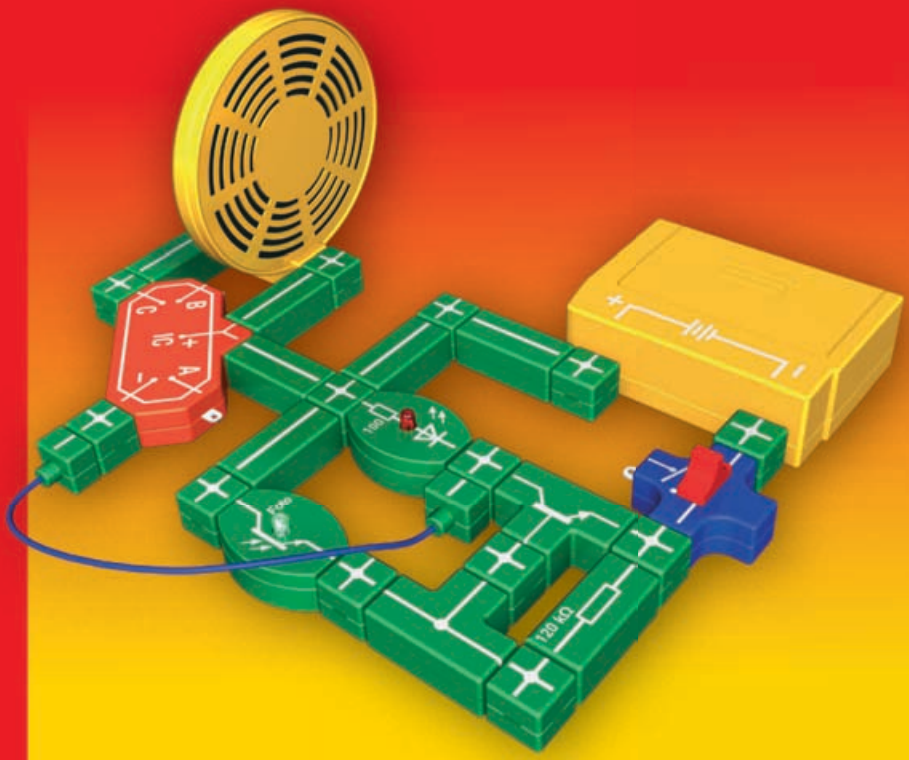
electron-x

ELECTRONICS
learning circuits

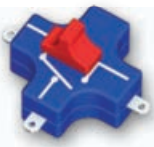
Thames & Kosmos

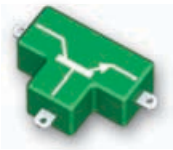


Experiment Manual

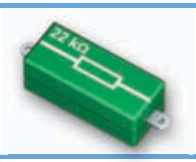
Instruction Manual Contents

The parts in your kit

Component	Qty.	Description	Appearance
Battery box Item No. 704484	**1**	The power pack that supplies the electricity for the experiments. Before starting the experiments, you will have to install two 1.5-volt AA batteries. You can then collect current from the two terminals (+ and -). Never directly connect these terminals to each other. The batteries and wires can heat up and explode, not to mention that the batteries will be quickly used up.	
Selector switch Item No. 705055	**1**	Depending on the setting of the switch, one or another pair of the three contact plugs will be electrically connected.	
Connector with 4 terminals (X-shaped) Item No. 705050	**20**	For connecting components. The metal plugs of the other components are inserted into the side slits so that they are electrically connected to each other as indicated by the white lines. In the instructions, they are called **"X-connectors."**	
Straight connector with 2 terminals (I-shaped) Item No. 705051	**10**	For the electrical connection of components. The two plugs are electrically connected to each other. In the instructions, they are referred to as **"I-connectors."**	
Angled connector with 2 terminals (L-shaped) Item No. 705052	**5**	For the electrical connection of components, but in a way that guides the current at a right angle. Looks like an "L," hence referred to as an **"L-connector"** in the instructions.	
Connector with 3 terminals (T-shaped) Item No. 705053	**2**	For electrical connections. The three plugs are electrically connected to each other as indicated by the white lines. In the instructions, they are referred to as **"T-connectors,"** because their shape is similar to a "T."	
Red light-emitting diode Item No. 708801	**1**	It emits a red light when current is flowing through it.	

