CIRCUIT MAKER

Skill Builder 125

Project 3

Projects 1-125

Instruction Manual

Ages 8+

753095

Table of Contents

WARNING: SHOCK HAZARD - Never connect Circuit Maker Skill Builder 125 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.

WARNING FOR ALL PROJECTS WITH A ! SYMBOL
Moving parts. Do not touch the motor or fan during operation. Do not lean over the motor. Do not launch the fan at people, animals, or objects. Eye protection is recommended.

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 the motor (M1) "+" marking is 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 8 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.

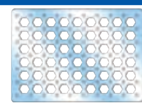
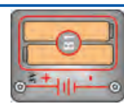
Never modify your parts, as doing so may disable important safety features in them, and could put your child at risk of injury.

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.
- Do not connect batteries or battery holders in parallel.
- Do not mix alkaline, standard (carbon-zinc), or rechargeable (nickel-cadmium) batteries.
- Remove batteries when they are used up.
- 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.

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

Important: If any parts are missing or damaged in shipping, **DO NOT RETURN TO Target**. Call toll-free (800) 533-2441 or e-mail to help@elenco.com. Customer Service • 150 Carpenter Ave. • Wheeling, IL 60090 U.S.A.

Qty.	ID	Name	Symbol	Part #	Qty.	ID	Name	Symbol	Part #
❒ 1		Base Grid (11.0” x 7.7”)		6SCBG	❒ 1 ❒ 1	M1	Motor Glow Fan		6SCM1 6SCM1FG
❒ 3	1	1-Snap Wire		6SC01	❒ 1	Q2	NPN Transistor		6SCQ2
❒ 6	2	2-Snap Wire		6SC02	❒ 1	R1	100Ω Resistor		6SCR1
❒ 3	3	3-Snap Wire		6SC03	❒ 1	R2	1KΩ Resistor		6SCR2
❒ 1	4	4-Snap Wire		6SC04	❒ 1	RP	Photoresistor		6SCRP
❒ 1	5	5-Snap Wire		6SC05	❒ 1	S1	Slide Switch		6SCS1
❒ 1	6	6-Snap Wire		6SC06	❒ 1	S2	Press Switch		6SCS2
❒ 1	B1	Battery Holder - uses Two 1.5V type AA (not incl.)		6SCB1	❒ 1	SP	Speaker		6SCSP
❒ 1	C5	470μF Capacitor		6SCC5	❒ 1	U1	Music Integrated Circuit		6SCU1
❒ 1	D1	Red Light Emitting Diode (LED)		6SCD1	❒ 1	U2	Alarm Integrated Circuit		6SCU2
❒ 1	L1	2.5V Lamp		6SCL1	❒ 1	U3	Space War Integrated Circuit		6SCU3

How to Use Circuit Maker Skill Builder 125

Circuit Maker Skill Builder 125 uses building blocks with snaps to build the different 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.

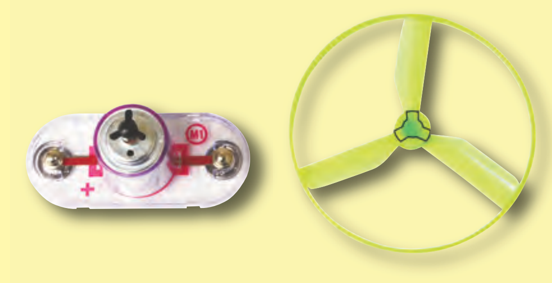
There is also a 1-snap wire that is used as a spacer or for interconnection between different layers.

You need a power source to build each circuit. This is labeled (B1) and requires two (2) 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.

Usually when the motor (M1) is used, the glow fan will be placed on it. On top of the motor shaft is a black plastic piece (the motor top) with three little tabs. Lay the fan on the black piece so the slots in its bottom "fall into place" around the three tabs in the motor top. If not placed properly, the fan will fall off when the motor starts to spin.



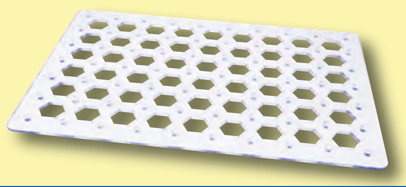
Note: While building the projects, be careful not to accidentally make a direct connection across the battery holder (a "short circuit"), as this may damage and/or quickly drain the batteries.

About Your Circuit Maker Skill Builder 125 Parts

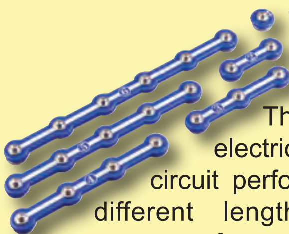
(Part designs are subject to change without notice).

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.



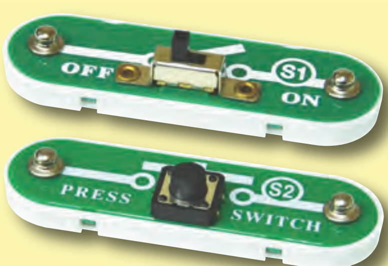
SNAP WIRES



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.

SLIDE & PRESS SWITCHES

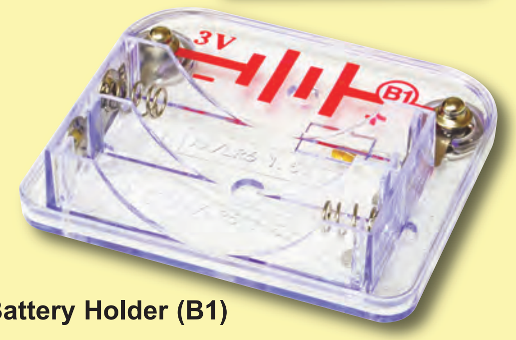
The **slide & press switches (S1 & S2)** connect (pressed or "ON") or disconnect (not pressed or "OFF") the wires in a circuit. When ON they have no effect on circuit performance. Switches turn on electricity just like a faucet turns on water from a pipe.



Slide & Press Switches (S1 & S2)

BATTERY HOLDER

The **batteries (B1)** 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 (B1)

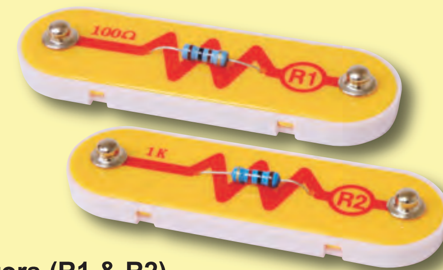
LAMP

A light bulb, such as in the **2.5V lamp (L1)**, 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 (L1)

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) and 1KΩ (R2) resistors** ("K" symbolizes 1,000, so R2 is really 1,000Ω). 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.



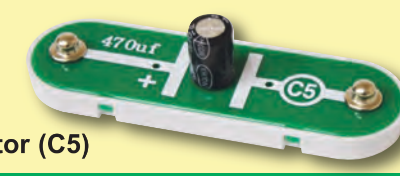
Resistors (R1 & R2)

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)

CAPACITOR

The **470μF capacitor (C5)** can store electrical pressure (voltage) for a period of time. This storage ability allows it to block stable voltage signals and pass changing ones. Capacitors are used for filtering and delay circuits.



Capacitor (C5)

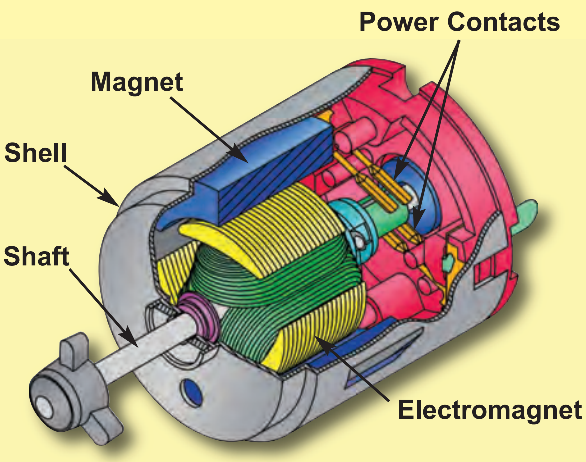
About Your Circuit Maker Skill Builder 125 Parts

MOTOR

The **motor (M1)** converts electricity into mechanical motion. An electric current in the motor will turn the shaft and the motor blades, and the fan blade if it is on the motor.

Motor (M1)

How does electricity turn the shaft in the motor? The answer is magnetism. Electricity is closely related to magnetism, and an electric current flowing in a wire has a magnetic field similar to that of a very, very tiny magnet. Inside the motor is a coil of wire with many loops wrapped around metal plates. This is called an electromagnet. If a large electric current flows through the loops, it will turn ordinary metal into a magnet. The motor shell also has a magnet on it. When electricity flows through the electromagnet, it repels from the magnet on the motor shell and the shaft spins. If the fan is on the motor shaft, then its blades will create airflow.



SPEAKER

The **speaker (SP)** 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 (SP)

TRANSISTOR

The **NPN transistor (Q2)** is a component that uses 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.

NPN Transistor (Q2)

LED

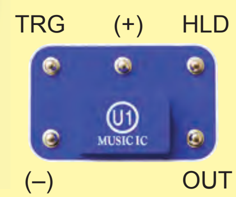
The **red LED (D1)** is a light emitting diode and may be thought of as a special one-way light bulb. In the "forward" direction, (indicated by the "arrow" in the symbol) electricity flows if the voltage exceeds a turn-on threshold (about 1.5V); brightness then increases. A high current will burn out 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 than your fingernail. These "integrated circuits" (ICs) are used in everything from simple electronic toys to the most advanced computers. The music, alarm, and space war ICs (U1, U2, and U3) in Circuit Maker Skill Builder 125 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:

Music IC:



Connections:
(+) - power from batteries
(–) - power return to batteries
OUT - output connection
HLD - hold control input
TRG - trigger control input

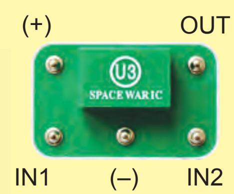
Music for a few seconds on power-up, then hold HLD to (+) power or touch TRG to (+) power to resume music.

Alarm IC:

Connections:
IN1, IN2, IN3 - control inputs
(–) - power return to batteries
OUT - output connection

Connect control inputs to (+) power to make five alarm sounds, see project 22 for configurations.

Space War IC:



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.

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).

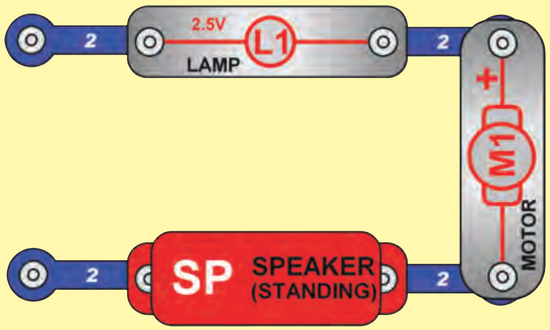
The "**power**" of electricity is a measure of how fast energy is moving through a wire. It is a combination of the voltage and current (Power = Voltage x Current). It is expressed in **watts** (W).

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).

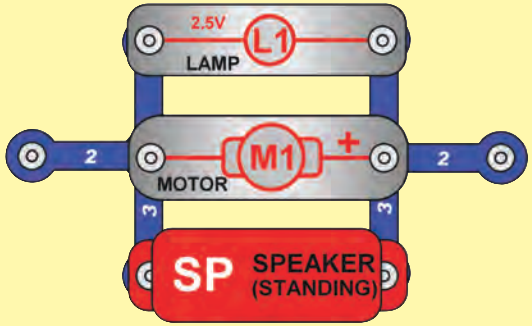
Nearly all of the electricity used in our world is produced at enormous generators driven by steam or water pressure. Wires are used to efficiently transport this energy to homes and businesses where it is used. Motors convert the electricity back into mechanical form to drive machinery and appliances. 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.

