ZEPHYR

More Than Just Play

Blix™

E-CIRCUITS LIGHT

- LIGHT SENSOR
- SAFE AND INTUITIVE
- EXPLORE RESISTORS
- EASY CONNECT

AGE 6-14

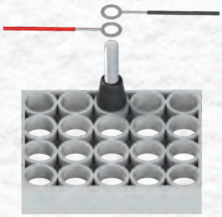
18 COMPONENTS

12 EXPERIMENTS

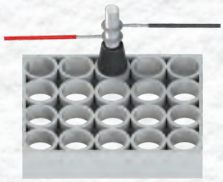
IMPORTANT INSTRUCTIONS

How To Connect

Fix connecting tower on the baseboard



Slide loops of wires you want to connect



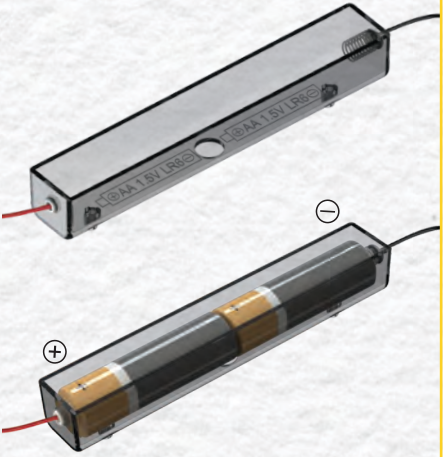
Connection completed!

Useful Tips

- Most circuit problems are due to incorrect assembly, so always double check that your circuit exactly matches the diagram.
- Always connect the battery in the end, after you have connected all the other components properly and check all the connections before turning on a circuit. This ensures that no component is damaged if the circuit is accidentally connected in a wrong manner.

Safety Guidelines

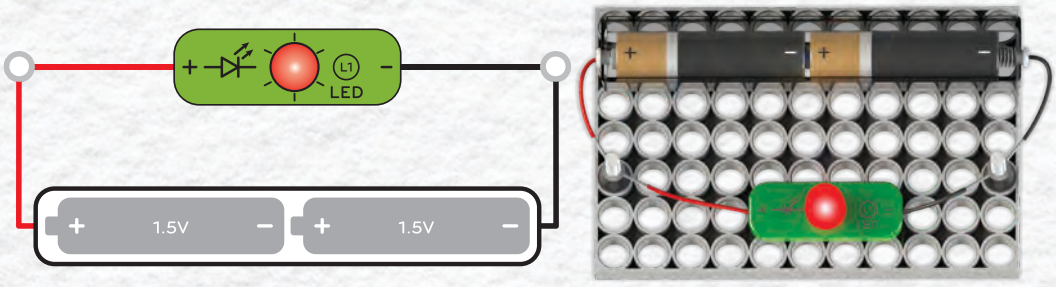
1. Do not mix old and new batteries.
2. Do not mix alkaline, standard (Carbon-Zinc) or rechargeable (Nickel-Cadmium) batteries.
3. Batteries are to be inserted by matching (+) and (-) polarity markings as shown in the image.
4. Non-rechargeable batteries are not to be charged.
5. Rechargeable batteries are to be removed before being charged.
6. Exhausted batteries are to be removed from kit.
7. The supply terminals are not to be short- circuited.
8. The kit is not intended for children under 6 years old.
9. Remove batteries before cleaning any part of the kit.
10. Never leave a circuit unattended while batteries are installed.
11. Never connect additional batteries or any other power sources to your circuits.



Add 2 x 1.5 V "AA" size batteries

Let's Make Our First Circuit!

- Attach the LED, Battery Box (WITHOUT batteries) & Connecting Towers to the Base Board.
- Connect the Red wire of the battery to the Red wire of the LED with the help of the Connecting Towers. Do the same for the Black wire.
- Double check with this image and connect EXACTLY as shown:



- Now insert the Batteries in the Box as indicated in the image. See the LED light up?
- Congratulations! You have just made your first circuit!

Did not work?

- Don't worry, it is common in electronics for things not to work because of tiny errors. Just check if all the wires are firmly connected & are connected as per the directions above. Also make sure the batteries are new and are inserted correctly in the box. Your circuit should work now!

