The Book of Awesomeness

Making music with pencil and paper
& other exciting experiments!

An initiative by Nirman Dave & Sohil Patel
from *FabLab CEPT, India*.

What's this?

Today, electronic circuits are build using circuit boards, thin copper stickers or thick copper wires. But what if you can build a circuit using just your pencil and paper?

Papertronics is one such initiative where we encourage everyone to build something innovative. No matter how complex an item looks, we believe that it should be simple inside.

With Papertronics we introduce one such innovative idea which is born from simple high school physics. In this idea, we will be able to light up an LED, create some awesome music, create an-auto controlled toy plane, design extra-ordinary games, etc. All of this using pencil and paper!

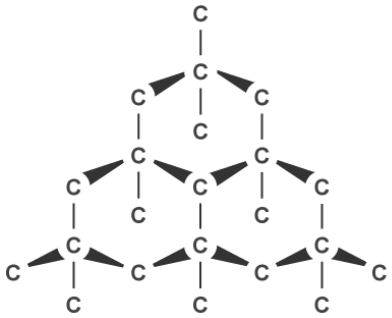
Papertronics was exclusively presented at MIT's FabLab Fab10 festival in Barcelona, Spain held on 2nd July to 8th July 2014 by Nirman Dave and Sohil Patel, members of FabLab CEPT, India.

Scientific blabbering

So how does this drawing thing work?

Well, when we use a pencil to draw out lines, we are actually drawing wires! So, we are drawing out copper wires with pencil and not having them physically.

This is because, the pencil contains graphite. Graphite is made almost entirely of carbon atoms. It has a hexagonal structure, and carbon atoms form double bonds with other carbon atoms. The Lewis structure of these bonds manifest to the fact that there are free electrons present in the carbon-carbon bond. These free electrons illustrate graphite's property of high electrical conductivity and low resistance.



With this property of graphite, we can allow the passage of electricity through paper by drawing lines of graphite with pencils. These dark, shaded lines will act as circuit wires, hence allowing you to create complex circuits just by drawing lines on paper!

Using this booklet

This booklet designed to make you feel more comfortable and easy while experimenting. Here is what journey will look like.

Consisting of two columns, the left column will give you instructions and the right will show tutorials for T1 to T4 levels. As you reach level 4, tutorials will be gone, and you will face real challenges. I won't say much, have a look.

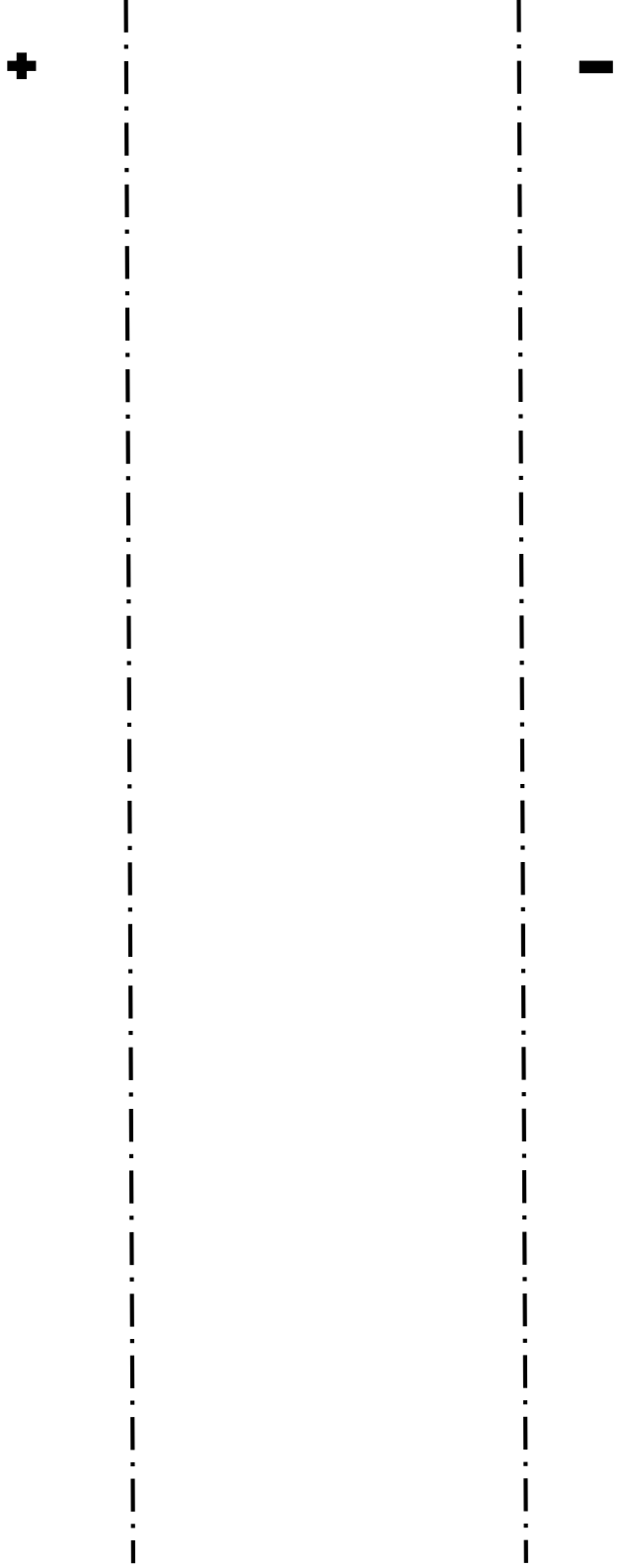
Instructions & challenges	Tutorials & workspace

