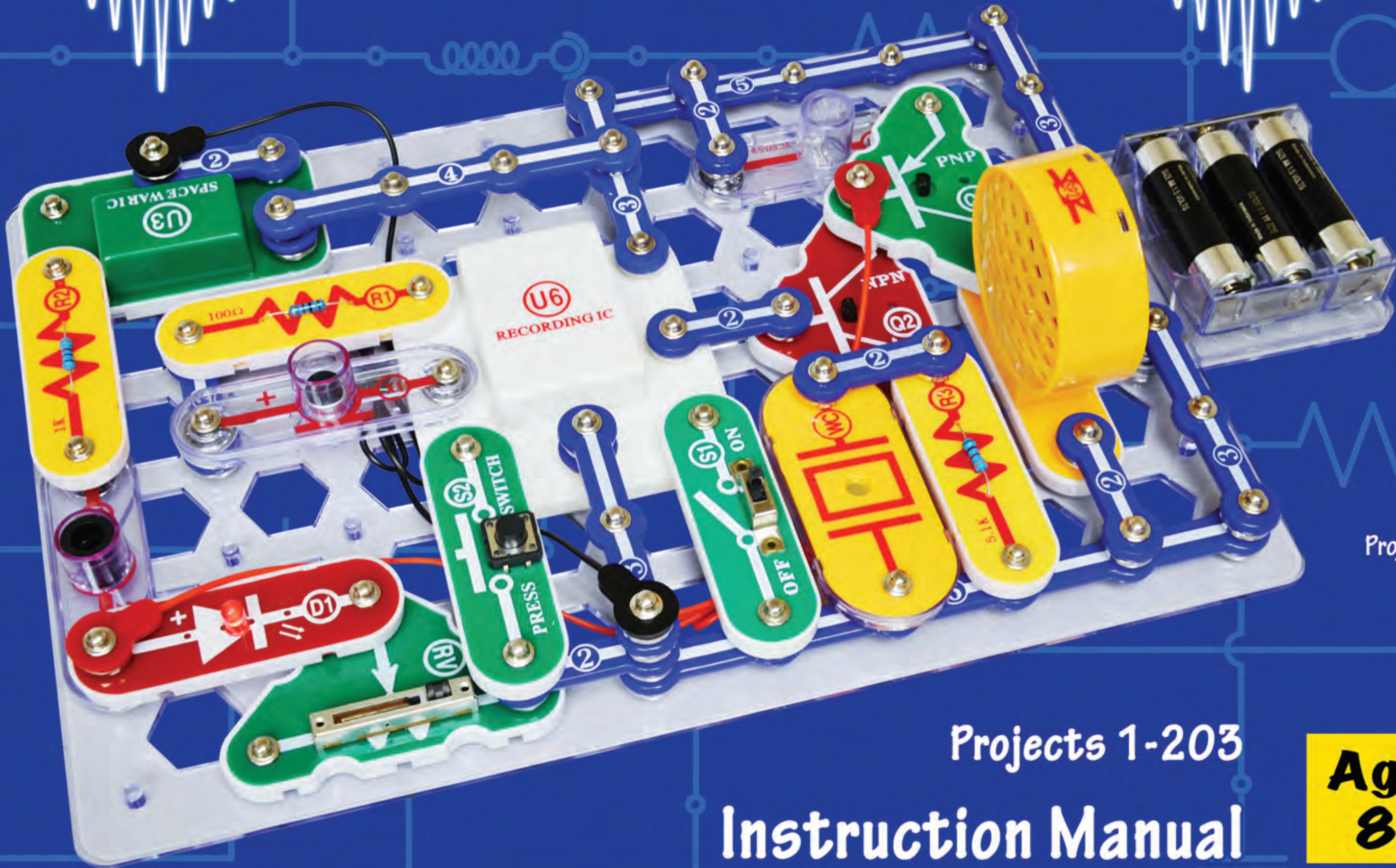
EDU-TOYS®

CIRCUIT MAKER

Sound Plus 200



Project 3

Projects 1-203

Instruction Manual

Ages 8+

U.S. Patents 7,144,255; 7,273,377; patents pending

753093

Table of Contents

WARNING: SHOCK HAZARD - Never connect Circuit Maker to the electrical outlets in your home in any way!

WARNING: CHOKING HAZARD - Small parts. Not for children under 3 years.

Conforms to all applicable U.S. government requirements.

Basic Troubleshooting

1. Most circuit problems are due to incorrect assembly, always double-check that your circuit exactly matches the drawing for it.
2. Be sure that parts with positive/negative markings are positioned as per the drawing.
3. Be sure that all connections are securely snapped.
4. Try replacing the batteries.

ELENCO® is not responsible for parts damaged due to incorrect wiring.

Note: If you suspect you have damaged parts, you can follow the Advanced Troubleshooting procedure on page 9 to determine which ones need replacing.

WARNING: Always check your wiring before turning on a circuit. Never leave a circuit unattended while the batteries are installed. Never connect additional batteries or any other power sources to your circuits. Discard any cracked or broken parts.

Adult Supervision: Because children's abilities vary so much, even with age groups, adults should exercise discretion as to which experiments are suitable and safe (the instructions should enable supervising adults to establish the experiment's suitability for the child). Make sure your child reads and follows all of the relevant instructions and safety procedures, and keeps them at hand for reference.

This product is intended for use by adults and children who have attained sufficient maturity to read and follow directions and warnings.

Never modify your parts, as doing so may disable important safety features in them, and could put your child at risk of injury.

Batteries:

- Use only 1.5V "AA" type, alkaline batteries (not included).
- Insert batteries with correct polarity.
- Non-rechargeable batteries should not be recharged. Rechargeable batteries should only be charged under adult supervision, and should not be recharged while in the product.
- Do not mix old and new batteries.
- Remove batteries when they are used up.
- Do not connect batteries or battery holders in parallel.
- Do not mix alkaline, standard (carbon-zinc), or rechargeable (nickel-cadmium) batteries.
- Do not short circuit the battery terminals.
- Never throw batteries in a fire or attempt to open its outer casing.
- Batteries are harmful if swallowed, so keep away from small children.

How to Use Circuit Maker Sound Plus 200

Circuit Maker Sound Plus 200 uses building blocks with snaps to build the different electrical and electronic circuits in the projects. Each block has a function: there are switch blocks, light blocks, battery blocks, different length wire blocks, etc. These blocks are different colors and have numbers on them so that you can easily identify them. The blocks you will be using are shown as color symbols with level numbers next to them, allowing you to easily snap them together to form a circuit.

For Example:

This is the switch block which is green and has the marking S2 on it. The part symbols in this booklet may not exactly match the appearance of the actual parts, but will clearly identify them.

This is a wire block which is blue and comes in different wire lengths.
This one has the number 2, 3, 4, 5, or 6 on it depending on the length of the wire connection required.

There is also a 1-snap wire that is used as a spacer or for interconnection between different layers.

You need a power source to build each circuit. This is labeled B3 and requires three (3) 1.5V "AA" batteries (not included).

A large clear plastic base grid is included with this kit to help keep the circuit blocks properly spaced. You will see evenly spaced posts that the different blocks snap into. The base has rows labeled A-G and columns labeled 1-10.

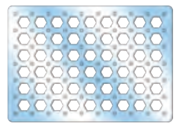
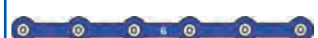
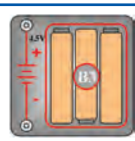
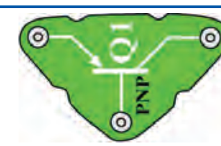
Next to each part in every circuit drawing is a small number in black. This tells you which level the component is placed at. Place all parts on level 1 first, then all of the parts on level 2, then all of the parts on level 3, etc.

Some circuits use the jumper wires to make unusual connections. Just clip them to the metal snaps or as indicated.

Note: While building the projects, be careful not to accidentally make a direct connection across the battery holder (a "short circuit"), as this may damage and/or quickly drain the batteries.

Parts List (Colors and styles may vary) Symbols and Numbers

Important: If any parts are missing or damaged, **DO NOT RETURN TO RETAILER**. Call customer service toll-free at (800) 533-2441 or e-mail us at: help@elenco.com.

Qty.	ID	Name	Symbol	Part #	Qty.	ID	Name	Symbol	Part #
❐ 1		Base Grid (11.0” x 7.7”)		6SCBG	❐ 1	C2	0.1μF Capacitor		6SCC2
❐ 4	1	1-Snap Wire		6SC01	❐ 1	C3	10μF Capacitor		6SCC3
❐ 7	2	2-Snap Wire		6SC02	❐ 1	C4	100μF Capacitor		6SCC4
❐ 4	3	3-Snap Wire		6SC03	❐ 1	D1	Red Light Emitting Diode (LED)		6SCD1
❐ 1	4	4-Snap Wire		6SC04	❐ 1		Jumper Wire (Black)		6SCJ1
❐ 1	5	5-Snap Wire		6SC05	❐ 1		Jumper Wire (Red)		6SCJ2
❐ 1	6	6-Snap Wire		6SC06	❐ 1	L4	Lamp		6SCL4
❐ 1	B3	Battery Holder - uses 3 1.5V type AA (not included)		6SCB3	❐ 1	Q1	PNP Transistor		6SCQ1

Parts List (Colors and styles may vary) Symbols and Numbers

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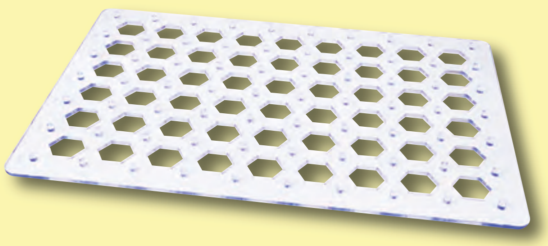
Qty.	ID	Name	Symbol	Part #	Qty.	ID	Name	Symbol	Part #
❒ 1	Q2	NPN Transistor		6SCQ2	❒ 1	S1	Slide Switch		6SCS1
❒ 1	R1	100Ω Resistor		6SCR1	❒ 1	S2	Press Switch		6SCS2
❒ 1	R2	1KΩ Resistor		6SCR2	❒ 1	SP2	Speaker		6SCSP2
❒ 1	R3	5.1KΩ Resistor		6SCR3	❒ 1	U3	Space War Integrated Circuit (IC)		6SCU3
❒ 1	R5	100KΩ Resistor		6SCR5	❒ 1	U6	Recording Integrated Circuit (IC)		6SCU6
❒ 1	RP	Photoresistor		6SCRP	❒ 1	WC	Whistle Chip		6SCWC
❒ 1	RV	Adjustable Resistor		6SCRV	❒ 1	X1	Microphone		6SCX1

About Your Circuit Maker Sound Plus 200 Parts

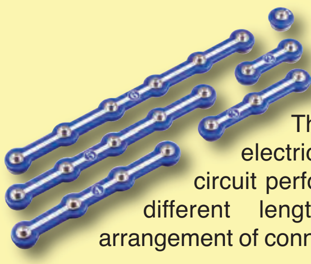
(Part designs are subject to change without notice).

BASE GRID

The **base grid** is a platform for mounting parts and wires. It functions like the printed circuit boards used in most electronic products, or like how the walls are used for mounting the electrical wiring in your home.



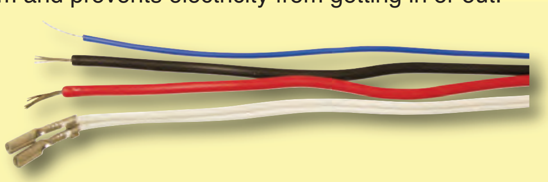
SNAP WIRES & JUMPER WIRES



The blue **snap wires** are wires used to connect components. They are used to transport electricity and do not affect circuit performance. They come in different lengths to allow orderly arrangement of connections on the base grid.

The red and black **jumper wires** make flexible connections for times when using the snap wires would be difficult. They also are used to make connections off the base grid.

Wires transport electricity just like pipes are used to transport water. The colorful plastic coating protects them and prevents electricity from getting in or out.



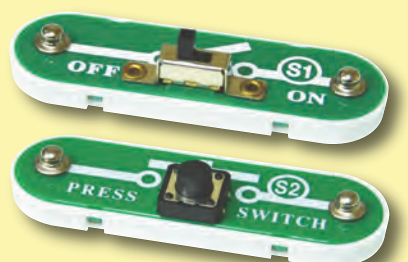
BATTERY HOLDER

The **batteries (B3)** produce an electrical voltage using a chemical reaction. This "voltage" can be thought of as electrical pressure, pushing electricity through a circuit just like a pump pushes water through pipes. This voltage is much lower and much safer than that used in your house wiring. Using more batteries increases the "pressure", therefore, more electricity flows.

Battery Holder (B3)

SLIDE & PRESS SWITCHES

The **slide** and **press switches (S1 & S2)** connect (pressed or "ON") or disconnect (not pressed or "OFF") the wires in a circuit. When ON they have no effect on circuit performance. Switches turn on electricity just like a faucet turns on water from a pipe.



Slide & Press Switches (S1 & S2)

RESISTORS

Resistors "resist" the flow of electricity and are used to control or limit the current in a circuit. Circuit Maker Skill Builder 125 includes **100Ω (R1), 1kΩ (R2), 5.1kΩ (R3), and 100kΩ (R5) resistors** ("k" symbolizes 1,000, so R3 is really 5,100Ω). Materials like metal have very low resistance (<1Ω), while materials like paper, plastic, and air have near-infinite resistance. Increasing circuit resistance reduces the flow of electricity.

Resistors (R1, R2, R3, & R5)

The **adjustable resistor (RV)** is a 50kΩ resistor but with a center tap that can be adjusted between 200Ω and 50kΩ.

Adjustable Resistor (RV)

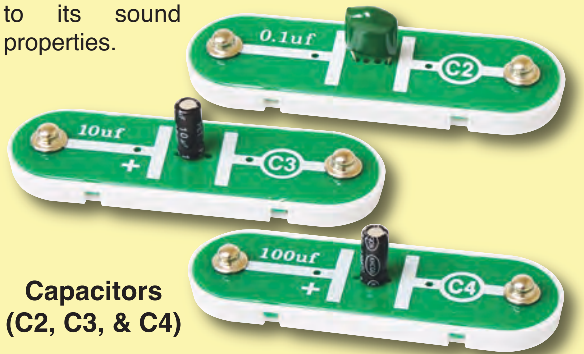
The **photoresistor (RP)** is a light-sensitive resistor, its value changes from nearly infinite in total darkness to about 1,000Ω when a bright light shines on it.

Photoresistor (RP)

About Your Circuit Maker Sound Plus 200 Parts

CAPACITORS

Capacitors are components that can store electrical pressure (voltage) for periods of time, higher values have more storage. Because of this storage ability they block unchanging voltage signals and pass fast changing voltages. Capacitors are used for filtering and oscillation circuits. This kit includes **0.1µF (C2), 10µF (C3), and 100µF (C4) capacitors**. The whistle chip (WC) also acts like a 0.02µF capacitor in addition to its sound properties.



Capacitors (C2, C3, & C4)

MICROPHONE

The **microphone (X1)** is actually a resistor that changes in value when changes in air pressure (sounds) apply pressure to its surface.

Microphone (X1)

LAMP

A light bulb, such as in the **4.5V lamp (L4)**, contains a special thin high-resistance wire. When a lot of electricity flows through, this wire gets so hot it glows bright. Voltages above the bulb's rating can burn out the wire.

Lamp (L4)

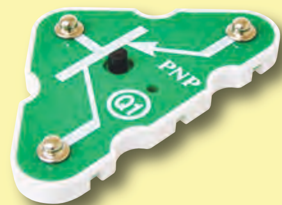
SPEAKER

The **speaker (SP2)** converts electricity into sound by making mechanical vibrations. These vibrations create variations in air pressure, which travel across the room. You "hear" sound when your ears feel these air pressure variations.

Speaker (SP2)

TRANSISTORS

The **PNP transistor (Q1)** and **NPN transistor (Q2)** are components that use a small electric current to control a large current, and is used in switching, amplifier, and buffering applications. Transistors are easy to miniaturize, and are the main building blocks of integrated circuits including the microprocessor and memory circuits in computers.



PNP Transistor (Q1)

NPN Transistor (Q2)

WHISTLE CHIP

The **whistle chip (WC)** contains two thin plates. When an electrical signal is applied across them they will stretch slightly in an effort to separate (like two magnets opposing each other), when the signal is removed they come back together. If the electrical signal applied across them is changing quickly, then the plates will vibrate. These vibrations create variations in air pressure that your ears feel just like sound from a speaker.

Whistle Chip (WC)

LED

The **red LED (D1)** is a light emitting diode and may be thought of as a special one-way light bulb. In the "forward" direction, (indicated by the "arrow" in the symbol) electricity flows if the voltage exceeds a turn-on threshold (about 1.5V); brightness then increases. A high current will burn out an LED, so the current must be limited by other components in the circuit. LEDs block electricity in the "reverse" direction.

LED (D1)

INTEGRATED CIRCUITS (ICs)

Some types of electronic components can be super-miniaturized, allowing many thousands of parts to fit into an area smaller that your fingernail. These "integrated circuits" (ICs) are used in everything from simple electronic toys to the most advanced computers. The **space war** and **recording IC modules (U3 & U6)** in Circuit Maker Sound Plus 200 are actually modules containing specialized sound-generation ICs and other supporting components (resistors, capacitors, and transistors) that are always needed with them. This was done to simplify the connections you need to make to use them. The descriptions for these modules are given here for those interested; see the projects for connection examples:

Space War IC:

(+) OUT

IN1 (–) IN2

Connections:
(+) - power from batteries
(–) - power return to batteries
OUT - output connection
IN1, IN2 - control inputs

Connect each control input to (–) power to sequence through 8 sounds.

Recording IC Module:

Mic + (+)

Mic –

OUT

Play (–) RC

Connections:
(+) - power from batteries
(–) - power return to batteries
RC - record
Play - play
OUT - output connection
Mic + - microphone input
Mic – - microphone input

See Project #4 for example of proper connections.

Introduction to Electricity

What is electricity? Nobody really knows. We only know how to produce it, understand its properties, and how to control it. Electricity is the movement of sub-atomic charged particles (called **electrons**) through a material due to electrical pressure across the material, such as from a battery.

Power sources, such as batteries, push electricity through a circuit, like a pump pushes water through pipes. Wires carry electricity, like pipes carry water. Devices like LEDs, motors, and speakers use the energy in electricity to do things. Switches and transistors control the flow of electricity like valves and faucets control water. Resistors limit the flow of electricity.

The electrical pressure exerted by a battery or other power source is called **voltage** and is measured in **volts** (V). Notice the "+" and "–" signs on the battery; these indicate which direction the battery will "pump" the electricity.

The **electric current** is a measure of how fast electricity is flowing in a wire, just as the water current describes how fast water is flowing in a pipe. It is expressed in **amperes** (A) or **milliamps** (mA, 1/1,000 of an ampere).

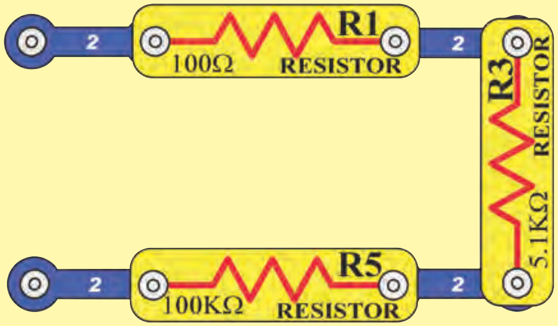
The "**power**" of electricity is a measure of how fast energy is moving through a wire. It is a combination of the voltage and current (Power = Voltage x Current). It is expressed in **watts** (W).

The **resistance** of a component or circuit represents how much it resists the electrical pressure (voltage) and limits the flow of electric current. The relationship is Voltage = Current x Resistance. When the resistance increases, less current flows. Resistance is measured in **ohms** (Ω), or **kilo ohms** (kΩ, 1,000 ohms).

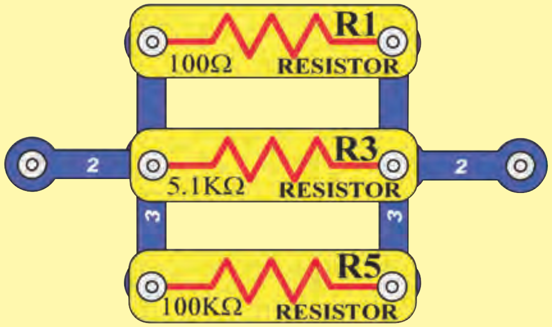
Nearly all of the electricity used in our world is produced at enormous generators driven by steam or water pressure. Wires are used to efficiently transport this energy to homes and businesses where it is used. Motors convert the electricity back into mechanical form to drive machinery and appliances. The most important aspect of electricity in our society is that it allows energy to be easily transported over distances.

Note that "distances" includes not just large distances but also tiny distances. Try to imagine a plumbing structure of the same complexity as the circuitry inside a portable radio - it would have to be large because we can't make water pipes so small. Electricity allows complex designs to be made very small.

There are two ways of arranging parts in a circuit, in series or in parallel. Here are examples:



Series Circuit



Parallel Circuit

Placing components in series increases the resistance; highest value dominates. Placing components in parallel decreases the resistance; lowest value dominates.

The parts within these series and parallel sub-circuits may be arranged in different ways without changing what the circuit does. Large circuits are made of combinations of smaller series and parallel circuits.

DOs and DON'Ts of Building Circuits

After building the circuits given in this booklet, you may wish to experiment on your own. Use the projects in this booklet as a guide, as many important design concepts are introduced throughout them. Every circuit will include a power source (the batteries), a resistance (which might be a resistor, capacitor, speaker, integrated circuit, etc.), and wiring paths between them and back. You must be careful not to create "short circuits" (very low-resistance paths across the batteries, see examples at right) as this will damage components and/or quickly drain your batteries. Only connect the ICs using configurations given in the projects, incorrectly doing so may damage them. **ELENCO® is not responsible for parts damaged due to incorrect wiring.**

Here are some important guidelines:

ALWAYS **USE EYE PROTECTION WHEN EXPERIMENTING ON YOUR OWN.**

ALWAYS include at least one component that will limit the current through a circuit, such as the speaker, lamp, ICs (which must be connected properly), motor, photoresistor, or resistor.

ALWAYS use the LED, NPN transistor, and switches in conjunction with other components that will limit the current through them. Failure to do so will create a short circuit and/or damage those parts.

ALWAYS disconnect your batteries immediately and check your wiring if something appears to be getting hot.

ALWAYS check your wiring before turning on a circuit.

ALWAYS connect capacitors so that the "+" side gets the higher voltage.

ALWAYS connect ICs using configurations given in the projects or as per the connection descriptions for the parts.

NEVER connect to an electrical outlet in your home in any way.

NEVER leave a circuit unattended when it is turned on.

NEVER touch the motor when it is spinning at high speed.

For all of the projects given in this book, the parts may be arranged in different ways without changing the circuit. For example, the order of parts connected in series or in parallel does not matter — what matters is how combinations of these sub-circuits are arranged together.

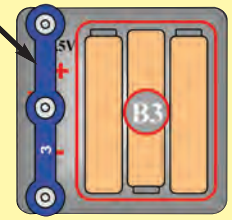
WARNING: SHOCK HAZARD - Never connect Circuit Maker Sound Plus 200 to the electrical outlets in your home in any way!

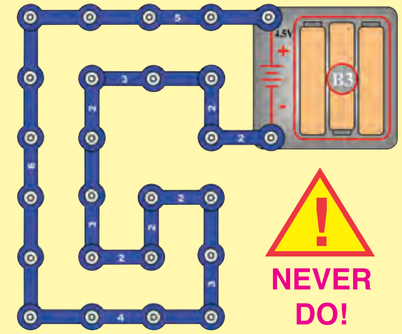
Warning to Circuit Maker owners: Do not connect additional voltage sources from other sets, or you may damage your parts. Contact ELENCO® if you have questions or need guidance.

Examples of SHORT CIRCUITS - NEVER DO THESE!!!

Placing a 3-snap wire directly across the batteries is a SHORT CIRCUIT.

NEVER DO!

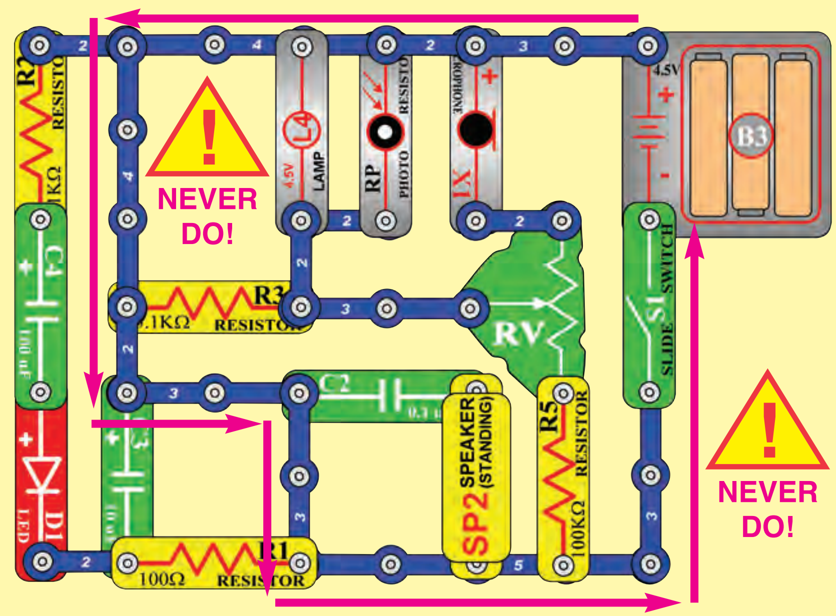




NEVER DO!

This is also a SHORT CIRCUIT.

When the slide switch (S1) is turned on, this large circuit has a SHORT CIRCUIT path (as shown by the arrows). The short circuit prevents any other portions of the circuit from ever working.



NEVER DO!

CAUTION: Do not mix alkaline, standard (carbon-zinc), or rechargeable (nickel-cadmium) batteries.

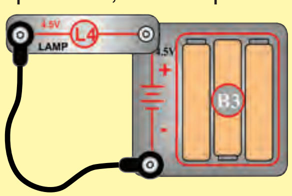
Advanced Troubleshooting (Adult supervision recommended)

ELENCO® is not responsible for parts damaged due to incorrect wiring.

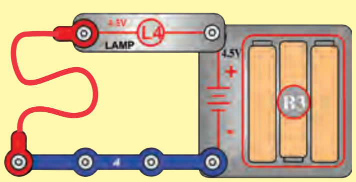
If you suspect you have damaged parts, you can follow this procedure to systematically determine which ones need replacing:

Note: Some of these tests connect an LED directly across the batteries without another component to limit the current. Normally this might damage the LED, however, Circuit Maker LEDs have internal resistors added to protect them from incorrect wiring, and will not be damaged.

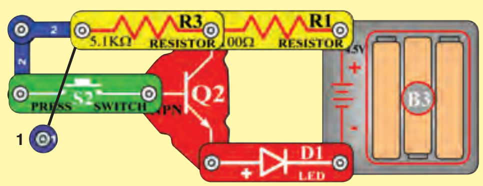
1. **Red LED (D1), 4.5V lamp (L4), speaker (SP2), and battery holder (B3):** Place batteries in holder. Place the red LED directly across the battery holder (LED + to battery +); it should light. Place the 4.5V lamp directly across the battery holder, it should light. "Tap" the speaker across the battery holder contacts, you should hear static as it touches. If none work, then replace your batteries and repeat. If still bad, then the battery holder is damaged.
2. **Jumper wires:** Use this mini-circuit to test each jumper wire, the lamp should light.



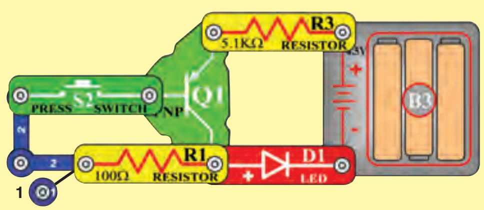
3. **Snap wires:** Use this mini-circuit to test each of the snap wires, one at a time. The lamp should light.



4. **Slide switch (S1) and press switch (S2):** Build Project #1; if the lamp (L4) doesn't light then the slide switch is bad. Replace the slide switch with the press switch to test it.
5. **100Ω (R1), 1KΩ (R2), and 5.1KΩ (R3) resistors:** Build Project #10; the red LED should be bright. If not, then R1 is damaged. Next use the 1KΩ and 5.1KΩ resistors in place of the 100Ω resistor; the LED should be dimmer but still light.
6. **Microphone (X1) and photoresistor (RP):** Build Project #13; if blowing into the microphone does not change the LED (D1) brightness then the microphone is bad. Replace the microphone with the photoresistor. Waving your hand over the photoresistor (changing the light that shines on it) should change the brightness of the LED or the photoresistor is bad.
7. **NPN transistor (Q2):** Build the mini-circuit shown here. The LED (D1) should only be on if the press switch (S2) is pressed. If otherwise, then the NPN is damaged.



8. **PNP transistor (Q1):** Build the mini-circuit shown here. The LED (D1) should only be on if the press switch (S2) is pressed. If otherwise, then the PNP is damaged.



9. **Adjustable resistor (RV):** Build Project #14, the resistor control lever can turn the LED (D1) on and off.
10. **Recording IC (U6):** Build Project #4. Make an 8 second recording, then listen to the three pre-recorded songs.
11. **Space war IC (U3:** Build Project #2, both switches (S1 and S2) should change the sound.
12. **Whistle chip (WC):** Build Project #165. When you press the press switch (S2) you should hear sound.
13. **100KΩ resistor (R5), 0.1μF (C2) capacitor and 10μF capacitor (C3):** Build Project #120, it makes sound unless the resistor is bad. Place the 0.1μF capacitor on top of the whistle chip (WC) and the sound changes (pitch is lower). Replace the 0.1μF with the 10μF ("+" on left) and the circuit will "click" about once a second.
14. **100μF (C4) capacitors:** Build Project #75, press the press switch (S2) and turn on the slide switch (S1). The LED (D1) should be lit for about 5 seconds then go out (press the press switch again to reset this).

Customer Service

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e-mail: help@elenco.com

Project Listings

Project Listings

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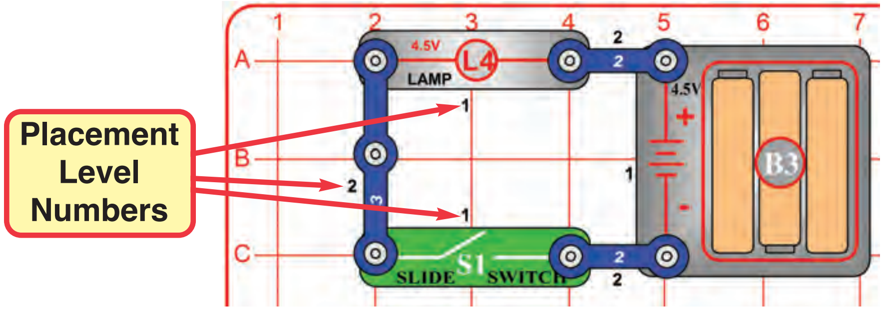
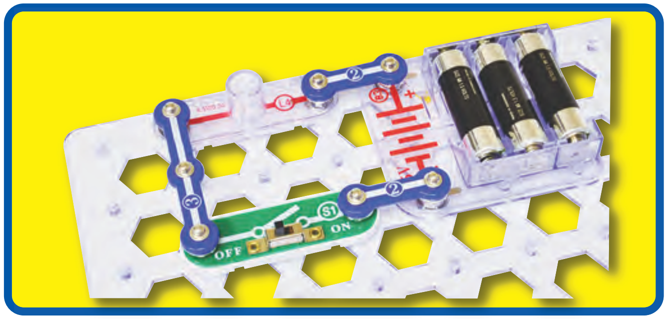
Project #1

Electric Light & Switch

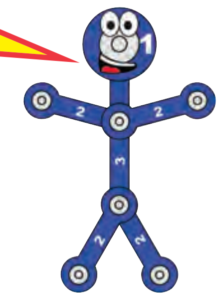




Circuit Maker Sound Plus 200 uses electronic blocks that snap onto a clear plastic grid to build different circuits. These blocks have different colors and numbers on them so that you can easily identify them.

Build the circuit shown on the left by placing all the parts with a black **1** next to them on the board first. Then, assemble parts marked with a **2**. Install three (3) "AA" batteries (not included) into the battery holder (B3). Turn on the slide switch (S1); the lamp (L4) lights.

When you close the slide switch (S1), current flows from the batteries through the lamp and back to the battery through the switch. The closed switch completes the circuit. In electronics this is called a closed circuit. When the switch is opened, the current can no longer flow back to the battery, so the lamp goes out. In electronics this is called an open circuit.



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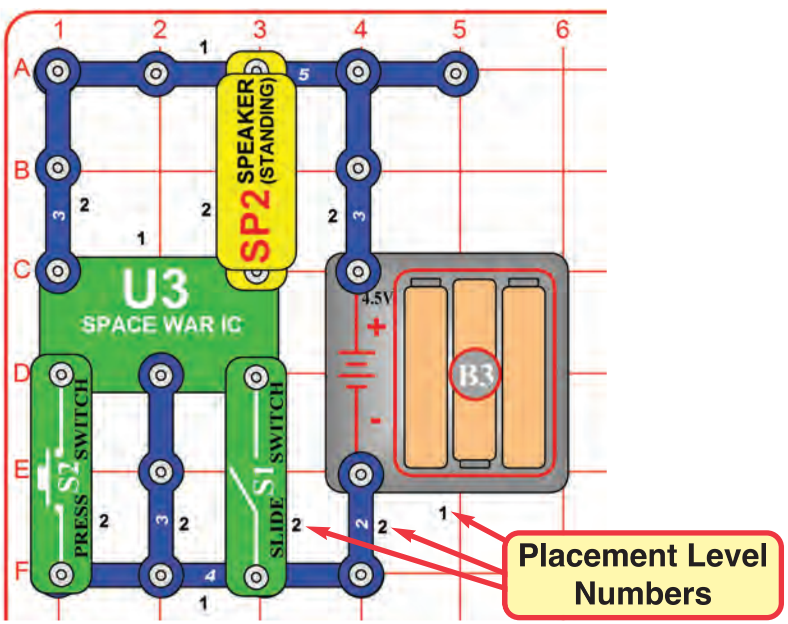
Project #2

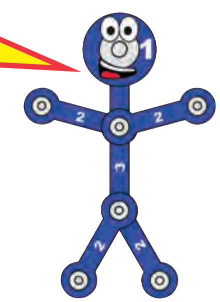
Space War



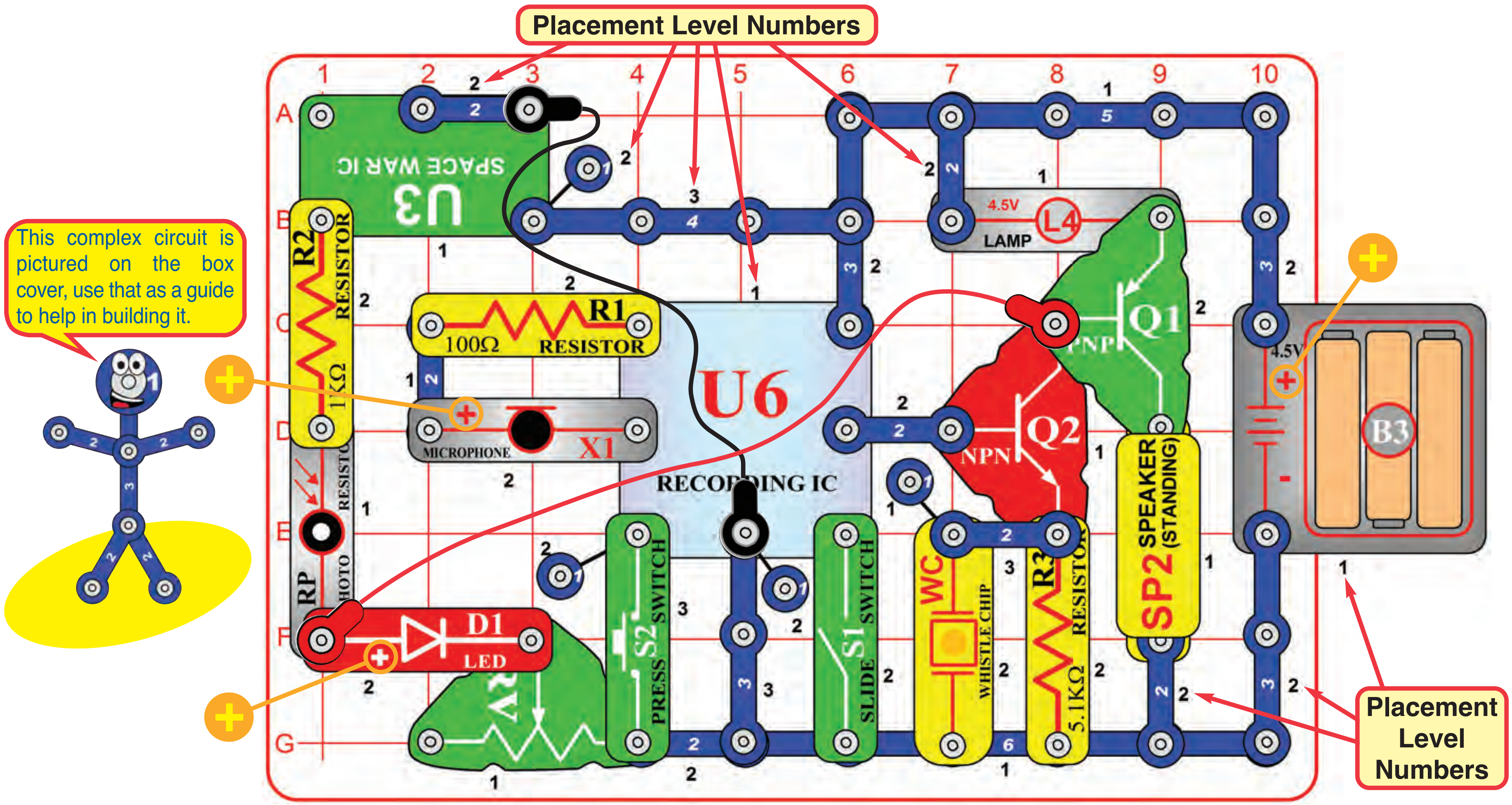
Build the circuit shown on the left, which uses the space war integrated circuit (U3). Activate it by flipping the slide switch (S1) or pressing the press switch (S2); do both several times and in combination. You will hear an exciting range of sounds, as if a space war is raging!

