MAKER FACTORY

ALTER 8+

ELECTRONIC ADVENT CALENDAR FOR KIDS

CALENDRIER ÉLECTRONIQUE DE L'AVENT POUR ENFANTS

ELEKTRONISCHE ADVENTSKALENDER VOOR KINDEREN

CALENDARIO DELL'AVVENTO ELETTRONICO PER KIDS

ELEKTRONICZNY KALENDARZ ADWENTOWY DLA DZIECI

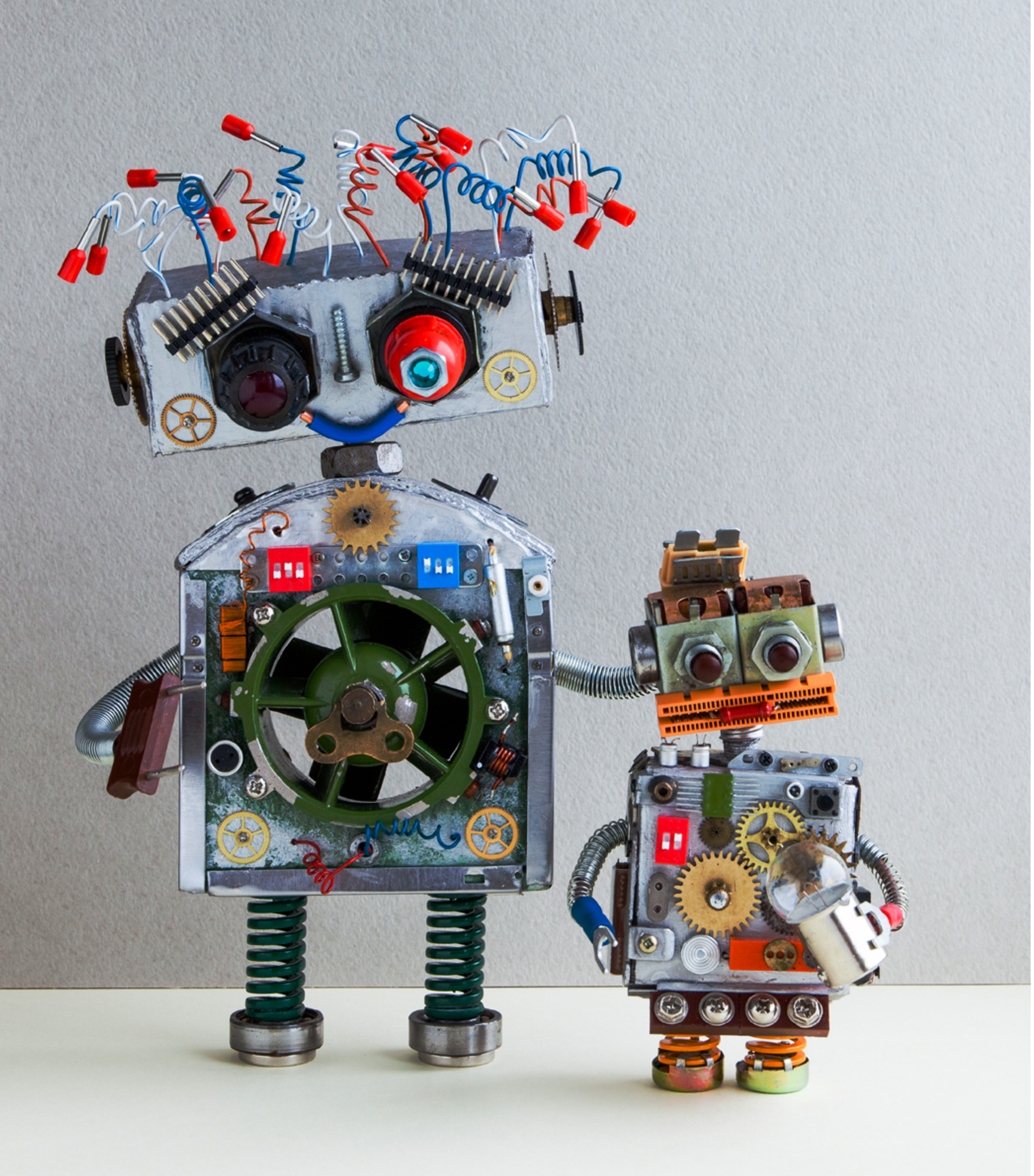
24 thrilling experiments

24 projets passionnants

24 boeiende projecten:

24 progetti entusiasmanti

24 fascynujące projekty



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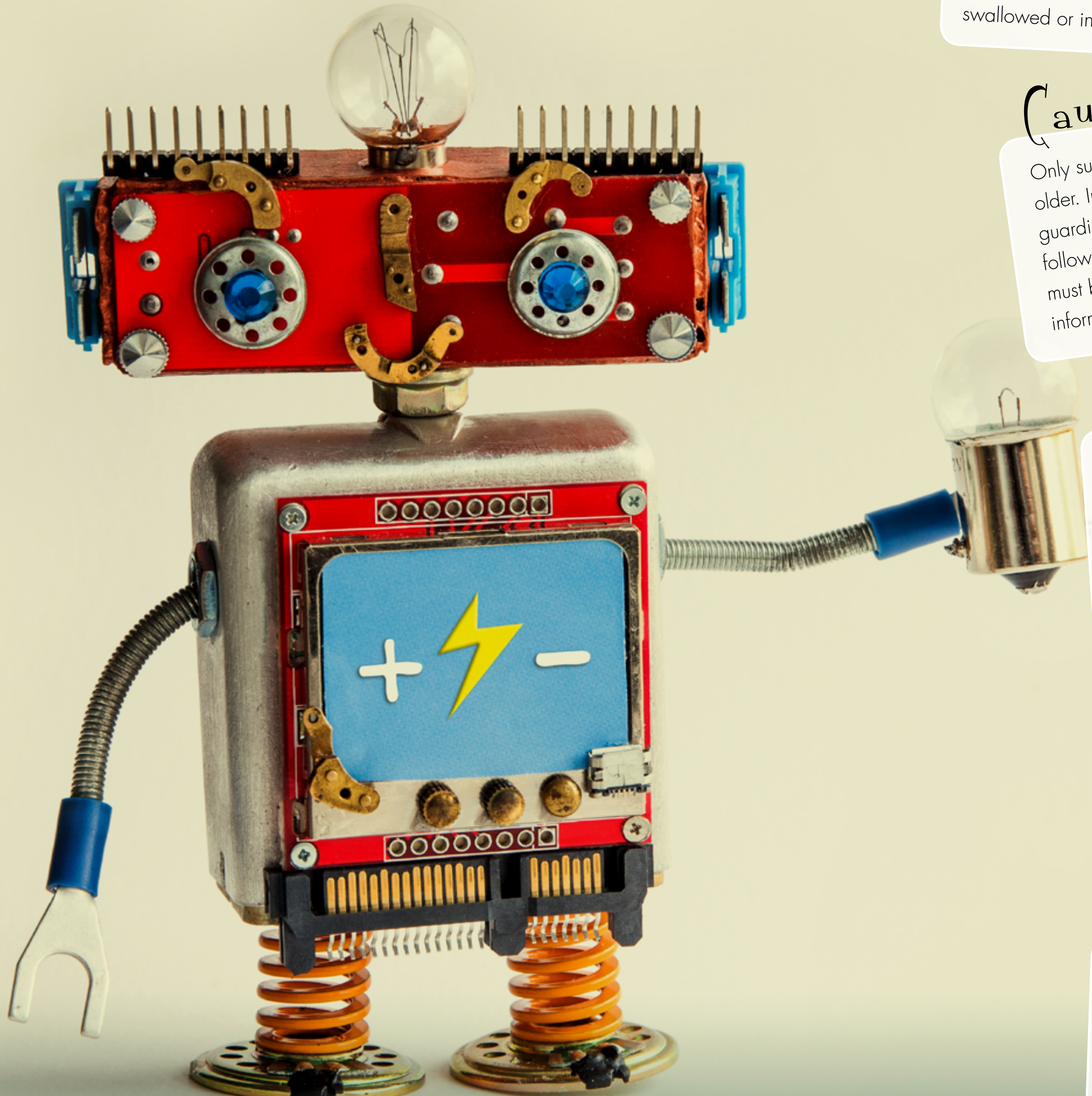
Safety instructions



for parents and children

Caution!

Not suitable for children under 3 years. There is a risk of suffocation due to small parts being swallowed or inhaled.

Caution!

Only suitable for children of 8 years or older. Instructions for parents and other guardians are enclosed and must be followed. Packaging and instructions must be kept as they contain important information.

Caution!

Risk of injury! There is a risk of injury when using tools and working with wood, metal and plastic. Take the age and experience of your child into account. Help with difficult or dangerous work steps. Check the safety of the toys you build yourself and be aware of the risk of injury from sharp edges when playing. If necessary, rework, file off sharp edges and deburr holes or cut edges.

Caution!

Eye protection and LEDs: Do not look directly into an LED from a short distance as this can cause damage to the retina!

Eye protection and LEDs: Do not look directly into an LED from a close distance, because a direct look can cause retinal damage! This is especially true for bright LEDs in clear housings and especially for power LEDs. With white, blue, violet and ultraviolet LEDs, the apparent brightness gives a false impression of the actual danger to your eyes. Special care should be taken when using converging lenses. Operate the LEDs as described in the manual, but not with larger currents.

Caution!

Do not carry out experiments on sockets! The 230 volts of the power supply are life-threatening! All experiments in this experiment package may only be carried out with the safe battery voltage of 9 volts. Then there is no danger of touching electrically conductive parts.

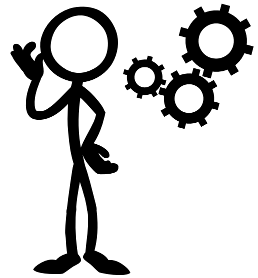
Please instruct your child clearly that they must read all instructions and safety instructions and to keep them near for reference. Notes and instructions concerning the assembly of the projects must always be followed.

Caution!

Avoid short circuits! A direct connection between negative and positive terminals must be avoided at all costs, because wires and batteries can become hot and the batteries then discharge quickly. In extreme cases, wires can become glowing hot and the battery can explode. There is a risk of fire and injury. Point out these dangers to your children and supervise the experiments. If possible, use only normal zinc-carbon batteries (6F20), which provide a lower short-circuit current and are therefore less dangerous than alkaline batteries (6RL61). Never use rechargeable batteries!

