

## Critical Making Box

# Light is Power

Build your own Flashlight  
and learn about the bright and  
the dark side of technology.

Age  
10+ | 1+



# TüftelAkademie



# Intro

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Critical making is a fun and creative way to think about solving problems and making things. It's all about using your imagination and creativity to come up with new ideas and designs. When you're doing critical making, you're not just making something for fun or for show. You're also thinking about the world around you and how you can make it better. You might come up with an invention that helps people, or a piece of art that makes people think about important issues.

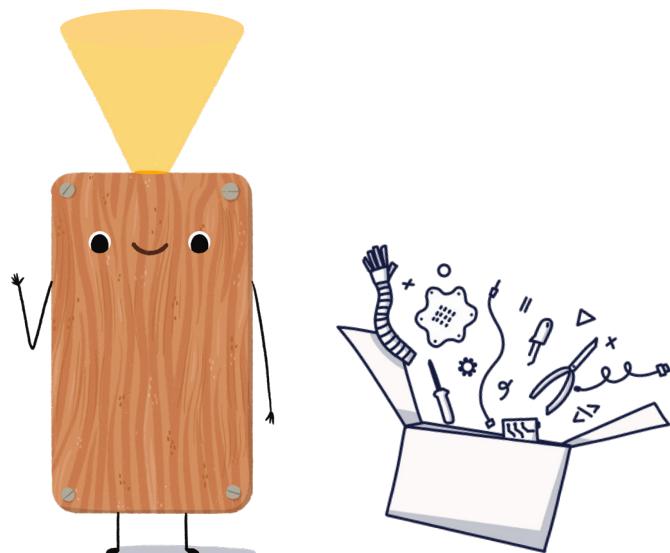
With this flashlight kit, we already created something for you to learn about critical making. Think about how important and powerful it is to have electric light available. But please don't stop there! The best part about critical making is that there are no rules! You can use any materials you want, and there's no right or wrong way to do it. You can experiment and try new things until you find what works best for you. The flashlight is just a starter.

So if you like to build, create, and imagine, critical making is the perfect way to put your skills to the test and make a difference in the world!

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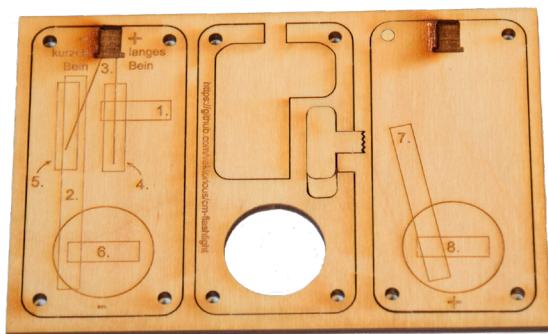
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# Instructions

## 1. The flashlight kit

Every great project requires parts, materials and tool. In the kit, we provide you with everything you need to build your flashlight. Unpack it and check if everything is there. You can find a list of material. Let's look at the different parts in detail.



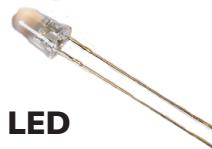
circuit board

4



copper band

not included and optional



LED



coin cell



4 screws



4 nuts

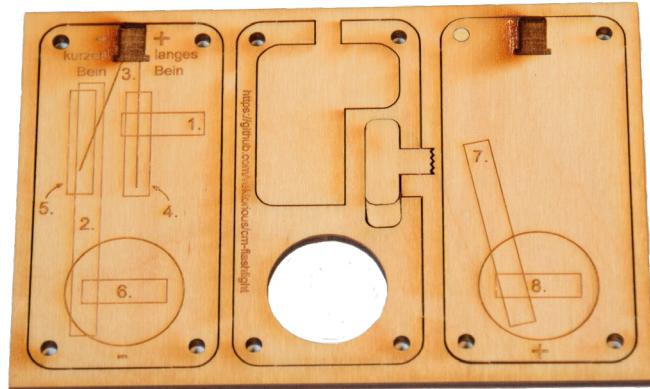
# Instructions

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## 2. What is a circuit board?