Like the other integrated circuits, the space war IC is a super-miniaturized electronic circuit that can play a variety of cool sounds stored in it by using just a few extra components.

In movie studios, technicians are paid to insert these sounds at the precise instant a gun is fired. Try making your sound occur at the same time an object hits the floor. It is not as easy as it sounds.



Project #3 Electronic Playground



Circuit Maker Sound Plus 200 uses electronic blocks that snap onto a clear plastic grid to build different circuits. These blocks have different colors and numbers on them so that you can easily identify them.

Build the circuit shown above by placing all the parts with a black **1** next to them on the board first. Then, assemble parts marked with a **2**. Then, assemble parts marked with a **3**. Install three (3) “AA” batteries (not included) into the battery holder (B3).

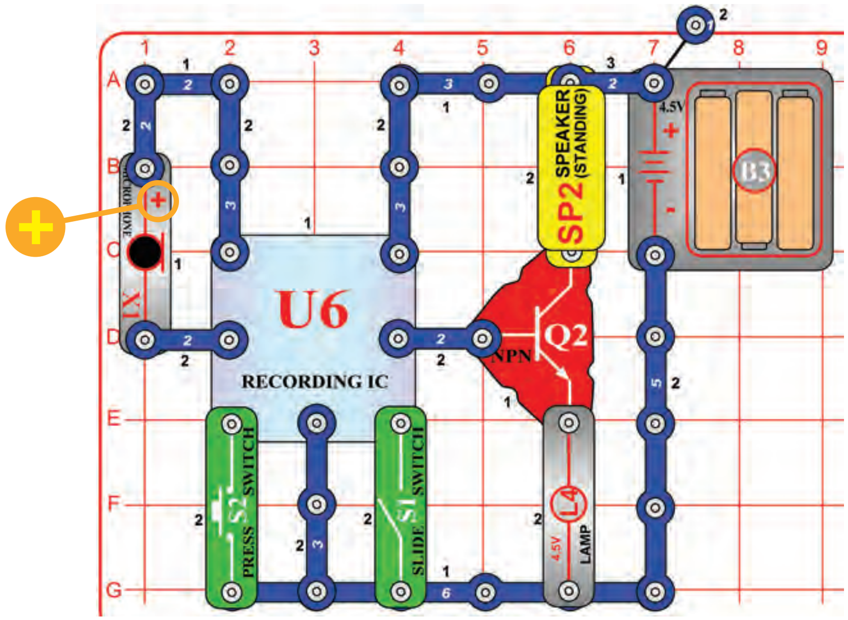
If there is light on the photoresistor (RP) then you will hear a bomb sound. Move the lever on the adjustable resistor (RV) to adjust the volume.

Push the press switch (S2) to play a recorded message followed by music, press it again to stop the music. Move the lever on the adjustable resistor to adjust the volume.

Turn on the slide switch (S1), you hear a beep signaling that you may begin recording. Talk into the microphone (X1) up to 5 seconds, and then turn off the slide switch (it also beeps after the 5 seconds expires).

The lamp (L4) will not light. The red LED (D1) will light at some settings on RV.

Project #4 Playback & Record



Build the circuit shown. Turn on the slide switch (S1), you hear a beep signaling that you may begin recording. Talk into the microphone (X1) up to 5 seconds, and then turn off the slide switch (it also beeps after the 5 seconds expires).

Press the press switch (S2) for playback. It plays the recording you made followed by one of three songs. If you press the press switch before the song is over, music will stop. You may press the press switch several times to play all three songs. The lamp (L4) is used to limit current and will not light.

Project #5 Light-Controlled Music

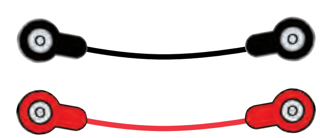
Use the circuit in Project #4. Replace the press switch (S2) with the photoresistor (RP), then turn on the slide switch (S1). Turn the music on and off by waving your hand over the photoresistor.

Project #6 Touch-Controlled Music

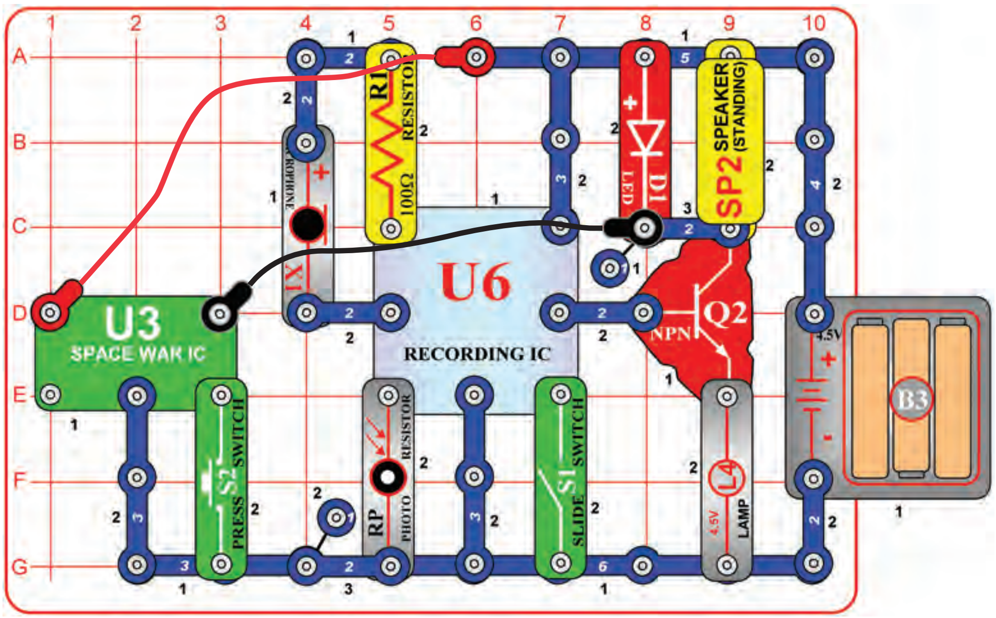
Use the circuit in Project #4. Place a single snap on base grid point F1. Replace the press switch (S2) with the PNP transistor (Q1, with the arrow on point E2) and then turn on the slide switch (S1). Turn the music on and off by touching points F1 & G2 at the same time. You may need to wet your fingers.

Project #7 Water Alarm

Use the circuit in Project #4. Make a new recording warning that you detected water. Remove the press switch (S2) and connect the ends of the red and black jumper wires where it had been. Place the other ends of the jumper wires into a cup of water to activate your alarm.



Project #8 Fun with Sounds



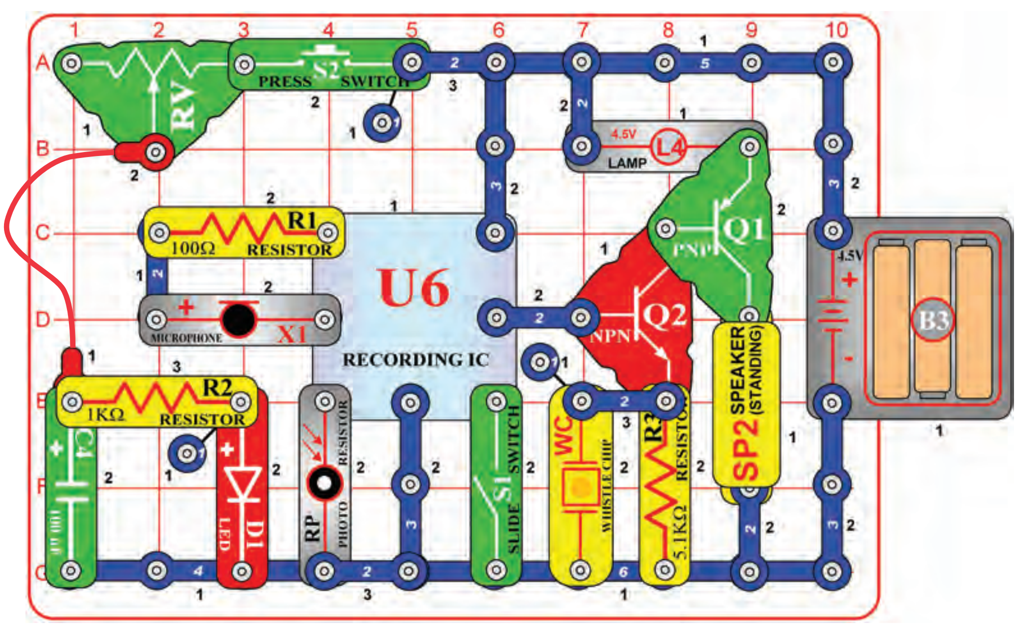
Uncover the photoresistor (RP) to play a recorded message followed by music, cover it to stop the music.

Turn on the slide switch (S1), you hear a beep signaling that you may begin recording. Talk into the microphone (X1) up to 5 seconds, and then turn off the slide switch (it also beeps after the 5 seconds expires).

Push the press switch (S2) several times to make space war sounds.

The red LED (D1) lights when there is sound. The lamp (L4) will not light.

Project #9 Playground



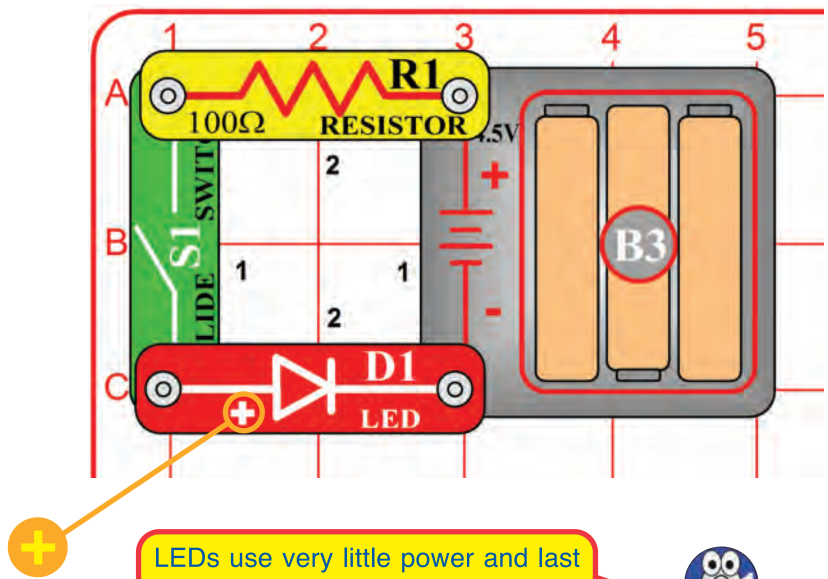
Uncover the photoresistor (RP) to play a recorded message followed by music, cover it to stop the music.

Turn on the slide switch (S1), you hear a beep signaling that you may begin recording. Talk into the microphone (X1) up to 5 seconds, and then turn off the slide switch (it also beeps after the 5 seconds expires).

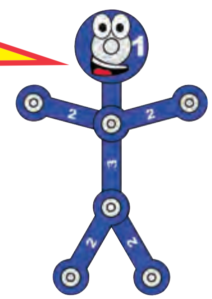
Set the lever on the adjustable resistor (RV) to the right. Push and release the press switch (S2); the red LED (D1) lights but doesn't goes out instantly. The lamp (L4) will not light.

If you swap the resistors (R1) and (R3) then the lamp will light, but the recording quality will be worse.

Project #10 Light Emitting Diode



LEDs use very little power and last for thousands of hours. That's why they replaced the standard light bulb in many products today.



Build the circuit shown on the left by placing all the parts with a black **1** next to them on the board first. Then, assemble parts marked with a **2**.

When you close the slide switch (S1), current flows from the batteries through the switch, through the resistor, through the LED (light emitting diode) and back to the battery. The closed switch completes the circuit. The resistor limits the current and prevents damage to the LED. NEVER PLACE AN LED DIRECTLY ACROSS THE BATTERY! If no resistor is in the circuit, the battery may push enough current through the LED to damage the semiconductor that is used to produce the light. LEDs are used in all types of electronic equipment to indicate conditions and pass information to the user of that equipment.

Reverse the position of the LED (so the "+" is on the right) and turn on the circuit - nothing happens. Since the LED is in backwards, current cannot flow. The LED is like a check valve that lets current flow in only one direction. Return the LED to the original position in the diagram.

Can you think of something you use every day that has an LED in it?

Project #11 Dim Light

Use the circuit from Project #10, but replace the 100Ω resistor (R1) with the 1KΩ resistor (R2). The LED is not as bright now because the resistance is higher. Now replace the 1KΩ resistor (R2) with the 5.1KΩ resistor (R3). The LED is even dimmer now because the resistance is even higher.

Project #12 Light Changing Light

Use the circuit from Project #10, but replace the 5.1KΩ resistor (R3) with the photoresistor (RP). Vary the brightness of the LED by adjusting how much light shines on the photoresistor.

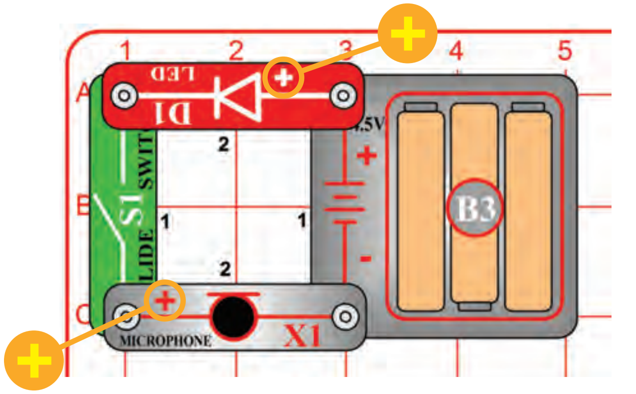
The photoresistor changes its resistance depending on how much light shines on it.

Project #13

Microphone Control

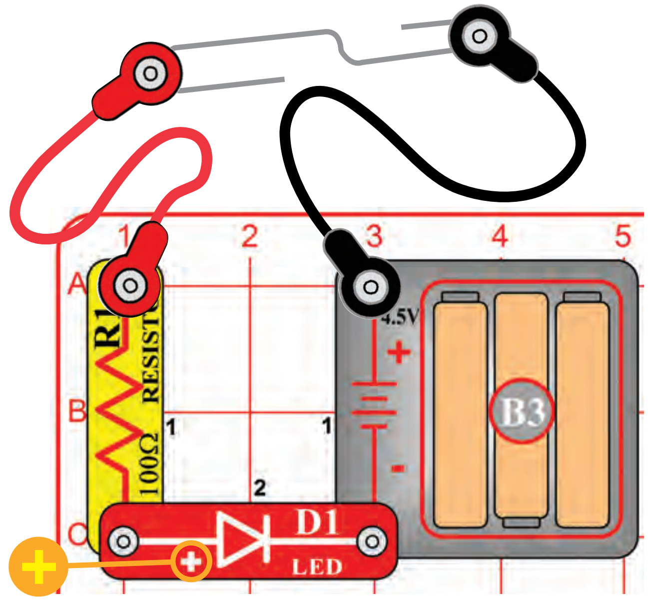
In this circuit, blowing on the microphone (X1) changes the LED (D1) brightness.

The resistance of the microphone changes when you blow on it. You can replace the microphone with one of the resistors to see what resistor value it is closest to.



Project #14

Conduction Detector

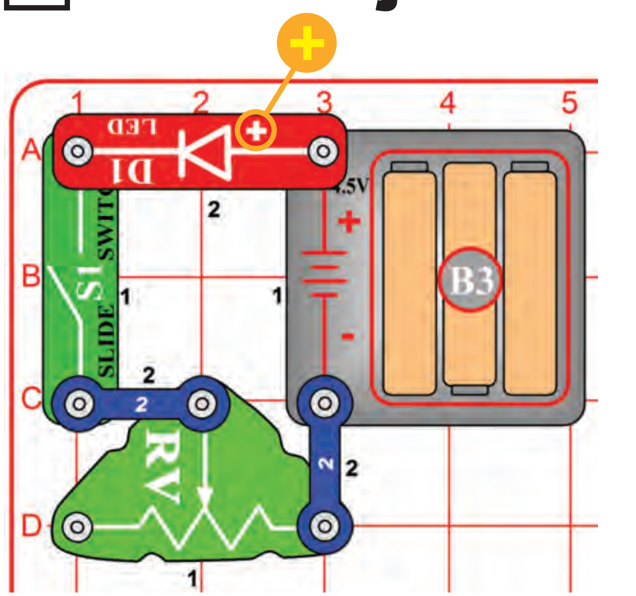


Build the circuit, but leave the ends of the red and black jumper wires unconnected at first.

When you place a paper clip (not included) across the loose ends of the jumper wires as shown, current flows from the batteries through the resistor, through the LED, and back to the battery. The paper clip completes the circuit and current flows through the LED. Place your fingers across the terminals and the LED does not light. Your body is too high of a resistance to allow enough current to flow to light the LED. If the voltage, which is electrical pressure, was higher, current could be pushed through your fingers and the LED would light. This detector can be used to see if materials like plastic, wood, cloth, aluminum, or paper are a good conductor or a poor conductor.

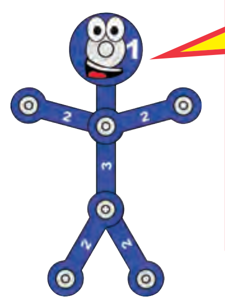
Project #15

Adjustable Brightness



In this circuit, changing the adjustable resistor (RV) setting changes the brightness of the LED (D1).

The lever on RV adjusts how much resistive material the electric current flows through.



Resistors are used to control or limit the flow of electricity in a circuit. Higher resistor values reduce the flow of electricity in a circuit.

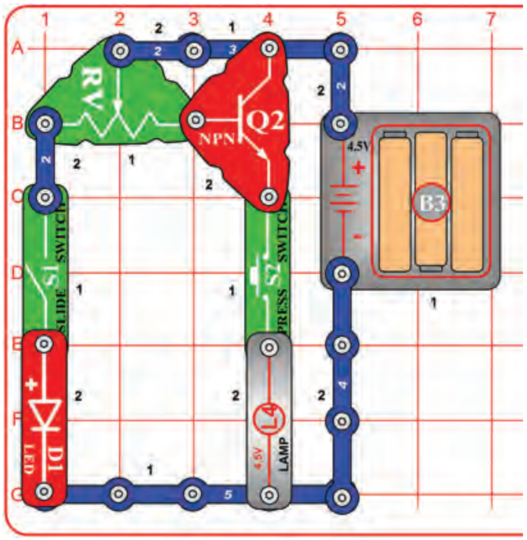
In this circuit, the adjustable resistor is used to adjust the LED brightness, to limit the current so the batteries last longer, and to protect the LED from being damaged by the batteries.

What is Resistance? Take your hands and rub them together very fast. Your hands should feel warm. The friction between your hands converts your effort into heat. Resistance is the electrical friction between an electric current and the material it is flowing through.

The adjustable resistor can be set for as low as 200Ω, or as high as 50,000Ω (50kΩ).

Project #16

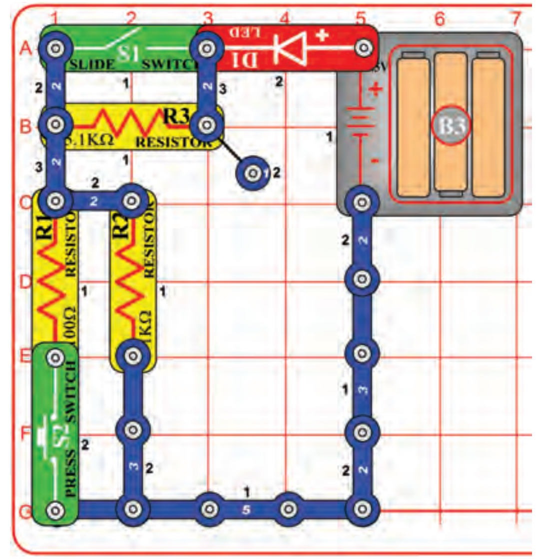
Red & White Control



Turn on the circuit using the slide switch (S1) and/or the press switch (S2) and move the adjustable resistor's (RV) control lever around to adjust the brightness of the D1 and L4. When the adjustable resistor is set to one side, that side will have low resistance and its light turns (assuming the switch on that side is ON) on while the other is OFF.

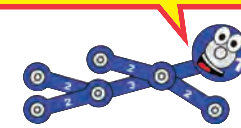
Project #17

Current Controllers



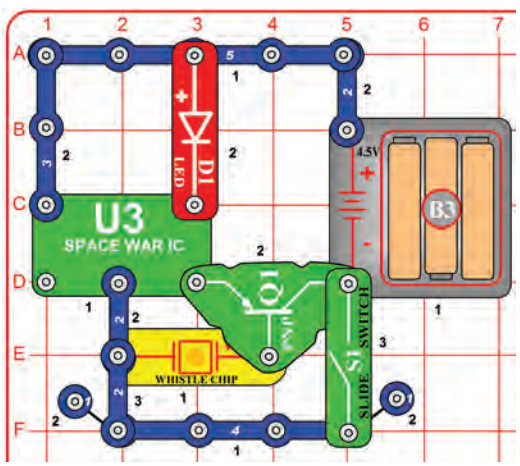
Build the circuit and turn on the slide switch (S1), the LED (D1) will be lit. To increase the LED brightness, turn on the press switch (S2). To decrease the LED brightness, turn off the slide switch.

With the slide switch on, the 1KΩ resistor (R2) controls the current. Turning on the press switch places the 100Ω resistor (R1) in parallel with it to decrease the total circuit resistance. Turning off the slide switch places the 5.1KΩ resistor (R3) in series with R1/R2 to increase the total resistance.



Project #18

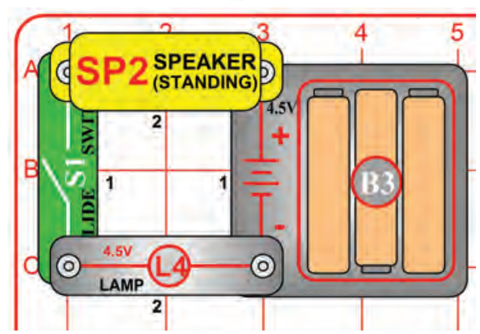
Touch Light



Tap on the whistle chip and the LED flickers. Tap again and the LED may flicker for a longer time. See how long the LED will stay on.

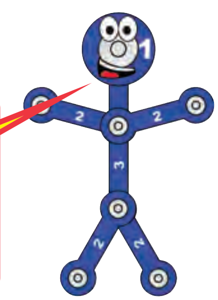
Project #19

Speaker Static

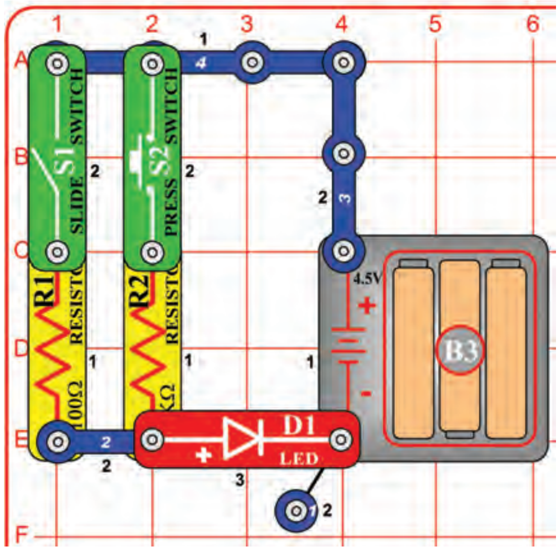


Turn the slide switch (S1) on and off several times. You hear static from the speaker (SP2) when you first turn on the switch, but hear nothing after it is left on.

The speaker uses electromagnetism to create changes in air pressure, which your ears feel and interpret as sound. Think of the speaker as creating pressure waves in the air just like waves in a pool. You only see waves in the pool when you disturb the water, so the speaker only makes sound when the voltage changes.



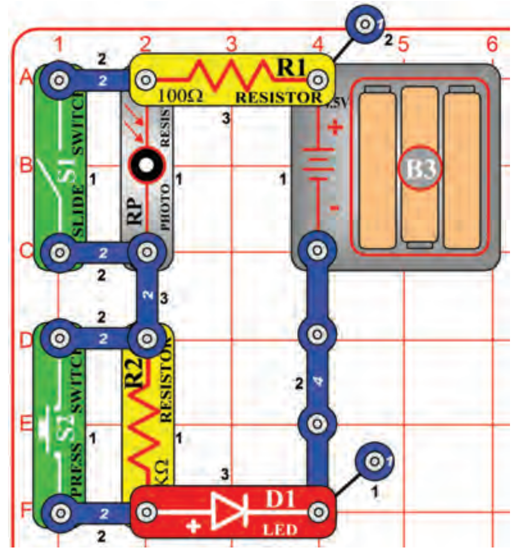
Project #20
Parallel Resistors



Turn on either or both switches (S1 & S2) and compare the LED (D1) brightness.

This circuit has the 100Ω resistor (R1) and 1KΩ resistor (R2) arranged in parallel. You can see that the smaller 100Ω resistor controls the brightness in this arrangement.

Project #21
Series Resistors



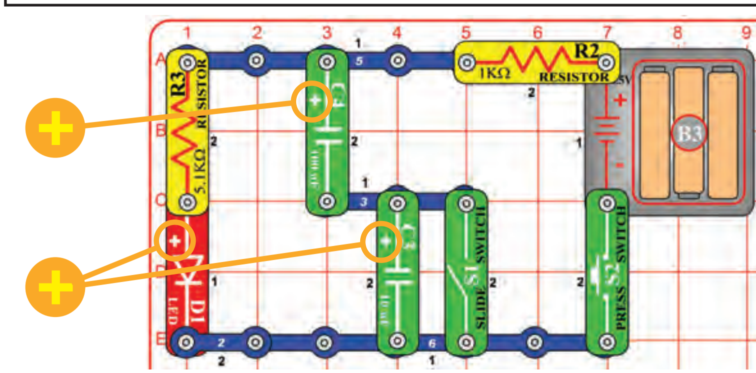
Turn on either or both switches (S1 & S2) and compare the LED (D1) brightness.

This circuit has the 100Ω resistor (R1), the 1KΩ resistor (R2), and the photoresistor (RP) arranged in series. You can see that the larger photoresistor controls the brightness in this arrangement (the resistance of the photoresistor will be much higher than the others, unless the light is very bright).

Project #22 Capacitors in Series

Turn on the slide switch (S1), then press and release the press switch (S2). The LED (D1) becomes bright when the 100μF capacitor (C4) charges up with the press switch on, then the LED slowly gets dim after you release the press switch.

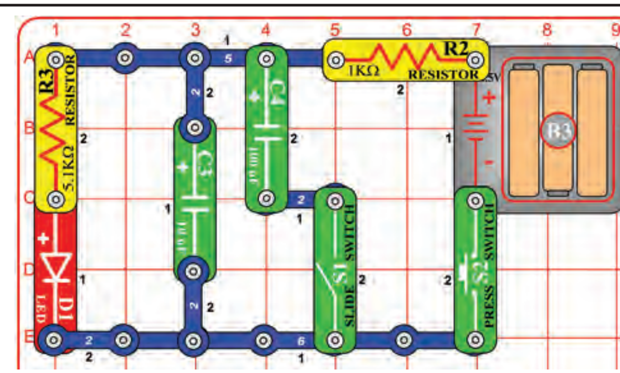
Now turn off the slide switch. Repeat the test with the slide switch off; you'll notice the LED goes out much faster after you release the press switch. The much smaller 10μF capacitor (C3) is now in series with the 100μF and so reduces the total capacitance (electrical storage capacity), and they discharge much faster. (Note that this is opposite to how resistors in series work).



Project #23 Capacitors in Parallel

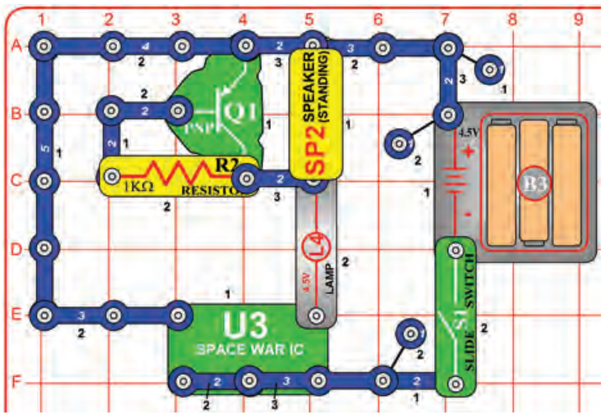
Turn off the slide switch (S1), then press and release the press switch (S2). The LED (D1) becomes bright when the 10μF capacitor (C3) charges up with the press switch on, then the LED slowly gets dim after you release the press switch.

Now turn on the slide switch and repeat the test; you'll notice the LED goes out much slower after you release the press switch. The much larger 100μF capacitor (C4) is now in parallel with the 10μF and so increases the total capacitance (electrical storage capacity), and they discharge much slower. (Note that this is opposite to how resistors in parallel work).

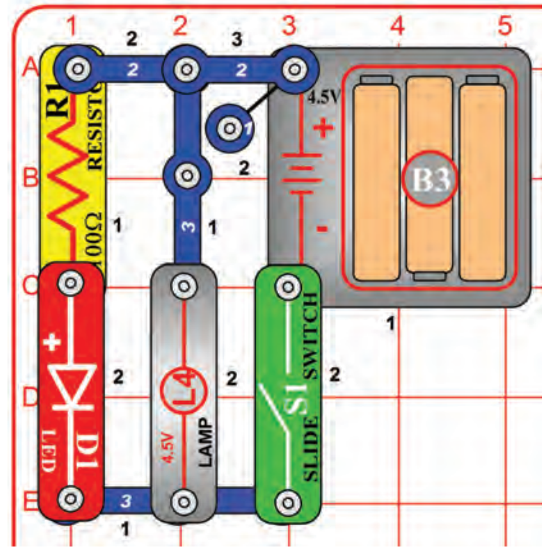


Project #24
Sound & Light in Series

Turn on the slide switch (S1) and the speaker sounds as the lamp (L4) lights. The speaker and lamp are in series. The transistor is used to increase the voltage on the lamp, otherwise it wouldn't light

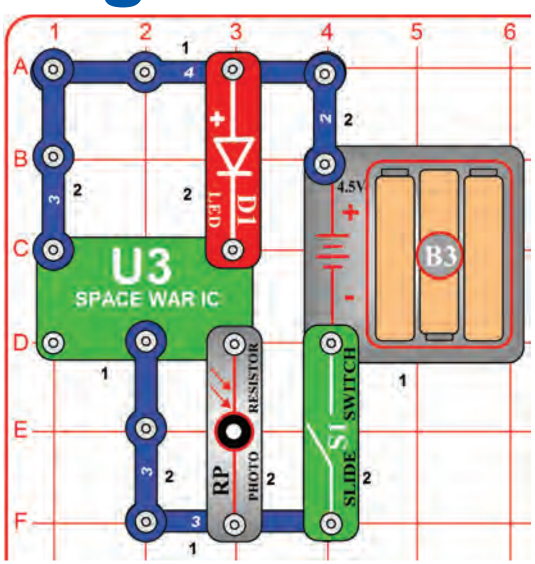


Project #25
Parallel Lamps



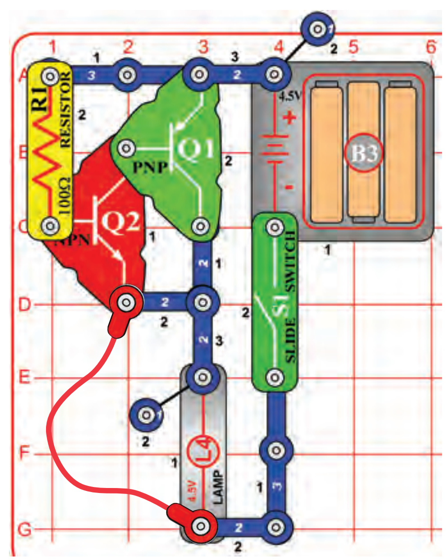
Turn on the slide switch (S1) and the LED (D1) and lamp (L4) light. If one of the them is broken then the other will still be on, because they are in parallel. An example of this is most of the lights in your house; if a bulb is broken on one lamp then the other lamps are not affected.

Project #26
Light-Controlled LED



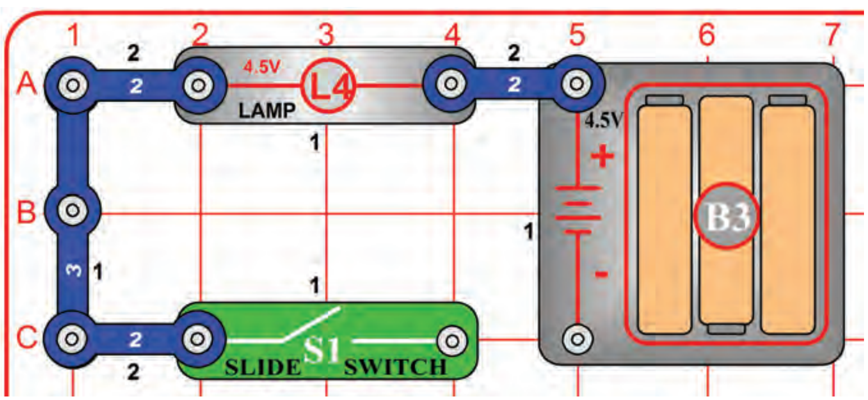
When there is light on the photoresistor (RP), its resistance is low and the LED (D1) will flicker. Shield the photoresistor from the light; the LED should turn off.

Project #27
Two-Transistor Light Alarm



Build the circuit with the jumper connected as shown, and turn it on. Nothing happens. Break the jumper connection and the lamp (L4) turns on. You could replace the jumper with a longer wire and run it across a doorway to signal an alarm when someone enters.

Project #28 The Fuse



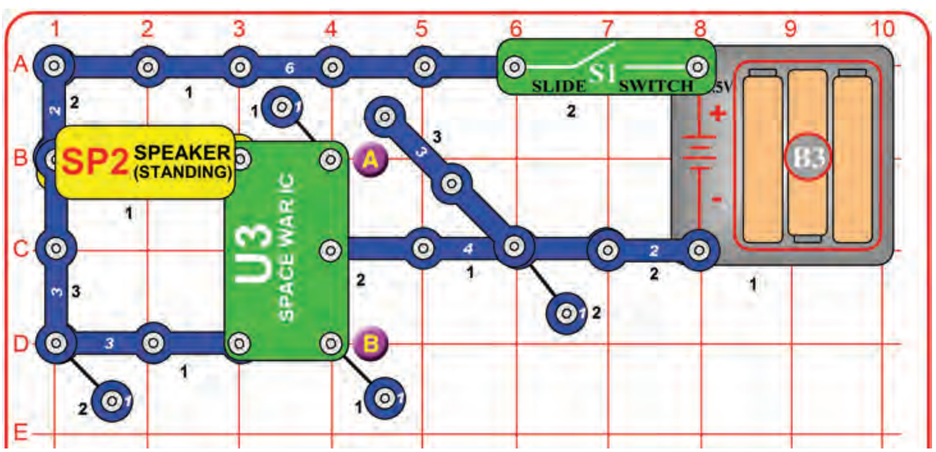
Build the circuit shown. Pretend the 2-snap wire marked fuse in the drawing on the left is a device that will open the circuit if too much current is taken from the battery. With the slide switch (S1) turned on, remove the 2-snap wire marked fuse and notice how the lamp (L4) shuts off. Until the fuse is replaced, the open circuit path protects the electronic parts. If fuses did not exist, many parts could get hot and even start fires. Replace the 2-snap wire and the lamp should light again.

Some fuses contain special wires that break when too much current flows, and need to be replaced after they activate. Other fuses can be reset by flipping a switch.

Many electronic products in your home have a fuse that will open when too much current is drawn. Can you name some?

Actual fuse - if too much current flows then the wire inside melts to break the circuit.

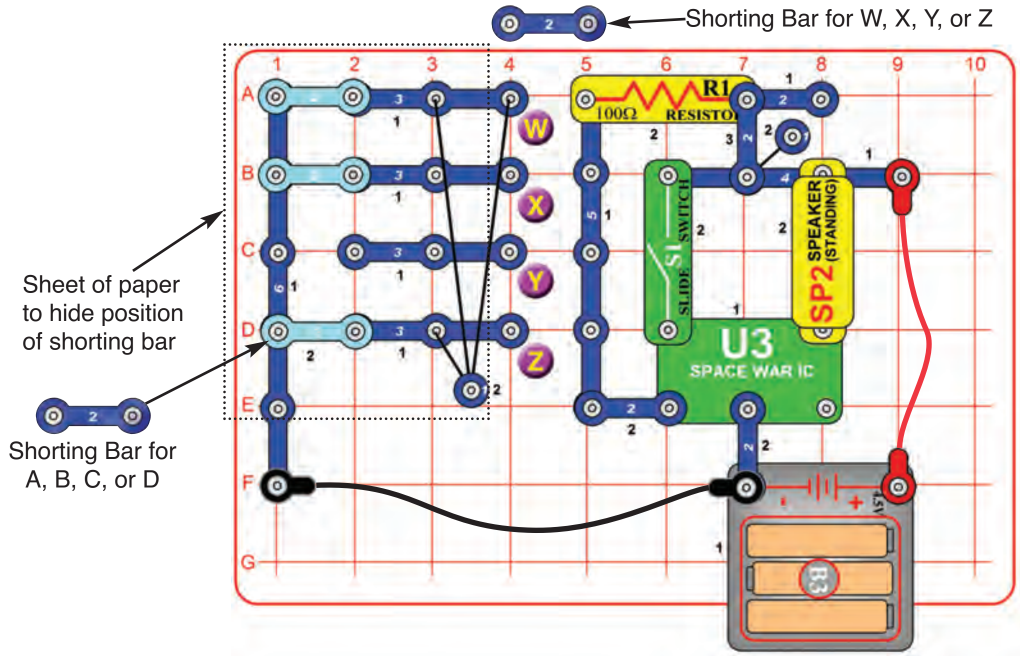
Project #29 Sound by Rotary Switch



Place the 3-snap as shown and turn the switch (S1) on. There should be no sound since the 3-snap is not touching point A or B. Now rotate the 3-snap to points A or B and the speaker sounds.

