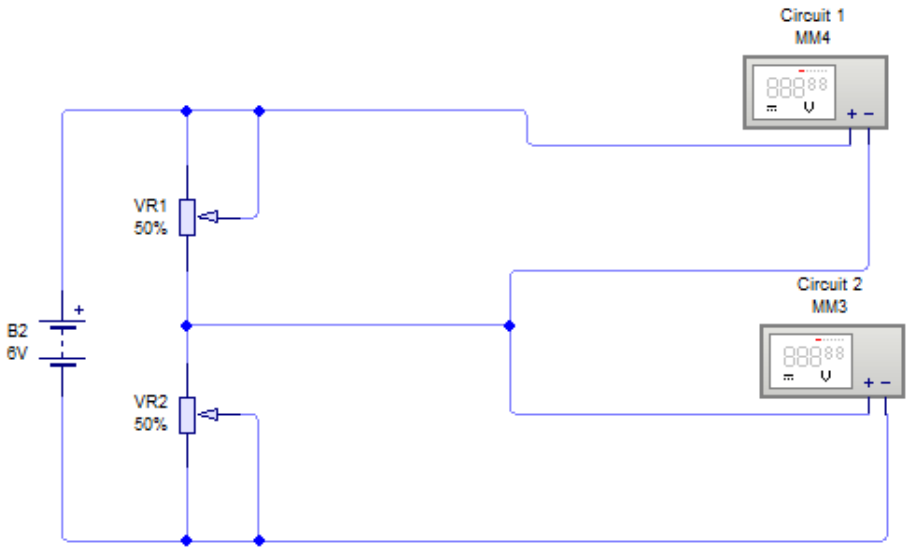
Project 6: Potential Divider Extended

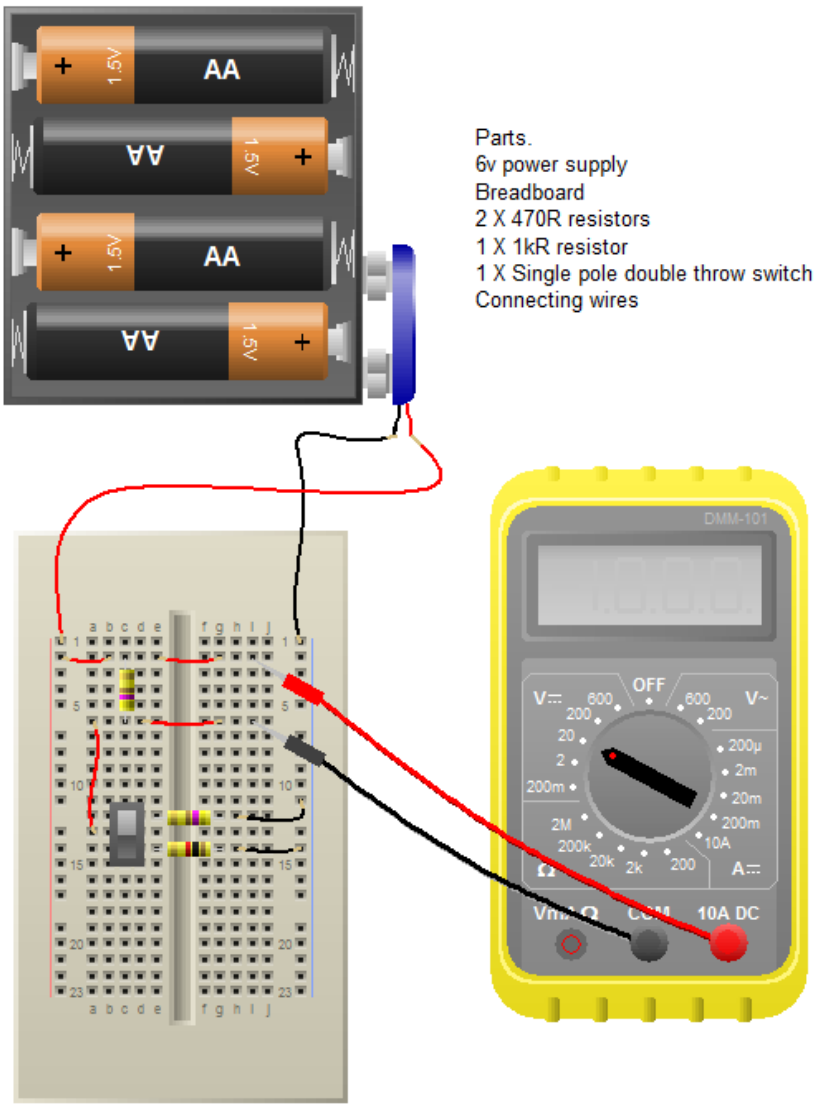
Parts.
6v power supply
Breadboard
2 X 470R resistors
1 X 1kR resistor
1 X Single pole double throw switch
Connecting wires



This circuit is a combination of the two circuits in Project 5.
As you can see, a simple circuit can enable us to have different voltages for our different needs.

The circuit below also shows how you could create varying voltages using pots instead of fixed value resistors.



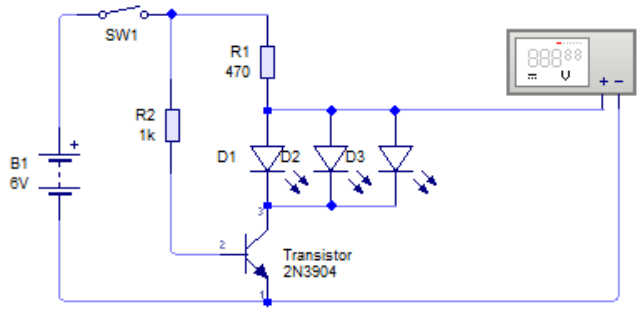


Parts.
6v power supply
Breadboard
2 X 470R resistors
1 X 1kR resistor
1 X Single pole double throw switch
Connecting wires

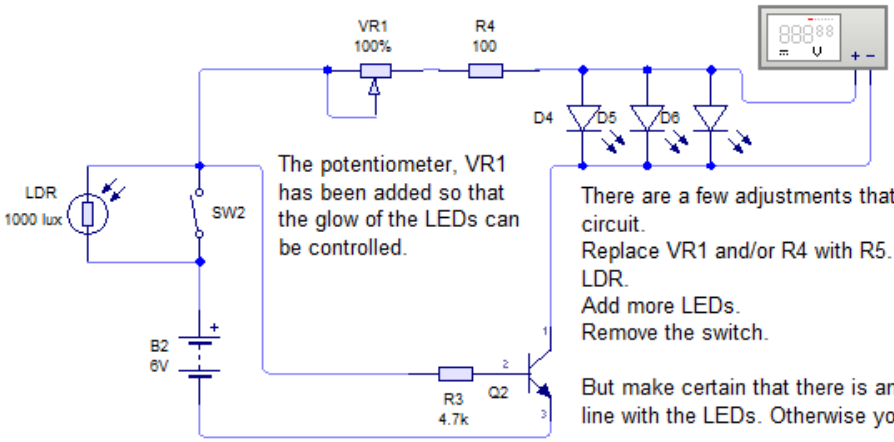
This is an extension of Project 5, using the same ideas that we have already built up. Here we can see that by moving the switch from one position to the other we get a different voltage on the output

Project 7: Transistor as a Switch

Parts.
6v power supply
Breadboard
For circuit 1
1 X 470R resistor
1 X 1kR resistor
or for circuit 2
1 X 100R resistor
1 X 4.7kR resistor
1 X 10kR potentiometer
and
1X 2N3904 NPN transistor
3 X LEDs (different colours up to you)
1 X Single pole switch or just fly wires
Connecting wires



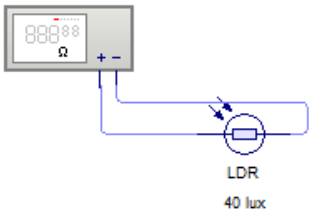
Ignore the multimeters.
They are only there to show what is happening in the circuit.



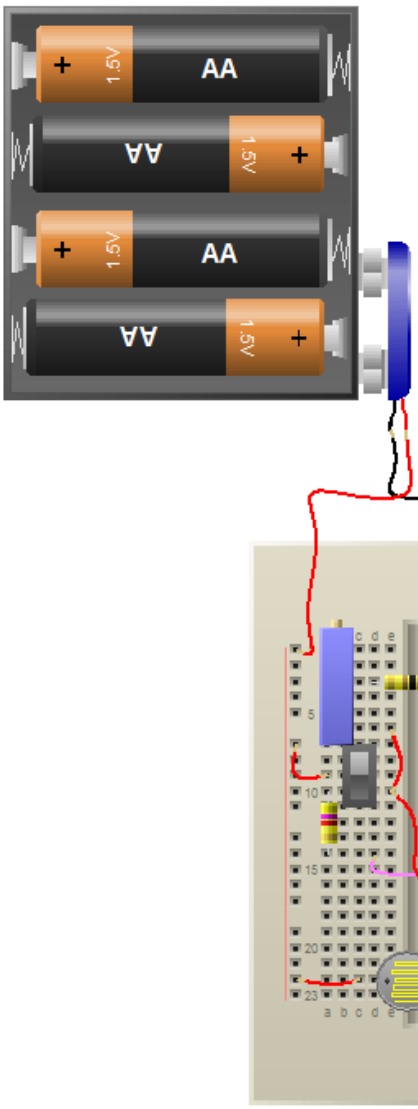
The potentiometer, VR1 has been added so that the glow of the LEDs can be controlled.

There are a few adjustments that you could make to this small circuit.
Replace VR1 and/or R4 with R5. See the note below about the LDR.
Add more LEDs.
Remove the switch.

But make certain that there is an equivalent resistance to R4 in line with the LEDs. Otherwise your LEDs will end up in the bin.



Notice that an LDR always has a resistance, unlike a potentiometer which will fall to zero.
In this circuit, the resistance of the LDR is added to the resistance of the potentiometer and therefore the LEDs will glow brighter with the switch in the on position.



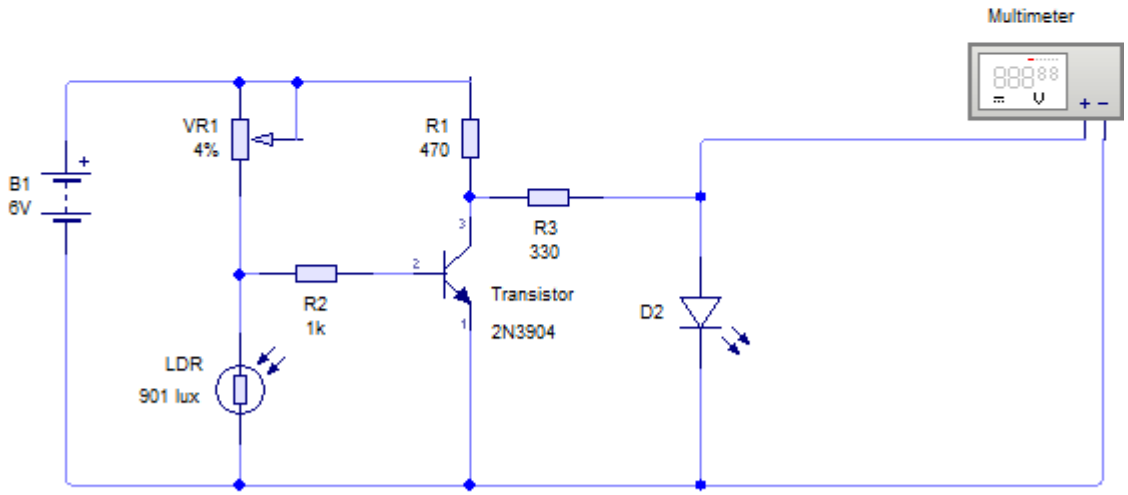
Parts.
6v power supply
Breadboard
For circuit 1
1 X 470R resistor
1 X 1kR resistor
or for circuit 2
1 X 100R resistor
1 X 4.7kR resistor
1 X 10kR potentiometer
and
1X 2N3904 NPN transistor
3 X LEDs (different colours up to you)
1 X Single pole switch or just fly wires
Connecting wires

Moving the switch will turn on or off.
The potentiometer will change the resistance of the circuit so that the glow of the LEDs is proportionate to its resistance. This could be swapped with a sensor like an LDR or Thermistor.
You could change the switch for just two pieces of wire and if they touch, the LEDs will glow, like in a fairground 'bendy wire and loop' game.

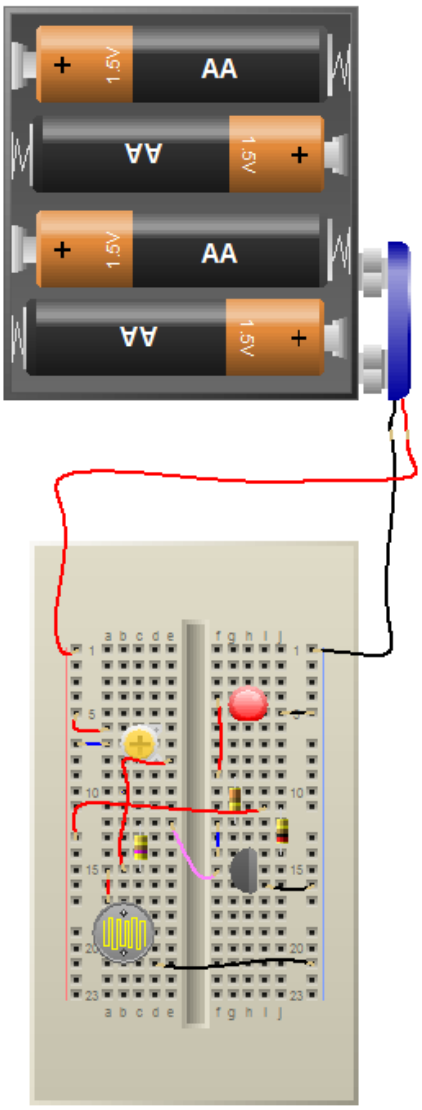
However, as is the point of this circuit, it is not the switch that is turning the LEDs on. It is only to isolate power. It is the transistor that is doing the work, and if you look carefully, the transistor circuit is almost independent of the actual switch or LDR.

Project 8: Transistor as a Switch with LDR

Parts.
6v power supply
Breadboard
1 X 470R resistor
1 X 1kR resistor
1 X 330R resistor
1 X 100kR potentiometer
1X 2N3904 NPN transistor
1 X LDR
1 X LED
Connecting wires



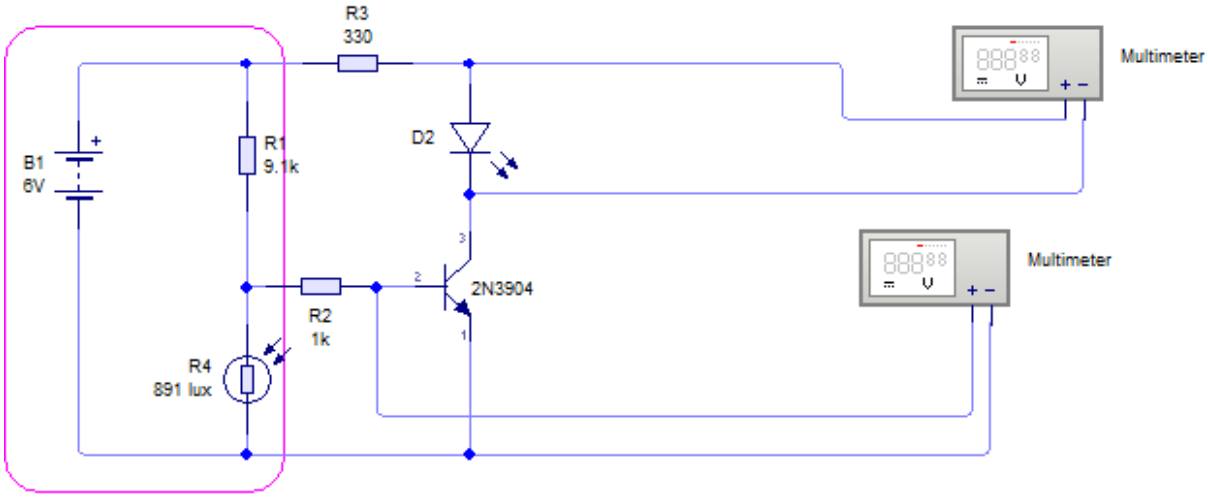
The diagram above is straight out of the book. It works well but with the LDR in its current position, the LED is on or off.
And not enough power to illuminate more than one LED.
Ultimately, it depends on what you want to do.



Parts.
6v power supply
Breadboard
1 X 470R resistor
1 X 1kR resistor
1 X 330R resistor
1 X 100kR potentiometer
1 X 2N3904 NPN transistor
1 X LDR
1 X LED
Connecting wires

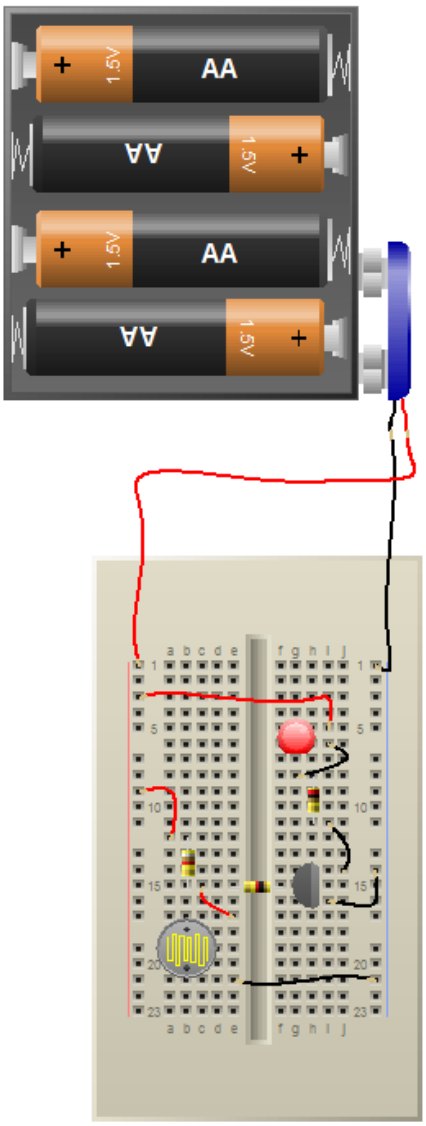
Project 9: Transistor as a Switch with LDR part two

Parts.
6v power supply
Breadboard
1 X 1kR resistor
1 X 9.1kR resistor
1 X 330R resistor
1X 2N3904 NPN transistor
1 X LDR
1 X LED
Connecting wires



The diagram above is similar the Project 8, but works in the opposite way.
When it is dark, the light will be on, but turns off when enought light shines on the LDR.

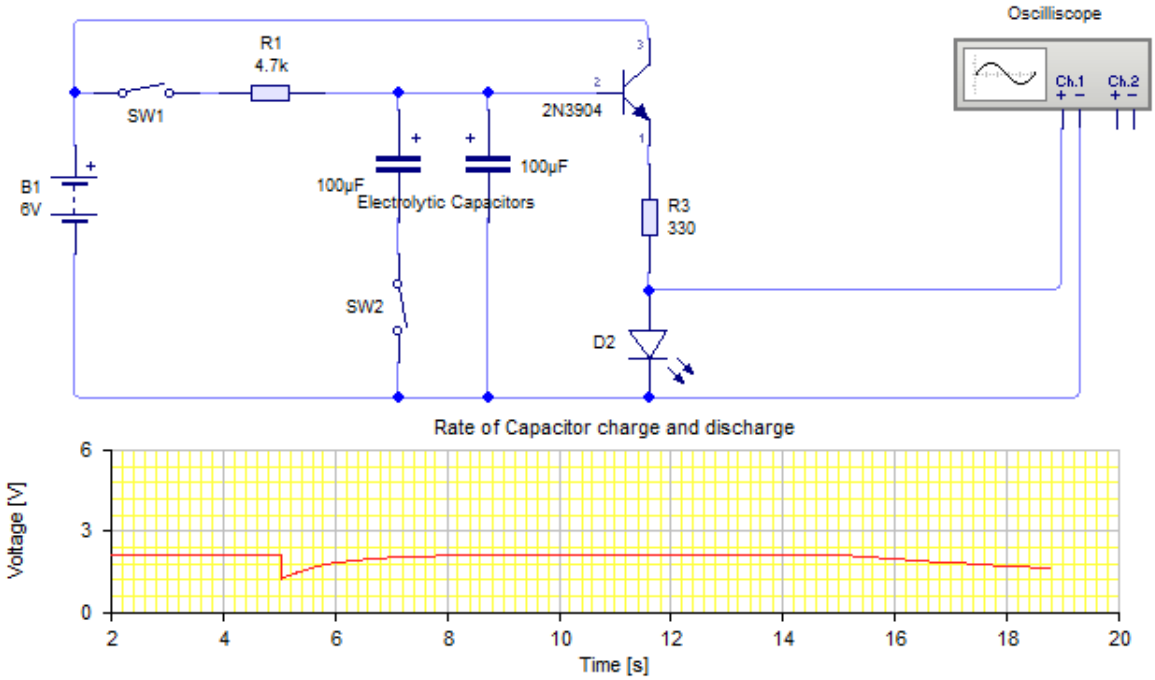
If you look at the section of circuit that is boxed, you will note that it is a typical potential divider that we saw in Project 5, but this time we are using a Light Dependant Resistor instead of a fixed resistor.
As soon as the LDR changes the difference in the lower part to approximately 700milli volt, the transistor will trigger and connect the LED to ground and therefore glow.



Parts.
6v power supply
Breadboard
1 X 1kR resistor
1 X 9.1kR resistor
1 X 330R resistor
1X 2N3904 NPN transistor
1 X LDR
1 X LED
Connecting wires

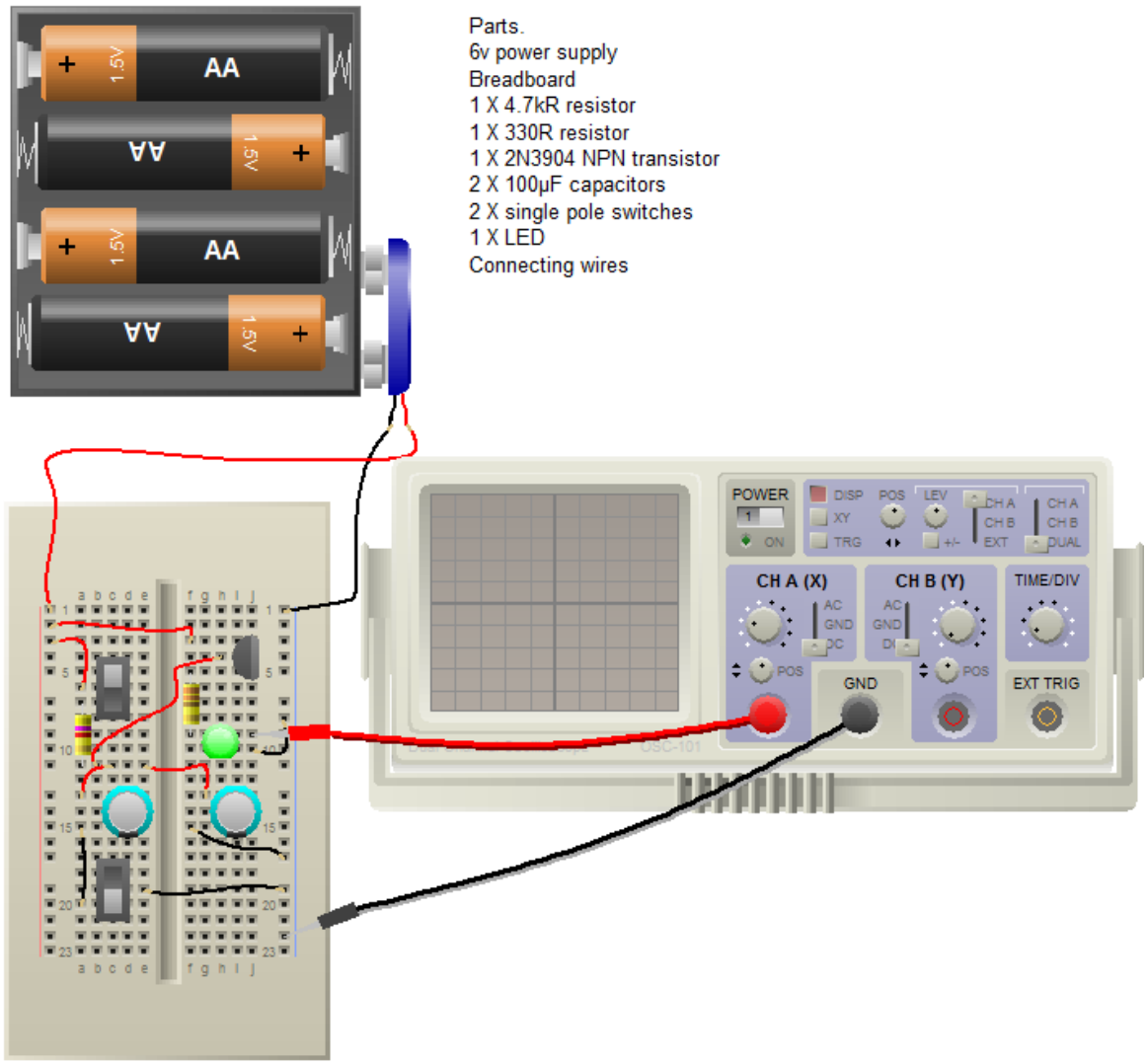
Project 10: Transistor as a Switch – LED Dimmer

Parts.
6v power supply
Breadboard
1 X 4.7kR resistor
1 X 330R resistor
1 X 2N3904 NPN transistor
2 X 100µF capacitors
2 X single pole switches
1 X LED
Connecting wires



Using a single capacitor (or with the second switched out), once SW1 is switched on then off again after a few seconds, the LED will glow and get dimmer over approx 20 seconds.
Switching in the second capactor will double the dimming time.
You can try different capacitor values for a longer or shorter effect.

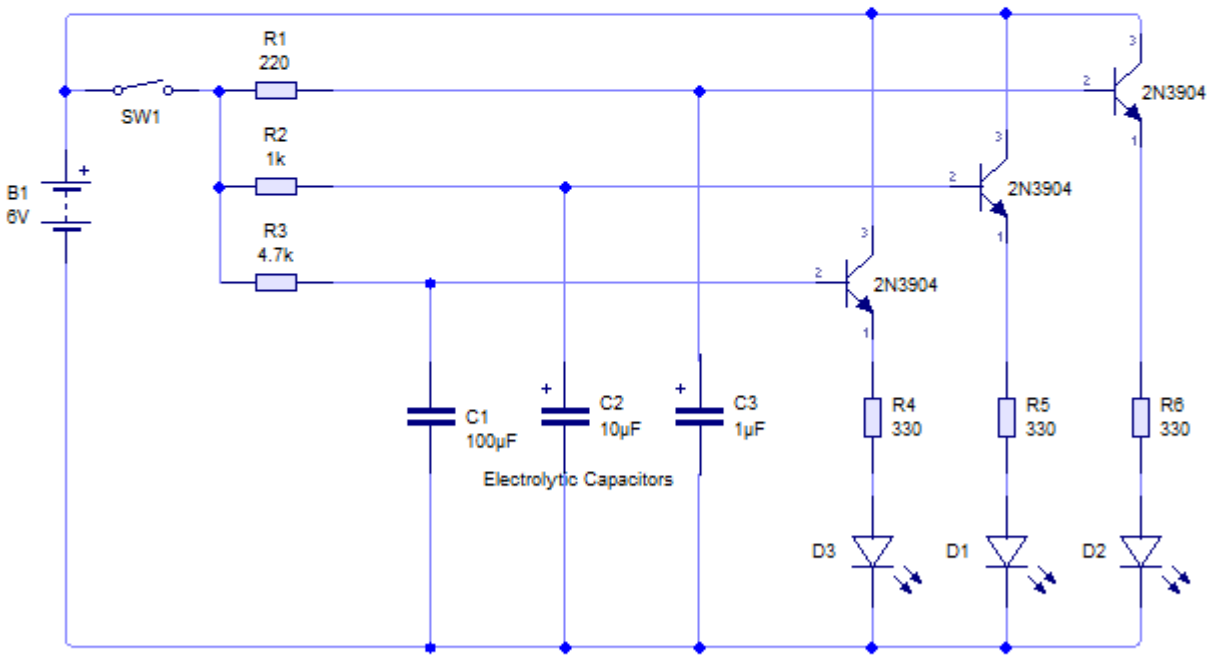
Don't forget that with capacitors that are in parallel as above, you add their values together.



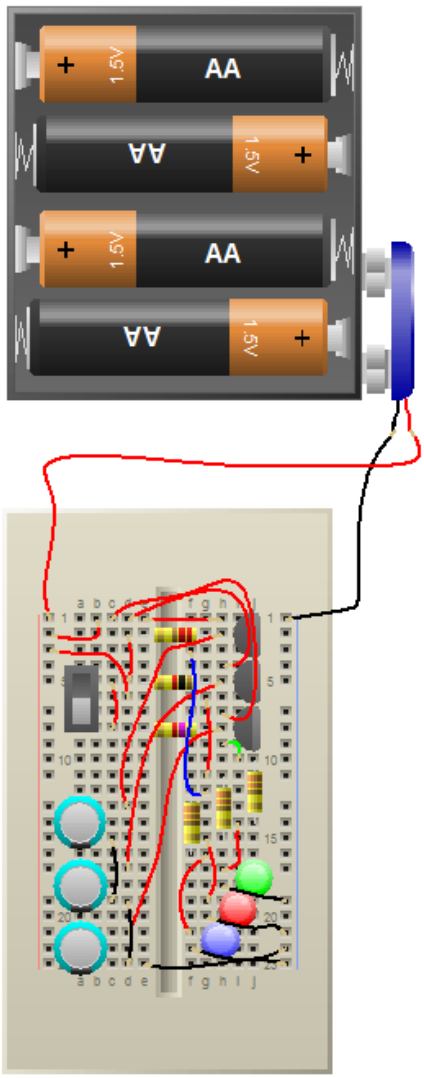
Parts.
6v power supply
Breadboard
1 X 4.7kR resistor
1 X 330R resistor
1 X 2N3904 NPN transistor
2 X 100µF capacitors
2 X single pole switches
1 X LED
Connecting wires

Project 11: Transistor as a Switch – LED Dimmer part two

Parts.
6v power supply
Breadboard
1 X 220R resistor
1 X 1kR resistor
1 X 4.7kR resistor
3 X 330R resistors
3 X 2N3904 NPN transistors
3 X 100µF capacitors
1 X single pole switch
3 X LEDs
Connecting wires



This is an extension to the previous project, only here to show that changing the values of R1, R2, R3, C1, C2 and C3 will change how long the LEDs glow for.