Component	Qty.	Description	Appearance
Green light-emitting diode Item No. 708802	**1**	It lights up green when current flows through it.	
Transistor (npn) Item No. 708800	**2**	The transistor is a fundamental electronic building block. It is hidden inside of electronic devices or computer chips, sometimes by the thousands. It serves as an amplifier or electric switch, and will play an important role in your experiments. It has three terminals — it's important not to mix up the different terminals!	
Phototransistor Item No. 708803	**1**	This component reacts to light: It lets electric current pass through more or less easily, depending on illumination.	
Sound-Generator (IC) Item No. 708804	**1**	This red-orange-colored building block produces various kinds of noises, because it has dozens of transistors inside its housing that work together in a complicated manner.	
Speaker Item No. 708805	**1**	It turns signals from the sound generator and a few other things into sounds you can hear.	
Resistor, 1 kilohm (1 kΩ) Item No. 708806	**1**	Resistors allow you to regulate the flow of current. They come in various electrical values, indicated in "kilohms" (kΩ). Careful, always insert the resistor with the indicated value!	
Resistor, 8.2 kilohms (8.2 kΩ) Item No. 708807	**1**	This is just like the 1-kilohm resistor, except this one offers 8.2 times the resistance to the current.	

The parts in your kit

Component	Qty.	Description	Appearance
Resistor, 22 kilohms (22 kΩ) Item No. 708808	**1**	This is just like the 1-kilohm resistor, except this one offers 22 times the resistance to the current.	
Resistor, 120 kilohms (120 kΩ) Item No. 708809	**1**	The same applies as with the 1-kilohm resistor, except this one offers 120 times the resistance to the current.	
Electrolytic capacitor, 100 microfarads (100 µF) Item No. 708810	**1**	Capacitors have important tasks to perform in circuits. They possess various electrical values, indicated in "microfarads" (µF). Install capacitors only as shown in the circuit diagrams. Pay attention to the correct value and the + sign, or they might get damaged.	
Capacitor, 0.1 microfarad (0.1 µF) Item No. 708812	**1**	Here, everything is just like with the 100-microfarad capacitor, except this one has a much lower microfarad value. It makes no difference how you insert this one.	
Red connecting wire with plugs Item No. 706428	**1**	For connecting electronic parts. At the ends, there are contacts that fit into the green wire connectors. Referred to in brief as **"red wire."**	
Blue connecting wire with plugs Item No. 706429	**1**	Like the red connecting wire with plugs, but in a different color. In the instructions, it is referred to in brief as **"blue wire."**	
Divider Item No. 706078	**1**	You can use this tool to pry the inserted components or connectors apart without bending the plugs. Slide it between the components and push the components apart.	

Additionally required household items
These are listed in italic (slanted) letters in the "You will need" sections.

- metal paper clips
- tape
- all-purpose glue
- aluminum foil
- scissors
- cardboard
- white paper
- plastic ruler
- very soft pencil
- cloth
- piece of plastic wrap
- table salt
- drinking glass
- teaspoon
- paper towel tube
- deionized water
- tap water
- thin wire
- flashlight
- TV remote
- digital camera

3 Green instead of red

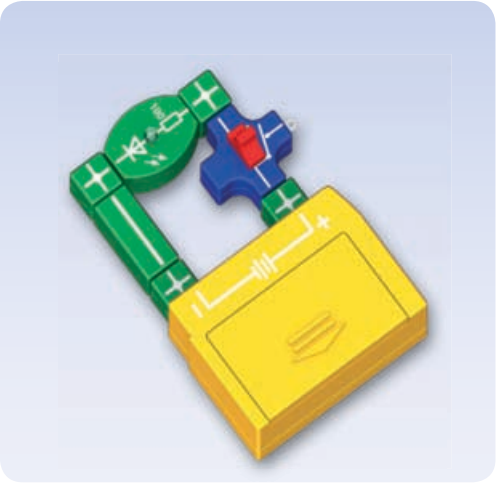
You performed the previous experiments with the red LED. Now it's the green LED's turn to shine.

You will need:

- Battery box
- 4 X-connectors
- 1 I-connector
- Selector switch
- Green LED

Here's how:

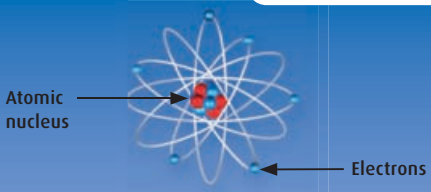
Assemble the same circuit as in Experiment 1, except this time use the green LED. Its green light will shine as soon as you push the switch.