Today most device use electric switches. Until the early 1970s, mechanical switches were used as channel selectors on television and other electronic equipment.

Project #30 Quiet Zone Game



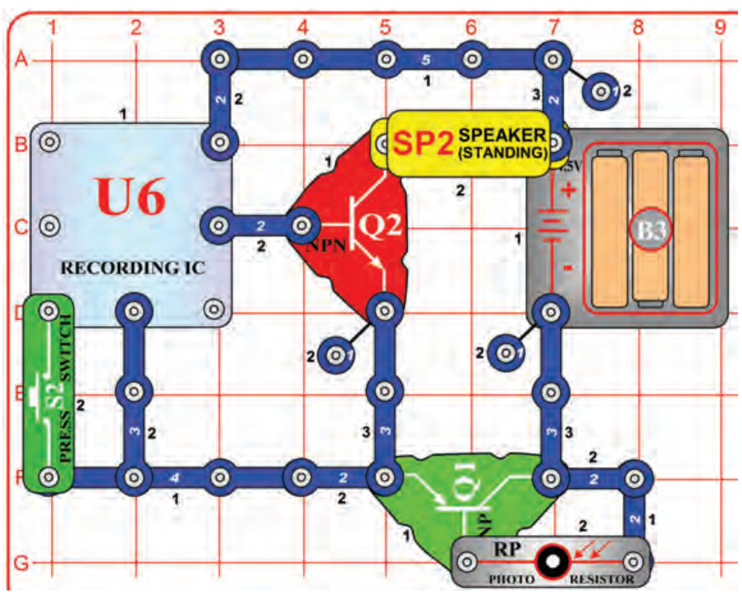
Build the circuit on the left. It uses both jumper wires as permanent connections. It also uses three (3) 2-snap wires ("shorting bars") under paper as shown.

Setup: Player 1 sets the "Quiet Zone" by placing three (3) shorting bars under the paper on row A, B, C, or D, leaving only one open. Player 2 must **NOT** know where the shorting bars are located under the paper.

Both Player 1 and Player 2 are given 10 points. The object is for Player 2 to guess the location of the "Quiet Zone" by placing their shorting bar at positions W, X, Y, or Z. In the drawing on the left, Player 1 sets up the "Quiet Zone" at position "C". If Player 2 places their shorting bar across "Z" on the first try, the sounds played mean they have not found the "Quiet Zone" and they lose 1 point. They have 4 tries to find the zone on each turn. Each time sounds are made, they lose a point.

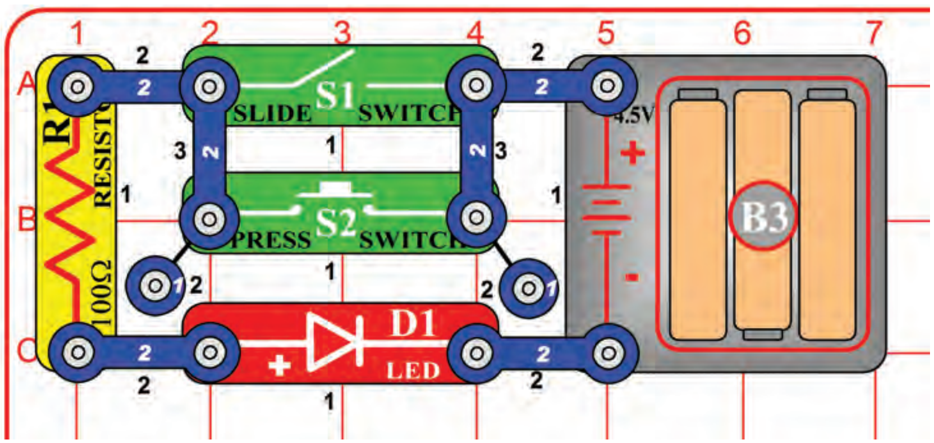
Player 2 then sets the A, B, C, D side and Player 1 starts searching. Play continues until one player is at zero points and makes sound during that player's turn.

Project #31 Music in the Light



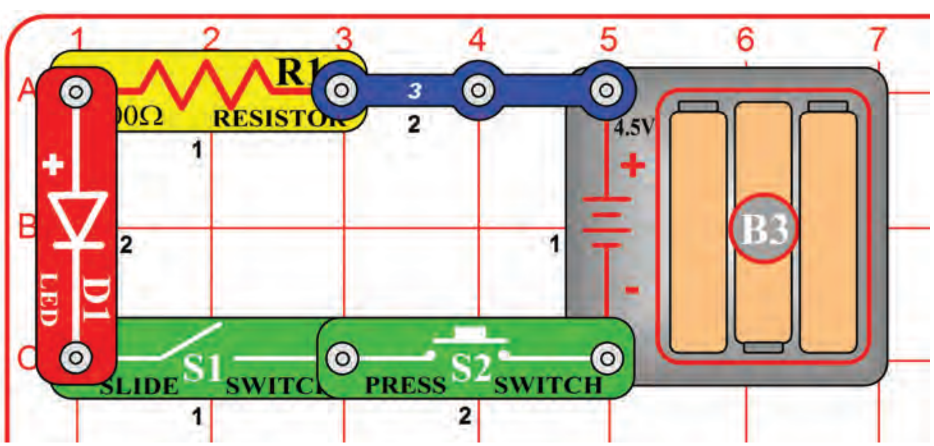
Press the press switch (S2) to play a recording followed by a song. If you press the press switch before the song is over, music will stop. Adjust the amount of light on the photoresistor (RP) to change the volume and alter the tone. Wave your fingers over the photoresistor for some cool sound effects.

Project #32 — This OR That



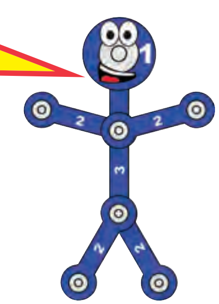
Build the circuit shown. Notice that if you turn on the slide switch (S1) OR press the press switch (S2) the LED (D1) lights up. There is no partially lit state here, the diode is either totally on or totally off. While this may seem very simple and boring, it represents an important concept in electronics. Two switches like this may be used to turn on a light in your house, or they might be two sensors at a railroad crossing used to start the ding-ding sound and lower the gate. You could also have more than two switches and the circuit would function the same way.

Project #33 — This AND That

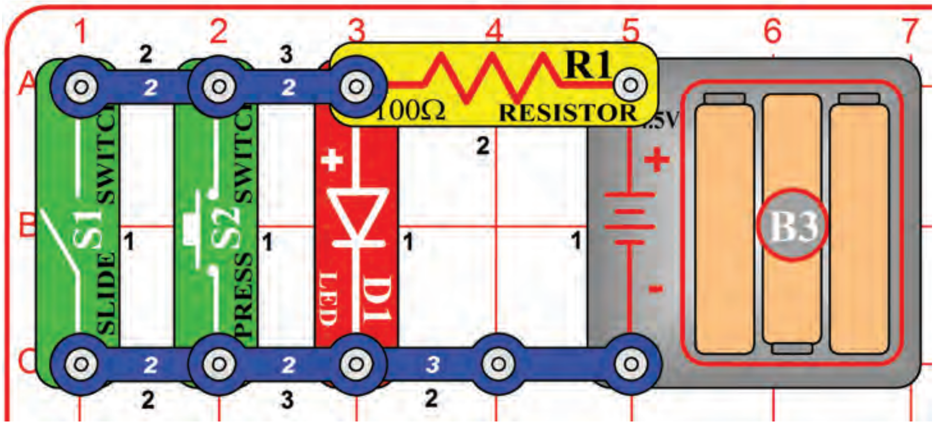


Build the circuit shown. Notice that if you turn on the slide switch (S1) AND press the press switch (S2) the LED (D1) lights up. Once again, there is no partially lit state here, the LED is either totally on or totally off. Two switches like this may be used to turn on the same light in your house, the room switch and the master switch in the electrical box. You could also have more than two switches and the circuit would function the same way.

Combinations of AND and OR circuits are used to add and multiply numbers together in modern computers. These circuits are made of tiny transistors in massive integrated circuits.

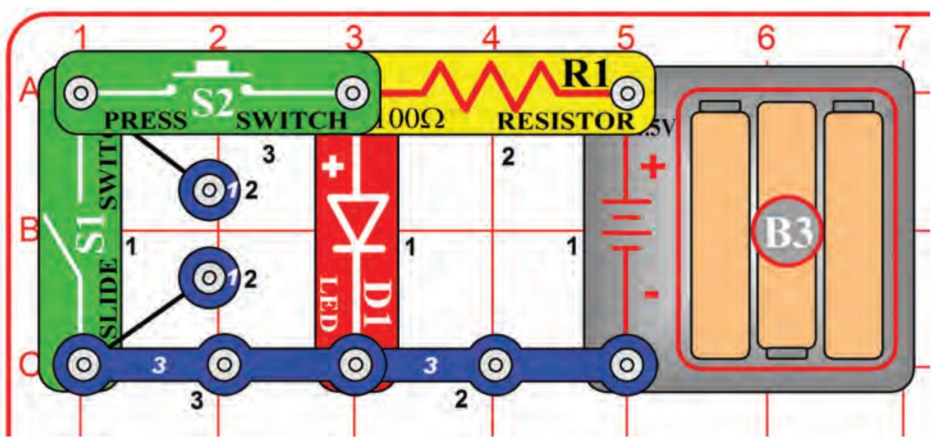


Project #34 Neither This NOR That



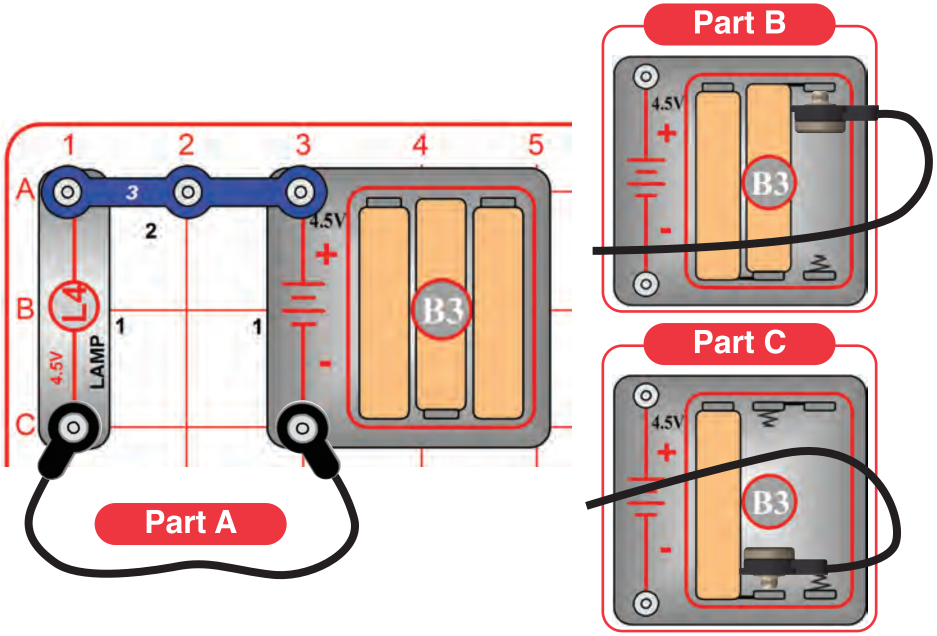
Build the circuit at left and test the combinations of the slide switch (S1) and press switch (S2). If you compare it to the OR circuit in Project #32, you can see the LED (D1) lights in the opposite combinations of that circuit. Hence, we refer to it as a NOR circuit (short for "NOT this OR that"). Like the OR and AND, it is an important building block in computers.

Project #35 NOT This AND That



Build the circuit at left and test the combinations of the slide switch (S1) and press switch (S2). If you compare it to the AND circuit in Project #33, you can see the LED (D1) lights in the opposite combinations of that circuit. Hence, we refer to it as a NAND circuit (short for "NOT this AND that"). This circuit can also have more or less than two inputs, though when it only has one input it is referred to as a NOT circuit. Like the OR, AND, and NOR, NAND and NOT are important building blocks in computers.

Project #36 Batteries in Series



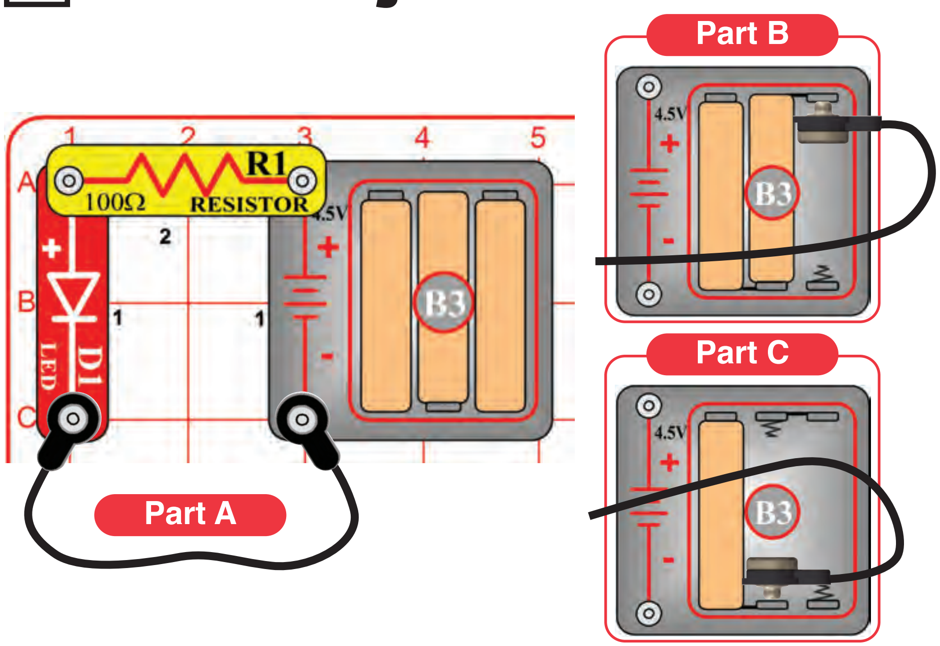
Build the circuit and connect the black jumper wire as shown in Part A. The lamp (L4) is bright because it is powered by three (3) 1.5V "AA" batteries (4.5V total).

Remove the right battery from the holder (B3) and move the end of the black wire to touch the right contact point in the holder as shown in Part B. The lamp is not as bright because now it is only powered by 2 batteries (3V total).

Now also remove the center battery from the holder and move the end of the black wire to touch the center contact point in the holder as shown in Part C. The lamp is dim because now it is only powered by 1 battery (1.5V total).

The batteries in the holder are connected in series to give a higher total voltage.

Project #37 Batteries in Series - LED



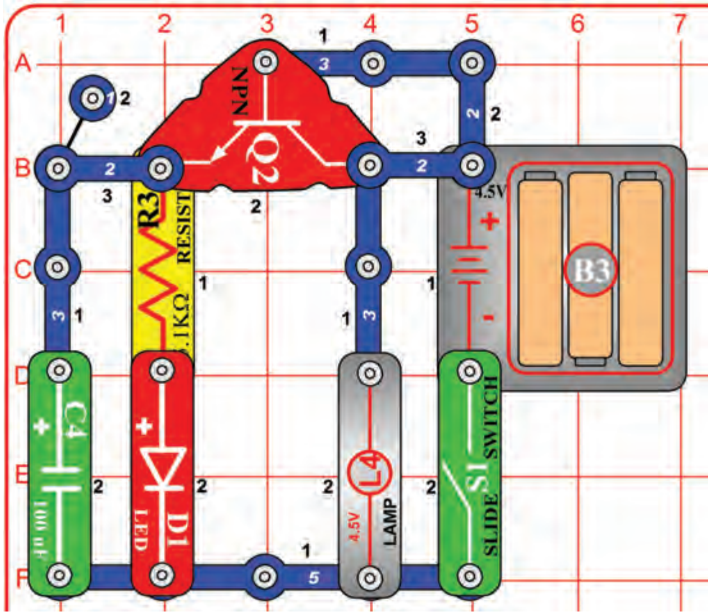
Build the circuit and connect the black jumper wire as shown in Part A. The red LED (D1) is bright because it is powered by three (3) 1.5V "AA" batteries (4.5V total).

Remove the right battery from the holder (B3) and move the end of the red wire to touch the right contact point in the holder as shown in Part B. The red LED is just about as bright because 2 batteries (3V total) give it enough voltage to work properly.

Now also remove the center battery from the holder and move the end of the red wire to touch the center contact point in the holder as shown in Part C. The red LED is dim.

Compare how the LED works here to how the lamp worked in the preceding project.

Project #38 Diode

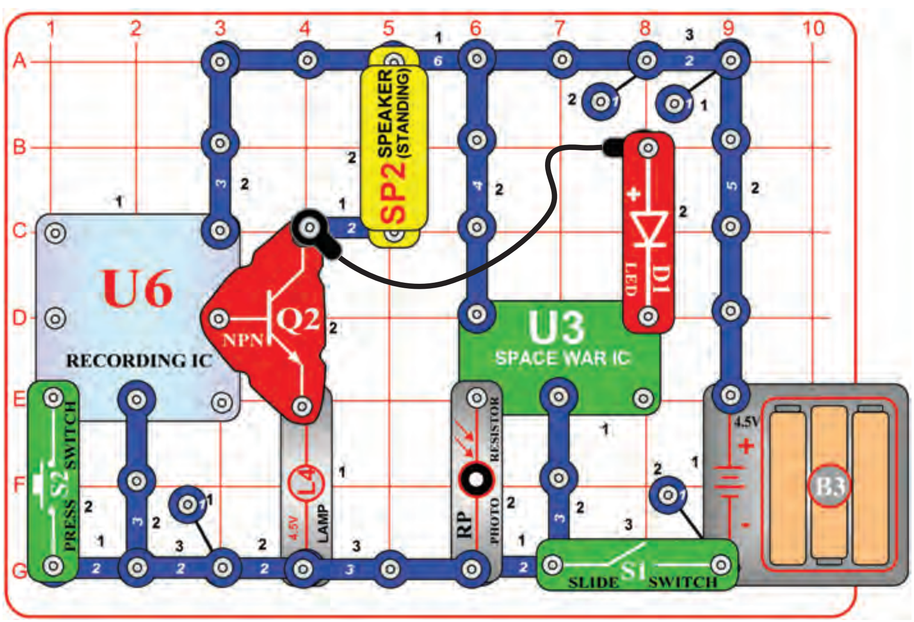


Diodes are electronic components that allow current to flow in only one direction, blocking it in the other. The red LED (D1) are special diodes that can emit light, and the transistors (Q1 & Q2) can also be used as diodes.

Turn on the slide switch (S1), the lamp (L4) will be bright and the LED (D1) will be lit. The NPN transistor (Q2) is used here as a diode, allowing the batteries to charge up the 100μF capacitor (C4) and light the LED.

Turn off the slide switch, the lamp will go dark immediately but the LED will stay lit for a few moments as capacitor C4 discharges through it. The transistor/diode isolates the capacitor from the lamp; if you bypass the transistor by placing a 3-snap wire over it (on level 4 across base grid locations B2-B4) then the lamp will drain the capacitor almost instantly.

Project #39 Musical Space War

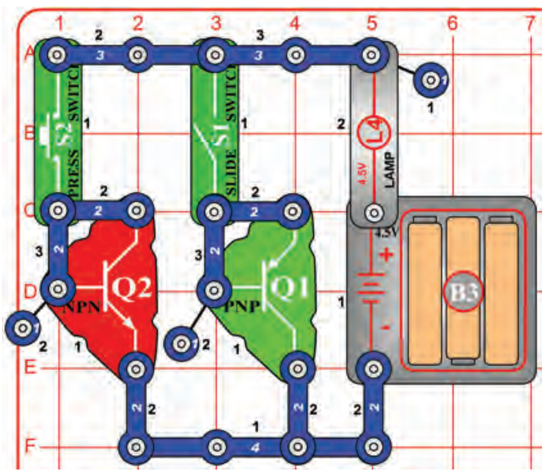


Turn on the slide switch (S1) and you hear space war sounds as the LED (D1) flashes. If you wave your hand over the photoresistor (RP), the sound changes. If you keep the photoresistor covered, then the sound will stop.

Press the press switch (S2) and you will hear music in addition to any space war sounds that are playing. Press the press switch again to change the music. You will also hear any recording you had made previously with other projects.

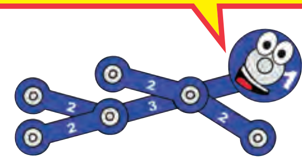
Project #40

Transistor Direction



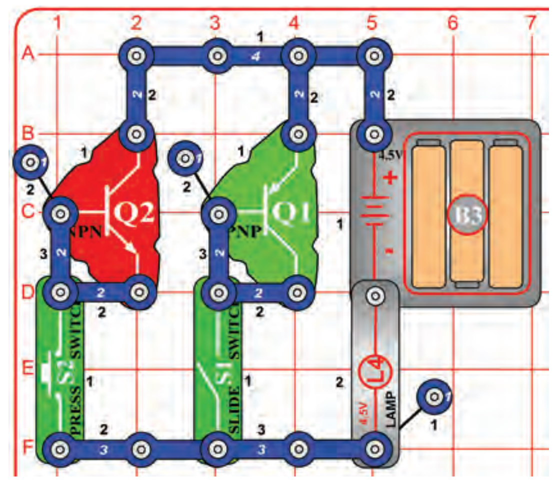
The press switch (S2) controls the NPN transistor (Q2) and can turn on the lamp. The slide switch (S1), however, cannot control the PNP transistor (Q1) and so cannot turn on the lamp.

The two transistors are installed the same way in the circuit but work differently - current can only flow in the direction of the arrow marked on the part.



Project #41

Another Transistor Direction

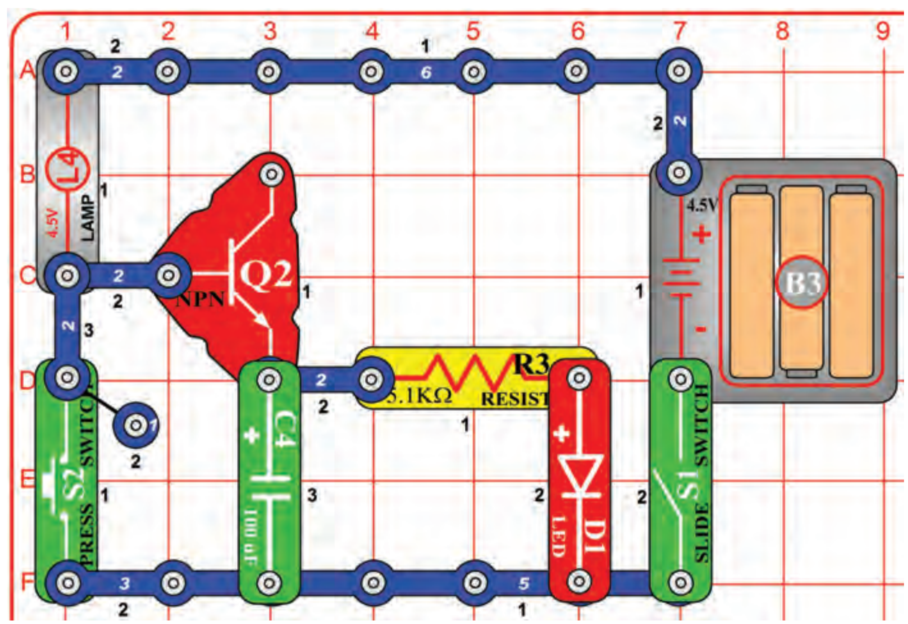


This circuit is similar to the preceding one except for the way the transistors are connected.

Now the press switch (S2) cannot control the NPN transistor (Q2) and so cannot turn on the lamp. The slide switch (S1), however, can control the PNP transistor (Q1) and so does turn on the lamp.

Project #42

Simple Rectifier



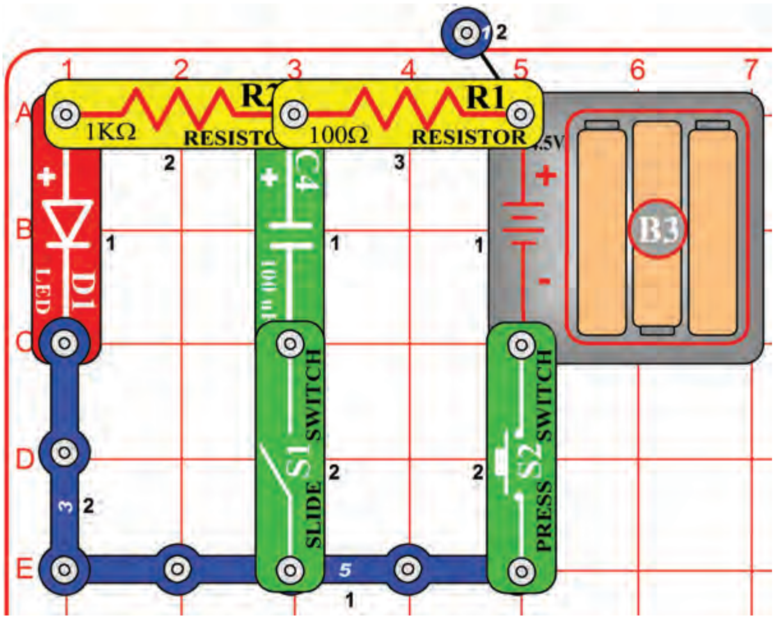
Turn on the slide switch (S1) and the LED (D1) lights; it will not be very bright so turn off the room lights or hold your fingers around it to see it better. Press the press switch (S2) several times very slowly; the LED and lamp (L4) go on and off.

Press the press switch many times quickly - the lamp still goes on and off but the LED stays on. Next, remove the 100μF capacitor (C4) from the circuit - the LED goes on and off now. Why?

Pressing the switch quickly simulates a changing voltage, which turns the LED on and off. The 100μF capacitor can store electricity, and it combines with the NPN transistor (Q2) to simulate a rectifier. This rectifier converts the changing voltage at the press switch into a constant voltage, which keeps the LED on.

The electricity supplied to your home by your electric company is actually a changing voltage. Many electronic products use rectifier circuits to convert this into a constant voltage like a battery provides.

Project #43 Slow Off Switch



Build the circuit, turn on the slide switch (S1), and press the press switch (S2). You see that the LED (D1) doesn't turn off immediately after you release the switch. If you remove the capacitor from the circuit by turning off the slide switch, then the LED goes off immediately.

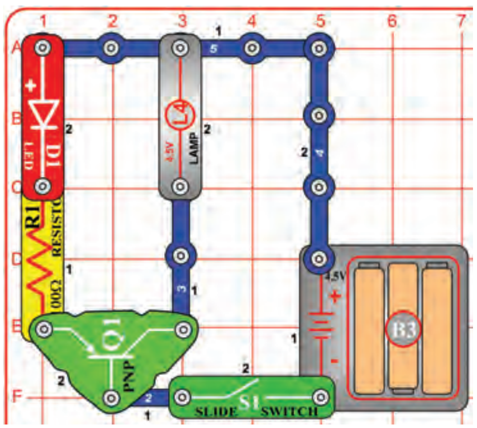
This delay in turning off the LED is caused by the 100μF capacitor (C4). Capacitors can store electricity and are used to delay changes in voltage. They can block unchanging voltages while passing fast-changing voltages.

Project #44 Slower Off Switch

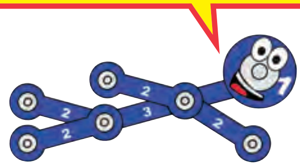
Change the 1KΩ resistor (R2) to the 5.1KΩ resistor (R3). Now the LED (D1) is dimmer but stays on longer.

Project #45 Current Control Q1

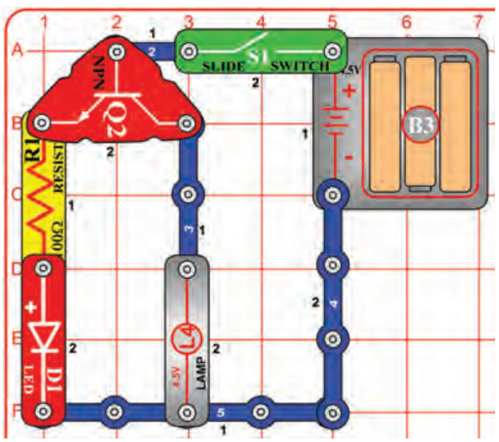
Turn on the slide switch (S1), the LED (D1) and lamp (L4) are bright. This is an unusual circuit which uses the PNP transistor (Q1) as two connected diodes to split the current from the batteries (B3) into the paths with the LED and lamp.



Transistors use a small current to control a large current, and have three connection points (the small current, the larger current, and the combined current). But they are actually constructed using two diodes that are connected together. These diodes are similar to your LED (light emitting diode) except that they don't emit light.

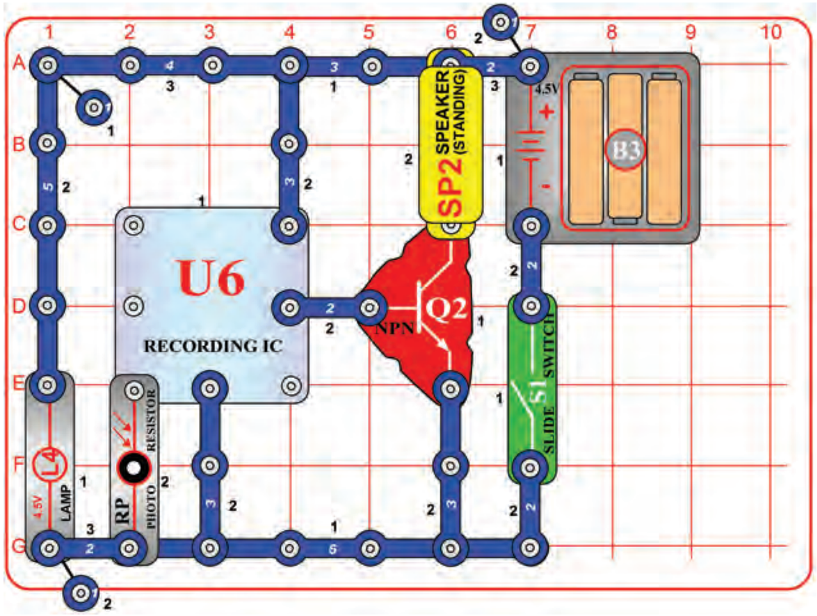


Project #46 Current Control Q2



This circuit is just like the preceding one but it uses the NPN transistor (Q2). The transistor connections are opposite to the NPN transistor (Q2), but otherwise the circuit works the same way.

Project #47 Reflection Detector

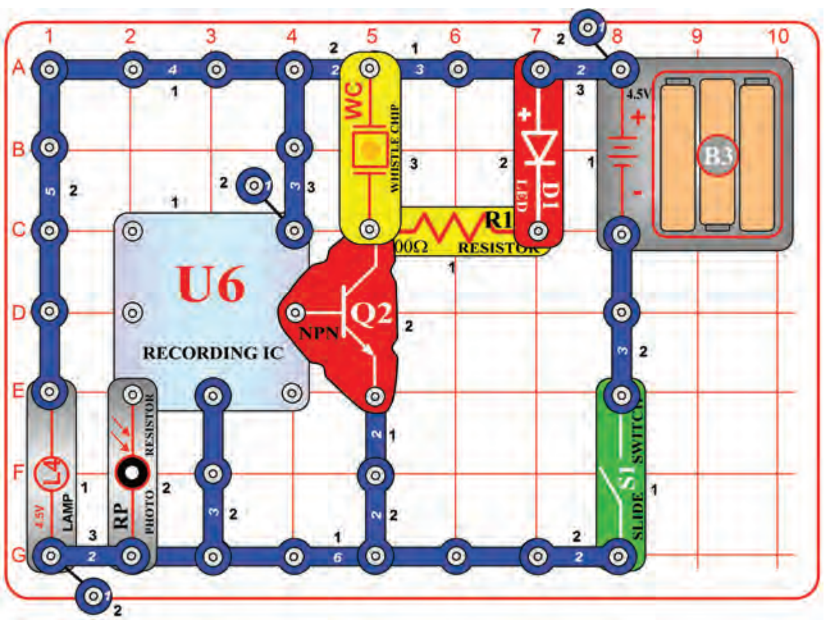


Build the circuit on the left. Place it where there won't be any room light hitting the photoresistor (RP) (such as in a dark room or under a table), and then turn it on. The 4.5V lamp (L4) will be bright but there should be no sound.

Reset the circuit by turning the slide switch (S1) off and back on. Take a small mirror and hold it over the lamp and photoresistor. You should hear sound now as the mirror reflects light from the lamp onto the photoresistor. You have a reflection detector!

The photoresistor is used as a switch here to turn on music from the recording IC (U6).

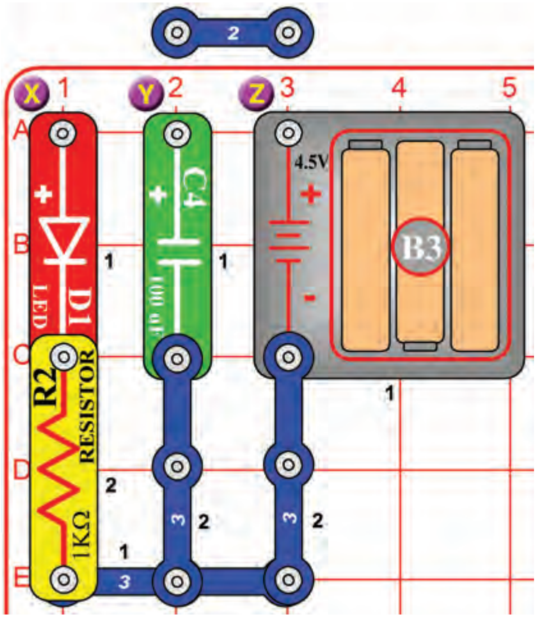
Project #48 Quiet Reflection Detector



Let's modify the reflection detector circuit so that it is not so loud. We'll also put a light on it that can be seen in a noisy room. Build the circuit on the left. Place it somewhere where there won't be any room light hitting the photoresistor (RP) (such as in a dark room or under a table), and then turn it on. The 4.5V lamp (L4) will be bright but there should be little or no sound.

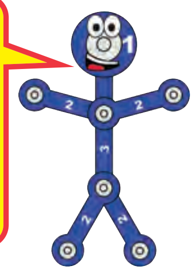
Take a small mirror and hold it over the lamp and photoresistor. You should hear a more faint sound and the LED (D1) should light now as the mirror reflects light from the lamp onto the photoresistor.

☐ Project #49 Make Your Own Battery



Build the circuit, then connect points Y & Z (use a 2-snap wire) for a moment. Nothing appears to happen, but you just filled up the 100μF capacitor (C4) with electricity. Now disconnect Y & Z and instead touch a connection between X & Y. The red LED (D1) will be lit and then go out after a few seconds as the electricity you stored in it is discharged through the LED and resistor (R2).

Notice that a capacitor is not very efficient at storing electricity - compare how long the 100μF kept the LED lit for with how your batteries run all of your projects! That is because a capacitor stores electrical energy while a battery stores chemical energy.



☐ Project #50 Make a Small Battery

In the preceding circuit, replace the 100μF capacitor (C4) with the 10μF capacitor (C3) and repeat the test. You see that the LED (D1) only lights for a moment, because the 10μF capacitor does not store as much electricity as the 100μF.

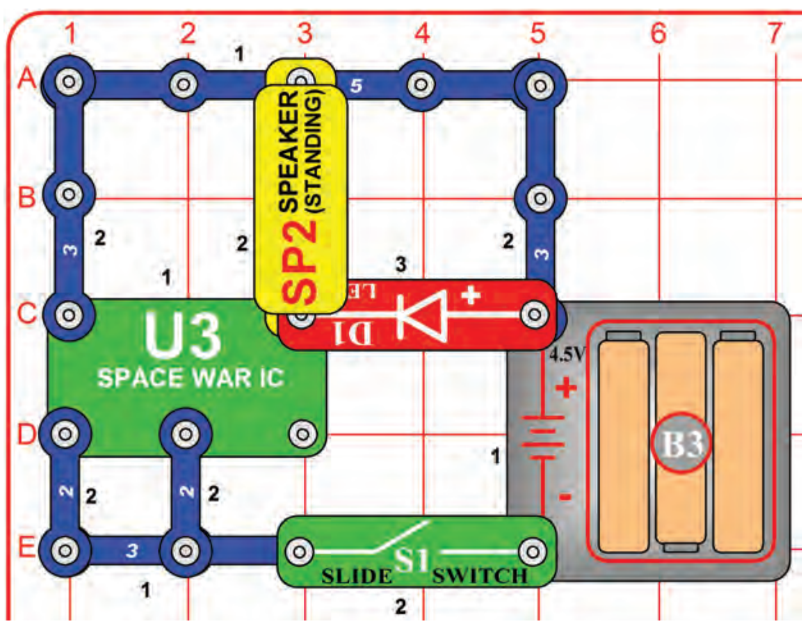
The 0.1μF capacitor (C2) stores very little electricity, so if you replace the 10μF capacitor with it then the LED will not light at all.

☐ Project #51 Make Another Battery

Place the 100μF capacitor (C4) back into the circuit. Now replace the 1KΩ resistor (R2) with the 100Ω resistor (R1) and try it. The LED (D1) gets brighter but goes out faster because less resistance allows the stored electricity to dissipate faster.

You can also change the resistor to the 5.1KΩ resistor (R3). The LED will be dimmer but stay on longer.