Children's electronic calendar 2019

LEDs, transistors and the piezo transducer



Dear children,

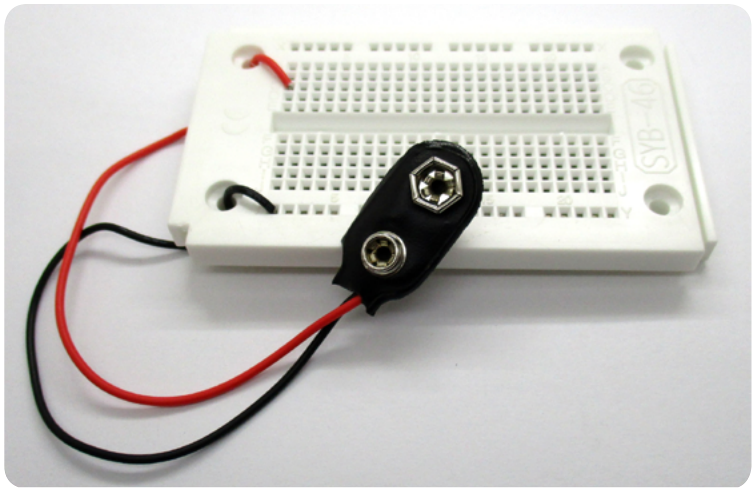
Running up to Christmas there are 24 electronic projects waiting for you. The focus is on transistors, light emitting diodes, a light sensor and a small speaker. You can build completely different things with these components. There is much to see, to hear and to experiment! And if you want, you can find the information you need here to learn more about how everything works.

1 Self-constructed red LED light

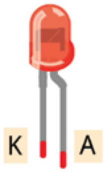
Behind the first door of your calendar you will find six components, so you can start right away. There are four things needed in each experiment: a plug-in board, a battery clip, a switch and a fuse. For the first experiment, there is also a resistor and a light-emitting diode (LED).

The battery cable must be fastened as firmly as possible so that it does not come loose during the many subsequent experiments. The exposed ends of the red and black cables must be plugged into exactly the right contact holes on the PCB. But first make small holes with a needle in the protective foil on the back of the plate and insert the cables from below. This prevents them from slipping easily.

The switch and fuse should be placed exactly in the position as shown. This then applies to all other experiments until Christmas. This will prevent big mistakes from occurring. The resistor and LED are part of the first experiment. Make sure the LED is installed the right way around. It

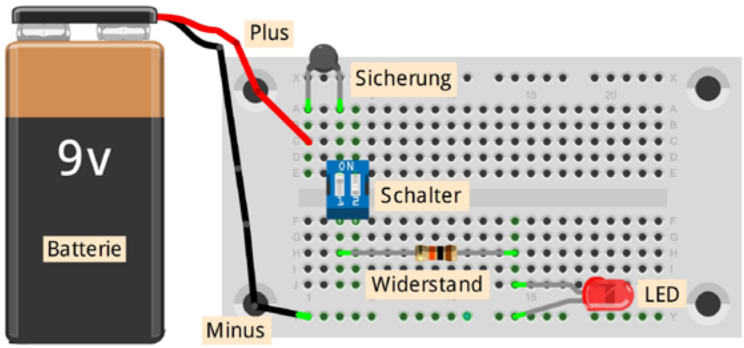


has a shorter wire (cathode = negative pole) and a longer wire (anode = positive pole). Inside you can see a slightly larger holder on the minus side, which carries the actual LED crystal.



Once you have finished setting up, compare your construction with the assembly picture. It's a good idea to get help from an adult who checks the first experiment again. In the following projects, only a few modifications are carried out, so that it becomes easier and easier.

Now the battery is connected for the first time. Your red LED light with switch is now ready. Slide the left switch to the ON position and your red LED will shine. If it doesn't work, check once more. The most common mistake is that the LED is installed the wrong way around. But don't be afraid, nothing will break. If used the right way around, it works.

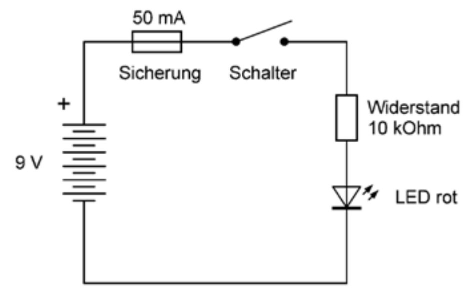


INFOBOX

Circuit diagrams

The circuit diagrams in this manual do not necessarily have to be observed in order to set up the experiments successfully. But they can help you understand everything better. A circuit diagram shows the connections of the parts in a simplified way with circuit symbols for each part. Once you get used to it, a circuit diagram will make it much easier to understand how everything fits together.

The battery consists of six battery cells of 1.5 V each. The longer line stands for the plus pole. The fuse is drawn as a box with a wire. The switch just shows an open connection. The resistor is displayed as a box. And the LED contains a triangle that represents the current direction. Two small arrows point to the light generated. In this diagram you can easily see that all components form a closed path. It's called a circuit. The path is only interrupted at one point - at the switch that is just opened.

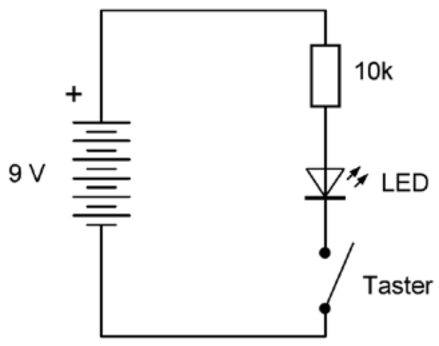


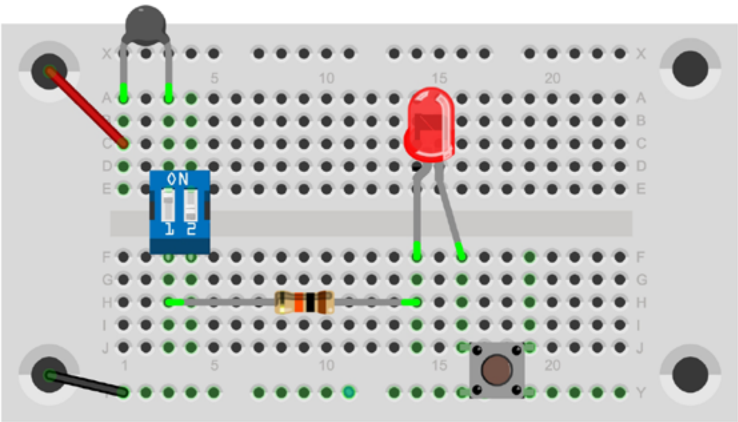
Attention!

Attention! Never connect an LED directly to a battery without a resistor. Without the resistor the current would be too high, and the LED would be destroyed.

2 Secret light signals

Behind door number 2 you will find a push-button switch with four connection pins. Install it in the circuit so that it turns on the power as soon as you press the button. Two of the connections are connected inside. If you have installed the push button the wrong way around, the power will always be on. When the LED lights up as soon as you press the button, it is correctly installed. Use the light button for Morse messages or for secret signs that no one else knows.

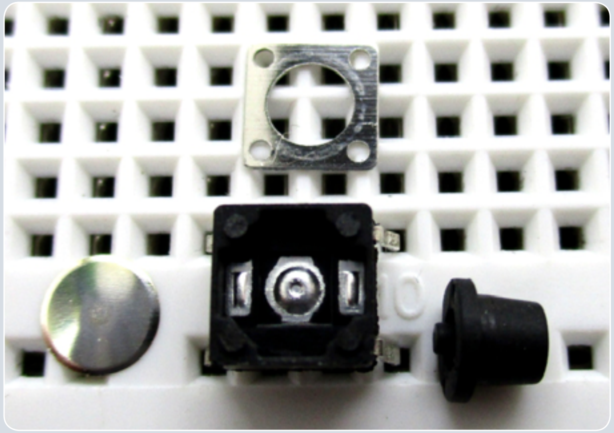




INFOBOX

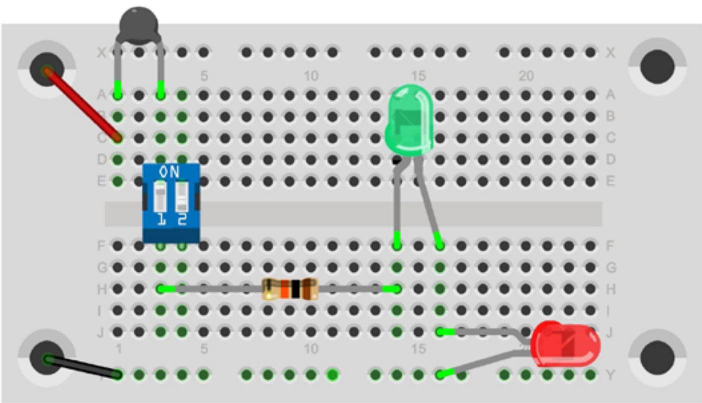
The inner workings of a push-button

Inside the push-button switch there is a slightly upward curved sheet which is pressed into place by pressing the button. At a certain force, it clicks, and the sheet metal bulges downwards. It touches the contact in the middle and thus closes the circuit.



3 Red and green

Behind door number 3 you will find a green LED. Integrate them into the circuit as shown in the picture. Then both LEDs will shine together, the red one and the green one. And switch 1 can switch both on and off at the same time.



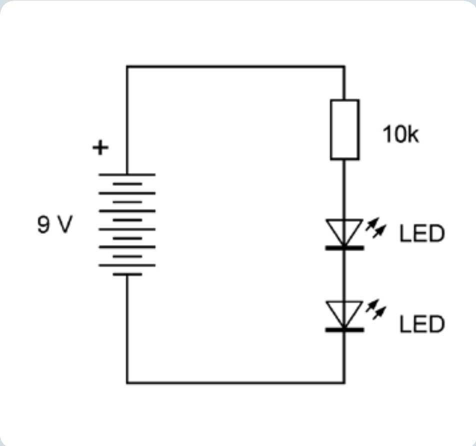
INFOBOX

Series connection

In series connection, the same current flows through two or more users. It's an "unbranched circuit" because the current runs in only one way. This means that the amperage is the same at every point. You can try this yourself by swapping both LEDs. The brightness remains exactly the same.

