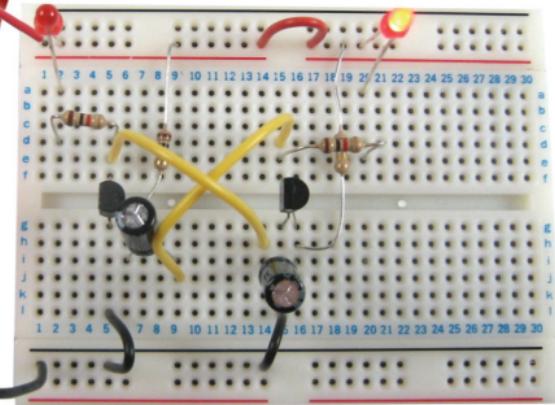




EDU01





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www.velleman.be
www.velleman-kit.com

11 Exciting projects which you can actually use.

Projects featured in this box:

- LED with push button* Light a LED when a pushbutton is pressed (pag.10)
A transistor as current amplifier* Light a LED using a transistor (pag.12)
Astable multivibrator** Let LEDs flash alternately (pag.14)
Simple burglar alarm with LED indication and sound** Example of a simple burglar alarm (pag.16)
Light detector** Switch on a LED when there is sufficient light (pag.18)
Polarity tester* Check battery polarity (pag.20)
Start-Stop circuit*** Control a LED using 2 pushbuttons (pag.22)
Timer circuit*** Make a LED switch off after a certain time (pag.24)
Light switch*** Make a LED switch on when it becomes dark (pag.26)
Water alarm** Make a liquid level trigger an alarm (pag.28)
Running light with 3 LEDs*** Make 3 LEDs light up shortly in succession (pag.30)

Difficulty level

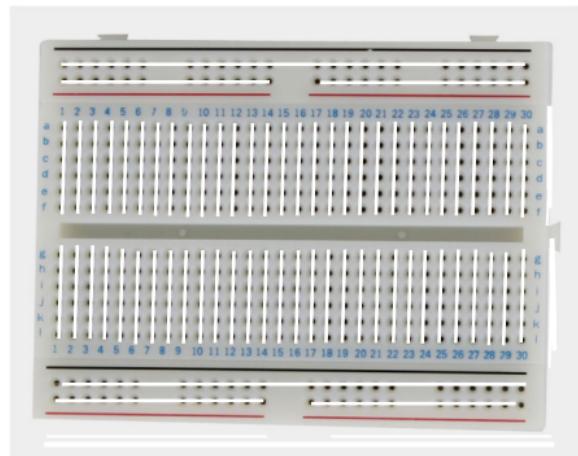
- * easy
- ** normal
- *** hard



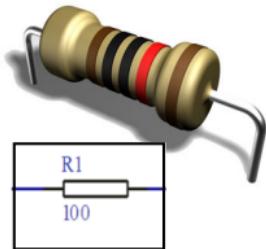
Parts supplied with this kit:

Breadboard

The **breadboard** will hold all your experiments. The white lines show how the holes are electrically connected with eachother
(Velleman part# SDAD102)



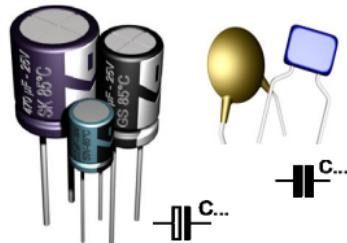
Resistors



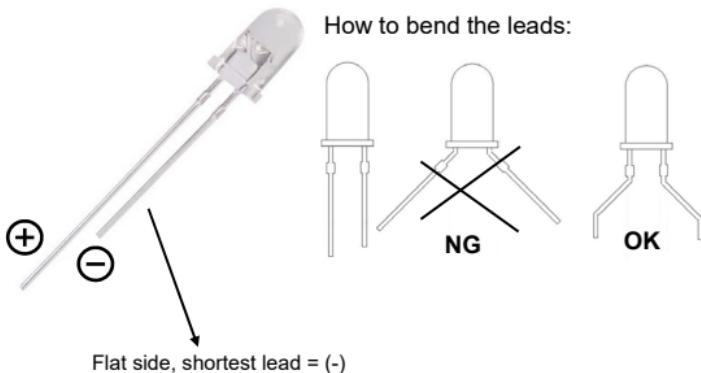
Various **resistor** values are supplied. They serve as current limiters or as voltage dividers. Resistors do not have a polarity. Resistor values are indicated by means of coloured rings. The unit of resistance is called 'Ohm'. (see colour code table in the package)

Capacitors

A capacitor is almost like a small battery, it can be charged using a power supply. Mostly used to stabilise or to filter out unwanted voltages. The unit is Farad: practical values are in μF , nF or pF . The supplied capacitor is an Electrolytic capacitor of $10\mu\text{F}$ and has a polarity, the long lead = +
(Velleman part# 10J0E)



Green & red LED



A LED is a Light Emitting Diode, it can emit light using a small current (max 20mA with a 1.8V drop).

Watch the polarity, long lead = + !

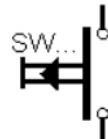
(Velleman part# L-7104LGD & L-7104LID)



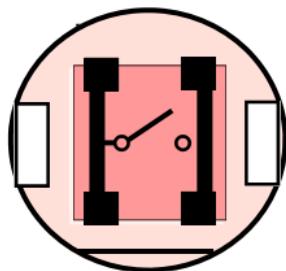
Push button

A push button will conduct current when pushed and interrupt the current when released.

(Velleman part# D6)

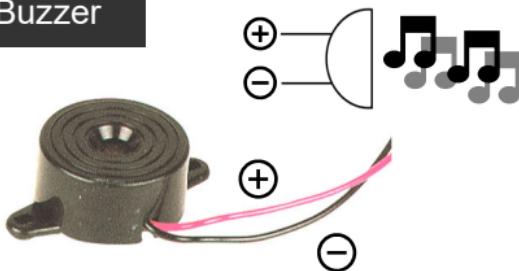


Inside connection



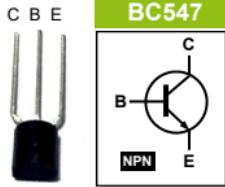
The supplied button has 4 connections, but only 2 are used.
2 are interconnected.