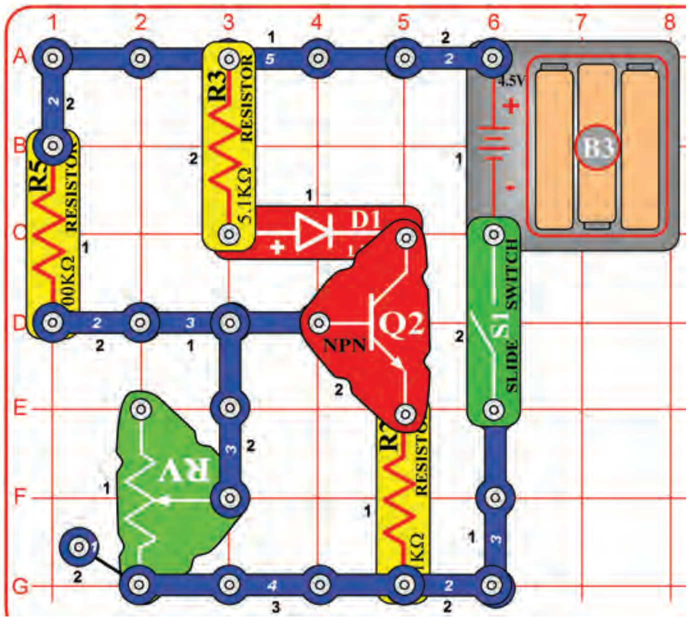
☐ Project #52 Bomb Sound



Turn the switch (S1) on and you hear the sound of a bomb dropping and then exploding. The LED (D1) lights and then flashes as the bomb explodes. This is one sound generated from the space war IC (U3).

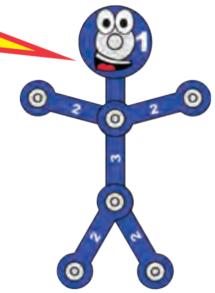
Project #53

Standard Transistor Circuit



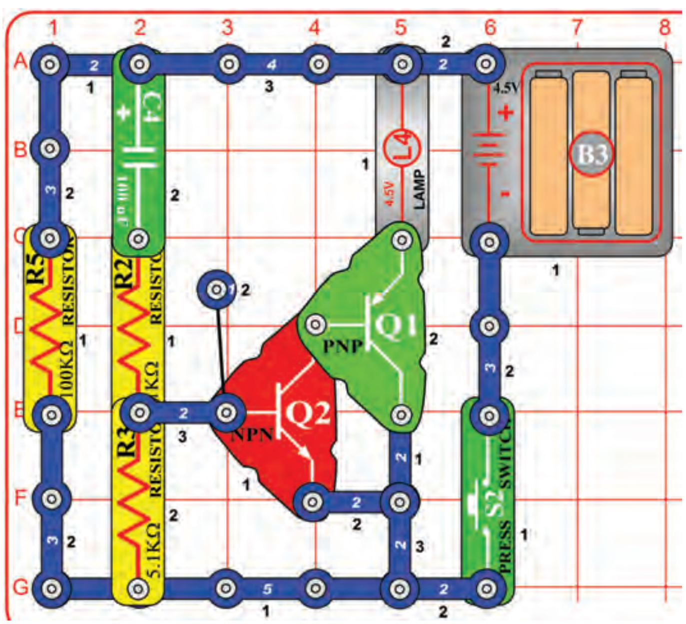
Turn on the slide switch (S1) and move the adjustable resistor (RV) control lever across its range. When the lever is all the way down the LED (D1) will be off, as you move the lever up it will come on and reach full brightness.

This circuit is considered the standard transistor configuration for amplifiers. The adjustable resistor control will normally be set so that the LED is at half brightness, since this minimizes distortion of the signal being amplified.



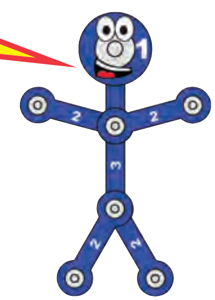
Project #54

Recharge Light

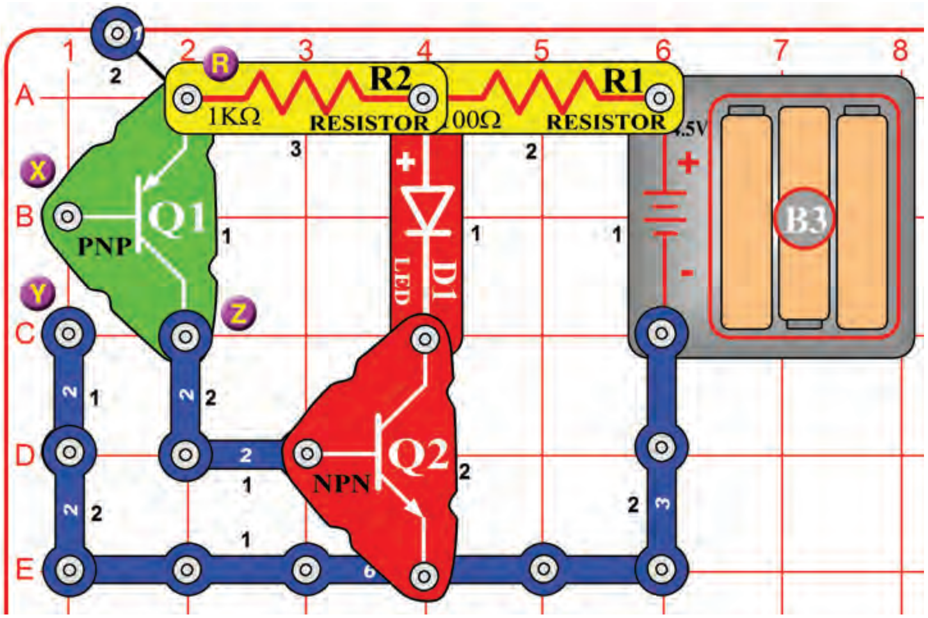


Press the press switch (S2) and the lamp (L4) will be on for a few moments. Wait 5-10 seconds before pressing the switch again, or nothing will happen.

Pressing the switch charges up the 100μF capacitor (C4) turning on transistors Q1 and Q2, and the lamp (L4) lights. Once C4 is charged up, the voltage at Q1 drops and it turns the lamp off. You must wait until C4 discharges to turn the lamp on again.



Project #55 Transistor Amplifiers



When you place one or more fingers across the two snaps marked X & Y you will notice the LED (D1) turns on. The two transistors are being used to amplify the very tiny current going through your body to turn on the LED. Transistors are actually electrical current amplifiers. The PNP transistor (Q1) has the arrow pointing into the transistor body. The NPN transistor (Q2) has the arrow pointing out of the transistor body. The PNP amplifies the current from your fingers first, then the NPN amplifies it more to turn on the LED.

Project #56 Pressure Meter

Use the circuit from Project #55 shown above.

When you placed your fingers across the two snaps marked X & Y you noticed the LED (D1) came on in Project #55. Repeat this process, but this time **press very lightly** on the two snaps marked X & Y. Notice how the brightness of the LED is dependent on the amount of pressure you use. Pressing hard makes the LED bright while pressing very gently makes it dim or even flash. This is due to what technicians call “contact resistance”. Even switches made to turn your lights on and off have some resistance in them. When large currents flow, this resistance will drop the voltage and produce the undesirable side effect of heat.

Project #57 Resistance Meter

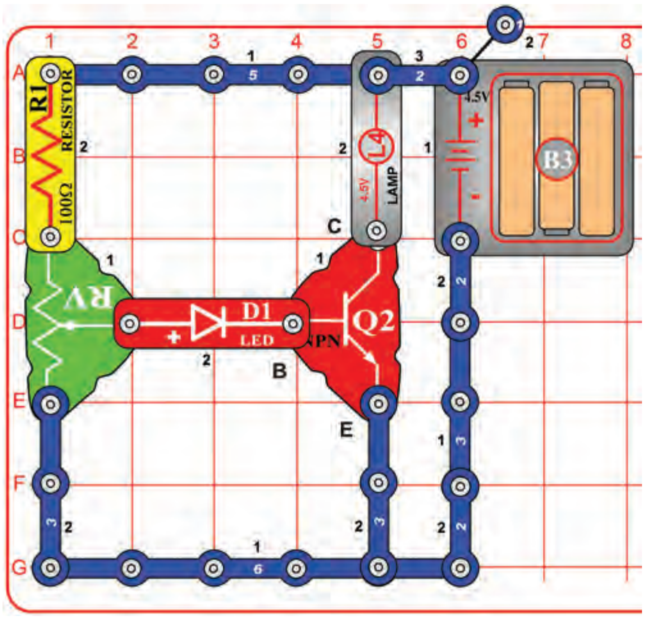
Use the circuit from Project #55 shown above.

When you placed your fingers across the two snaps marked X & Y you noticed the LED (D1) came on in Project #55. In this project, you will place different resistors across R & Z and see how bright the LED glows. Do not snap them in; just press them up against the snaps labeled R & Z in the diagram above.

First, place the 100KΩ resistor (R5) across the R & Z snaps and note the brightness of the LED. Next, press the 5.1kΩ resistor (R3) across R & Z. Notice how the LED gets brighter when the resistance is less. This is because the NPN amplifier (Q2) gets more current at its input when the resistance is lower. The PNP amplifier (Q1) is not used in this test.

Project #58

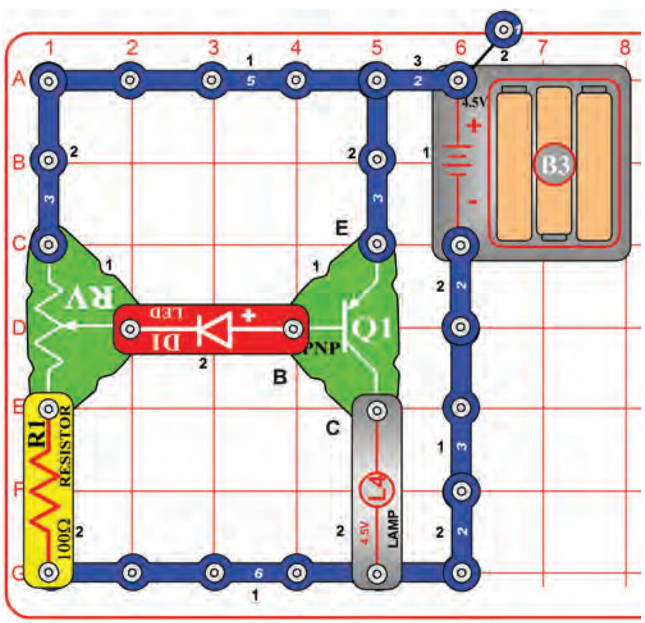
NPN Amplifier



There are three connection points on an NPN transistor (Q2), called base (marked B), emitter (marked E), and collector (marked C). When a small electric current flows from the base to the emitter, a larger (*amplified*) current will flow from the collector to the emitter. Build the circuit and slowly move up the adjustable resistor (RV) control. When the LED (D1) becomes bright, the lamp (L4) will also turn on and will be much brighter.

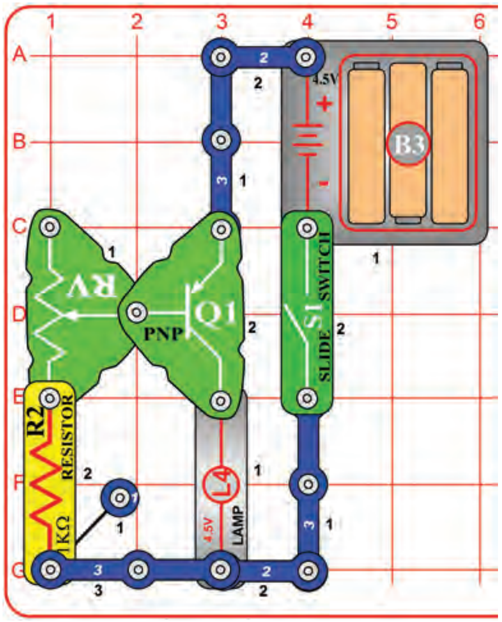
Project #59

PNP Amplifier



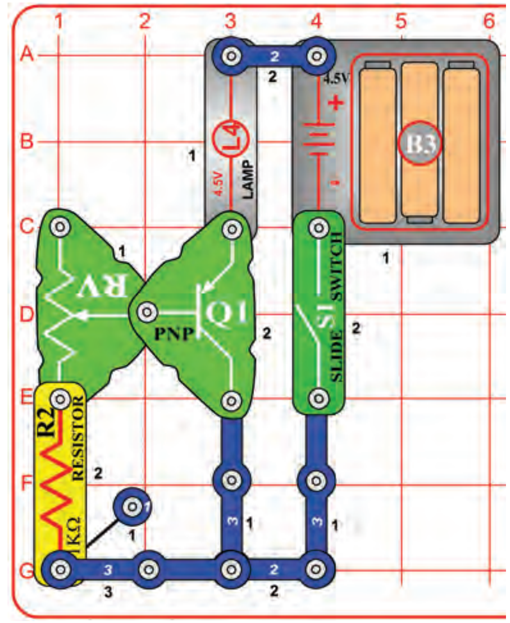
The PNP transistor (Q1) is similar to the NPN transistor (Q2) in the preceding project, except that the electric currents flow in the opposite directions. When a small electric current flows from the emitter to the base, a larger (*amplified*) current will flow from the emitter to the collector. Build the circuit and slowly move up the adjustable resistor (RV) control. When the LED (D1) becomes bright, the lamp (L4) will also turn on and will be much brighter.

☐ Project #60 PNP Collector



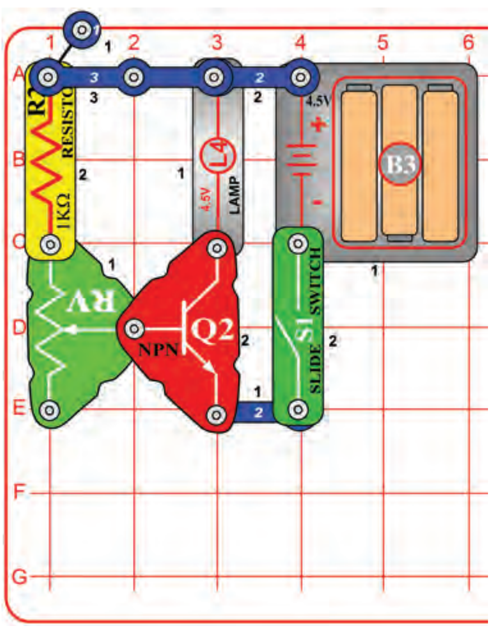
Build the circuit and vary the lamp (L4) brightness with the adjustable resistor (RV), it will be off for most of the resistor's range. The point on the PNP (Q1) that the lamp is connected to (point E3 on the base grid) is called the collector, hence the name for this project.

☐ Project #61 PNP Emitter



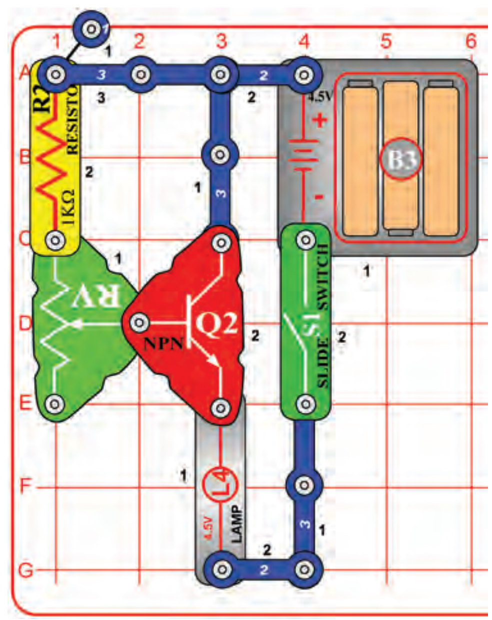
Compare this circuit to that in Project #60. The maximum lamp (L4) brightness is less here because the lamp resistance reduces the emitter-base current, which controls the emitter-collector current. The point on the PNP (Q1) that the lamp is now connected to (grid point C3) is called the emitter.

☐ Project #62 NPN Collector



Compare this circuit to that in Project #60, it is the NPN transistor (Q2) version and works the same way. Which circuit makes the lamp (L4) brighter? (They are about the same because both transistors are made from the same materials).

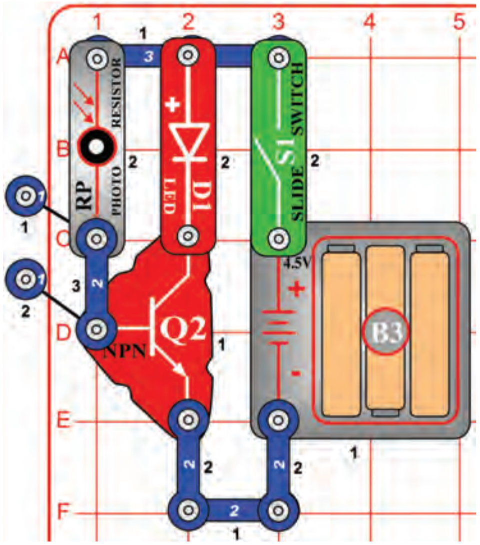
☐ Project #63 NPN Emitter



Compare this circuit to that in Project #61. It is the NPN transistor (Q2) version and works the same way. The same principles apply here as in Projects #60-#62, so you should expect it to be less bright than Project #62 but as bright as Project #61.

Project #64

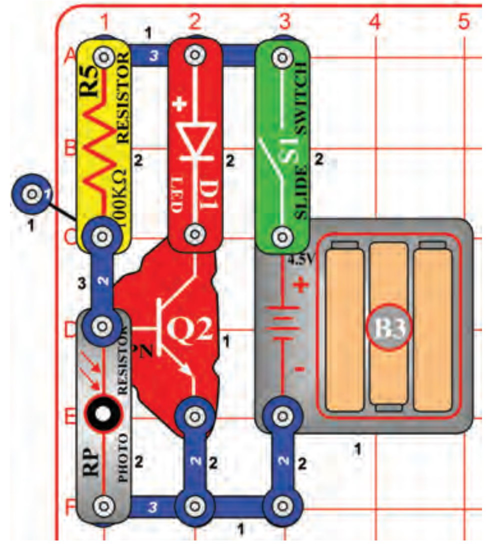
NPN Light Control



Turn on the slide switch (S1), the brightness of the LED (D1) depends on how much light shines on the photoresistor (RP). The resistance drops as more light shines, allowing more current to the NPN (Q2).

Project #65

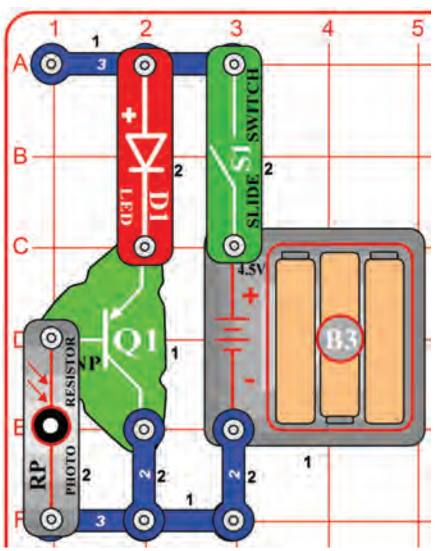
NPN Dark Control



Turn on the slide switch (S1), the brightness of the LED (D1) depends on how LITTLE light shines on the photoresistor (RP). The resistance drops as more light shines, diverting current away from the NPN (Q2).

Project #66

PNP Light Control

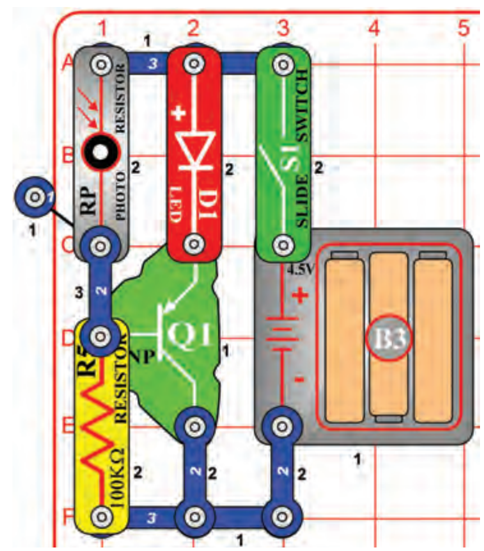


Turn on the slide switch (S1), the brightness of the LED (D1) depends on how much light shines on the photoresistor (RP).

The resistance drops as more light shines, allowing more current through the PNP (Q1). This is similar to the NPN (Q2) circuit above.

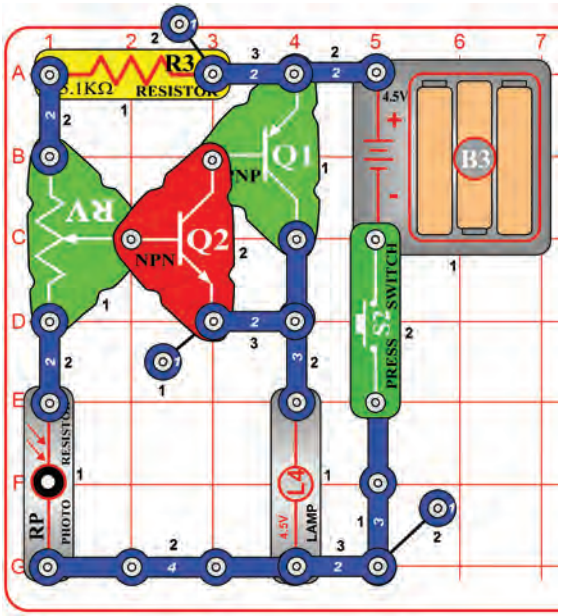
Project #67

PNP Dark Control



Turn on the slide switch (S1), the brightness of the LED (D1) depends on how LITTLE light shines on the photoresistor (RP). The resistance drops as more light shines, so more current gets to the 100kΩ resistor (R5) from the photoresistor path and less from the PNP-diode path. This is similar to the NPN circuit above.

☐ Project #68 Automatic Street Lamp

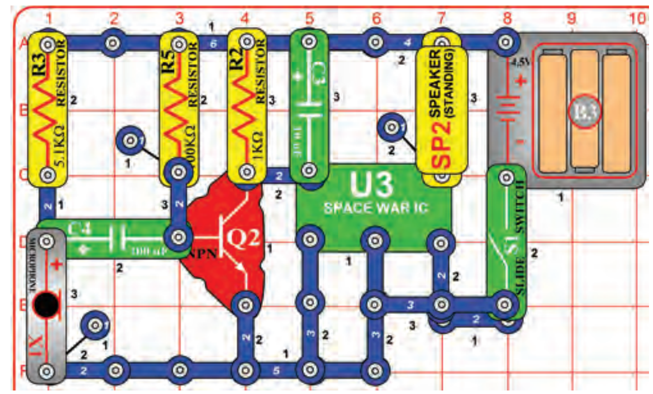


Press the press switch (S2) on and set the adjustable resistor (RV) so the lamp (L4) just lights. Slowly cover the photoresistor (RP) and the lamp brightens. If you place more light at the photoresistor the light dims.

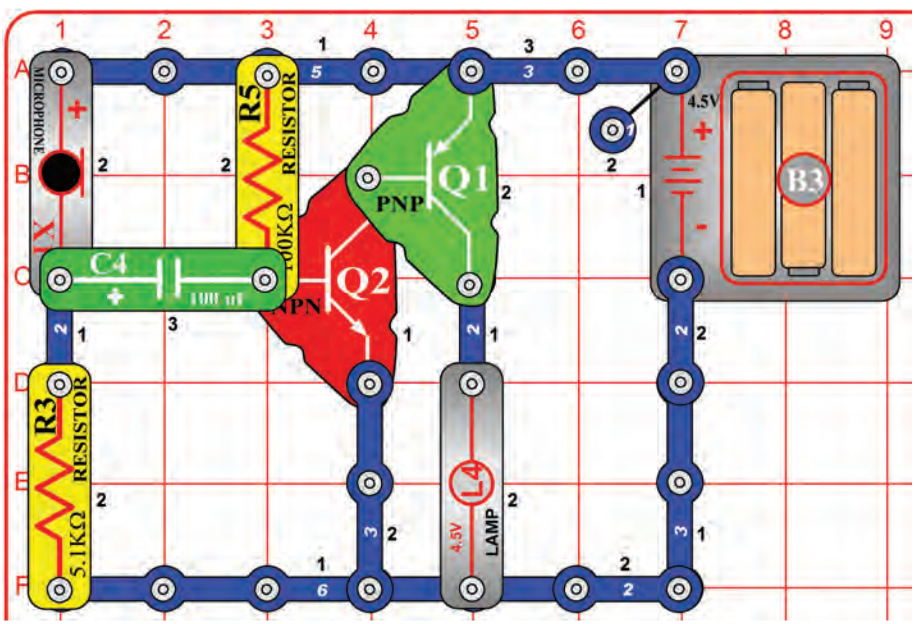
This is an automatic street lamp that you can turn on by a certain darkness and turn off by a certain brightness. This type of circuit is installed on many outside lights and forces them to turn off and save electricity. They also come on when needed for safety.

☐ Project #69 Voice Control

Turn the slide switch (S1) on and there should be no sound. The transistor is on so the voltage on U3 is low. Blowing on the microphone (X1) turns transistor (Q2) off, the voltage on U3 voltage goes high and the speaker will sounds.



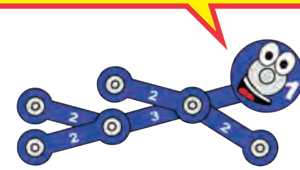
☐ Project #70 Blowing Off the Electric Light



Install the parts. The lamp (L4) will be on. It will be off as long as you blow on the microphone (X1).

Speaking loud into the mic will change the brightness of the lamp.

The microphone is a resistor that changes in value due to the changes in air pressure on its surface.

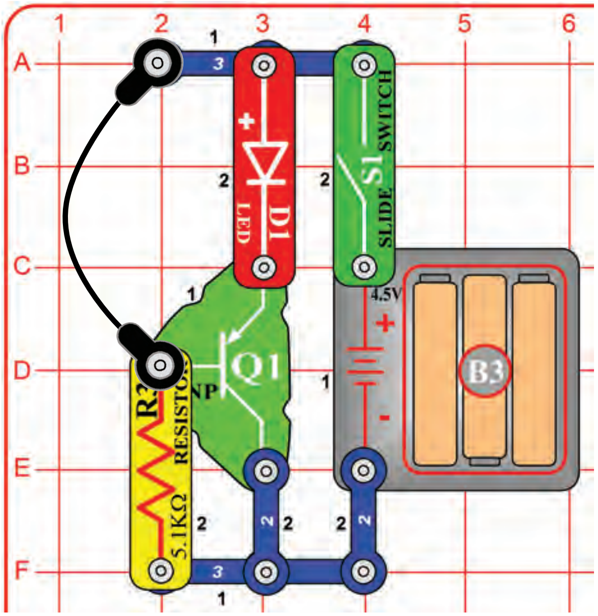


☐ Project #71 Listen to Your Breath

Modify the circuit in the preceding project by replacing the lamp (L4) with the speaker (SP2). Blow into the microphone and hear it in the speaker.

Talk directly into the microphone. You can hear your voice on the speaker, though it may be badly distorted.

☐ Project #72 — Light Alarm

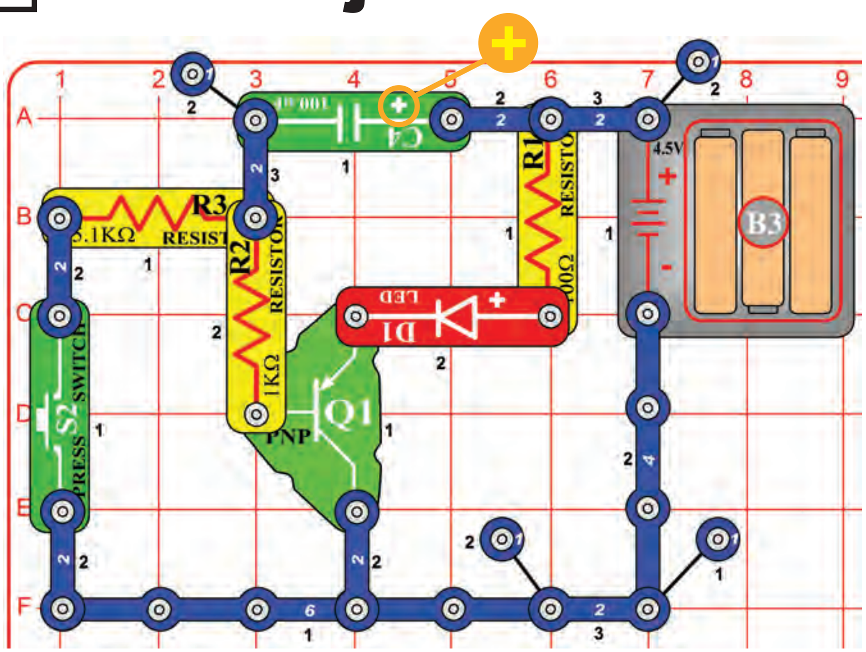


Build the circuit with the jumper connected as shown, and turn it on. Nothing happens. Break the jumper connection and the light turns on. You could replace the jumper with a longer wire and run it across a doorway to signal an alarm when someone enters.

☐ Project #73 — Brighter Light Alarm

Modify the circuit in the preceding project by replacing the LED (D1) with the 4.5V lamp (L4) and replacing the 5.1KΩ resistor (R3) with the 100Ω resistor (R1). It works the same way but is brighter now.

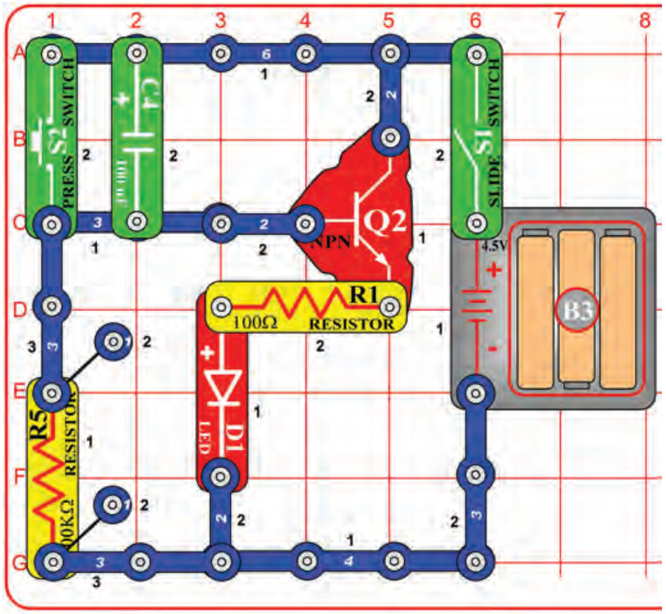
☐ Project #74 — Light Dimmer



Press the press switch (S2) to complete the current's path flow. You might expect the LED (D1) to light instantly but it doesn't. The charging current flows into the 100μF capacitor (C4) first. As the capacitor charges, the charging current decreases, input current to the PNP transistor (Q1) increases. So current begins to flow to the LED and the LED gradually brightens.

Now release the press switch. The capacitor begins to discharge, sending input current to the transistor. As the capacitor discharges, the input current reduces to zero and gradually turns off the LED and the transistor.

Project #75 Auto-Off Night Light



When you turn on the slide switch (S1) the first time the LED (D1) will come on and very slowly get dimmer and dimmer. If you turn the slide switch (S1) off and back on after the light goes out it will NOT come on again. The 100μF capacitor (C4) has charged up and the NPN transistor amplifier (Q2) can get no current at its input to turn it on.

This circuit would make a good night-light. It would allow you to get into bed, and then it would go out. No further current is taken from the battery so it will not drain the batteries (B3) even if left on all night.

Project #76 Discharging Caps

Use the circuit from Project #75 shown above.

When you first turned on the slide switch (S1) in Project #75, the LED (D1) came on and very slowly got dimmer and dimmer. When you turned the slide switch (S1) off and back on after the light went out, it did NOT come on again. The 100μF capacitor (C4) was charged and everything stopped. This time turn the slide switch off. Then press the press switch (S2) for a moment to discharge the 100μF capacitor. Now when you turn the slide switch back on the delay repeats. Shorting a capacitor with a low resistance will allow the charges on the capacitor to leave through the resistance. In this case, the low resistance was the press switch.

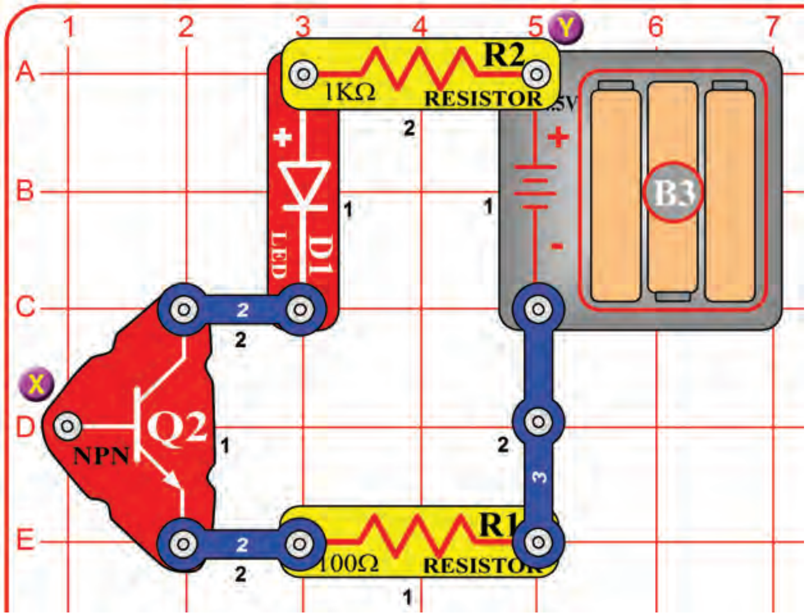
Project #77 Changing Delay Time

Use the circuit from Project #75 shown above.

Change the 100μF capacitor (C4) to the 10μF capacitor (C3). Make sure the capacitor (C3) is fully discharged by pressing the press switch (S2) before closing the on-off slide switch (S1). When slide switch is turned on, notice how much quicker the LED (D1) goes out. Since 10μF is smaller than 100μF, the LED will go out faster. The bigger the capacitor the longer the delay.

In electronics, capacitors are used in every piece of equipment to delay signals or tune circuits to a desired frequency.

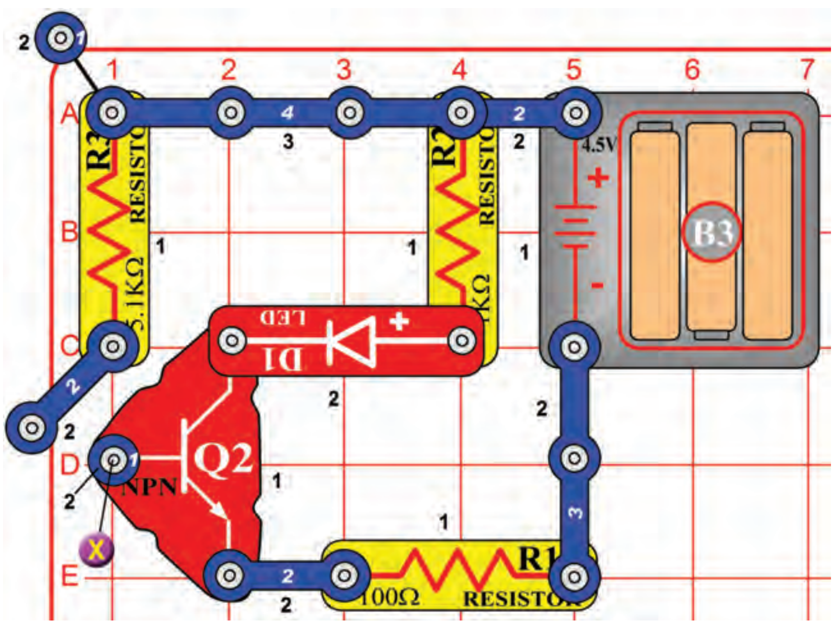
Project #78 Two-Finger Touch Lamp



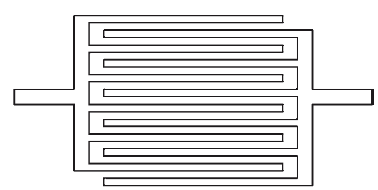
Build the circuit on the left. You're probably wondering how it can work, since one of the points on the NPN transistor (Q2) is unconnected. It can't, but there is another component that isn't shown. That component is you.

Touch points X & Y with your fingers. The LED (D1) may be dimly lit. The problem is your fingers aren't making a good enough electrical contact with the metal. Wet your fingers with water or saliva and touch the points again. The LED should be very bright now. Think of this circuit as a touch lamp since when you touch it, the LED lights. You may have seen such a lamp in the store or already have one in your home.

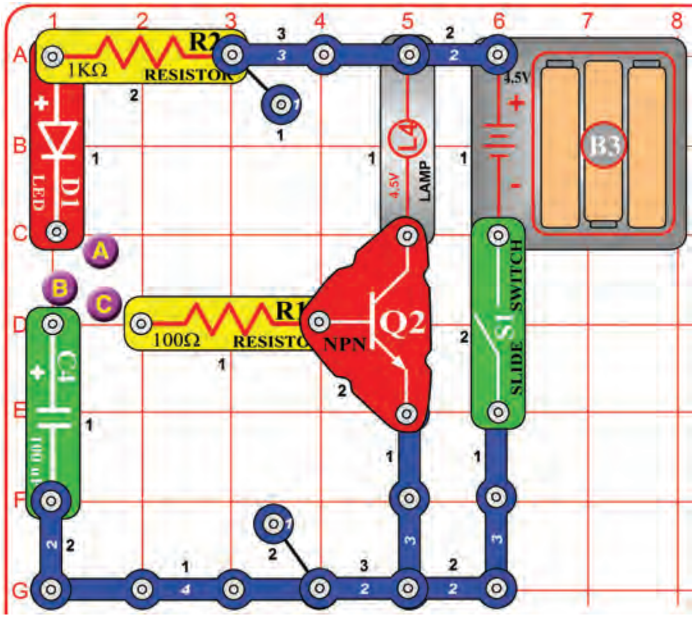
Project #79 One-Finger Touch Lamp



The touch lamps you see in stores only need to be touched by one finger to light, not two. So let's see if we can improve the last circuit to only need one finger. Build the new circuit, note that near point X there is a 2-snap wire that is only mounted on one side, swing it so the plastic touches point X. Wet a large area of one of your fingers and touch it to both metal contacts at point X at the same time; the LED (D1) lights. To make it easier for one finger to touch the two contacts, touch lamps or other touch devices will have the metal contacts interweaved as shown below and will also be more sensitive so that you don't have to wet your finger to make good contact.