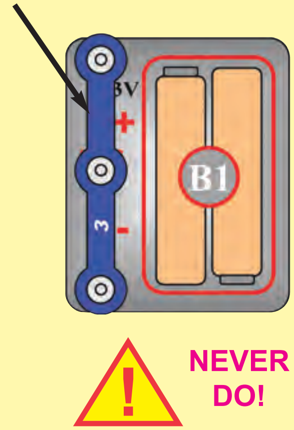
For all of the projects given in this book, the parts may be arranged in different ways without changing the circuit. For example, the order of parts connected in series or in parallel does not matter — what matters is how combinations of these sub-circuits are arranged together.

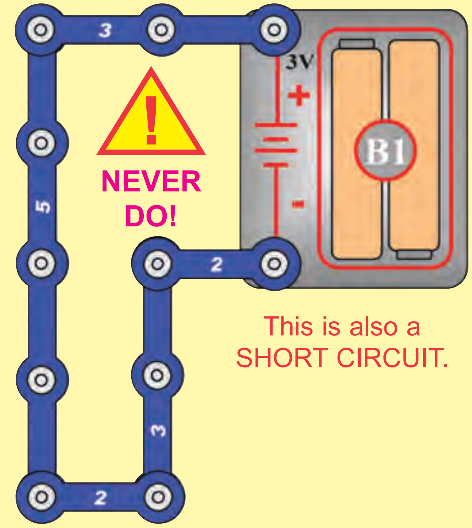
WARNING: SHOCK HAZARD - Never connect Circuit Maker Skill Builder 125 to the electrical outlets in your home in any way!

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!!!

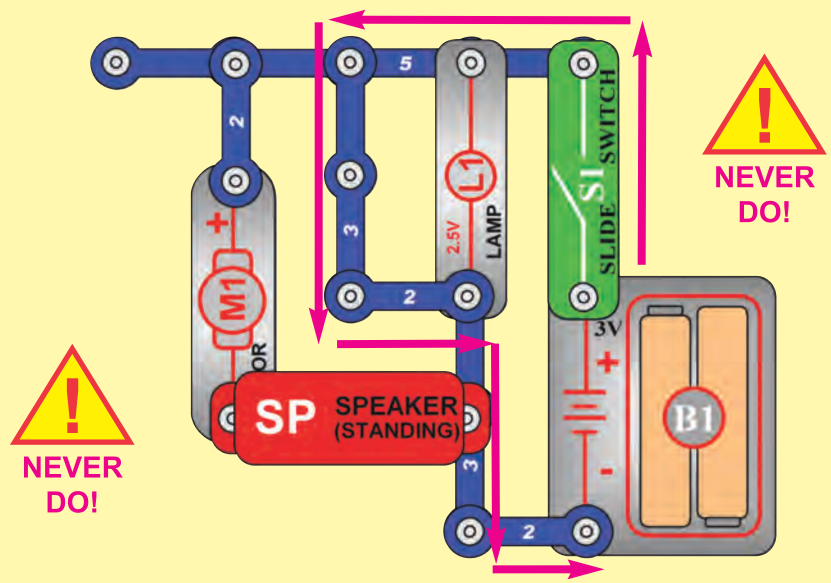
Placing a 3-snap wire directly across the batteries is a SHORT CIRCUIT.





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.



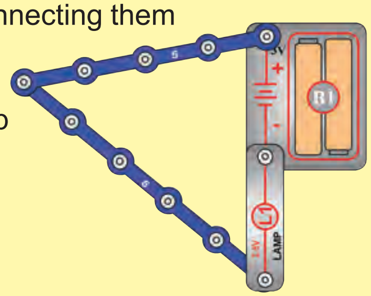
Advanced Troubleshooting (Adult supervision recommended)

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:

1. **2.5V lamp (L1), motor (M1), speaker (SP), and battery holder (B1):** Place batteries in holder. Place the 2.5V lamp directly across the battery holder, it should light. Do the same with the motor (motor + to battery +), it should spin to the right at high speed. "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. If the motor spins but does not balance the fan, check the black plastic piece on the motor shaft; it should have 3 prongs.

2. **Snap wires:** Use this mini-circuit to test the 5-snap and 6-snap wires. The lamp should light. Then test each of the 1-snap, 2-snap, 3-snap, and 4-snap wires by connecting them between the ends of the 5-snap and 6-snap.



3. **Slide switch (S1) and Press switch (S2):** Build Project #1, if the lamp (L1) doesn't light then the slide switch is bad. Replace the slide switch with the press switch to test it.

4. **100Ω resistor (R1), 1KΩ resistor (R2), and LED (D1):** Build Project #11 except initially use the speaker (SP) in place of the resistor, the LED should light. Then, replace the speaker with the 100Ω resistor; the LED should still light. Then, replace the 100Ω resistor with the 1KΩ resistor; the LED should light but not as brightly.

5. **Alarm IC (U2):** Build Project #21, you should hear a siren. Then place a 3-snap wire between grid locations A1 and C1, the sound is different. Then move the 3-snap from A1-C1 to A3-C3 to hear a third sound.

6. **Music IC (U1):** Build Project #86 but use the press switch (S2) in place of the photoresistor (RP). Turn it on and the LED (D1) flickers for a while and stops, it resumes if you press and hold down the press switch. Then touch a 3-snap wire across base grid points A1 and C1 and the flickering resumes for a while.

7. **Space war IC (U3) and photoresistor (RP):** Build Project #4, both switches (S1 and S2) should change the sound. Then replace the slide switch (S1) with the photoresistor, waving your hand over it should change the sound.

8. **NPN transistor (Q2):** Build Project #31. When both switches are on, the lamp lights and motor spins. If one switch is off, nothing happens.

9. **470μF capacitor (C5):** Build Project #50, then press and release the switch. The LED should go off slowly.

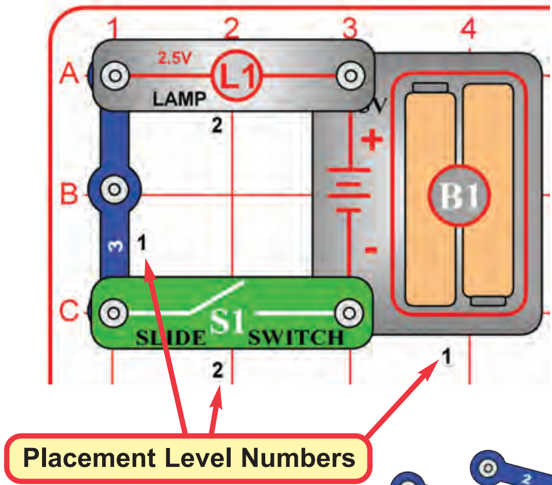
Customer Service

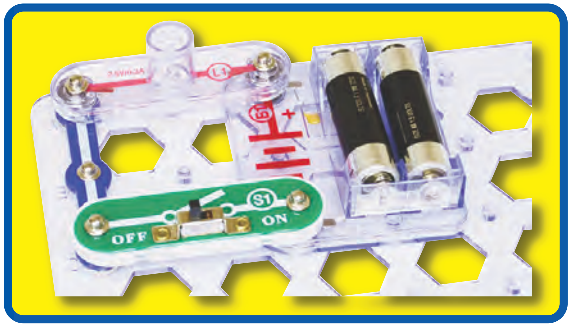
Call toll-free: (800) 533-2441
e-mail: help@elenco.com

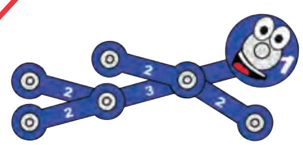
Project Listings

Project Listings

Project #1 Turn on the Light







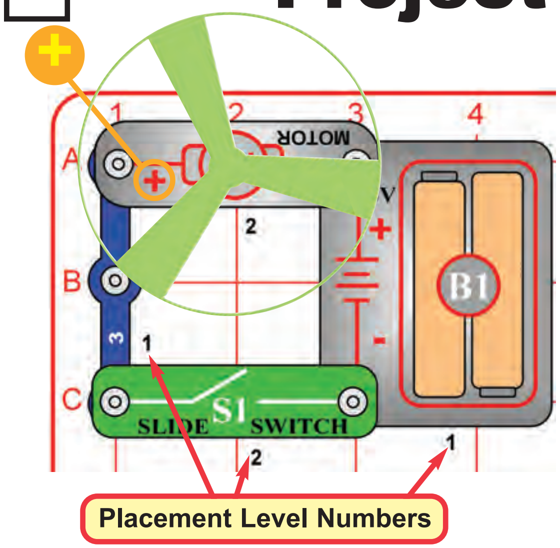
Snappy says the lamp contains a special thin high-resistance wire. When a lot of electricity flows through it, it gets so hot it glows bright.

Circuit Maker Skill Builder 125 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 two (2) “AA” batteries (not included) into the battery holder (B1) if you have not done so already.

When you turn on the slide switch (S1), electricity flows from the batteries through the lamp (L1) and back to the batteries through the switch. The switch completes the circuit. The lamp gets bright as electricity flows through it.

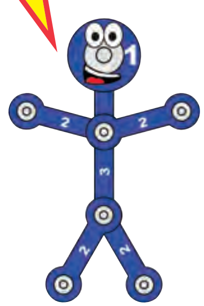
Project #2 Up, Up, and Away!



WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

WARNING: Fan may not rise until switch is released.

The air is being blown down through the blade and the motor rotation locks the fan on the shaft. When the motor is turned off, the blade unlocks from the shaft and is free to act as a propeller and fly through the air. If speed of rotation is too slow, the fan will remain on the motor shaft because it does not have enough lift to propel it.



Build the circuit shown on the left by placing the parts with a black **1** next to them on the base grid first. Then, assemble parts marked with a **2**. Place the glow fan on the motor. New alkaline batteries are recommended for this project.

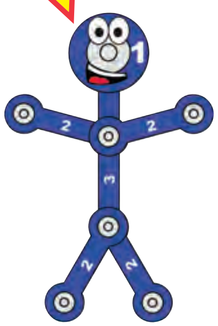
Turn on the slide switch (S1), wait for the motor to reach full speed, then turn off the switch. The glow fan should rise and float through the air like a flying saucer. Be careful not to look directly down on the glow fan when it is spinning.