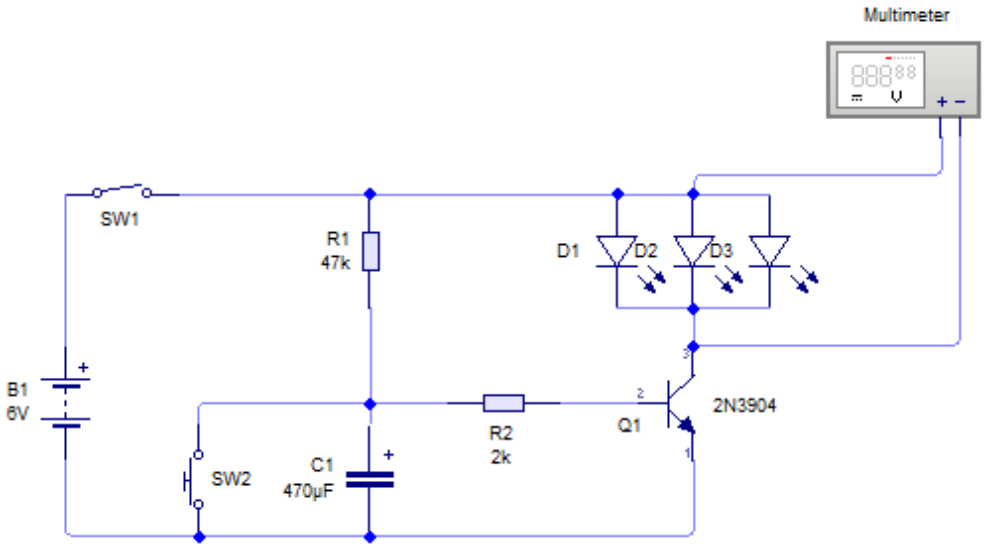
Parts.
6v power supply
Breadboard
1 X 220R resistor
1 X 1kR resistor
1 X 4.7kR resistor
3 X 330R resistors
3 X 2N3904 NPN transistors
3 X 100µF capacitors
1 X single pole switch
3 X LEDs
Connecting wires

As our projects get more involved, the finished product can look quite messy, and sometimes difficult to follow. But, if you take the circuit a bit at a time, the building of the breadboard circuit will seem a lot easier than it first looks.

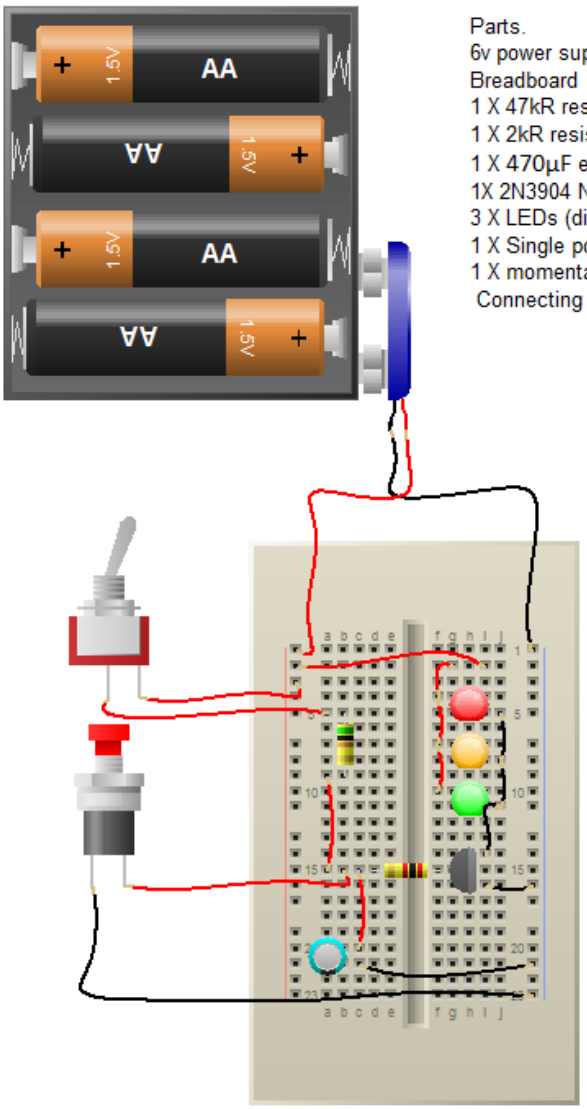
Try to take the time to understand the circuit diagrams, as using both illustrations together will often help.

Project 12: Simple Timer

Parts.
6v power supply
Breadboard
1 X 47kR resistor
1 X 2kR resistor
1 X 470µF electrolytic capacitor
1X 2N3904 NPN transistor
3 X LEDs (different colours up to you)
1 X Single pole switch
1 X momentary switch
Connecting wires



SW1 is the main trigger switch, on a door, window, pressure mat etc.
When the capacitor begins to charge, the timer starts, 500µF will give about 6-7 seconds here whilst 1000µF will give about 11-13 seconds, before the LEDs start to glow
When SW2 is depressed, the capacitor discharges, and starts the cycle again until SW1 is turned off

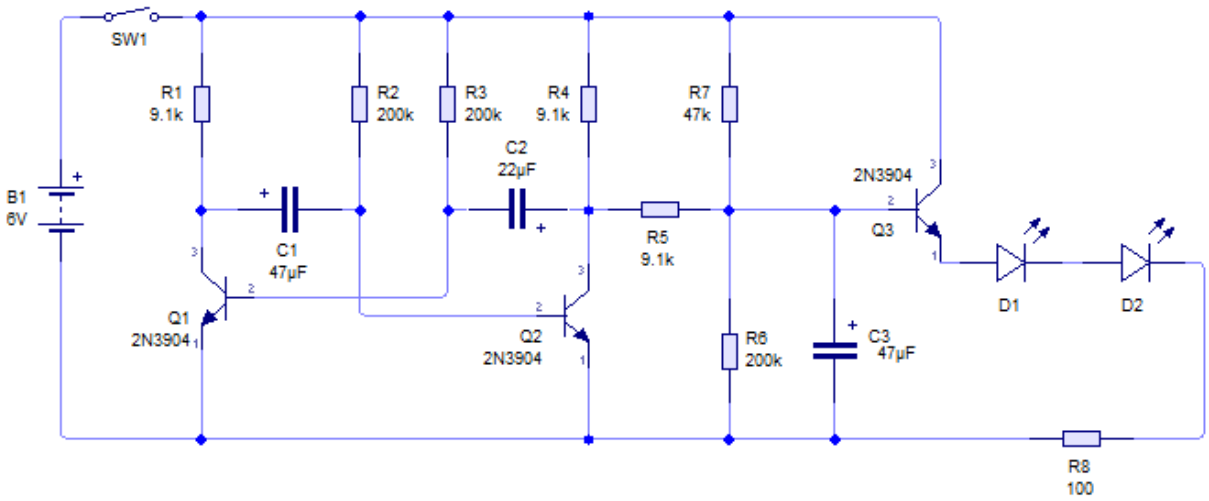


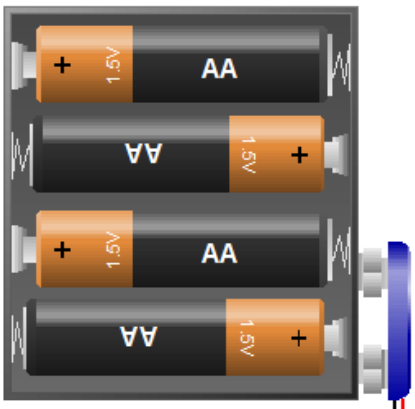
Parts.
6v power supply
Breadboard
1 X 47kR resistor
1 X 2kR resistor
1 X 470µF electrolytic capacitor
1X 2N3904 NPN transistor
3 X LEDs (different colours up to you)
1 X Single pole switch
1 X momentary switch
Connecting wires

We used off-board switches here for illustration only. On-board switches will work just the same.

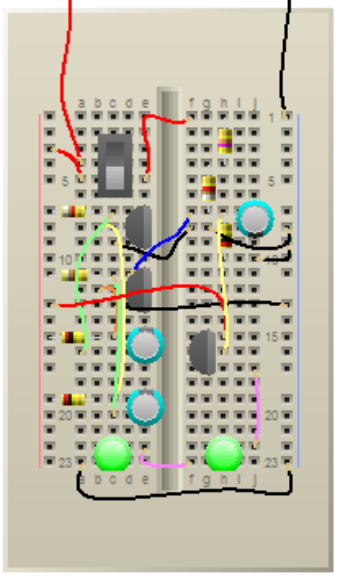
Project 13: Cats Eyes using an Astable Multivibrator

Parts.
6v power supply
Breadboard
1 X 100R resistor
3 X 9.1kR resistors
1 X 47kR resistor
3 X 200kR resistors
2 X 47µF electrolytic capacitors
1 X 22µF electrolytic capacitor
3 X 2N3904 NPN transistors
2 X LEDs (green)
1 X Single pole switch
Connecting wires





Parts.
6v power supply
Breadboard
1 X 100R resistor
3 X 9.1kR resistors
1 X 47kR resistor
3 X 200kR resistors
2 X 47µF electrolytic capacitors
1 X 22µF electrolytic capacitor
3 X 2N3904 NPN transistors
2 X LEDs (green)
1 X Single pole switch
Connecting wires

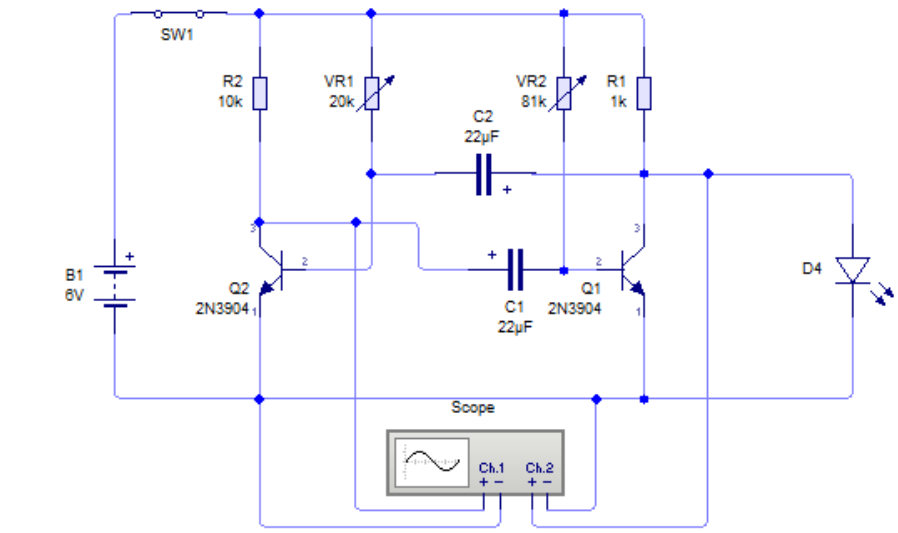


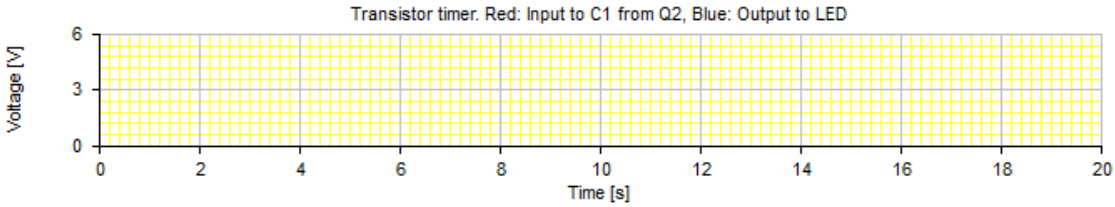
Spooky cats eyes at a distance.

The two capacitors at the multivibrator transistors are different values, which gives us different on and off times.
The 22µF controls the off time.

Project 14: Transistor Astable

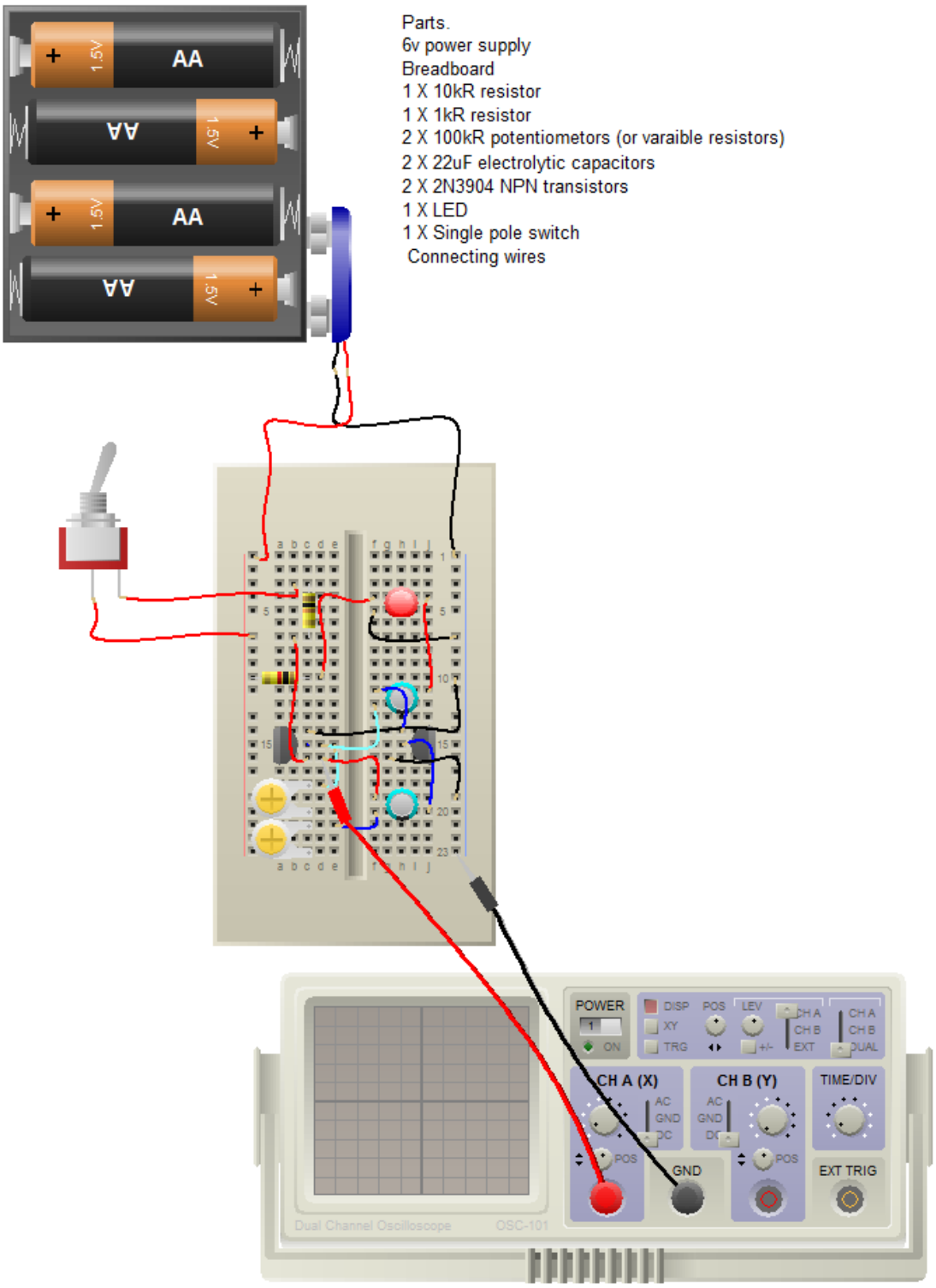
Parts.
6v power supply
Breadboard
1 X 10kR resistor
1 X 1kR resistor
2 X 100kR potentiometors (or varaible resistors)
2 X 22uF electrolytic capacitors
2 X 2N3904 NPN transistors
1 X LED
1 X Single pole switch
Connecting wires





VR1 and VR2 can be changed to vary the flash rate of the LED.

As you can see from the oscilloscope output, there are some random spikes in the voltage both within the circuit and its output into the LED.
In this circuit, this will not cause any problems, but may do if you are controlling anything other than the simple circuit that we have here.

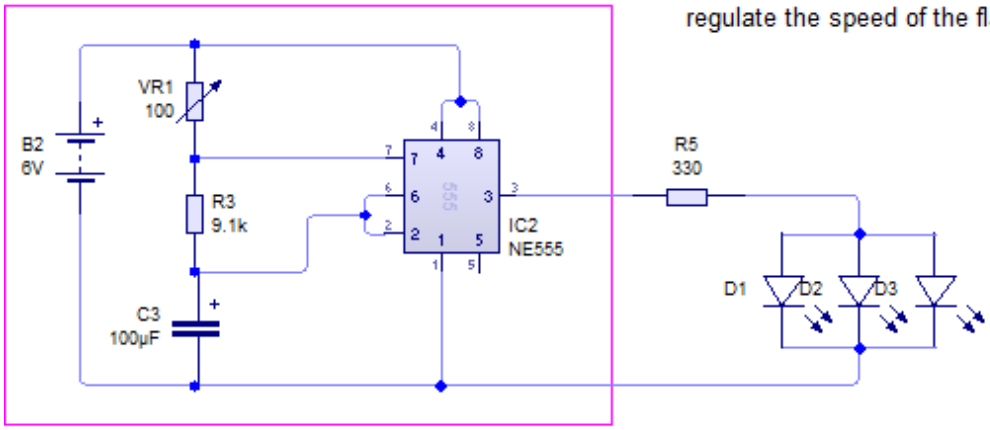


Parts.
6v power supply
Breadboard
1 X 10kR resistor
1 X 1kR resistor
2 X 100kR potentiometors (or varaible resistors)
2 X 22uF electrolytic capacitors
2 X 2N3904 NPN transistors
1 X LED
1 X Single pole switch
Connecting wires

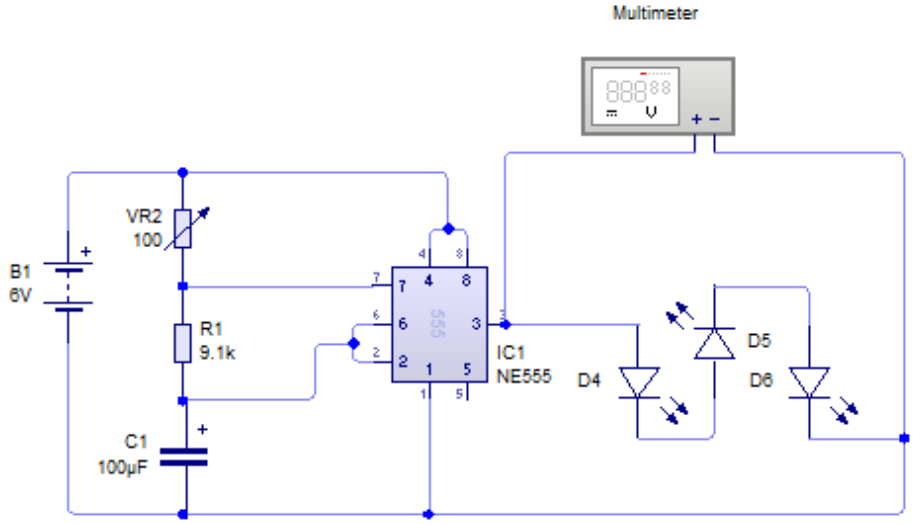
Project 15: Timer with a 555 Integrated Circuit

Parts.
6v power supply
Breadboard
1 X 9.1kR resistor
1 X 330R resistor
1 X 10k potentiometer
1 X 100µF electrolytic capacitor
1 X 555 IC
3 X LEDs (different colours up to you)
Connecting wires

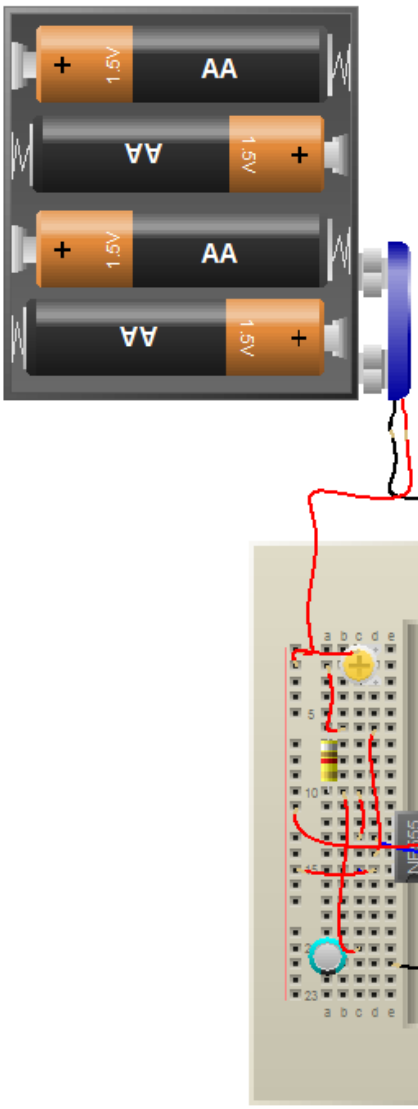
The potentiometer VR allows us to regulate the speed of the flash.



The boxed area above is commonaly known as an Astable circuit.



The second timer circuit above is solely to show that the voltage at pin 3 of the IC is sufficient enough to power three LEDs in series rather than in parallel as in all other circuits so far. This also allows us to do away with the 330Ω resister at pin 3.



Parts.
6v power supply
Breadboard
1 X 9.1kR resistor
1 X 330R resistor
1 X 10k potentiometer
1 X 100µF electrolytic capacitor
1 X 555 IC
3 X LEDs (different colours up to you)
Connecting wires

1: gnd
2: trigger
3: output
4: reset

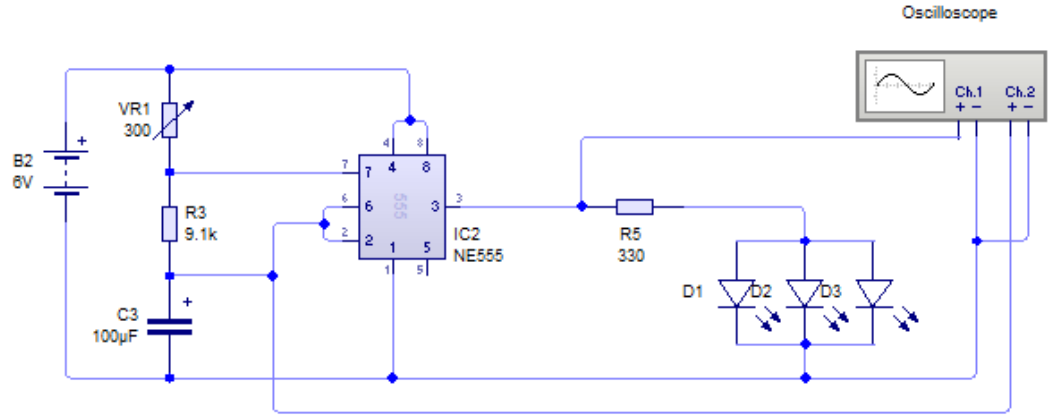
8: 3 - 15v
7: discharge
6: threshold
5: control

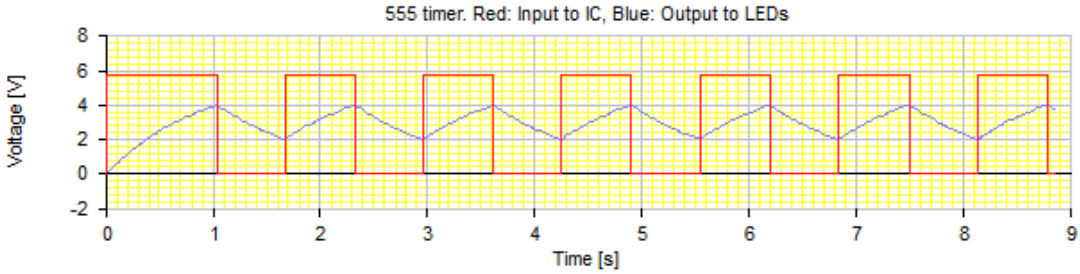
Pin 1 on all chips is denoted by a notch in the chip or a dot (or both).
As you can see above, the continuation of the pins is 'around the end' then back up to the top.
Unfortunately the pins are not normally displayed on a circuit diagram in the same way. They are displayed based on how the pins work together within the IC releative to common usage.

The breadboard is designed with the groove along its centre to allow an IC to be used on the board and all pins will have their own connection point.

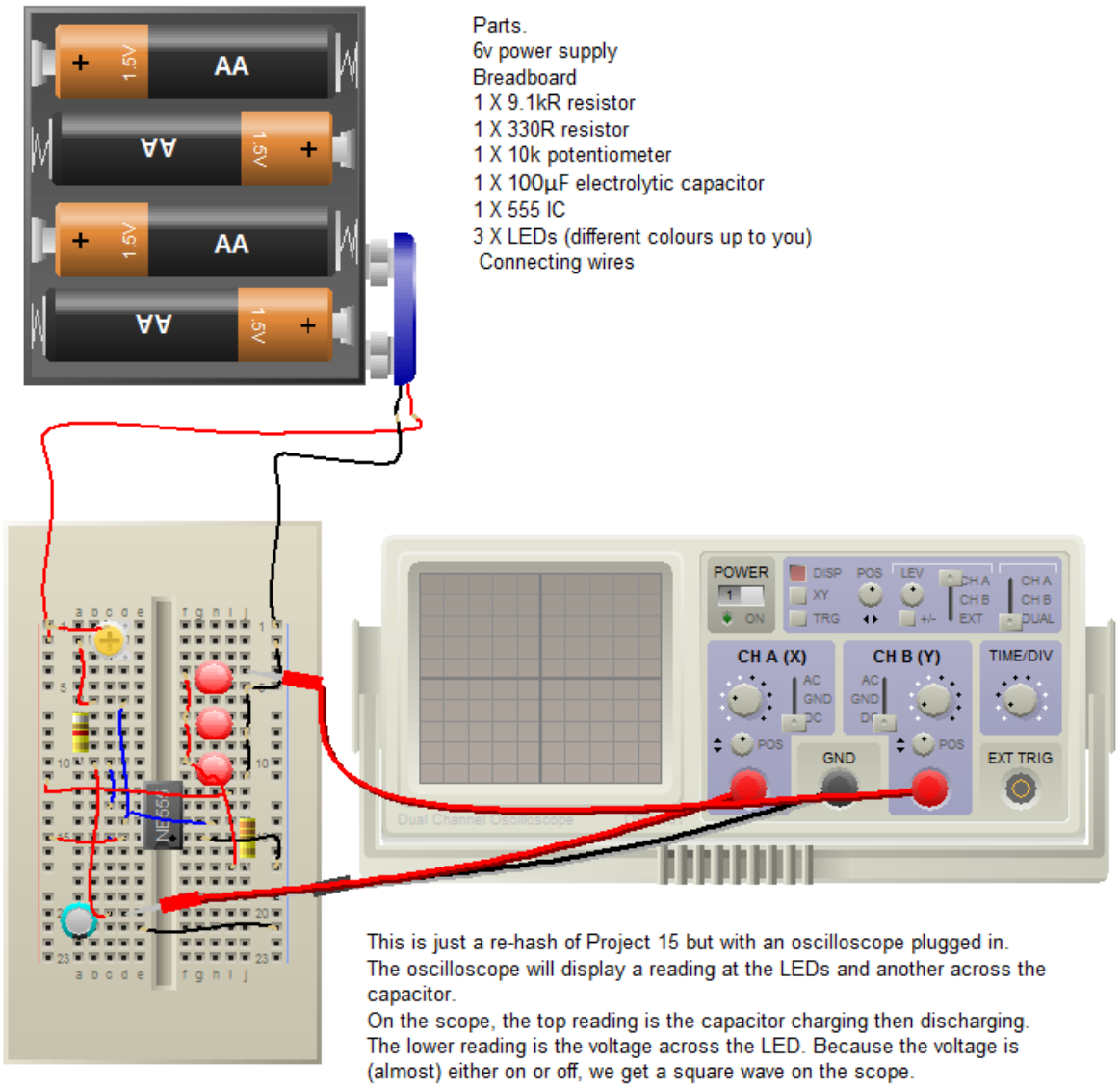
Project 16: Timer on Oscilloscope

Parts.
6v power supply
Breadboard
1 X 9.1kR resistor
1 X 330R resistor
1 X 10k potentiometer
1 X 100µF electrolytic capacitor
1 X 555 IC
3 X LEDs (different colours up to you)
Connecting wires





Using the 555 timer in your circuit will supply you with exactly the same smooth output each time.



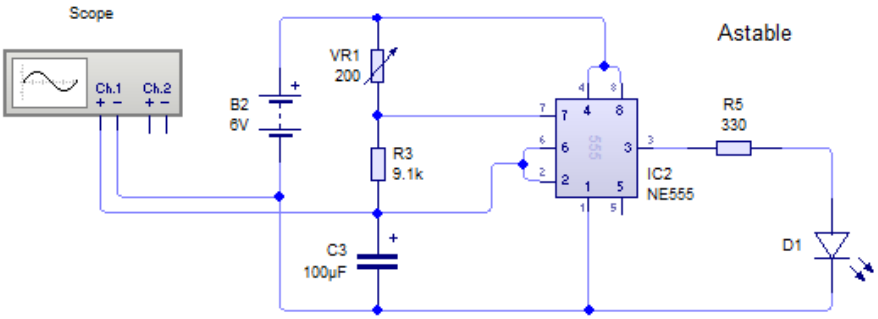
Parts.
6v power supply
Breadboard
1 X 9.1kR resistor
1 X 330R resistor
1 X 10k potentiometer
1 X 100µF electrolytic capacitor
1 X 555 IC
3 X LEDs (different colours up to you)
Connecting wires

This is just a re-hash of Project 15 but with an oscilloscope plugged in.
The oscilloscope will display a reading at the LEDs and another across the capacitor.
On the scope, the top reading is the capacitor charging then discharging.
The lower reading is the voltage across the LED. Because the voltage is (almost) either on or off, we get a square wave on the scope.

If you watch the scope, you will see that while the LEDs are lit, the capacitor is slowly charging. When the 555 timer switches the 'power off' to the LEDs, the capacitor discharges.