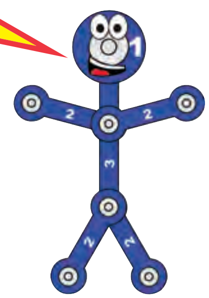


Project #80 Storing Electricity

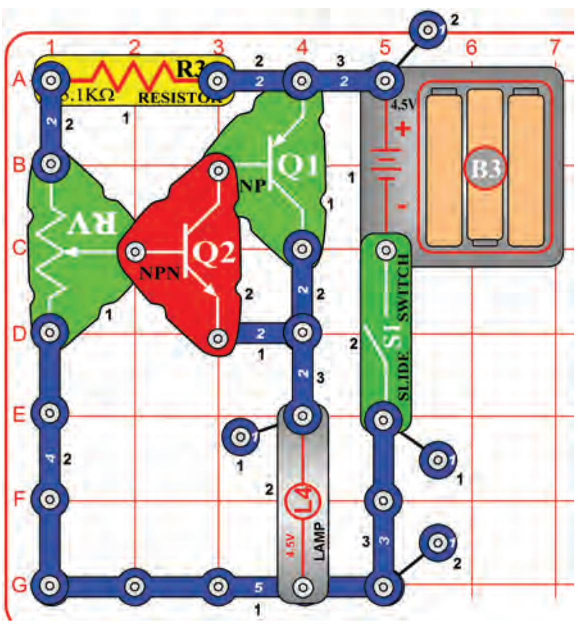


Turn the slide switch (S1) on and connect points A & B with a 2-snap wire. The red LED (D1) will flash and the 100μF capacitor (C4) will be charged with electricity. The electricity is now stored in the capacitor. Disconnect points A & B. Connect points B & C and there will be a flash from the 4.5V lamp (L4).

The capacitor discharges through the resistor to the base of the NPN transistor (Q2). The positive current turns on the transistor like a switch, connecting the lamp to the negative (–) side of the batteries. The light will go out after the capacitor discharges, because there is no more current at the base of the transistor.

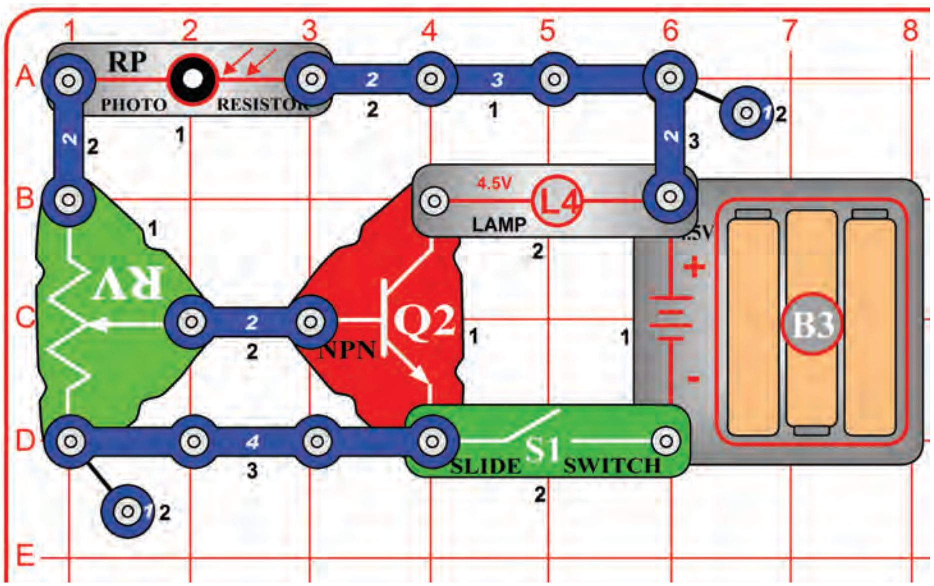


Project #81 Lamp Brightness Control



Here is a combination with two transistors. This combination increases the amplifying power. By changing the resistance, the current at the base of the transistor is also changed. With this amplifying ability of the combination, there is a greater change of current to the 4.5V lamp (L4). This changes the brightness.

Project #82 Motion Detector

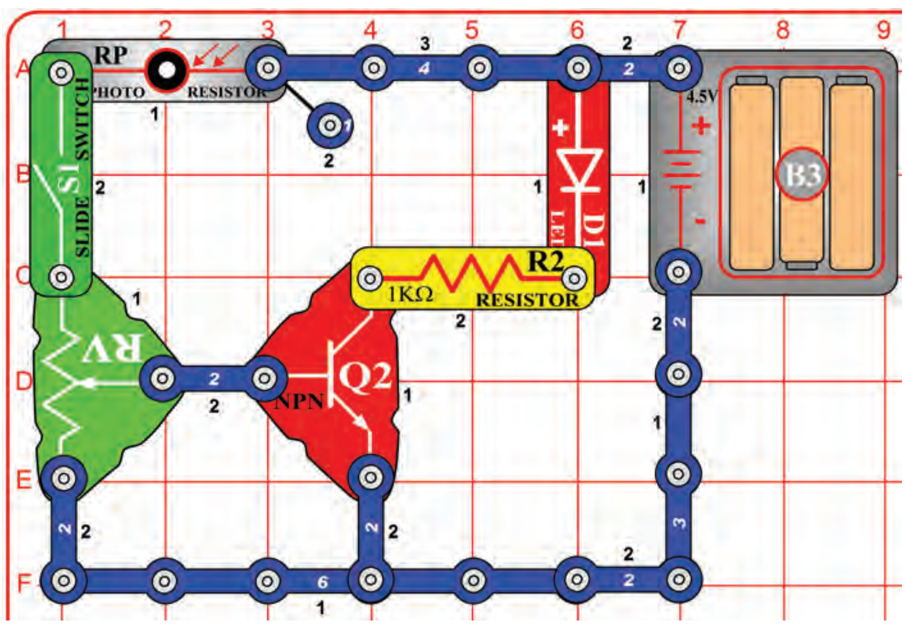


Place this circuit near a bright light. Turn the slide switch (S1) on and move the adjustable resistor (RV) control all the way up. The brightness of the lamp (L4) is at maximum. Now, move the adjustable resistor control down until the lamp goes out. Set the control up a little and the lamp lights dimly.

Move your hand from side to side over the photoresistor (RP). As your hand blocks the light, the lamp goes out.

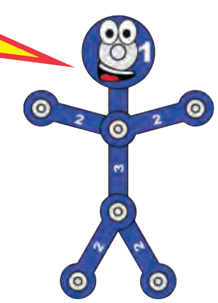
Wave your hand over the photoresistor (RP) and the lamp turns off and on. The resistance changes as the amount of light strikes the photoresistor. As the light decreases, the resistance increases. The increased resistance lowers the voltage at the base of the NPN transistor (Q2). This turns off the transistor, preventing current flowing through the lamp to the negative (–) side of the battery (B3). Wave your hand over the photoresistor at different distances. The lamp gets brighter the farther away your hand is.

Project #83 LED Motion Detector

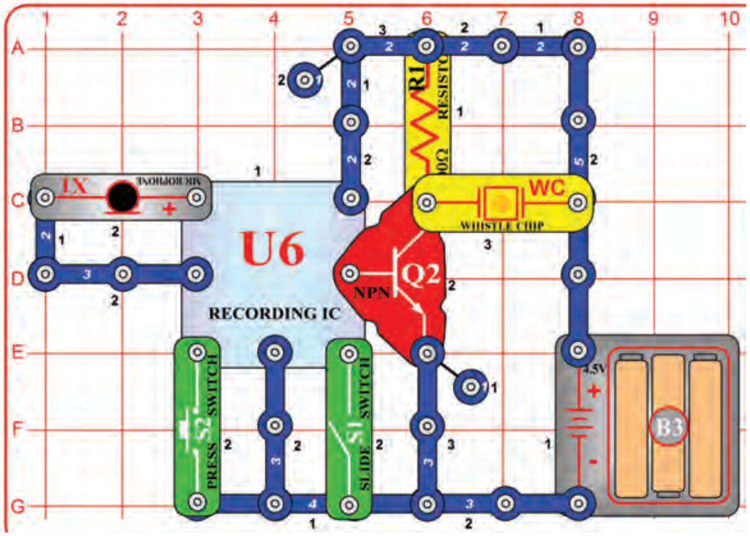


The amount of light changes the resistance of the photoresistor and the current flow to the base of the NPN transistor (Q2). The transistor acts like a switch. Its base current is supplied through the photoresistor. As the base current changes, so does the current flow through the LED. With no base current, the LED goes out.

There are many applications for the use of the detector. The most common is in the alarm system industry. Some other applications are automatic door openers, light switches in hallways, stairways and areas that increase safety for the public.



Project #84
Whistling Recording IC



Build the circuit shown. Turn on the slide switch (S1), you hear a beep signaling that you may begin recording. Talk into the microphone (X1) up to 5 seconds, and then turn off the slide switch (it also beeps after the 5 seconds expires). Press the press switch (S2) for playback. It plays the recording you made followed by one of three songs. If you press the press switch before the song is over, music will stop. You may press the press switch several times to play all three songs.

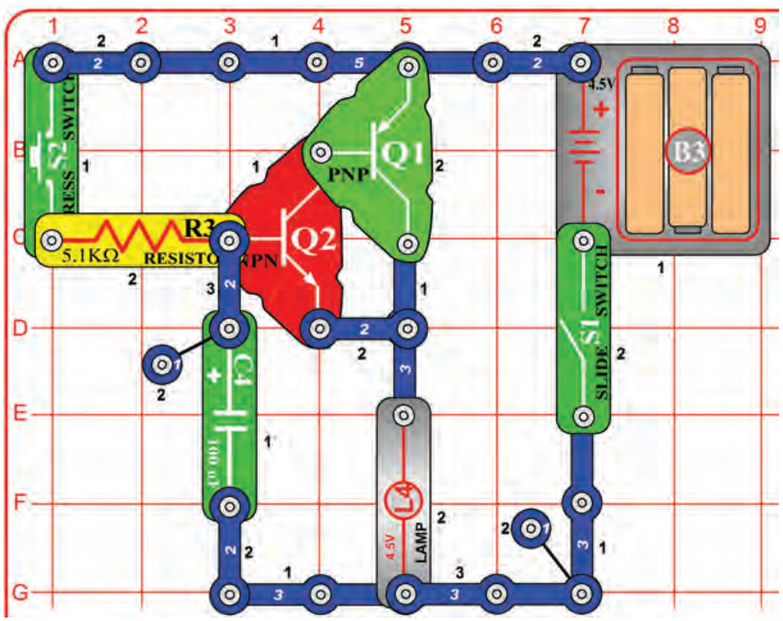
Project #85
Two-Sound Output

Use the preceding circuit, but replace the 3-snap at base grid locations E6-G6 with the speaker (SP2) and place the red LED (D1) over the 100Ω resistor (R1). It will be across base grid locations A6-C6 on level 4, with its "+" side on top (at A6).

Project #86
Lights On & Off

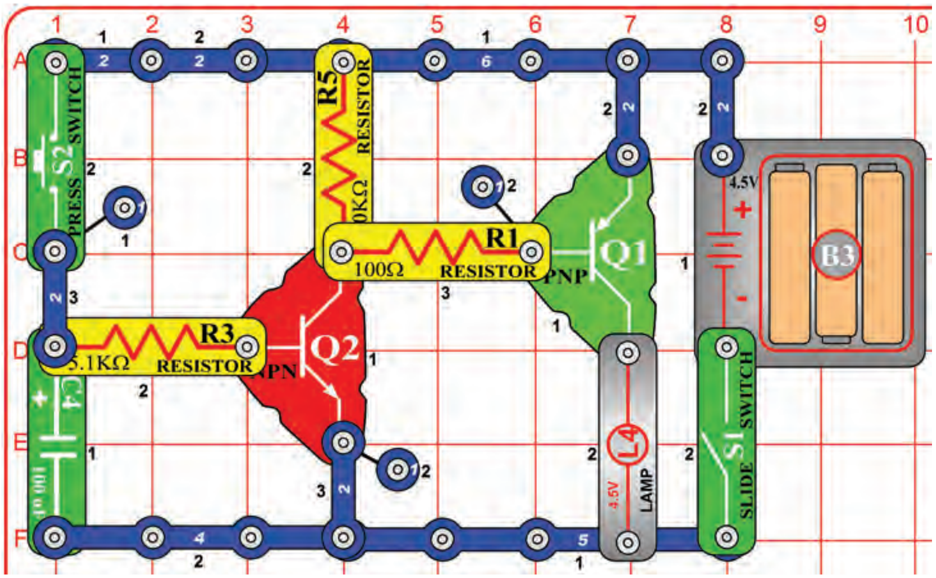
Use the preceding circuit, but place the red LED (D1) over the NPN transistor. It will be across base grid locations C6-E6 on level 4.

Project #87
Delayed Action Lamp



Turn on the slide switch (S1) and press the press switch (S2). The lamp (L4) turns on slowly, but stays on for a while after you release the press switch.

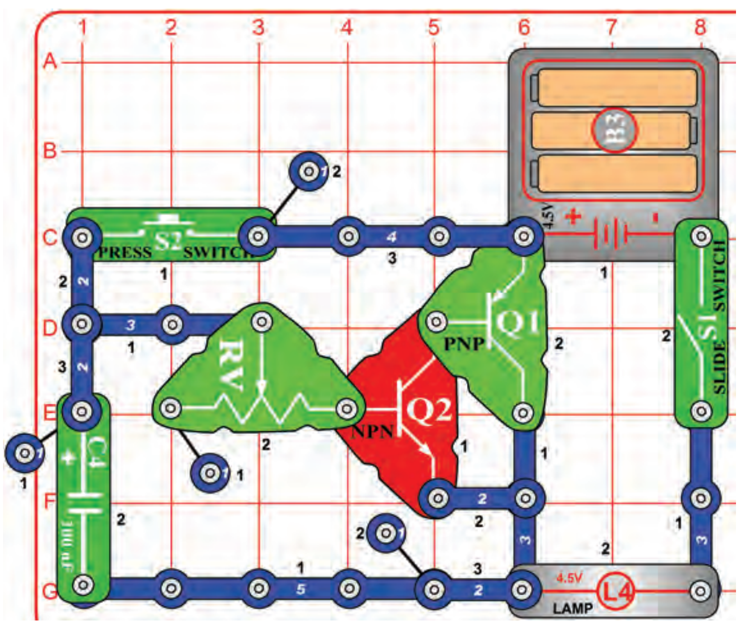
☐ # Project #88 Watch Light



Turn on the switch and press the press switch (S2). The lamp (L4) stays on for a few seconds after you release the press switch.

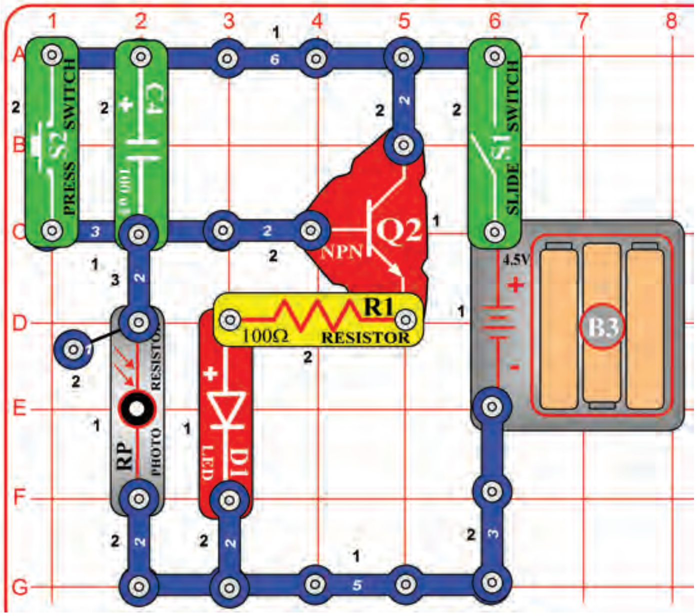
A miniature version of a circuit like this might be in your wristwatch - when you press a light button on the watch to read the time in the dark, a light comes on but automatically turns off after a few seconds to avoid draining the battery.

☐ # Project #89 Adjustable Time Delay Lamp



Turn on the switch and press the press switch (S2). The lamp (L4) stays on for a few seconds after you release the press switch. You can change the delay time with the adjustable resistor (RV).

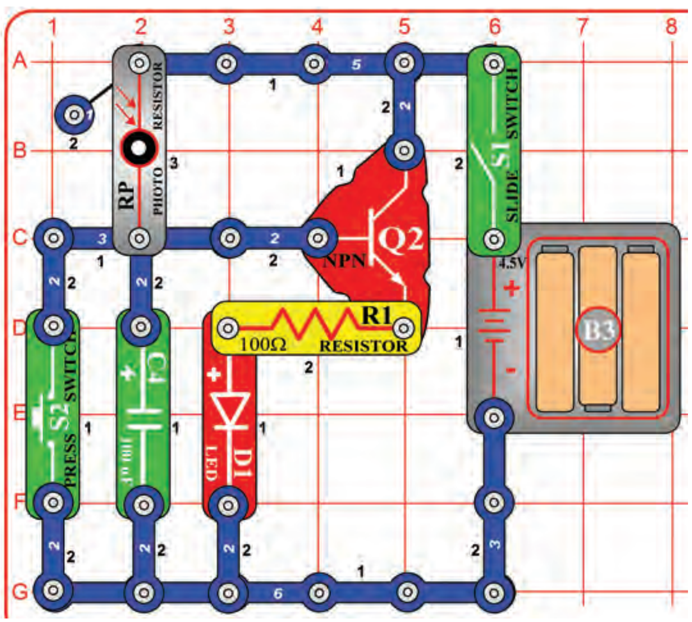
Project #90 Photo-Off Night Light



Cover the photoresistor (RP) and turn on the slide switch (S1). The LED (D1) is bright, but it will very slowly get dimmer and dimmer as the 100μF capacitor (C4) charges up. If you turn the slide switch off and back on after the light goes out, it will NOT come on again. Press the press switch (S2) to discharge the capacitor and reset the circuit.

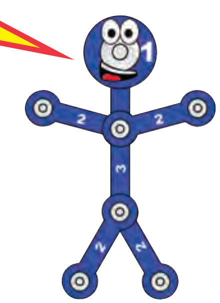
If you uncover the photoresistor and let light shine on it, then the LED will get dark quickly. The photoresistor has much lower resistance with light on it, and this lower resistance allows the capacitor to charge up faster.

Project #91 Sunrise Light

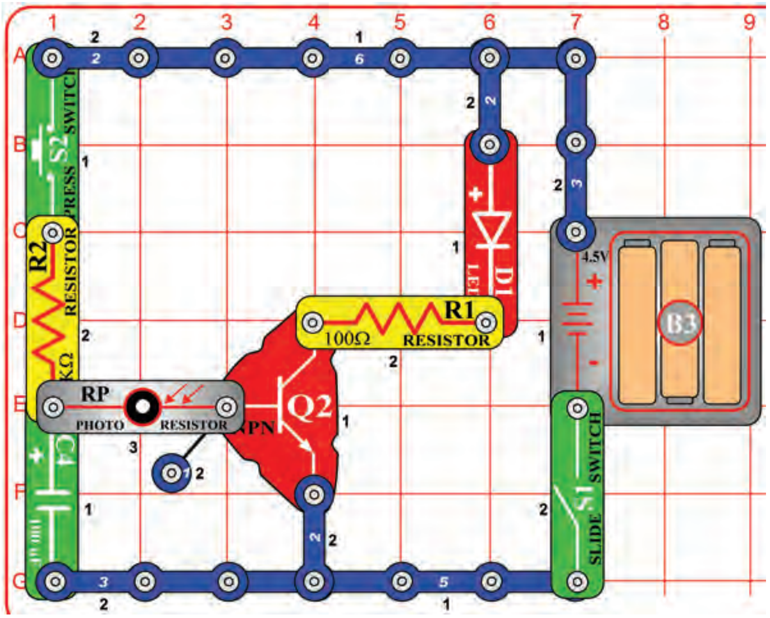


Cover the photoresistor (RP) and turn on the slide switch (S1). The LED (D1) is off, but if you wait a long time then it will eventually light up. Uncover the photoresistor and the LED will light up in just a few seconds. Press the press switch (S2) and reset the circuit.

The resistance of the photoresistor controls how long it takes to charge up the 100μF capacitor (C4). Once the capacitor is charged, current can flow into the NPN transistor (Q2) and turn on the LED. Pressing the press switch discharges the capacitor.

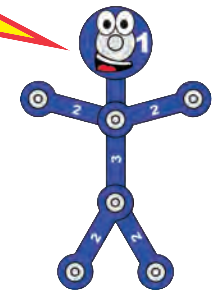


Project #92 Capacitor Photo Control

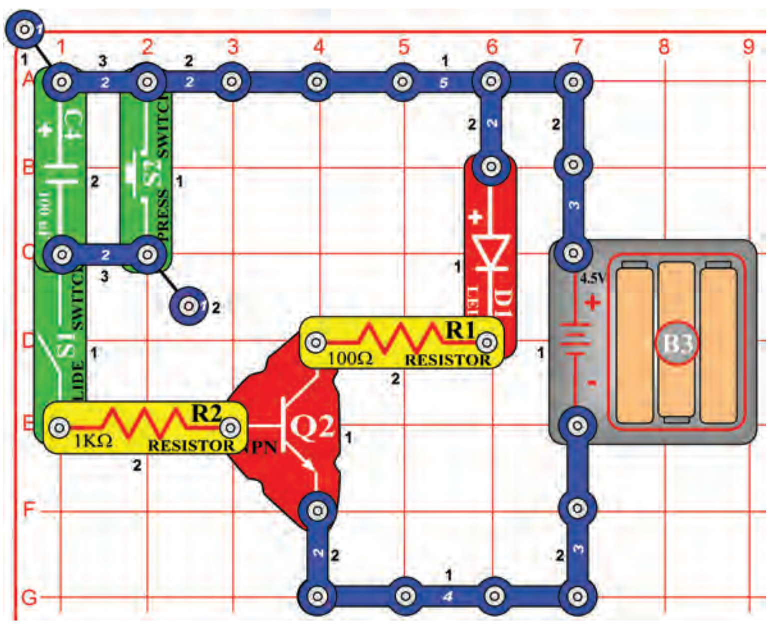


Turn on the slide switch (S1) and press the press switch (S2). If there is light on the photoresistor (RP), then the LED (D1) will stay on for a few seconds after you release the press switch.

The energy stored in the 100μF capacitor (C4) keeps the controlling current to the NPN transistor (Q2) on even though the press switch was turned off. If it is dark, the high resistance of the photoresistor shuts off the current to the transistor.



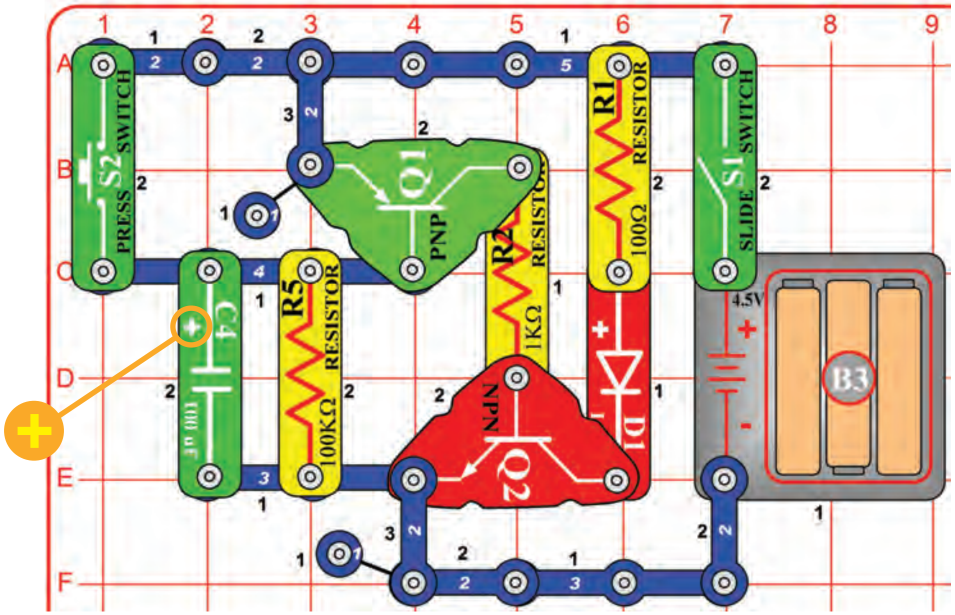
Project #93 Capacitor Control



Build the circuit and turn on the slide switch (S1). The LED (D1) is bright but slowly gets dark as the 100μF capacitor (C4) charges up.

The LED will stay dark until you press the press switch (S2), which discharges the capacitor.

Project #94 Turn Off Timer



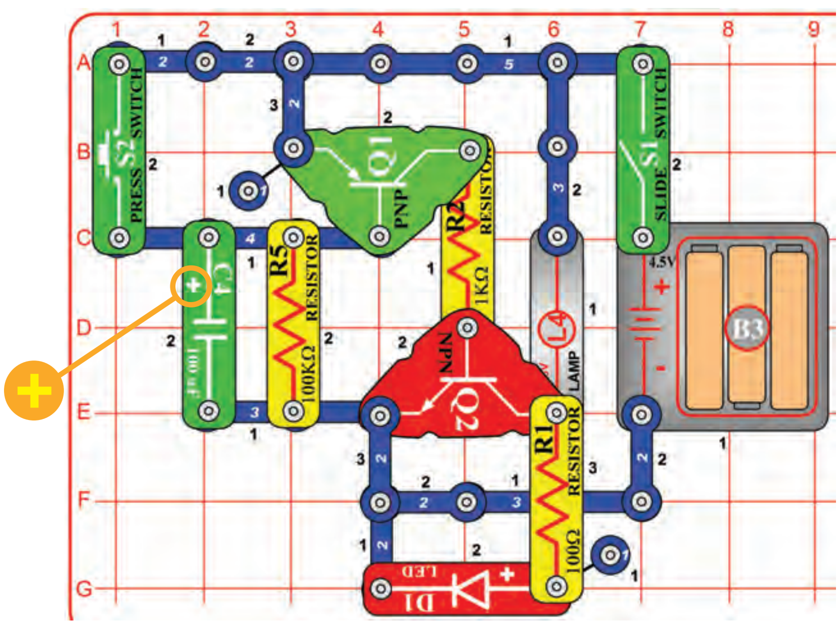
Turn on the slide switch (S1). Pressing the press switch (S2) down increases the voltage at the base of Q1. This turns the Q1, Q2, and LED (D1) off as the capacitor (C4) charges up. As you release the press switch, the capacitor starts discharging through resistor R5.

When the voltage from the discharging capacitor drops low enough, Q1, Q2, and the LED turn on after a few seconds.

Project #95 Turn Off Timer - Lamp

Replace the LED (D1) with lamp (L4) and the 100Ω resistor (R1) with a 3-snap wire.

Project #96 LED & Bulb Timer

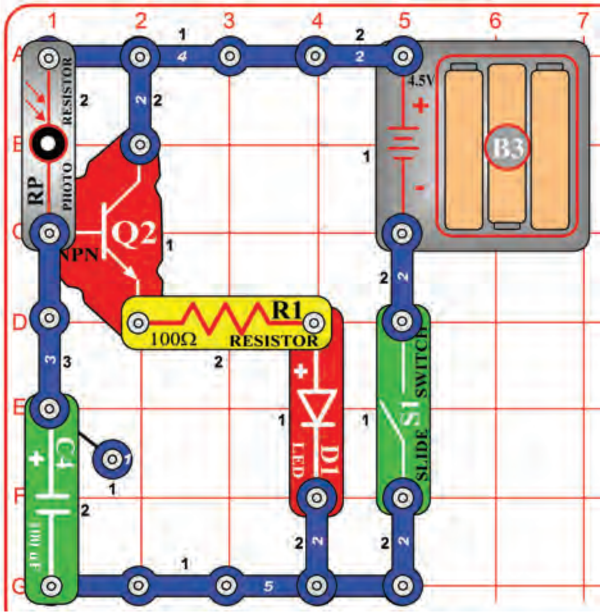


When you press the press switch (S2), the lamp (L4) turns off and the LED lights. When the voltage from the discharging capacitor drops low enough, Q1, Q2, and the lamp turn on and the LED turns off.

Project #97 LED & Bulb Short Timer

You can shorten the timer delay by replacing the 100μF capacitor (C4) with the 10μF capacitor, or by replacing the 100KΩ resistor (R5) with the 5.1KΩ resistor (R3).

Project #98 Slow Light Dimmer



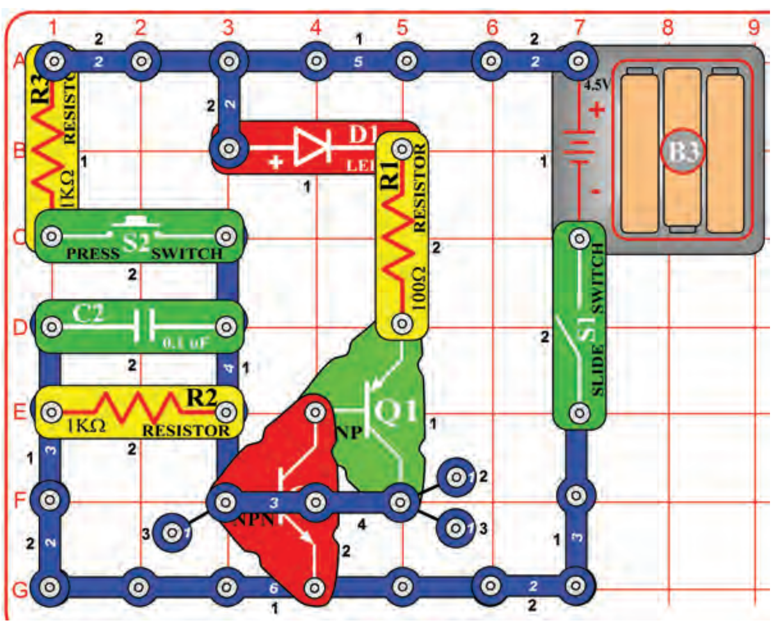
Turn on the slide switch (S1) and the LED (D1) comes on if there is light on the photoresistor (RP). If you cover the photoresistor, then the LED will stay on for a while, until the 100μF capacitor (C4) discharges.

Project #99 Not-So-Slow Light

In the preceding circuit, speed up how quickly the LED shuts off by replacing the 100μF capacitor (C4) with the smaller 10μF capacitor (C3).

The 0.1μF capacitor (C2) stores very little electricity, so if you replace the 10μF capacitor with it then the LED will shut off right away.

Project #100 The SCR



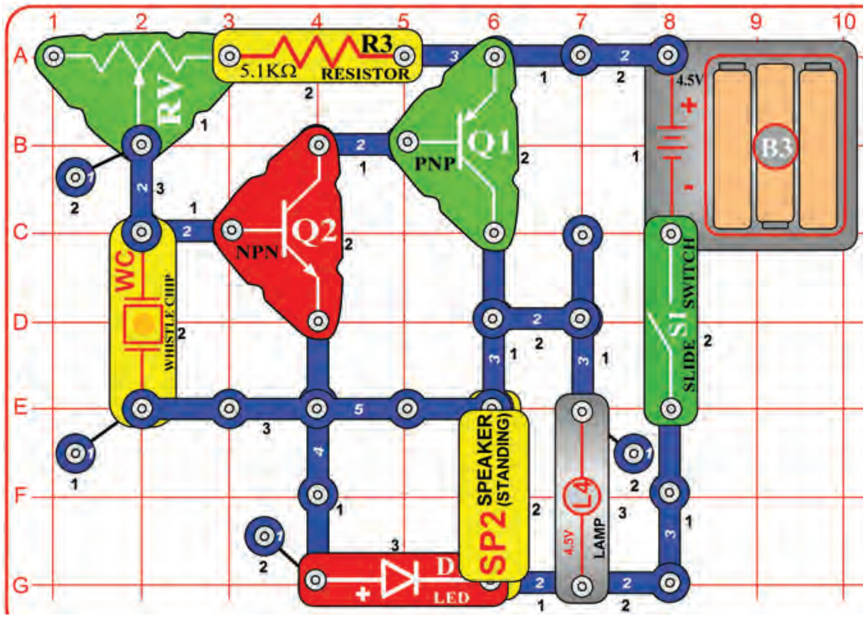
The transistors (Q1 & Q2) are connected so when the base of Q2 goes high, both Q2 and Q1 turn on. They will remain on until the slide switch (S1) is turned off. Turn on the slide switch and the LED (D1) should not light. Now press the press switch (S2) and the LED lights. Turn the LED off by turning the slide switch off.

The two transistors act as an electronic device called an SCR (Silicon Controlled Rectifier). A three-pin device that once its base is triggered, remains on until the current flow through it stops.

Project #101 Light-Controlled SCR

Replace resistor R3 with the photoresistor (RP). The LED (D1) will only light when the press switch (S2) is pressed and there is enough light on the photoresistor. Turn on the slide switch (S1) and place your finger over the photoresistor. Press the press switch and the LED should not light. Remove your finger and press the press switch again, the LED should light now.

Project #102 Adjustable Tone Generator



Turn on the slide switch (S1); the speaker (SP2) will sound and the LED (D1) will light. Adjust the adjustable resistor (RV) to make different tones. In an oscillator circuit, changing the values of resistors or capacitors can vary the output tone or pitch.

Project #103 Photosensitive Electronic Organ

Modify the preceding circuit by replacing the 5.1KΩ (R3) with the photoresistor (RP). Turn on the slide switch (S1). The speaker (SP2) will sound and the LED (D1) will light. Move your hand up and down over the photoresistor (RP) and the frequency changes. Decreasing the light on the photoresistor increases the resistance and causes the circuit to oscillate at a lower frequency. Notice that the LED flashes also at the same frequency as the sound.

By using your finger, see if you can vary the sounds enough to make this circuit sound like an organ playing.

Project #104 Electronic Cicada

Using the circuit from Project #103, replace the photoresistor (RP) back to the 5.1KΩ resistor (R3). Place the 0.1μF capacitor (C2) on top of the whistle chip (WC). Turn the slide switch (S1) on and adjust the adjustable resistor (RV). The circuit produces the sound of the cicada insect. By placing the 0.1μF capacitor on top of the whistle chip, the circuit oscillates at a lower frequency. Notice that the LED flashes also at the same frequency.

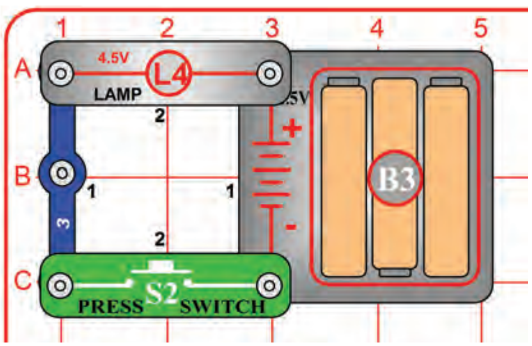
It is possible to pick resistors and capacitors that will make the pitch higher than humans can hear. Many animals, however, can hear these tones. For example, a parakeet can hear tones up to 50,000 cycles per second, but a human can only hear to 20,000.

☐ Project #105 Morse Code

This simple circuit can be used for communication. Press the press switch (S2) in long and short bursts to make a pattern of light flashes representing the dots and dashes shown in the Morse Code table shown. You can use Morse Code and this circuit to send secret messages to some friends in the room without others knowing what you're saying.

If you have a strong flashlight or searchlight then you can send messages to friends far away at night. During World War II Navy ships sometimes communicated by flashing Morse Code messages between ships using searchlights (because radio transmissions might reveal their presence to the enemy).

Years ago Indians would send messages to other tribes using smoke signals and a special code.

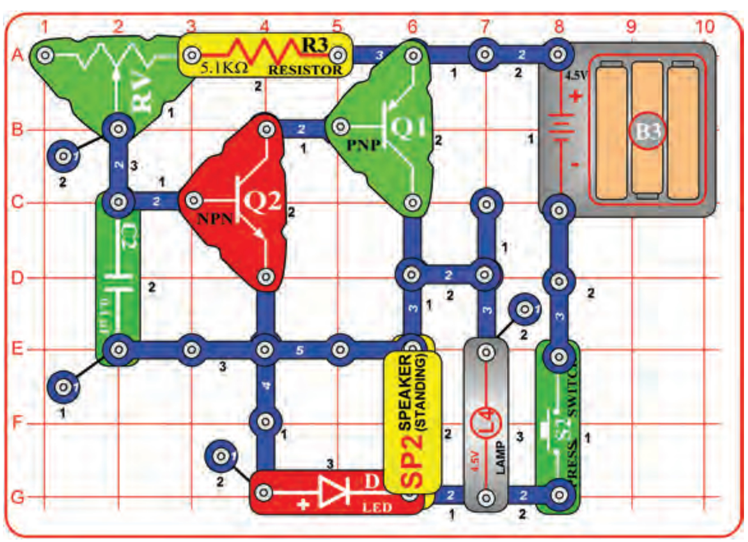


Morse Code: The forerunner of today's telephone system was the telegraph, which was widely used in the latter half of the 19th century. It only had two states - on or off (that is, transmitting or not transmitting), and could not send the range of frequencies contained in human voices or music. A code was developed to send information over long distances using this system and a sequence of dots and dashes (short or long transmit bursts). It was named Morse Code after its inventor. It was also used extensively in the early days of radio communications, though it isn't in wide use today. It is sometimes referred to in Hollywood movies, especially Westerns.