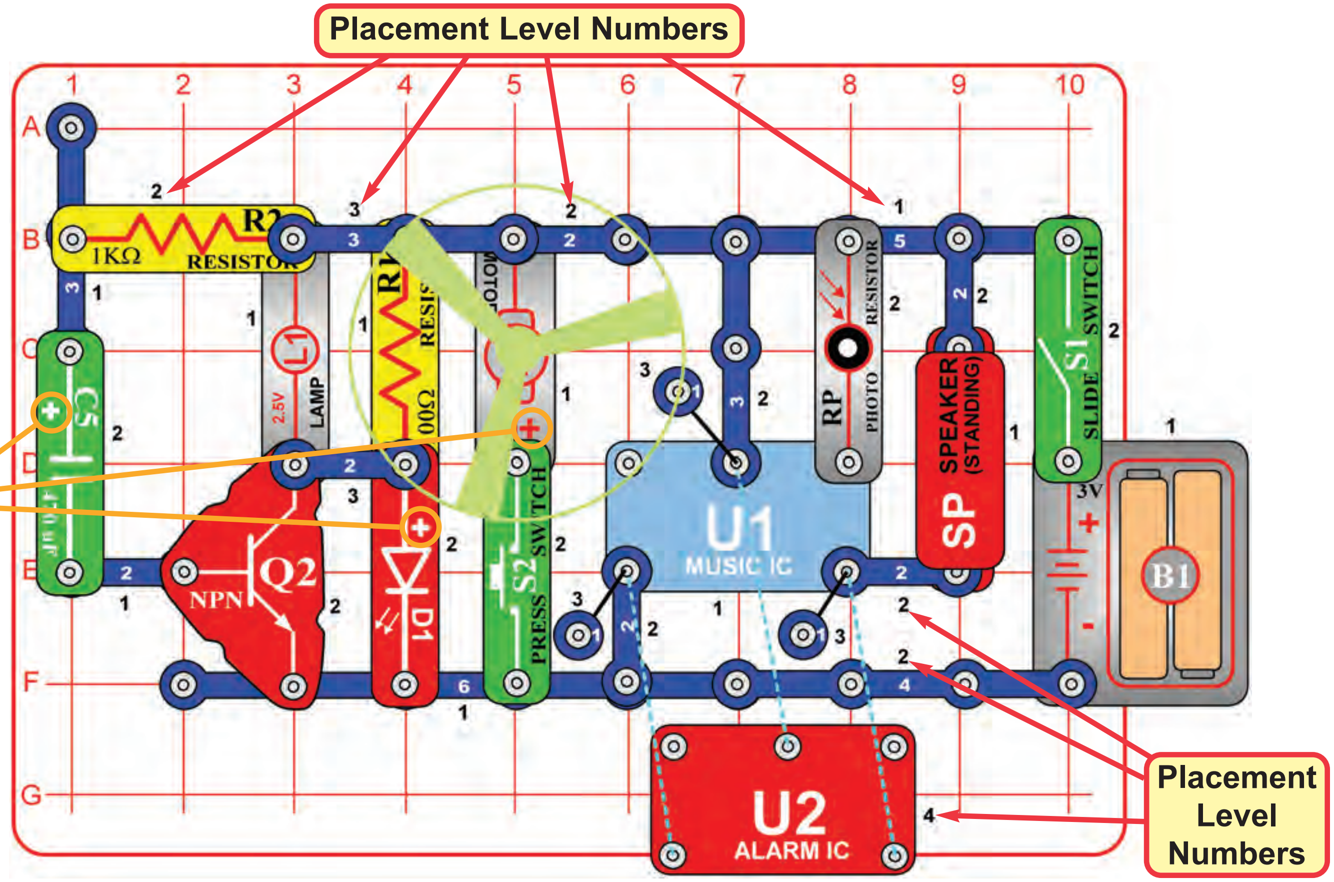
If the fan doesn’t fly off, then turn the switch on and off several times rapidly when it is at full speed.

The glow fan will glow in the dark. It will glow best after absorbing sunlight for a while. The glow fan is made of plastic, so be careful not to let it get hot enough to melt. The glow looks best in a dimly lit room.

Project #3 Super Circuit

This complex circuit is pictured on the box cover. Use that as a guide to help in building it.





WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

WARNING: Fan may not rise until switch is released.

Circuit Maker Skill Builder 125 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**. Then, assemble the part marked with a **4** (the alarm IC (U2), which should be placed directly over the music IC (U1)). Install two (2) "AA" batteries (not included) into the battery holder (B1).

Place the glow fan on the motor (M1).

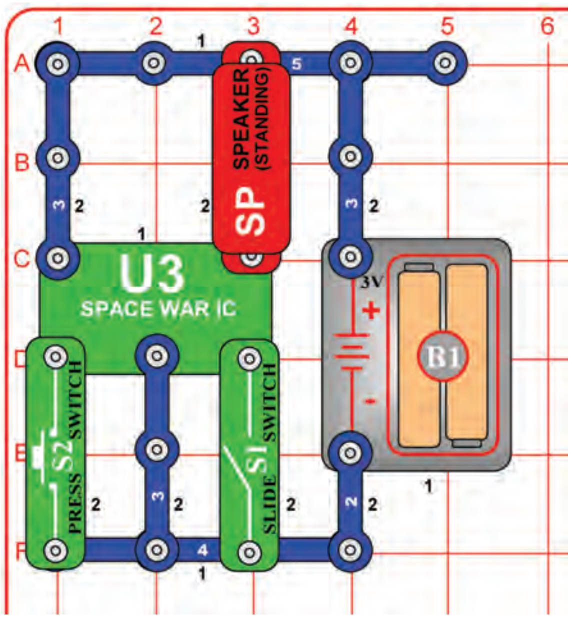
Turn on the slide switch (S1). You hear music and alarm sounds, and the red LED (D1) lights. The lamp (L1) may light briefly before the red LED turns on. Cover the photoresistor (RP) to change the sound a little.

Push the press switch (S2) to spin the motor and glow fan. Release the press switch when the motor is spinning at full speed. The glow fan should float through the air like a flying saucer. Be careful not to look directly down on the glow fan when it is spinning.

If the fan doesn't fly off, then push and release the press switch several times rapidly when it is at full speed.

If the 470μF capacitor (C5) is discharged when you turn on the slide switch, then the lamp will light for a few seconds as the circuit charges up C5. L1 will not light again until C5 is discharged. To discharge C5, remove it from the circuit and place it directly on the 4-snap wire for an instant, then move it back to its normal spot in the circuit.

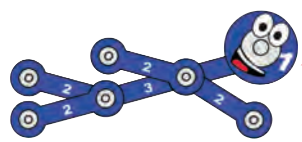
Project #4 Space War



Build the circuit shown on the left, which uses the space war integrated circuit. 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!

The space war IC (U3) 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.

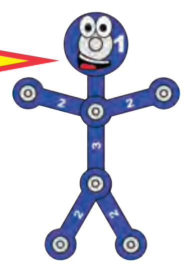


The Space War, Alarm, and Music ICs contain specialized ICs combined with other electrical components (resistors, capacitors, transistors) designed to produce various cool sounds and music.

Project #5 Loud in Light

Use the circuit from Project #4 above, but replace the slide switch (S1) with the photoresistor (RP). The circuit immediately makes noise. Try turning it off. If you experiment, then you can see that the only ways to turn it off are to cover the photoresistor, or to turn off the lights in the room (if the room is dark). Since light is used to turn on the circuit, you might say it is a "light switch".

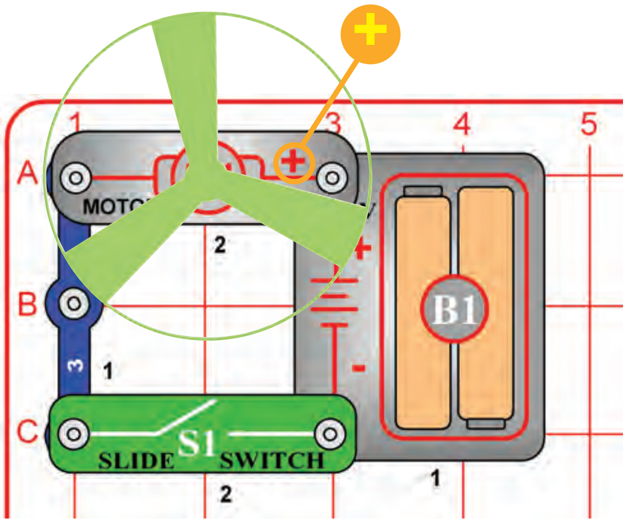
The photoresistor contains material that changes its resistance when it is exposed to light; as it gets more light, the resistance of the photoresistor decreases. Parts like this are used in a number of ways that affect our lives. For example, you may have streetlights in your neighborhood that turn on when it starts getting dark and turn off in the morning.



Project #6 Paper Player

Use the same circuit as for Project #5. Find a piece of white paper that has a lot of large black or dark areas on it, and slowly slide it over the photosensitive resistor. You may need to shine a flashlight over the paper. You should hear the sound pattern constantly changing, as the white and dark areas of the paper control the light to the photosensitive resistance. You can also try the pattern below or something similar to it.

Project #7 — Stick Around Saucer

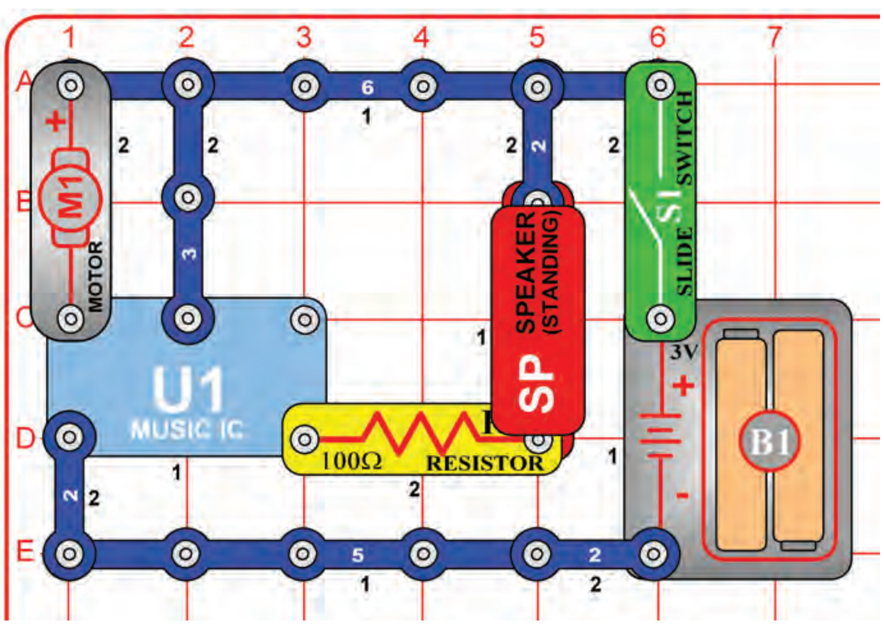


Build the circuit shown on the left which is the same as the circuit in Project #2 but with the motor part reversed. Place the glow fan on the motor.

Turn on the slide switch (S1), wait for the motor to reach full speed, then turn off the switch. This time, the glow fan does not fly because the fan is now rotating in the opposite direction such that the airflow is pushing the fan downward.

⚠ **WARNING:** Moving parts. Do not touch the fan or motor during operation.

Project #8 — Rotate & Roar

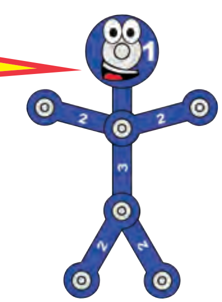


Build the circuit shown on the left, but leave the fan off the motor (M1). When you turn on the slide switch (S1), the music may play for a short time and then stop. After the music has stopped, spin the motor with your fingers. The music should play again for a short time, then stop.

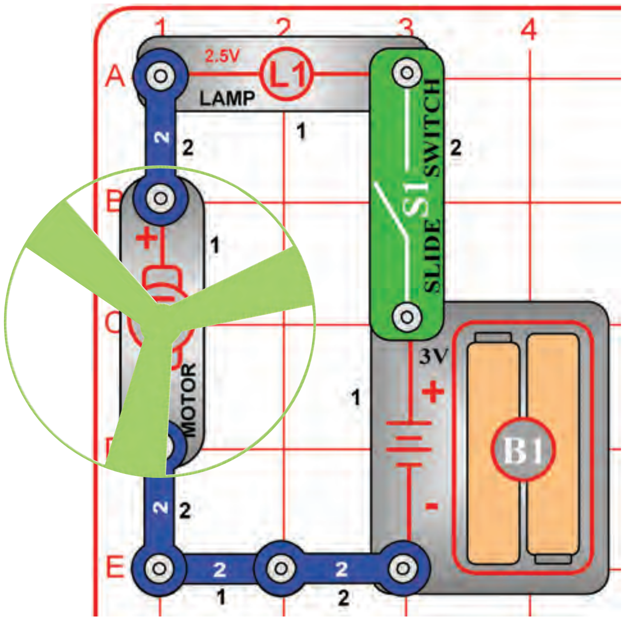
Now replace the 100Ω resistor (R1) with a 3-snap wire, and notice how the sound is affected.