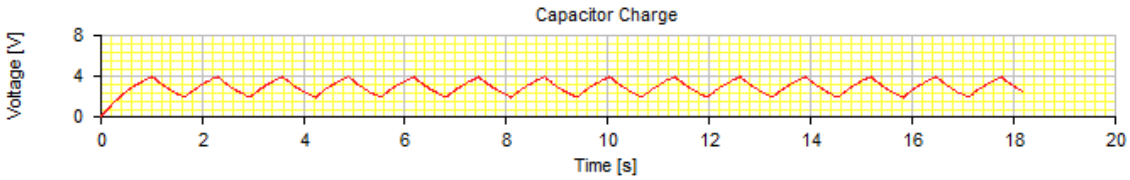
Project 17: Astable and Monostable

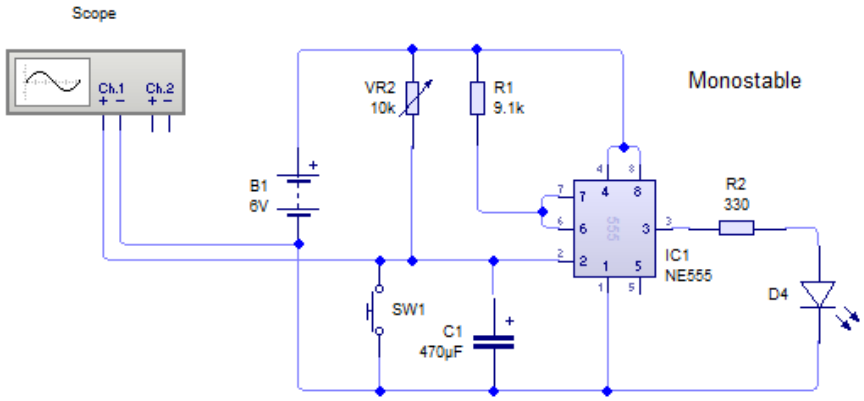
Parts.
6v power supply
Breadboard
2 X 9.1kR resistors
2 X 330R resistors
2 X 10k potentiometer
1 X 100µF electrolytic capacitor
1 X 470µF electrolytic capacitor
2 X 555 IC
2 X LED
1 X momentary push switch
Connecting wires



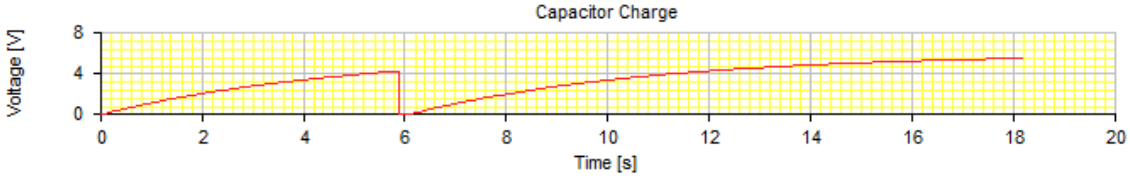
VR1 allows us to regulate the spped of the flash.

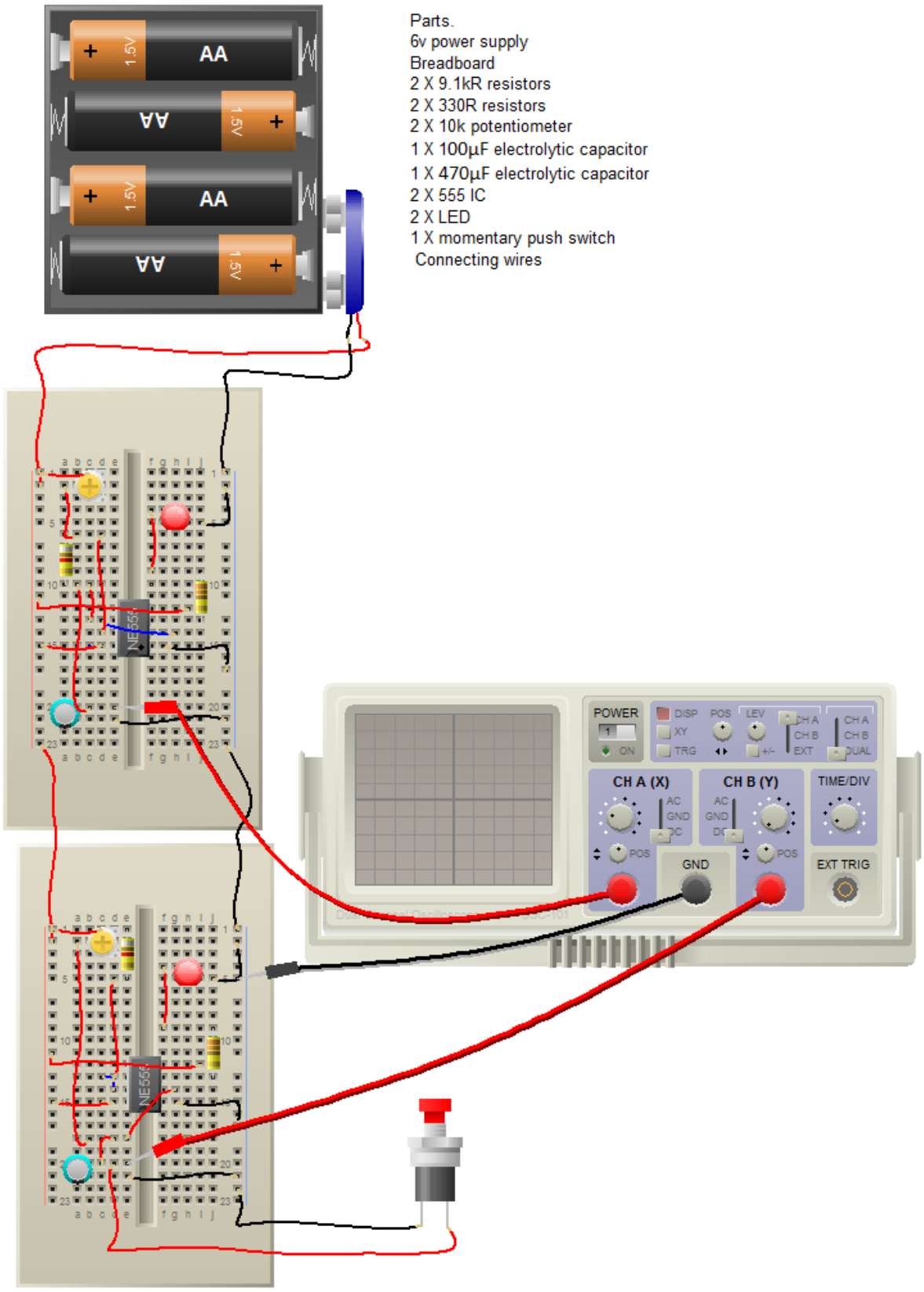
Because pins 2 and 6 are connected, the circuit will reset and trigger itself.





Press SW1 to reset and trigger

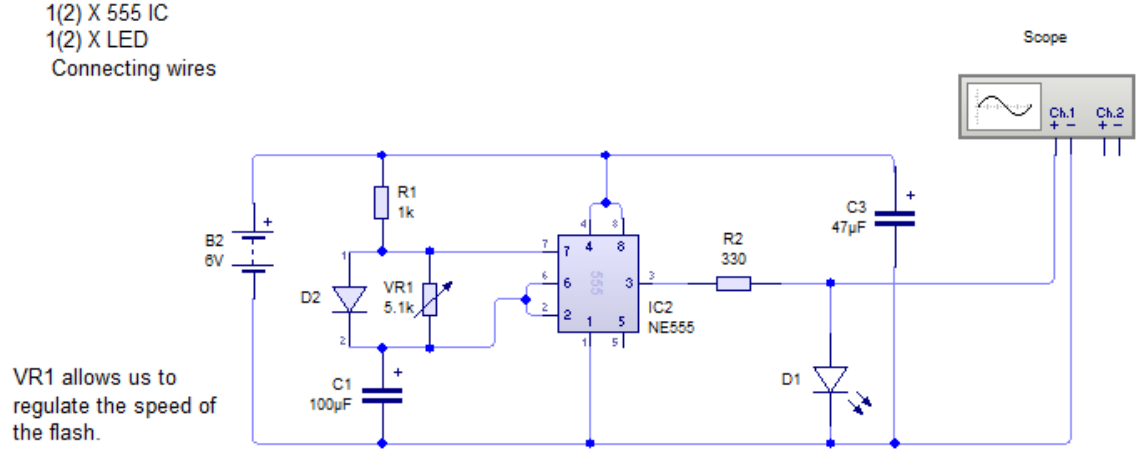




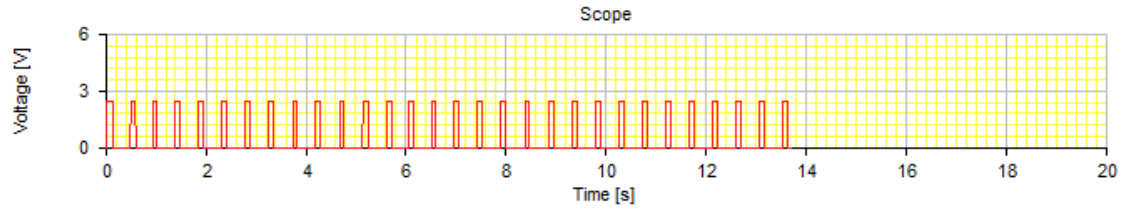
Parts.
6v power supply
Breadboard
2 X 9.1kR resistors
2 X 330R resistors
2 X 10k potentiometer
1 X 100µF electrolytic capacitor
1 X 470µF electrolytic capacitor
2 X 555 IC
2 X LED
1 X momentary push switch
Connecting wires

Project 18: Gated 555 Timer

Parts.
6v power supply
Breadboard
1(2) X 1kR resistor
1(2) X 330R resistor
1(2) X 10k potentiometer
1(2) X 100µF electrolytic capacitor
1 X 47µF electrolytic capacitor
1(2) X general purpose diode
1(2) X 555 IC
1(2) X LED
Connecting wires

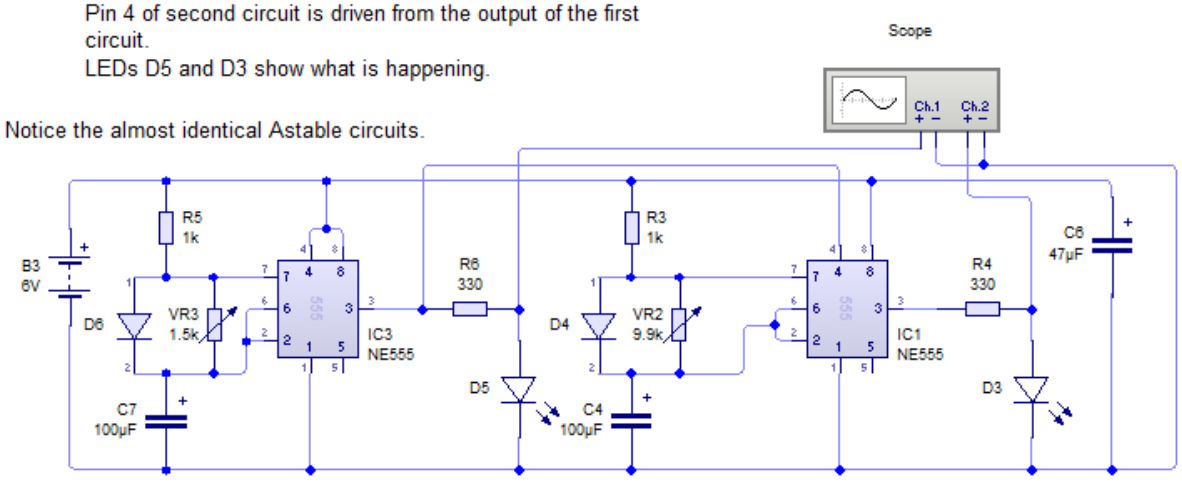


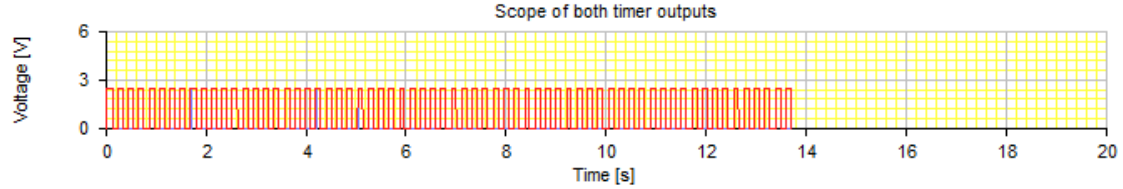
VR1 allows us to regulate the speed of the flash.

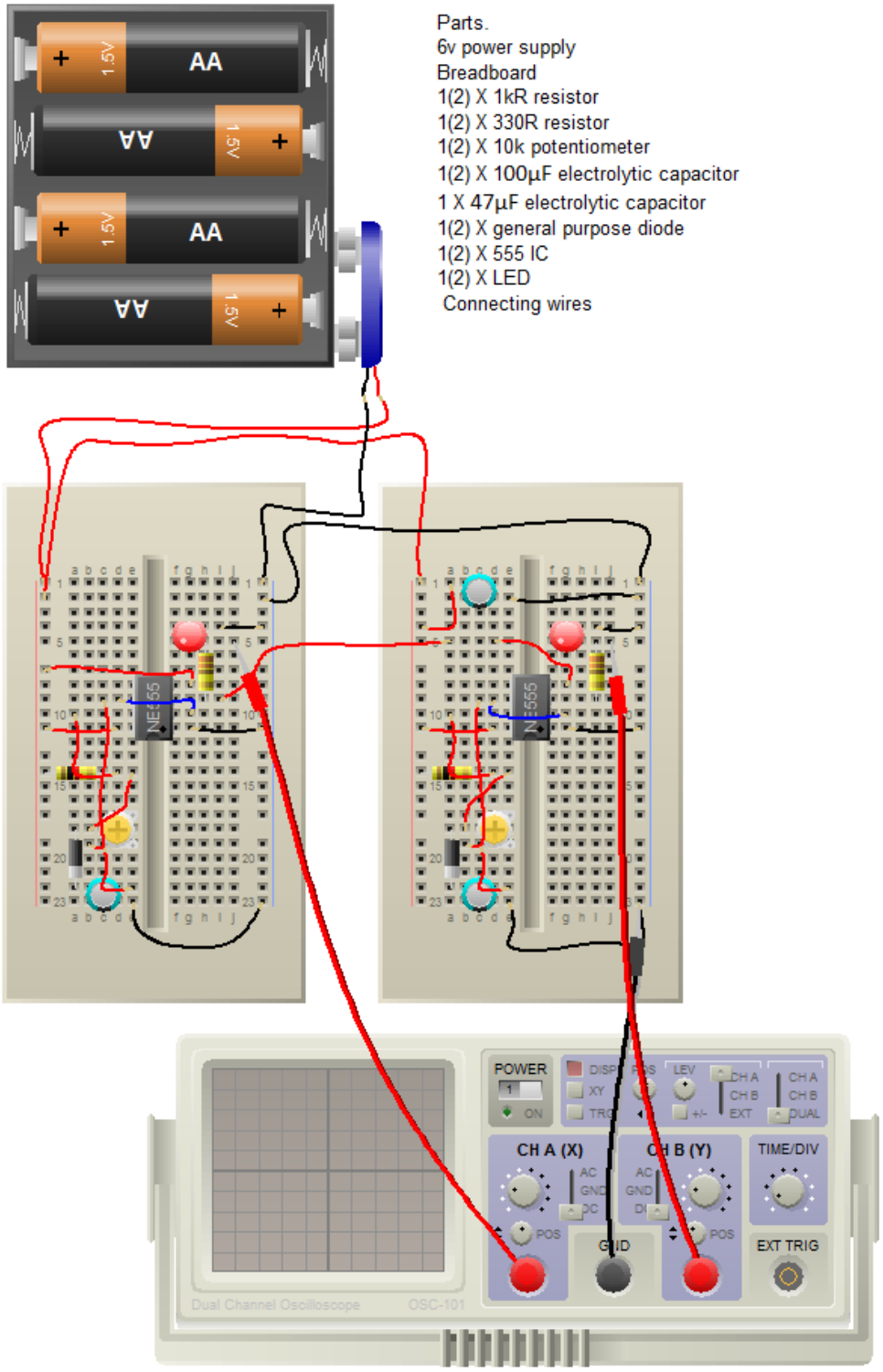


Gated Astable.
Pin 4 of second circuit is driven from the output of the first circuit.
LEDs D5 and D3 show what is happening.

Notice the almost identical Astable circuits.



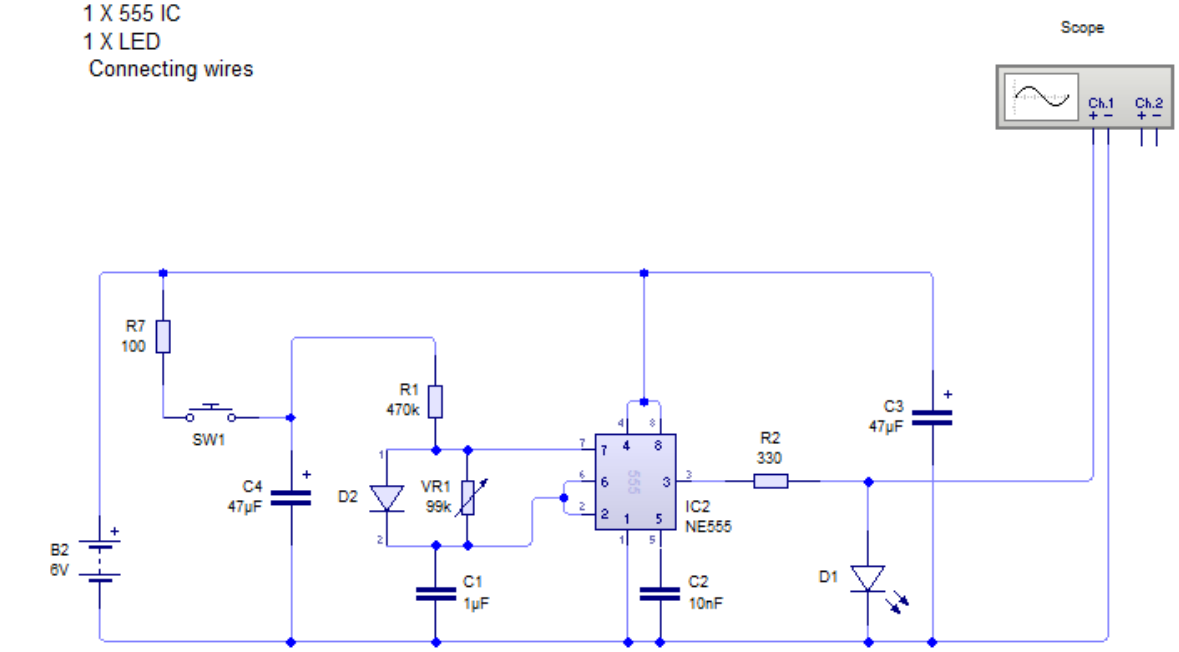


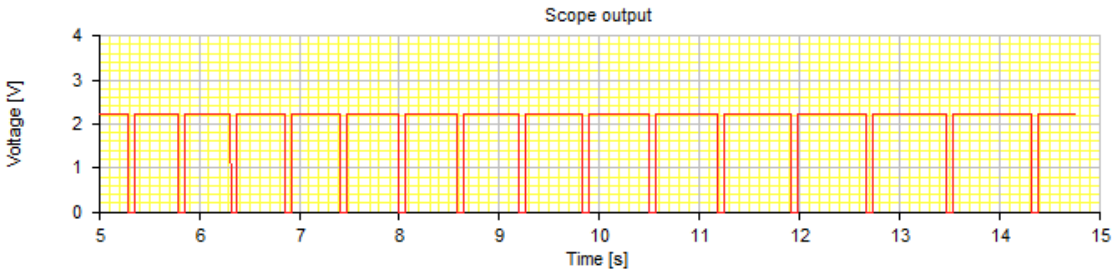


Parts.
6v power supply
Breadboard
1(2) X 1kR resistor
1(2) X 330R resistor
1(2) X 10k potentiometer
1(2) X 100µF electrolytic capacitor
1 X 47µF electrolytic capacitor
1(2) X general purpose diode
1(2) X 555 IC
1(2) X LED
Connecting wires

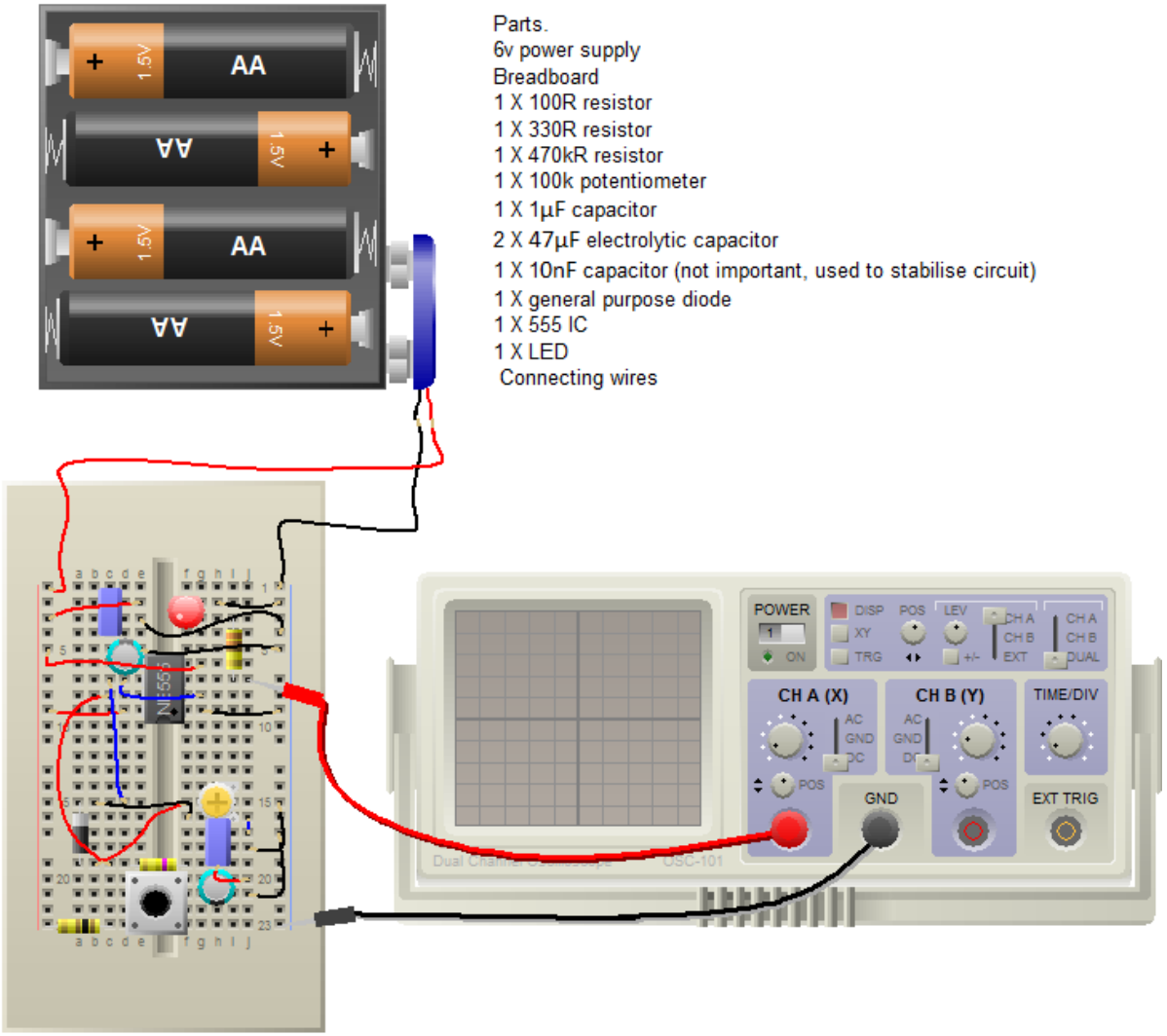
Project 19: Diminishing Frequency Astable

Parts.
6v power supply
Breadboard
1 X 100R resistor
1 X 330R resistor
1 X 470kR resistor
1 X 100k potentiometer
1 X 1µF capacitor
2 X 47µF electrolytic capacitor
1 X 10nF capacitor (not important, used to stabilise circuit)
1 X general purpose diode
1 X 555 IC
1 X LED
Connecting wires





When SW1 is depressed, the capacitor C4 charges quickly.
When the switch is released, C4 discharges slowly through the Astable which will oscillate.
The timing capacitor, C1, will take longer and longer to charge until C4 itself is fully discharged and the oscillation will stop.
The larger the value of C4, the longer the oscillation period.
Changing the value of C1 up or down will also effect the timing and the oscillation.

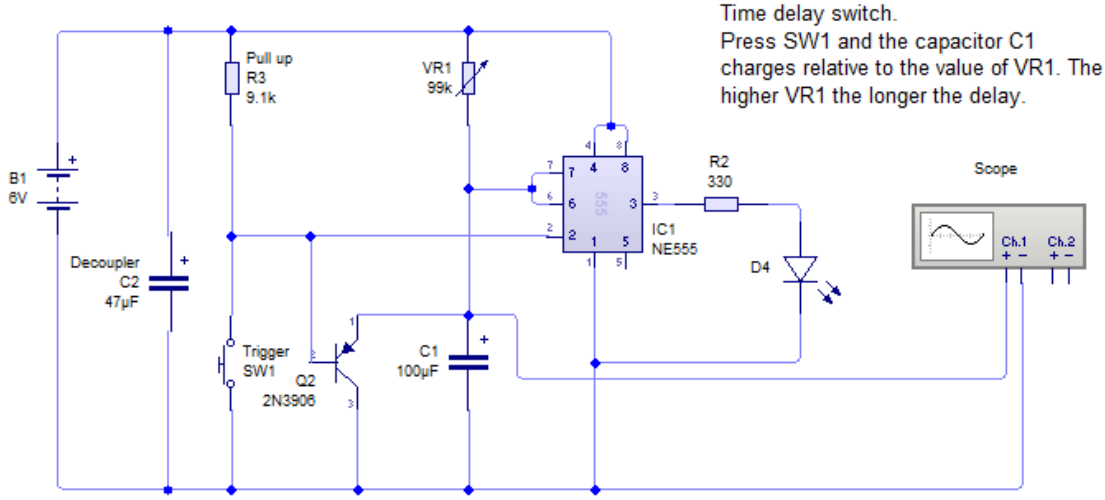


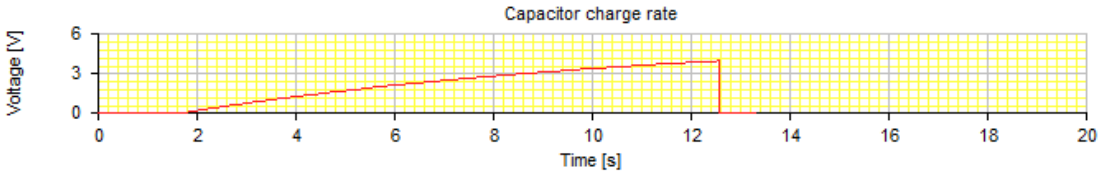
Parts.
6v power supply
Breadboard
1 X 100R resistor
1 X 330R resistor
1 X 470kR resistor
1 X 100k potentiometer
1 X 1µF capacitor
2 X 47µF electrolytic capacitor
1 X 10nF capacitor (not important, used to stabilise circuit)
1 X general purpose diode
1 X 555 IC
1 X LED
Connecting wires

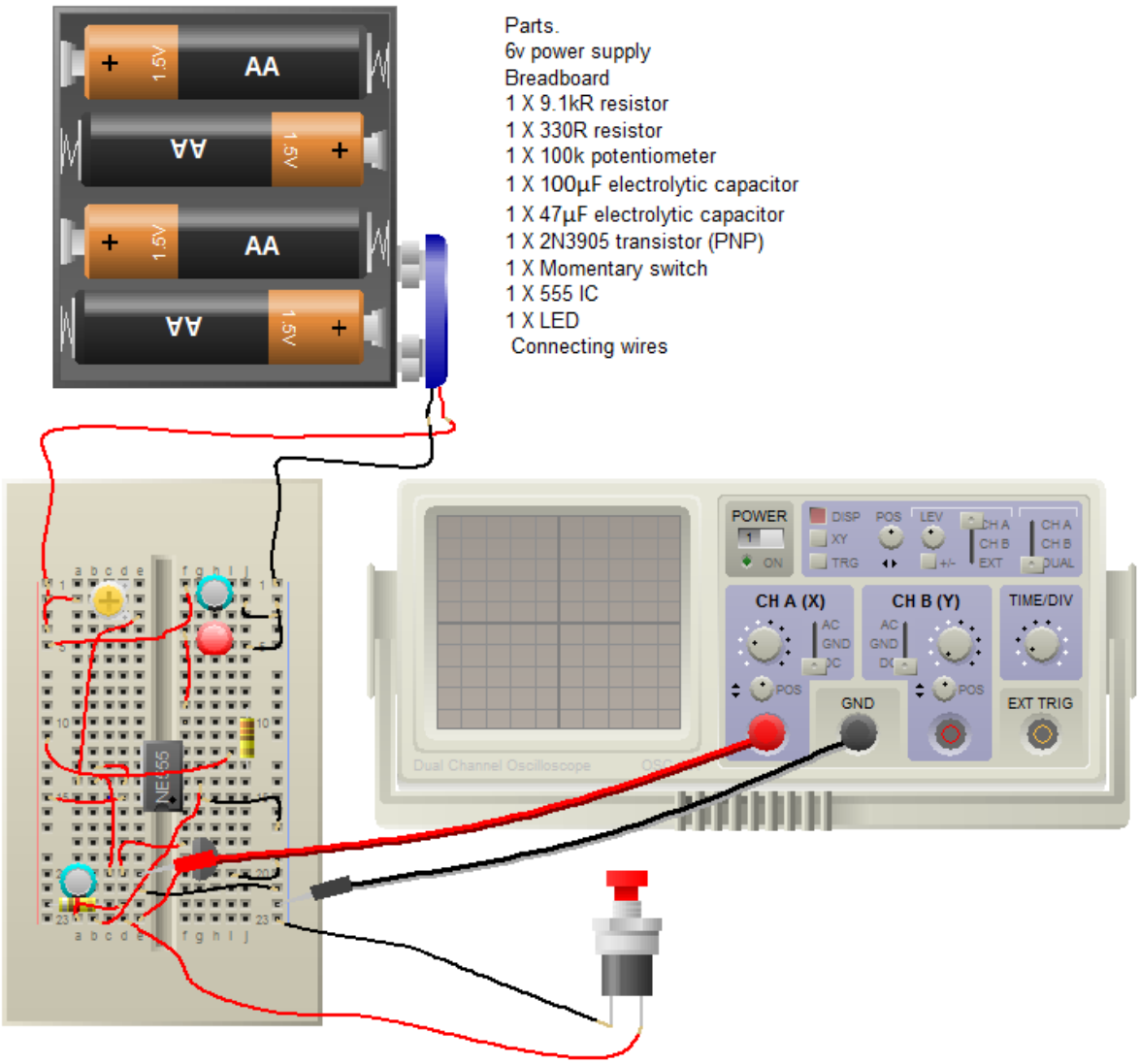
Project 20: More Monostable: Delay Timer

Parts.
6v power supply
Breadboard
1 X 9.1kR resistor
1 X 330R resistor
1 X 100k potentiometer
1 X 100µF electrolytic capacitor
1 X 47µF electrolytic capacitor
1 X 2N3905 transistor (PNP)
1 X Momentary switch
1 X 555 IC
1 X LED
Connecting wires

Time delay switch.
Press SW1 and the capacitor C1 charges relative to the value of VR1. The higher VR1 the longer the delay.