MORSE CODE

A	. _	N	_ .	Period	. _ . _ . _
B	_ . . .	O	_ _ _	Comma	_ _ . . _ _
C	_ . _ .	P	. _ _ .	Question	. . _ _ . .
D	_ . .	Q	_ _ . _	1	. _ _ _ _
E	.	R	. _ .	2	. . _ _ _
F	. . _ .	S	. . .	3	. . . _ _
G	_ _ .	T	_	4	. . . . _
H	. . . .	U	. . _	5	. . . . .
I	. .	V	. . . _	6	_ . . . .
J	. _ _ _	W	. _ _	7	_ _ . . .
K	_ . _	X	_ . . _	8	_ _ _ . .
L	. _ . .	Y	_ . _ _	9	_ _ _ _ .
M	_ _	Z	_ _ . .	0	_ _ _ _ _

☐ Project #106 Audio Morse Code

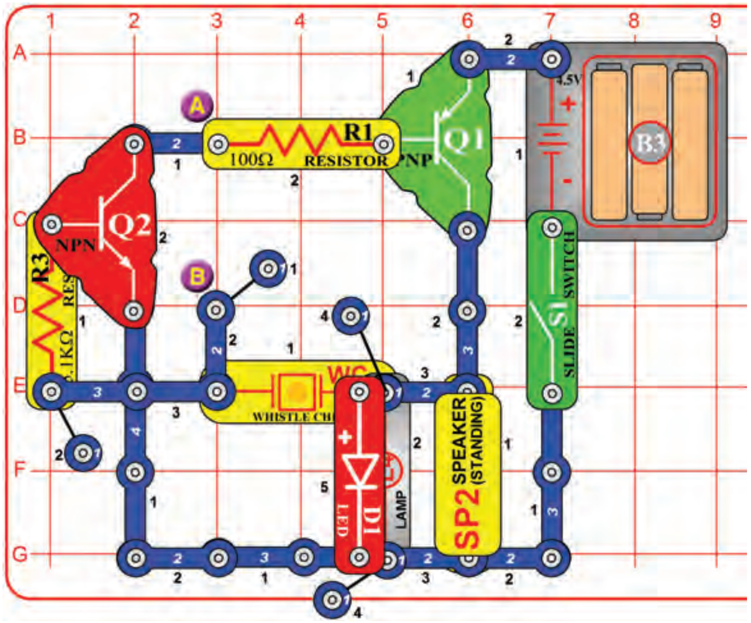


Build the circuit and set the adjustable resistor (RV) control lever to the left. When you press down on the press switch (S2) you will here a tone. By pressing and releasing the press switch you can generate long and short tones called Morse code. For International code, a short tone is represented by a "+", and a long tone by a "–". See the chart above for letter or number followed by code.

☐ Project #107 Dog Whistle

Use the preceding circuit, but change the 5.1KΩ resistor (R3) to the 100Ω resistor (R1). While holding down the press switch (S2), move the slider on the adjustable resistor (RV) around. When the slider is near the 100Ω resistor you won't hear any sound, but the circuit is still working. This oscillator circuit is making sound waves at a frequency too high for your ears to hear. But your dog may hear it, because dogs can hear higher frequencies than people can.

Project #108 The Lie Detector



Turn on the slide switch (S1) and place your finger across points A & B. The speaker (SP2) will output a tone and the LED (D1) will flash at the same frequency. Your finger acts as a conductor connecting points A & B. When a person is lying, one thing the body starts to do is sweat. The sweat makes the finger a better conductor by reducing its resistance.

As the resistance drops, the frequency of the tone increases. Lightly wet your finger and place it across the two points again. Both the output tone and LED flashing frequency increase. If your finger is wet enough, then the lamp will be bright and the sound stops - indicating you are a big liar! Now change the wetness of your finger by drying it and see how it affects the circuit. This is the same principle used in lie detectors that are sold commercially.

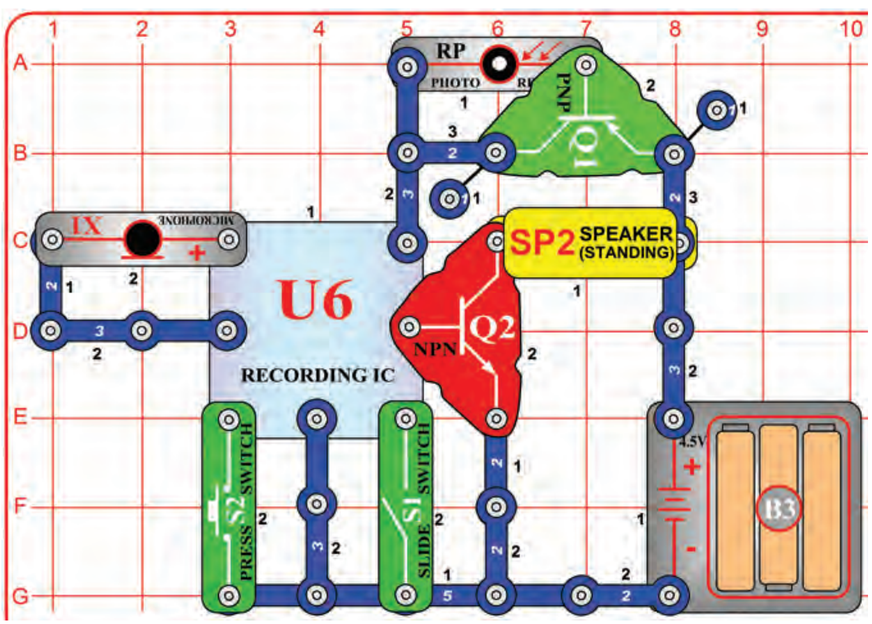
Project #109 Clicking Liar

Change the circuit by removing the LED and 4th level 1-snaps and placing the 0.1μF capacitor (C2) on top of the whistle chip (WC), on level 5.

Project #110 Slow Clicking Liar

Replace the 0.1μF capacitor (C2) with the 10μF capacitor (C3, “+” side on left).

Project #111 Photo-Powered Recording



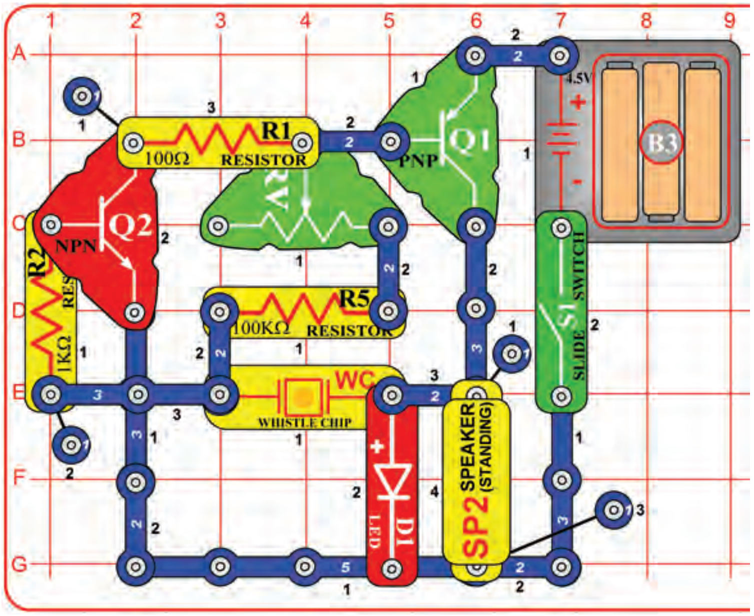
Build the circuit shown and press the press switch (S2). It plays a recording followed by one of three songs. Adjust the amount of light on the photoresistor (RP) to change the volume and alter the tone. Wave your fingers over the photoresistor for some cool sound effects.

You can change the recorded message. Turn on the slide switch (S1), you hear a beep signaling that you may begin recording. Talk into the microphone (X1) up to 5 seconds, and then turn off the slide switch. Partly covering the photoresistor will reduce the recording quality.

Project #112 Photo Whistle Music

Use the preceding circuit. Replace the speaker (SP2) with the whistle chip (WC) and then place the 100Ω resistor (R1) over it using a 1-snap.

Project #113 Whiner



Build the circuit, turn it on, and move the setting on the adjustable resistor (RV). It makes a loud, annoying whine sound. The red LED (D1) appears to be on, but it is actually flashing at a very fast rate.

Project #114 Hummer

Now place the 0.1μF capacitor (C2) above the whistle chip (WC) and vary the adjustable resistor (RV) again. The frequency (or pitch) of the whine has been reduced by the greater added capacitance and it sounds more like a hum now.

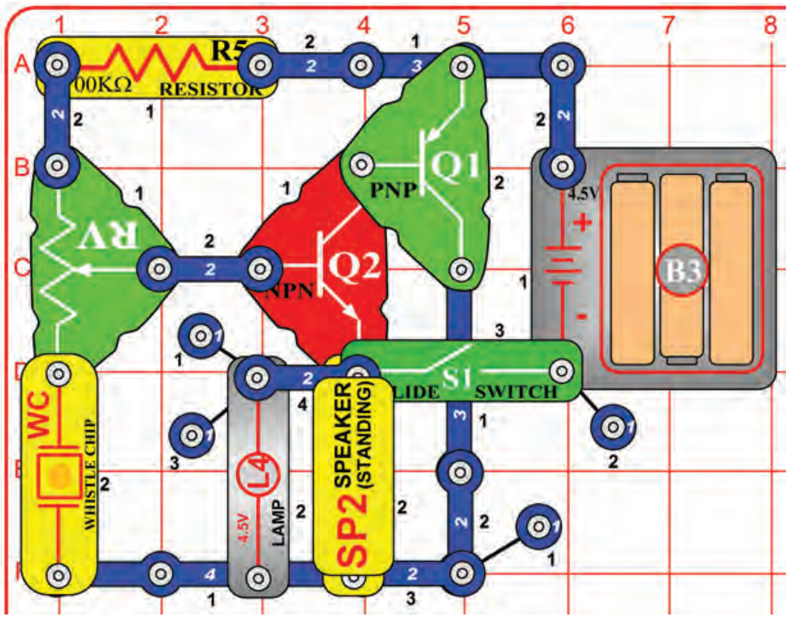
Project #115 Adjustable Metronome

Now place the 10μF capacitor (C3, "+" side on right) above the whistle chip (WC) and vary the adjustable resistor (RV) again. There is no hum now but instead there is a click and a flash of light repeating about once a second, like the "beat" of a sound. It is like a metronome, which is used to keep time for the rhythm of a song.

Project #116 Quiet Flasher

Leave the 10μF capacitor (C3) connected but replace the speaker (SP2) with the 4.5V lamp (L4).

Project #117 Hissing Foghorn



Build the circuit on the left and move the adjustable resistor (RV) setting. Sometimes it will make a foghorn sound, sometimes it will make a hissing sound, and sometimes it will make no sound at all.

Project #118 Hissing & Clicking

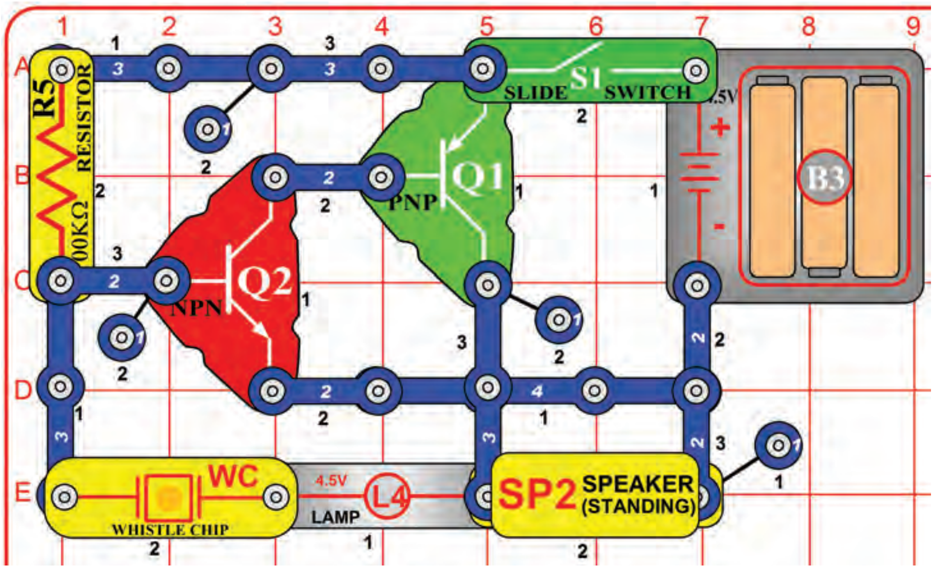
Modify the circuit in Project #117 by replacing the 100KΩ resistor (R5) with the photoresistor (RP).

Move the adjustable resistor (RV) setting until you hear hissing sounds, and then shield the photoresistor while doing so and you hear clicking sounds.

Project #119 Video Game Engine Sound

Remove the photoresistor (RP) from the circuit in Project #118 and instead touch your fingers between the contacts at points A4 and B1 on the base grid while moving the adjustable resistor (RV). You hear a clicking that sounds like the engine sound in auto-racing video games.

☐ Project #120 Tone Generator



Build the circuit and turn it on; you hear a high-frequency sound

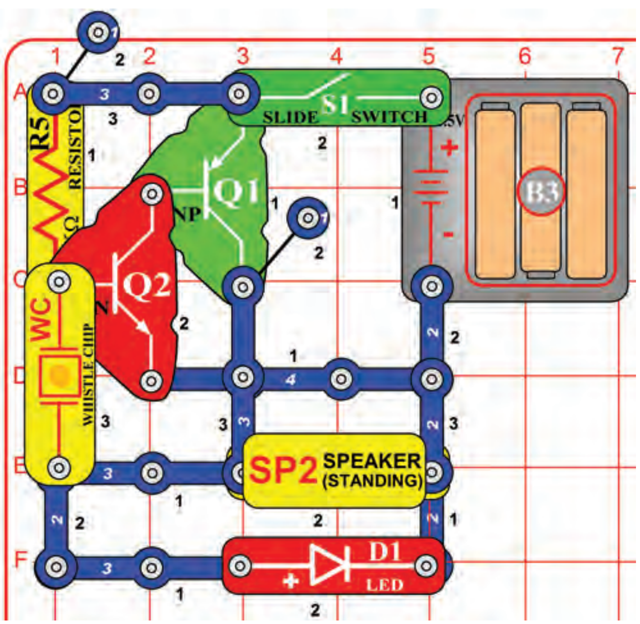
☐ Project #121 Tone Generator (II)

Place the 0.1μF capacitor (C2) on top of the whistle chip (WC) in the preceding circuit, you hear a lower-frequency sound. Why? The whistle chip is used here as a capacitor and by placing the 0.1μF on top (in parallel) we have increased the capacitance, and doing so lowers the frequency.

☐ Project #122 Tone Generator (III)

Now replace the 0.1μF (C2) with the much larger 10μF capacitor (C3), (orient with the positive (+) side towards the left); the circuit just clicks about once a second. There isn't a constant tone anymore due to other transistor properties. You need a different type of circuit to create very low frequency tones.

☐ Project #123 More Tone Generator



Build the circuit; as the name suggests, this circuit is similar to that in Project #120. Turn it on; you hear a middle-frequency sound.

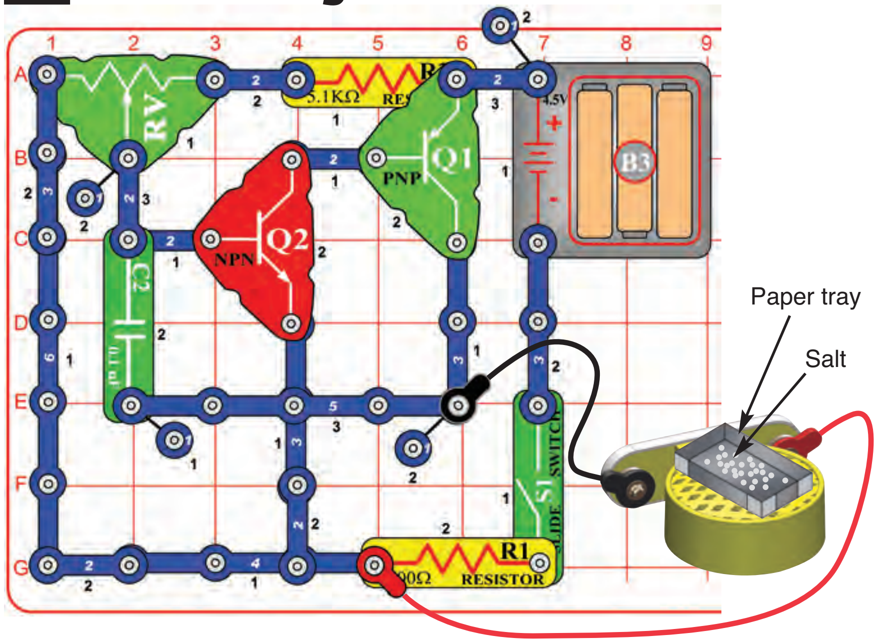
☐ Project #124 More Tone Generator (II)

Place the 0.1μF capacitor (C2) on top of the whistle chip (WC). The sound is different now because the added capacitance has lowered the frequency. The LED appear to be on, but are actually blinking at a very fast rate.

☐ Project #125 More Tone Generator (III)

Now place the 10μF capacitor (C3, "+" side up) on top of the whistle chip (WC). You hear a clicking sound as the LEDs blink about once a second.

☐ Project #126 Sound Wave Magic



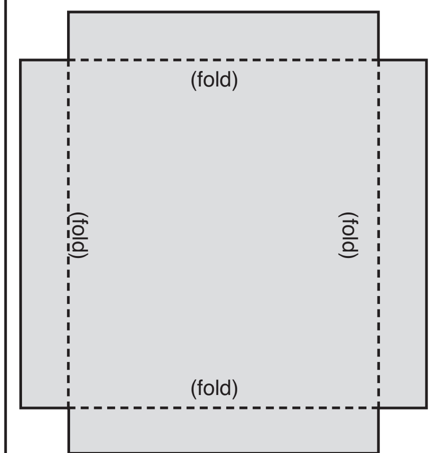
Build the circuit shown on the left and connect the speaker (SP2) using the two (2) jumper wires. Then, lay the speaker on a flat hard surface.

Setup: Use some paper and scissors to cut out a rectangular pattern. Use the one shown below as a guide. Use colored paper if available. Fold at the points shown. Scotch tape the corners so the tray has no cracks at the corners. Place the tray over the speaker and sprinkle a small amount of white table salt in the tray. There should be enough salt to cover the bottom with a little space between each salt grain.

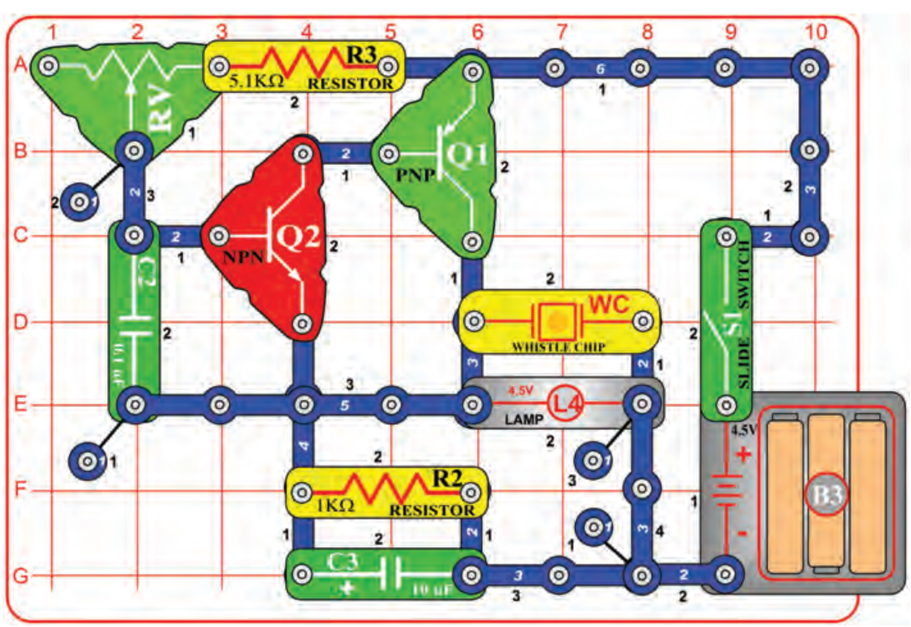
Sound Magic: Turn on the circuit by turning on the slide switch (S1). Adjust the adjustable resistor (RV) for different pitches and watch the salt particles. Particles that bounce high are directly over the vibrating paper and ones that do not move are in the nodes where the paper is not vibrating. Eventually, all the salt will move to the areas that have no vibration, and stay there.

Change the position of the tray and the material used to create different patterns due to the sound. Try sugar and coffee creamer, for example, to see if they move differently due to the sound waves.

Sample Cut-out Pattern



☐ Project #127 Pitch

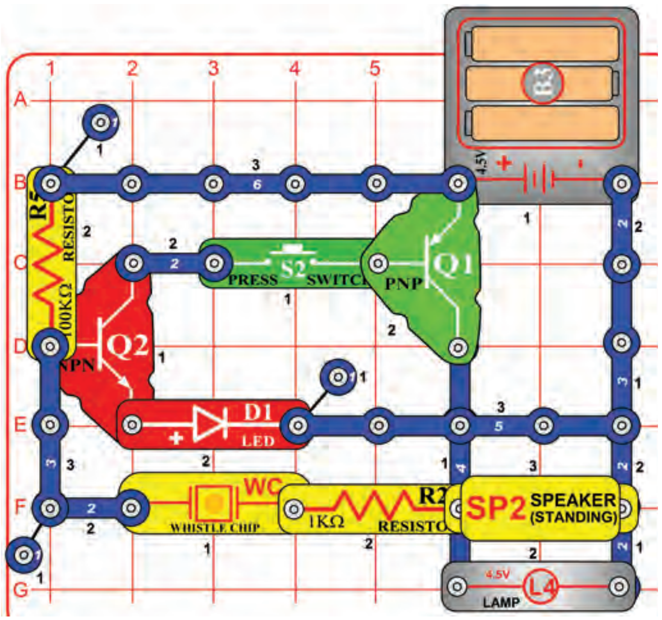


Build the circuit on the left, turn it on, and vary the adjustable resistor (RV). The *frequency* or *pitch* of the sound is changed. Pitch is the musical profession's word for frequency. If you've had music lessons, you may remember the music scale using chords such as A3, F5, and D2 to express the *pitch* of a sound. Electronics prefers the term *frequency*, as in when you adjust the frequency on your radio.

☐ Project 128 Photo Pitch

Replace the 5.1KΩ resistor (R3) with the photoresistor (RP). Wave your hand up and down over the photoresistor to change the sound. Changing the light on the photoresistor changes the circuit resistance just like varying the adjustable resistance does. **Note:** If you have the adjustable resistor (RV) set to the right and light shining on the photoresistor, then you may not get any sound because the total resistance is too low for the circuit to operate.

Project #129 — High Pitch Bell

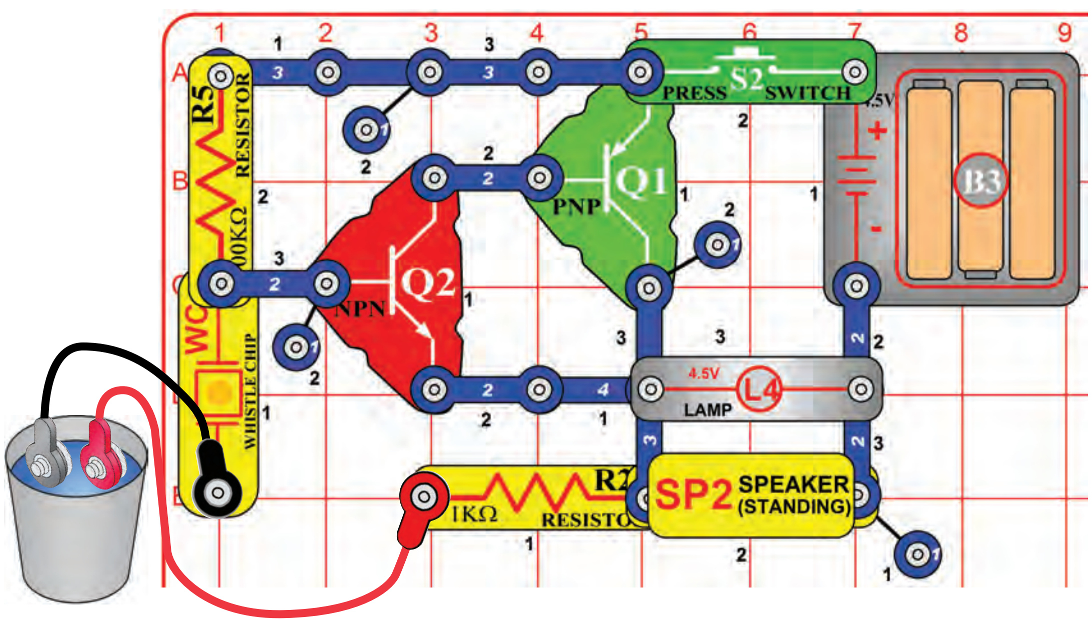


Build the circuit shown and press the press switch (S2). The circuit starts to oscillate. This generates the sound of a high pitch bell.

Project #130 — Steamship

Using the preceding circuit, connect the 0.1μF capacitor (C2) across the whistle chip. Press the press switch (S2). The circuit now generates the sound of a steamship.

Project #131 — Water Alarm

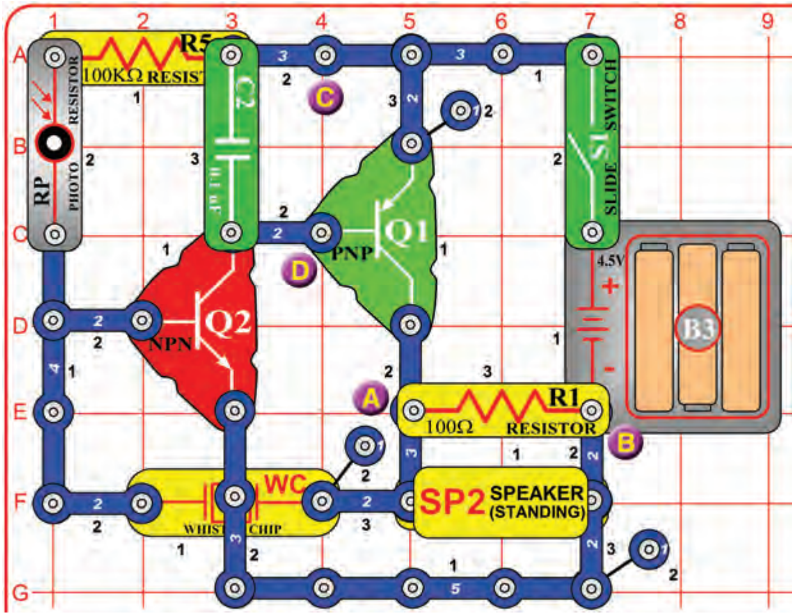


Build the circuit , and connect the two jumpers to it, place the loose ends of the jumpers into an empty cup (without them touching each other). Press the press switch (S2) - nothing happens. Add some water to the cup and an alarm will sound. Add salt to the water and the tone changes.

You can also test different liquids and see what tone they produce.

Don't drink any water used here.

☐ Project #132 Buzzing in the Dark

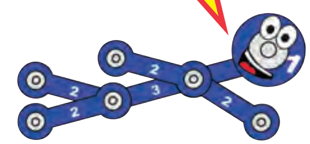


This circuit makes a high-frequency screaming sound when light shines on the photoresistor (RP), and makes a buzzing sound when you shield the photoresistor.

☐ Project #133 Touch Buzzer

Remove the photoresistor (RP) from the preceding circuit and instead touch your fingers across where it used to be (points A1 and C1 on the base grid) to hear a cute buzzing sound.

The circuit works because of the resistance in your body. If you put back the photoresistor and partially cover it, you should be able to make the same resistance your body did, and get the same sound.



☐ Project #134 High Frequency Touch Buzzer

Now place the lamp (L4) across the points marked A & B (in parallel with the speaker, SP2). Now touching your fingers between A1 & C1 creates a higher frequency sound.

☐ Project #135 High Frequency Water Buzzer

Now connect two (2) jumper wires to points A1 & C1 (that you were touching with your fingers) and place the loose ends into a cup of water. The sound will not be much different now, because your body is mostly water and so the circuit resistance has not changed much.

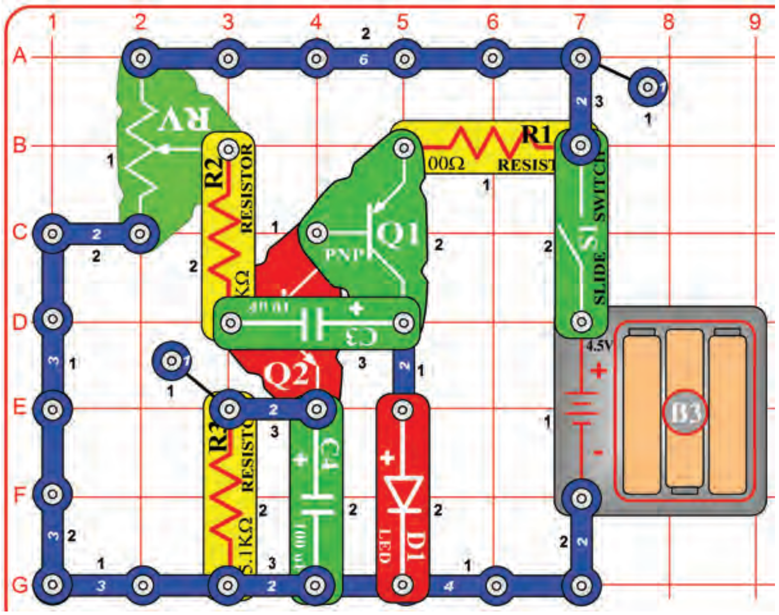
☐ Project #136 Mosquito

Place the photoresistor (RP) into the circuit in Project #135 across where you were connecting the jumpers (points A1 & C1 on the grid, and as shown in Project #132). Now the buzz sounds like a mosquito.

☐ Project #137 Loud Mosquito

Now place the 10μF capacitor (C3, "+" side up) across the points marked C & D (in parallel with the 0.1μF capacitor, C2). Now the sound is much louder.

Project #138 Oscillator



Turn on the slide switch (S1). Move the lever on the adjustable resistor (RV) until the LED (D1) is blinking. Adjust RV to see how fast and how slow you can make the LED blink. The LED may blink so fast that it looks like it is on all of the time.

Project #139 Pulse Oscillator

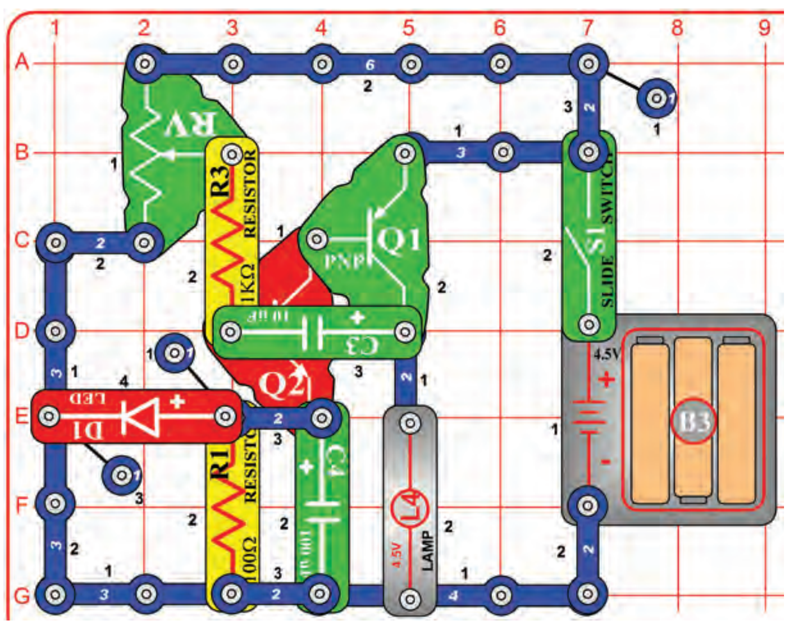
Use the circuit from Project #138. Connect a 1-snap to E5 and G5 and then connect the speaker (SP2) across the LED (on level 4).

Turn the slide switch (S1) on and move the lever on the adjustable resistor (RV) until you can hear the oscillator on the speaker (SP2). The sound will not be very loud, and you will not hear sounds at all settings of the adjustable resistor.

Project #140 Whistle Oscillator

Modify the preceding circuit by replacing the speaker (SP2) with the whistle chip (WC). The sound may not be very loud.

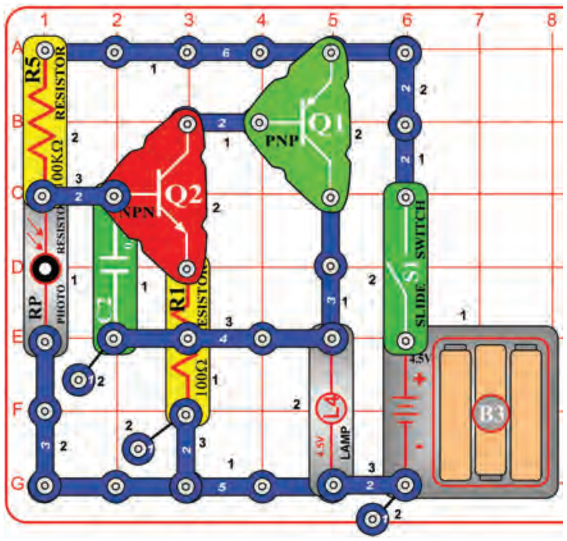
Project #141 Flasher



Turn on the slide switch (S1) and slowly move the lever on the adjustable resistor (RV) until both the lamp (L4) and LED (D1) are flashing. They will only flash together over a narrow range of the lever setting.

Project #142

Mail Notifying Electronic Lamp



Turn on the slide switch (S1). If there is enough light on the photoresistor (RP), the lamp (L4) will not light. Place your finger over the photoresistor and now the lamp lights. The lamp will stay on until you turn off the slide switch. A simple mail notifying system can be made using this circuit.

If the photoresistor and the red LED (D1) were inside the mailbox facing each other, then if there were mail, the light would be blocked from the photoresistor and the lamp would turn on.

Project #143

Mail Notifying Electronic Lamp & Sound

You can replace the 0.1μF capacitor (C2) with the whistle chip (WC) to add sound.

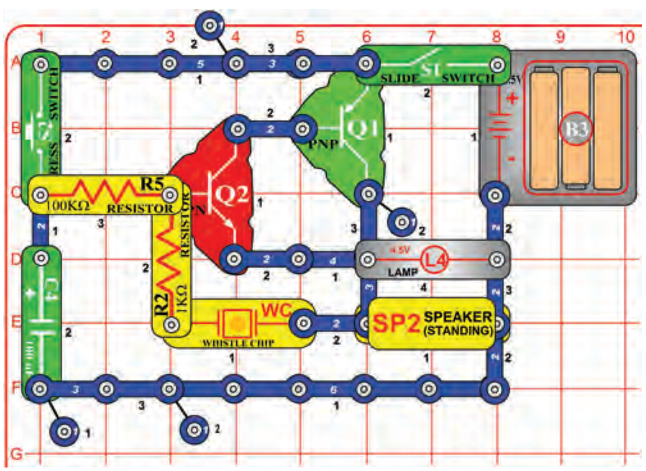
Project #144

Mail Notifying Mode Change

Using a 1-snap, place the speaker (SP2) at across locations E2-G6. When the lamp turns off the speaker will sound briefly.

Project #145

Lasting Doorbell



Build the circuit on the left; note that there is a 4-snap wire on layer 1 that is not connected to a 3-snap wire that runs over it on layer 3. Turn on the slide switch (S1), then press and release the press switch (S2). There is a doorbell sound that slowly fades away.

When the press switch is pressed, the transistors (Q1, Q2) are supplied with current for oscillation. At the same time, the 100μF capacitor (C4) is being charged. When the press switch is released, the capacitor discharges and keeps the oscillation going for a while.

Project #146 Lasting Clicking

Place the 10μF capacitor (C3) on top of the whistle chip (WC). Press and release the press switch (S2). It makes a clicking sound that repeats for a while.

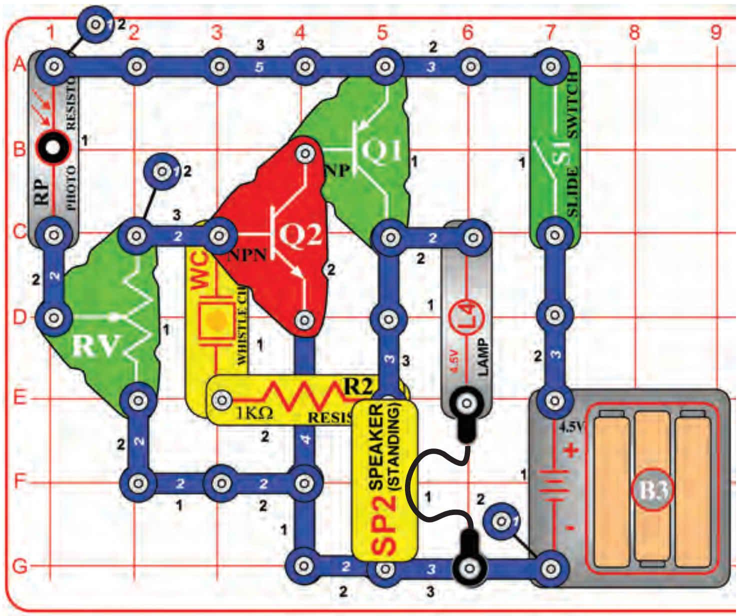
Project #147 Shorter Doorbell

Use the Project #145 circuit but replace the 100μF capacitor (C4) with the 10μF capacitor (C3). Press and release the press switch (S2). It makes a tone that lasts a few seconds.

Project #148 Lighted Doorbell

Use the preceding circuit but replace the 1KΩ resistor (R2) with the 5.1KΩ resistor (R3) and lamp (L4) with the red LED (D1), with "+" on left. Press and release the press switch (S2). It makes a tone and lights the LED for a few seconds.

☐ Project #149 Light Oscillator

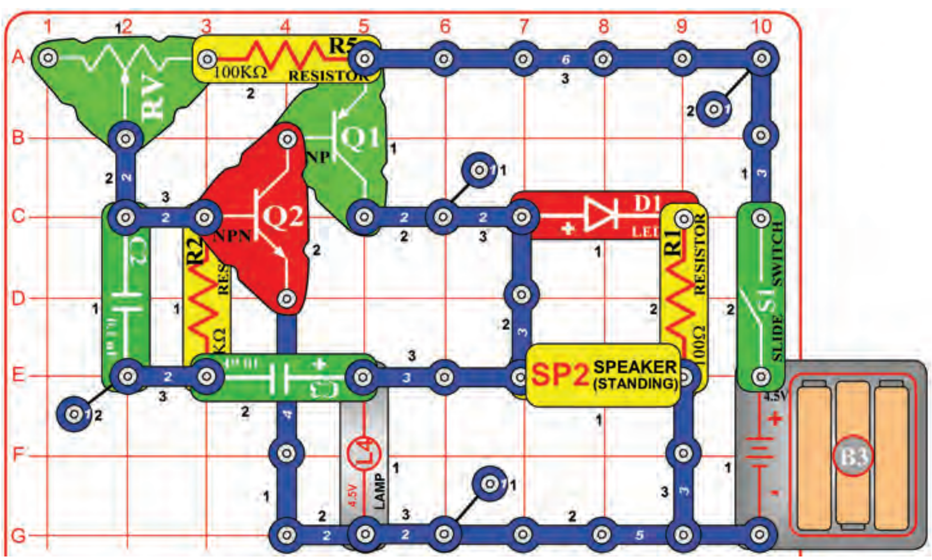


Set the adjustable resistor (RV) to the middle position and then turn on the slide switch (S1). Wave your hand over the photoresistor (RP) and the sound changes. You can adjust the sensitivity by moving the adjustable resistor to a different position.