How it works:

The green LED works just like the red one, except the light-emitting material has been changed so that it produces green light.

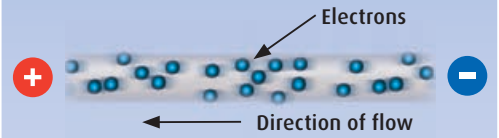
Science Database



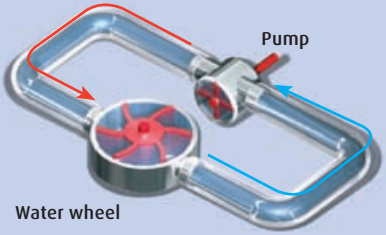
Electrical current and electronics

For a long time, researchers have puzzled over the nature of "electrical current." It is invisible, with only its effects being noticeable. Today, we know that it is a "flow of electrons." Electrons are smaller and more mobile than atoms, and they have lots of unusual properties.

Normally, "electrons" are firmly attached to the atom they belong to. But sometimes, especially in metals, electrons can get free and zoom around among the atoms. You can picture electrons in a wire like water in a pipe.



When water is set in motion by a pump, it starts to flow through the pipe. This flow can be used to drive a small water wheel, for example.



With electricity, too, there are things like pumps (for example, batteries) that set the electron cloud in the wire in motion. This is called "electrical current." You can use electrons to do lots of amazing things. The technology of controlling electrons toward certain goals is called "electronics." With the help of transistors, capacitors, resistors, and LEDs, we can make electrons do what we want them to.

39 Alarm! Overflow!

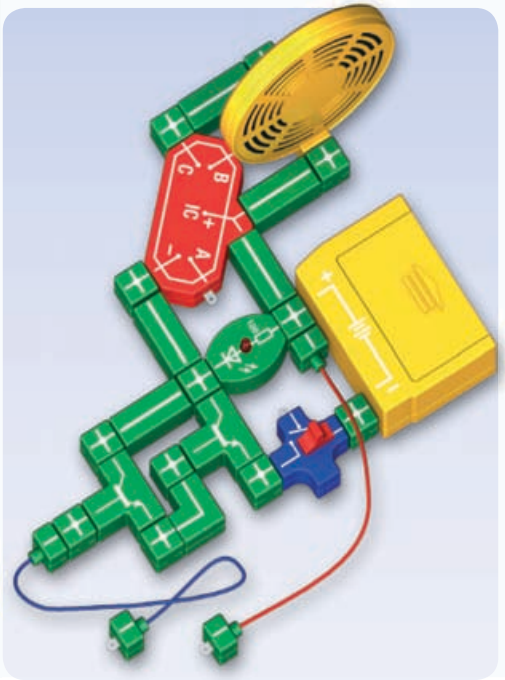
In factories, there are often automatic filling systems for tanks. So they need an electronic means to determine when a tank is full and to switch off the pump. And in the basement of a house, it's useful to have an automatic monitoring system to sound an alarm when rainwater gets in. A water level sensor can handle tasks like those.

You will need:

- Circuit from Experiment 38
- *Tape*
- *Drinking glass*
- *Tap water*

Here's how:

1. Tape the free ends of the wires to the rim of an empty glass. The plugs should hang about 2 cm below the rim, and there should be a few centimeters of space between them.
2. Switch on the circuit and slowly pour water into the glass. As soon as the water reaches the two plugs, the LED will light up and the alarm will sound.



How it works:

The water makes a connection between the plugs when it reaches them and the circuit responds.

40 Low water level alarm

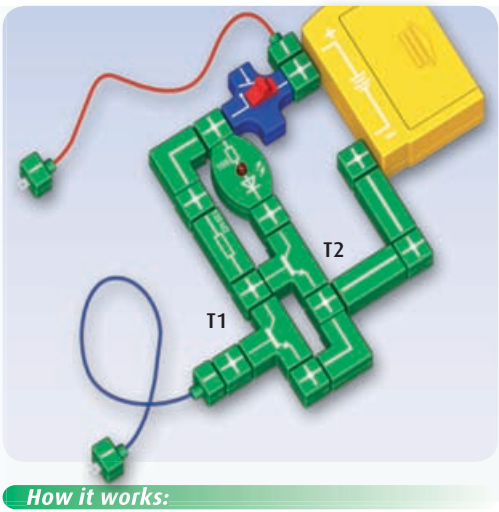
Circuits like this one warn you when a liquid level is too low, such as the gasoline level in a car's gas tank.