The battery voltage of 9 V is divided between three users. The red LED has 1.8 V, the green LED has 2.2 V, and the resistor has 5 V. If all partial voltages are added up, we get a total voltage of:

1.8 V + 2.2 V + 5.0 V = 9.0 V

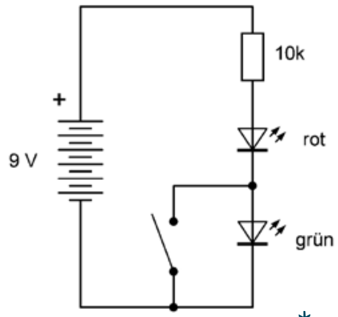


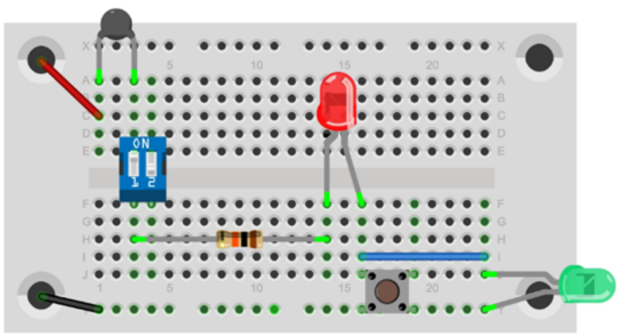
A simplified circuit diagram of a series connection

4 Green turned off

Open the 4th door and remove the cable with two plugs. If you install it along with the push button as shown in the picture, you can switch off the green LED by pressing the button. If the button is closed, you have built a by-pass for the electric current. The current then no longer flows through the green LED, but through the switch. The green LED goes off, but the red LED becomes a little brighter at this moment.

In fact, the switch briefly closes the green LED. This type of short-circuit is permitted only because the resistance in the circuit keeps the current sufficiently low. However, a direct short circuit of the battery in the form of a connection between the positive and negative poles must be avoided at all costs!





INFOBOX

Resistors and their colour rings

The coloured rings on the resistors stand for numbers. They are read one after the other, starting at the ring closest to the edge of the resistors. The first two rings stand for two digits, the third for added zeros. Together they denote the resistance in ohms. A fourth ring indicates the accuracy. All resistors in this calendar have a gold ring. This means that the value can be 5% higher or lower than indicated by the coloured rings. Your first resistance is read like this:
Brown = 1, black = 0,
orange = 000, together 10,000 Ω (Ohm), i.e. 10 kΩ (Kiloohm).

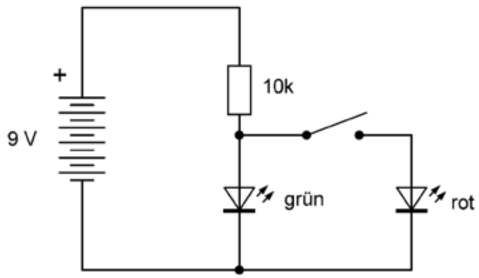
The resistance colour code

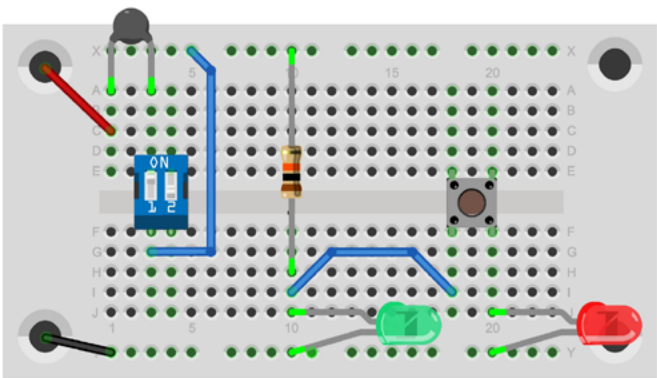
Colour	Ring 1 1st digit	Ring 2 2nd digit	Ring 3 Multiplier	Ring 4 Tolerance
black		0	1	
brown	1	1	10	1 %
red	2	2	100	2 %
orange	3	3	1000	
yellow	4	4	10000	
green	5	5	100000	0,5 %
blue	6	6	1000000	
violet	7	7	10000000	
grey	8	8		
white	9	9		
gold			0,1	5 %
silver			0,01	10 %

5 Colour selector

Behind door number 5 you will find a second cable. Use it to convert your circuit so that the red LED is not switched on until you press the push button. At the same moment the green LED will go out. With this switch you can change the colour: pressed = red, released = green.

Once the switch is closed, both LEDs will be connected in parallel. One might think that current would flow through both and that both would glow. This is actually the case when the same LEDs are used. But there's a big difference here. The green LED needs more current than the red LED. If the red LED is now switched on, the LED voltage drops to such an extent that the green LED can no longer shine.





INFOBOX

Voltage, resistance and current

You may already know that the electrical voltage is measured in volts (V). The battery is 9 V. Resistance is measured in ohm (kΩ) or kilo-ohm (1 kΩ = 1,000 Ω). But there is another very important measurement: The electrical current is measured in amperes (A) or in milliamperes for small currents (mA = 1/1000 A). All these names come from famous researchers who were the first to research electricity about 200 years ago: Alessandro Volta, Georg Simon Ohm and André-Marie Ampère.

A measuring device could be used to measure how much current flows through the LED. But you can also calculate it, if you know the voltage of the battery and the voltage of the LED. If the battery is still new, it will have a voltage of 9 V. The green LED needs about 2 V. That leaves 7V for the resistor. And then you can do the calculation like this:

Current = voltage/resistance

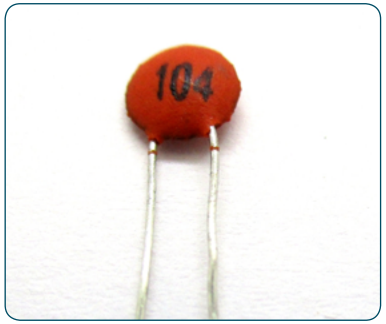
Current = 7 V/10,000 Ω

Current = 0.0007 A = 0.7 mA

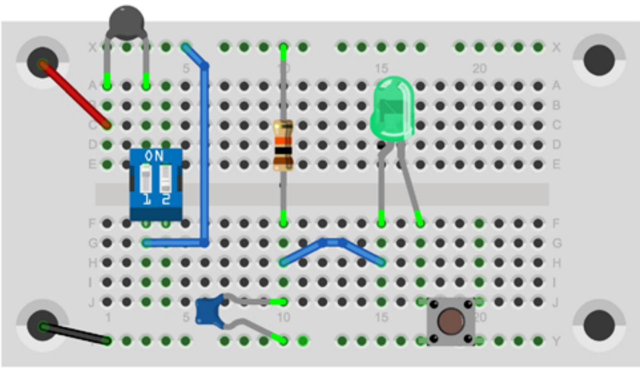
That's not much, there is a flow of only 0.7 mA, although the LED can handle a current of 20 mA. But the battery lasts for a very long time! It usually has a capacity of 500 mAh (500 mAh), so it could deliver 500 mA for one hour or 1 mA for 500 hours. Your lamp will therefore glow at 0.7 mA for about 700 hours, which is about a month long.

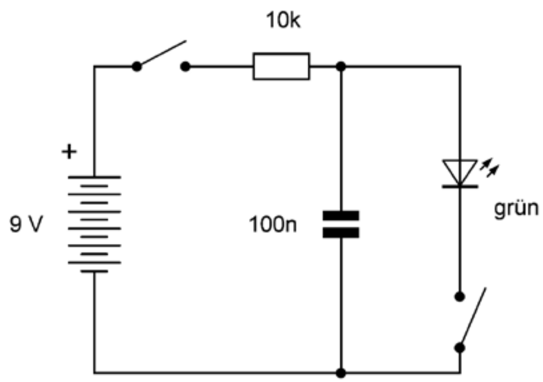
6 Stored Energy

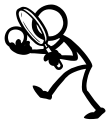
On the sixth day on your calendar, you will find new component behind the door: a capacitor. It is a small, light brown disc with two wires. On it you will find the inscription 104, which stands for 100 nF (100 Nanofarad). A capacitor can be charged and discharged. If you set the main switch 1 to ON, it is charged. You can then turn it off again, wait a little and press the button. This creates a small LED flash that discharges the capacitor. You can think of it as a kind of battery that can be recharged over and over again. However, your charged capacitor contains very little energy.



A capacitor consists of two metal surfaces with an insulating layer between them. Therefore, it is shown in the circuit diagram with two unconnected lines. The component also has an outer protective layer and can look rather different depending on the make. In the assembly pictures, a blue, square capacitor is depicted, yours is round and light brown. The inscription indicates the capacity of this capacitor. This is a measure of how much energy the capacitor contains at a given voltage. The unit of capacity is called Farad (after the famous researcher Michael Faraday). The smaller units are microfarad (µF), nano-farad (nF) and picofarad (pF). The label 104 stands for 1, 0, 0000, i.e. 100,000 Picofarad, 100,000 pF = 100 nF.



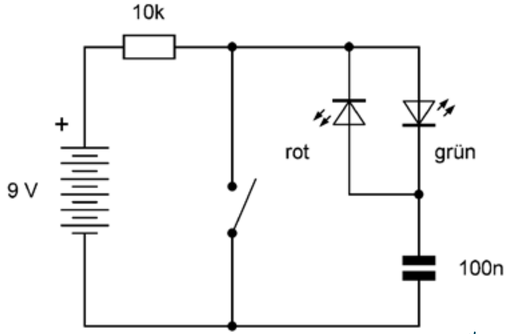


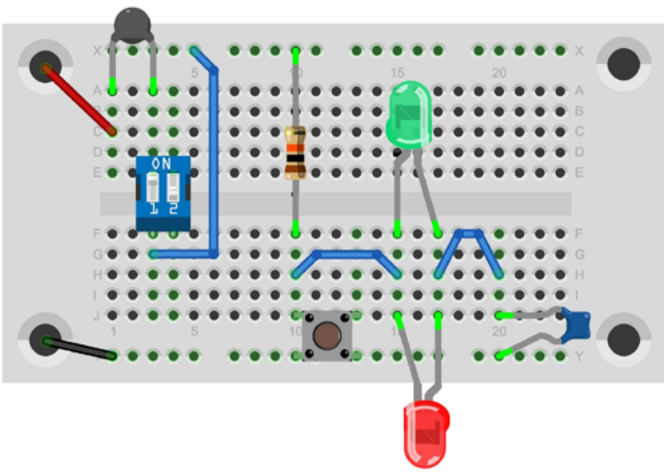


7 Coloured flashes of light

Behind the seventh door you'll find another cable. Now build your circuit and insert the red LED. Pay attention to the direction of installation! The red LED appears to be installed the wrong way around, i.e. with the cathode towards the positive pole of the battery. Using the button, you can alternately charge (contact open) or discharge (contact closed). When charging, a green flash of light is generated, when discharging, a red light appears. You can repeat the alternating charging and discharging as often as you like. Each time you press the button, a red flash will appear; once you release it, a green flash will appear.

Your battery delivers direct current. This means that the current always flows in the same direction. In your circuit, however, an alternating current is created when activating your push button. In one direction the green LED shines, in the other direction the red one will shine. Therefore, both LEDs in this circuit had to be installed with different directions.