☐ Project #150 Another Light Oscillator

Change the whistle chip (WC) to the 0.1μF capacitor (C2) and see how the sound changes.

☐ Project #151 Sound & Light Stepper Circuit

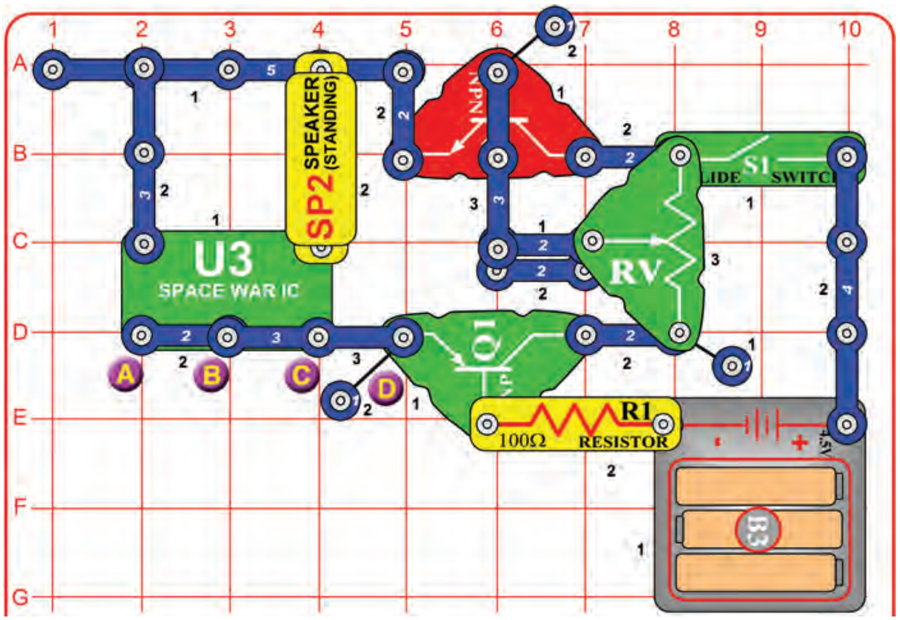


Set the adjustable resistor (RV) to the far left and turn on the slide switch (S1). The circuit produces around two pulses per second, which power the speaker (SP2), lamp (L4), and LED (D1). Increase the rate by moving the adjustable resistor to the right.

☐ Project #152 Another Light Oscillator

Change the 10μF capacitor (C3) to the 100μF (C4) and see how the time changes.

☐ Project #153 Transistor Power



Set the adjustable resistor (RV) to the top position, turn the slide switch (S1) on and the speaker (SP2) sounds. Slowly adjust the adjustable resistor down; the loudness decreases and the time the sound is on is longer. Adjusting the lever down turns the NPN transistor (Q1) off, lowering the voltage on space war IC (U3).

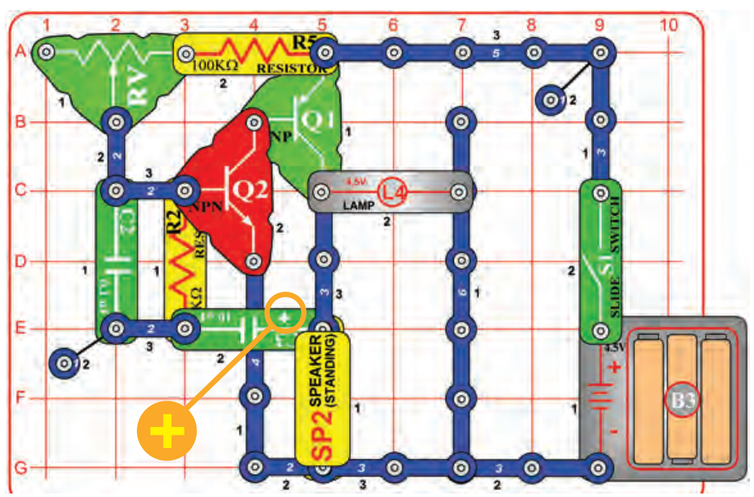
☐ Project #154 Transistor Power (II)

Change the sound by modifying the preceding circuit. Move the 2-snap across A & B to B & C. Operate the circuit the same as Project #153.

☐ Project #155 Static Space Sounds

Modify the previous circuit by placing 2-snaps across A & B, C & D and a 3-snap across B & D.

☐ Project #156 Blink & Beep

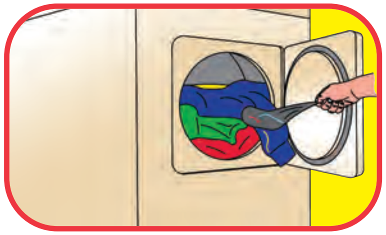


Set the adjustable resistor (RV) to the far left and turn on the slide switch (S1). The LED (D1) lights and the speaker (SP2) sounds once per second. Adjusting the adjustable resistor to the right increases the rate.

☐ Project #157 Blink & Beep (II)

Replace the 10μF capacitor (C3) with the 100μF capacitor (C4). When you turn on the slide switch (S1), LED (D1) will light about every 10 seconds. The speaker (SP2) clicks as the light blinks.

Project #158 Electricity You Can Wear



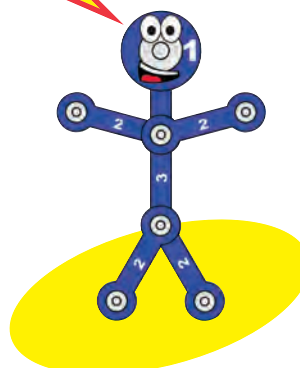
Find some clothes that cling together in the dryer, and try to uncling them.

The crackling noise you hear when taking off a sweater is static electricity. You may see sparks when taking one off in a dark room.

Rub a sweater (wool is best) and see how it clings to other clothes.

Note: This project works best on a cold dry day. If the weather is humid, the water vapor in the air allows the static electric charge to dissipate, and this project may not work.

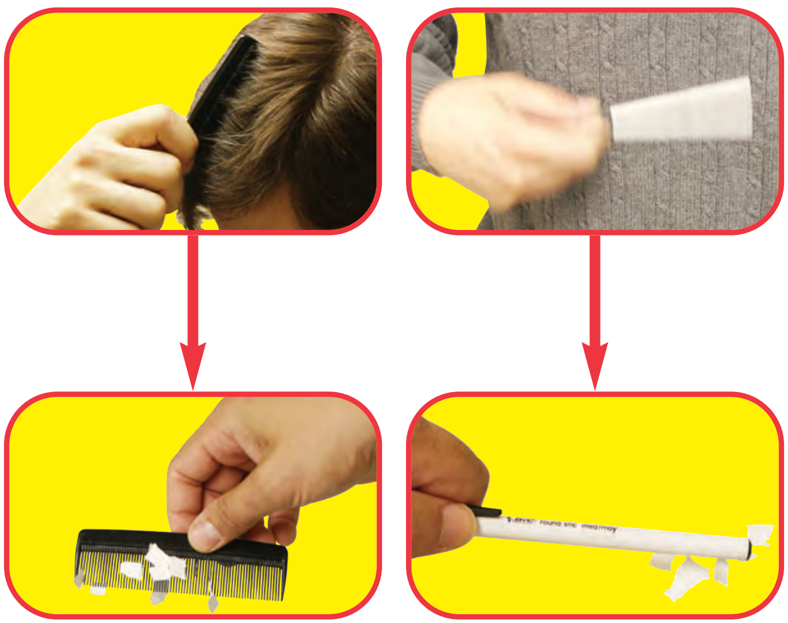
Snappy says: clothes can cling together because electricity is all around us.



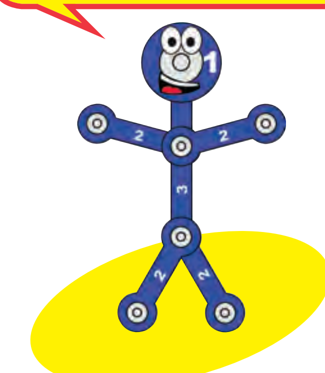
Did you ever wonder why clothes cling together when they come out of the dryer? Did you ever hear a crackling sound when you take off a sweater? (If the room is dark you might even see sparks.) Did you ever feel a "zap" when you touch someone wearing a sweater on a dry day?

These effects are caused by electricity. We call this static electricity because the electrical charges are not moving, although pulling clothes apart sounds like static on a radio. When electricity is moving (usually through wires) to do something in another place, we call it an electric current.

Project #159 Electricity in Your Hair



Snappy says: notice how your hair can "stand up" or be attracted to the comb when the air is dry. Wetting your hair dissipates the static charge.



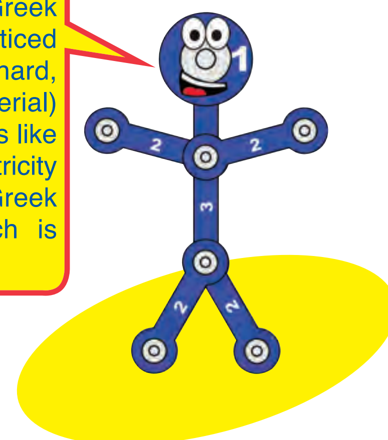
You need a comb (or a plastic ruler) and some paper for this project. Rip up the paper into small pieces. Run the comb through your hair several times then hold it near the paper pieces to pick them up. You can also use a pen or plastic ruler, rub it on your clothes (wool works best).

Rubbing the comb through your hair pulls extremely tiny charged particles from your hair onto the comb. These give the comb a static electrical charge, which attracts the paper pieces.

Note: This project works best on a cold dry day. If the weather is humid, the water vapor in the air allows the static electric charge to dissipate, and this project may not work.

Project #160 Bending Water

Static electricity was discovered more than 2,500 years ago when the Greek philosopher Thales noticed that when amber (a hard, clear, yellow-tinted material) is rubbed, light materials like feathers stick to it. Electricity is named after the Greek word for amber, which is electron.



You need a comb (or plastic ruler) and a water faucet for this project. Run the comb through your hair several times then hold it next to a slow, thin stream of water from a faucet. The water will bend towards it. You can also use a plastic ruler. Rub it on your clothes (wool works best).

Rubbing the comb through your hair builds up a static electrical charge on it, which attracts the water.

Note: This project works best on a cold dry day. If the weather is humid, the water vapor in the air allows the static electric charge to dissipate, and this project may not work.

Project #161 Static Tricks

Take a piece of newspaper or other thin paper and rub it vigorously with a sweater or pencil. It will stick to a wall.

Cut the paper into two long strips, rub them, then hang them next to each other. See if they attract or repel each other.

If you have two balloons, rub them to a sweater and then hang the rubbed sides next to each other. They repel away. You could also use the balloons to pick up tiny pieces of paper.

Note: This project works best on a cold dry day. If the weather is humid, the water vapor in the air allows the static electric charge to dissipate, and this project may not work.

Electricity vs. Gravity:

Electricity is immensely more powerful than gravity (gravity is what causes things to fall to the ground when you drop them). However electrical attraction is so completely balanced out that you don't notice it, while gravity's effects are always apparent because they are not balanced out.

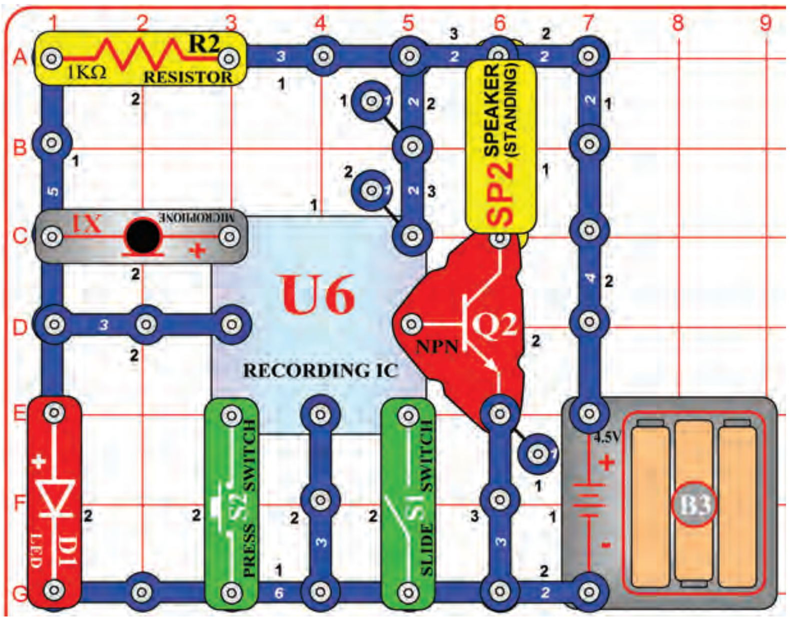
Gravity is actually the attraction between objects due to their weight (or technically, their mass). This effect is extremely small and can be ignored unless one of the objects is as big as a planet (like the earth). Gravity attraction never goes away and is seen every time you drop something. Electrical charge, though usually balanced out perfectly, can move around and change quickly.

For example, you have seen how clothes can cling together in the dryer due to static electricity. There is also a gravity attraction between the sweaters, but it is always extremely small.

Electricity

Gravity

Project #162 Recording LED Indicator



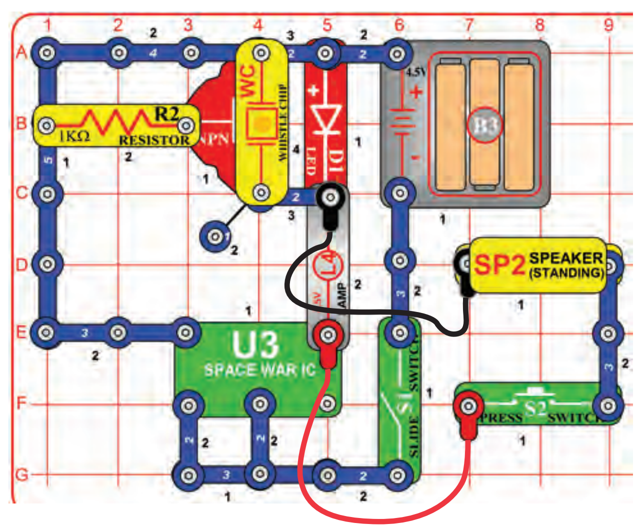
The circuit uses sound (beep) and light (LED) to indicate that you are recording. Build the circuit and the red (D1) should light. Now turn on the slide switch (S1). You hear one beep and the LED turns off. Speak into the microphone (X1) to record a message. When you turn off the slide switch, or the circuit beeps twice (indicating the recording is finished), the red LED turns on again. Make sure that the slide switch is turned off. Press the press switch (S2) to hear your recording followed by a song.

Project #163 Pencil Alarm

Remove the press switch (S2) and connect the red and black jumper wires where it had been. Leave the loose ends of the jumpers unconnected for now. There is one more part you need and you are going to draw it. Take a pencil (No. 2 lead is best but other types will also work). **SHARPEN IT**, and fill in the shape below. You will get better results if you place a **hard**, flat surface directly beneath this page while you are drawing. Press **hard** (but don't rip the paper), and fill in the shape **several times** to be sure you have a **thick, even layer** of pencil lead.

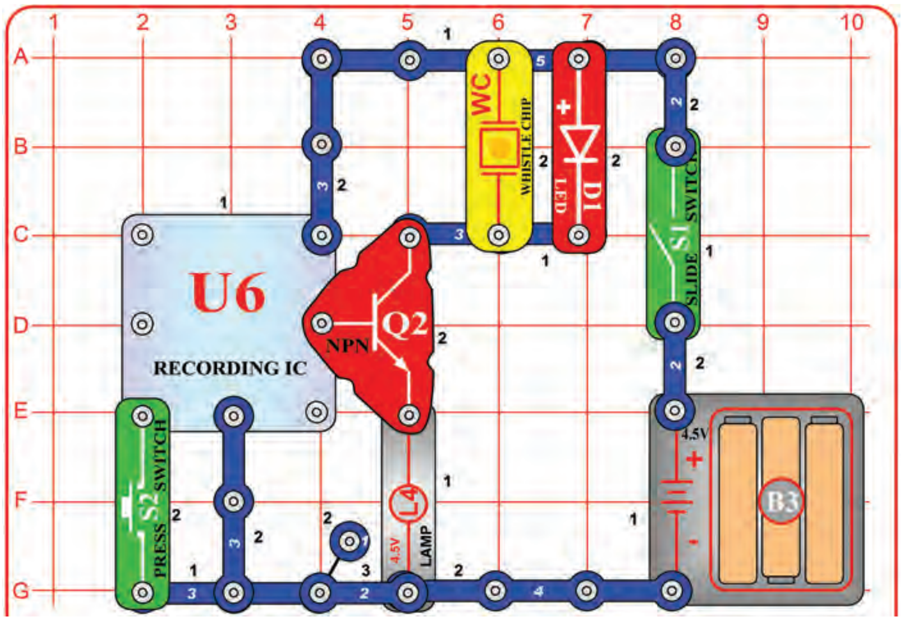
Press the loose ends of the jumpers to the shape and move them around over the drawing to trigger your alarm. If you don't hear any sound then move the ends closer together and move over the drawing, add another layer of pencil lead, or put a drop of water on the jumper ends to get better contact.

Project #164 Two Lights Two Sounds



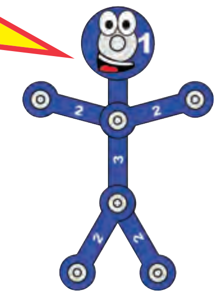
Turn on the slide switch (S1), the whistle chip (WC) sounds and D1 and L4 light. The whistle chip (WC) and LED are in parallel. To connect the speaker in parallel with the lamp press S2. Now you have two parallel circuits connected in series.

Project #165 LED Music



Press the press switch (S2) once. The LED lights and music plays for a while. Press the press switch again and see how long the second song plays. When the second song stops, press the press switch (S2) again to play the third song.

The lamp (L4) is used to limit the current and will not light. The music may be preceded by a recording, but the recording quality will not be as good as when it is played using the speaker (SP2).



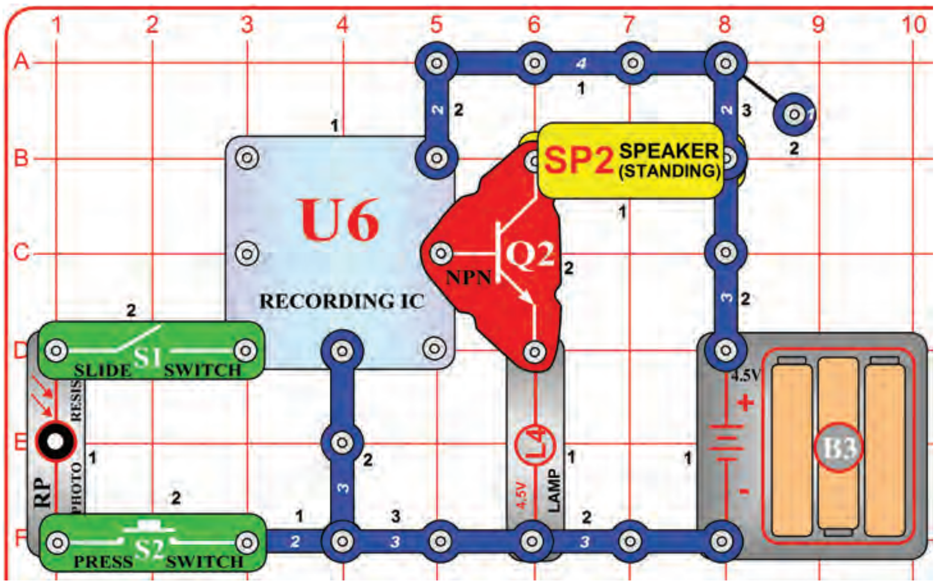
Project #166 Light-Controlled LED Time Delay

Use the circuit in Project #165. Replace the press switch (S2) with the photoresistor (RP). Turn the LED (D1) on and off by waving your hand over the photoresistor.

Project #167 Touch-Controlled LED Time Delay

Use the circuit in Project #165. Replace the press switch (S2) with the PNP transistor (Q1, arrow on U6 and a 1-snap on base grid point F1). Turn the LED (D1) on and off by touching grid points F1 & G2 at the same time. You may need to wet your fingers.

Project #168 Music AND Gate

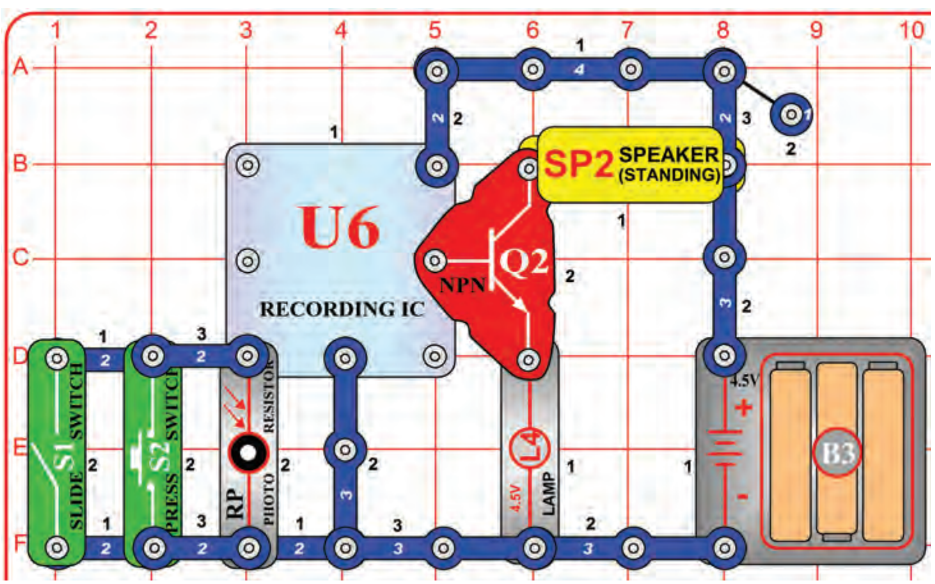


You will only hear music if you turn on the slide switch (S1) AND press the press switch (S2) AND there is light shining on the photoresistor (RP). This is referred to as an AND gate in electronics. The lamp (L4) is only used to limit current and will not light.

This concept is important in computer logic.

Example: If condition W, condition X, AND condition Y are true, then execute instruction Z.

Project #169 Music OR Gate

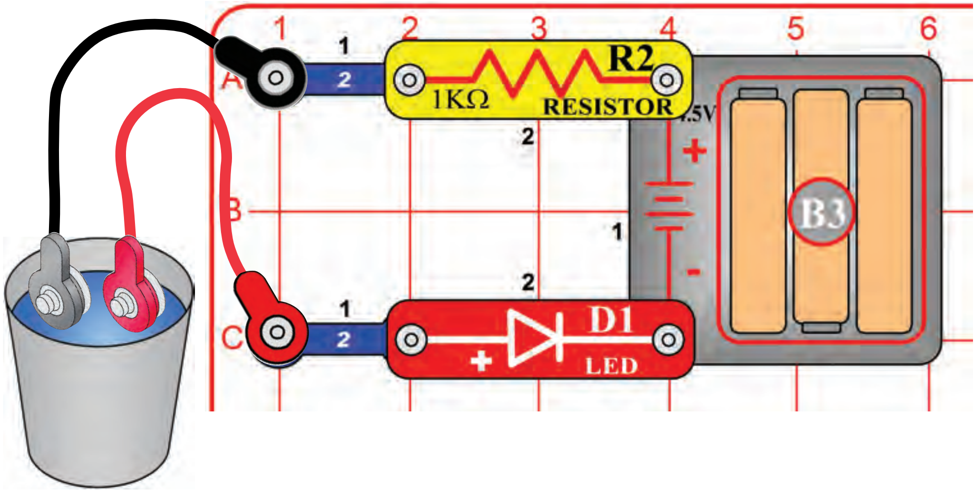


You will hear music if you turn on the slide switch (S1) OR press the press switch (S2) OR there is light shining on the photoresistor (RP). This is referred to as an OR gate in electronics. The lamp (L4) is only used to limit current and will not light.

This concept is important in computer logic.

Example: If condition W, condition X, OR condition Y is true, then execute instruction Z.

Project #170 Water Detector

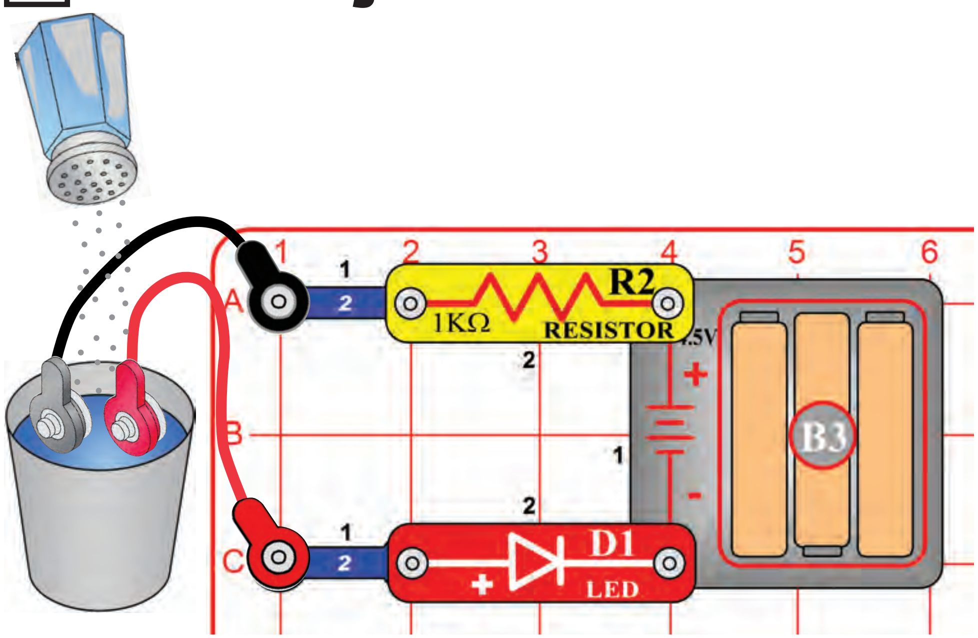


Build the circuit at left and connect the two jumpers to it, but leave the loose ends of the jumpers lying on the table initially. The LED (D1) will be dark because the air separating the jumpers has very high resistance. Touch the loose jumper ends to each other and the LED will be bright, because with a direct connection there is no resistance separating the jumpers.

Now take the loose ends of the jumpers and place them in a cup of water, without letting them touch each other. The LED should be dimly lit, indicating you have detected water!

For this experiment, your LED brightness may vary depending upon your local water supply. Pure water (like distilled water) has very high resistance, but drinking water has impurities mixed in that increase electrical conduction.

Project #171 Saltwater Detector

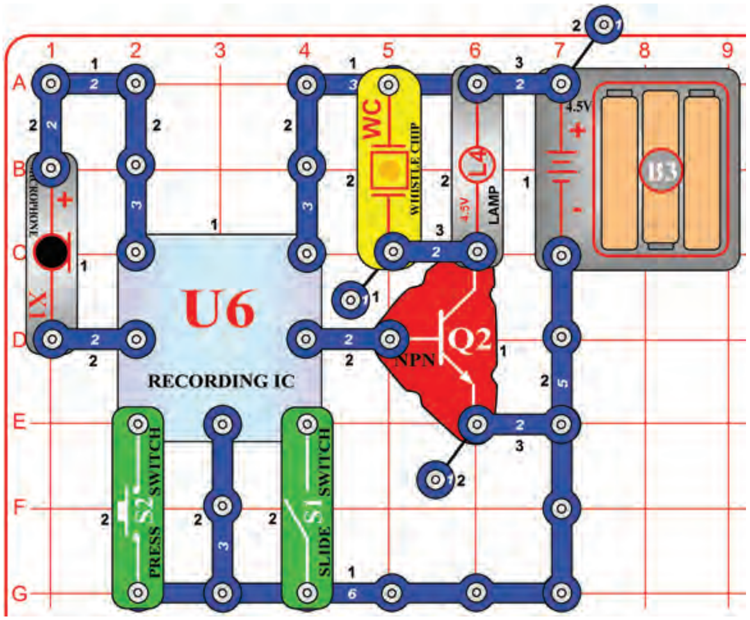


Place the jumpers in a cup of water as in the preceding project; the LED (D1) should be dimly lit. Slowly add salt to the water and see how the LED brightness changes, mix it a little so it dissolves. It will slowly become very bright as you add more salt. You can use this bright LED condition as a saltwater detector! You can then reduce the LED brightness by adding more water to dilute the salt.

Take another cup of water and try adding other household substances like sugar to see if they increase the LED brightness as the salt did.

Project #172

Playback & Record with Light

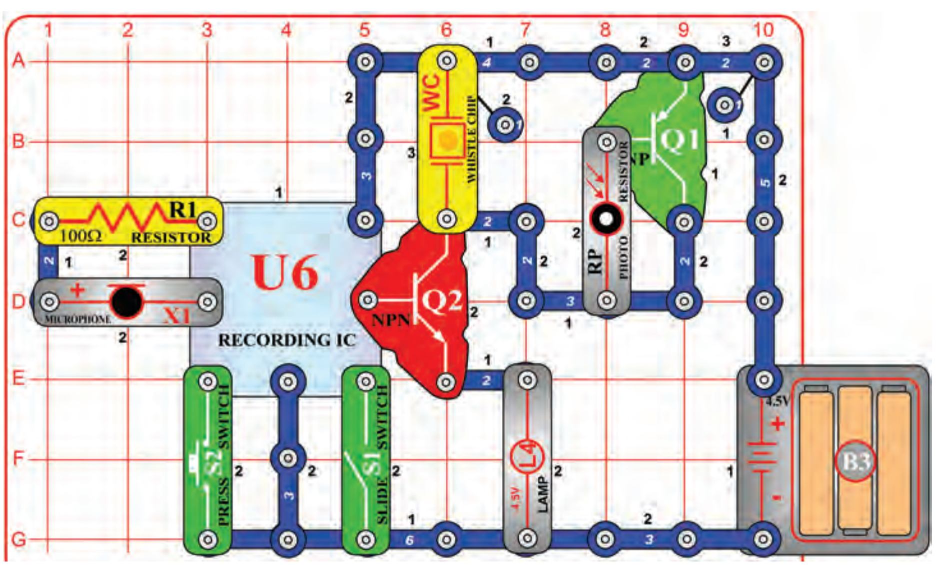


Build the circuit shown. Turn on the slide switch (S1), you hear a beep signaling that you may begin recording. Talk into the microphone (X1) up to 5 seconds, and then turn off the slide switch (it also beeps after the 5 seconds expires).

Press the press switch (S2) for playback. It plays the recording you made followed by one of three songs. If you press the press switch before the song is over, music will stop. You may press the press switch several times to play all three songs. The lamp will light while the music plays, though it may not be very bright.

Project #173

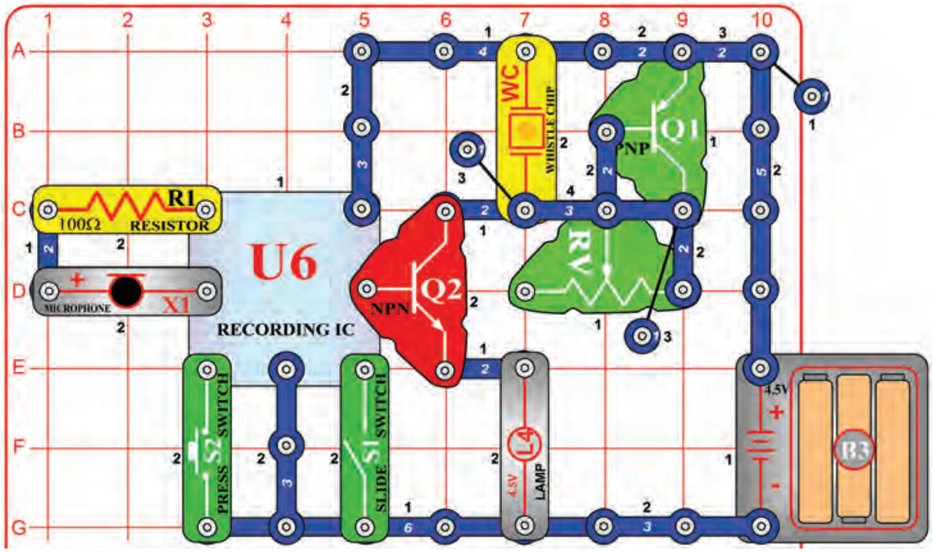
Photo Music



Build the circuit shown and press the press switch (S2). It plays a recording followed by one of three songs. Adjust the amount of light on the photoresistor (RP) to change the volume and alter the tone. Wave your fingers over the photoresistor for some cool sound effects. You may press the press switch several times to play three songs. The lamp (L4) is used to limit the current and will not light.

You can change the recorded message. Turn on the slide switch (S1), you hear a beep signaling that you may begin recording. Talk into the microphone (X1) up to 5 seconds, and then turn off the slide switch (it also beeps after the 5 seconds expires).

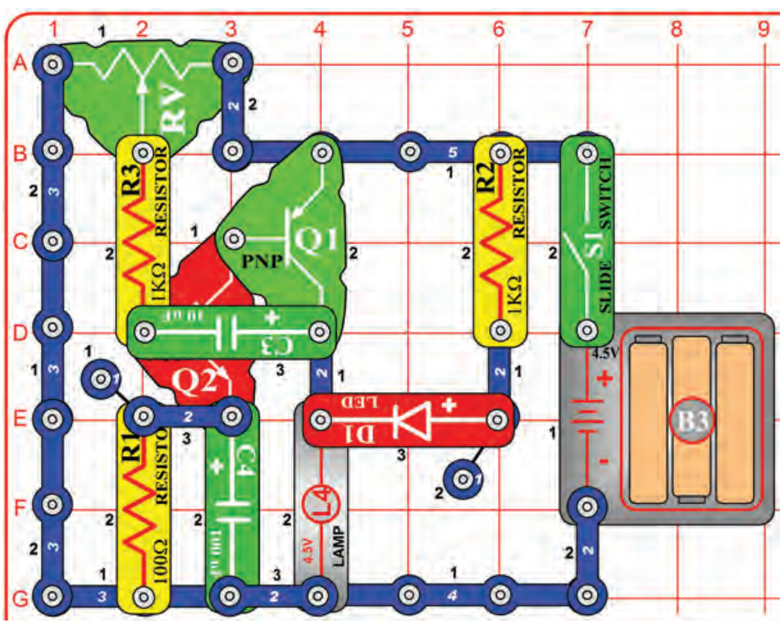
Project #174 Sliding Music



Build the circuit shown and press the press switch (S2). It plays a recording followed by one of three songs. Move the slider on the adjustable resistor (RV) around to change the volume and for some sound effects. You may press the press switch several times to play three songs. The lamp is used to limit the current and will not light.

You can change the recorded message. Turn on the slide switch (S1), you hear a beep signaling that you may begin recording. Talk into the microphone (X1) up to 5 seconds, and then turn off the slide switch (it also beeps after the 5 seconds expires).

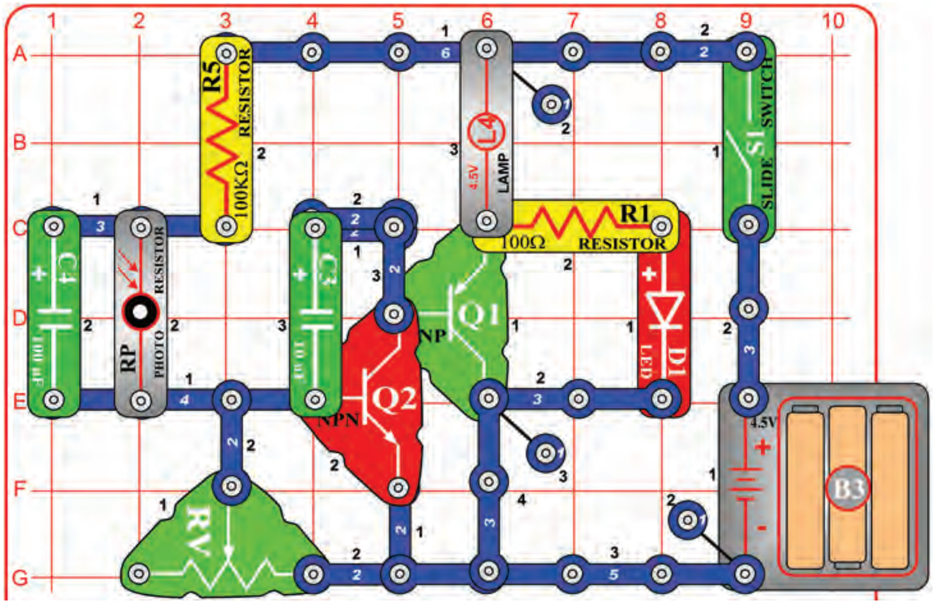
Project #175 Synchronized Flasher



Turn on the slide switch (S1) and slowly move the lever on the adjustable resistor (RV) until both the lamp (L4) and LED (D1) are flashing. They will only flash together over a narrow range of the lever setting.

Replace the red LED (D1) with the whistle chip (WC) and readjust the adjustable resistor until the whistle chip clicks and the lamp lights.