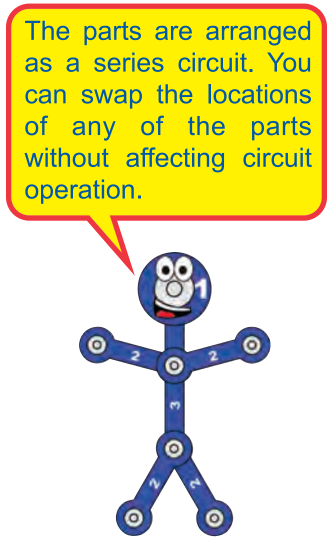
In this project, you changed the amount of current that goes through the speaker (SP) and increased the sound output of the speaker.

Resistors are used throughout electronics to limit the amount of current that flows.



☐ Project #9 Spin & Dim





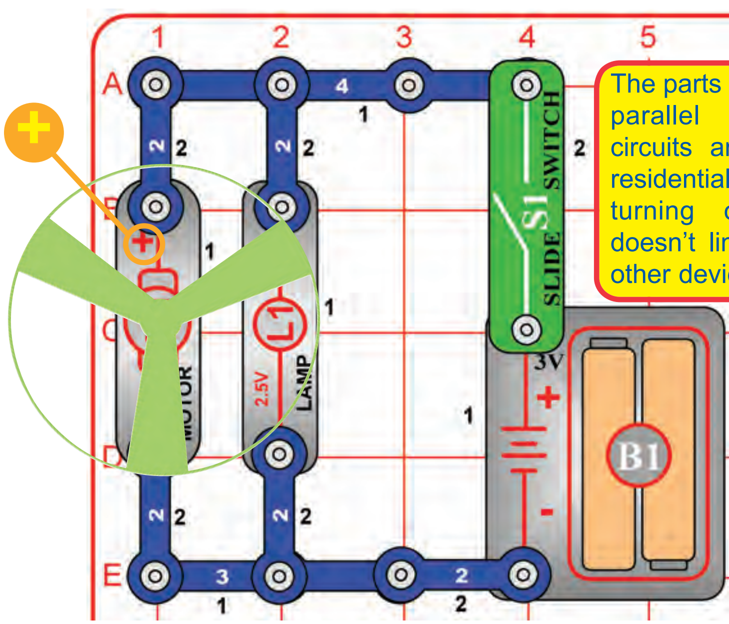
Build the circuit shown on the left.

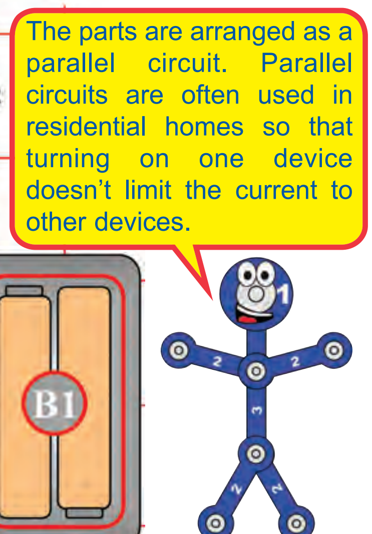
When you turn on the slide switch (S1), the fan will spin and the lamp (L1) should turn on. The fan will take a while to start turning due to inertia. Inertia is the property that tries to keep a body at rest from moving and tries to keep a moving object from stopping.

The lamp helps protect the motor from getting the full voltage when the switch is turned on. Part of the voltage goes across the lamp and the rest goes across the motor. Remove the fan and notice how the lamp gets dimmer when the motor does not have to spin the fan blade.

⚠ **WARNING:** Moving parts. Do not touch the fan or motor during operation.

☐ Project #10 Balanced Buddies





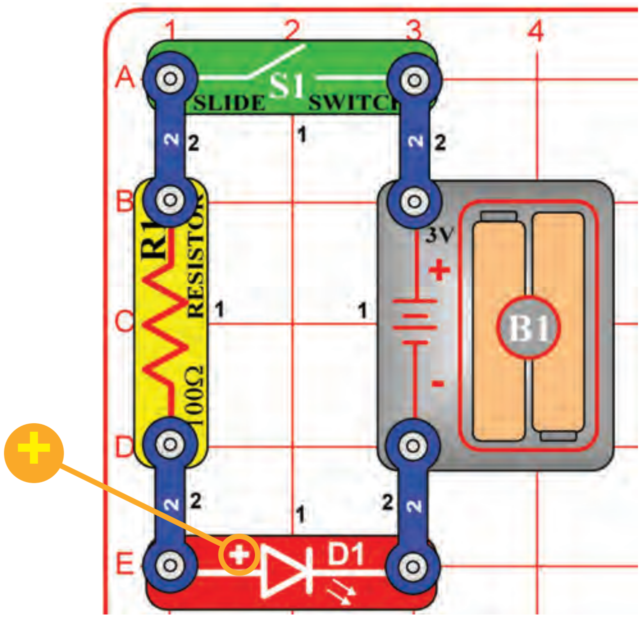
Build the circuit shown on the left.

When you turn on the slide switch (S1), both the fan and the lamp (L1) should turn on. The fan will take a while to start turning due to inertia. In this connection, the lamp does not change the current to the motor (M1). The motor should start a little faster than in Project #9.

Remove the fan and notice how the lamp does not change in brightness as the motor picks up speed. It has its own path to the battery (B1).

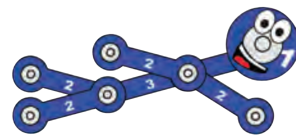
⚠ **WARNING:** Moving parts. Do not touch the fan or motor during operation.

Project #11 The Diode Dude



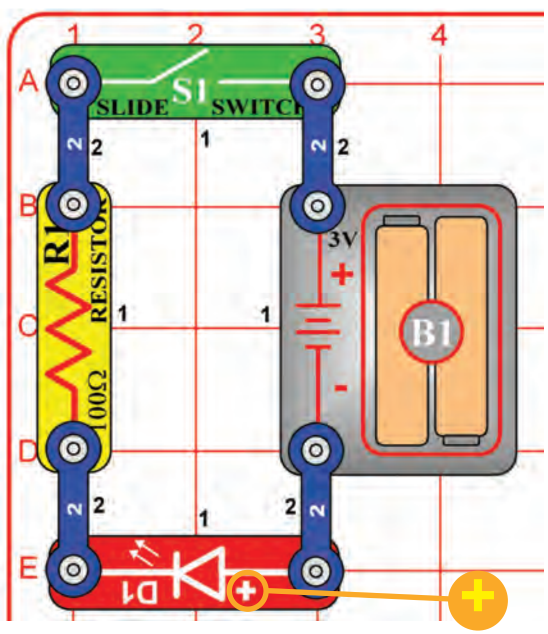
Build the circuit shown on the left.

When you turn on the slide switch (S1), current flows from the batteries (B1) through the switch, through the 100Ω resistor (R1), through the LED (D1, light emitting diode) and back to the battery. The turned on 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. Can you think of something you use everyday that has an LED in it?

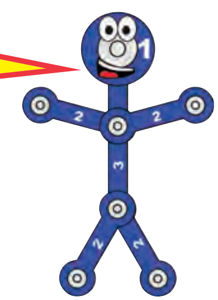
Project #12 One Way Works



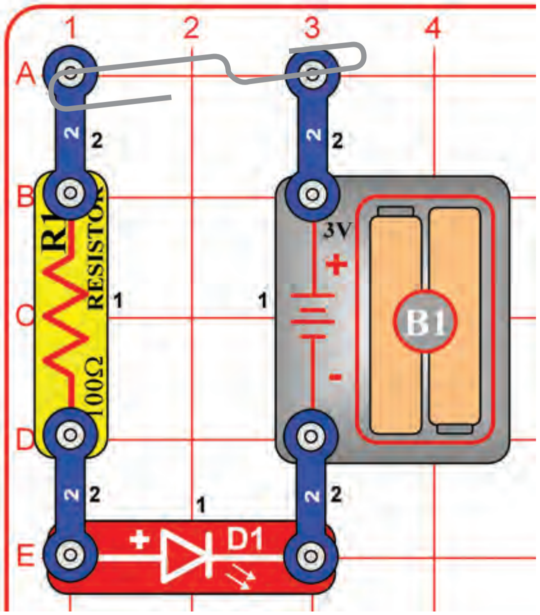
Rebuild the circuit used in Project #11 but put the LED in as shown on the left.

This time when you turn on the slide switch (S1), current does not flow from the batteries (B1) through the 100Ω resistor (R1) or through the LED (D1), and hence the LED does not light up. This is because the LED is in backwards. The LED is like a check valve that lets current flow in only one direction (into the + end and out the other end).

An electronic component that needs to be connected in one direction is said to have polarity. Other parts like this will be discussed in future projects. Placing the LED in backwards does not harm it because the voltage is not large enough to break down this electronic component.

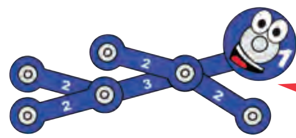


Project #13 Clippy the Conductor



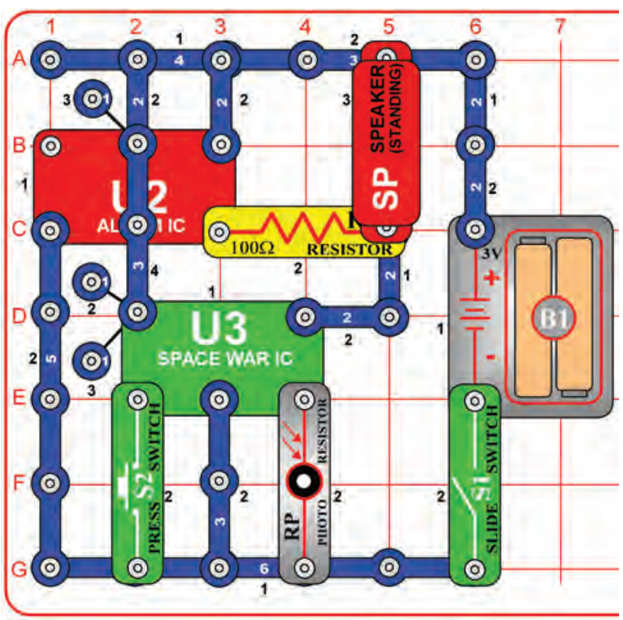
Rebuild the circuit from Project #11 but leave the slide switch (S1) out as shown on the left.

When you place a paper clip across the terminals as shown in the picture on the left, current flows from the batteries (B1) through the 100Ω resistor (R1), through the LED (D1), 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.



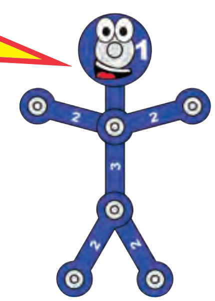
This detector can be used to see if a material like plastic is a good conductor or a poor conductor. Materials that make the LED bright pass electricity easily, and are called conductors. Most metals are good conductors, and copper is used in most house wiring. Materials that block the flow of electricity are called insulators. Plastic, paper and air are insulators.