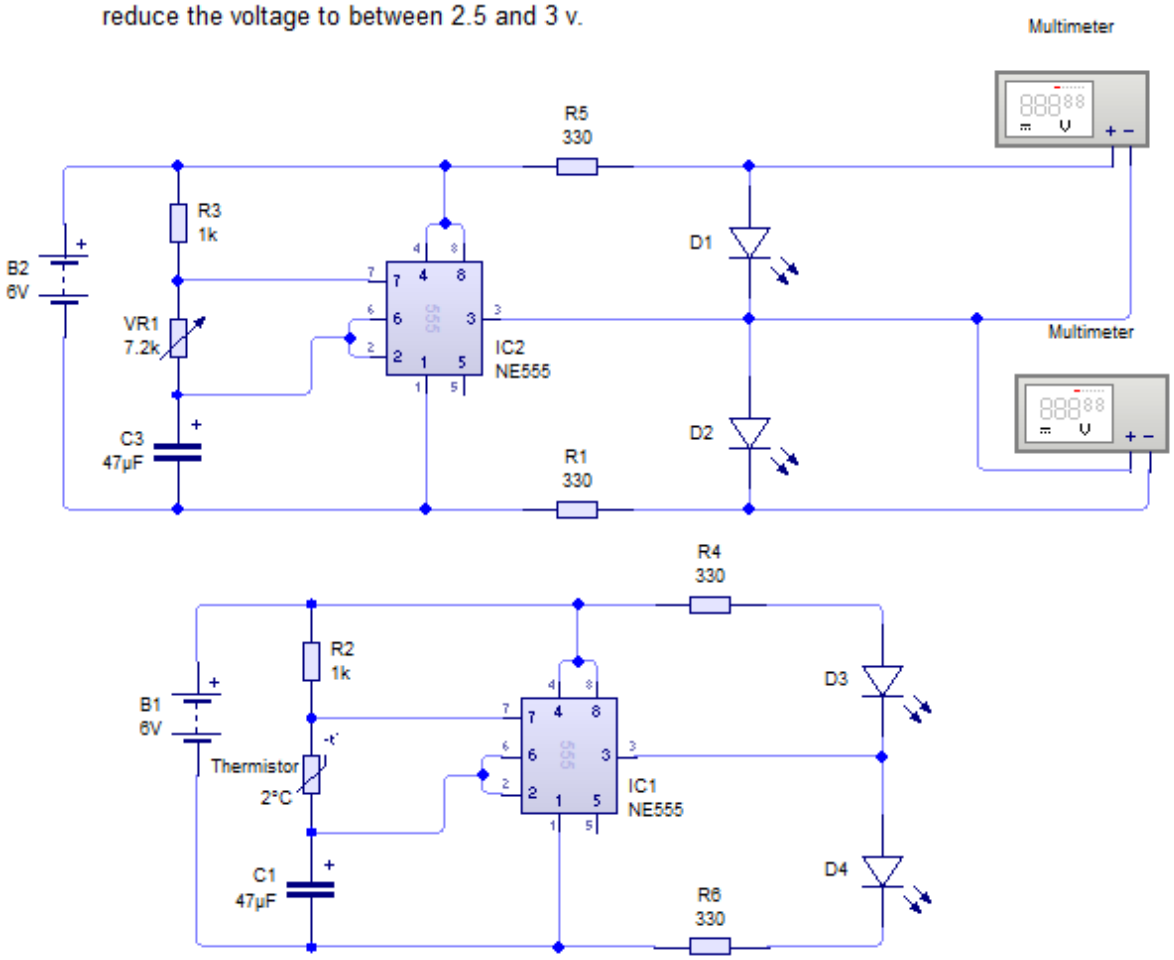


Parts.
6v power supply
Breadboard
1 X 9.1kR resistor
1 X 330R resistor
1 X 100k potentiometer
1 X 100µF electrolytic capacitor
1 X 47µF electrolytic capacitor
1 X 2N3905 transistor (PNP)
1 X Momentary switch
1 X 555 IC
1 X LED
Connecting wires

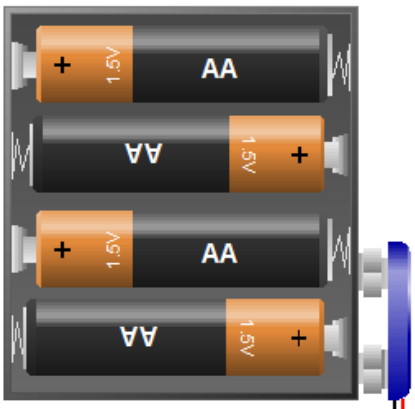
Project 21: Flasher with a 555 Integrated Circuit

Parts.
6v power supply
Breadboard
1 X 1kR resistor
2 X 330R resistor
1 X 10k potentiometer
1 X 47µF electrolytic capacitor
1 X 555 IC
2 X LEDs (different colours up to you)
Connecting wires

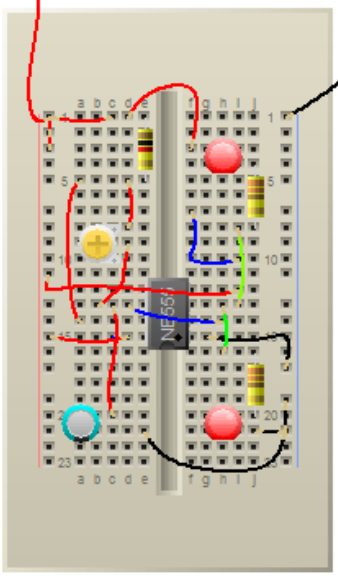
Check the rating on your LEDs if you can.
With R1 and R5 at 220Ω, the voltage across the LEDs is slightly over 3v. Increasing the resistors to 300Ω ish will reduce the voltage to between 2.5 and 3 v.



Changing the circuit very slightly by adding a thermistor in place of the potentiometer, we could have flashing LEDs to act as a warning as the temperature rises.



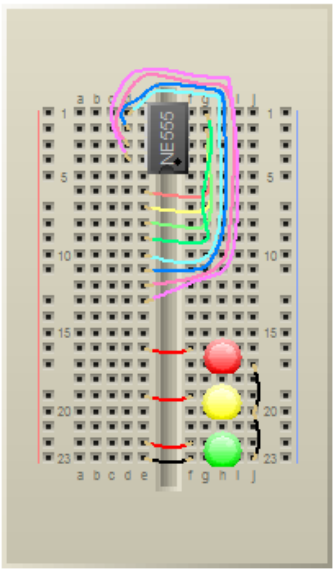
Parts.
6v power supply
Breadboard
1 X 1kR resistor
2 X 330R resistor
1 X 10k potentiometer
1 X 47µF electrolytic capacitor
1 X 555 IC
2 X LEDs (different colours up to you)
Connecting wires



The idea behind the board on the right is to (sort of) tidy up and/or speed up the chip wiring.
Ideally on a second breadboard.

Pin 1 - row 6 (mostly gnd)
Pin 2 - row 7
Pin 3 - row 8 (output)
Pin 4 - row 9 (mostly Vcc)
Pin 5 - row 10 (rarely used)
Pin 6 - row 11
Pin 7 - row 12
Pin 8 - row 13 (mostly Vcc)

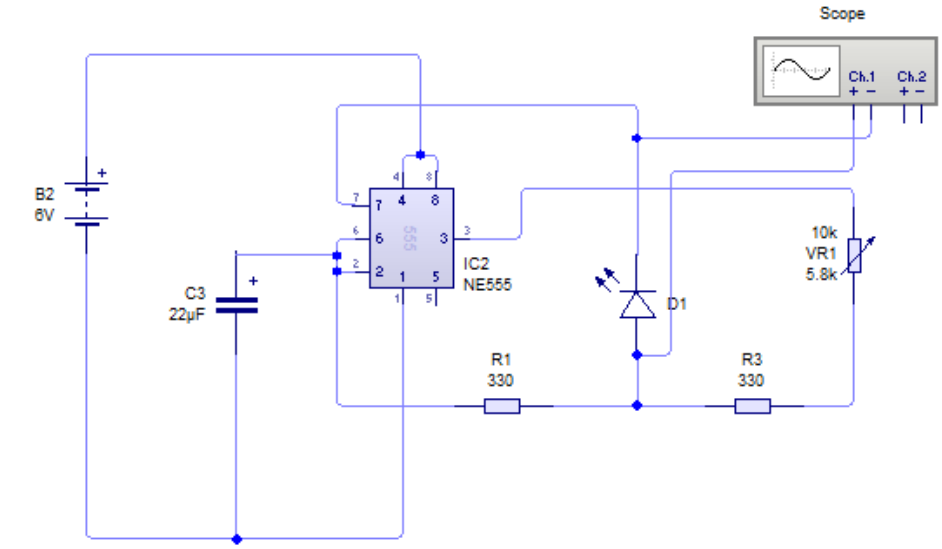
LEDs are also used a lot in experimentation.
Row 16 - Red
Row 19 - Yellow
Row 22 - Green
Row 23 - gnd
Once they are on the board they can be used together or

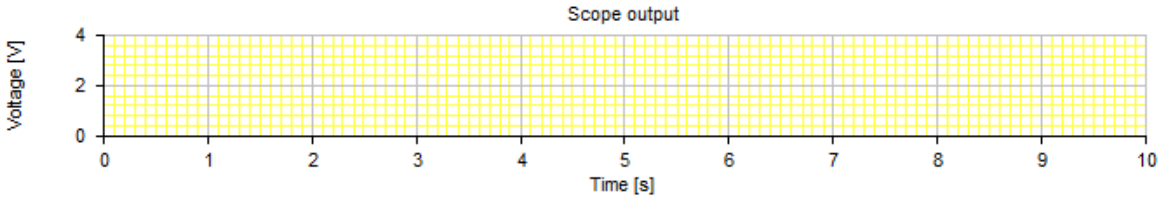


Not pretty but working with chips often looks worse:)
The secret is, take one pin at a time.

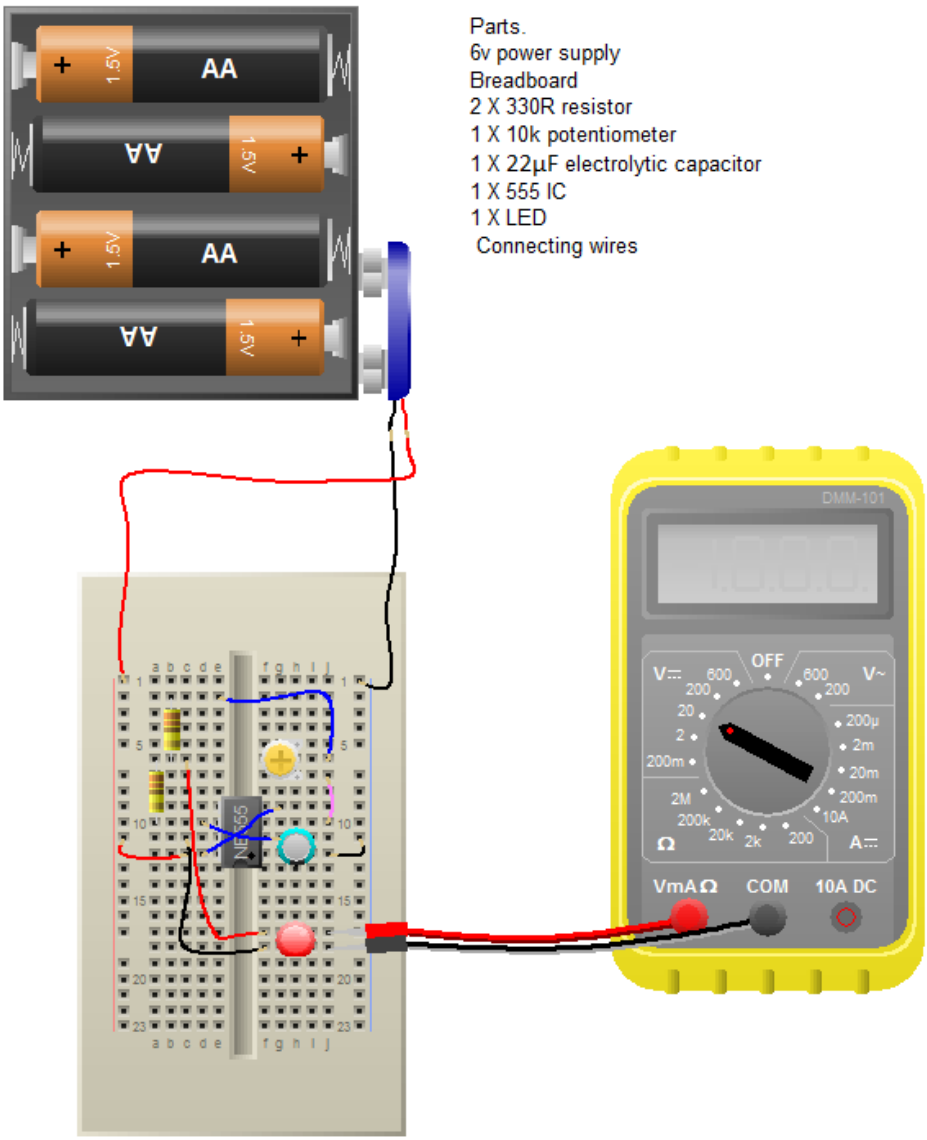
Project 22: Flasher: Random? (flasher with less wiring)

Parts.
6v power supply
Breadboard
2 X 330R resistor
1 X 10k potentiometer
1 X 22µF electrolytic capacitor
1 X 555 IC
1 X LED
Connecting wires





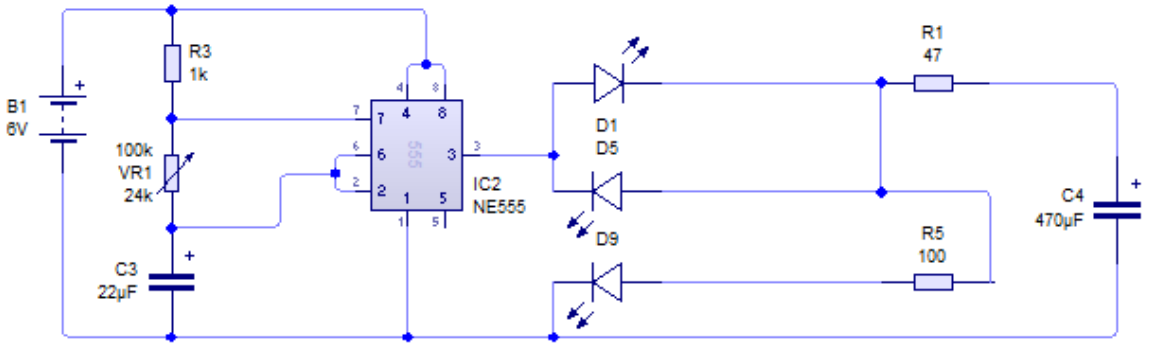
VR1 will modify the flash rate.
Try changing the value of C3 (increase), R1 and R2 (decrease) to change the effect.



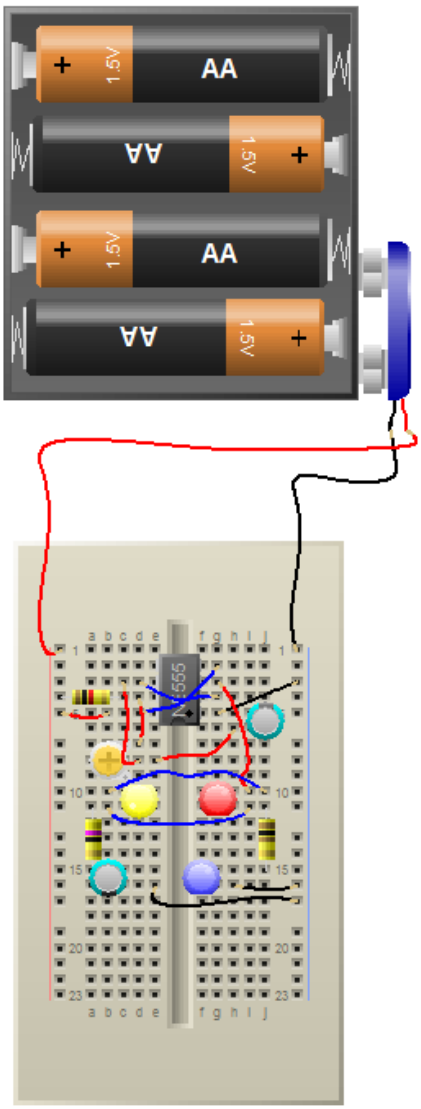
Parts.
6v power supply
Breadboard
2 X 330R resistor
1 X 10k potentiometer
1 X 22µF electrolytic capacitor
1 X 555 IC
1 X LED
Connecting wires

Project 23: Flasher with Integrated Circuit part two

Parts.
6v power supply
Breadboard
1 X 1kR resistor
1 X 100R resistor
1 X 47R resistor
1 X 100k potentiometer
1 X 22µF electrolytic capacitor
1 X 470µF electrolytic capacitor
1 X 555 IC
3 X LEDs (different colours up to you)
Connecting wires



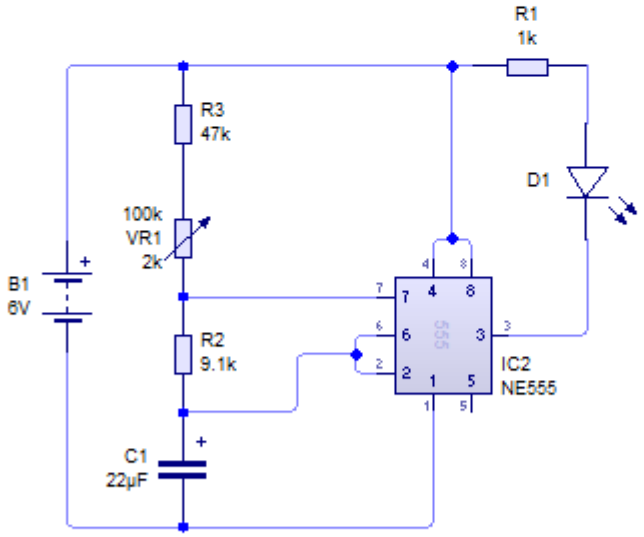
This circuit gives a nice effect of flashing LEDs.
Changing the total value of C1 and C4 will modify the way the LEDS are flashed.
VR1 will change the flash rate. Again VR1 could be any resistive sensor.



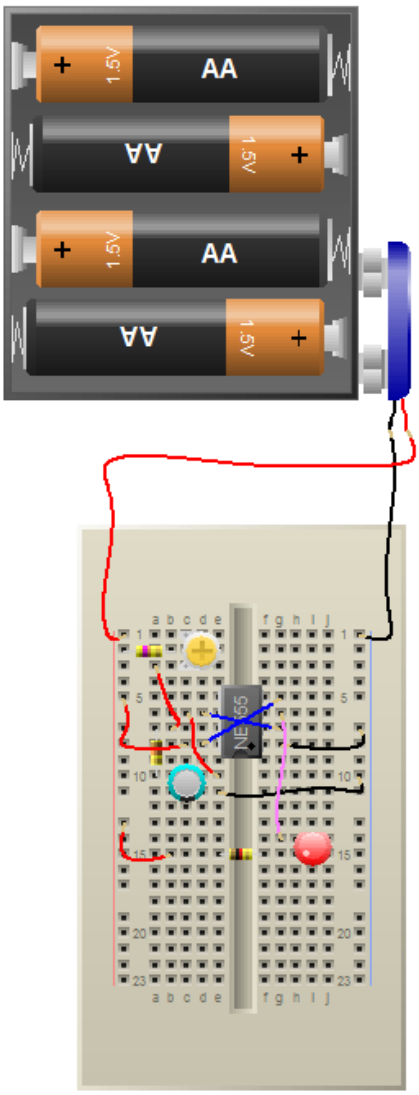
Parts.
6v power supply
Breadboard
1 X 1kR resistor
1 X 100R resistor
1 X 47R resistor
1 X 100k potentiometer
1 X 22µF electrolytic capacitor
1 X 470µF electrolytic capacitor
1 X 555 IC
3 X LEDs (different colours up to you)
Connecting wires

Project 24: Slow Blink

Parts.
6v power supply
Breadboard
1 X 1kR resistor
1 X 9.1kR resistor
1 X 470kR resistor
1 X 100kR potentiometer
1 X 22µF electrolytic capacitor
1 X 555 IC
1 X LED
Connecting wires



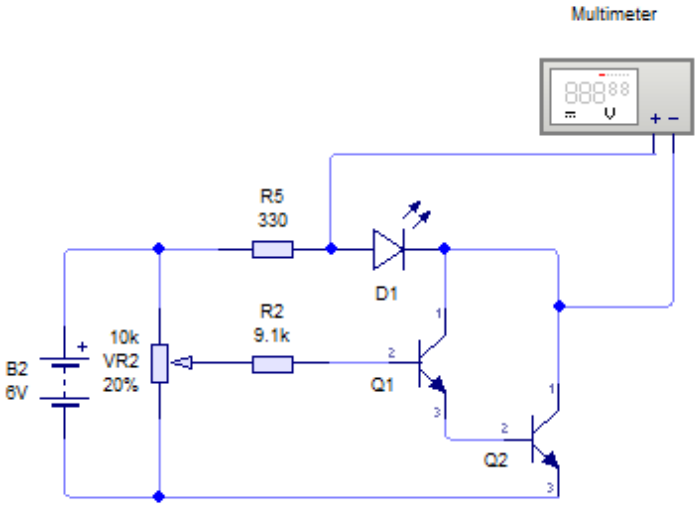
A nice simple circuit to give a slow flash of the LED.
Can be used for a dummy or real surveilance camera,
Changing the value of R3 and VR1 (up or down) will change the rate of flash.
Changing the value of C1 will change how it flashes.



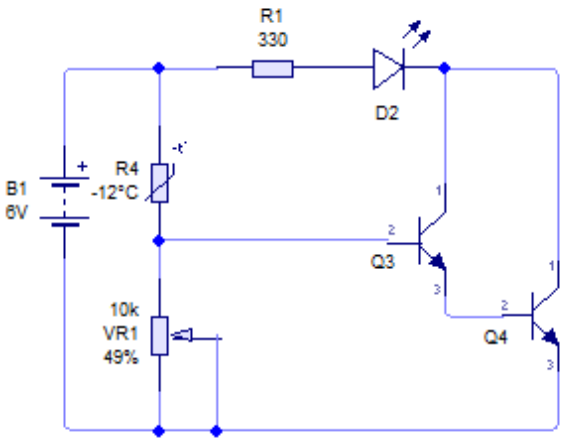
Parts.
6v power supply
Breadboard
1 X 1kR resistor
1 X 9.1kR resistor
1 X 470kR resistor
1 X 100kR potentiometer
1 X 22µF electrolytic capacitor
1 X 555 IC
1 X LED
Connecting wires

Project 25: Darlington Pair

Parts.
6v power supply
Breadboard
1 X 9.1kR resistor
2 X 330R resistors
2 X 10k potentiometers
2 X LEDs
4 X 2N3904 NPN transistors
1 X 25 degree C thermistor
Connecting wires

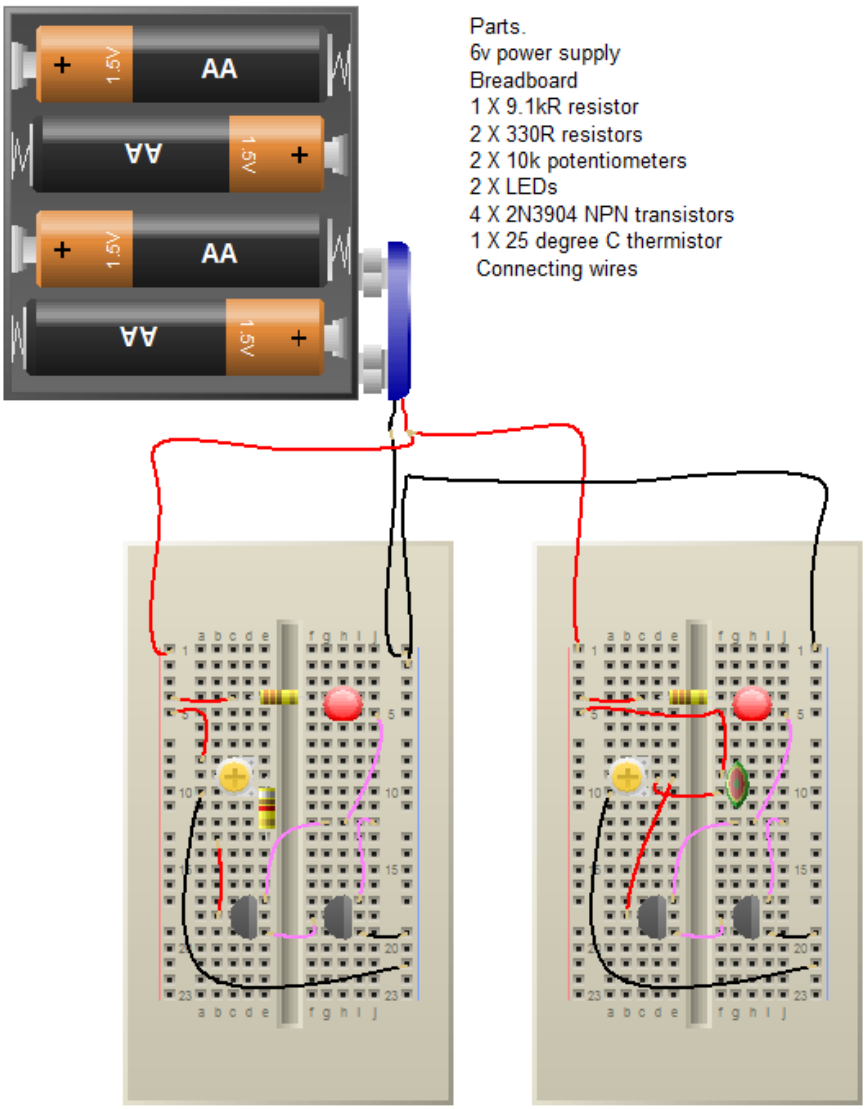


Improved switching with a Darlington Pair



With a thermister and a potentiometer, we can turn on the LED when a certain temperature is reached.

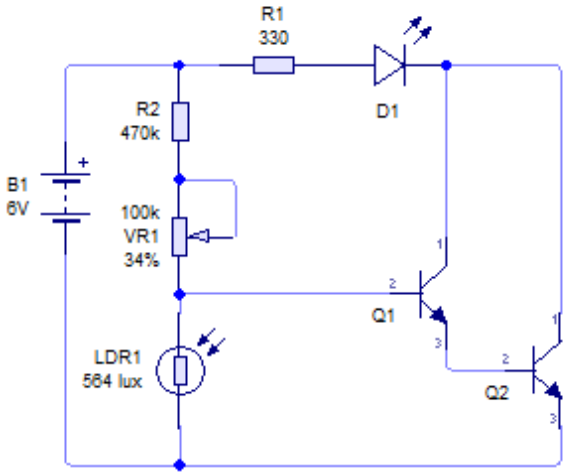
Another very simple but effective circuit which with a little imagination can be put to use in many places where temperature or light need to be monitored.



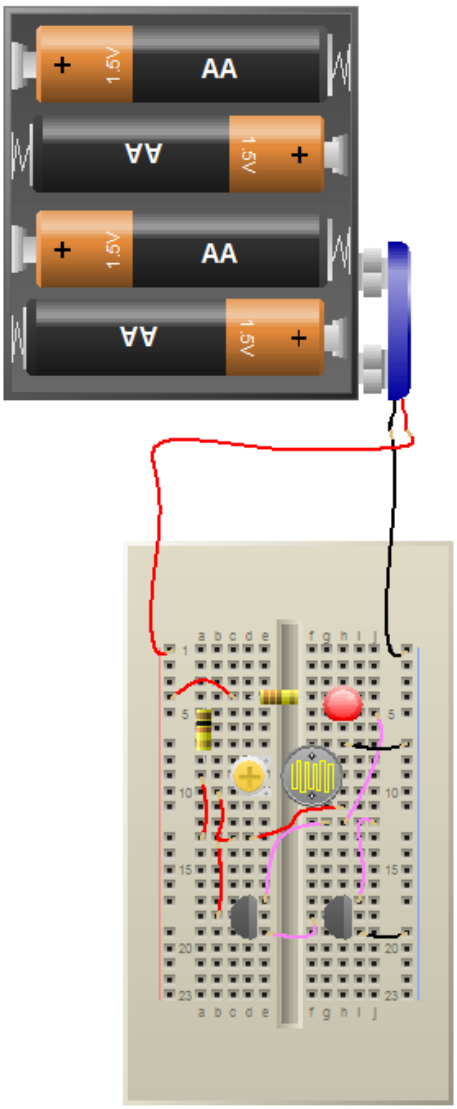
Parts.
6v power supply
Breadboard
1 X 9.1kR resistor
2 X 330R resistors
2 X 10k potentiometers
2 X LEDs
4 X 2N3904 NPN transistors
1 X 25 degree C thermistor
Connecting wires

Project 26: Darlington Pair: Night Light

Parts.
6v power supply
Breadboard
1 X 470kR resistor
1 X 330R resistor
1 X 100k potentiometer (maybe not needed)
1 X LED
1 X LDR
2 X 2N3904 NPN transistors
Connecting wires



With an LDR and a potentiometer, we can turn on the LED when a certain level of light is reached.