Buzzer

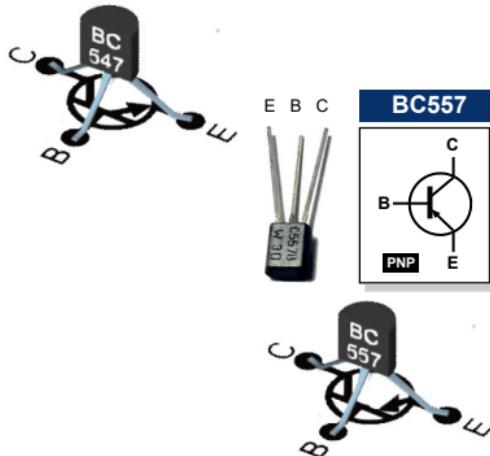


A **buzzer** produce a signalling sound to alert for a dangerous situation, timer confirmation, a button is pressed, ... The pitch of the buzzer can't be changed because the frequency of the oscillator is fixed. (Velleman part# SV3)

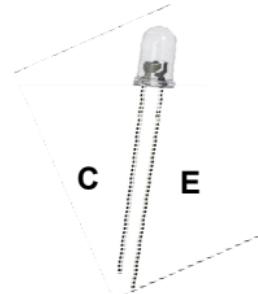
Transistors



A transistor is an amplification device. By means of a small current, a much larger current is controlled. Transistors come in two flavours, NPN and PNP-types, depending on the polarity. With this kit, you receive a BC557 (PNP) and a BC547 (NPN) transistor. A transistor has 3 pins: Base, Emitter and Collector. (Velleman part# BC557B, BC547B)

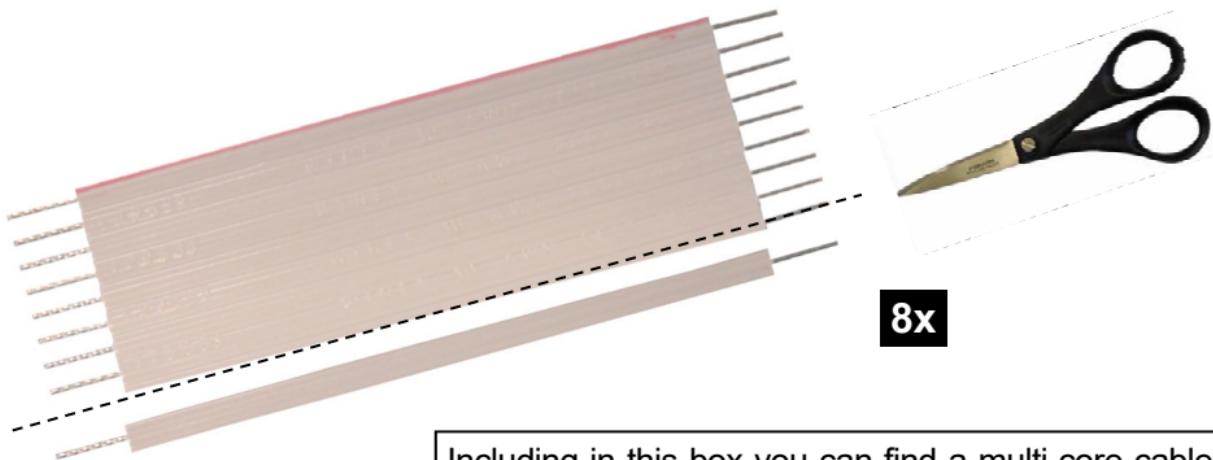


Phototransistor



A phototransistor is a transistor that conducts current when the photocell inside it is sufficiently exposed to light. You can use it as a light switch in electrical circuits. (Velleman part# SGPT5053C)

Flatcable



8x

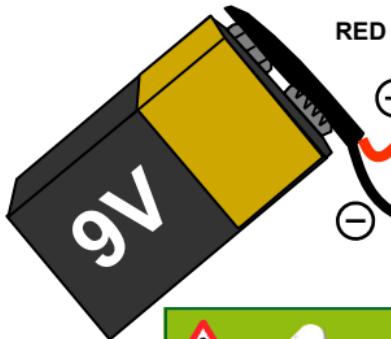
Including in this box you can find a multi-core cable. The wires must be separated from each other before use. This can be done using a wire-cutter or pair of scissors. Use the separate wires to connect components (indicated in the drawing by a thick black line) Velleman part# FC8)

PROJECTS

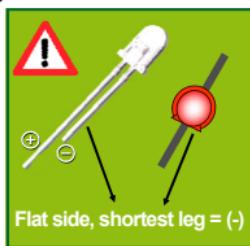


Project 1: LED with push button

As long as the push button is pressed the led will light



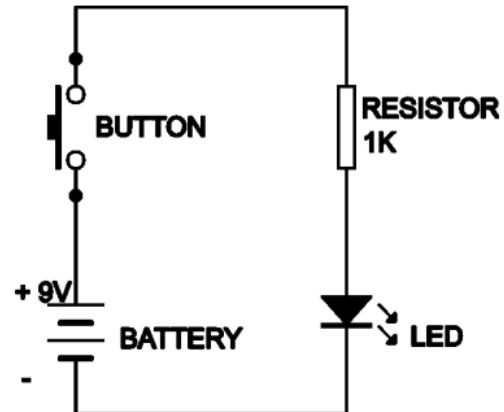
*Not included



Required parts: 9V battery*, 1000 ohm resistor (brown black red), red LED, push-button

How it works: As long as the push button is pressed, a closed circuit is formed that makes the current flow and the LED lights up. Current flows from the (+) of the battery to the push-button, resistor, (+) of the LED and via the (-) of the LED back to the battery.

Using a 1000ohm resistor the current will be about 0.007A (7mA).



Calculation of the resistor:

$$\text{resistor} = \frac{\text{battery voltage} - \text{LED voltage}}{\text{LED current}}$$

$$\text{resistor} = \frac{9V - 1.8V}{0.007} = 1000\text{ohm}$$

Time to experiment:

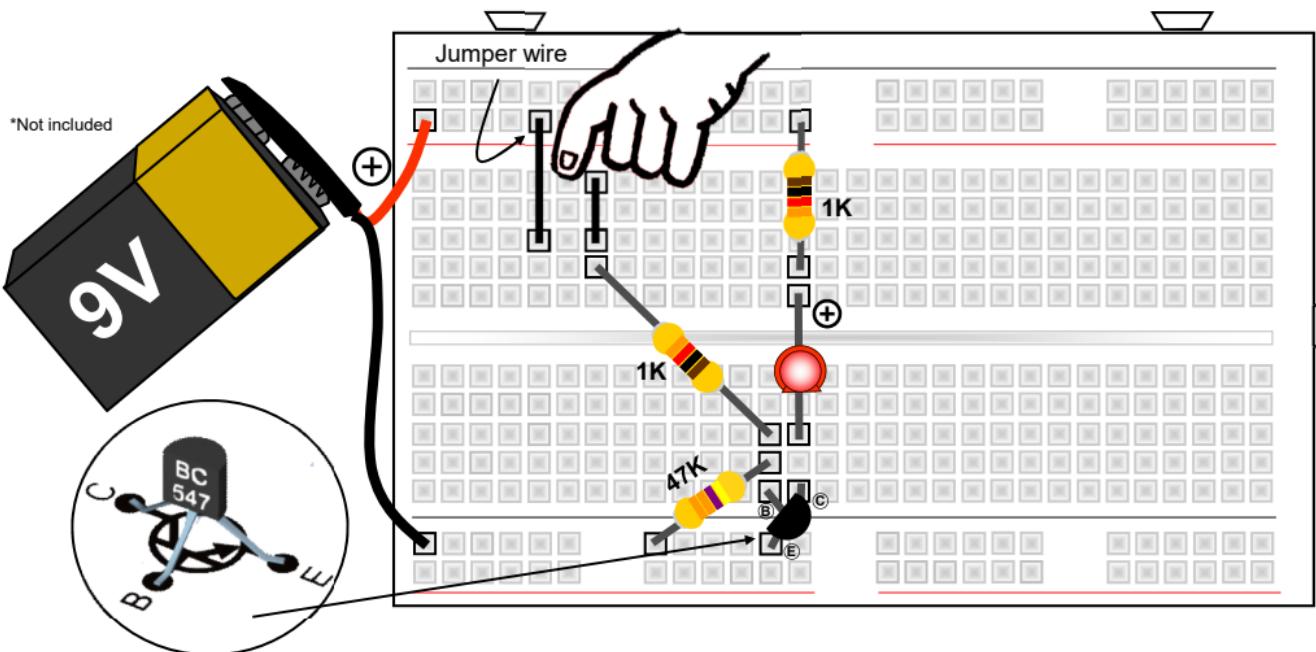
What happens when you swap (+) and (-) of the led?