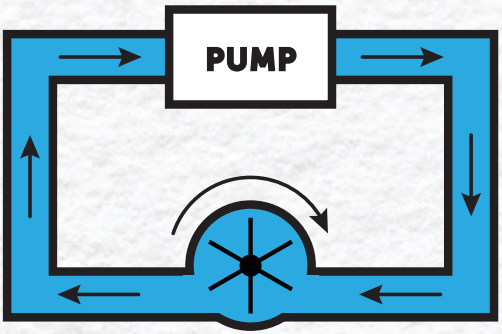
Keep in mind!

- Remember all the steps that we followed here to make and check the circuit. These will be very helpful in making the other circuits in this book work quickly!
- Once you are confident and are able to make connections properly in the first go, you can connect the battery box with batteries from the start. But for the first few circuits, follow above steps to ensure no component gets damaged.

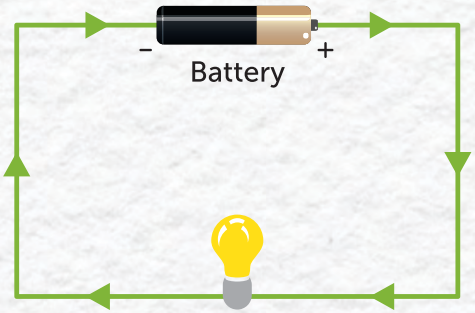
What Is An Electric Circuit?

An electric circuit is like a path for electricity. A circuit is completed when two terminals ("+" & "-") of a battery are connected through a wire or any other conducting material. When this happens, the electricity starts flowing from "+" to "-" terminal of the battery.

You can think of the battery as a water pump and the wire like a water pipe. The battery pumps electricity into the wire from one terminal to the other.



Water wheel



Bulb

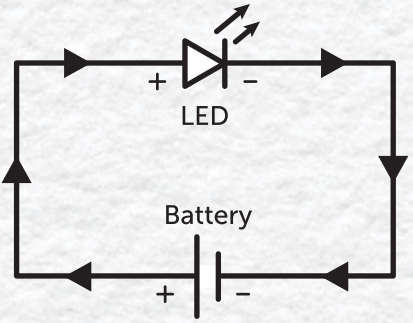
Thus battery is the "power source" that is required in every electric circuit. The components connected in the circuit make use of this power. For example a bulb glows by using power from the battery just in the same way as a water wheel will rotate by using the power of a water pump!

Just remember this!

- If you want to check whether a circuit is complete or not, look for a continuous path from the '+' to the '-' terminal of a battery!

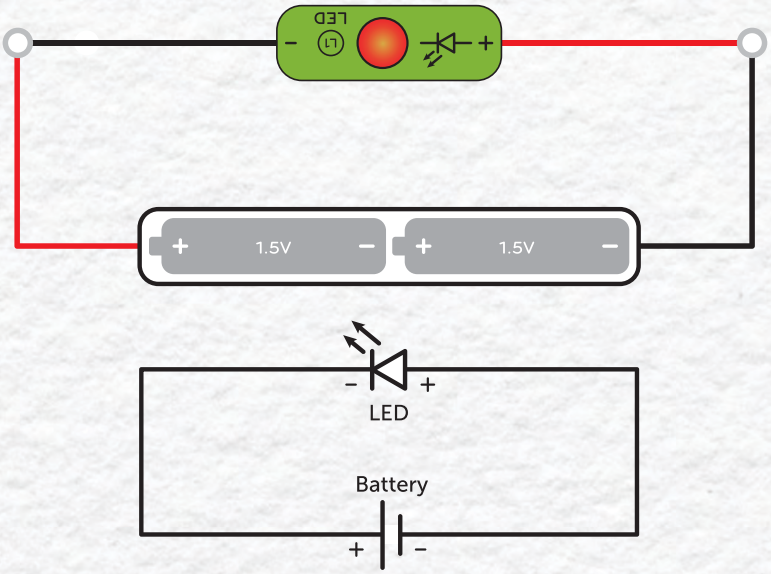
Circuit Diagrams!

- Engineers use "Circuit Symbols" to represent circuits in a concise way. The diagrams made using these symbols are called "Circuit Diagrams".
- Can you identify the components from this diagram?
- Can you now relate the previous circuit to the water diagram and this circuit diagram?



Led in Reverse!