You will need:

- Battery box
- 10 X-connectors
- 2 I-connectors
- 2 L-connector
- 2 Transistors
- Red LED
- Selector switch
- Red wire
- Blue wire
- 120 kΩ Resistor
- *Drinking glass*
- *Tape*
- *Teaspoon*
- *Tap water*

Here's how:

1. Assemble the circuit and secure the free wire ends to the inside of the glass. Switch on; the LED shines.
2. Fill the glass with tap water until both plugs are submerged. The LED will go out.
3. Now take water out with the teaspoon. At the moment that the water no longer creates a connection between the plugs, the LED will turn on.



How it works:

As long as the water creates a connection between the plugs, the first transistor's base is connected to the positive battery terminal, so its C-E section is conductive. That means that the second transistor's base is connected to its emitter and the negative terminal, and the current is blocked in spite of the connection with the positive terminal via the 120-kΩ resistor: The LED remains dark. If the water level drops, the first transistor's C-E section cuts off, and the base connection via the 120-kΩ resistor ensures that the second transistor is conductive. Then the LED lights up.

63 Adjustable sound pitch

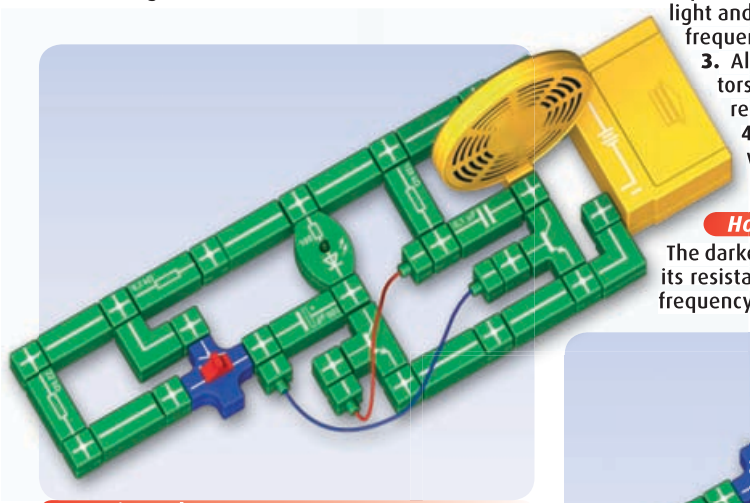
It can be a little bit tedious to reinsert resistors. You can use the selector switch to choose between two tone pitches.

You will need:

- Battery box
- 20 X-connectors
- 7 I-connectors
- 3 L-connector
- 2 Transistors
- 120 kΩ Resistor
- 22 kΩ Resistor
- 8.2 kΩ Resistor
- 100-µF capacitor
- 0.1-µF capacitor
- Speaker
- Green LED
- Selector switch
- Blue wire
- Red wire

Here's how:

1. After assembly, you will hear a tone in the speaker.
2. Push the selector switch to the other setting: The sound changes.



How it works:

When you slide the selector switch, it connects the 22-kΩ resistor in series with the 8.2-kΩ resistor, which changes the left capacitor-resistor combination and, thus, the sound as well.

64 Light-controlled flasher

In addition to the fixed-value resistors, you also have the phototransistor. With its help, you can use changes in external lighting conditions to adjust the flash tempo.

You will need:

- Battery box
- 17 X-connectors
- 6 I-connectors
- 2 L-connector
- 2 Transistors
- Phototransistor
- all the resistors
- 100-µF capacitor
- 0.1-µF capacitor
- Red LED
- Green LED
- Selector switch
- Blue wire
- Red wire

Here's how:

1. Insert the phototransistor into the blinker circuit from Experiment 61 in place of the resistor mounted on the left.
2. Shade the phototransistor or expose it to bright light and observe how the blink frequency changes.
3. Also try inserting different resistors on the right, and compare the results.
4. Swap the capacitors and check what happens.

How it works:

The darker the phototransistor, the higher its resistance value. That causes the blink frequency to drop as it gets less light.