What happens when you replace the 1000 ohm resistor with a 100K ohm resistor (brown black yellow gold) ?



Project 2: Transistor acting as current amplifier

Light up a LED using a transistor, use your finger as a switch



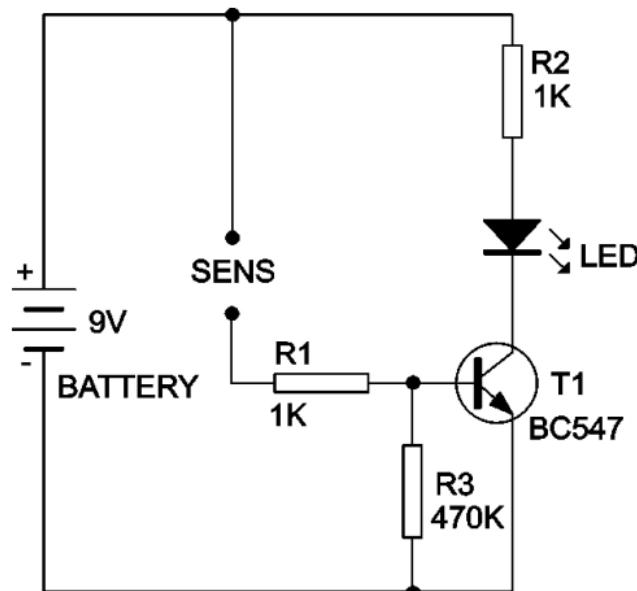
Required parts: 9V battery*, 1K resistor (brown black red gold), 470K resistor (yellow purple yellow gold), red LED, BC547 transistor, wire jumper.

How it works: In this circuit, the small current flowing through your finger will be amplified by the transistor.

The base current that runs via your finger and resistor R1, is amplified by transistor T1. The amplified current flows through the LED and R2 making the LED lit.

R3 will prevent the transistor from unwanted functioning.

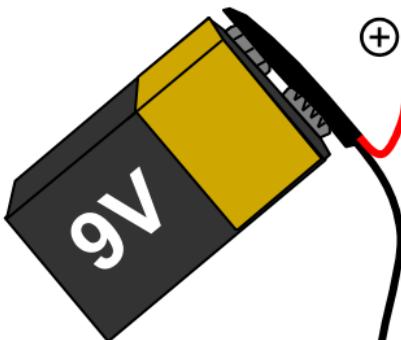
HINT: wet your finger to make the LED light up stronger.





Project 3: Astable multivibrator (flashing LEDs)

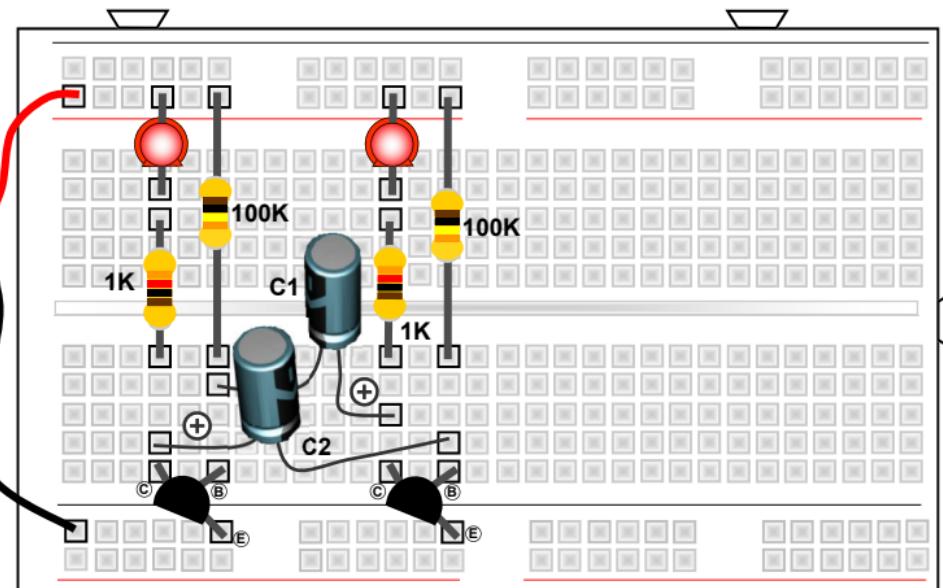
Let LEDs flash alternately



*Not included

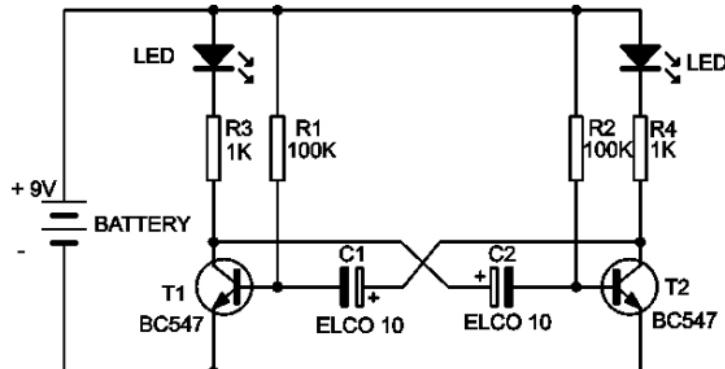


**WATCH THE
CAPACITOR
POLARITY**



Required parts: 9V battery*, 2x 1K resistor (brown black red gold), 2x 100K resistor (brown black yellow gold), 2x red LED, 2 x BC547 transistors, 2x 10 μ F electrolytic capacitors

How it works: The 2 transistors alternately conduct because the capacitors are charged and discharged. The speed at which this happens depends on the capacitors (C1, C2) and the resistors (R1, R2). Use a higher capacitor and resistor value in order to extend the LED lighting time.