A (printed) circuit board (PCB) is a substrate which carries and connects electronic components. Today, PCBs can be found in almost all electronic products. Have you already seen a PCB? They are usually green, hold many tiny components and have lines connecting them.

For our flashlight we use a laser-cut wood parts as baseboard. But there is something else, we need to turn it into a circuit board ...



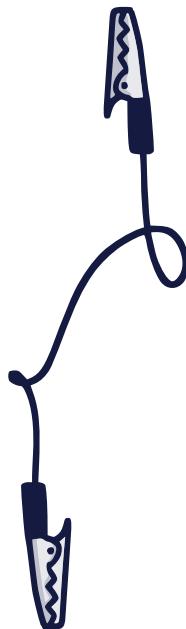
## Instructions

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### 3. What is the copper tape for?

Yes, you are right. We need something to create electric connections between components on the board. On a PCB, the connections are created by thin lines of copper. We will use copper tape to create the circuit on our board.

Now let's have a look at the components, we need to connect. It's like a cable!



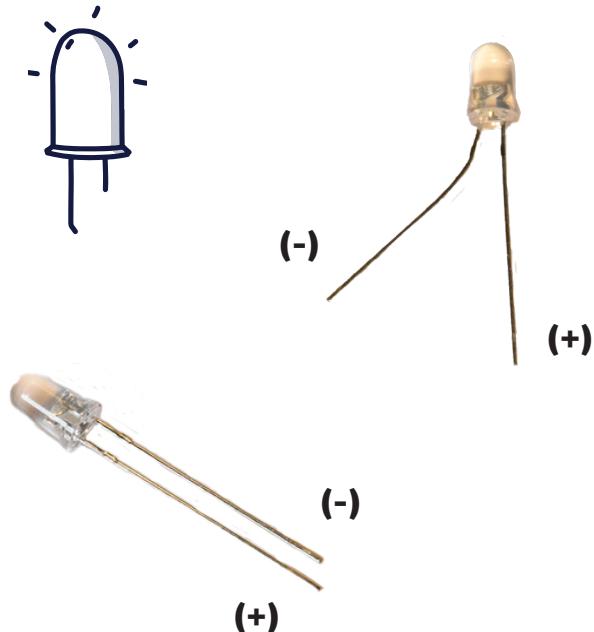
# Instructions

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## 4. What is an LED?

You probably already heard about LED lights. LED is short for light-emitting diode, a component which can turn electric energy into light. LEDs are a great invention because they are much more energy efficient. They consume more than ten times less energy, to produce the same brightness as old light bulbs. They are also much smaller and easier to use.

We also use a white LED for our flashlight. It looks like a small bulb with two legs. It only produces light if the current flows through it from one direction. The lengths of the legs are different, so you know which side is which. The way you put the LED in is called the „polarity.“ That just means there's a positive (+) and a negative (-) end to the LED, and you need to connect them to the right parts of the device you're using. We will show you how to connect the LED in your flashlight in a later step.



# Instructions

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## 5. What is a coin cell?

A coin cell is a small, round battery that looks like a coin or a button. It's called a coin cell because it's shaped like a coin, and it's flat, like a cell. They are used in many small devices, like watches, remote controls, and some toys.

The battery works by storing energy inside of it. When you use a device that has a coin cell, the energy from the battery powers the device, so it can do its job. In our case, it lights up the LED of the flashlight.

Like an LED, a battery also has a polarity, a positive (+) and a negative (-) side. On coin cells, usually only the positive side is marked with a “+” sign.