Project #14 Nifty Noises

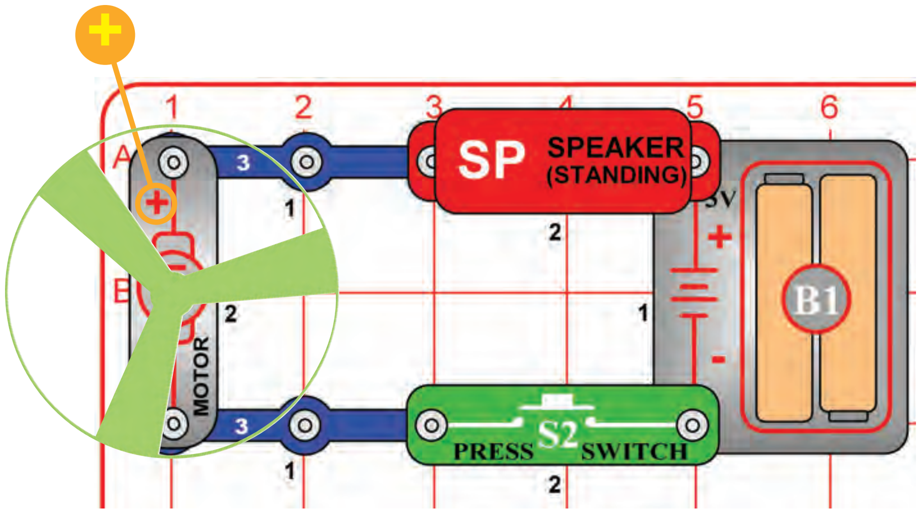


Build the circuit shown. Turn it on, press the press switch (S2) several times, and wave your hand over the photoresistor (RP) to hear all the sound combinations. You can make the sound from the alarm IC (U2) louder by replacing the 100Ω resistor (R1) with the 2.5V lamp (L1).

A photoresistor is a light-controlled variable resistor. The resistance of the photoresistor decreases with increasing light intensity.



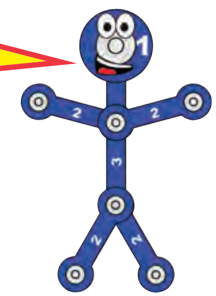
Project #15 — Mumbling Motor



Place the fan on the motor (M1). Press the press switch (S2) and listen to the motor. Why does the motor make sound?

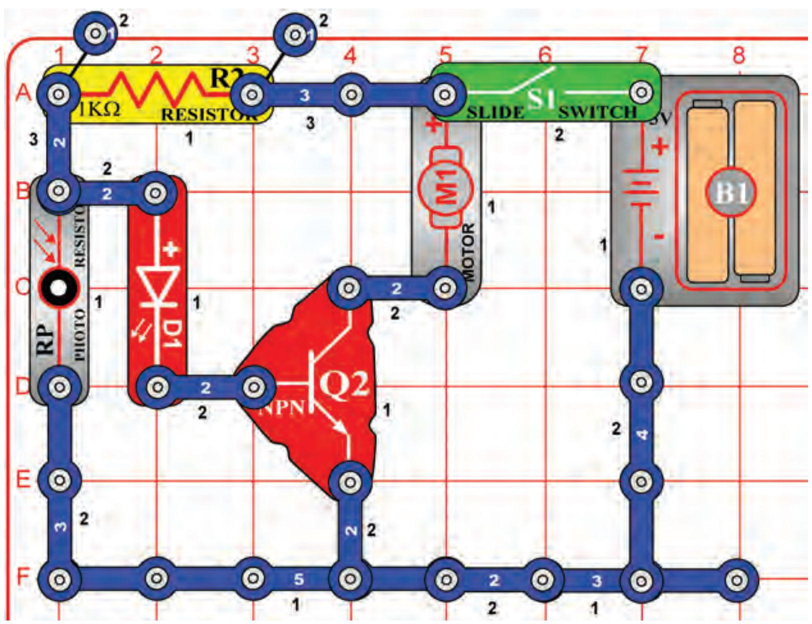
If you replace the motor with the 2.5V lamp (L1), then it will work the same as the “Hear the Motor” project, but only make noise when the lamp is turned ON or OFF.

A motor uses magnetism to convert electrical energy into mechanical spinning motion. As the motor shaft spins around it connects / disconnects several sets of electrical contacts to give the best magnetic properties. As these contacts are switched, an electrical disturbance is created, which the speaker (SP) converts into sound.



WARNING: Moving parts. Do not touch the fan or motor during operation.

Project #16 — Lift Loss

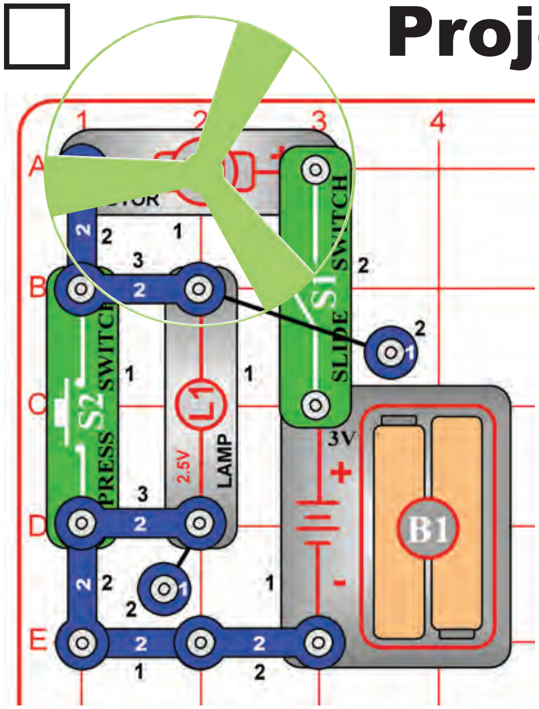


Build the circuit to the left.

Cover the photoresistor (RP) and turn on the slide switch (S1). The motor (M1) should spin. If not, give it a push to get it started. Now uncover the photoresistor or get a flashlight and shine it on the photoresistor. The motor will slow down as more light reaches the photoresistor, and will stop spinning if enough light reaches the photoresistor. This circuit demonstrates how darkness can be used to control a fan. Try this circuit with and without the fan on the motor.

WARNING: Moving parts. Do not touch the fan or motor during operation.

Project #17 Hi-Low Fan

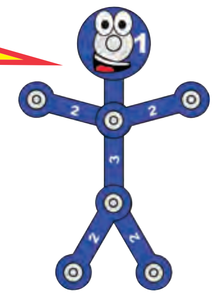


WARNING: Moving parts. Do not touch the fan or motor during operation.

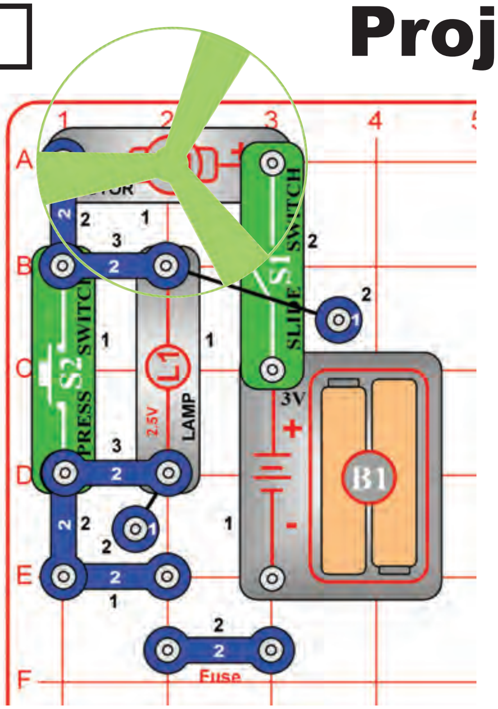
Build the circuit shown on the left.

When you close the slide switch (S1), current flows from the batteries through the slide switch (S1), motor (M1), the lamp (L1), and back to the battery (B1). When the press switch (S2) is closed, the lamp is shorted and motor speed increases.

The principle of removing resistance to increase motor speeds is only one way of changing the speed of the motor. Commercial fans do not use this method because it would produce heat in the resistor and fans are used to cool circuits by moving air over them. Commercial fans change the amount of voltage that is applied to the motor using a transformer or other electronic device.



Project #18 Fuse or Lose

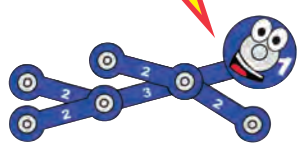


WARNING: Moving parts. Do not touch the fan or motor during operation.

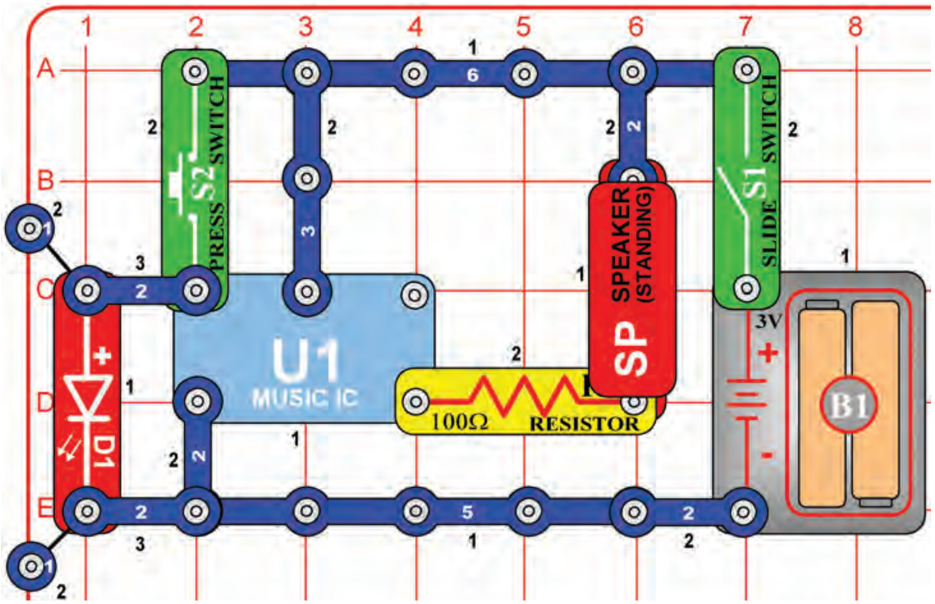
Use the circuit built in Project #17.

When you close the slide switch (S1), current flows from the batteries through the slide switch (S1), the lamp (L1), motor (M1), and back to the battery (B1). 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. When press switch (S2) is closed, the light is shorted and motor speed increases due to an increase in current to the motor. While still holding press switch (S2) down, remove the 2-snap wire marked fuse and notice how everything stops. 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 circuit should return to normal.

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

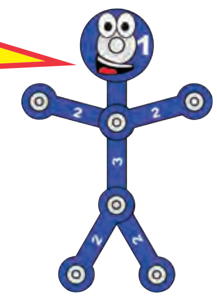


Project #19 Magical Music

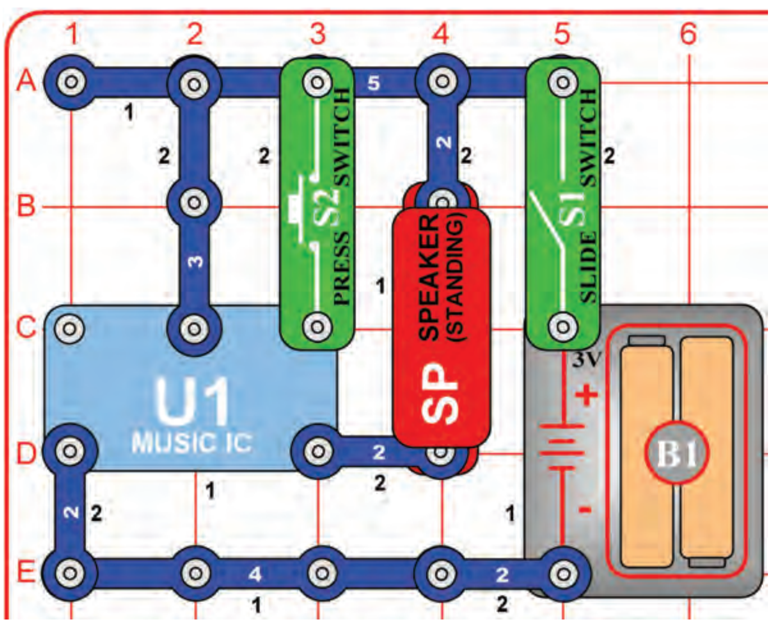


Build the circuit shown on the left. When you turn on the slide switch (S1), the music integrated circuit (U1) may start playing one song then stop. Each time you press the press switch “doorbell button” (S2) the song will play again and stop. Even if you let go of the press switch (S2), the integrated circuit keeps the song playing until it has reached the end of the song.