- Connect the LED & Battery Box as shown here. Notice that the LED is connected in an opposite way this time, with its black wire connected to battery's red wire and red wire connected to black!
- Then insert the batteries in the box.



- Did the LED glow this time? That's because LED is a "polar" component!

Red, Black & Blue!

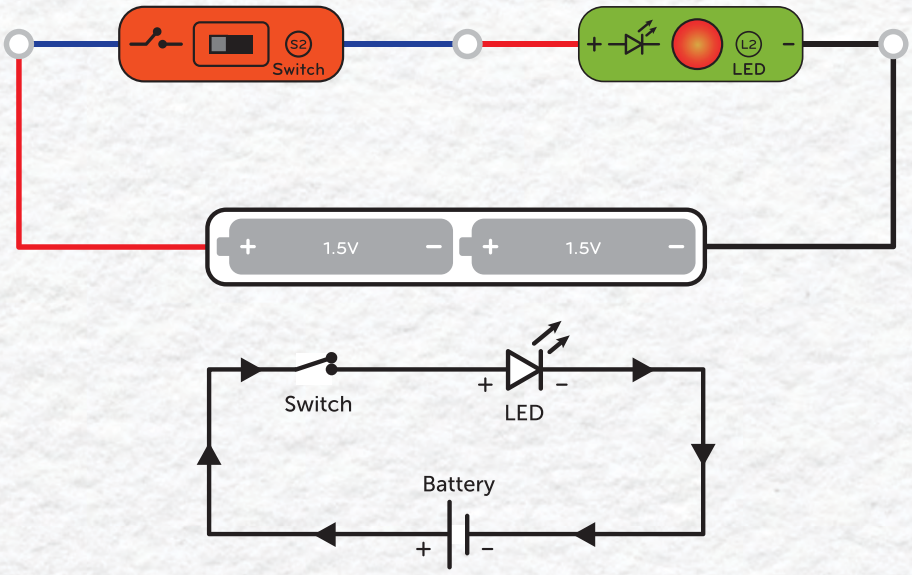
- The + & - signs on the components (denoted by red & black wires) are actually referred to as "Polarities". This means that the component is not uniform and will behave differently when connected in one way & differently in the other!
- The components with blue wires are non-polar and can work in any direction!

Light emitting diode

- LED stands for Light Emitting Diode. "Diodes" are special components similar to valves, that work properly only if connected in the "forward" direction i.e. when the electricity enters at the +/red and leaves at the -/black terminal!

Light Switch

- Connect the Slide Switch & LED as shown. Set the Switch to OFF position.
- Then connect the battery.



- Now turn ON the switch to light up!
- Did you figure out how the connections worked here to complete the circuit? How did the Switch magically make & break the circuit?

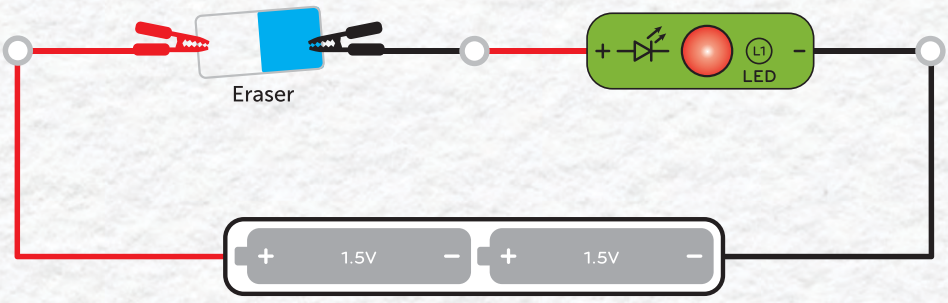
Open & closed circuits

For a circuit to be complete there should be a continuous path for electricity from one battery terminal to the other. Even if one terminal is disconnected, the circuit will be incomplete and called an "Open Circuit". A completed circuit is called a "Closed Circuit".

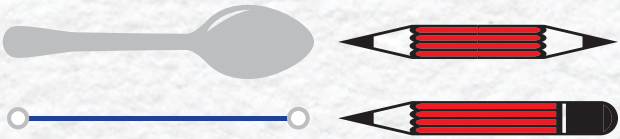
A Switch helps you open & close circuits with ease by connecting & disconnecting the terminals. Think of it just like a water tap!