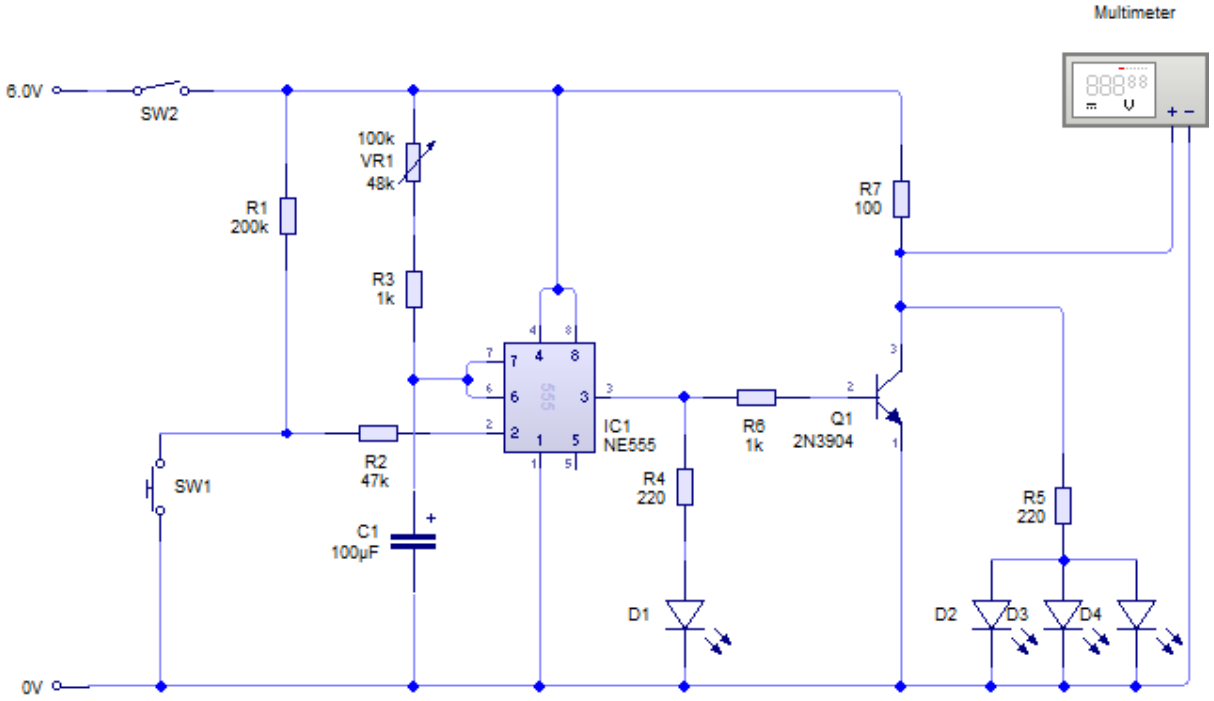


Parts.
6v power supply
Breadboard
1 X 470kR resistor
1 X 330R resistor
1 X 100k potentiometer (maybe not needed)
1 X LED
1 X LDR
2 X 2N3904 NPN transistors
Connecting wires

Project 27: Variable Delay Timer

Parts.
6v power supply
Breadboard
1 X 200kR resistor
2 X 1kR resistors
1 X 47kR resistor
1 X 100R resistor
2 X 220R resistors
1 X 100k potentiometer
1 X 100µF electrolytic capacitor
4 X LEDs
1 X 555 timer IC
1 X 2N3904 NPN transistor
Switch
Connecting wires

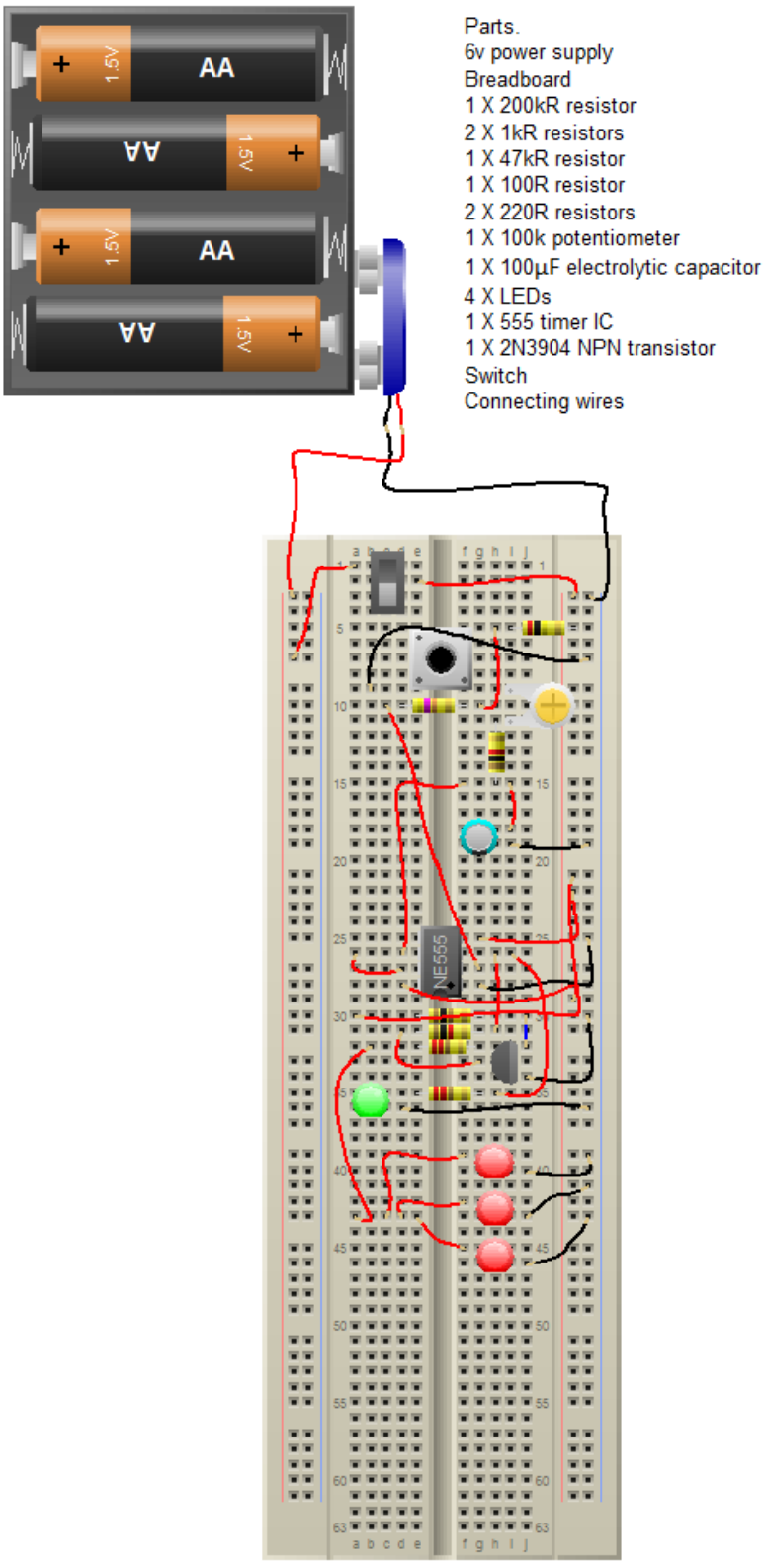
From now on we will only show Voltage rails and not a battery on the circuit diagrams.



An ideal circuit for an entry/exit delay switch.

SW2 turns the power on.
When SW1 is depressed D1 will alight for a time determined by the value of VR1.
Once the time has elapsed, D1 will go out and D2, D3 and D4 will alight.
Instead of LEDs (D1, D2, D3) we could control a relay, servo etc to do many tasks.

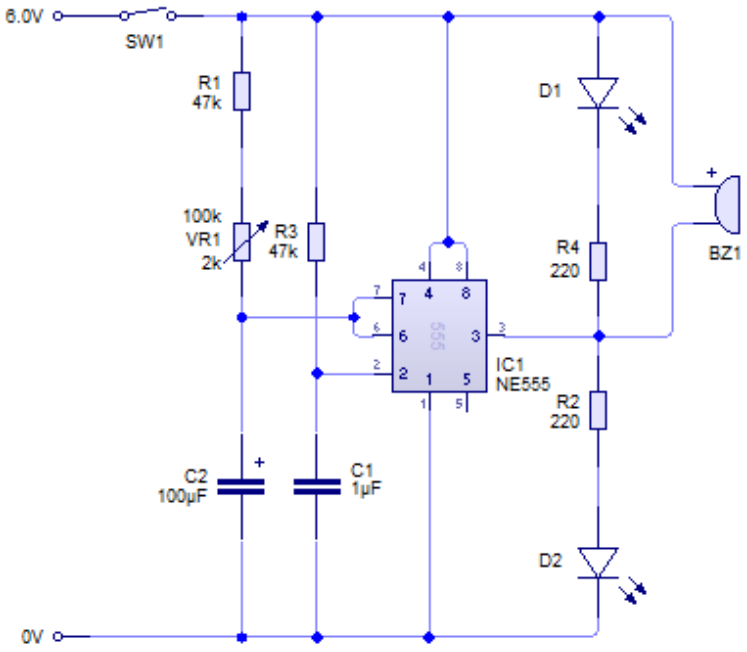
Increasing the value of C1 will also increase the amount of time



Parts.
6v power supply
Breadboard
1 X 200kR resistor
2 X 1kR resistors
1 X 47kR resistor
1 X 100R resistor
2 X 220R resistors
1 X 100k potentiometer
1 X 100µF electrolytic capacitor
4 X LEDs
1 X 555 timer IC
1 X 2N3904 NPN transistor
Switch
Connecting wires

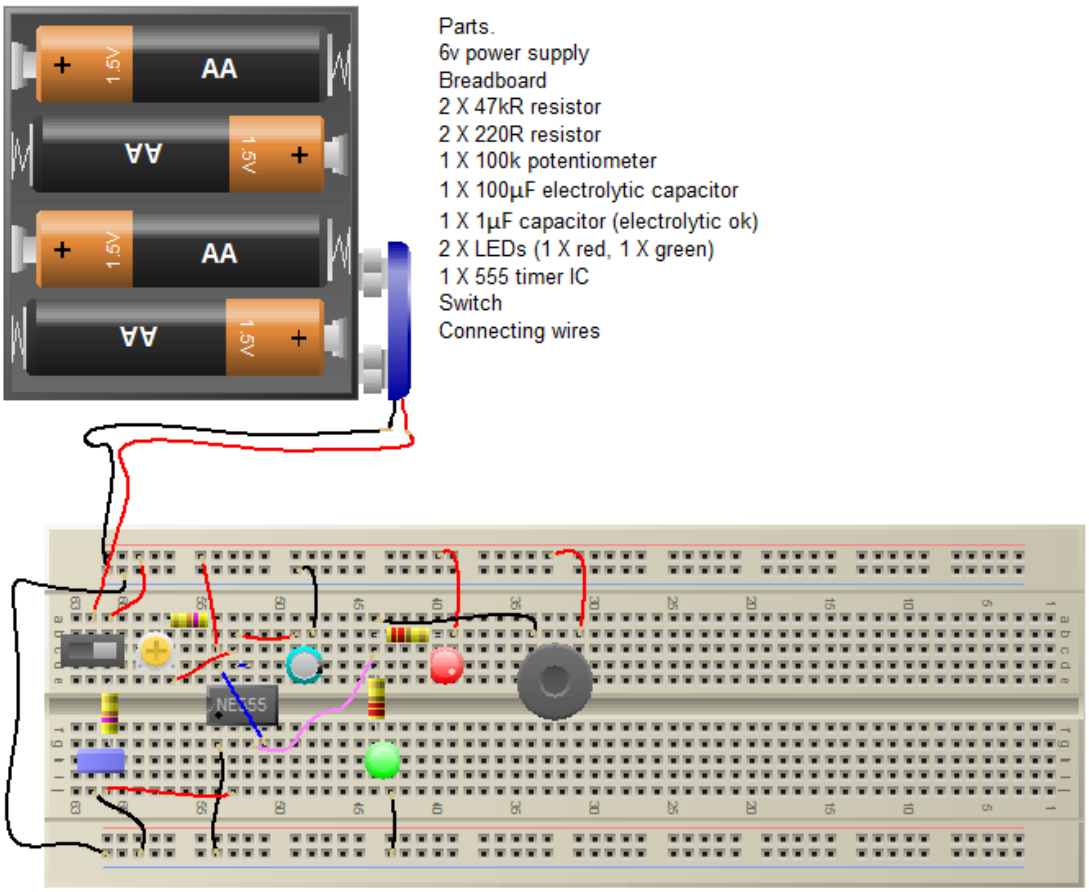
Project 28: Variable Delay Timer with Buzzer

Parts.
6v power supply
Breadboard
2 X 47kR resistor
2 X 220R resistor
1 X 100k potentiometer
1 X 100µF electrolytic capacitor
1 X 1µF capacitor (electrolytic ok)
2 X LEDs (1 X red, 1 X green)
1 X 555 timer IC
Switch
Connecting wires



An ideal circuit for an entry/exit delay switch.

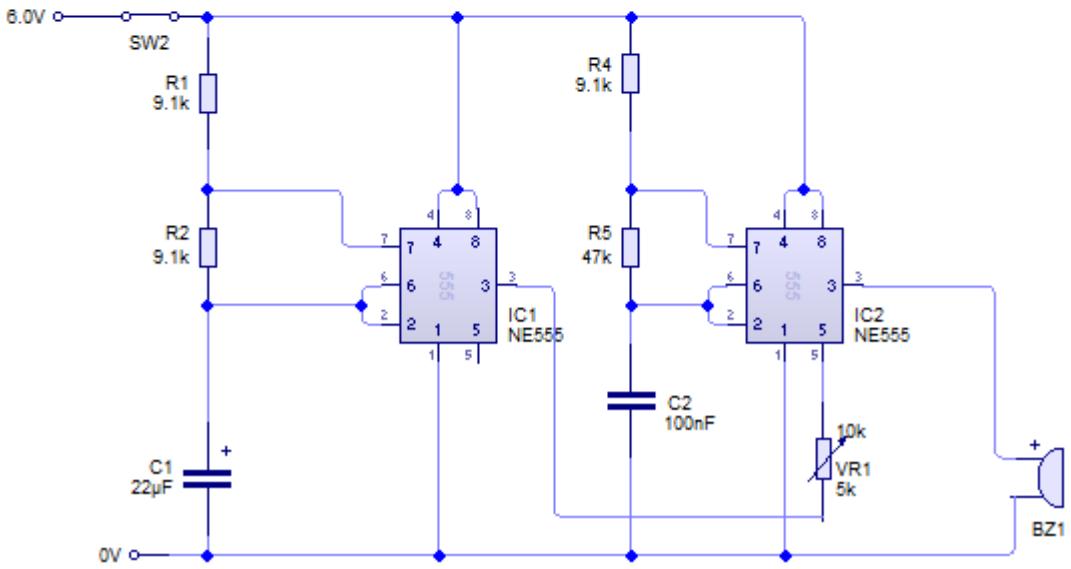
SW1 turns the power on.
When SW1 is depressed D2 will alight for a time determined by the value of VR1 and R1.
Once the time has elapsed, D1 will go out and D2, will alight, and the buzzer will beep.

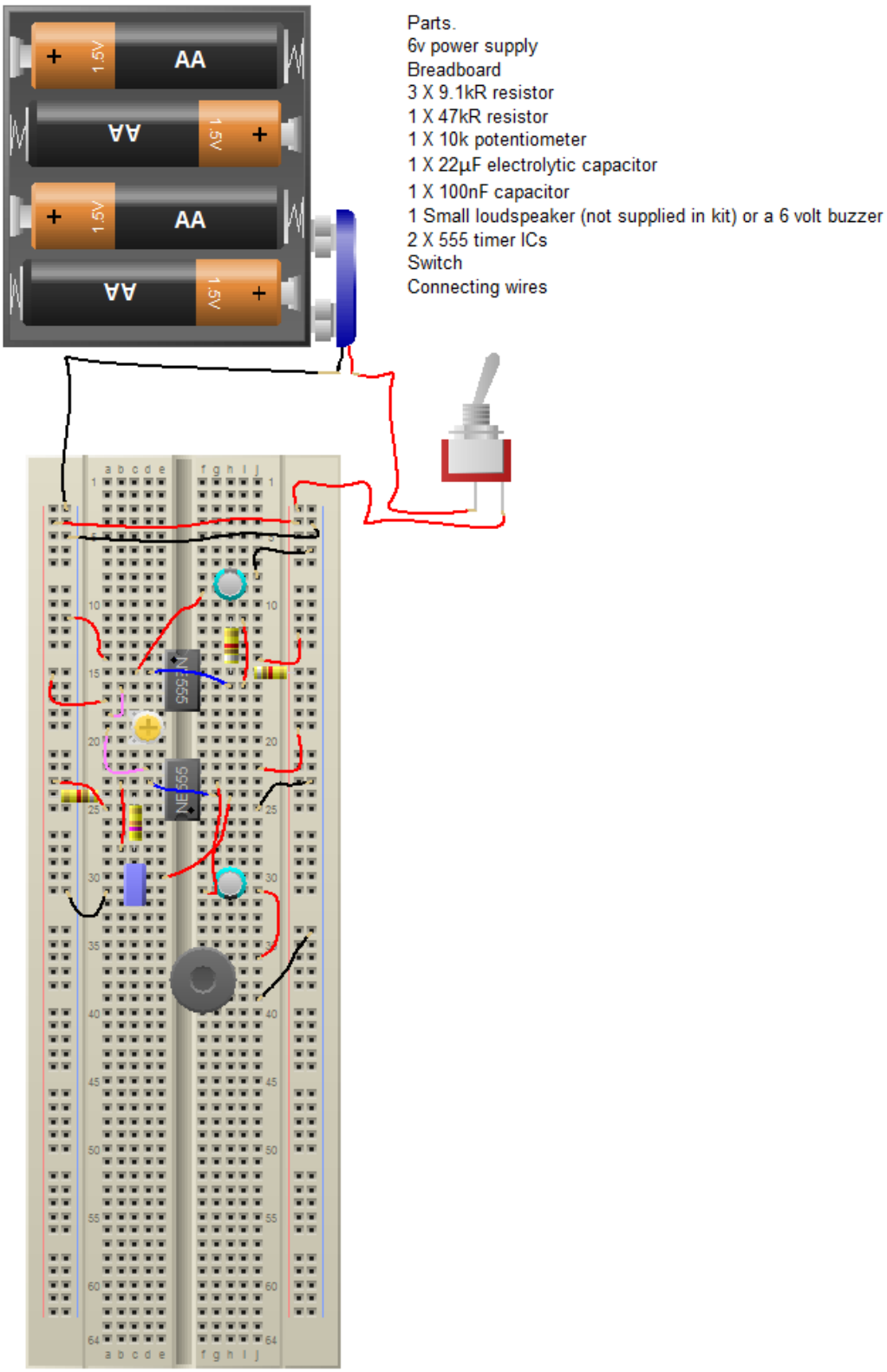


Parts.
6v power supply
Breadboard
2 X 47kR resistor
2 X 220R resistor
1 X 100k potentiometer
1 X 100µF electrolytic capacitor
1 X 1µF capacitor (electrolytic ok)
2 X LEDs (1 X red, 1 X green)
1 X 555 timer IC
Switch
Connecting wires

Project 29: Siren

Parts.
6v power supply
Breadboard
3 X 9.1kR resistor
1 X 47kR resistor
1 X 10k potentiometer
1 X 22µF electrolytic capacitor
1 X 100nF capacitor
1 Small loudspeaker (not supplied in kit) or a 6 volt buzzer
2 X 555 timer ICs
Switch
Connecting wires

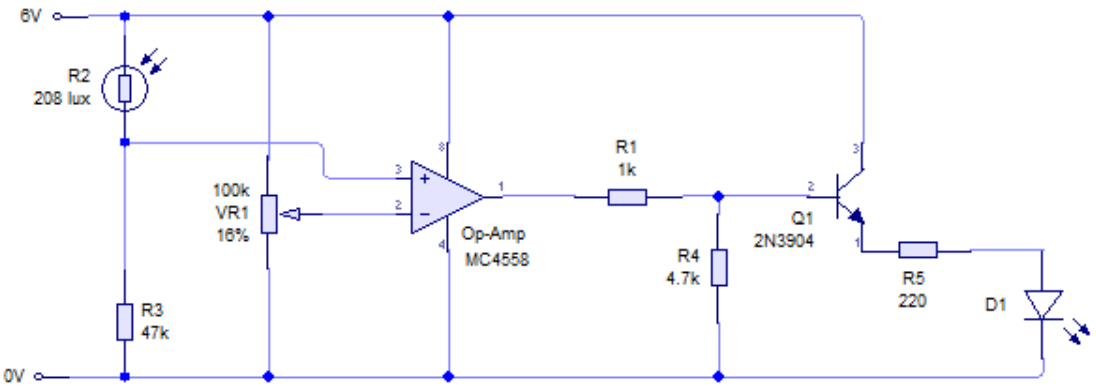




Parts.
6v power supply
Breadboard
3 X 9.1kR resistor
1 X 47kR resistor
1 X 10k potentiometer
1 X 22µF electrolytic capacitor
1 X 100nF capacitor
1 Small loudspeaker (not supplied in kit) or a 6 volt buzzer
2 X 555 timer ICs
Switch
Connecting wires

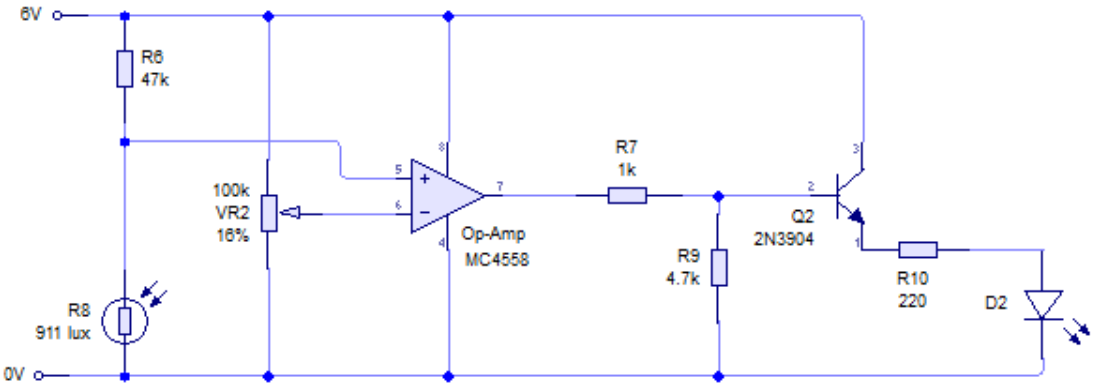
Project 30: Operation Amplifier with Transistor

Parts.
6v power supply
Breadboard
1 X 4.7kR resistor
1 X 47kR resistor
1 X 1kR resistor
1 X 220R resistor
1 X 100k potentiometer
1 X 4558 Op amp IC
1 X 2N3904 transistor
1 X LDR
1 X LED
Connecting wires

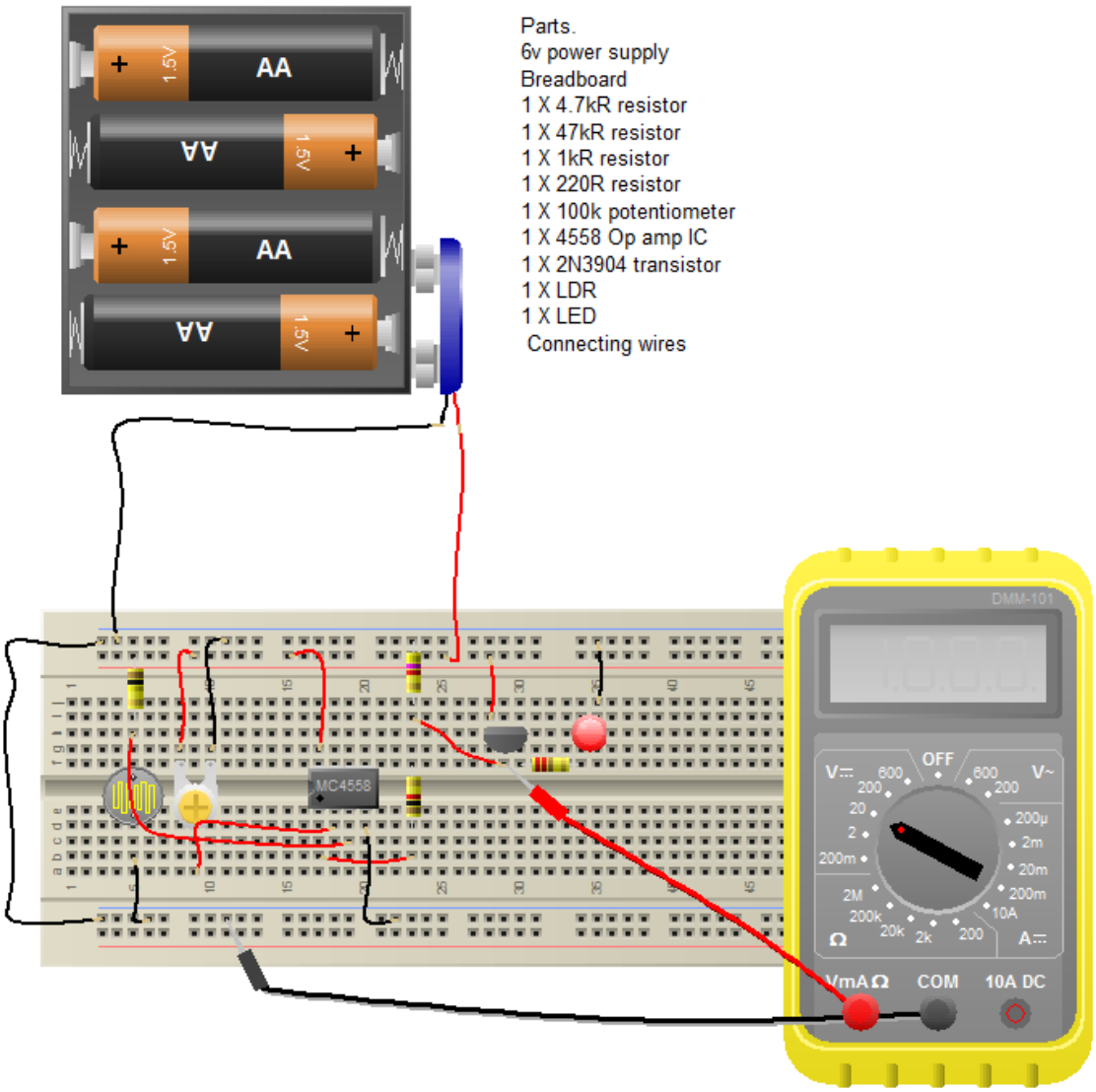


The LED will light when light hits the LDR (R2).
VR1 adjusts the sensitivity.

Commonly referred to as a Comparator circuit.



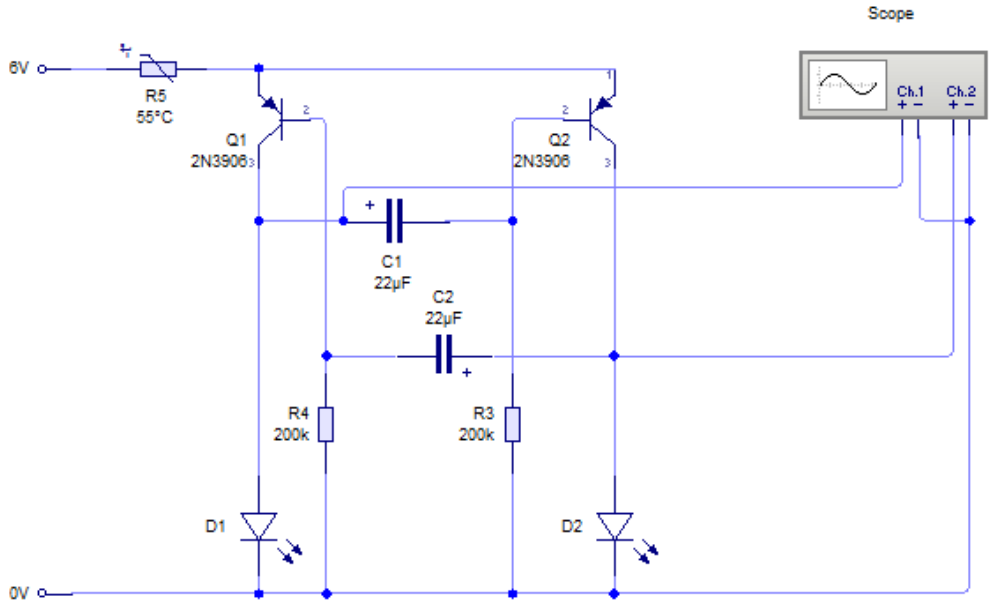
By swapping the positions of the LDR and 100k resistor we now get a more sensitive effect

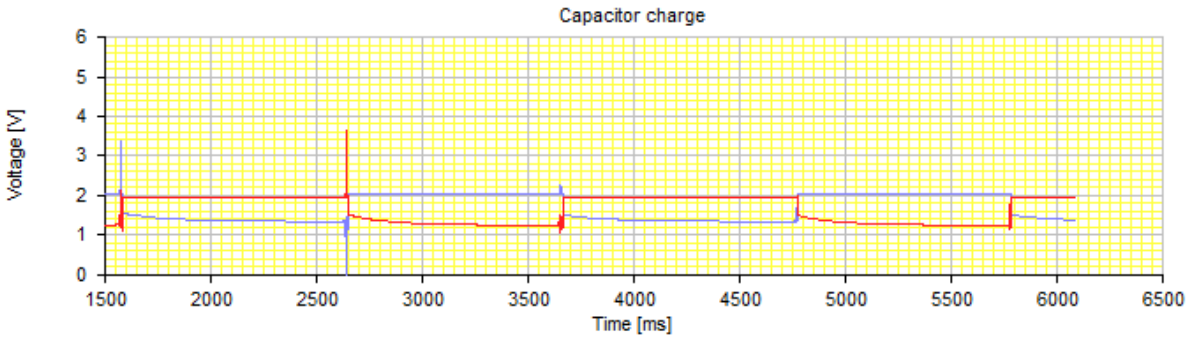


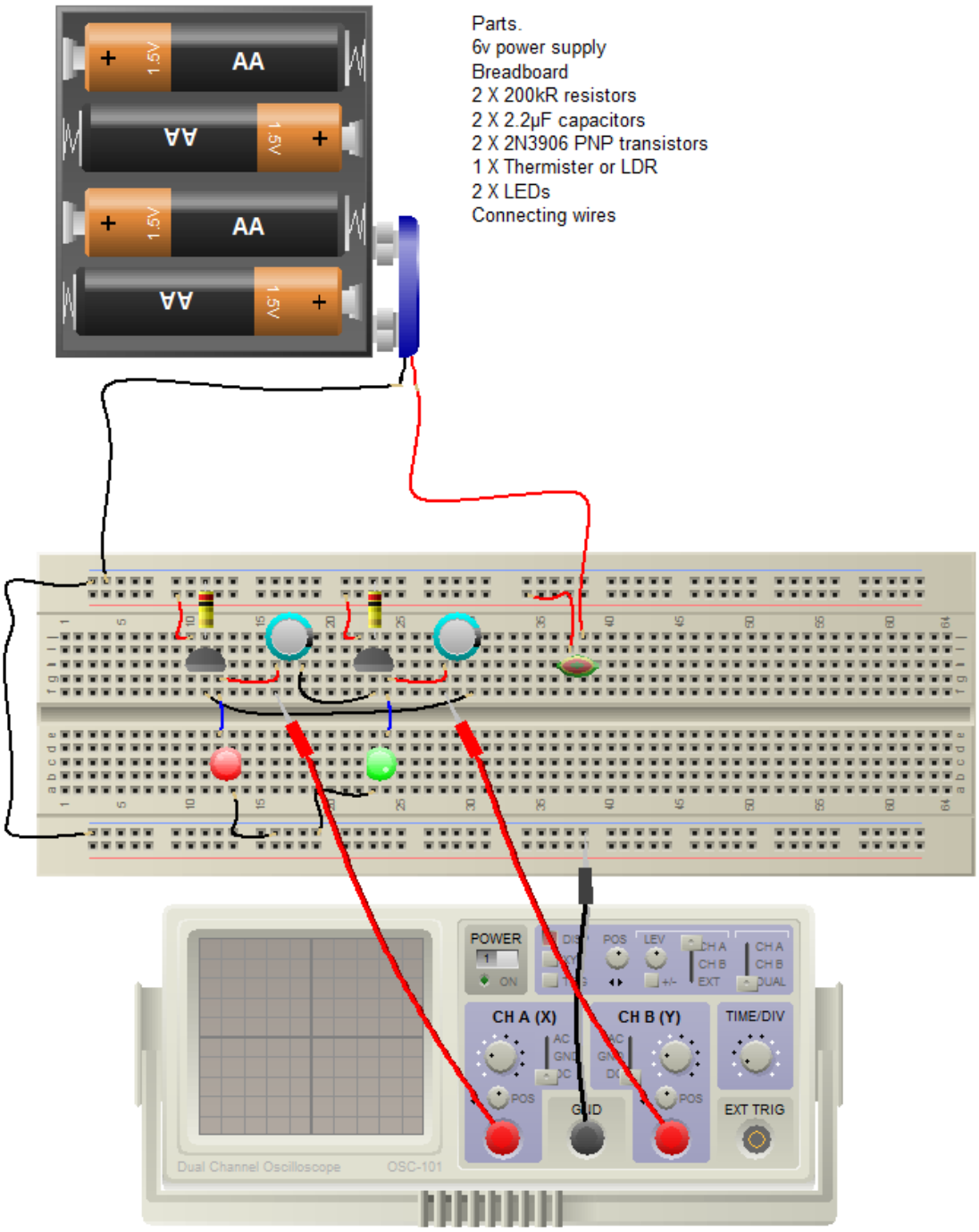
Parts.
6v power supply
Breadboard
1 X 4.7kR resistor
1 X 47kR resistor
1 X 1kR resistor
1 X 220R resistor
1 X 100k potentiometer
1 X 4558 Op amp IC
1 X 2N3904 transistor
1 X LDR
1 X LED
Connecting wires