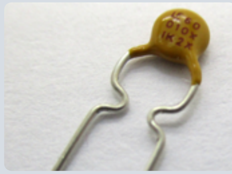




INFOBOX

The PTC fuse

All your experiments are secured by a fuse to help if a mistake occurs. If you accidentally short-circuit a cable, it could become glowing hot, or the battery could heat up, break, or even explode. But the fuse will prevent that from happening.



Many fuses just blow when you cause a short circuit. You will then need a new fuse. But your special fuse is different. This is a self-resetting fuse, also known as a PTC fuse. If too much current flows during a short-circuit, the PTC fuse becomes hot and lets only a little current through because its resistance rises sharply. That's where the name comes from. PTC stands for "Positive Temperature Coefficient" and means that the resistance increases as the temperature rises. If you then switch off the power and eliminate the fault, it cools down and is as good as new again.

Attention!

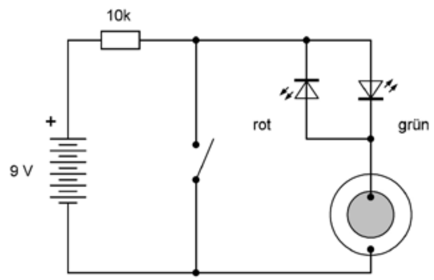
Please do not try it out, as the battery will quickly become unusable in the event of a short circuit. Also, the PTC fuse can reach about 60 degrees and can easily burn your fingers. But that would still be better than glowing wires and exploding batteries. So always remember: The safety device is only there for emergencies, similar to the emergency brake on a train.

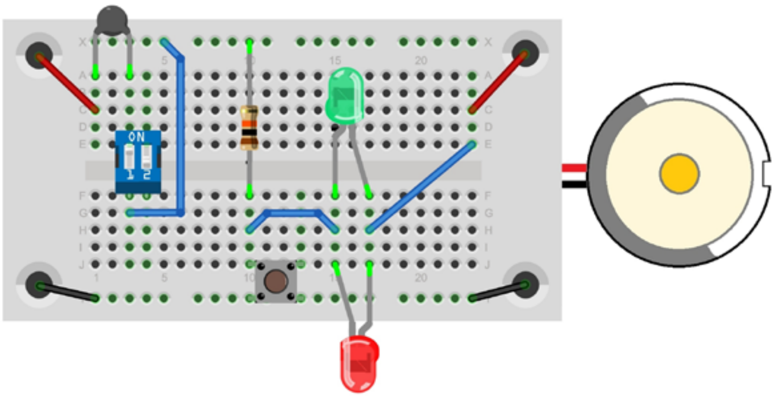
8 Electrical noises

Open the 8th door and discover a small piezo speaker with two wires. The connecting wires are very thin and soft and must therefore be protected just like the battery cables. Make two more holes in the protective foil of the adapter board and guide the wires through from below. Then feed them through the holes provided, where they should stay until the last experiment.

In this circuit, there is also a push switch, and once again a small red and green light will flash each time the switch is activated. You will also now hear a soft but clear click from the speaker each time. However, the click of the snap-in switch may drown out the speaker. Use a metal wire or object to connect the two terminals of the button to make the click quieter.

The comparison with the previous experiment has already proven that the piezo speaker functions like a capacitor. And indeed, the structure of a capacitor can also be clearly seen. One metal plate is a thin sheet. This then follows the insulating layer of a thin, grey disc. The second metal plate is a silver-plated surface. There is an electrical attraction between the two metal surfaces which change when the capacitor is charged or discharged. This creates a small movement that generates the noise.

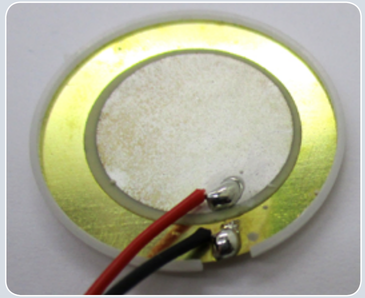




INFOBOX

Piezoelectricity

The Greek word piezo means pressure, and some materials such as quartz have a piezoelectric effect. If you press on it, an electrical charge is generated. Conversely, when an electrical charge is applied, a deformation occurs as if one were pressing on the material.

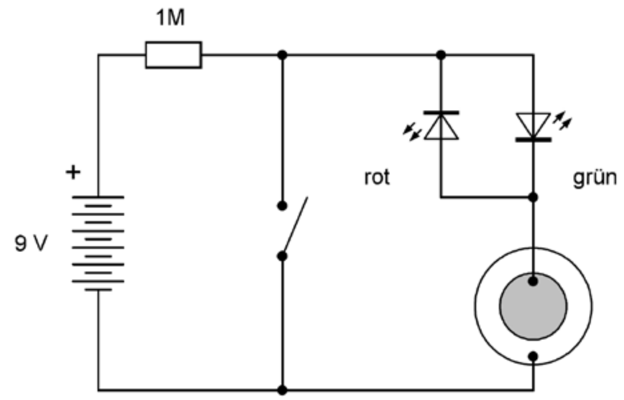


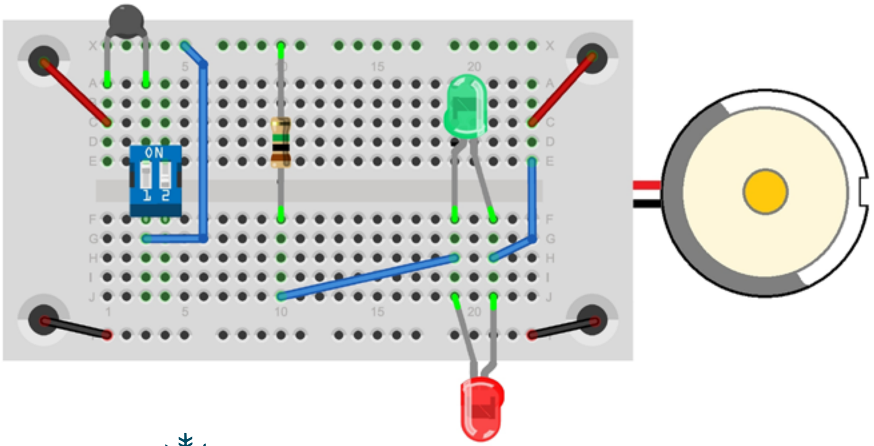
The insulation in your piezo speaker is ceramic, similar to porcelain. Once an electrical voltage is connected, the disc bends slightly. This creates a noise.

9 Braked current

Behind the 9th door you will find a new resistor with the colours brown, black and green. It has 1,000 kΩ (Kiloohm), so a 1 MΩ (Megaohm). This very large resistor provides a very small current that only slowly charges the piezo transducer. Open and close the contact several times. Both LEDs will clearly flash. But the piezo speaker only produces a crack when the contact is closed.

Once again you can also use a wire or other metal object if the button is too loud. Once the contact is opened, however, no audible noise is generated. The reason for this is the large resistance in the circuit. Only a small charging current will flow, slowly charging the piezo converter. The result is only a slow, silent deformation. Once the contact is closed, on the other hand, a sudden discharge with rapid deformation and a distinct cracking will occur.



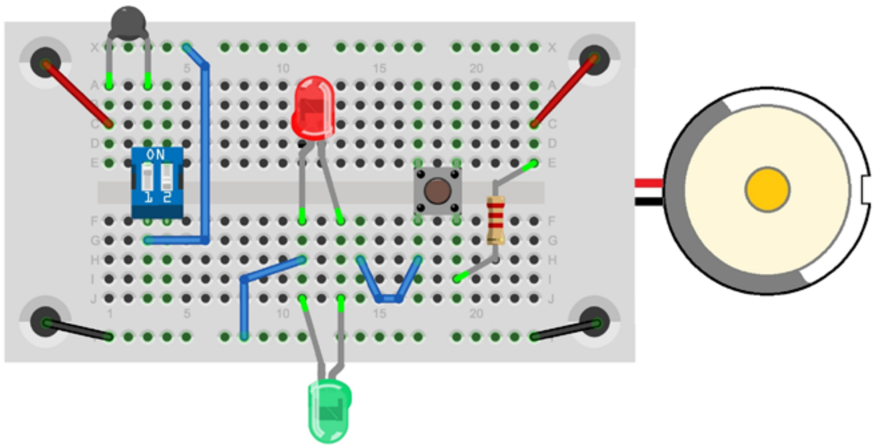


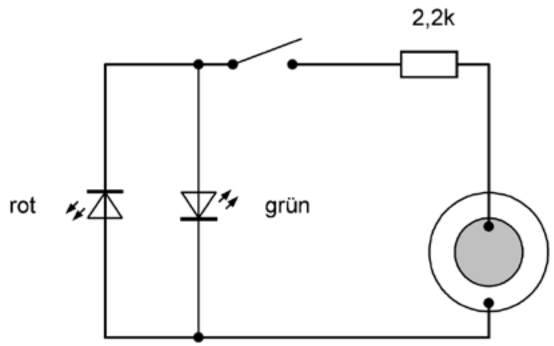
10 Light flashes without battery

Open the 10th door and remove another resistor. It is 2.2 kΩ and has three red coloured rings. Now build a circuit with the piezo speaker, the resistor and two LEDs. The battery is not connected and may be removed from the battery clip. The push button should be pressed for the first experiment. Now lightly tap the piezo disc. This will again result in weak red and green flashes of light. Attention! You must not use too much force, otherwise the ceramic disc could break.

The experiment has shown that the piezo speaker can not only convert electrical energy into sound, but also vibrations into electrical energy. The same component functions as a speaker, microphone and electrical generator. Therefore, it is also called a "piezoelectric sound transducer".

Deformation owing to pressure on the membrane causes charging and thus generates electrical energy. But the same also achieves a change in temperature. It's easy to try. Open the switch and hold your warm finger against the membrane for a few seconds. Then close the contact. It will cause a crackling sound and a flash of light. Then open the contact and wait a little longer until the pane has cooled down again. Closing the contact again generates another crackling sound and a second flash of the other colour. Use a cable instead of the push button to hear soft sounds from the piezo transducer.

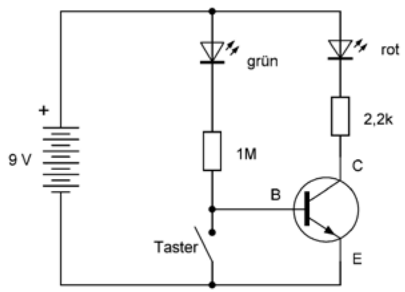


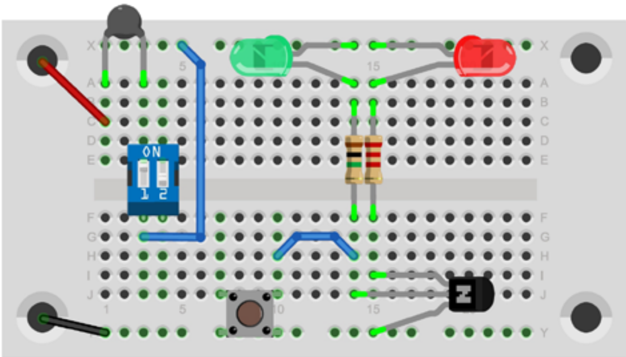


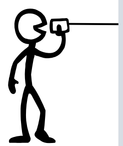
11 Amplified current

On the eleventh day you will receive an important component of your calendar: the transistor. The transistor has three connections which should not be confused with each other. They are called emitter (E), base (B) and collector (C). By the way, the abbreviation C comes from the English spelling (collector). The emitter should be connected to the negative terminal of the battery. The flat, labelled side of the transistor must point to the left.