Conductor Tester

- Connect the Clip Wire and LED as shown.
- Then connect the battery.
- Try connecting different things like spoons, erasers, pencils, pencil sharpened from both ends, wire, wire's outer covering etc. between the 2 clips.



Also try connecting these objects between the clips



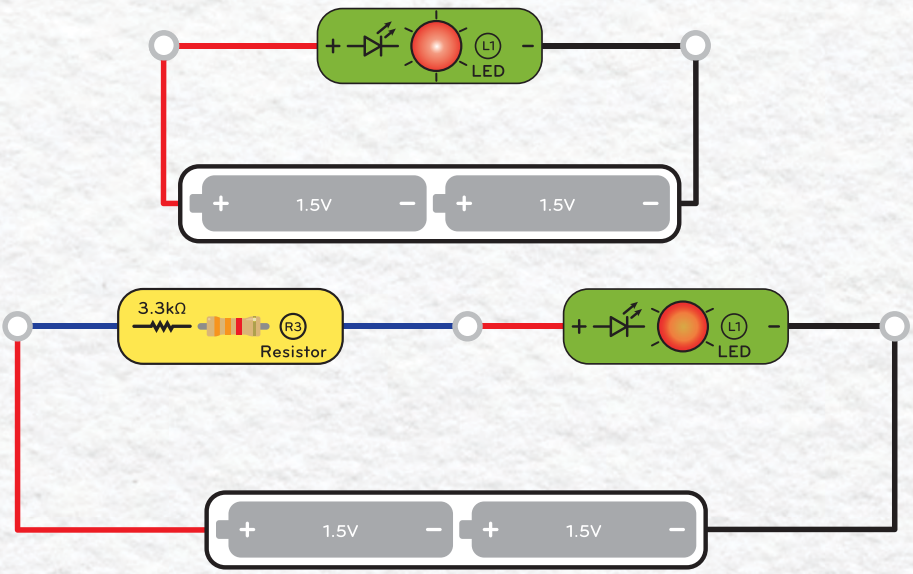
- What did you observe? Did the LED glow for all the materials?

Conductors & Insulators

- Conductors are materials that allow electricity to pass easily whereas Insulators don't. So, when you connected a conductor between the clips, the circuit got completed but for an insulator it remained open and so, the LED didn't glow!
- In general, metals like iron, copper, gold etc. are conductors where as non-metals like wood, rubber, plastic etc. are insulators.

Brightness Under Control!

- First connect the LED & Battery as shown in the 1st diagram below. Note the LED's brightness.
- Now add the 3.3kΩ (R3) Resistor to the circuit as shown in the 2nd diagram.



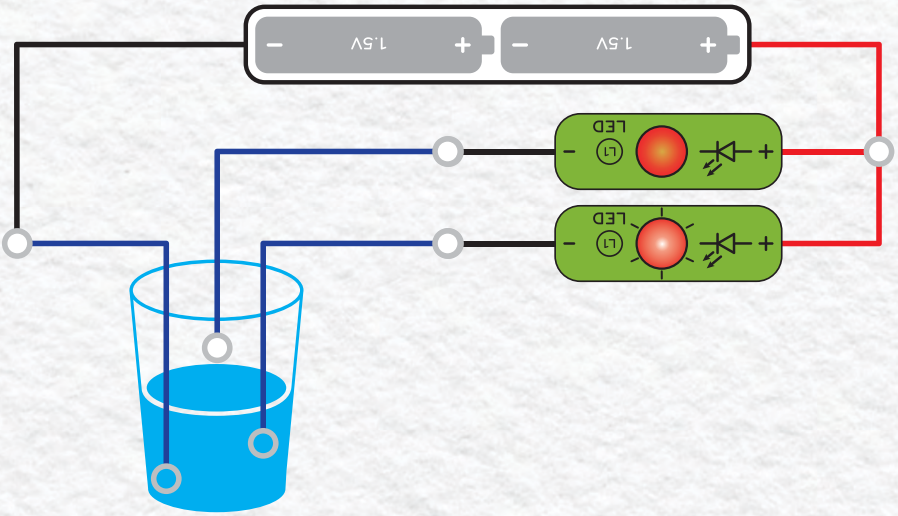
- The LED will still glow but its brightness would have decreased a bit after connecting the resistor.