Project 31: Dual Transistor Multivibrator

Parts.
6v power supply
Breadboard
2 X 200kR resistors
2 X 2.2µF capacitors
2 X 2N3906 PNP transistors
1 X Thermister or LDR
2 X LEDs
Connecting wires



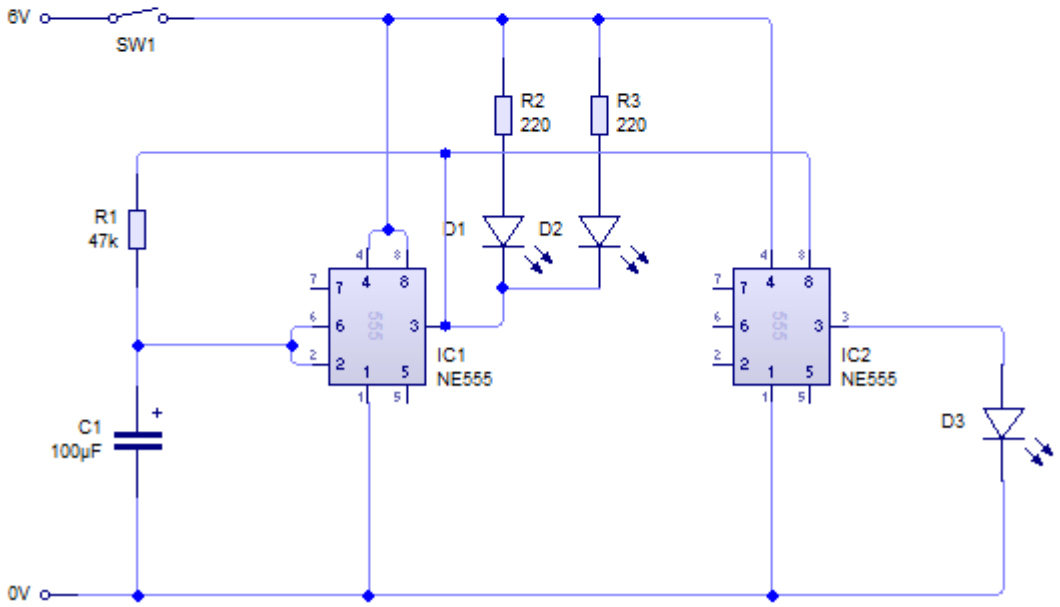


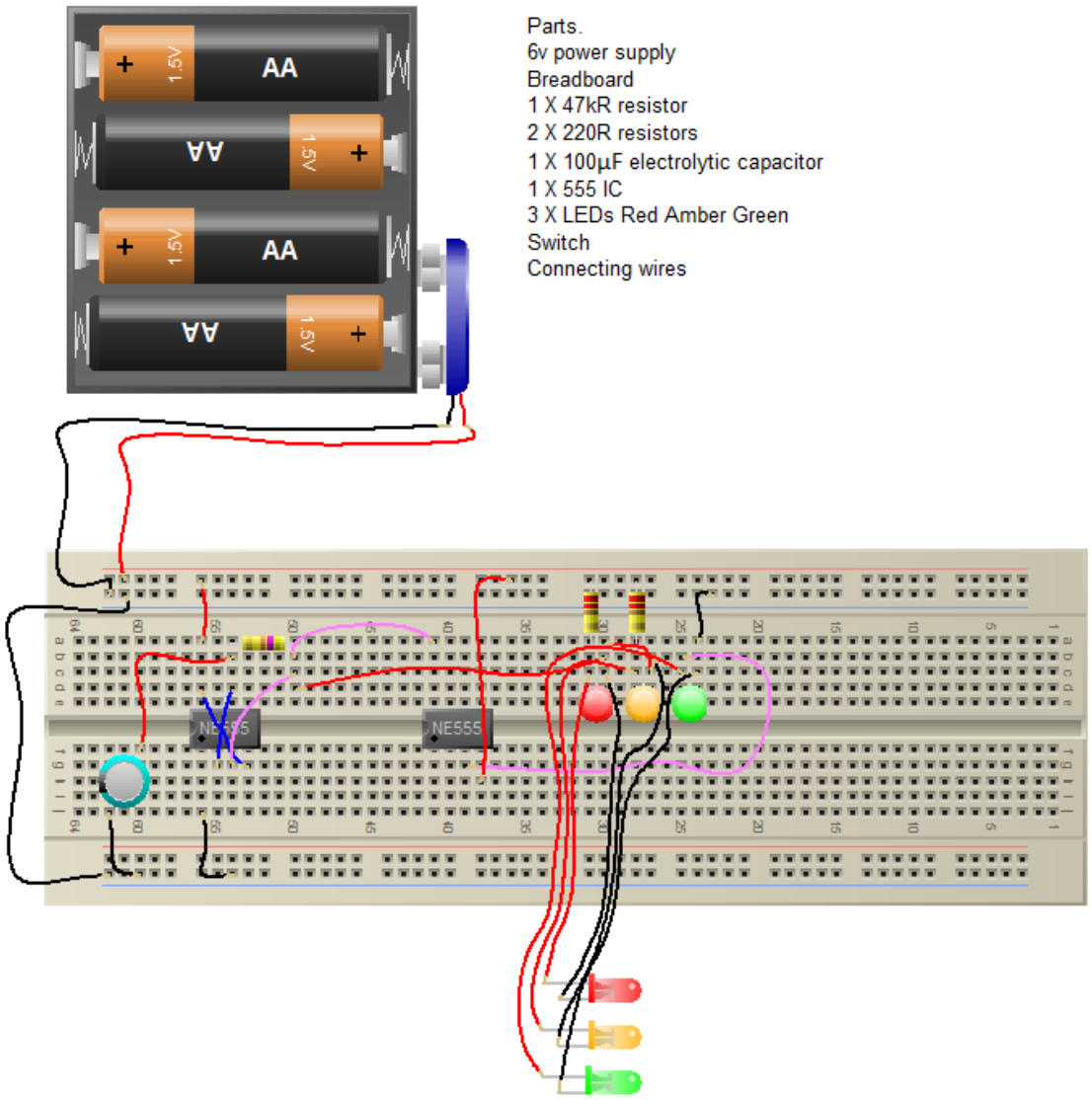


Parts.
6v power supply
Breadboard
2 X 200kR resistors
2 X 2.2µF capacitors
2 X 2N3906 PNP transistors
1 X Thermister or LDR
2 X LEDs
Connecting wires

Project 32: Traffic Lights: Australian Style

Parts.
6v power supply
Breadboard
1 X 47kR resistor
2 X 220R resistors
1 X 100µF electrolytic capacitor
1 X 555 IC
3 X LEDs Red Amber Green
Switch
Connecting wires

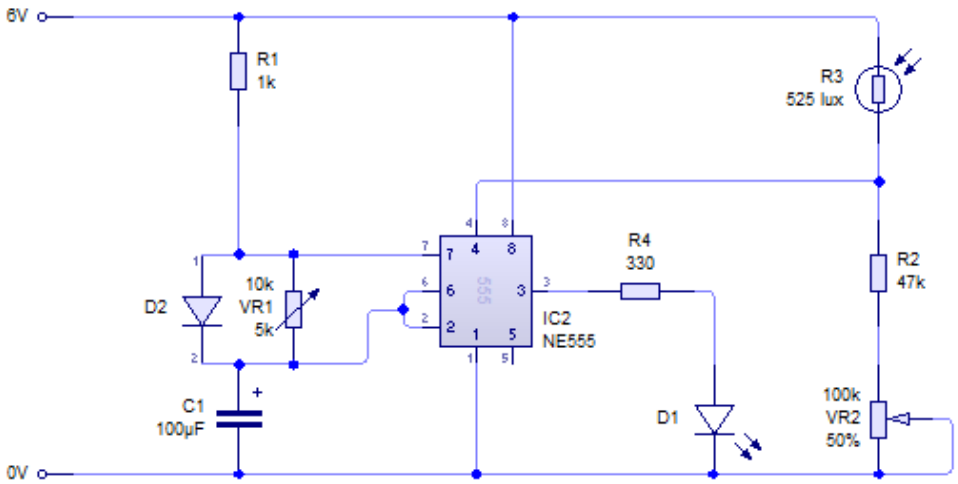




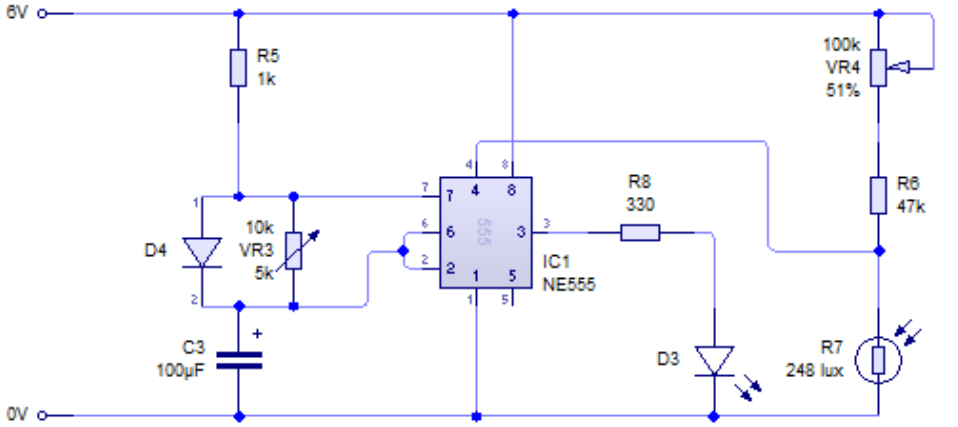
Parts.
6v power supply
Breadboard
1 X 47kR resistor
2 X 220R resistors
1 X 100µF electrolytic capacitor
1 X 555 IC
3 X LEDs Red Amber Green
Switch
Connecting wires

Project 33: Light and Dark Detector with 555 Timer

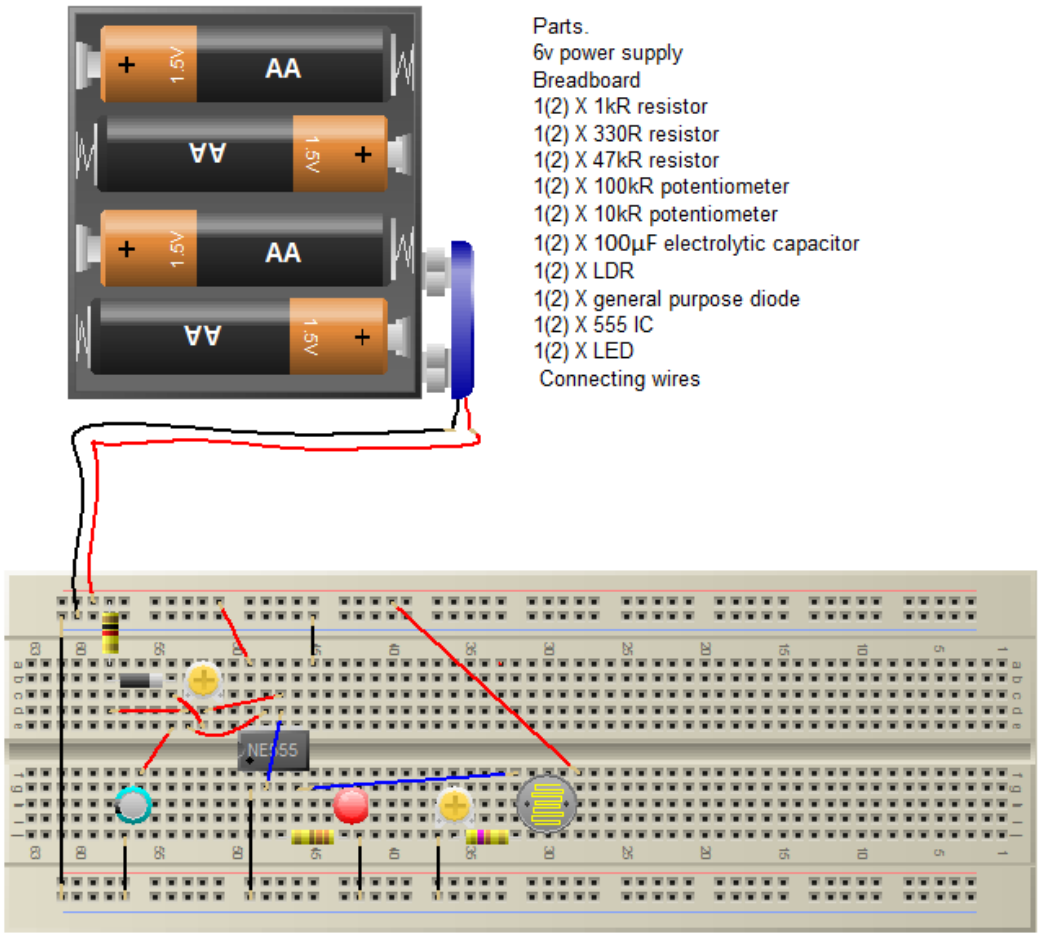
Parts.
6v power supply
Breadboard
1(2) X 1kR resistor
1(2) X 330R resistor
1(2) X 47kR resistor
1(2) X 100kR potentiometer
1(2) X 10kR potentiometer
1(2) X 100µF electrolytic capacitor
1(2) X LDR
1(2) X general purpose diode
1(2) X 555 IC
1(2) X LED
Connecting wires



Light detector



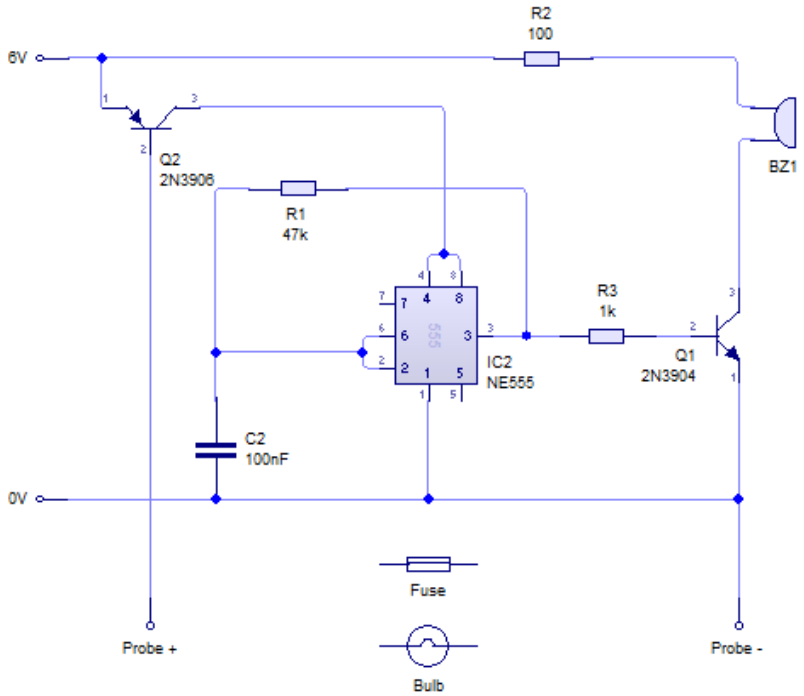
Dark detector



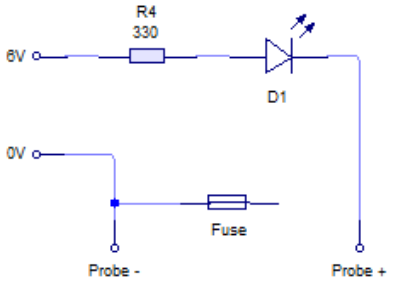
Parts.
6v power supply
Breadboard
1(2) X 1kR resistor
1(2) X 330R resistor
1(2) X 47kR resistor
1(2) X 100kR potentiometer
1(2) X 10kR potentiometer
1(2) X 100µF electrolytic capacitor
1(2) X LDR
1(2) X general purpose diode
1(2) X 555 IC
1(2) X LED
Connecting wires

Project 34: Continuity Tester

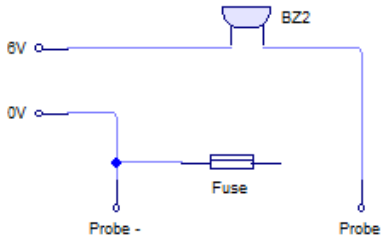
Parts.
6v power supply
Breadboard
1 X 47kR resistor
1 X 100R resistor
1 X 1kR resistor
1 X 100nF capacitor
1 X 2N3906 pnp transistor
1 X 2N3904 npn transistor
1 X 555 IC
1 X Buzzer
Connecting wires

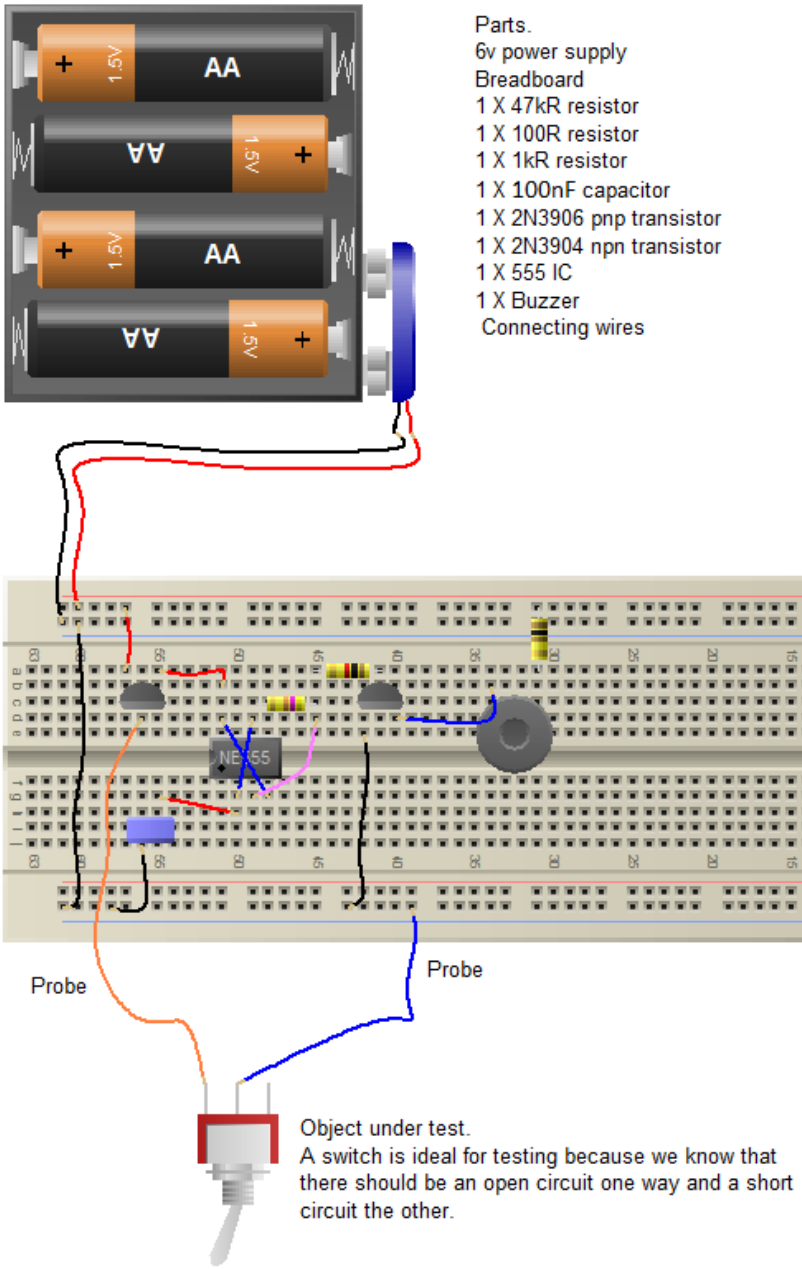


Simple continuity tester. Ideal for testing fuses, filiment lamps or anything that should have continuity, like a wire.
This circuit will also test continuity of something that has resistance up to about 200k.
If the probes are disconnected, no power is used, so there is no need for a power switch.



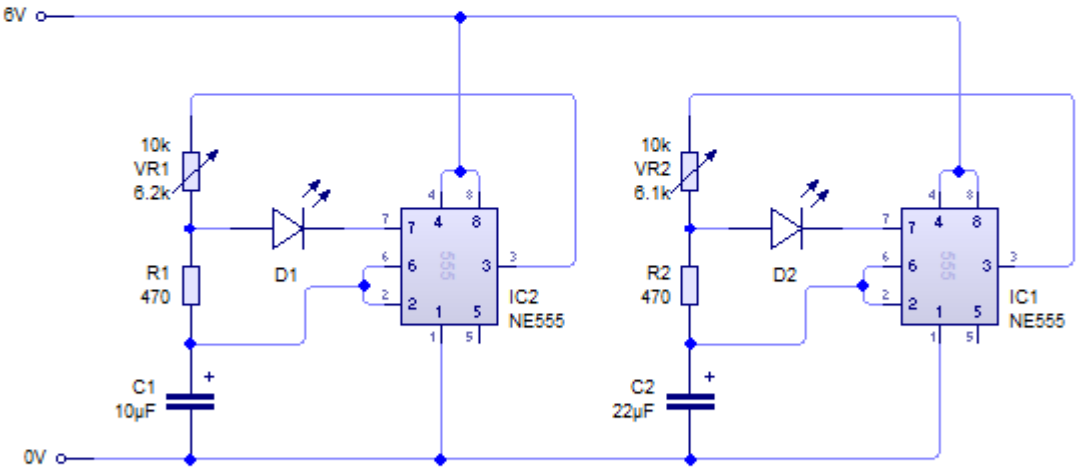
Or, if you want something even more basic





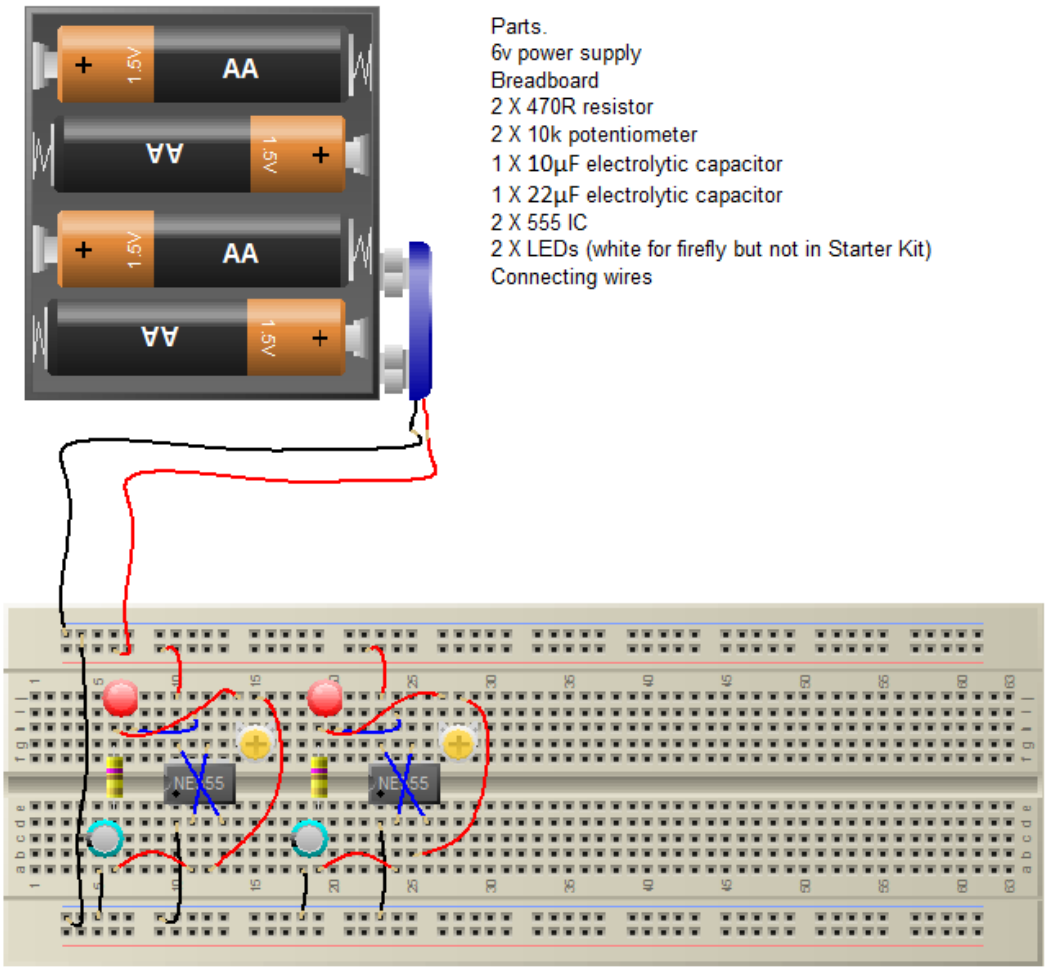
Project 35: Firefly Flasher

Parts.
6v power supply
Breadboard
2 X 470R resistor
2 X 10k potentiometer
1 X 10µF electrolytic capacitor
1 X 22µF electrolytic capacitor
2 X 555 IC
2 X LEDs (white for firefly but not in Starter Kit)
Connecting wires



Two almost identical circuits in one.
The principle is to have a random(ish) flashing white lights at the bottom of the garden somewhere that resembles fireflies.

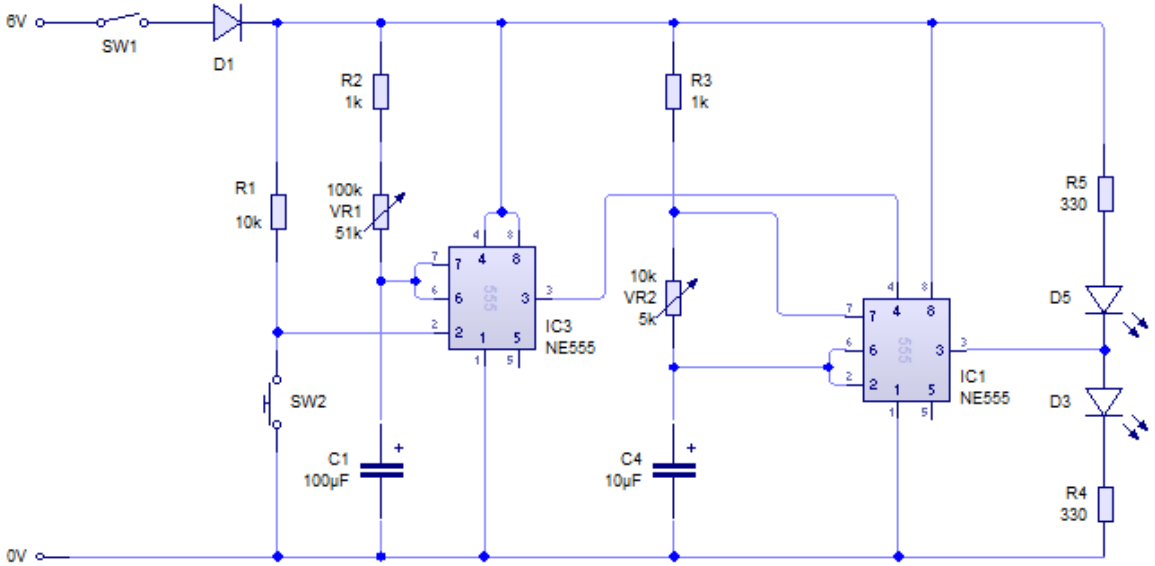
What the circuit really shows is that by changing the value of the capacitor (C1/C2) you can achieve a different randomness.



Parts.
6v power supply
Breadboard
2 X 470R resistor
2 X 10k potentiometer
1 X 10µF electrolytic capacitor
1 X 22µF electrolytic capacitor
2 X 555 IC
2 X LEDs (white for firefly but not in Starter Kit)
Connecting wires

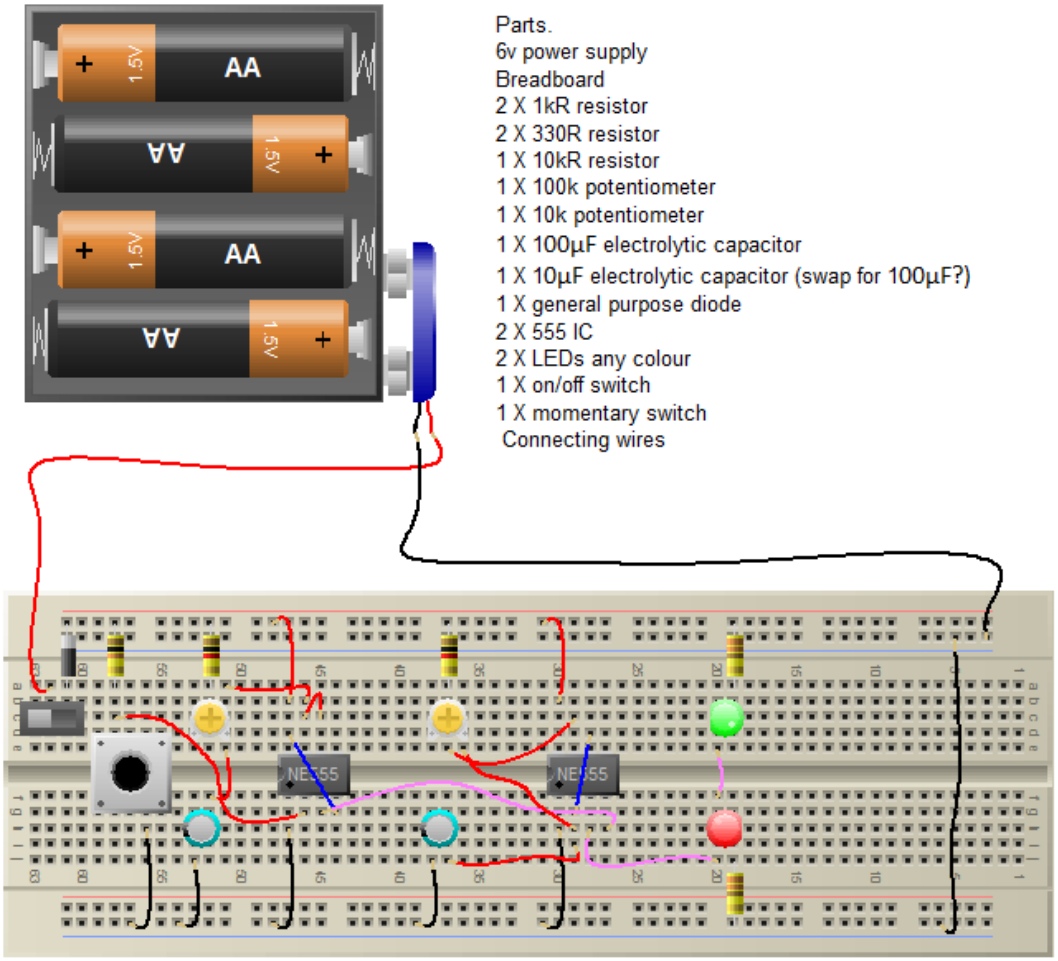
Project 36: Monostable and Astable Together

Parts.
6v power supply
Breadboard
2 X 1kR resistor
2 X 330R resistor
1 X 10kR resistor
1 X 100k potentiometer
1 X 10k potentiometer
1 X 100µF electrolytic capacitor
1 X 10µF electrolytic capacitor (swap for 100µF?)
1 X general purpose diode
2 X 555 IC
2 X LEDs any colour
1 X on/off switch
1 X momentary switch
Connecting wires



Simple example of a monostable circuit controlling an astable one.
The trigger switch SW2 sets pin 2 of the monostable low, and the output pin (3) goes high for a time predetermined by VR1.
This triggers the astable and flashes the LEDs.
Changing VR1 will change the amount of time that the astable will run for.
Changing VR2 will change the flash rate.
Changing C4 from 10µF to 100µF will also have an effect on the flash rate.