Musical integrated circuits are used to entertain young children in many of the toys and chairs made to hold infants. If the music is replaced with words, the child can also learn while they are entertained. Because of great advances in miniaturization, many songs are stored in a circuit no bigger than a pinhead.

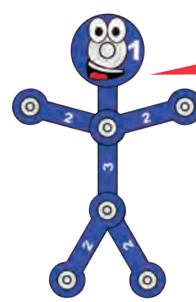


Project #20 Press & Play



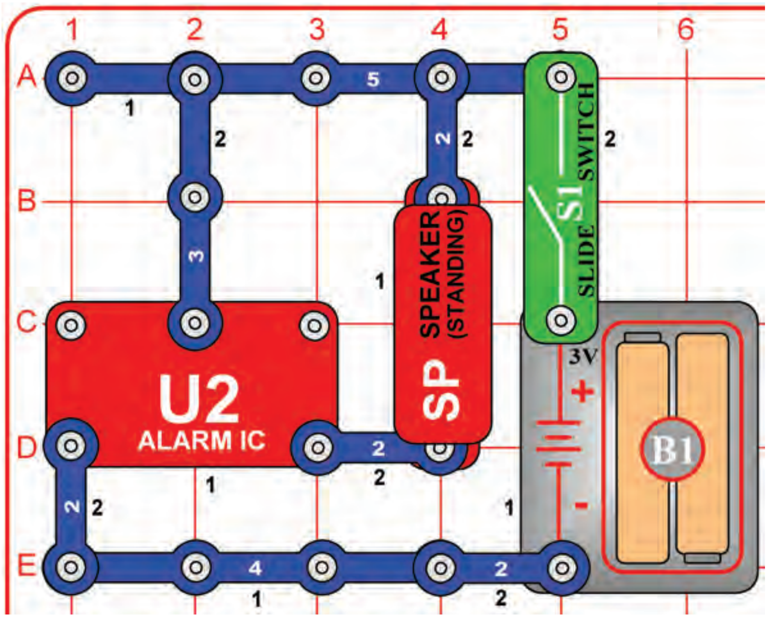
Modify the circuit used in Project #19 to look like the one shown on the left.

When you turn on the slide switch (S1), the music integrated circuit (U1) may start playing one song then stop. The song will be much louder than in the previous project because it is now being used as an alarm. Each time you press the press switch “alarm button” (S2) after the song stops playing, the song will play again, but only while you hold the button down.



Having no resistor in series with the speaker allows more current to flow through the speaker producing a louder sound.

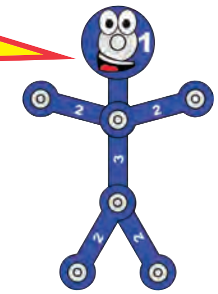
Project #21 — Simple Siren



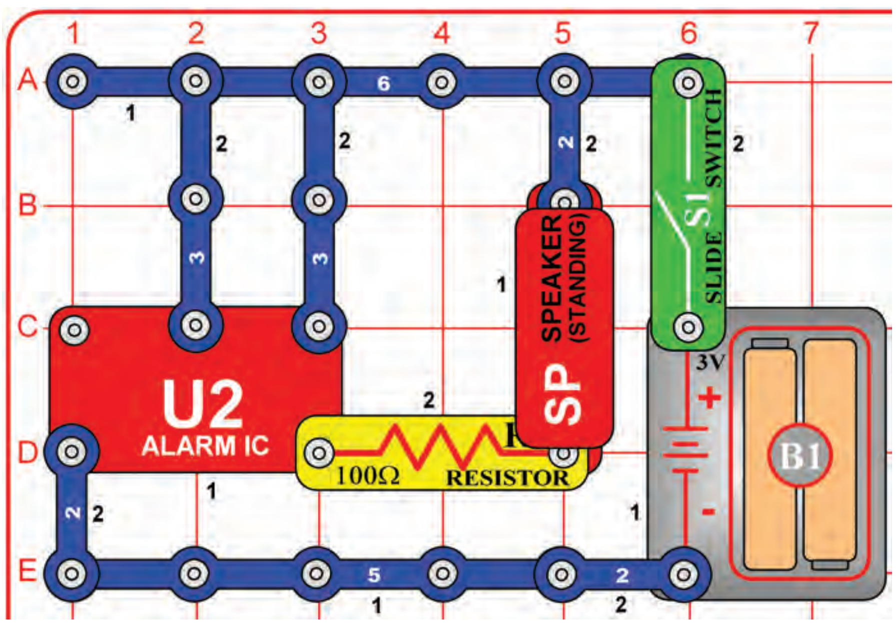
Build the circuit shown on the left.

When you turn on the slide switch (S1), the integrated circuit (U2) should start sounding a very loud alarm sound. This integrated circuit is designed to sweep through all the frequencies so even hard of hearing people can be warned by the alarm.

If the alarm sound in this circuit was passed through an amplifier and installed into a police car, it would also serve as a good police siren.



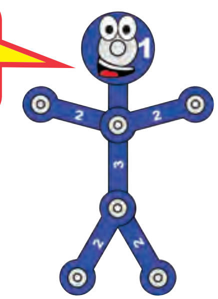
Project #22 — Laser Blaster



Build the circuit shown on the left.

When you turn on the slide switch (S1), the integrated circuit (U2) should start sounding a laser gun sound. This integrated circuit is designed to produce different sounds that can easily be changed. You can even switch the sound on and off quickly to add sound effects to your games or recordings.

This circuit demonstrates how sounds can be made for electronic games.



☐ Project #23 Mind Reader Game

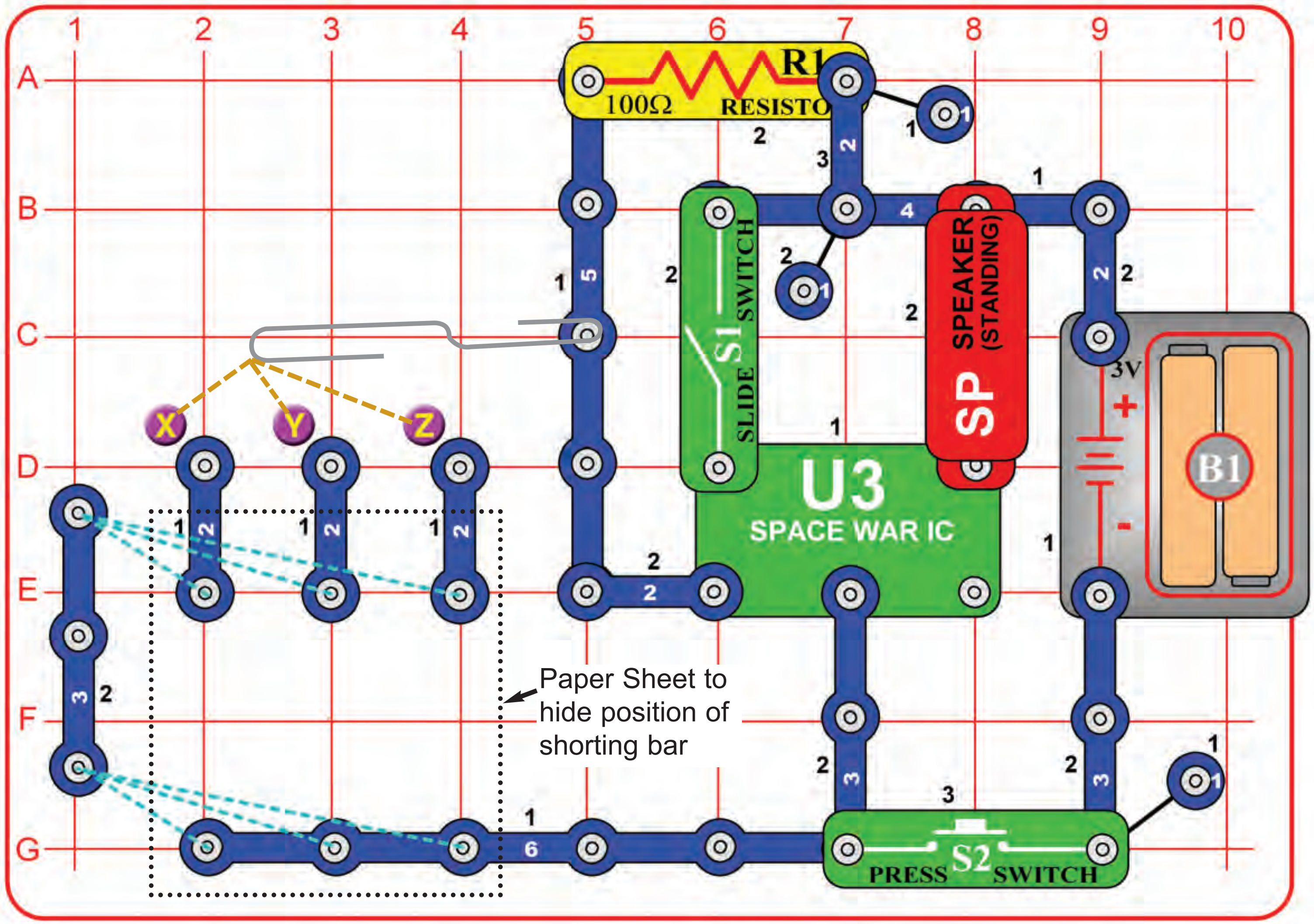
Build the circuit below. It uses a paper clip and a 3-Snap Wire as “shorting bars”.

Setup: Player 1 sets the target by placing the 3-snap shorting bar under the paper on column 2, 3 or 4. Player 2 must NOT know where the shorting bar is located under the paper.

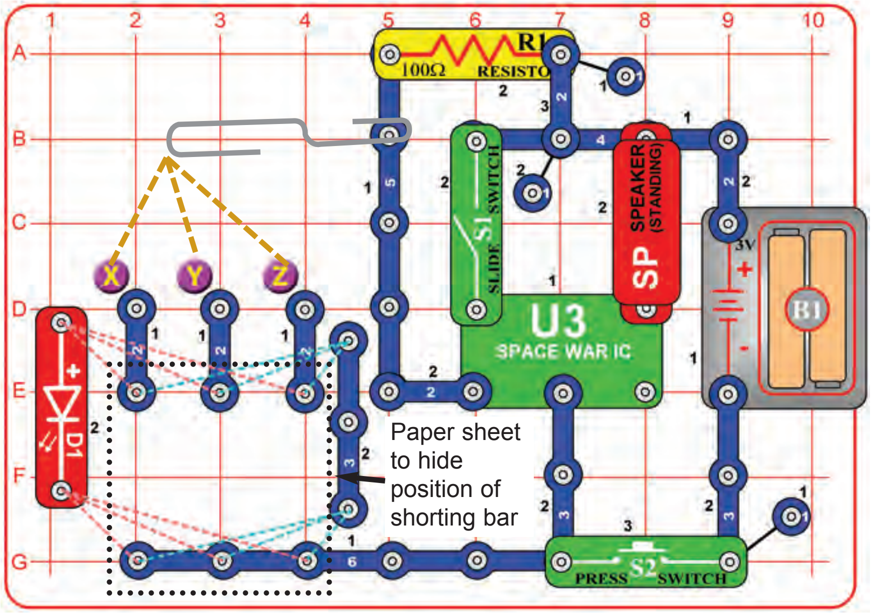
The object is for Player 2 to guess the location by placing one end of the paper clip on the 5-snap wire as shown, and the other end of the paper clip at positions X, Y, or Z and then pressing the press switch (S2). If Player 2 places the paper clip at the correct position, the sounds played indicates a “hit”. He keeps guessing until he hits. After each hit, remove the 3-snap shorting bar and slide the switch off and on to reset the sound.