Resistance & Resistors

- Resistance is the phenomenon of opposing the flow of electricity. Ohm (Ω) is the unit of "Resistance", in the same way as metre is the unit of length. Just like 10 km, 10 kΩ means 10,000 ohms of resistance!
- Every material or component has some value of resistance. Conductors have very low resistance and insulators have very high resistance.
- Resistance is not always bad; in fact it is very important in electronics because it allows us to control the flow of electricity. That's why Resistors have a specific resistance value that can be added to a circuit to precisely control electricity!

Water Level Indicator

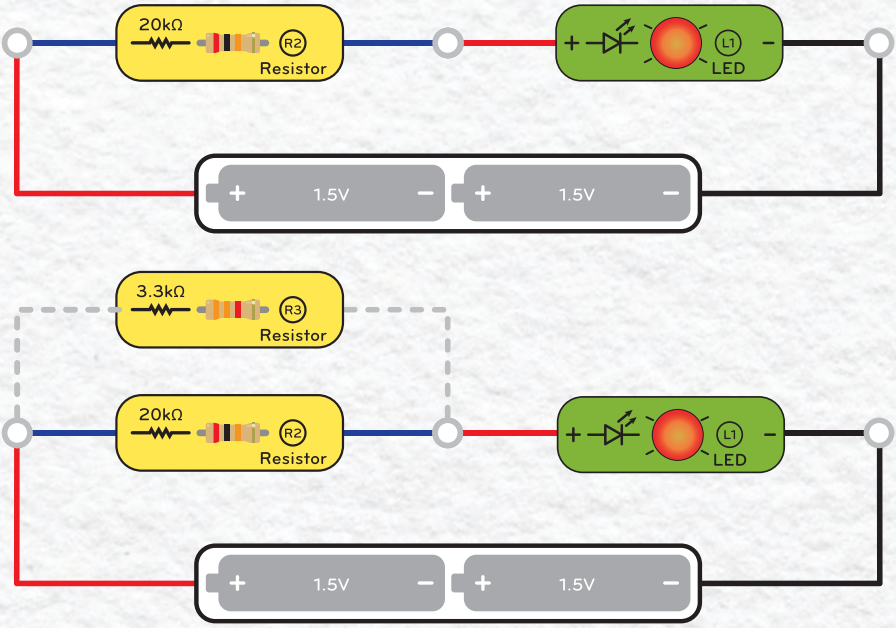
- Do you know that regular tap water is a conductor of electricity? This is because tap water generally contains a few minerals that allow small amounts of electricity to pass through. This means that tap water will also "close" the previous circuit and cause the LED to glow! We are going to use exactly this concept to make a cool water level indicator!
- Connect the LEDs, Jumper Wires and the Battery as shown. Use a dark room for this experiment.
- Here the Jumper Wires will act as a switch in the same way as the Clip Wires.
- Now tape the Jumper Wire pairs to the glass at 3 different depths as shown. The jumper connected to –ve goes at the bottom, one jumper at around middle depth and the other one near the top.



- Slowly start pouring tap water.
- As soon as a particular Jumper Wire pair comes in contact with water, it completes the circuit and the corresponding LED will glow. This way you can tell the level of water from the number of the LEDs!
- Now you would have understood why one should not touch electric appliances or switches with wet hands, to prevent us from getting a shock!

Resistors In Parallel

- Connect the 20kΩ (R2) Resistor, LED & Battery as shown.
- Now connect the 3.3kΩ (R3) Resistor besides R2 as shown.



- Did you observe that the brightness of the LED is increasing?
- This is because we are connecting the Resistors in "Parallel"!

Parallel Connections

In electronics, Parallel connection means that components are connected side by side such that electricity has multiple parallel paths to flow. If any component is removed or damaged, other paths aren't affected! Our homes use parallel connections, so when you turn off the lights, the fans don't switch off!