This circuit could be used as an entry/exit delay trigger on a door or window.
Or you could control SW2 by some other circuit detecting temperature or light etc.

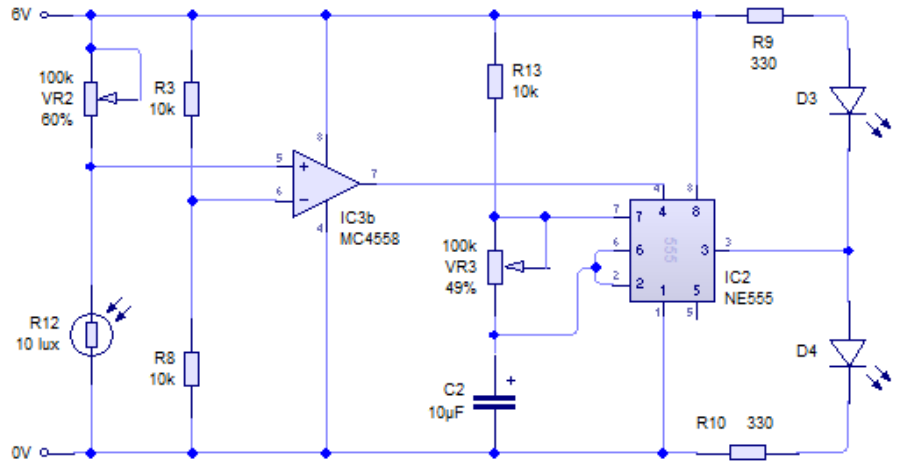


Parts.
6v power supply
Breadboard
2 X 1kR resistor
2 X 330R resistor
1 X 10kR resistor
1 X 100k potentiometer
1 X 10k potentiometer
1 X 100µF electrolytic capacitor
1 X 10µF electrolytic capacitor (swap for 100µF?)
1 X general purpose diode
2 X 555 IC
2 X LEDs any colour
1 X on/off switch
1 X momentary switch
Connecting wires

Project 37: 555 Timer and Operational Amplifier Together

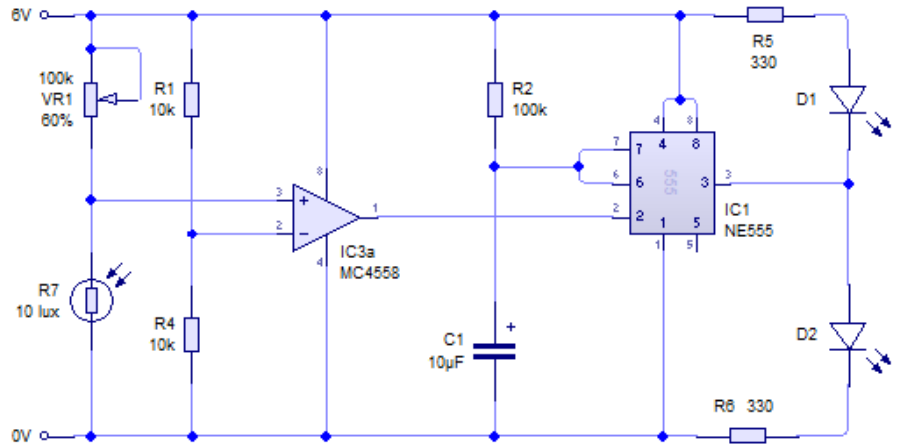
Parts.
6v power supply
Breadboard
2 (5) X 10kR resistor
1 X 100kR resistor
2 (4) X 330R resistor
1 (2) X 10µF electrolytic capacitor
1 (3) X 100k potentiometer
1 (2) X LDR
1 (2) X Op amp IC
1 (2) X 555 timer IC
2 (4) X LEDs (Red and Green)
Connecting wires

Using an Op Amp with a 555 monostable to detect change in temperature.
By adjusting VR1/VR2 we can set the desired temperature before the LEDs change from green to red.
Notice that the output of the op-amp is the input of the astable.

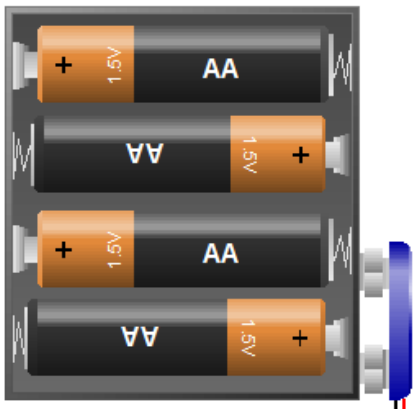


Astable

A variation on the first circuit, this one will flash the two LEDs when the temperature raises above the set threshold.

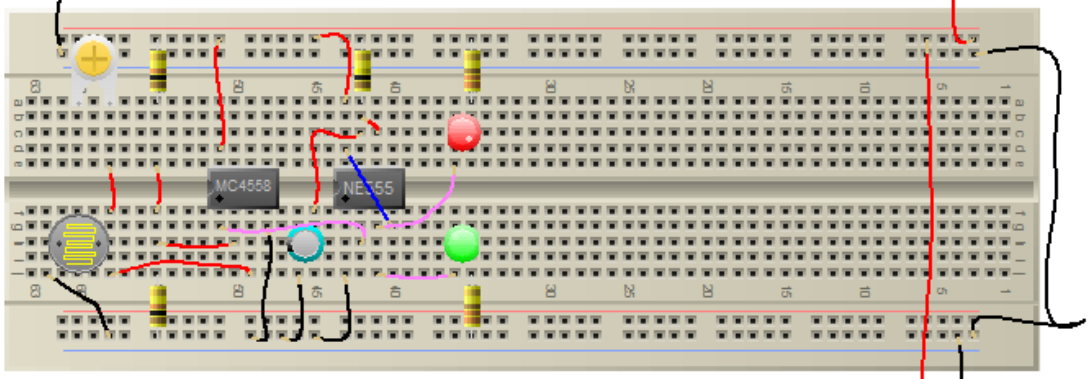


Monostable

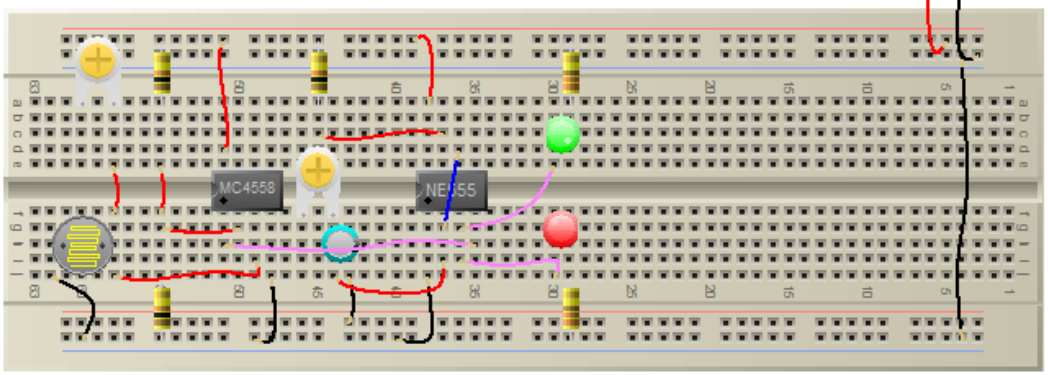


Parts.
6v power supply
Breadboard
2 (5) X 10kR resistor
1 X 100kR resistor
2 (4) X 330R resistor
1 (2) X 10µF electrolytic capacitor
1 (3) X 100k potentiometer
1 (2) X LDR
1 (2) X Op amp IC
1 (2) X 555 timer IC
2 (4) X LEDs (Red and Green)
Connecting wires

Monostable

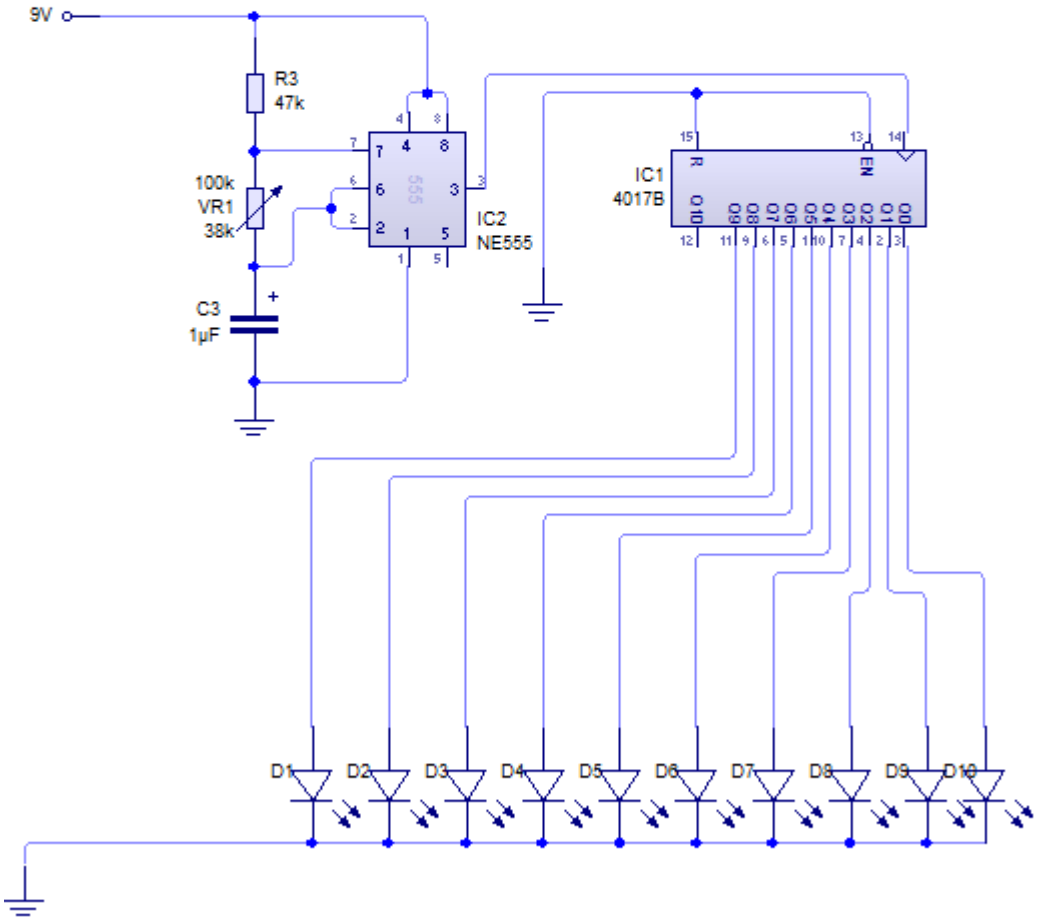


Astable

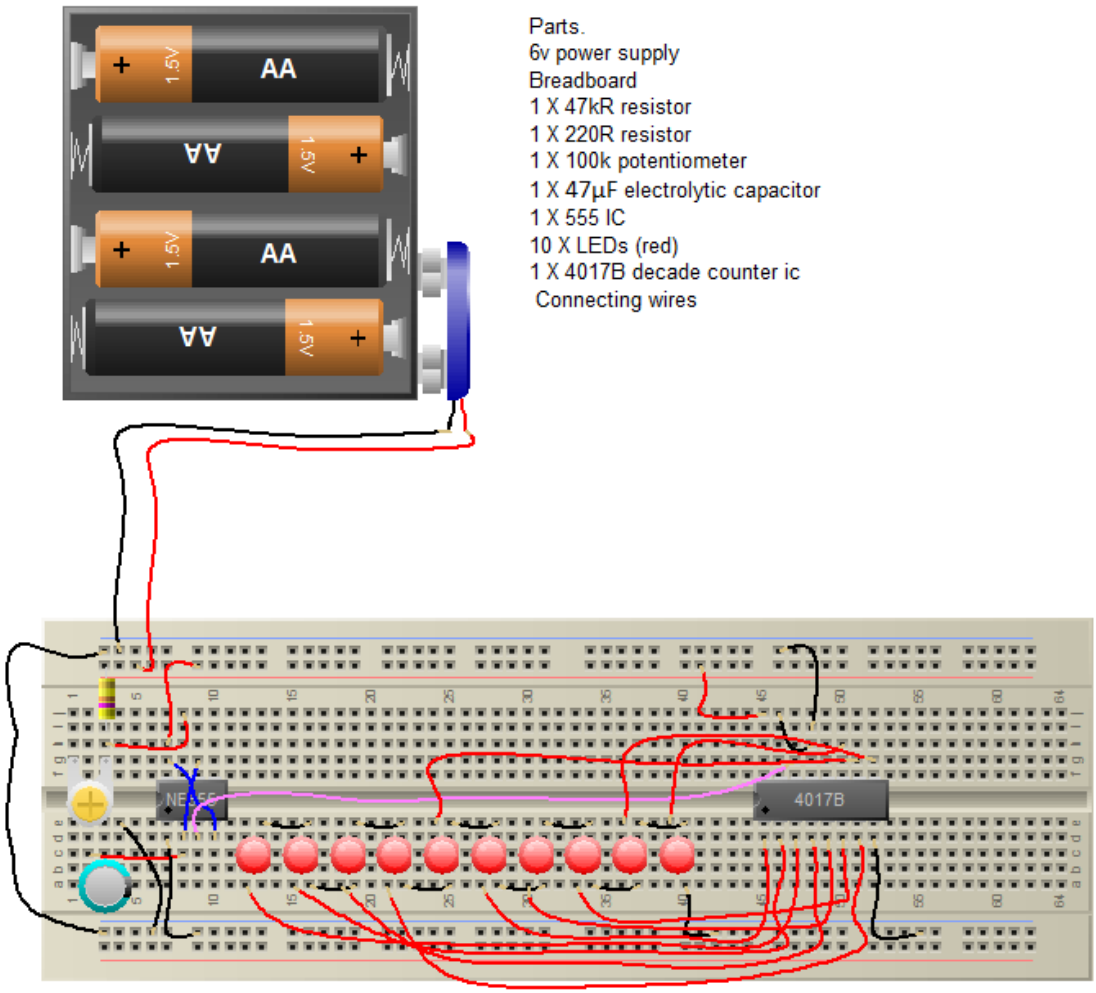


Project 38: LED Chaser

Parts.
6v power supply
Breadboard
1 X 47kR resistor
1 X 220R resistor
1 X 100k potentiometer
1 X 47µF electrolytic capacitor
1 X 555 IC
10 X LEDs (red)
1 X 4017B decade counter ic
Connecting wires



Note: Not described on the circuit diagram.
Pin 8 on the 4017 goes to ground,
Pin 16 on the 4017 goes to the live rail.

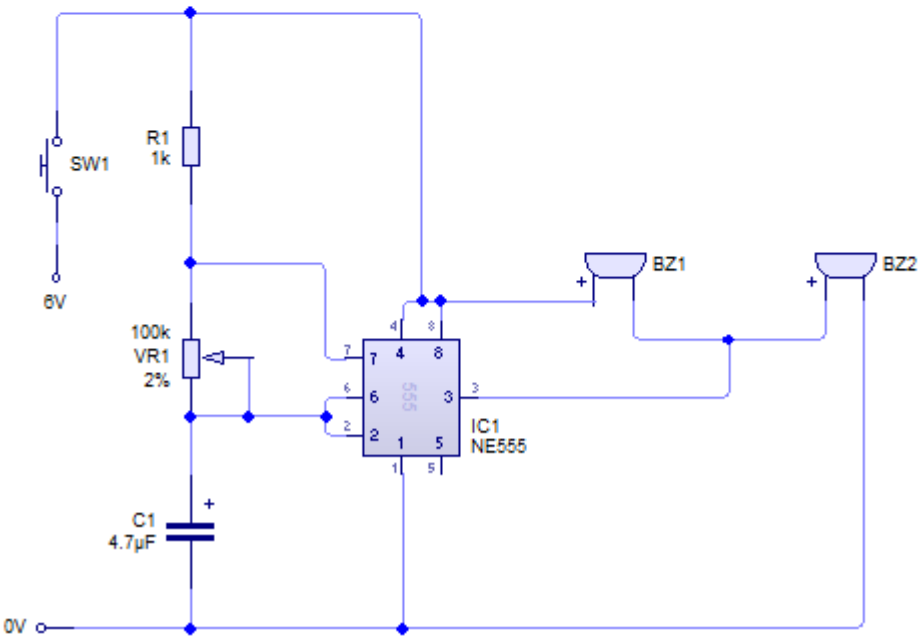


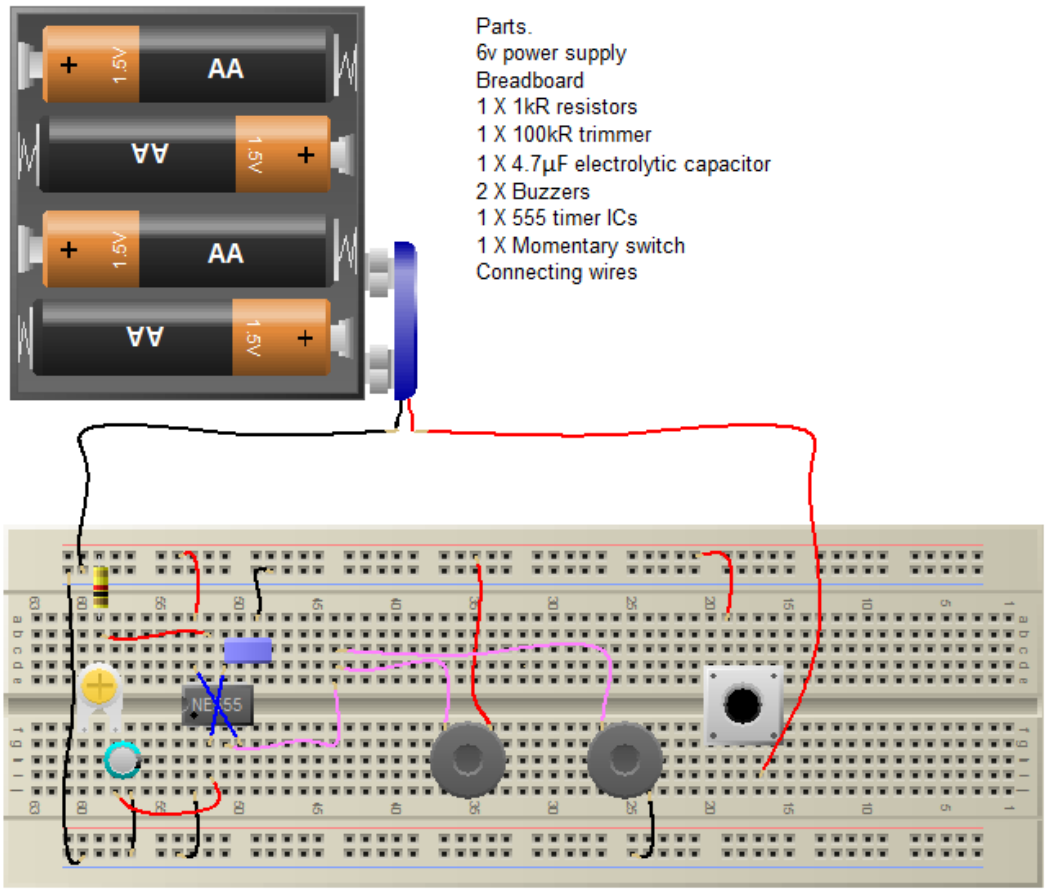
Parts.
6v power supply
Breadboard
1 X 47kR resistor
1 X 220R resistor
1 X 100k potentiometer
1 X 47µF electrolytic capacitor
1 X 555 IC
10 X LEDs (red)
1 X 4017B decade counter ic
Connecting wires

Note: Not described on the circuit diagram.
Pin 8 on the 4017 goes to ground,
Pin 16 on the 4017 goes to the live rail.

Project 39: 2 ToneAlarm

Parts.
6v power supply
Breadboard
1 X 1kR resistors
1 X 100kR trimmer
1 X 4.7µF electrolytic capacitor
2 X Buzzers
1 X 555 timer ICs
1 X Momentary switch
Connecting wires

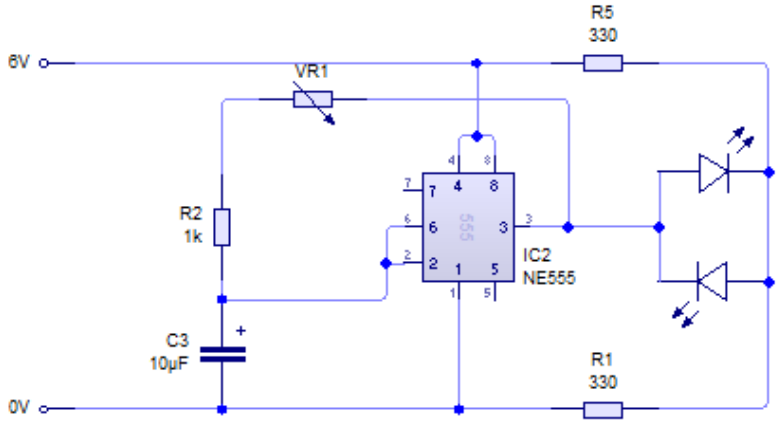




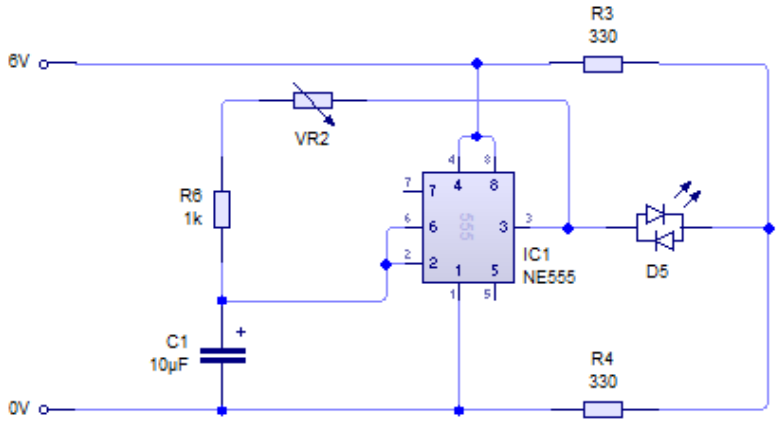
Parts.
6v power supply
Breadboard
1 X 1kR resistors
1 X 100kR trimmer
1 X 4.7µF electrolytic capacitor
2 X Buzzers
1 X 555 timer ICs
1 X Momentary switch
Connecting wires

Project 40: Bi-Polar LED Flasher with 555 Timer

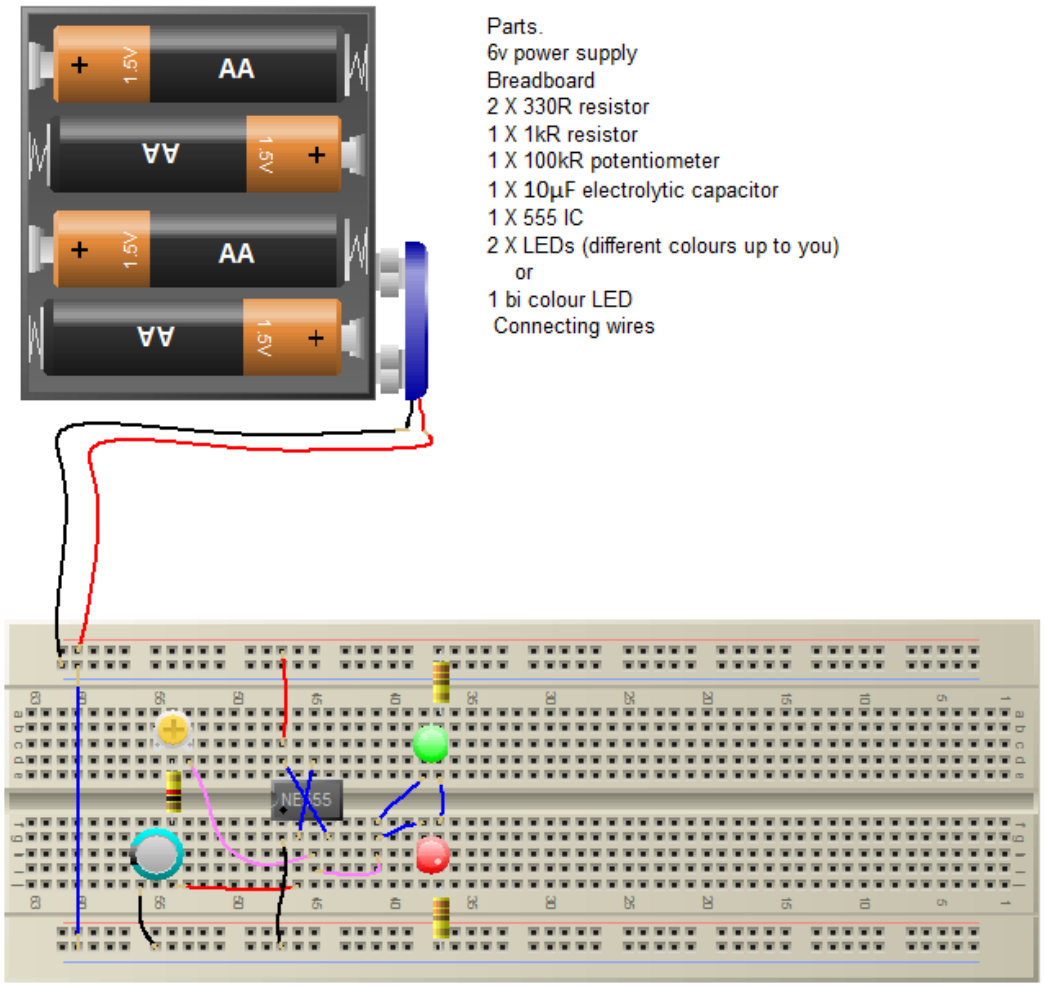
Parts.
6v power supply
Breadboard
2 X 330R resistor
1 X 1kR resistor
1 X 100kR potentiometer
1 X 10µF electrolytic capacitor
1 X 555 IC
2 X LEDs (different colours up to you)
or
1 bi colour LED (not supplied in starter kit)
Connecting wires



With 2 different LEDs



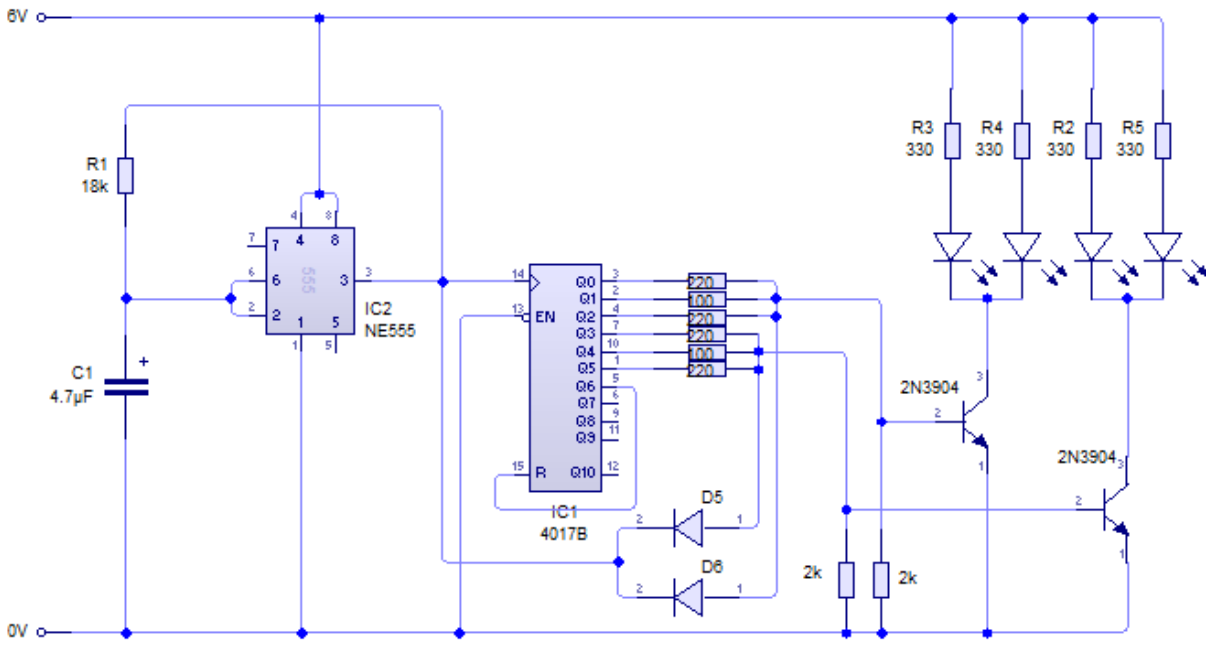
With 1 bi-polar LED



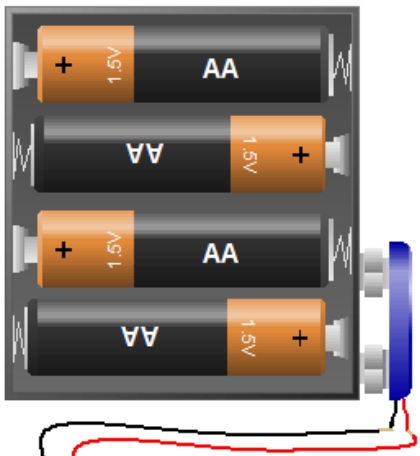
Parts.
6v power supply
Breadboard
2 X 330R resistor
1 X 1kR resistor
1 X 100kR potentiometer
1 X 10µF electrolytic capacitor
1 X 555 IC
2 X LEDs (different colours up to you)
or
1 bi colour LED
Connecting wires

Project 41: Police Lights

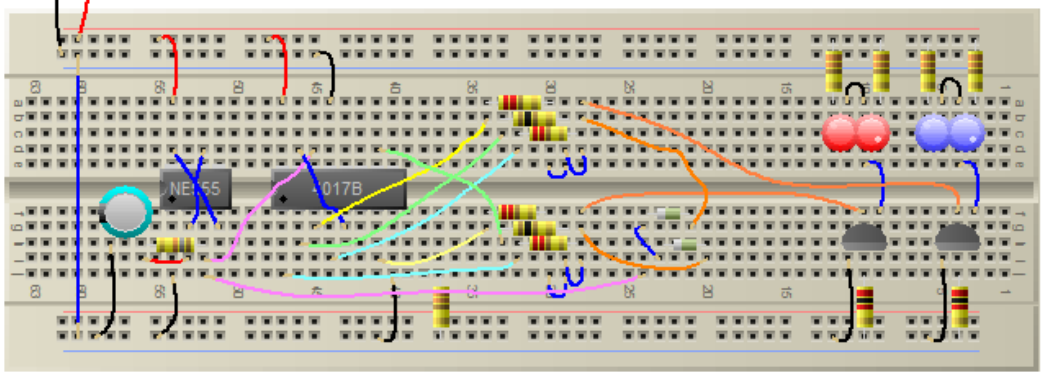
Parts.
6v power supply
Breadboard
4 X 330R resistors
2 X 2kR resistors
1 X 18kR resistor
4 X 220R resistor
2 X 100R resistor
1 X 4.7µF electrolytic capacitor
2 X 2N3904 NPN transistors
2 X general purpose diodes
1 X 555 IC
1 X 4017 IC
4 X LEDs (2 X 2 colours)
Connecting wires



Note: Not described on the circuit diagram.
Pin 8 on the 4017 goes to ground,
Pin 16 on the 4017 goes to the live rail.