# Instructions

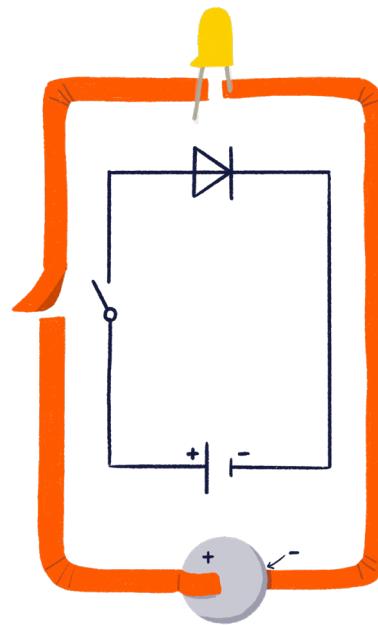
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## 6. What is an electric circuit?

Let's bring everything together: An electric circuit is a path that electricity can flow through. It's kind of like a river bed in which the water flows, but instead of water, it's electricity that's flowing along the path. A circuit is made up of a few different things. There's a power source, which in our case is a coin cell, that gives the electricity energy. There's also something called a load, which is a device that uses the electricity. Here we use the LED as load.

Finally, there are wires (in our case, copper tape) that connect the power source and the load together. Think of the wires like the river bed that the electricity travels in.

When everything is connected in the circuit and the wires make a complete path, the electricity can flow from the power source to the load. We can use a switch to connect and unconnect the circuit. This is how we can turn our flashlight on and off.

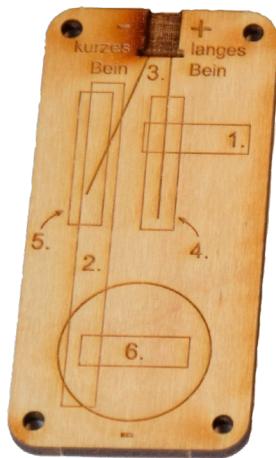


# Instructions

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## 7. Let's start building!

Remove the wooden parts from the frame. You need the four parts, which you can see here. You can scrap the leftover parts and the frame, or better recycle them in a future project.

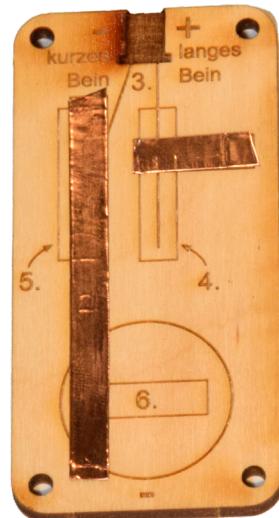


# Instructions

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## 8. Copper tape 1

Now we will begin to prepare the electric connections by sticking the copper tape to the boards. The size of the copper tape pieces you need are indicated on the wooden part. Let's start with the bottom piece. It's the one with the most markings. Either tear or cut off pieces from the copper tape and attach them at position 1 and 2. The copper tape is self-sticking, and you just have to remove the protective foil. Sometimes this can be a bit fiddly and the copper tape sometimes tends to curl up, so take your time. When you successfully attached the tape to the wood, stroke along it and firmly press it onto the wood to make sure it sticks properly and is flat.

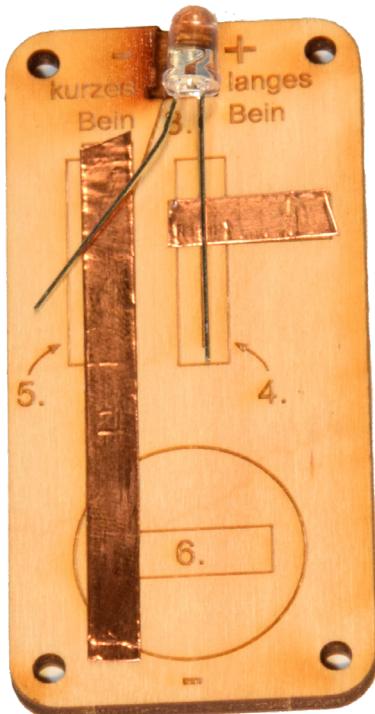
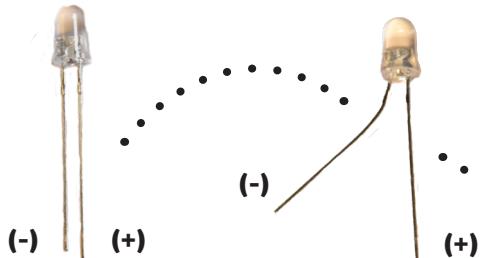