Player 2 then sets the 2, 3, 4 side and player 1 tries his luck.

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



Project #24 — Don't Make a Sound



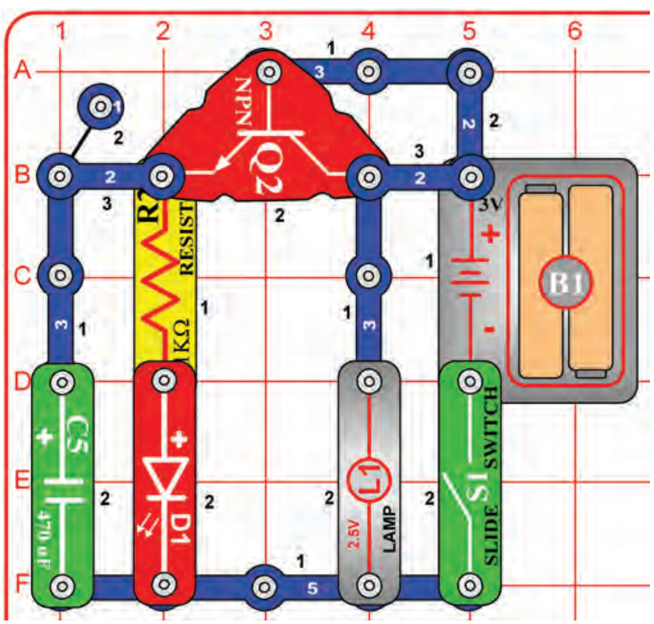
Use the circuit from Project #23, but now place a 3-snap wire and the LED (D1) as "shorting bars" under the paper sheet as shown on left.

Setup: Player 1 sets the "Quiet Zone" by placing the 3-snap wire and the LED (D1) under the paper on columns 2, 3 or 4, leaving only one open. Player 2 must NOT know where these "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 the paper clip at positions X, Y, or Z and pressing the press switch. If Player 2 places the paper clip on the correct column, and a sound plays when he presses the press switch, this means he has not found the "Quiet Zone" and he loses 1 point. He has three (3) tries to find the zone on each turn. Each time sounds are made he loses a point.

Player 2 then sets the 2, 3 or 4 side and player 1 starts searching. Play continues until one player is at zero points and makes sound during that players turn.

Project #25 — Discover the Diode

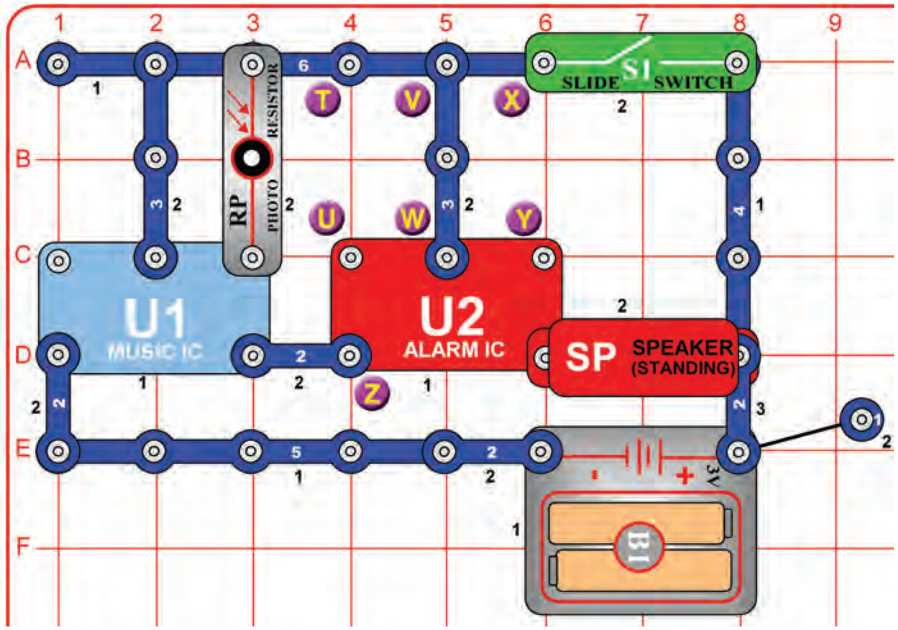


Diodes are electronic components that allow current to flow in only one direction, blocking it in the other. The red LED (D1) is a special diode that can emit light, and the transistor (Q1) can also be used as a pair of diodes.

Turn on the slide switch (S1), the lamp (L1) 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 470 μF capacitor (C5) 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 C5 discharges through it. The transistor/diode isolates the capacitor from the lamp.

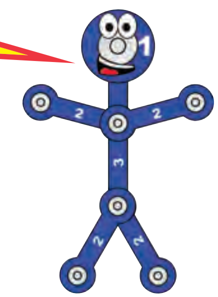
Project #26 Shine On Siren



Build the circuit shown on the left.

Cover the photoresistor (RP) and turn on the switch (S1). A police siren is heard for a while and stops, then you can control it by covering or uncovering the photoresistor.

This circuit demonstrates how sounds can be synchronized to light patterns through the photoresistor.



Project #27 Shooting Sounds

Modify Project #26 by connecting points X & Y. The circuit works the same way but now it sounds like a machine gun.

Project #28 Song & Siren

Now remove the connection between X & Y and then make a connection between T & U. The circuit works the same way but now it sounds like a fire engine.

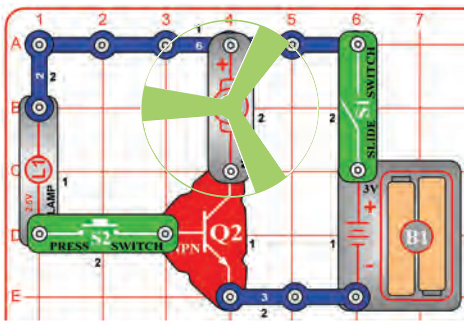
Project #29 Ambulance Melody

Now remove the connection between T & U and then make a connection between U & Z. The circuit works the same way but now it sounds like an ambulance.

Project #30 Static Song

Now remove the connections between U & Z and between V & W, then make a connection between T & U. The circuit works the same way but now it sounds like a familiar song but with static.

Project #31
Transistor Control

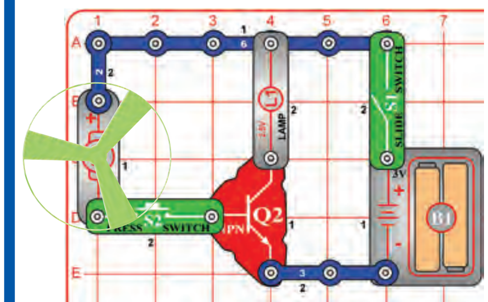


Place the fan on the motor (M1) and turn on the slide switch (S1) - nothing happens. Push the press switch (S2), the lamp lights and the motor spins.

The NPN transistor (Q2) uses the lamp current to control the motor current. A small current through the lamp branch creates a large current through the motor branch. They combine in the transistor and leave through the 3-snap branch.

WARNING: Moving parts. Do not touch the fan or motor during operation.

Project #32
Slow & Bright

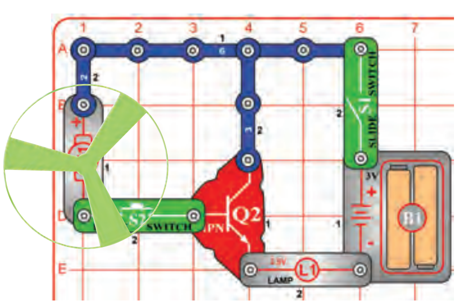


Compare this circuit to Project #31. It works the same way, but the lamp is brighter here and the motor is slower.

This time the NPN transistor (Q2) uses the motor current to control the lamp current. A current through the motor branch creates a larger current through the lamp branch. They combine in the transistor and leave through the 3-snap branch.

WARNING: Moving parts. Do not touch the fan or motor during operation.

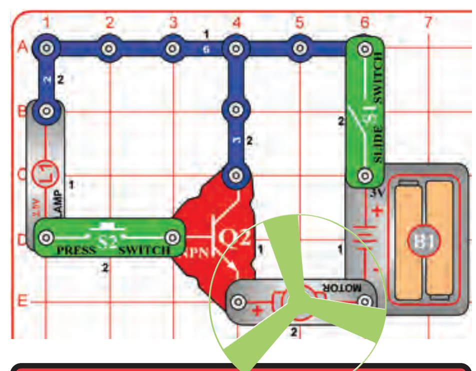
Project #33
Stop & Shine



Compare this circuit to Project #32. It works in a similar way, but the motor does not spin even though the lamp is bright. But the lamp is not as bright here as in Project #32.

The currents in the motor branch and 3-snap branch are combined into the lamp branch. Since the 3-snap has no resistance, the current through its branch will be much larger than the motor branch current.

Project #34
Murky Motor

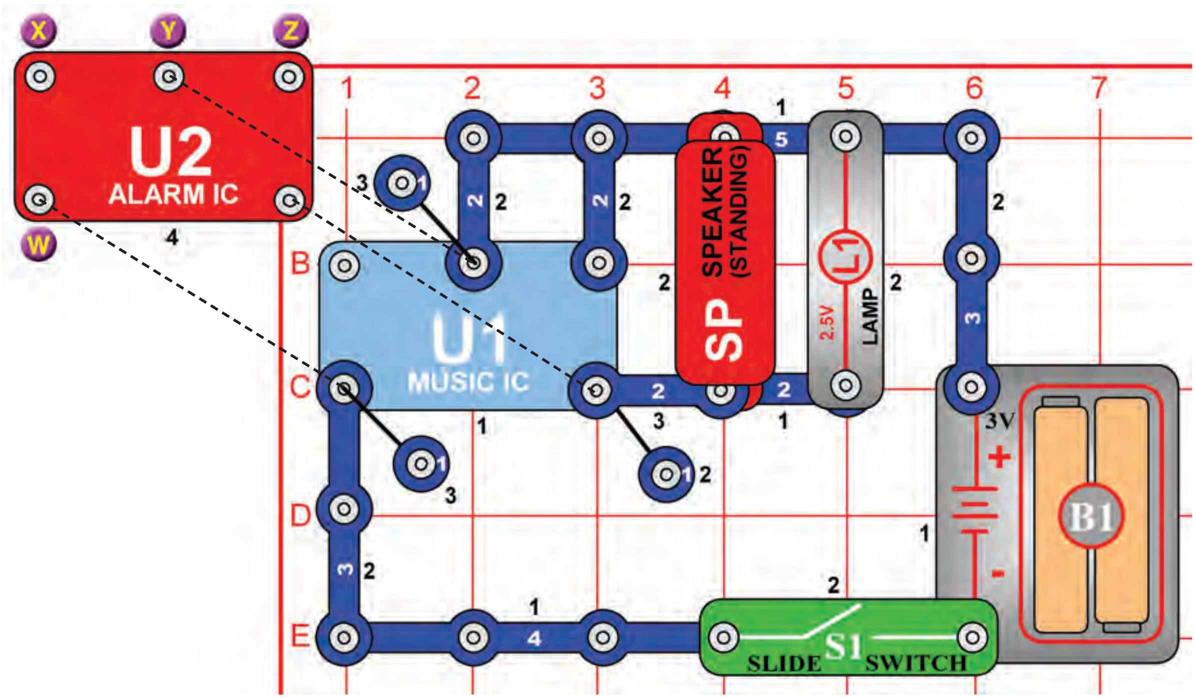


Compare this circuit to Project #33. It works in a similar way, the lamp is off but the motor spins. But the motor does not spin as fast as in Project #31.