The LED on-time can be calculated:

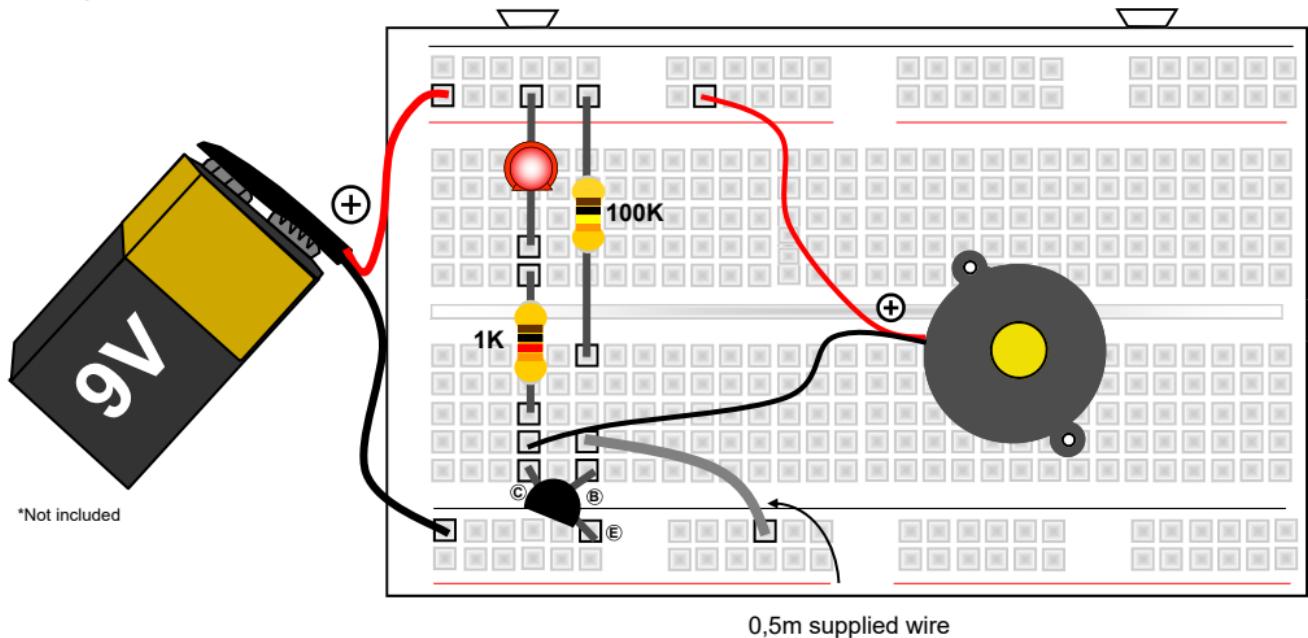
$$T = 0.693 \times R1(\Omega) \times C1(F)$$

$$T = 0.693 \times 100.000 \times 0.00001 = 0.693\text{sec.}$$



Project 4: Simple burglar alarm with LED indication and sound.

Make an alarm signal sound when the circuit is interrupted...

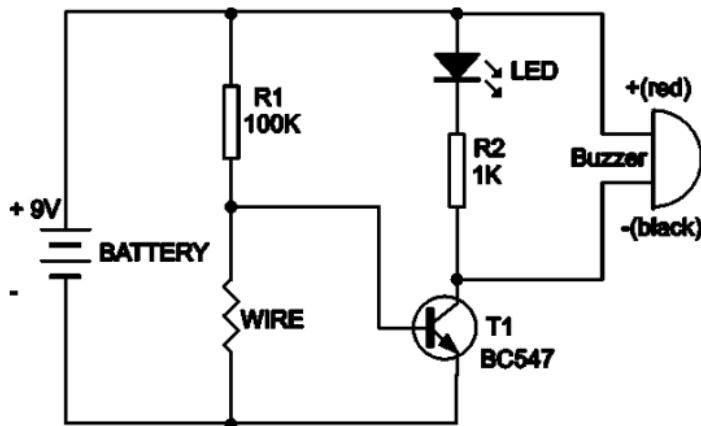


Required parts: 9V battery*, 1K resistor (brown black red gold), 100K resistor (brown black yellow gold), red LED, BC547 transistor, buzzer, 0,5m supplied wire.

How it works: An alarm sounds when the normally closed security circuit (here indicated as 'WIRE') is interrupted.

Replace this normally closed circuit (WIRE) by a normally closed window or door switch; when e.g. the window is opened the contact within the window switch is interrupted, the security circuit is opened and the buzzer sounds.

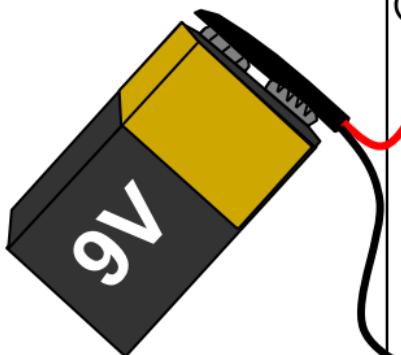
The alarm signal ends as soon as the security circuit is closed again.



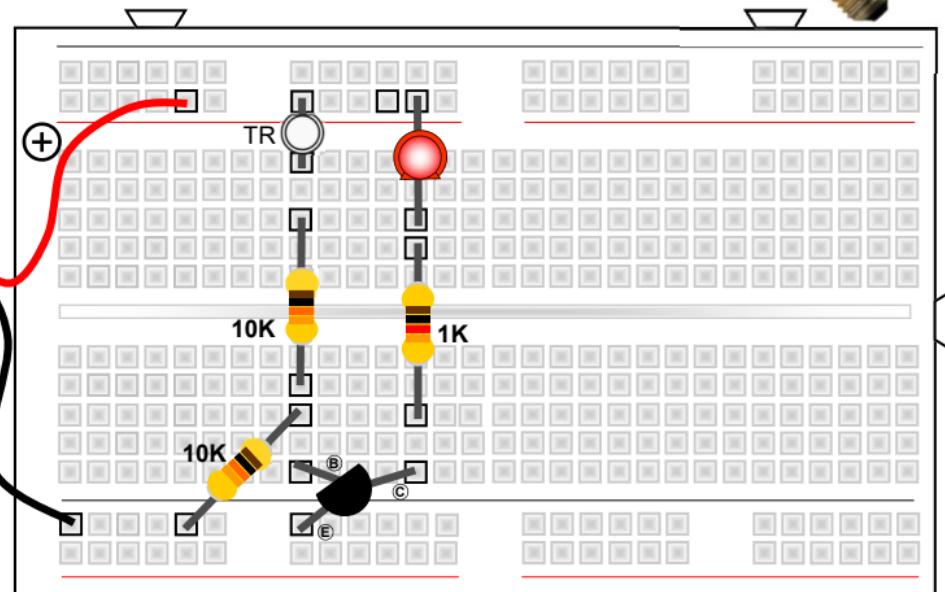


Project 5: Light detector

Switch on a LED when there is sufficient light



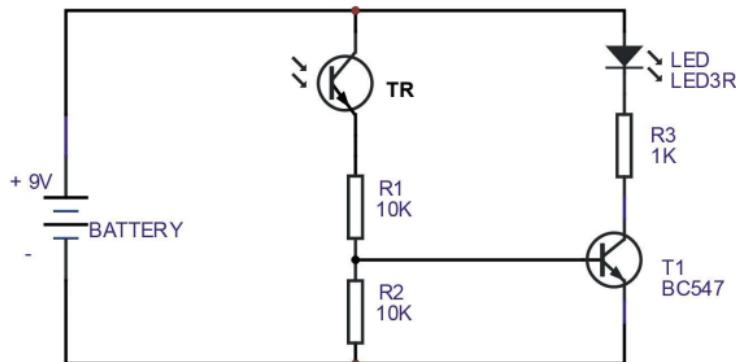
*Not included



Required parts: 9V battery*, 1K resistor (brown black red gold), 2x 10K resistor (brown black orange gold), red LED, BC547 transistor, phototransistor (TR).