Level #T1

Simple LED test

In this tutorial, all you have to do is trace the path given on the right with pencil. Make it dark. Then attach the crocodile clips connected to a 9V battery on one end and a LED on the other end. Make sure you don't mess up the positive and negative terminals!

Try checking what happens when the distance between the LED and battery decreases. By moving the LED in different positions. Then note down your observations below.

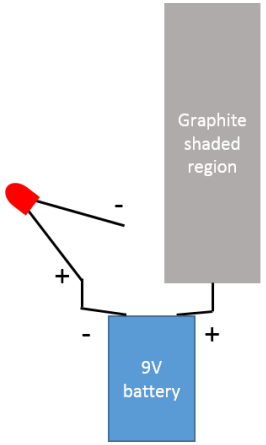


Level #T2

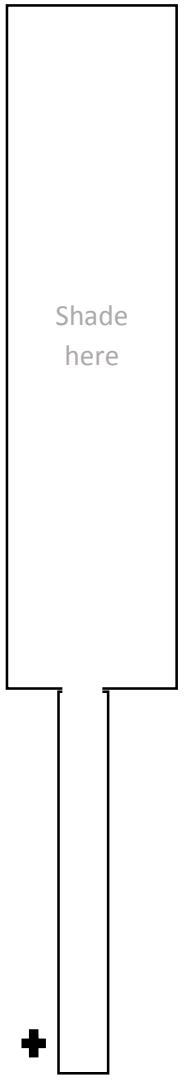
Variable resistor

In this tutorial you will have to create a variable resistor. Don’t worry, all you have to do is pick up your pencil and fill up the block in the left.

Then attach the positive terminal of the crocodile clips connected to a 9V battery on one end of the block, name it origin. And the negative terminal to the positive terminal of the LED. And let the negative terminal of the LED be free.



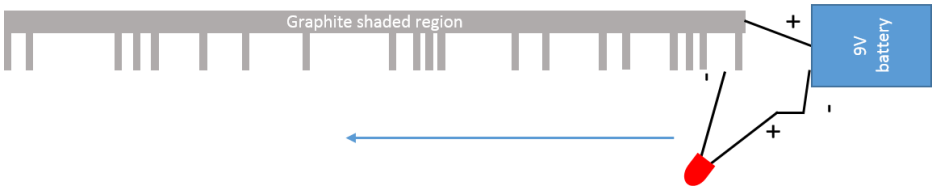
Then pin the negative terminal of the LED on one end of the block and vary its distance from the origin. This will affect the brightness of the bulb, hence creating a variable resistor, with just pencil and paper!