The experiment shows the typical behaviour of a transistor. If the pushbutton switch is still open, the green LED shines dim, but the red LED is very bright. If you press the button, the red LED goes out. The transistor behaves like a switch. A small current through the basic connection causes a large current to be switched on through the collector connection. However, if you connect the base and emitter via the button or pull out the green LED, the red LED will also turn off.







INFOBOX

Transistors

The transistor in your experiment contains a silicon crystal. Silicon (Si) is contained in large quantities in normal quartz sand (quartz = silicon oxide). It belongs to the group of semiconductors, i.e. substances that neither conduct electricity well, such as metals, nor insulate it well, such as glass or rubber. In order to achieve a very specific conductivity, tiny traces of other substances are added to the pure silicon. Depending on the type of these substances, N-silicon or P-silicon is obtained. There are three layers in your transistor: NPN. Other types have a different layer sequence, namely PNP. They function similarly, but with a different current direction.

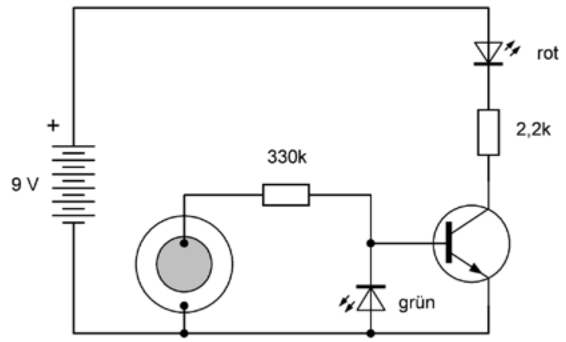
Transistors are important components in all areas of electronics, in radios and televisions as well as in smartphones and computers. Transistors are installed everywhere. It is therefore worthwhile to understand exactly how a transistor works.

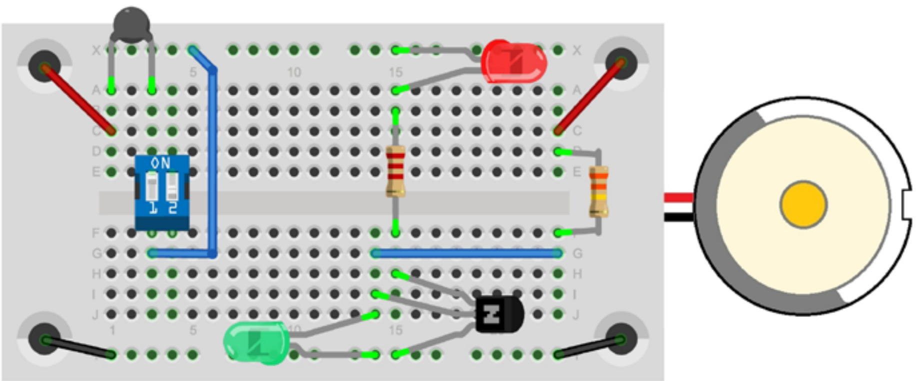
Take a good look at your transistor. There's a label: BC547B. With this description you can order exactly the right transistor, which is manufactured by several companies by the way. Or you can search the Internet for the data sheet of this type. It contains many properties and measured values, some of which are only clearly understood by experts. In a nutshell: This NPN transistor can withstand a voltage of 50 V and a current of 100 mA. And it can amplify the current at least 200 times.

12 Amplified light flashes

Behind the 12th door you will find a resistor marked 330 kΩ (Orange, Orange, Yellow). Integrate it into this amplifier circuit using a transistor. If you now tap softly on the piezo disc, the red LED will emit a strong flash. But weak flashes of light also come from the green LED. Please note that the green LED is installed in a different way than normal, namely with the anode (long wire) at the minus pole of the battery.

Because the transistor conducts current in only one direction, the green LED must ensure that current can also flow in the opposite direction. As previous experiments have shown, the piezo converter supplies an alternating current. In this case, the green LED shows the directly generated current, while the red LED shows the current amplified by the transistor.





13

Touch switch

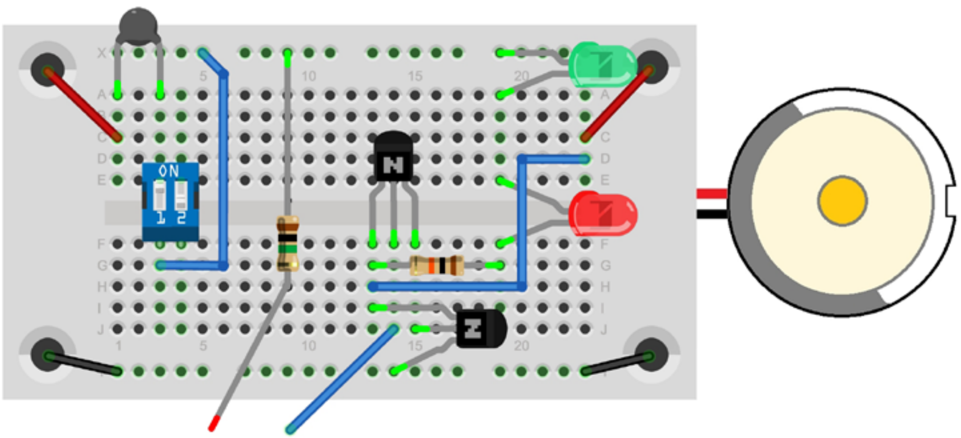
Behind door number 13, you will find a second transistor of type BC547. Along with the first transistor, it should now provide even more amplification. Both collector terminals are directly connected, and the emitter of the first transistor leads to the base of the second transistor. This circuit is called a Darlington circuit. With this a touch switch will be built here. If you touch the cable and the resistor with your finger at the same time, a very small, harmless and imperceptible current flows through your finger, which is amplified to such an extent that both LEDs are switched on.

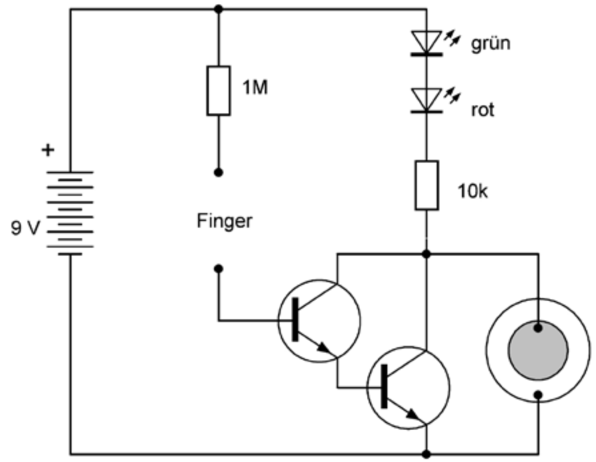
The speaker is again connected to the collector of the transistors. And sometimes you will hear strange sounds. Just touch the base cable. Depending on where you are, you may hear a crackling, humming or buzzing sound from the speaker. The noise can become even stronger if two people touch both wires. It comes from the electrical wiring in the room. If you also move your feet on the floor, you can sometimes see the LEDs flashing or flickering. It indicates the electric charge of your body through friction on the shoes.

INFOBOX

The Darlington Circuit

The connection of two transistors as shown in the circuit diagram is called a Darlington circuit. Two transistors amplify more than one. This is especially true for this circuit, where the already amplified current is amplified again by a second transistor. The name comes from its inventor, Sidney Darlington, who came up with the idea in 1952. Both collectors are connected, and the emitter of the first transistor flows to the base of the second transistor. The Darlington circuit behaves like a single transistor with huge gain.

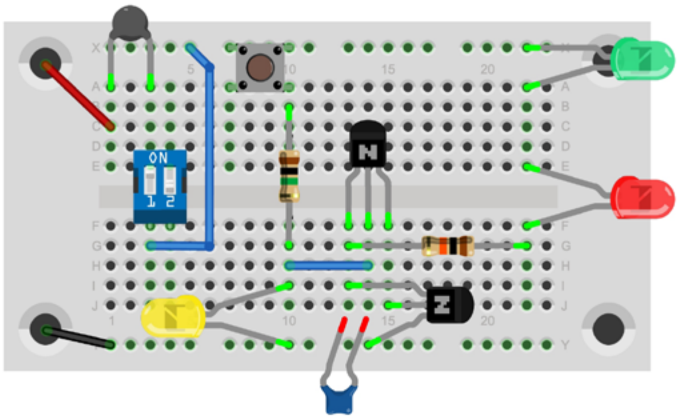


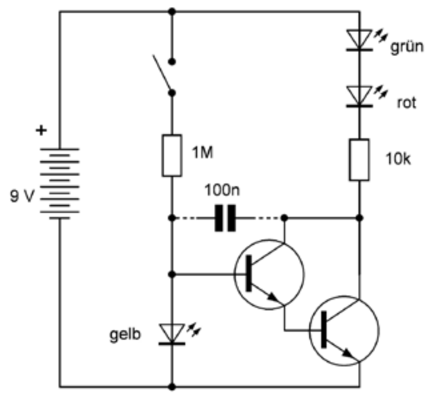


14 The light sensor

There is a yellow LED behind door number 14. You could install it in your circuit instead of the red or green LED and try out another colour. But it can also perform a completely different task. In this experiment, the yellow LED is used as a light sensor. When illuminated, it delivers a very small current, similar to a solar cell. This is then amplified by two transistors and causes the other two LEDs to shine. Do not install the capacitor first. Test the experiment using a flashlight. The stronger you illuminate the yellow LED, the brighter the other two LEDs will shine.

In addition, a capacitor is then inserted into this circuit, which serves to greatly slow down the switching on and off. Only when you have illuminated your photo diode long enough, the red and green LEDs will light up. After switching off, they then continue to glow for a long time and only go out slowly. In addition, the push button switch is also installed. You can turn on the light quickly and let it go out slowly over half an hour.