How it works: A LED lights up when enough light hits the phototransistor (TR). The phototransistor is light sensitive, in dark conditions it has a high resistance, and in light conditions it has a low resistance.

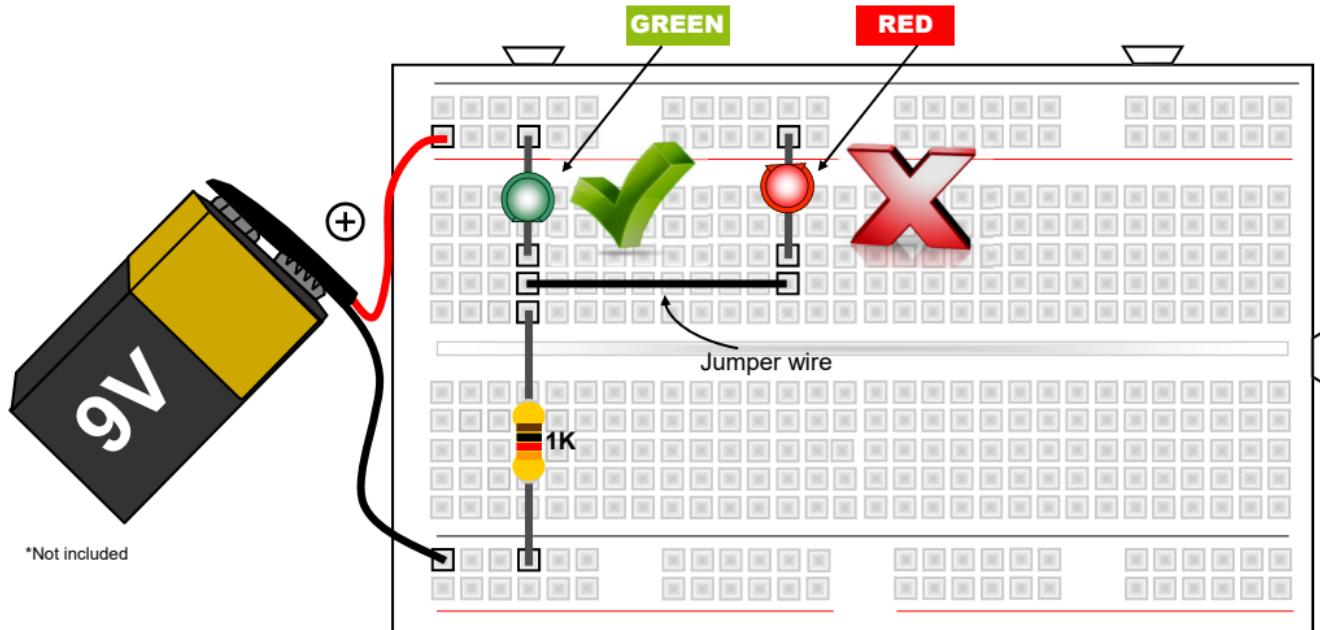
Across the phototransistor is a positive potential which is fed to the base of the transistor enabling it to switch. Resistor R2 creates a switching point which determines when the transistor starts to conduct. Resistor R1 limits the current that flows through the phototran-





Project 6: polarity tester.

Check the polarity of a battery

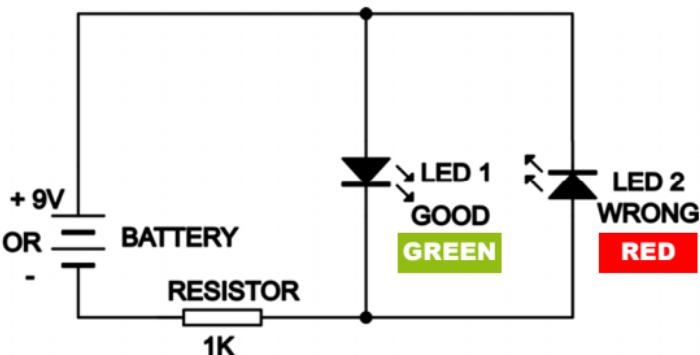


*Not included

Required parts: 9V battery*, 1K resistor (brown black red gold), red LED, green LED, wire jumper

How it works: When the 9V battery is connected to the circuit with the right polarity the green LED (good) will light up. Current can flow from the "+" of the battery through the green LED and via the resistor back to the "-" of the battery. The red LED (wrong) will not light up as it is polarised in the opposite direction.

When swapping the connection of the battery (switch the red and the black wires) the red LED will light up. This way we can determine whether a battery is connected the right way or not.



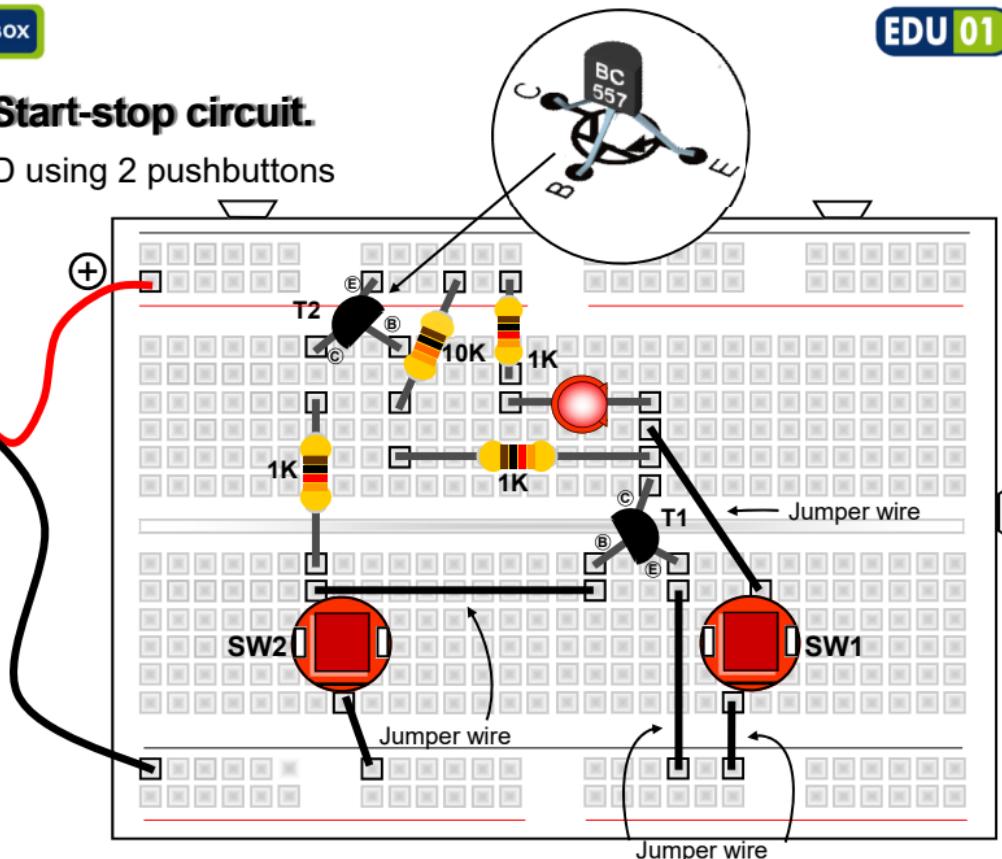
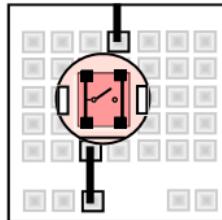