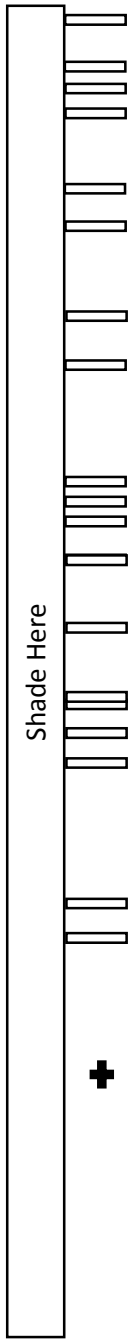
Level #T3

Disco lights

This tutorial will teach you how to make your own disco lights. All you have to do is add small lines/dots to the circuit shown in level 3. And then pass the LED over those lines.



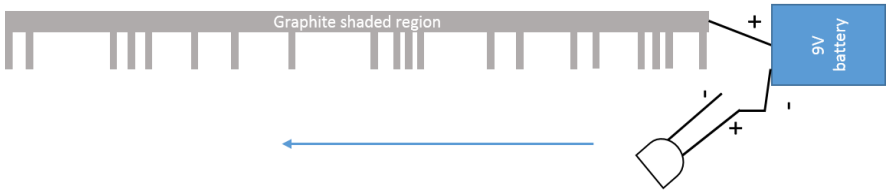
The concept remains simple, when the negative terminal of the LED comes in contact with the graphite line. It glows up, however, when not in contact it does not glow. When this LED is slides through the graphite lines, a continuous pattern of on and off is shown. And your disco light has been made! Use the template on the right to create your own LED disco light.

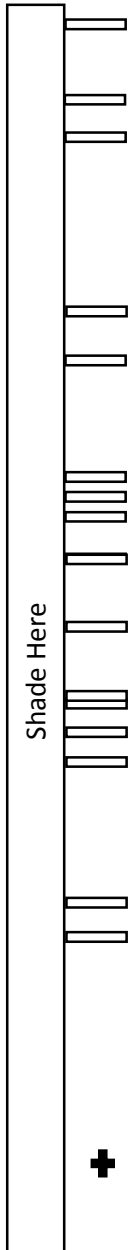


Level #T4

Making music with pencil and paper

The design remains the same as it was in level 3. All you have to do is attach a buzzer instead of the LED. Hence the buzzer will buzz each time it passes over a graphite line. Later rearrange the graphite lines to buzz the buzzer at given points. Hence creating music.





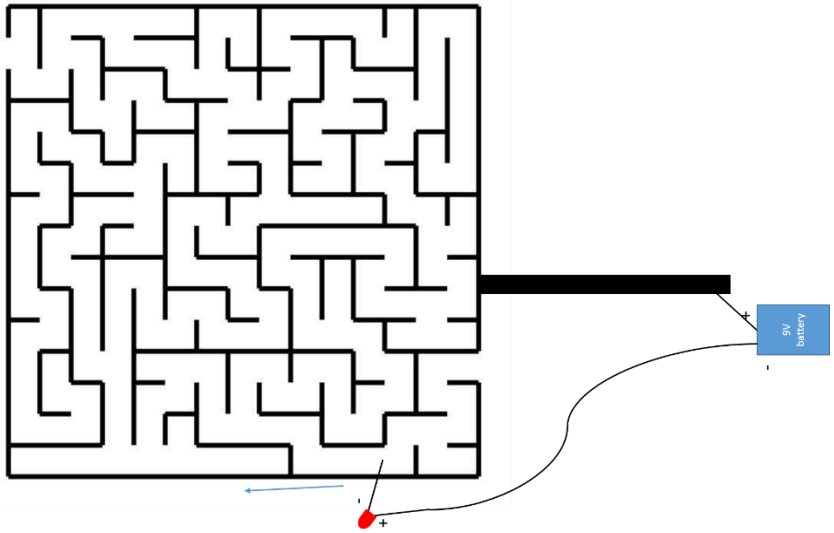
Level #C1

Lost in the maze

Until now you have only encountered T levels, which were simple tutorials with templates. This is the first C level, this level introduces new challenges and allows your creativity to fly.