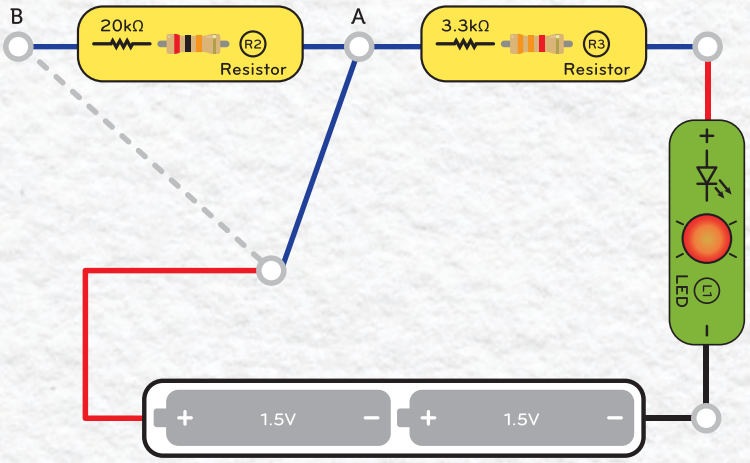
For Resistors, the Net Resistance decreases in parallel connections and becomes lower than the least value of Resistance. So, when R2 & R3 got connected in parallel the total resistance R would be:

$$\frac{1}{R} = \frac{1}{R2} + \frac{1}{R3} = \frac{1}{20k\Omega} + \frac{1}{3.3k\Omega} \qquad \therefore R = 2.83k\Omega$$

so, connecting these 2 resistors in parallel is equivalent to connecting a 2.83kΩ resistor, causing brightening the LED!

Resistors In Series

- Connect the LED, 3.3kΩ (R3) & 20kΩ (R2) Resistors as shown.
- Now connect the Battery and Jumper Wire exactly as shown.
- Connect the Jumper Wire first to A, and then to B as shown.



- Did you observe that the brightness of the LED is decreased?
- This is because we are connecting the Resistors in "Series"!

Series Connections

In electronics, Series connection means that components are connected one after the other in a line such that electricity has only one path to flow. If any one component is removed, the circuit gets opened and no electricity can flow!

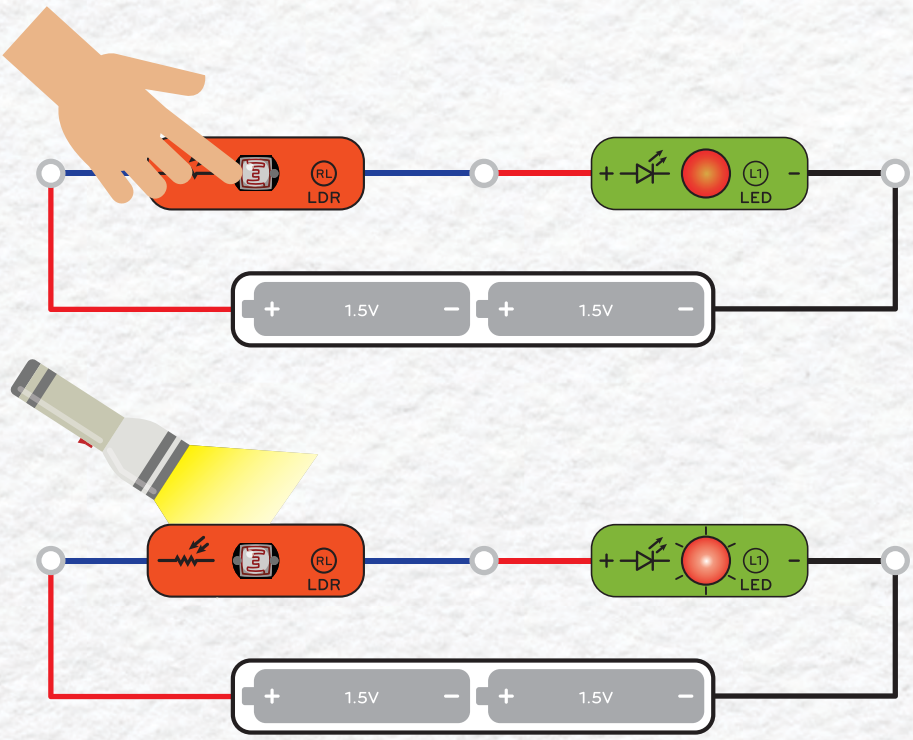
For Resistors, the Net Resistance adds up in series and the total resistance R would be:

$$R = R2 + R3 = 20k\Omega + 3.3k\Omega = 23.3k\Omega$$

so, connecting these 2 resistors in series is equivalent to connecting a 23.3 kΩ resistor, causing dimming the LED!

Light Controls Light!

- Make sure that you are in a well lit up place. Avoid a dark room for this project.
- Connect the LDR, LED & Battery as shown.