# Instructions

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## 9. Add the LED

The LED has two legs with different lengths. The long leg is positive (+), the short leg negative (-). Slightly bend the short leg like it is indicated on the wood part. Now place the LED on the wood (3) and press the legs down on the copper tape, from the previous step. Now fix both legs with additional copper tape (4 & 5). Pay attention to the markings on the wood, there should be no connection between the two legs of the LED.



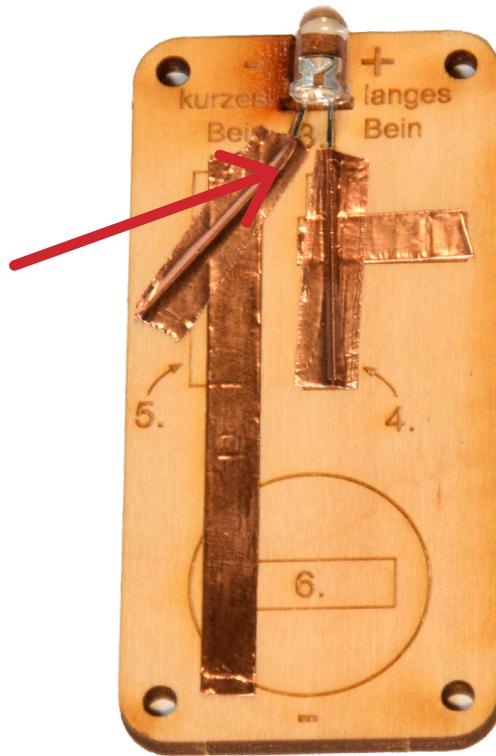
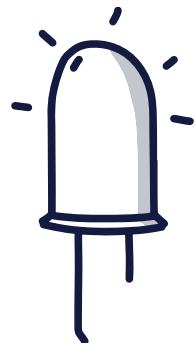
# Instructions

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## 10. Copper tape 2

This one is easy: Just put some copper tape on position 6. It will connect the negative (-) side of the battery to the negative leg of the LED.

**Important:** There should be no connection between the two legs



# Instructions

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## 11. Copper tape 3

Continue with the lid and put copper tape on position 7 and 8. It will connect the negative (-) side of the battery to the switch.