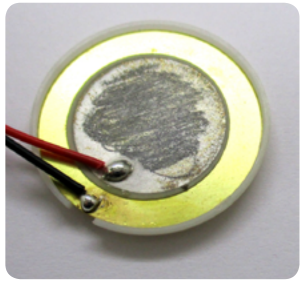
INFOBOX

Photodiode

Each diode consists of a semiconductor with a PN barrier layer, which conducts the current in one direction and does not let any current through in the other, i.e. blocks the current. In addition to light emitting diodes, there are also rectifier diodes and photodiodes made of silicon - the same material your transistors are made of. A photodiode uses a particularly large area so that a lot of light from outside can penetrate into the barrier layer. There, the light ensures that an electrical voltage is generated and that the current can flow. An LED has a similar structure, but only a very small area. Therefore, the light-dependent current is rather weak. However, after a large amplification by the two transistors, it will be sufficient for this experiment.

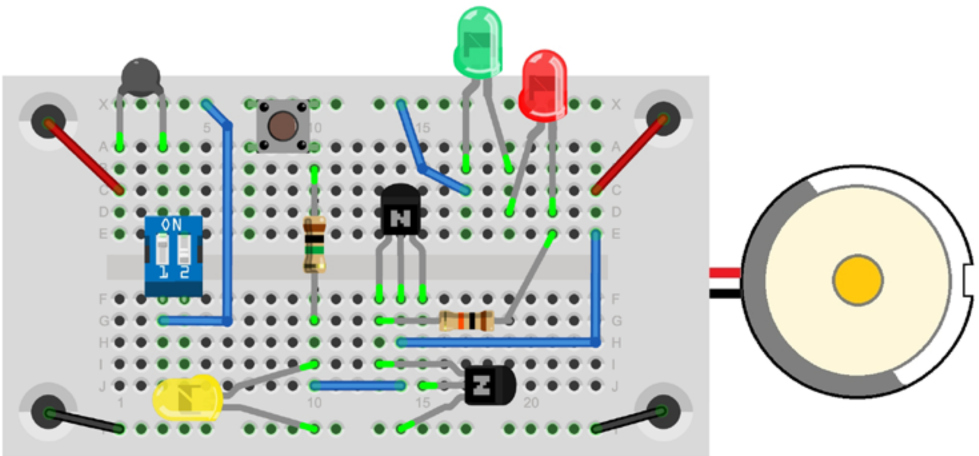
The red or green LED can also work as a photodiode. Replace the LED in your circuit and make sure you insert it in the right direction. This way, you can explore which LED is the best photo diode.

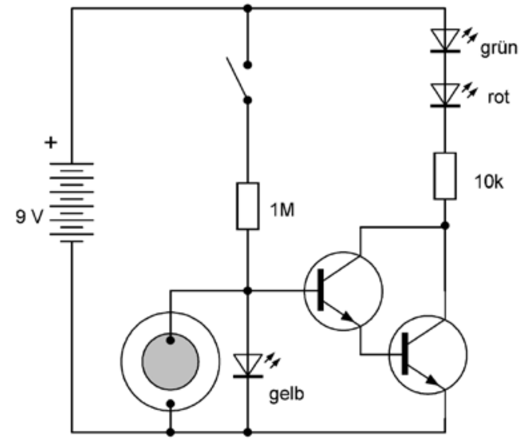
15 The motion detector

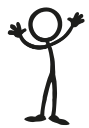


Behind the 15th door you'll find another cable. You will be building using an infrared motion detector. The actual sensor is the piezo disc. You already know that when the temperature changes, it generates an electrical voltage. And this also works without direct contact if you get close. It is even better if you darken the silver layer of the disc with a soft pencil. Your warm hand radiates infrared heat. When it hits the blackened sensor, it heats up a little. This produces only a very small electrical current. That's why you need a good amplifier, which here consists of a Darlington circuit. In addition, a very small base current is needed, which the is supplied by the yellow LED depending on the lighting. In addition, there are buttons for continuous light.

Wait a while until the red and green LEDs shine evenly and dimly. With a short push of the button you can shorten the waiting time. Then hold your hand about 5 cm away from the piezo disc. After a few seconds, the brightness of the LEDs will change. Remove the hand and observe the opposite change in brightness. The two LEDs can therefore indicate the approach of the hand. However, the direction of the change cannot be predicted. You can change them by swapping both cables of the piezo speaker. The LEDs should shine brighter if you hold your hand closer to the piezo disc. With this you have built night light with a proximity sensor.



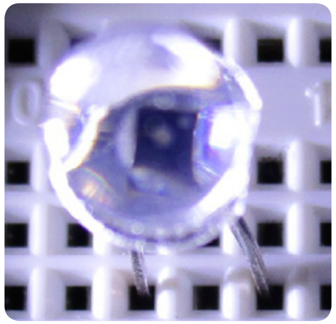


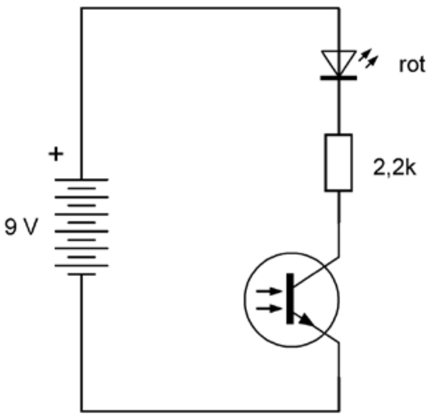


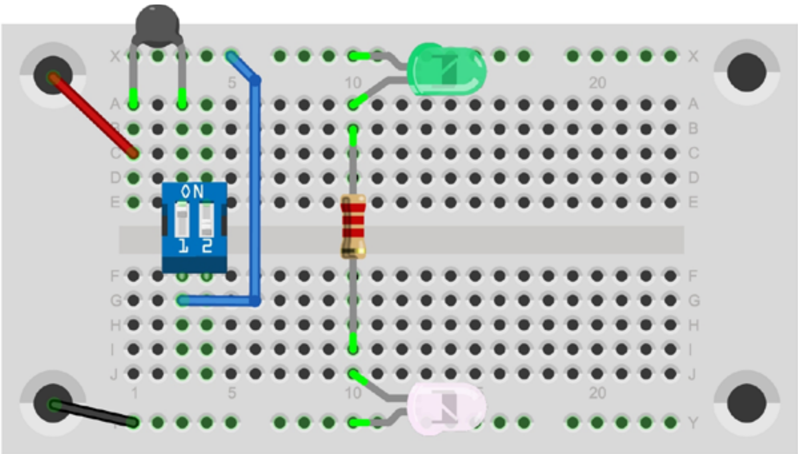
16 One light amplifier

Open door number 16 and take out a new component. At first glance, it looks like an LED in a clear housing, but in fact it is a light sensor; more precisely, a photo transistor. Install it along with a resistor and an LED. Make sure you install it the right way around. Unlike what you know about an LED, the long wire has to be connected to the negative terminal, because that is the emitter. The red LED lights up brighter when more light falls on the photo transistor. The red LED goes out in complete darkness.

Like a normal transistor, the phototransistor has an emitter (long wire) and a collector (short wire). There is also a base, but it has no connection. The base current is supplied by a built-in photodiode. If you look at the transparent case from the front, you will see a relatively large black area. That's the light-sensitive photodiode. It is significantly larger than the area of an LED crystal. Therefore, the phototransistor is much more sensitive than the LED in your light sensor from experiment 14.



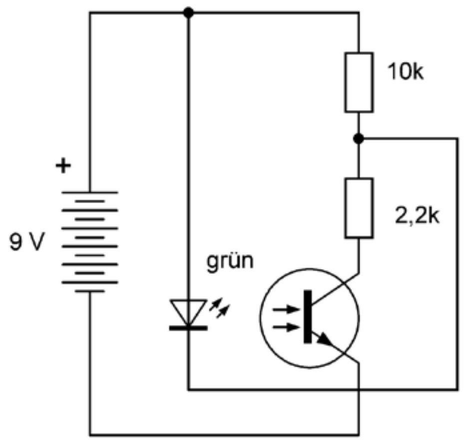


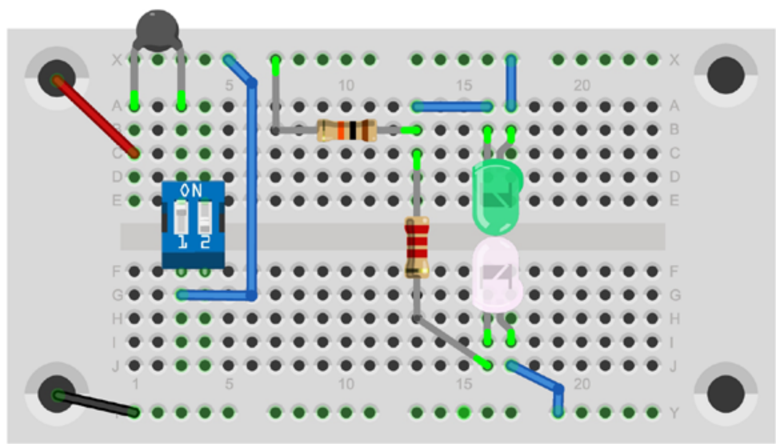


17 Fototransistor/LED-Flipflop

You'll find another cable behind door number 17. Now you are going to build a circuit with an LED and a photo transistor that switches each other on or off. Bend the wires to fit so that the LED is mounted opposite the phototransistor and illuminates it directly. For this reason, the switched-on state is maintained even in the dark. But if you put a sheet of paper between them, the LED will turn off and won't turn on by itself when you pull the paper out. But it only takes a short flash of light or the light of a lamp to switch it on again. You can place the circuit in a dark room and after a while find out if someone has switched on the light in the meantime.

This circuit is also called a flip-flop circuit because it can switch between the two states On (flip) and Off (flop). In this case, switching is achieved by lighting and shading. The resistance of 10 kΩ determines the brightness at which the flip-flop switches to the on state. If you install a resistor with 330 kΩ in its place, the circuit already reacts to much weaker light.