- Now slowly bring your hand closer to the LDR. Whoa! the LED goes dim!
- Throw some light, by a torch or phone's flash, on the LDR. The LED goes bright!
- You can also try switching your room's lights on and off!

This awesome phenomenon happened due to the LDR!

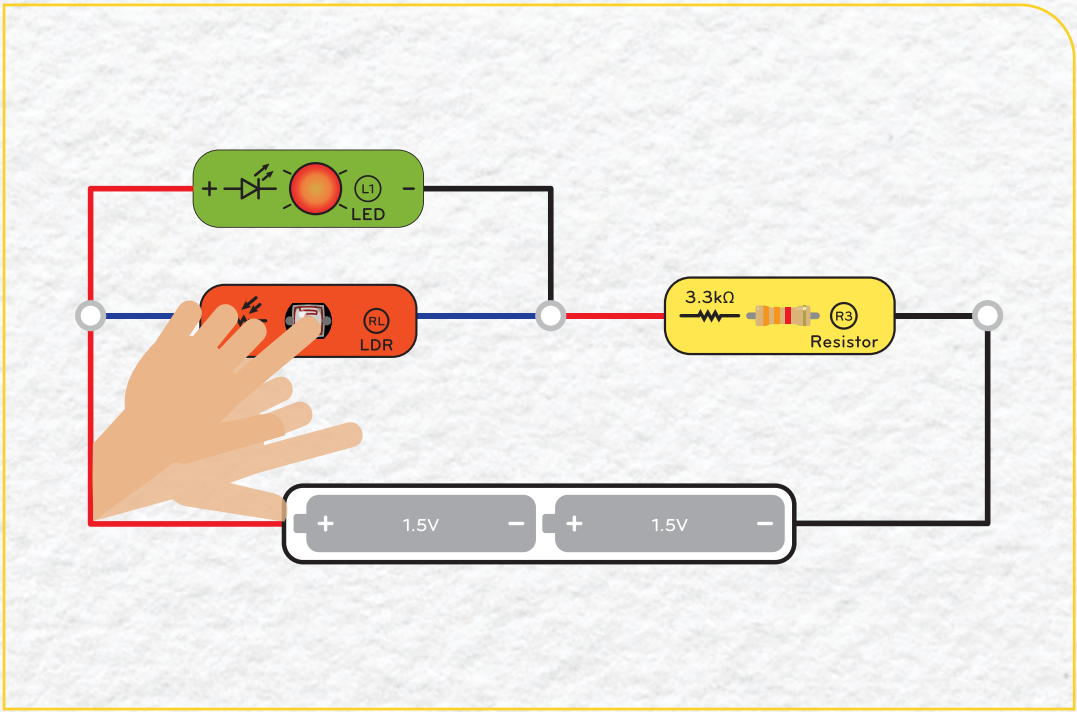
Light Dependent Resistor

- Yes, that's LDR's full name! As the name suggests, it's a resistor whose resistance changes with light. If more light falls on it, the resistance goes down and if it's dark around, the resistance goes up! That's why the LED became brighter when more light fell on the LDR!
- LDRs are used widely as light sensors in applications like automated street lights, automatic car headlights, mobile phone's light sensor etc.

Auto Night Lights!

The previous circuit was interesting but wouldn't it be more helpful if the LED lit up when it is dark instead of when it is already bright outside? We are going to do a nice trick to do achieve just that!

- Make sure that you are in a well lit up place. Avoid a dark room for this project.
- Connect the Battery, LDR and 3.3kΩ (R3) resistor in series as shown.
- Connect the LED in parallel to the LDR.

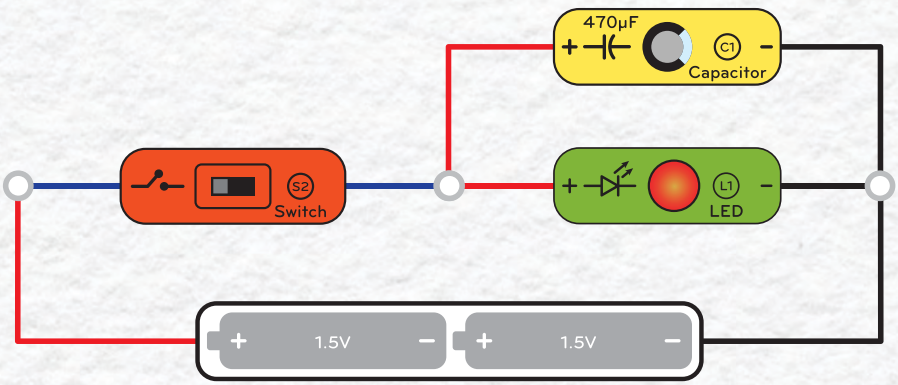


- Now move your hand closer to the LDR. The LED starts glowing!
- You can also try switching your room's lights on and off!