Parts.
6v power supply
Breadboard
4 X 330R resistors
2 X 2kR resistors
1 X 18kR resistor
4 X 220R resistor
2 X 100R resistor
1 X 4.7µF electrolytic capacitor
2 X 2N3904 NPN transistors
2 X general purpose diodes
1 X 555 IC
1 X 4017 IC
4 X LEDs (2 X 2 colours)
Connecting wires

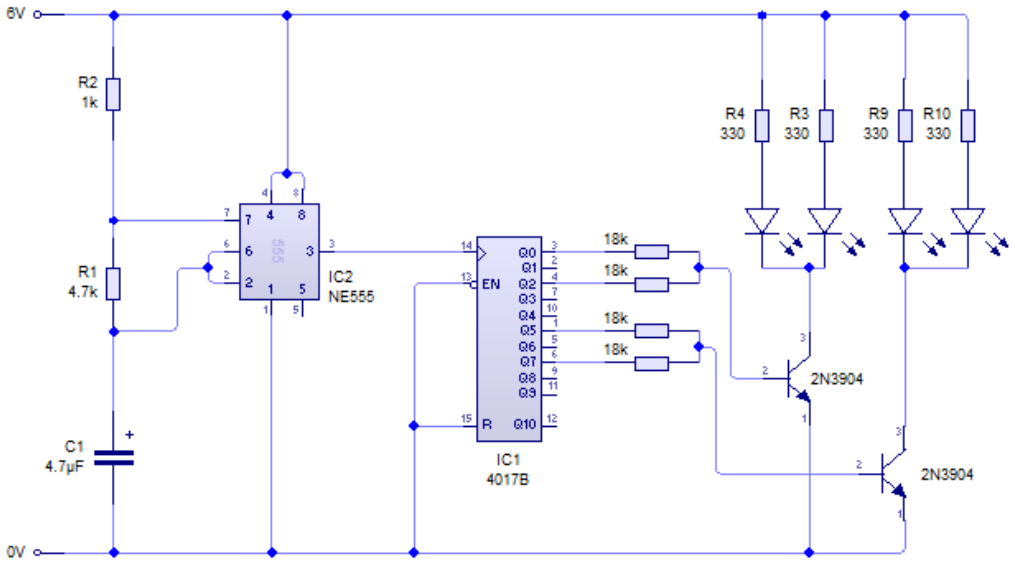


Note: Not described on the circuit diagram.
Pin 8 on the 4017 goes to ground,
Pin 16 on the 4017 goes to the live rail.

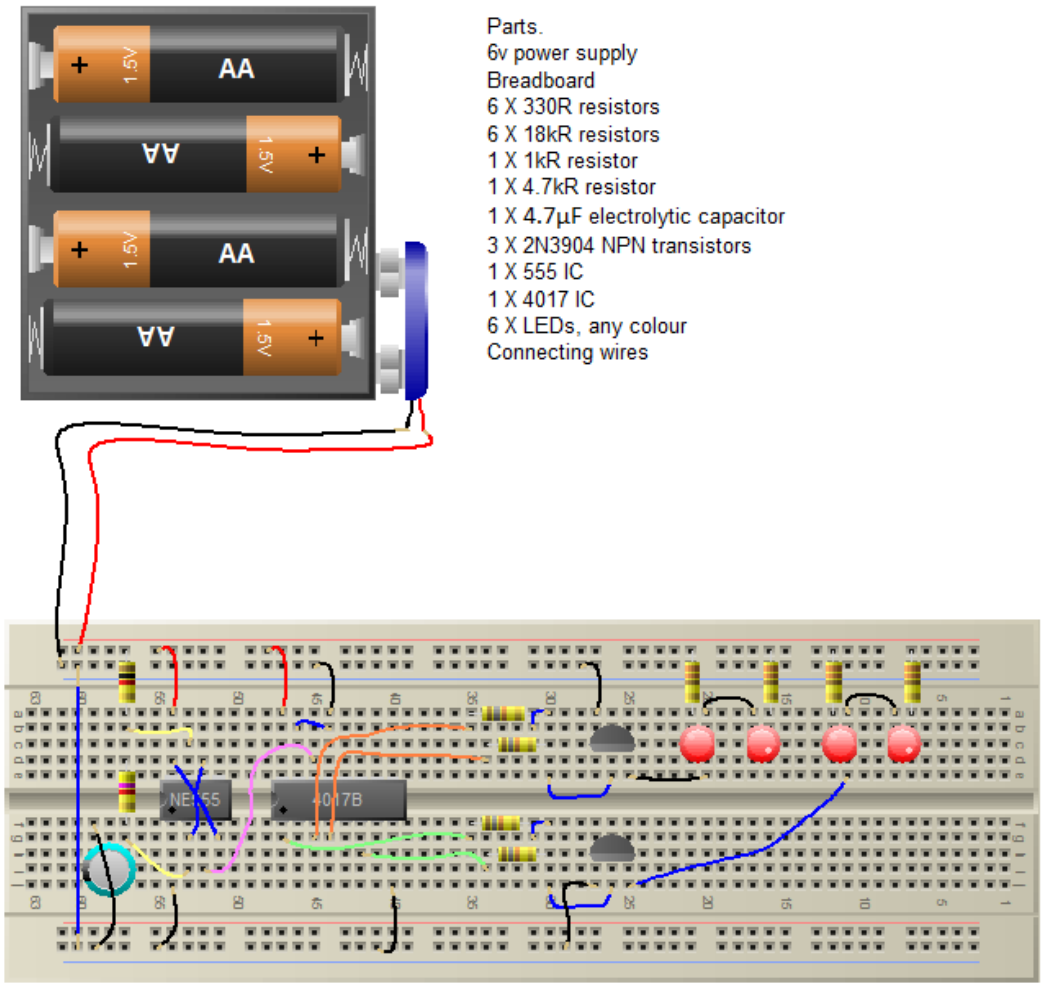
Project 42: Strobe LEDs

Parts.
6v power supply
Breadboard
6 X 330R resistors
6 X 18kR resistors
1 X 1kR resistor
1 X 4.7kR resistor
1 X 4.7µF electrolytic capacitor
3 X 2N3904 NPN transistors
1 X 555 IC
1 X 4017 IC
6 X LEDs, any colour
Connecting wires

Note: Not described on the circuit diagram.
Pin 8 on the 4017 goes to ground,
Pin 16 on the 4017 goes to the live rail.



This circuit is very similar to Project 41, maybe a little less complicated, but shows that different configurations can achieve similar results.
This project is entitled Strobe LEDS, but a strobe is normally white and there are no white LEDs in the Starter Kit, but that should not stop you creating this little circuit with any colour you like.
The output of the 4017 IC, starts at the top (shown above) pin 3 and cylcles through to pin 11, and the speed that it cycles is based on the output of the 555 timer, and that speed, as we have found in previous projects is based on the values of R2, R1 and C1.



Parts.
6v power supply
Breadboard
6 X 330R resistors
6 X 18kR resistors
1 X 1kR resistor
1 X 4.7kR resistor
1 X 4.7µF electrolytic capacitor
3 X 2N3904 NPN transistors
1 X 555 IC
1 X 4017 IC
6 X LEDs, any colour
Connecting wires

Note: Not described on the circuit diagram.
Pin 8 on the 4017 goes to ground,
Pin 16 on the 4017 goes to the live rail.

Project Basics: Components

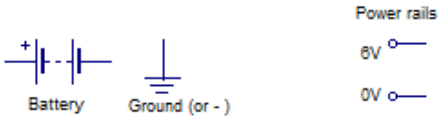
To understand a circuit diagram you first have to be able to recognise the different components that are in use.
This may sound difficult, but in reality, there are not really that many in most circuits.

Our circuit diagrams start off with just a few and progressively get more complex.
So, the idea is that you get used to seeing the common component symbols and as new ones are added, they are easire to remember.

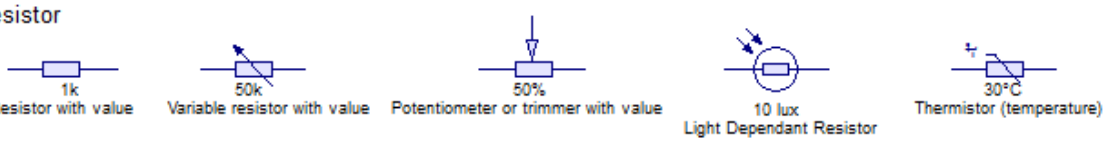
Before you know it, you will be an expert in reading and understanding most diagrams that you will ever come across

This page is to point you in the general direction of becoming that expert.

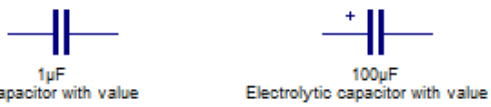
Power



Resistor

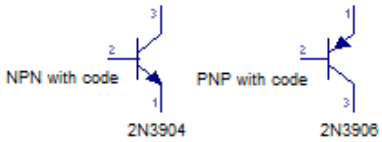


Capacitor

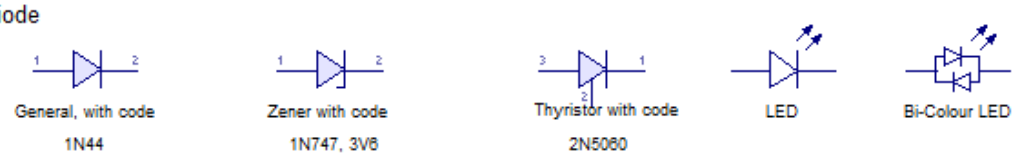


Transistor

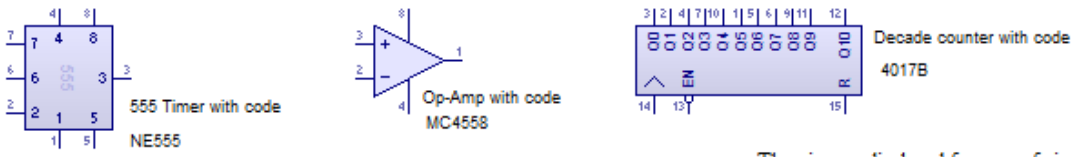
Pin 1 = Collector, Pin 2 = Base,
Pin 3 = Emitter



Diode



Integrated circuit



There are many more integrated circuits available but these are the main ones that we start off with.

The pins are displayed for ease of circuit diagramming not building

Project Basics: Resistors

The first and most common electronic component is the resistor
A resistor is a passive component used to control current in a circuit. Its resistance is given by the ratio of voltage applied across its terminals to the current passing through it.
Therefore a particular value of resistor, for fixed voltage, limits the current through it.

- Resistance - the value of resistance, measured in Ohms
- Power - The amount of power the resistor can handle safely.
- Voltage - Rarely specified, but this is the maximum voltage that may appear across a resistor.

The resistance value is specified in ohms, the standard symbol is "R" or the Omega symbol.
The base formula for resistance is Ohm's law

$R = V / I$ Where V is voltage, I is current, and R is resistance

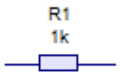
Another formula you need with resistance is Power (P)

$P = V^2 / R$

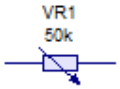
$P = I^2 * R$

A useful thing to remember for a quick calculation is that
1V across a 1k resistor will have 1mA of current flow
So 10V across 1k will be 10mA

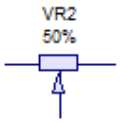
Symbol representation in a circuit diagram.



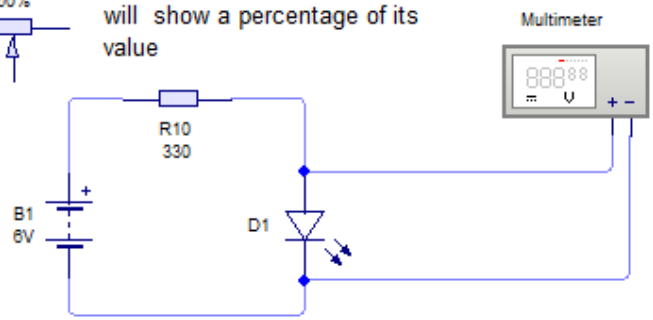
Fixed. Showing value and possibly numbering.



Variable. Showing value.



Potentiometer. Normally showing value. In our circuits will show a percentage of its value



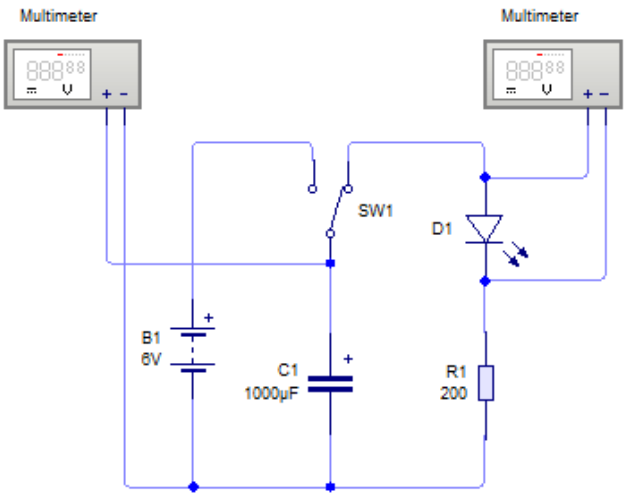
This is the most basic example of a fixed resistor in use.
LEDs have a forward voltage of 3v ish, so we require a resistor to limit the voltage going through it otherwise it will burn out very quickly

Essentially, resistance is used to reduce the flow of electricity to other components.
That may be a fixed value, a preset but adjustable value, or fully adjustable like the volume control on your stereo.
They all do the same job, whether it is restricting power to a LED so that it does not burn out or increasing the volume on your stereo so that you can hear your favourite music better.

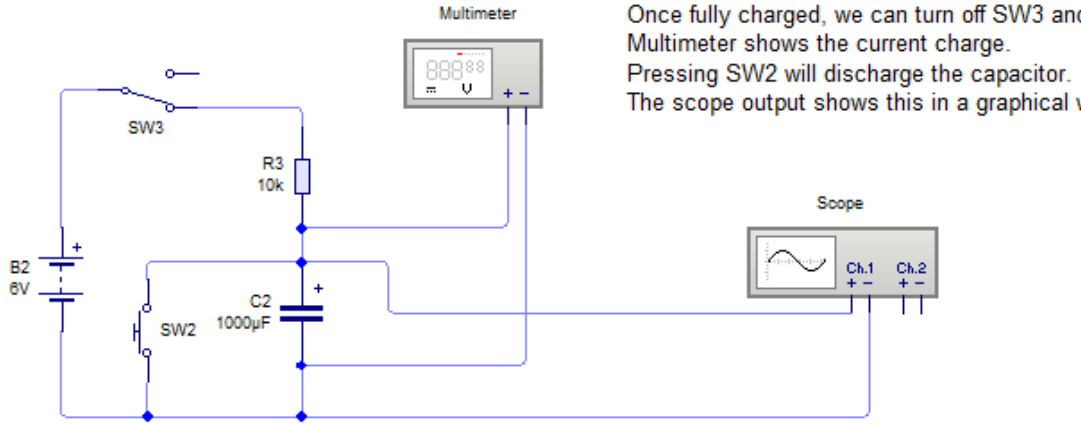
If it is electronic then resistors will be found in every circuit that you come across.

Project Basics: Capacitors

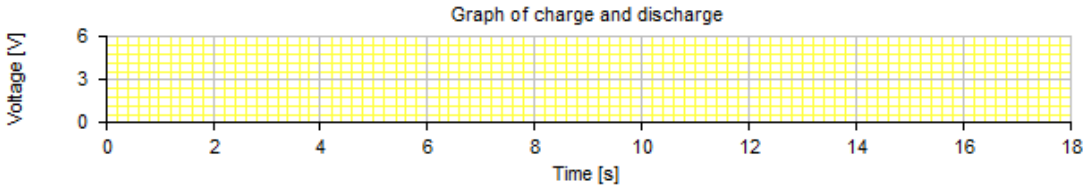
A capacitor is a passive component used to store charge.
The charge (q) stored in a capacitor is the product of its capacitance (C) value and the voltage (V) applied to it.
Capacitors offer total reactance to zero frequency so they are used for blocking DC components or bypassing the AC signals.
Capacitors are often used for smoothing power supply variations.
Other uses include, coupling the various stages of audio system, tuning in radio circuits etc.

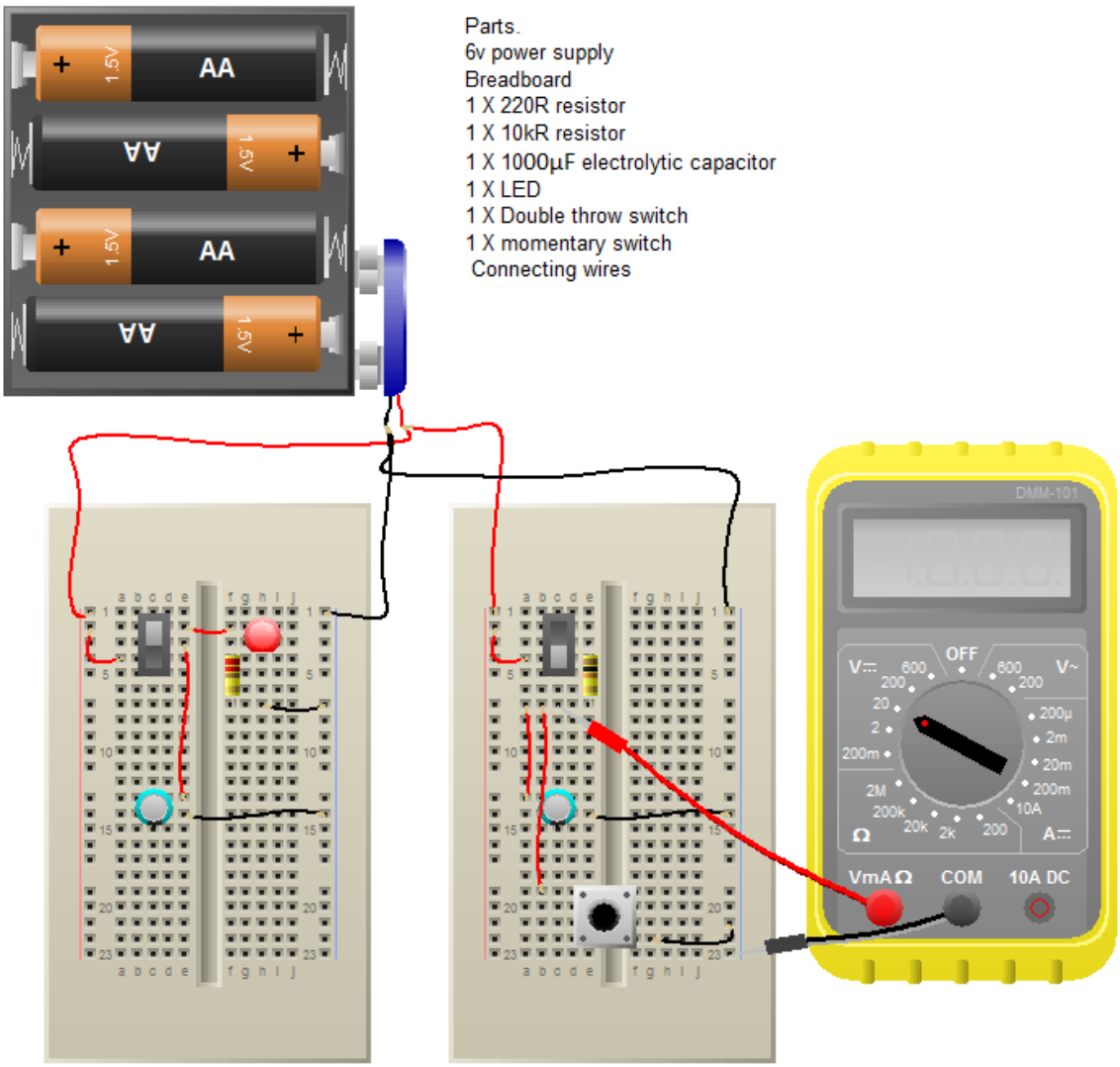


This is the most basic example of a capacitor in use.
When SW1 is connected to the battery, it charges up the capacitor.
Disconnecting from the battery with SW1, the energy in the capicitor is released flowing through the LED as the Multimeter MM2 shows.



Here, we charge the capacitor by turning on SW3.
Once fully charged, we can turn off SW3 and the Multimeter shows the current charge.
Pressing SW2 will discharge the capacitor.
The scope output shows this in a graphical way



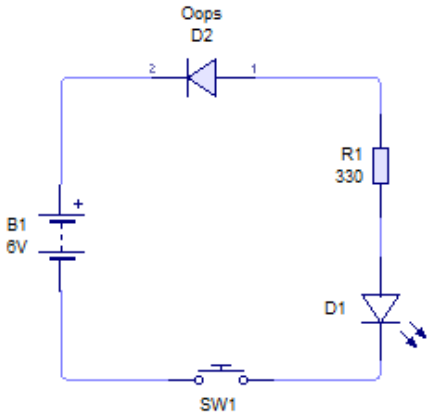


Parts.
6v power supply
Breadboard
1 X 220R resistor
1 X 10kR resistor
1 X 1000µF electrolytic capacitor
1 X LED
1 X Double throw switch
1 X momentary switch
Connecting wires

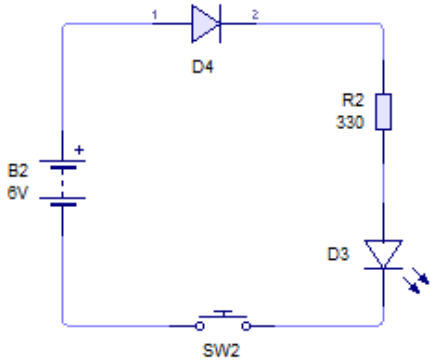
Project Basics: Diodes

Parts.
6v power supply
Breadboard
1(2) X 330R resistor
1(2) X push to make switch
1(2) X LEDs
Connecting wires

This circuit will not function because the diode is the wrong way around



This circuit will function because the diode is the correct way around



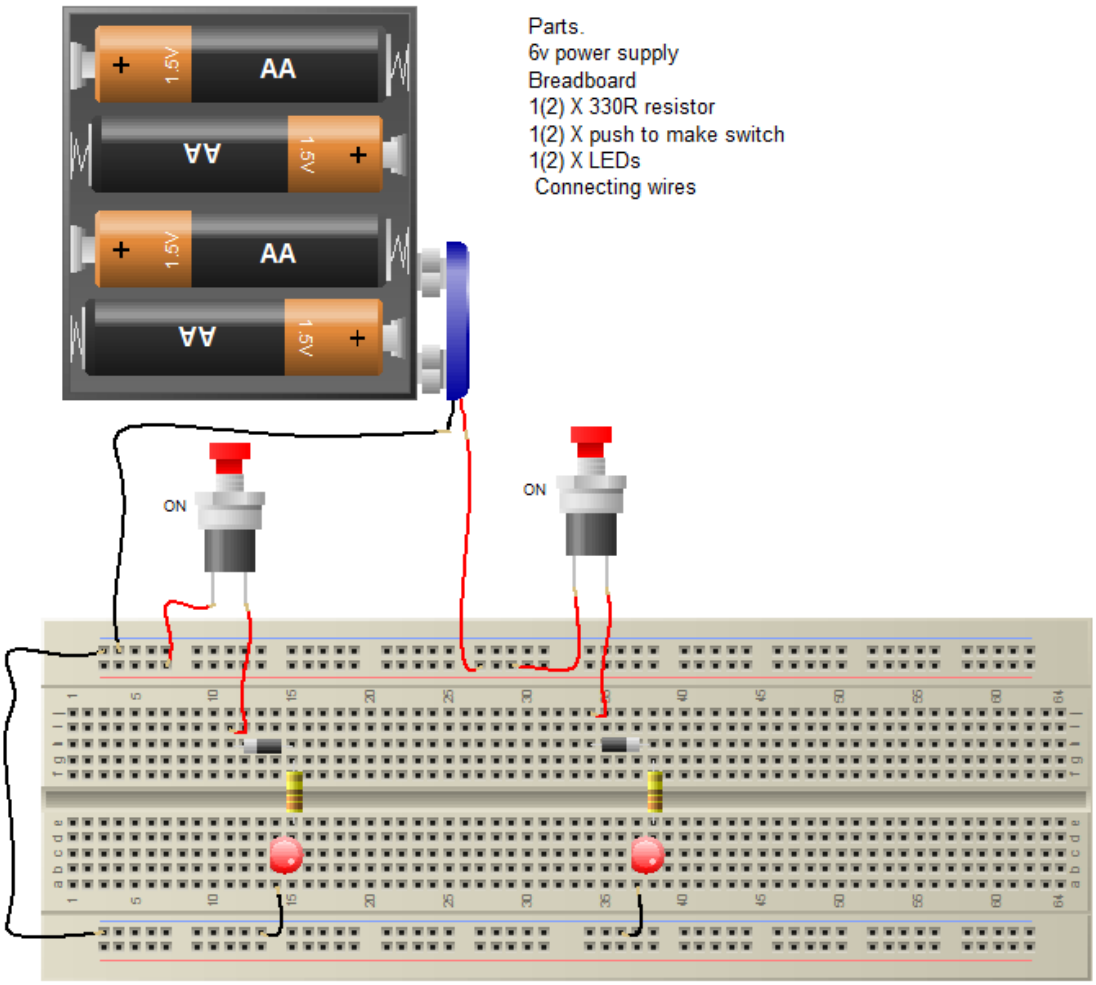
If you look at the diode in the first circuit, you will notice that the bar on the diode symbol is facing the positive terminal of the battery.
Almost all diodes have a marker on them. This marker is usually a ring or a dot near to one end of the diode. This is negative and must point towards the negative part of the circuit if you want power to flow through them.

In this circuit, and a large quantity of circuits in this project collection, we use LEDs to visually show the circuit working.
LEDs are also diodes and if you look at both circuits above you will see that the bar on the symbol points towards negative.
You will also often see a resistor in series with the LED. This is there to protect the LED.
In this circuit we use a 6 volt power source.
The typical LED datasheet may show a forward voltage of about 2.2 volts and a forward current of 20mA, although they do vary not just by size but also by colour.
That means we have to protect the LED from the difference, 6 - 2.2 = 3.8volts.

Now, we don't do math at Breadboard Electronics, we do circuits, but here is an exception to that rule just to prove a point. Again, there are plenty of resources on the Internet to help you with the math, if that is what you want.

Using Ohms Lay:- R = V / I
Resistance = (battery v - LED v) / (LED forward current / 1000) = (6 - 2.2) / (20/1000) = 3.8 / 0.02 = 190
So, the value of the resistor must be at least 190ohms.

Because the LEDs have different requirements for different colours, we generally use a 330ohm resistor which we know will satisfy our need every time regardless of which LED that you select.
But if you feel that you need to be accurate, the math is always there for you in the form of Ohms Law.



Parts.
6v power supply
Breadboard
1(2) X 330R resistor
1(2) X push to make switch
1(2) X LEDs
Connecting wires

As you can see, the diode in the left circuit has its markered end flowing straight towards the positive of the battery.

Project Basics: Sensors

Our Starter Kit contains two common sensors for testing our world.

They are: the Light Dependent Resistor (LDR) and the Thermistor.

An **LDR**, as its full name suggests, offers resistance in response to the ambient light.

The resistance decreases as the intensity of light increases, and vice versa.

In the absence of light, an LDR exhibits a very high resistance measured in mega-ohms, and decreases to a few hundred ohms in the presence of light.

It can act as a sensor, since a varying voltage drop can be obtained in accordance with the varying light.

A **Thermistor** is also a type of resistor, whose resistance is dependent upon its exposed temperature.

The most typical Thermistors are positive temperature coefficient (PTC), where resistance increases with temperature.

There are others that work in the opposite way and there can be an awful lot of maths involved too.

Project Basics: Integrated Circuits (ICs)

Before we start, I would like to say that there are hundreds of Integrated Circuits available from a very long standing 555 timer to the latest (currently) 6th Generation Intel Core i7 Processor.

An IC can contain anything from just a handful to billions of components etched onto layers within them (9 million transistors per mm^2). All designed with a specific task.

However our Starter Kit and therefore this book only contain three. A 555 Timer, an Op-Amp and a 4017 Decade Counter.

All three have different but very meaningful tasks to fulfil.

What you will find is that in a circuit diagram, the pins will not be in the same order as the physical IC. This is done solely to make the circuit diagram easier to read.

All of the ICs that you are likely to come across will be dual inline pin (DIP) type and all of the ones that I have used, are notched or marked on one end. With the IC horizontally in front of you and the notch or mark to your left, pin 1 is bottom left going numerically anti-clockwise from there.

What's Next

Arduino

All this is leading up to an open-source microcontroller named Arduino.

This is where all that you have learnt starts to get really interesting as you are able to re-use some of your circuits and all of your components into creating projects that you may want to keep or even sell and make your fortune.

Too complex to explain fully here, but in a nutshell, you can build myriad projects, from a temperature sensor to turn on the greenhouse heating to a two wheeled balancing car to a robot.

The Arduino is programmed in a C++ like language that is quite easy to master, and being open-source, there is a lot of help available on the internet.