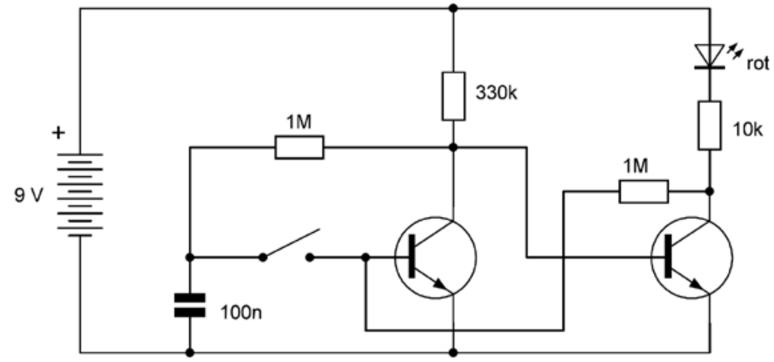


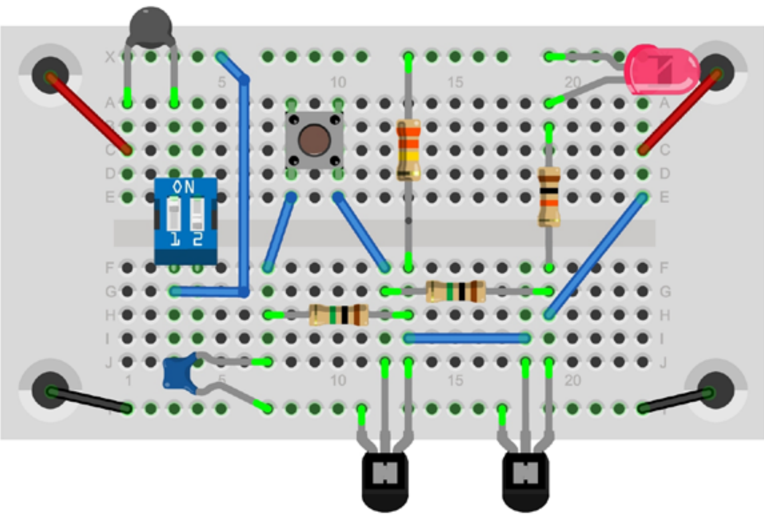


18 Key switch

Behind door number 18 you will find another resistor with 1 MΩ (1 MOhm, brown, black, green). With this you'll be building a button switch. Each press on the button changes the state of the LED to On - Off - On - Off and so on. The last state is retained after release. Here, too, the speaker can remain connected. You will hear a click every time you switch.

This circuit is also called toggle flipflop. If you press the button ten times, the LED is on exactly five times during this time. Therefore, this circuit halves the number of on states.





INFOBOX

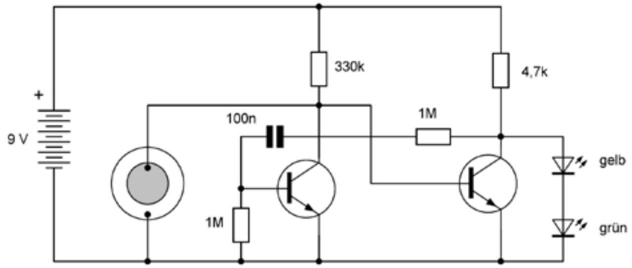
The Flipflop

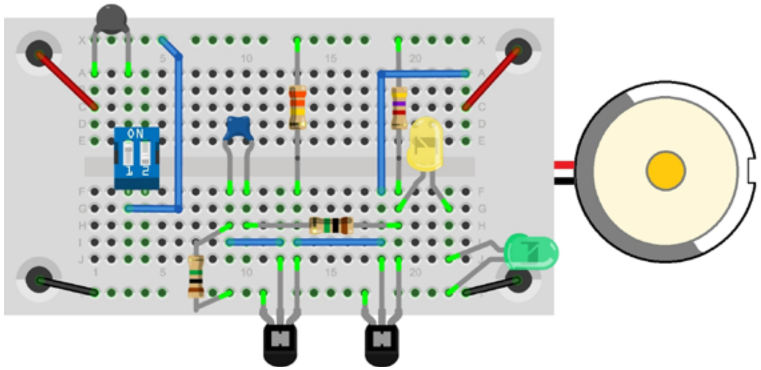
A flipflop is a circuit that can have two stable states. The existing state remains stored as long as you do not intentionally change it. The flip-flop is therefore also an information memory. In this case, only one piece of information is stored. You can call them "yes" or "no", but also "one" or "zero" or in this case "on" or "off". Many flip-flops together are used as memory in computers and store large amounts of data.

19 Button switch

Open the 19th door and remove the resistor with 4.7 kΩ (yellow, violet, red). Now build a flipflop that turns on the LED for a short time each time you press on the piezo disc and then turns off by itself. It is often enough to tap on the table next to the sensor. This time there are two LEDs in series at the output.

A circuit like this is called a monostable flipflop. This means that there is only one stable state, in this case the off state. The on state is only switched on for a short time, until the capacitor is fully charged.

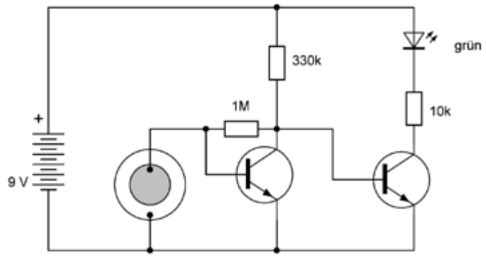


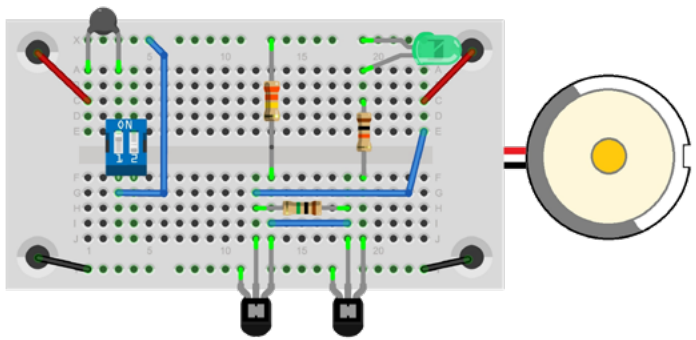


20 A vibration sensor

Door number 20 hides a resistor with 10 kΩ (brown, black, orange). It is used in this circuit as a series resistor for the LED. Two transistors form a sensitive amplifier. In the idle state, the LED lights up only weakly. The piezo converter is connected to the input of the amplifier. When the diaphragm of the piezo transducer is made to vibrate, it generates a small voltage which is greatly amplified. That's why the LED flickers clearly visible.

The circuit even reacts to loud sound. The piezo converter then works like a microphone. Clap your hands and watch the LED flicker. Then turn the transducer over and place a small weight on the diaphragm. It could be an eraser or a coin, for example. Then gently tap the table. The LED will flicker brightly. Even the smallest vibrations of the floor can be displayed when someone is walking through the room.





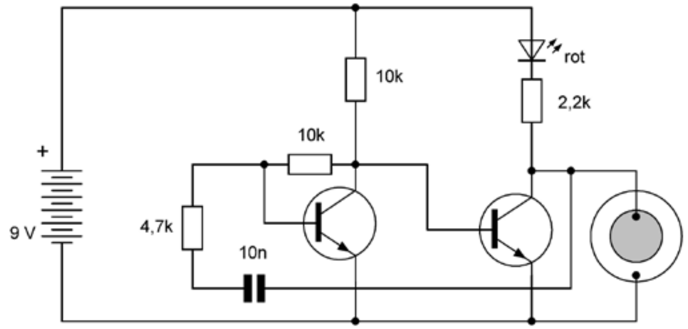
21

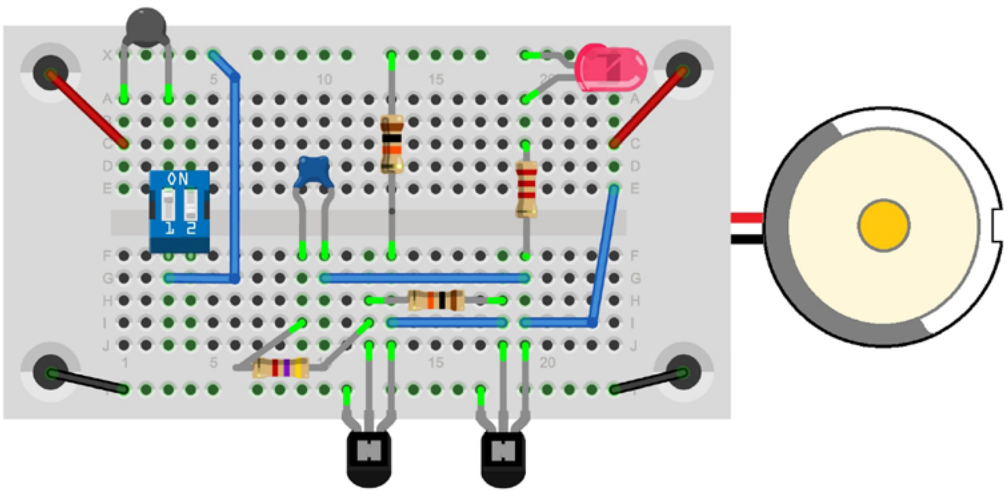
A tone generator

Behind door number 21 you'll find a capacitor with 10 nF (overprint 103). Now build an electronic sound generator. You will hear a uniform sound from the speaker. Touch the condenser with your fingers so that it heats up a little. The tone changes very slowly. Touching the piezo transducer also changes the sound.

The frequency, i.e. the pitch, depends on the components. Replace the small capacitor with 10 nF with the larger one with 100 nF. The tone is now much deeper and more like a rattling. The sound can be changed by partially holding the sound hole of the speaker.

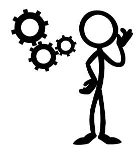
The LED seems to light up evenly. But if you make a quick movement with your eyes, you will see that it actually flickers very quickly.





You can see the flickering even more clearly if you look at the LED over a small mirror while moving move at the same time. This way you can even recognise the individual vibrations of the high tone.

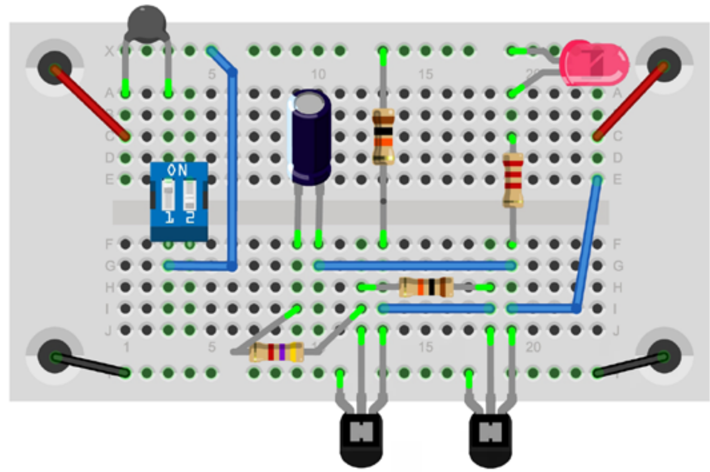
The two transistors switch each other on and off again and again. This circuit is called a stable flip-flop, because neither of the two states is stable. The fast changes create a movement of the piezo disc and thus a sound.