Project 7: Start-stop circuit.

Control a LED using 2 pushbuttons



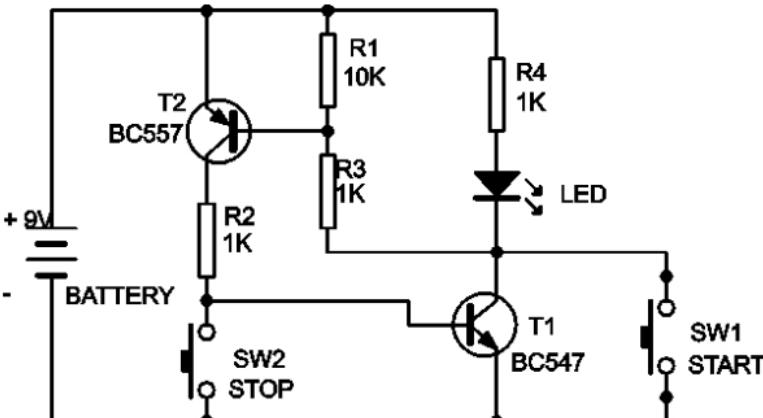
*Not included



Required parts: 9V battery*, 3 x1K resistor (brown black red gold), 10K resistor (brown black orange gold), red LED, 2 x push-button, 1x BC547 transistor, 1x BC557 transistor, 5 x wire jumper

How it works: The “START” button will light up the LED; it will remain on when the pushbutton is released. To switch off the LED, press the “STOP” button.

T1 and T2 are in state of rest (OFF, no current). By pressing the “START” button a current flows via R4 through the LED. At the same time the base of T2 is pulled low (was high via R1). Since the value of R3 is much lower than R1 the voltage on the base of T2 drops making it conduct and via the collector of T2 and R2. T1 also starts to conduct. From this point on, both transistors keep each other in conducting state, even when the “START” button is released. Pressing the “STOP” button will end the current flow towards the base of T1 and it will stop conducting. The circuit is interrupted and T2 will also stop conducting. The LED will turn off.



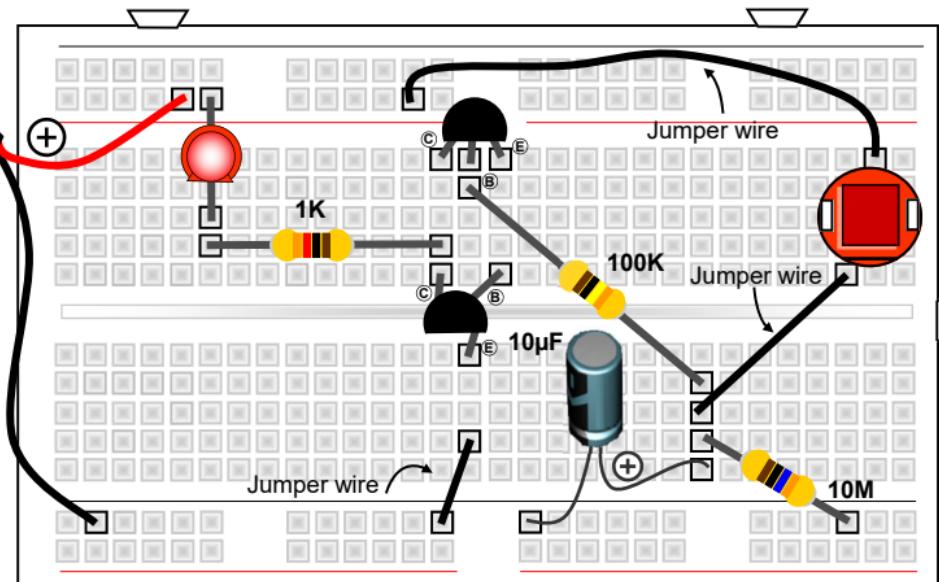
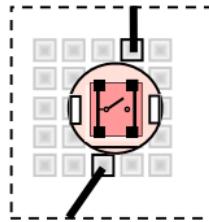


Project 8: Timer circuit.

Make a LED switch off after a certain time

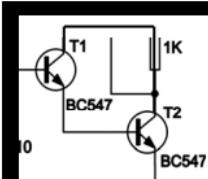
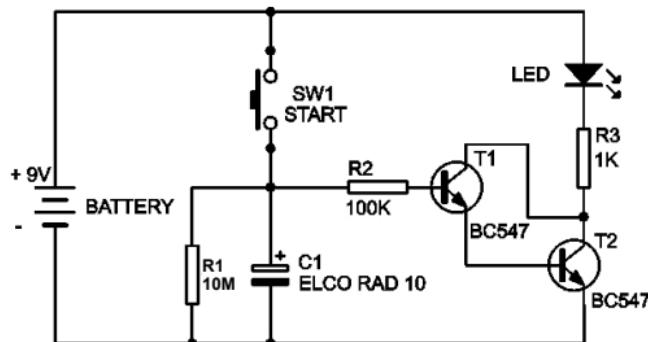


*Not included



Required parts: 9V battery*, 1K resistor (brown black red gold), 100K resistor (brown black orange gold), 1M resistor (brown black green gold), Red LED, push-button, 2x BC547 transistor, 10µF electrolytic capacitor, 3 x wire jumper

How it works: When pushing the push button shortly, the LED will turn on and after a while it will go out. By pushing the push button the capacitor will quickly charge; when releasing the button the capacitor will release its stored energy via both transistors – both will start to conduct and the LED will light up. The current needed to make T2 conduct is limited as T1 and T2 form a Darlington transistor circuit. The time needed to discharge the capacitor is also determined by resistor R1. The smaller R1 the faster the capacitor is discharged and the LED switches off. When R1 is removed, the capacitor discharges solely via the base current of T1. Switching off is a lot slower now and takes ± 1 minute.