By modifying the circuit in this way, we flipped the operation of the previous circuit and made it much more useful! This arrangement of resistors is called a "Voltage Divider".

On & Faaaaaaaaade!

- Connect the Switch, Capacitor, LED & Battery as shown.
- Mind the polarity of the Capacitor and connect EXACTLY as shown!



- Now turn ON the Switch for some time and then turn it OFF.
- Did you see something cool? The lights didn't go off instantly but instead they slowly faded! All thanks to the Capacitor for this!

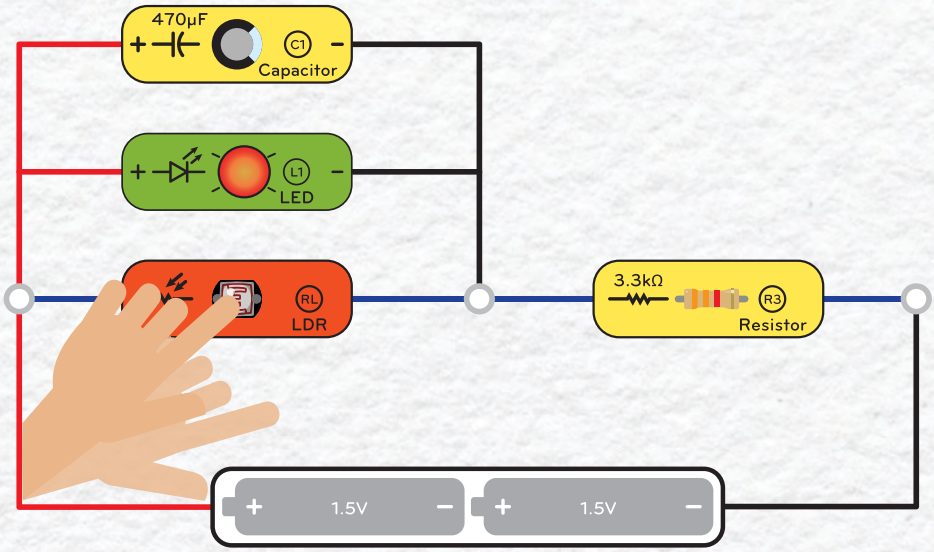
Capacitor

- Capacitors are very fundamental electronic components like Resistors. They are like small & temporary electric storage tanks which store electricity inside them for some time and give it back to the circuit when electricity is cut-off.
- So, when the Switch was ON the, not only did the LED glow but the Capacitor also got charged and when it went OFF, the capacitor discharged slowly and provided electricity to the LED for some time!
- You would have seen such fading LEDs many times when you turn off your TV, mobile charger, LED lights etc. You guessed it right. This is because the mighty Capacitor is used in all of these circuits!

Magical Lights!

Wouldn't it be cool if we could add a fading effect to our automatic night lights to make them act just like a movie theatre's lights or a car's interior lights!

- Make sure that you are in a well lit up place. Avoid a dark room for this project.
- Connect the same circuit as the Auto Night Lights project.
- Then add a Capacitor in parallel to the LED as shown.



- Now bring your hand close, place it on the LDR, do your favourite magical action, spell some magical words and wait in this position for some time.
- The LED will slowly receive energy from you and come to life! Move away from the LDR and it will slowly fade!
- All this magic was due to the Capacitor! Interesting isn't it!

Thank You!

Hope you enjoyed playing and learning with this kit. We bet that you'll be able to see things differently and understand how they work and what they're made of.

You should definitely try to break open old gadgets & toys and learn more about them. Also, try searching the internet and learn more about the concepts or projects that appeal to you the most! Make your own cool projects and magic tricks from the things you learnt here!

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E - CIRCUITS

LIGHT

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For suggestions or feedback, please contact on
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