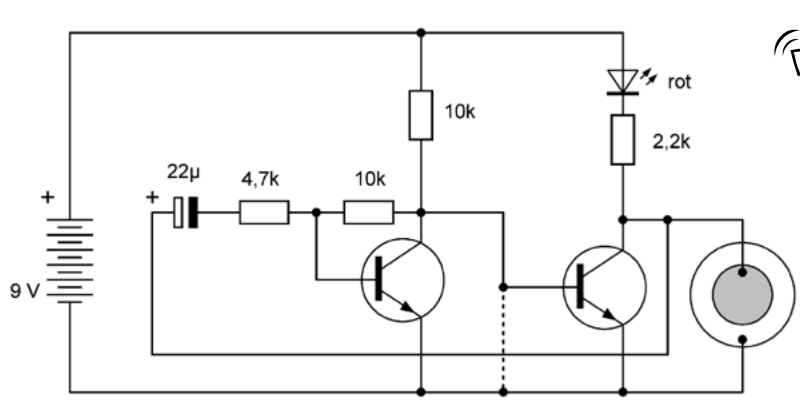


22 Flashing LED

Door 22 hides a larger capacitor with 22 µF (22 microfarad). It is an electrolytic capacitor (electrolytic capacitor) that has a positive pole and a negative pole. Make sure you install it in the right direction. The negative pole has a shorter wire and is marked with a white line. A microfarad is 1,000 times larger than a nano-farad. 22 µF is therefore 220 times more than 100 nF. Put the electrolytic capacitor in the circuit of the last day. This turns the tone generator into a slow flashing light. If the speaker is still connected, you will hear a slow click.

This circuit can also be used as an alarm system. The schematic shows a dashed line representing a cable that may or may not be available. If you install a cable between the base and emitter of the right transistor, you'll turn off the flashing light. This cable is your alarm loop. Tie it to a door or a window with a thread; when it is opened, it is pulled out. This way you can see the alarm. If you use the small capacitor with 10 nF, the alarm becomes audible.





INFOBOX

The oscillator

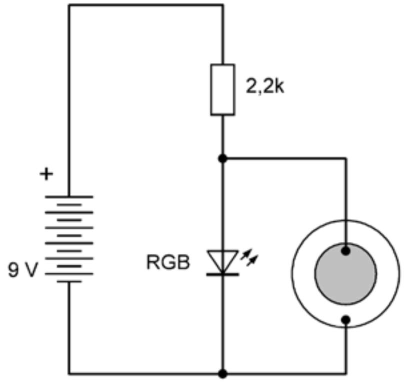
A circuit that generates vibrations independently is also called an oscillator. Oscillators are important circuits in electronics and computer technology. In a computer, many components work in common mode. This beat is generated by an oscillator, much like a conductor conducts an entire orchestra with his baton.

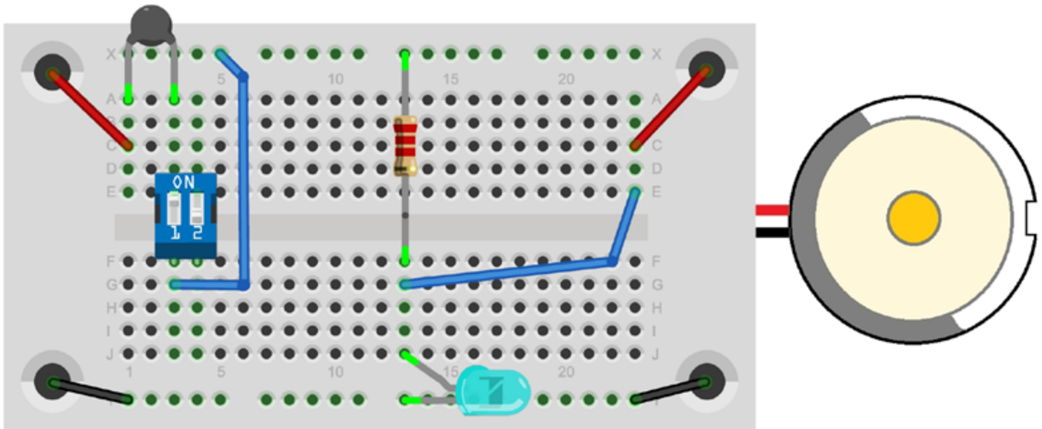
23

Automatic colour change

Open door number 23 and remove the very special LED in a clear housing. It actually contains three LED crystals in the colours red, green and blue (RGB) as well as a controller that switches the individual colours and fades them into each other. If you look into the RGB LED from the front when it is switched off, you can see the individual parts.

Like a normal LED, the RGB LED also needs a resistor in series. The piezo speaker is also connected for this test. You'll hear strange sounds when the colours switch. Sometimes the controller creates a kind of flashing light. Then all you'll hear is a click. In other phases, the fade is gradually made from one colour to another. In fact, the controller then switches each of the LEDs on and off in very rapid succession, changing the ratio of switch-on lengths. In this way a changeable tone is created.





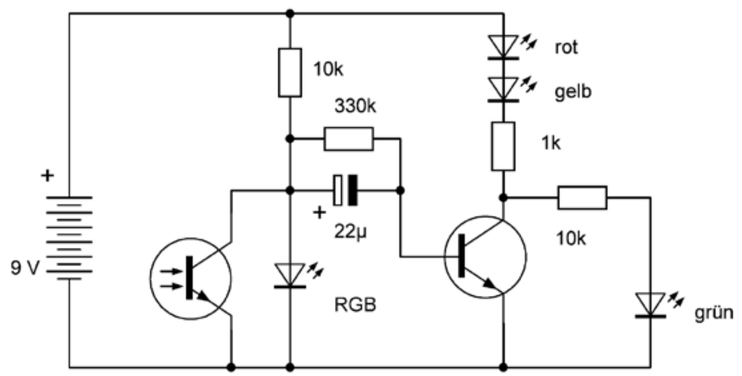
Attention!

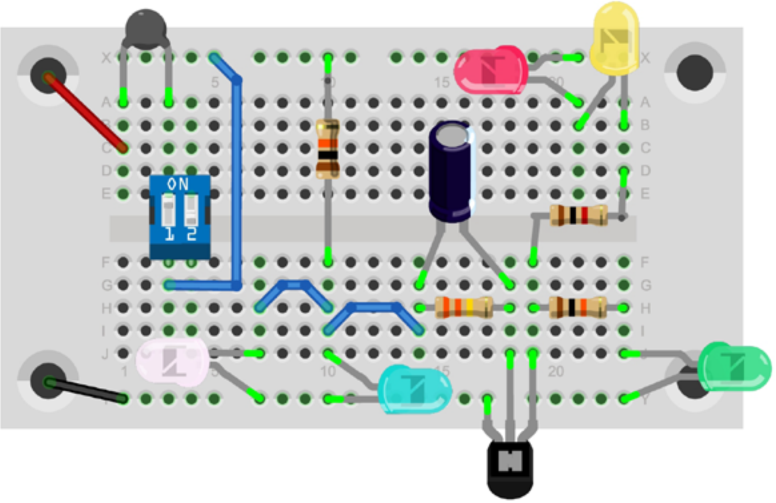
Do not look directly into the LED from a short distance when switched on! The blue light is particularly harmful to your eyes.

24 Four-way flashing light

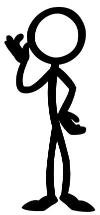
Behind the 24th door you'll find a resistor with only 1 kΩ (brown, black, red). It is used to achieve a larger LED current and more brightness. The circuit uses all LEDs together. All show a flashing flickering light controlled by the RGB LED and transistor. In addition, the photo transistor is built in to switch off the flickering at high brightness. With this, you can build a Christmas LED lamp that only becomes active in the dark. The lights look like sparkling stars and flickering candles.

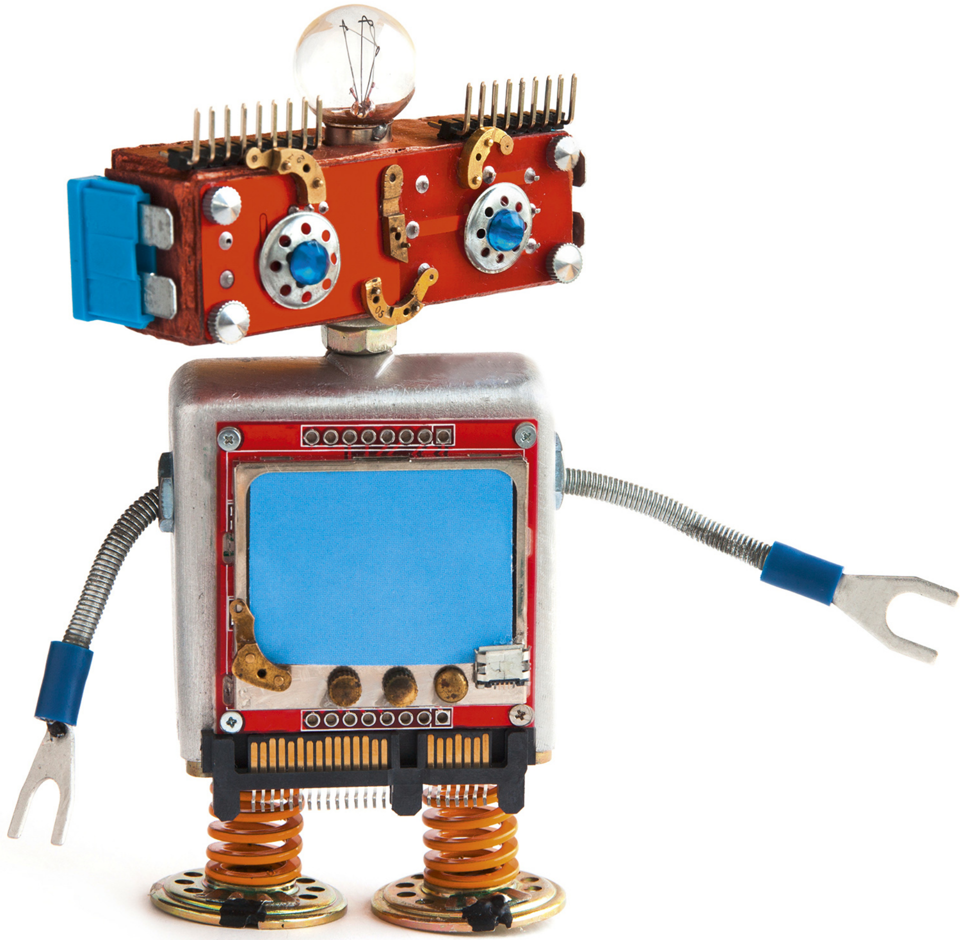
You have now completed so many experiments that you can easily implement your own ideas and requests for modification.





You know how to make a flash or a sound, how to change the LED brightness and much more. Take all components and continue experimenting with them. Maybe someday you'll invent new things.





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