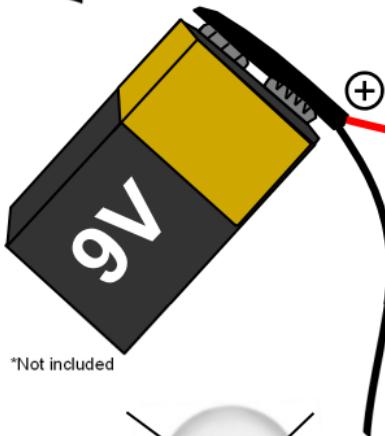
In electronics, the Darlington circuit is a structure consisting of two bipolar transistors connected in such a way that the current amplified by the first transistor is amplified further by the second one. This configuration gives a much higher current gain than each transistor taken separately.

The total gain of both transistors can be calculated: $\beta = \beta(T1) \times \beta(T2)$

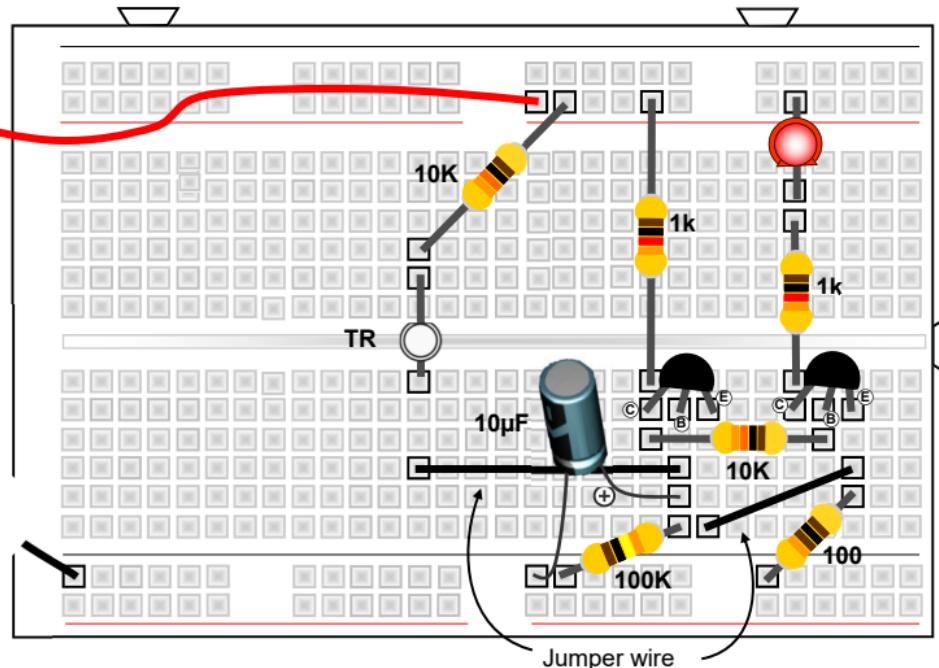


Project 9: Light switch

Make a LED switch on when it becomes dark



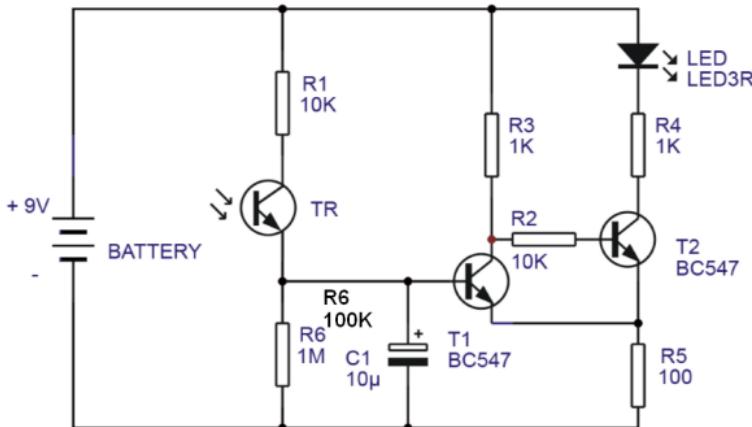
*Not included



Jumper wire

Required parts: 9V battery*, 100 ohm resistor (brown black brown gold), 2 x 1K resistor (brown black red gold), 2 x 10K resistor (brown black orange gold), 100K resistor (brown black yellow gold), 2x BC547 transistor, 10 μ F electrolyte capacitor, phototransistor (TR), Red LED, 2x wire jumper

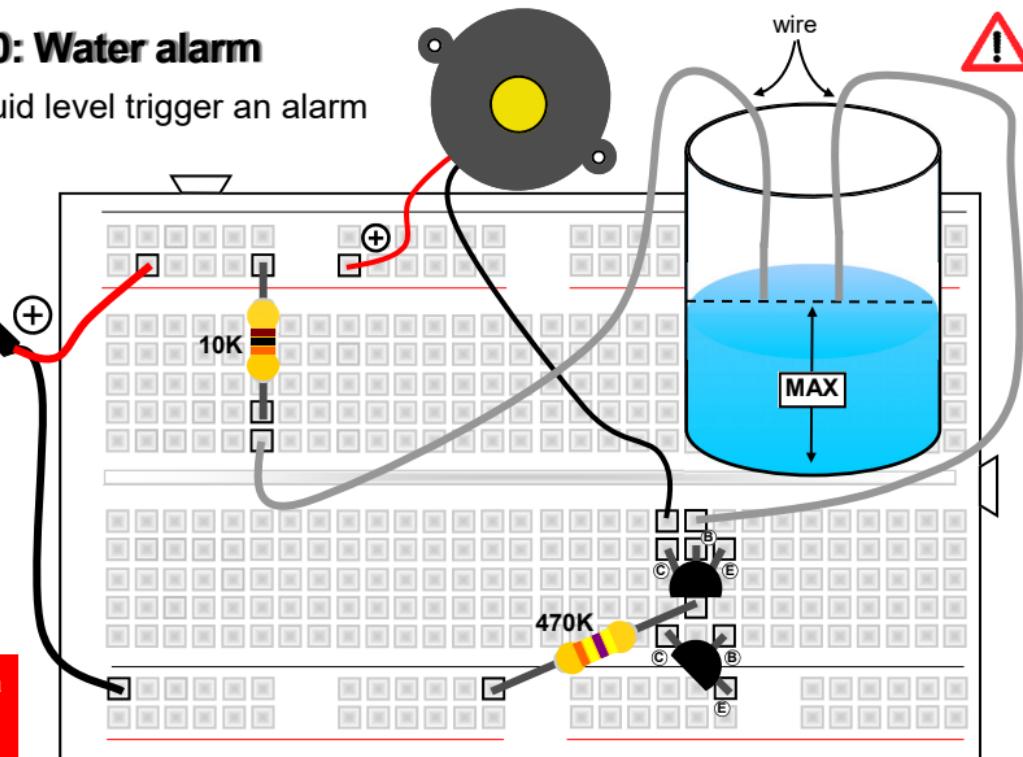
How it works: This circuit will make a LED switch on when it becomes darker. Transistors T1 and T2 form a Schmitt-trigger circuit. The output of a Schmitt trigger is switched over at a certain voltage at the input (the trigger level). The purpose here is the switch the LED on or off completely. As long as there is no light on the phototransistor, there is no base current to T1 and it will not conduct. As long as this is the case, T2 will receive a base current via R2 and R3 and conducts; the LED will be on. When light shines on the phototransistor, the voltage on the base of T1 rises. T1 will start to conduct when this voltage is higher than the voltage over $R_5 + U_{be}$ of T1. When this is the case, the base voltage of T2 drops and T2 does not longer conduct and the LED goes off. Because of the change in flow through R5 when the LED switches off, the threshold level for which T2 will conduct again in darkness also changes.