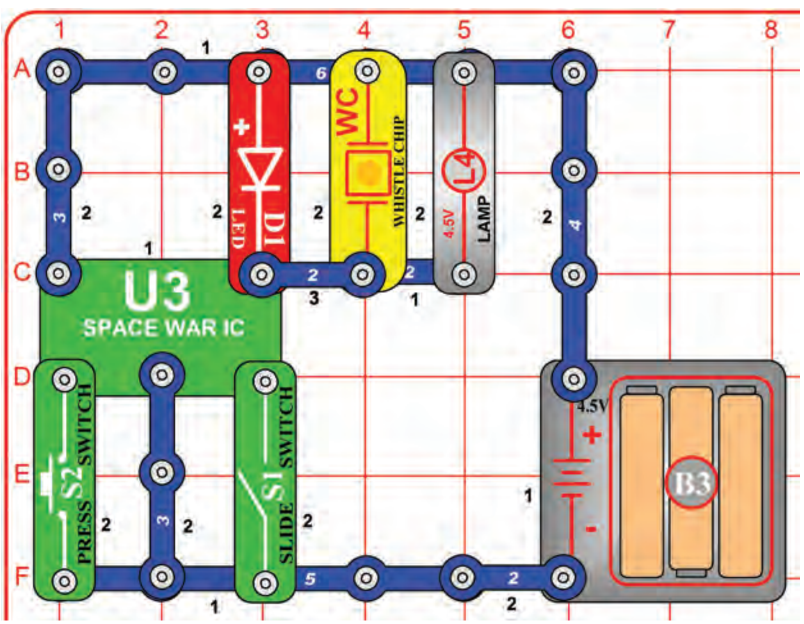
☐ Project #176 Slow Light Switcher



Turn the slide switch (S1) on. Set the adjustable resistor (RV) so that the lamp (L4) is on when there is light on the photoresistor (RP), and the LED (D1) is on when you cover the photoresistor.

When you cover or uncover the photoresistor, the lamp & LED take a few seconds to switch on or off.

☐ Project #177 Space Battle



Build the circuit shown on the left. Activate the circuit by turning on the slide switch (S1) or pressing the press switch (S2), do both several times and in combination. You will hear exciting sounds and see flashing lights, as if a space battle is raging!

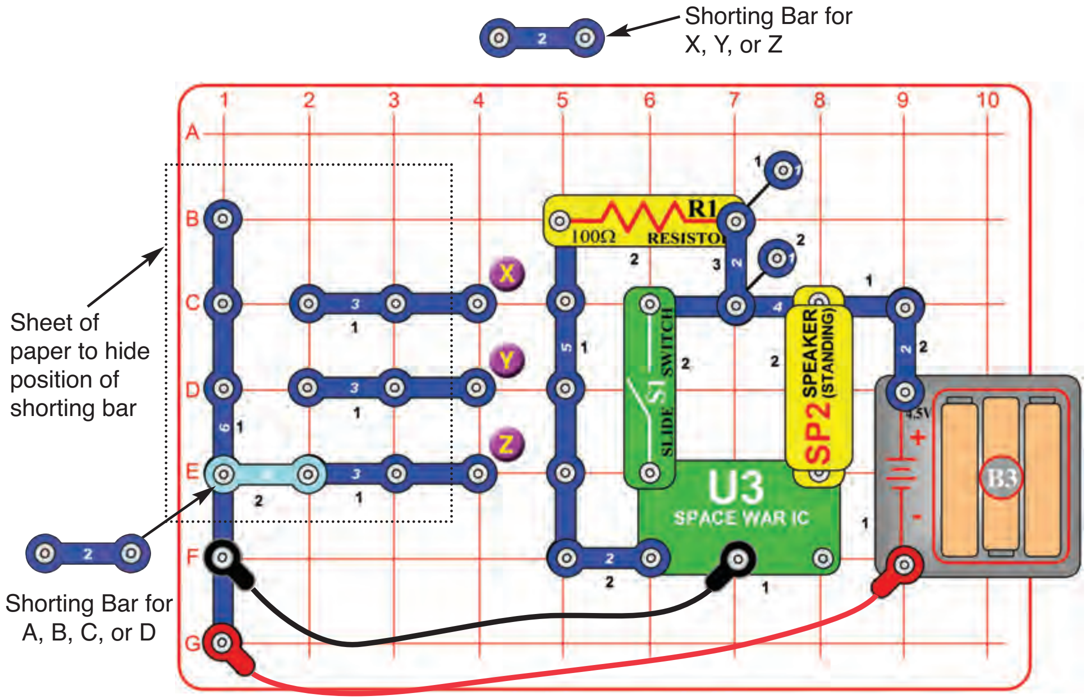
☐ Project #178 Space Battle (II)

Replace the slide switch (S1) with the photoresistor (RP). Now covering and uncovering the photoresistor will change the sound.

☐

Project #179

Electronic Bombing Game



Build the circuit at left. It uses both jumper wires as permanent connections. It also uses two 2-snap wires as "shorting bars".

Setup: Player 1 sets the target by placing one shorting bar under the paper on row C, D, or E. Player 2 must NOT know where the shorting bar is located under the paper.

The object is for Player 2 to guess the location by placing their shorting bar (another 2-snap) at positions X, Y, or Z. In the drawing on the left Player 1 set up this hole at position "E". If Player 2 places their shorting bar across "Z" on the first try then they get a hit. They keep guessing until they hit. After each hit, remove the shorting bars and slide the switch off and on to reset the sound.

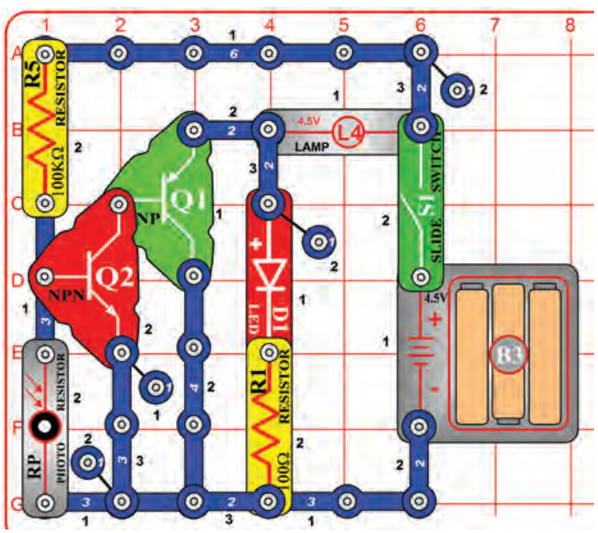
Player 2 then sets the C, D, E side and player 1 tries their luck.

Play multiple rounds and see who gets the best overall score. The winner will be the player who is best at reading their opponent's mind.

☐

Project #180

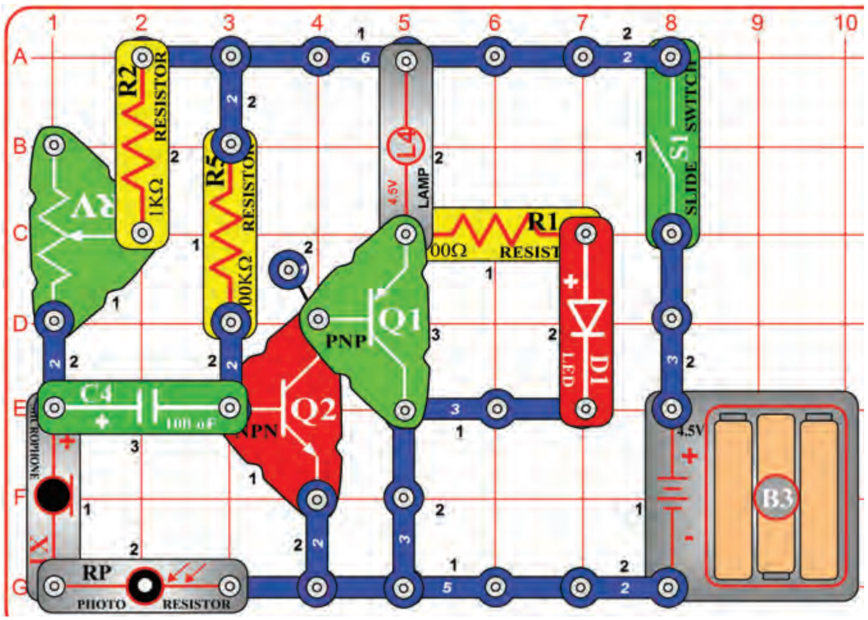
Photo Switcher



Turn the slide switch (S1) on. If there is light on the photoresistor (RP) then the LED (D1) turns on. Cover the photoresistor to switch off the LED and switch on the lamp (L4).

Project #181

Blowing & Shining Lights

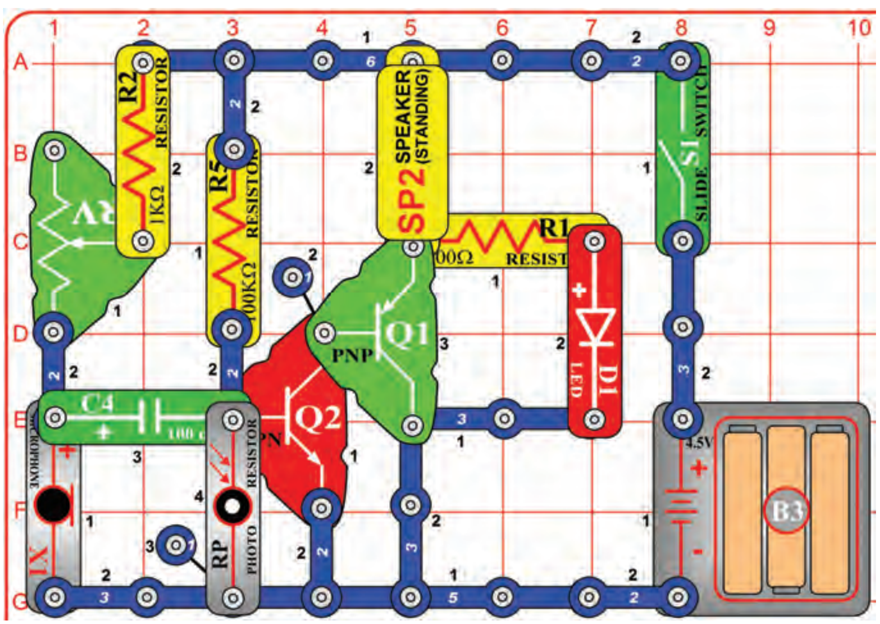


Set the adjustable resistor (RV) lever to middle position and turn on the slide switch (S1). Blow on the microphone (X1) and cover/uncover the photoresistor (RP) to turn the lamps (L4) and LED (D1) on and off.

Move the lever on the adjustable resistor around to adjust the sensitivity.

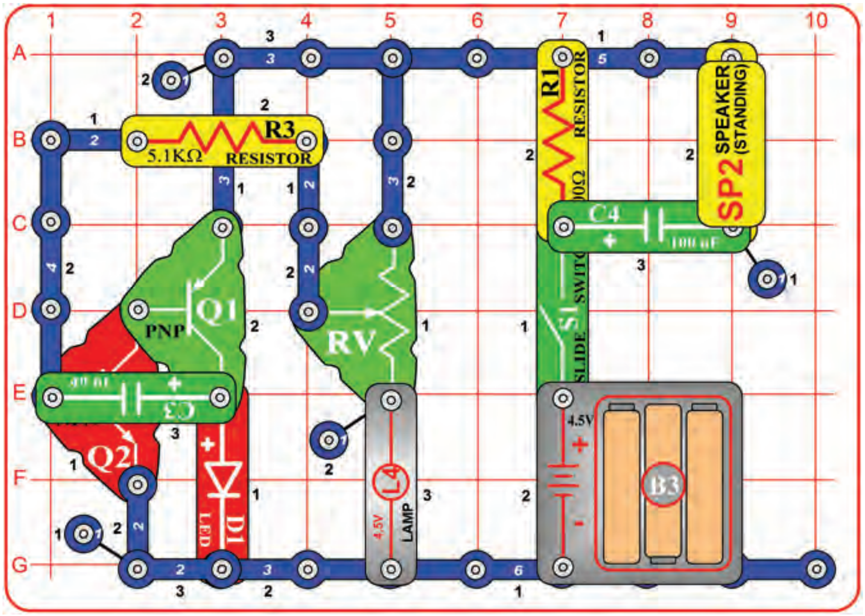
Project #182

Adjustable Blowing Sound



Turn on the slide switch (S1). Blow into the microphone (X1) and you hear static from the speaker (SP2). The adjustable resistor (RV) setting and the amount of light on the photoresistor (RP) change the sensitivity. The red LED (D1) is also controlled by the photoresistor.

☐ Project #183 Tunable Oscillator



Turn on the slide switch (S1) and slowly move the adjustable resistor (RV) control lever until the red LED (D1) is flashing. The speaker (SP2) will also make a clicking sound. The lamp (L4) will not light.

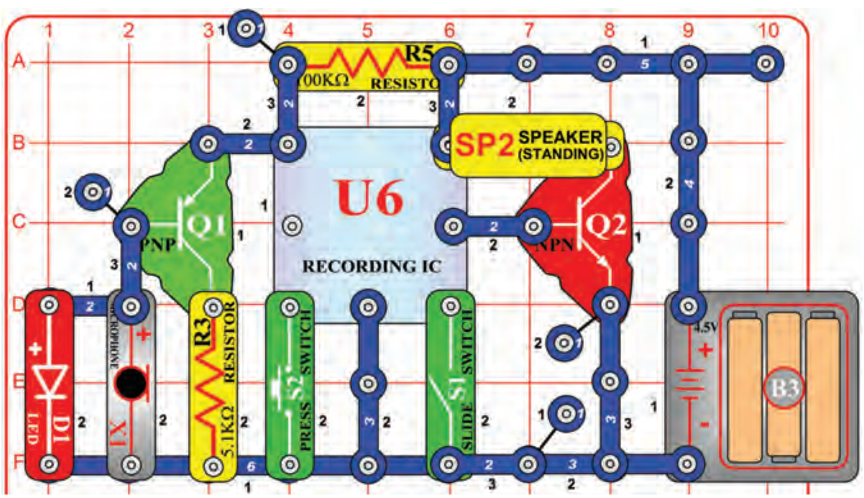
You can remove the speaker if you don't like the clicking sound.

☐ Project #184 High Low Oscillator

Use the Project #183, replace the capacitor C3 with C2 and the frequency should be higher.

Replace the 5.1KΩ resistor (R3) with the photoresistor (RP) and set RV to the middle. Now you can and control the frequency by waving your hand over the photoresistor (RV).

☐ Project #185 Recording IC

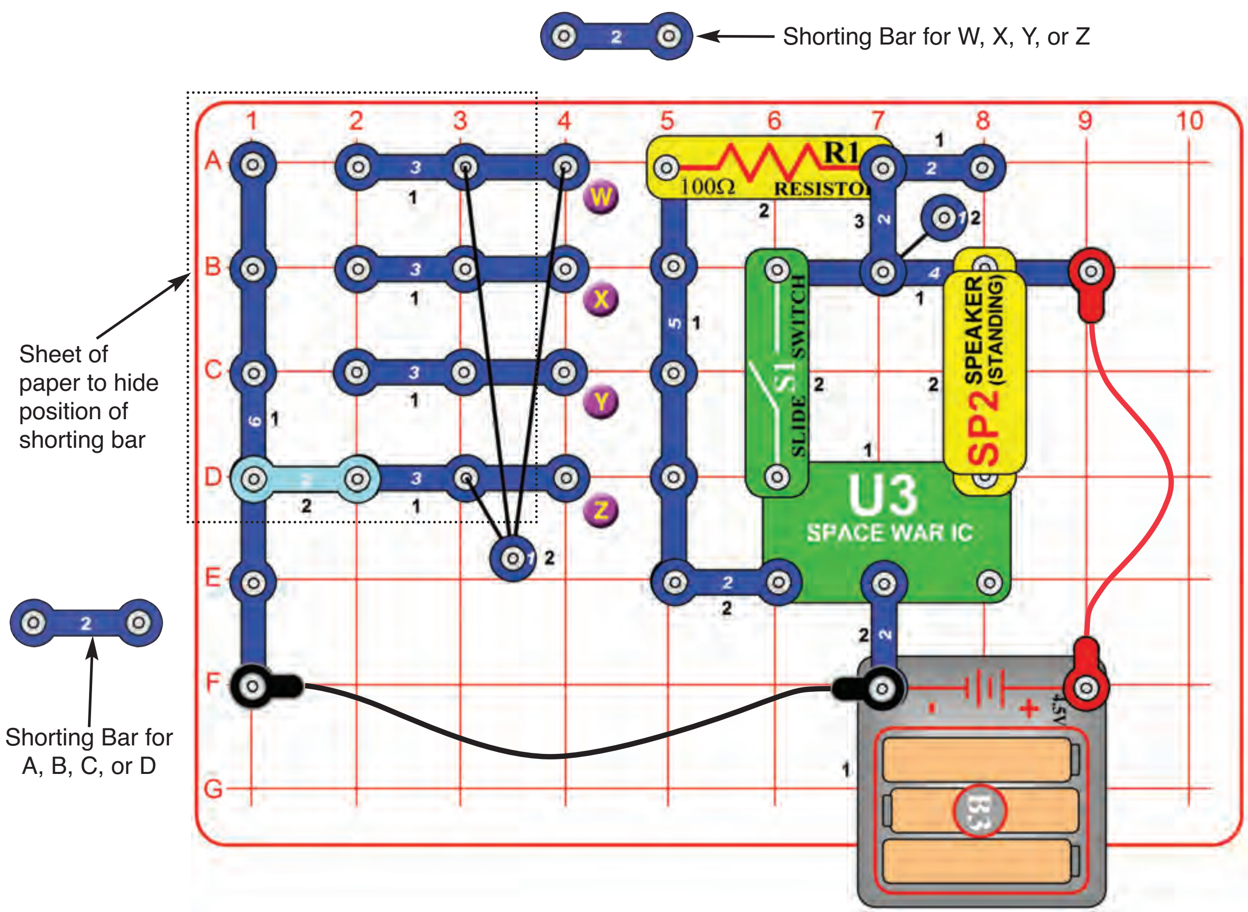


Build the circuit shown. Turn on the slide switch (S1), you hear a beep signaling that you may begin recording. Talk into the microphone (X1) up to 5 seconds, and then turn off the slide switch (it also beeps after the 5 seconds expires). Press the press switch (S2) for playback. It plays the recording you made followed by one of three songs. If you press the press switch before the song is over, music will stop. You may press the press switch several times to play all three songs.

☐ Project #186 Whistle Recording

Use the circuit in Project #185, but replace the microphone (X1) with the whistle chip (WC). The whistle chip can be used as a microphone, though the sound quality is not as good.

Project #187 Mind Reading Game



Build the circuit shown on the left. It uses two (2) 2-snap wires as shorting bars.

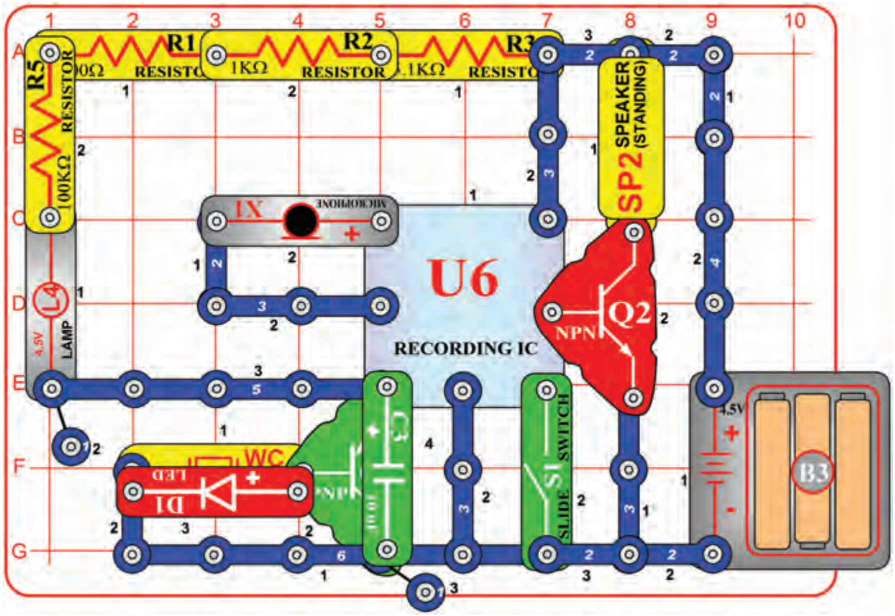
Setup: Player 1 sets up by placing one shorting bar under the paper on row A, B, C, or D. Player 2 must **NOT** know where the shorting bar is located under the paper.

The object is for Player 2 to guess the location by placing their shorting bar at positions W, X, Y, or Z. In the drawing on the left, Player 1 sets up at position “D”. If Player 2 places their shorting bar across “Z” on the first try, then they guessed correctly and marks a 1 on the score card sheet under that round number. If it takes three tries, then they get a three.

Player 2 then sets the A, B, C, D side and Player 1 tries their luck. Each player records their score for each round. When all 18 rounds have been played, the player with the lowest score wins. Additional players can play.

Round #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total
Player 1																			
Player 2																			
Player 3																			
Player 4																			

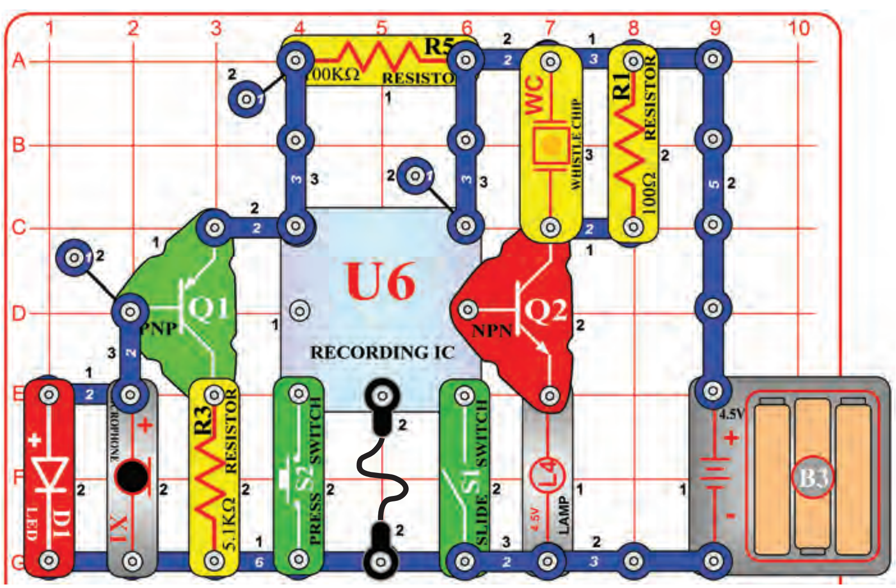
☐ Project #188 Tap Start Recorder



Build the circuit shown. Tap the case of the red LED (D1) for playback. It plays the recording you made followed by one of three songs. If you tap the case during playback, the music stops. The lamp (L4) and red LED do not light in this project. The lamp function as a jumper and the red LED as a diode.

You can change the recorded message. Turn on the slide switch (S1) and talk into the microphone (X1) up to 5 seconds, and then turn off the slide switch.

☐ Project #189 Transistor Mic

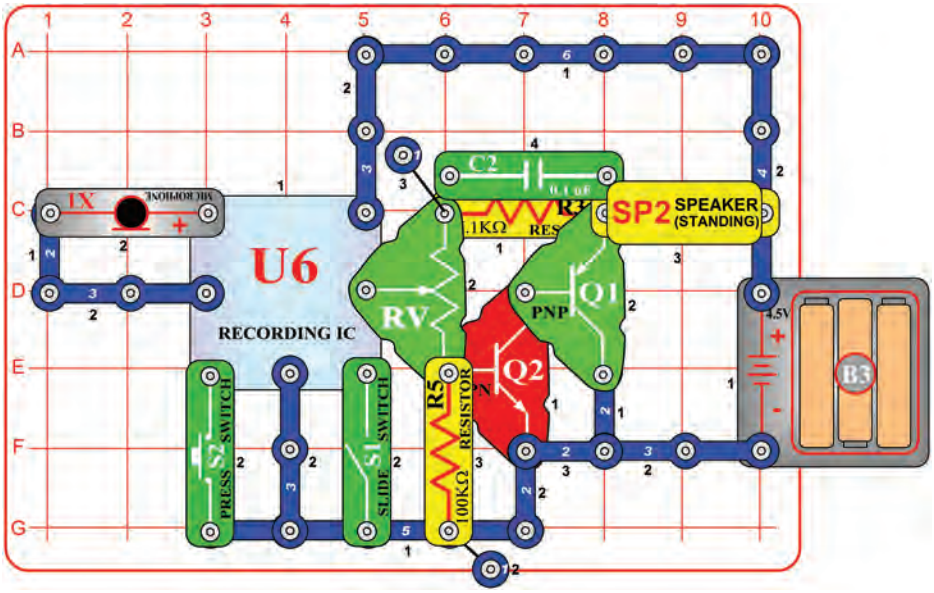


Build the circuit shown. Turn on the slide switch (S1), you hear a beep signaling that you may begin recording. Talk into the microphone (X1) up to 5 seconds, and then turn off the slide switch (it also beeps after the 5 seconds expires). Press the press switch (S2) for playback. It plays the recording you made followed by one of three songs. The lamp (L4) will not light.

☐ Project #190 Transistor Mic with Speaker

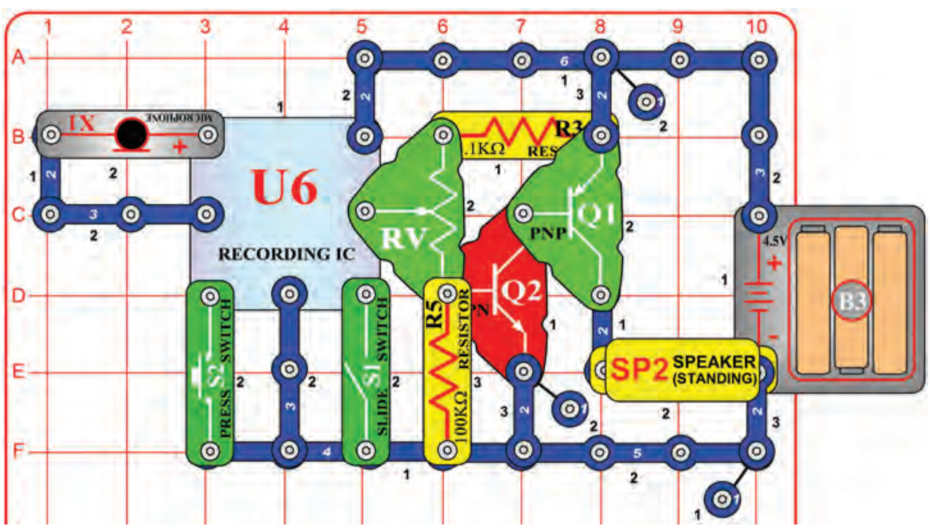
Use the circuit in Project #189 and replace the 100Ω resistor (R1) with the speaker (SP2). Now the speaker and whistle chip (WC) will sound as the music plays.

Project #191 Adjustable Volume



This circuit uses the variable resistor (RV) as a volume control. Build the circuit and set RV to the middle position. As the music plays, you can adjust the volume by moving RV control up or down from the center position.

Project #192 Adjustable Volume Music

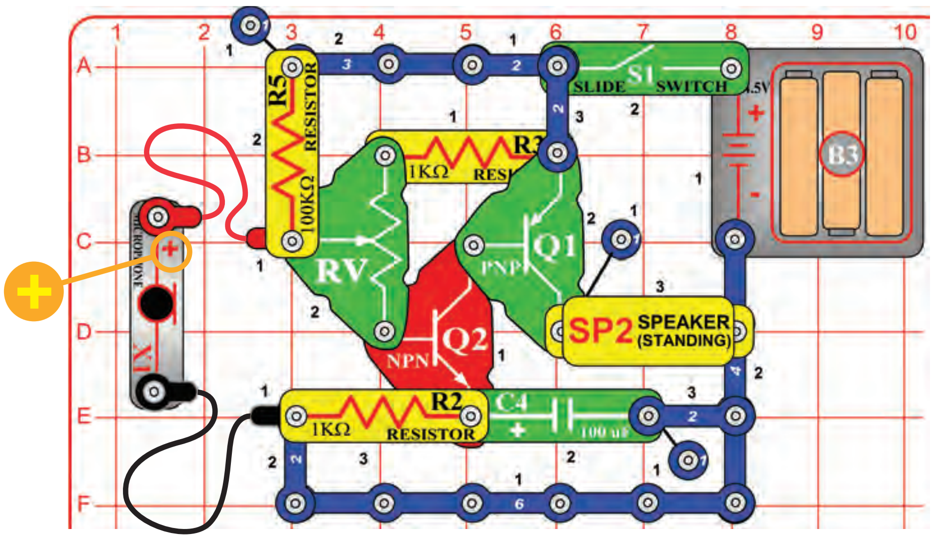


This circuit uses the variable resistor (RV) as a volume control. Build the circuit and set RV to the middle position. As the music plays, you can adjust the volume by moving RV control up or down from the center position.

Project #193 Adjustable Volume with Light

Use the circuit in Project #192 and place the lamp (L4) across the PNP transistor (Q1) using a 1-snap (across base grid locations B8-D8, level 4). When the recording IC (U6) is playing, the lamp should be off and then turn on when the music stops.

☐ Project #194 Audio Amplifier



Build this audio amplifier circuit shown. Set the slide switch (S1) on and talk or blow into the microphone (X1). You should hear your voice on the speaker (SP2). Your voice will not be very loud. Control the volume by adjusting the RV control.

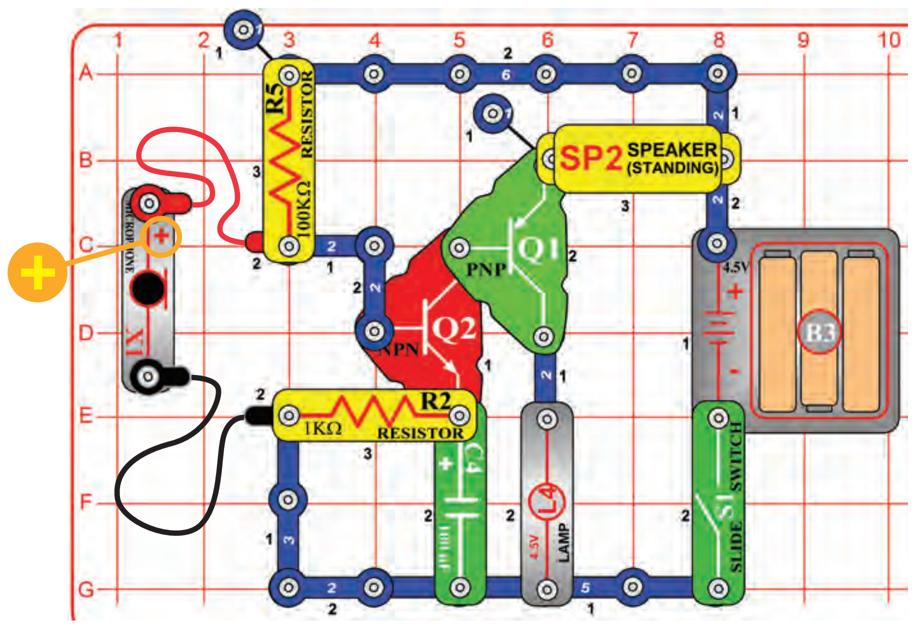
☐ Project #195 Whistling Sound Amplifier

Using the circuit in Project #194. Replace the speaker (SP2) with the whistle chip (WC), then place the 100Ω resistor (R1) across the whistle chip. Now you will hear the sound through the whistle chip.

☐ Project #196 Whistle Amplifier

Using the circuit in Project #194 replace the microphone (X1) with the whistle chip (WC). Set the adjustable resistor (RV) control to the bottom and tap or blow on the whistle chip.

☐ Project #197 Blowing Audio Amplifier



Build this audio amplifier circuit shown. Set the slide switch (S1) on and blow into the microphone (X1). You should hear static on the speaker (SP2).

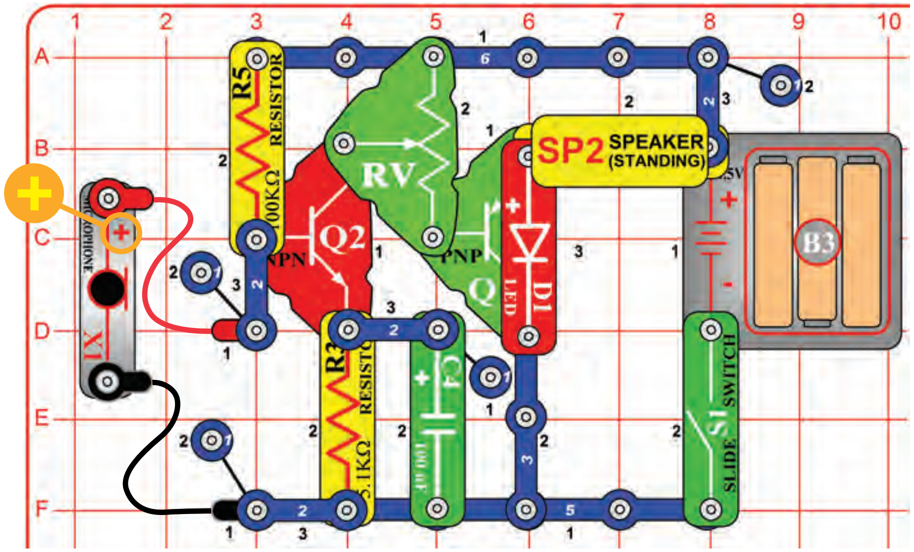
☐ Project #198 Photo Audio Amplifier

Using the circuit in Project #197, replace the 100KΩ resistor (R5) with the photoresistor (RP). Blow into the microphone (X1) and you should hear static. Cover the photoresistor for the loudest sound.

☐ Project #199 Photo Whistle Amplifier

Using the circuit in Project #198, replace the microphone (X1) with the whistle chip (WC). Blow into the whistle chip and you should hear sound. Cover the photoresistor (RP) for loudest sound.

Project #200 Air Audio Amplifier



Build this audio amplifier circuit shown. Set the adjustable resistor (RV) control lever to the bottom position. Set the slide switch (S1) on and blow into the microphone (X1). You should hear static on the speaker (SP2) and the LED (D1) may flicker.

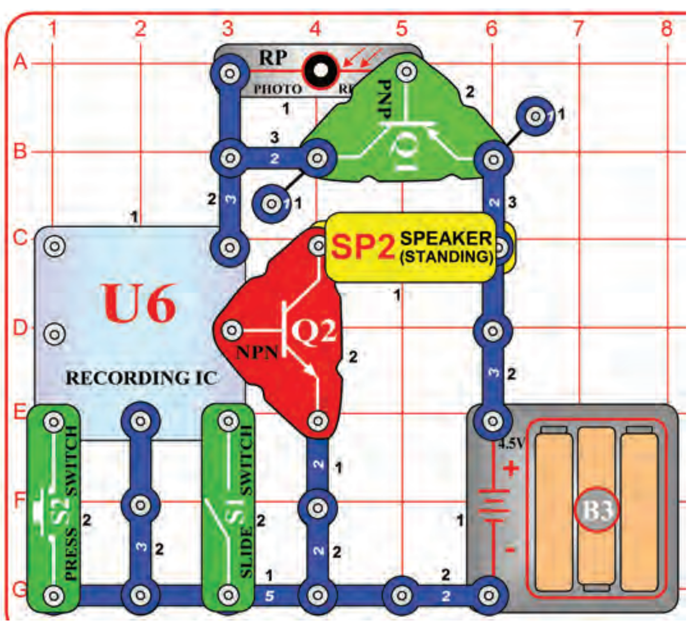
Project #201 Red LED Audio Amplifier

Use the circuit in Project #200 and swap the location of the speaker (SP2) and the 3-snap at D6-F6. Move the red LED (D1) so it is across base grid locations D6-D8 (+ towards D6). You should hear noise on the speaker and the LED may flicker.

Project #202 Whistle Chip Audio Amplifier

Use the circuit in Project #201, replace the microphone (X1) with the whistle chip (WC). Blow into the whistle chip. You should hear static on the speaker (SP2) and the LED (D1) may flicker. Notice how sensitive the whistle chip is compared to the microphone.

Project #203 Photo Powered Music



Build the circuit shown and turn on the slide switch (S1). Press the press switch (S2) to play a recording followed by a song. If you press the press switch before the song is over, music will stop. Adjust the amount of light on the photoresistor (RP) to change the volume and alter the tone. Wave your fingers over the photoresistor for some cool sound effects.

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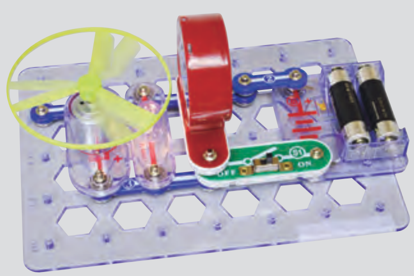
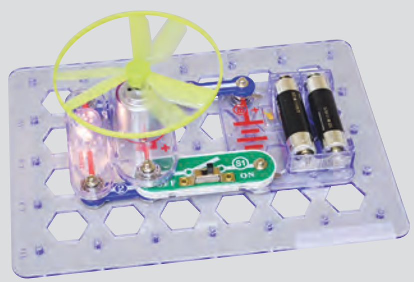


All at Once



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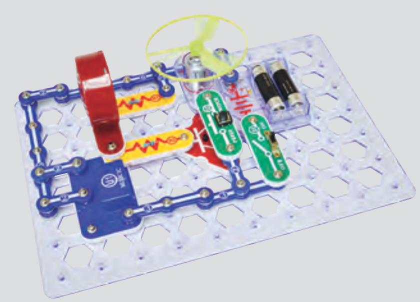
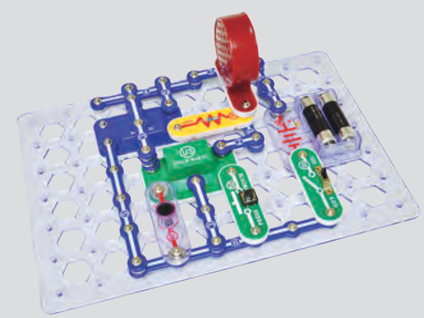


Dancing Motor



Crazy Combo

CM-200 Block Layout

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