This level is all about creating your own maze game. Using the same concept, draw simple pencil lines and pass the LED pin through it solving the puzzle. Make sure it doesn't touch the graphite line. If it does, the LED glows up and you are dead!

Your challenge is to use the workspace on the right to create your own maze game. The circuit is similar to the ones displayed in tutorials, however have a look at the picture below for reference.



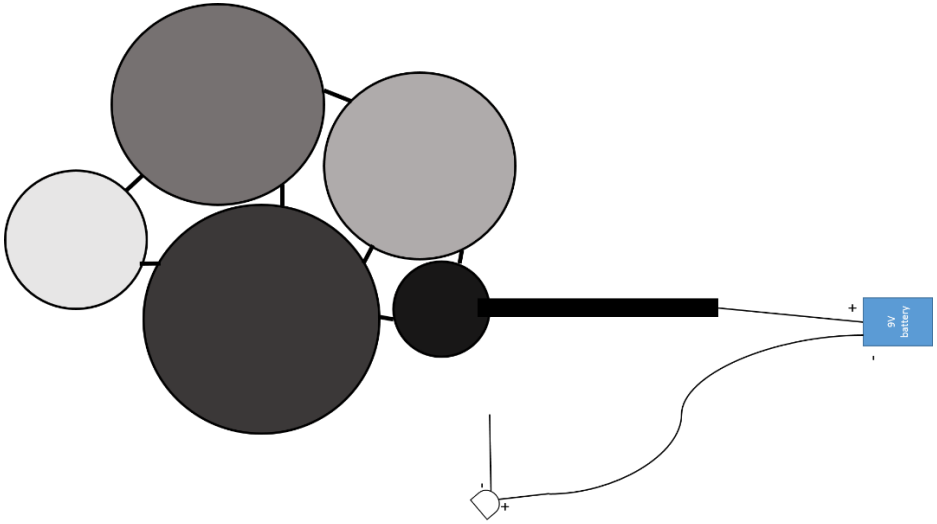
Workspace area

Level #C2

Buzzing drums

Well, besides making music from buzzers u can make drums too! All you have to do is make different connecting circles and shade them with pencil. Every circle has a different shade, leading to different electrical conductivity and hence different sounds!

Your challenge is to create your own drums using the workspace area on the right. The circuit is similar to the ones displayed in tutorials, however have a look at the picture below for reference.



Workspace area

Level #C3

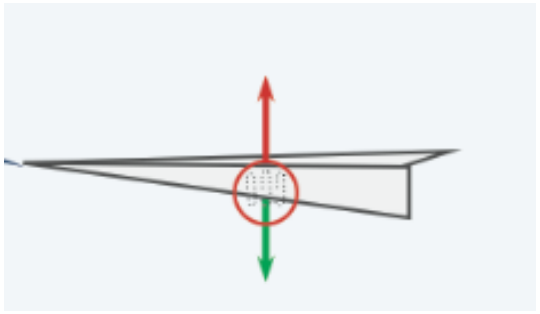
Automated paper plane

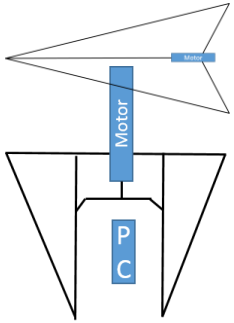
We all know how to make paper planes. But how about u attach a motor behind the plane, using pencil cells and graphite lines instead of wires!

A motor is attached at the end of the plane. The motor is connect to a pencil cell using a graphite line. When a u-pin is added beneath the paper plane the lines touch the pencil cell, completing the circuit and hence powering the motor. Allowing plane to fly! [You will need a *micro helicopter motor* only]

With such an embedded circuit in the paper plane, your plane will be able to fly more efficiently and smoothly. Bur keep in mind, **your challenge is to create such am embedded circuit using a motor, pencil cells, pencil and paper.**

Here is a supporting diagram to give you a brief idea.





Workspace area

Endless possibilities

The book may end here but Papertronics has endless possibilities. Use your creativity and try making something new! Hope you enjoyed the idea.

Best of luck & keep it *creative*!

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Created for the FabLabs

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