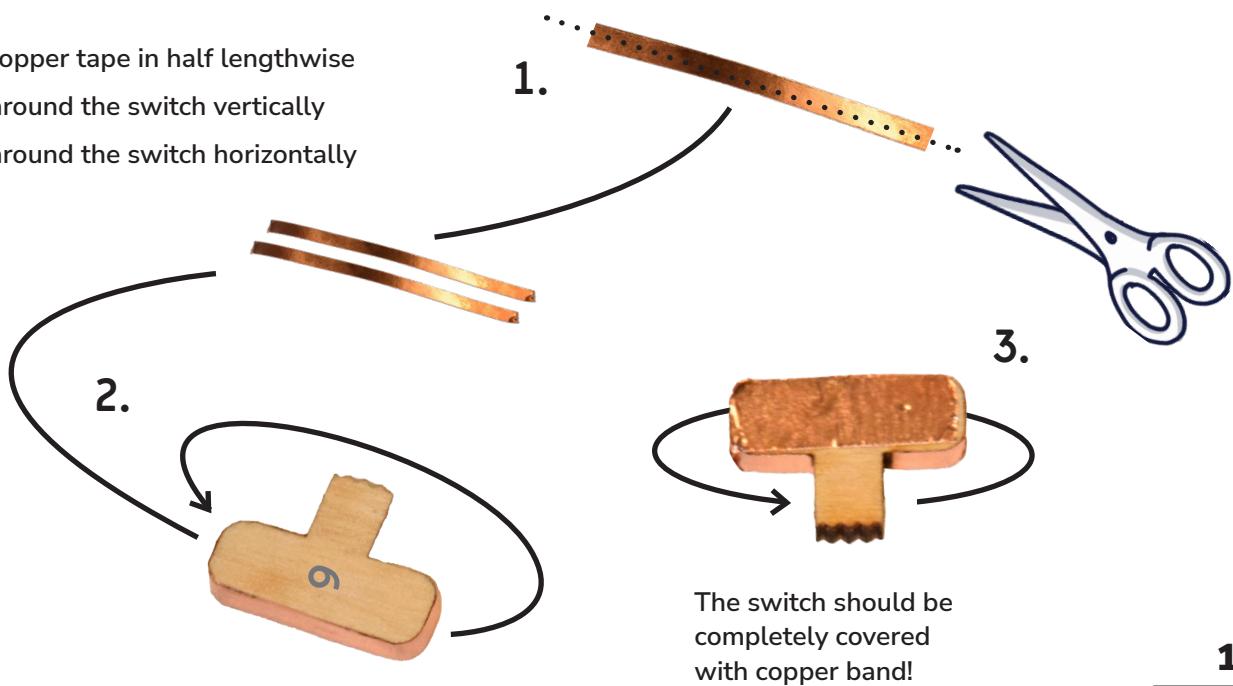
## Instructions

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### 12. Copper tape 4

Now let's prepare the switch. Wrap copper tape around it (9) so you don't see the number marking anymore.

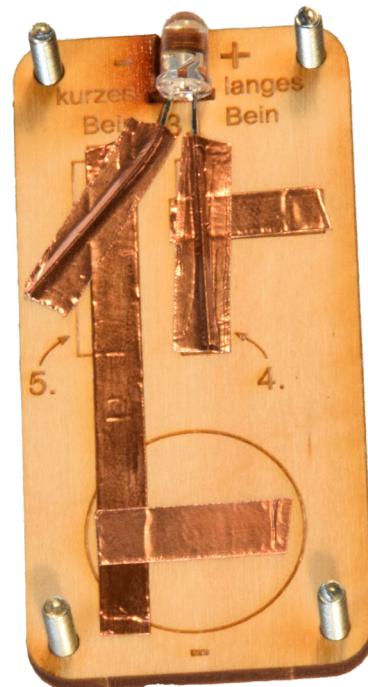
1. Cut the copper tape in half lengthwise
2. Wrap it around the switch vertically
3. Wrap it around the switch horizontally



## Instructions

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### 13. Insert screws into the ground plate



## Instructions

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### 14. Put the middle part on top



# Instructions

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## 15. Put in switch and coin cell

Put the switch and the battery in their places. The positive side of the battery (marked +) should face you.



# Instructions

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## 16. Put the lid on it

Finally, add the lid and screw the nuts on the screws. Don't fasten them too much because it will make it harder to move the switch.

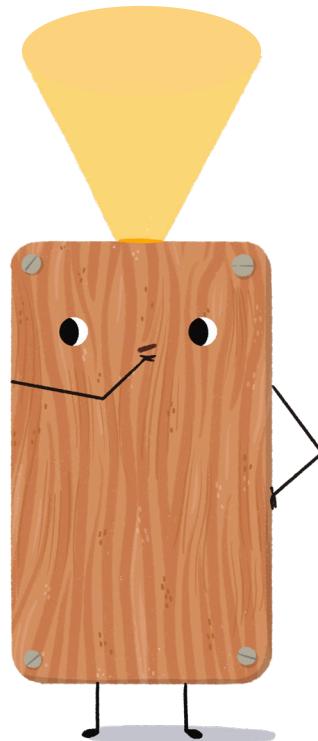


# Instructions

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## 17. Testing

Now your flashlight should already work. Don't worry if it doesn't! Troubleshooting is fun and we have a full guide for you at the end of this tutorial.