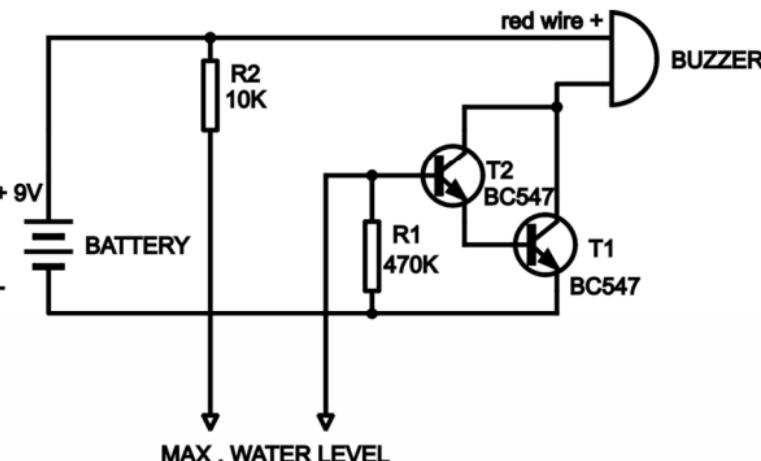
Project 10: Water alarm

Make a liquid level trigger an alarm



Required parts: 9V battery, 10K resistor (brown black orange gold), 470K resistor (yellow purple yellow gold), buzzer, 2x BC547 transistor, 2 wires

How it works: The 2 sensor wires must be placed in a tank at a certain distance (e.g. use a drinking cup). Fill up the tank with a conducting liquid (e.g. water) until the level reaches both sensor wires. A small current will flow via R2 towards the base of T2. The base is protected against interference with a resistor R1.



T1 & T2 are configured as a Darlington switch hence only a very small current is needed to make T1 conduct and activate the alarm sound.

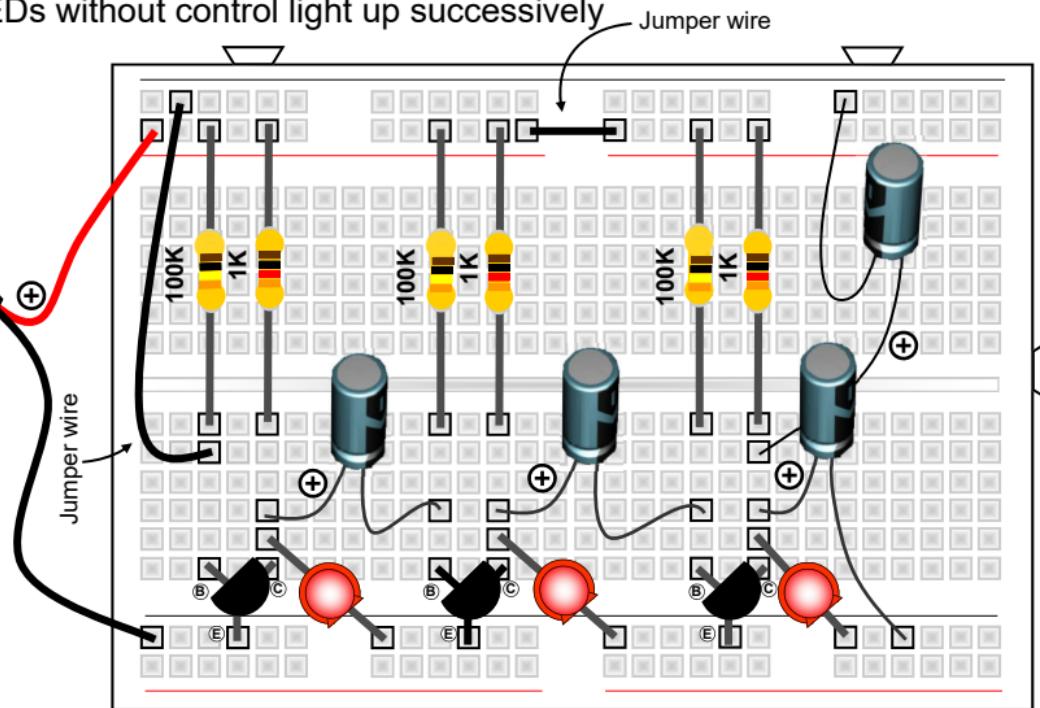


Project 11: Running light with 3 LEDs

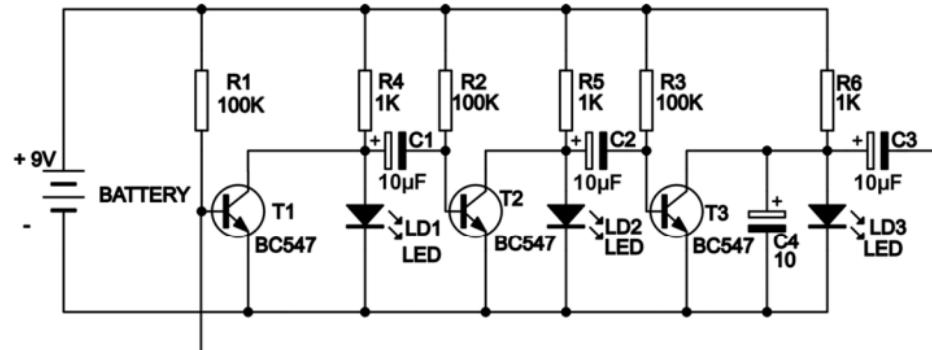
Make 3 LEDs without control light up successively



*Not included



Required parts: 9V battery*, 3x1K resistor (brown black red gold), 3x100K resistor (brown black yellow gold), 3 x red LED, 3x BC547 transistor, 3x10 μ F electrolytic capacitor, 2x wire jumper



This circuit makes each LED light up shortly in succession. The circuit consists of 3 identical channels. It is theoretically possible to expand; per LED a similar circuit is needed in series with the previous. The capacitor of the next channel is charged when the transistor of the previous channel is not conducting. As long as a certain transistor is not conducting, the relevant LED will light up. Capacitor C4 is added to the circuit to create a certain starting condition when connecting power and to ensure a good operation.

Time to experiment: What happens when you change the value of R1, R2 and R3 to 10K?