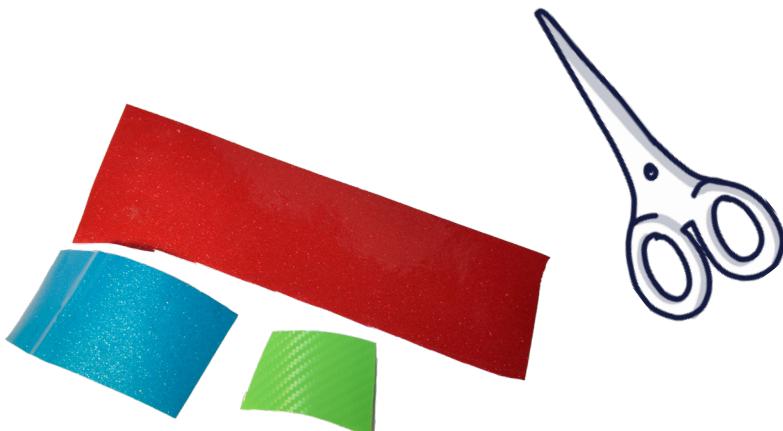


## Instructions

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### 18. Decoration!

Well, the flashlight looks a bit plain, doesn't it? Go ahead and decorate, modify and improve it with whatever you find. We put some sticker foil into the box as a starter.



# Instructions

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## 19. Troubleshooting

### The flashlight doesn't light up:

- Check orientation of the coin cell

- Check the orientation of the LED (long and short leg) ?

If the orientation of the LED is wrong, don't remove it. Just change the orientation of the coin cell (turn it around) so it matches the LED.

- Are all (copper tape) connections solid?

There are usually loose connections at the LED. Press the copper tape firmly onto the wood and streak along it with your finger nail. You can use a piece of metal (e.g. unfolded, unpainted paperclip) to bridge connections to see which connection might be faulty

- Check for a short circuit

Especially the place between the LED legs is prone to short circuits.

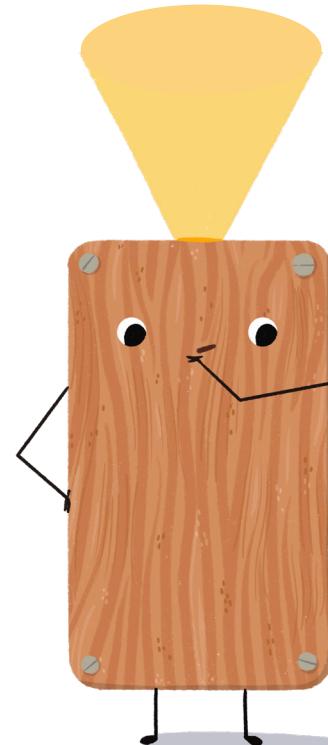
Check if there is any connection between the two legs.

### The switch is hard to move:

- Try to loosen the screws a bit. But not too much, they should not fall apart.

- If there is too much copper tape on the switch, it can get stuck.

Flatten it with pressure or remove overlapping tape.



# Imprint

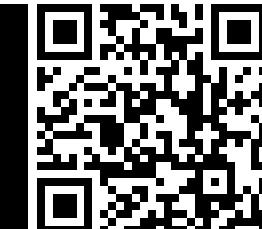
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This box was developed as part of the Critical Making Project ([criticalmaking.eu](http://criticalmaking.eu)). The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 101006285.

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**Source files are available online:**



<https://github.com/vektorious/cm-flashlight>



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