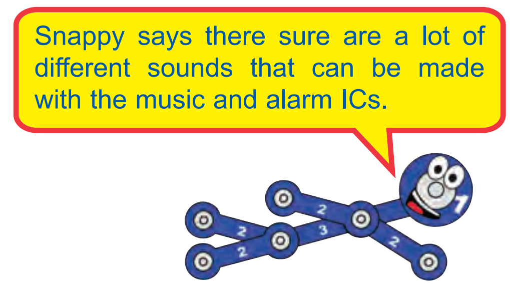
The currents in the lamp branch and 3-snap branch are combined into the motor branch. Since the 3-snap has no resistance, the current through its branch will be much larger than the lamp branch current.

WARNING: Moving parts. Do not touch the fan or motor during operation.

☐ Project #35 Mixed Up Music



In the circuit, the outputs from the alarm and music ICs are connected together. Build the circuit shown and then place the alarm IC (U2) directly over the music IC (U1), resting on two 1-snaps and a 2-snap. Turn on the switch (S1) and you will hear a siren and music together while the lamp (L1) varies in brightness.



☐ Project #36 Blaster Disaster

Modify the last circuit by connecting points Y & Z with a 2-snap (on level 5). The circuit works the same way but now it sounds like a machine gun with music.

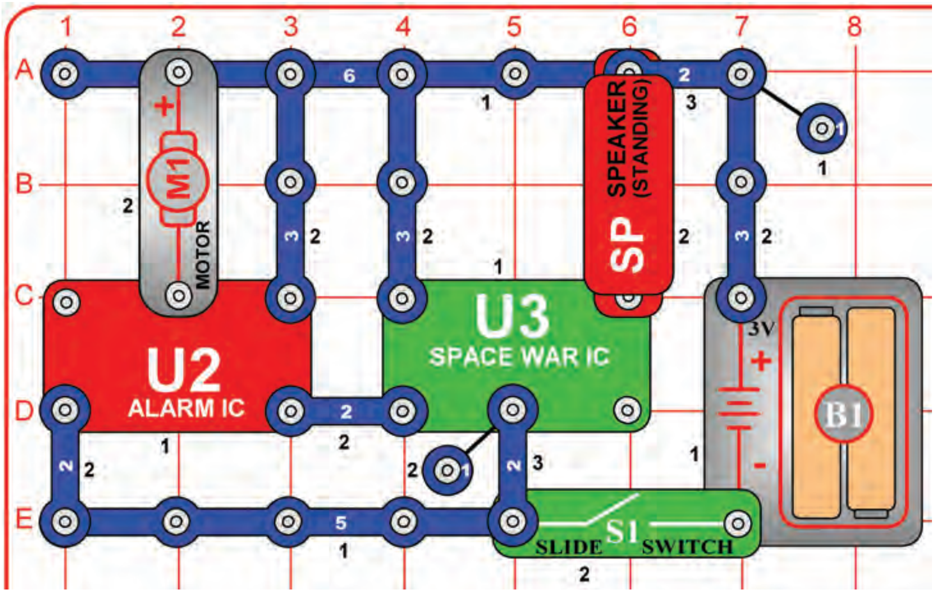
☐ Project #37 Siren & Song

Now remove the 2-snap connection between Y & Z and then make a 2-snap connection between X & Y (on level 5). The circuit works the same way but now it sounds like a fire engine with music.

☐ Project #38 Ambulance Song

Now remove the 2-snap connection between X & Y and then make a 2-snap connection between W & X (on level 5). The circuit works the same way but now it sounds like an ambulance with music.

☐ Project #39 Space Battle



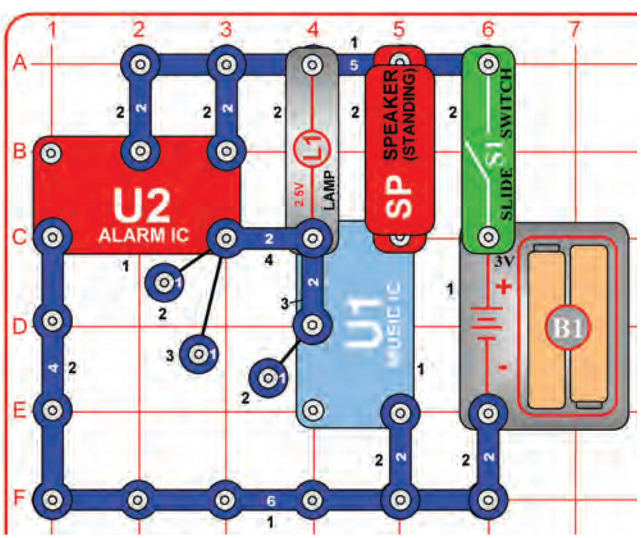
Build the circuit shown on the left. Turn on the switch (S1) and you will hear exciting sounds, as if a space battle is raging!

The motor (M1) is used here as a 3-snap wire, and will not spin.

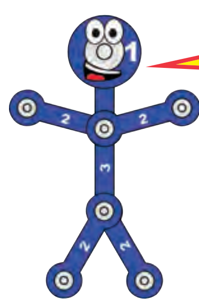
☐ Project #40 Bizarre Blinker

The preceding circuit is loud and may bother people around you, so replace the speaker (SP) with the LED (D1). Make sure you connect the LED with the positive (+) side on A6, not U3. Now you have a silent space battle.

☐ Project #41 Sporadic Sounds



Build the circuit shown on the left and turn it on. The lamp (L1) alternates between being on and off while the speaker (SP) alternates between two musical tones... like someone is flipping a switch, but at a very consistent rate. Periodic signals like this are very important in electronics.

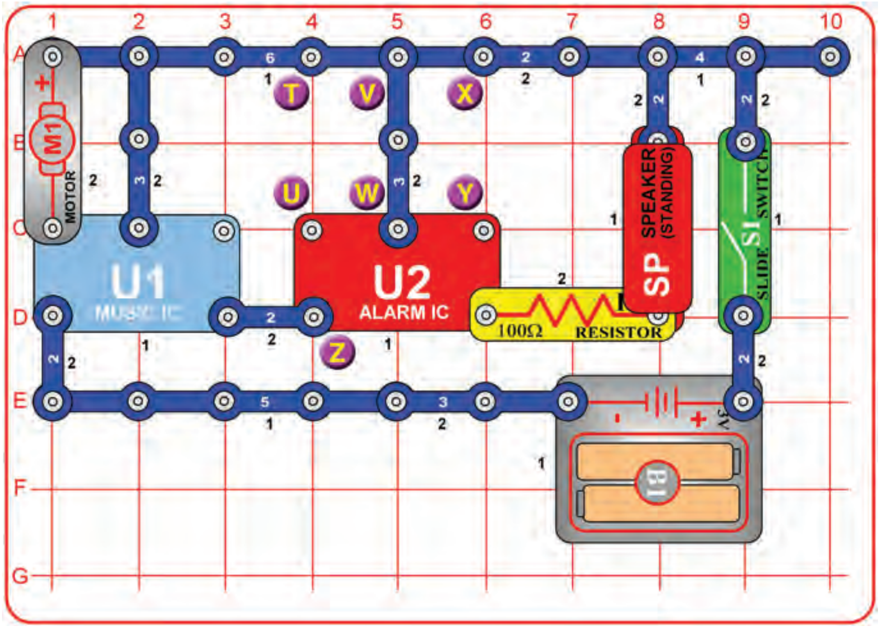


Periodic electrical signals are used for things like flashing yellow lights or sometimes in consumer devices to indicate batteries are low.

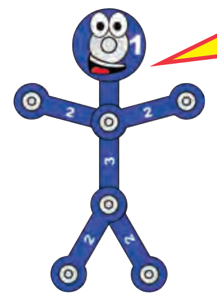
☐ Project #42 Blinking Double Flashlight

In the circuit at left, replace the speaker (SP) with an LED (D1). Make sure you connect the LED with the positive (+) side on A5, not U1. The lamp (L1) alternates between being on and off while the LED alternates between being dimmer and brighter.

Project #43 Motor Magic



This circuit is controlled by spinning the motor (M1) with your hands. Turn on the switch. A police siren is heard and then stops. Spin the motor and it will play again. Note, however, that music can be heard faintly in the background of the siren.



This project shows how a motor can be used to convert mechanical energy to electrical energy and sound. 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 #44 Spin & Shoot

Modify the last circuit by connecting points X & Y with the 2.5V lamp (L1). The circuit works the same way but now it sounds like a machine gun.

Project #45 Spin Out Siren

Now remove the connection between X & Y and then make a connection between T & U with the 2.5V lamp (L1). The circuit works the same way but now it sounds like a fire engine.

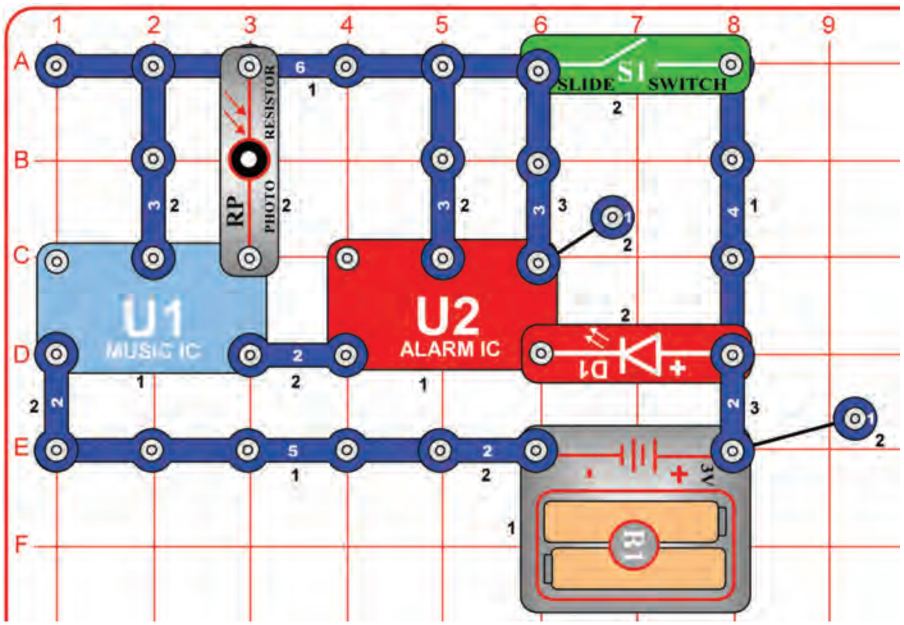
Project #46 Whirl Out Warning

Now remove the connection between T & U and then make a connection between U & Z. The circuit works the same way but now it sounds like an ambulance.

Project #47 Turn a Tune

Now remove the connections between U & Z and between V & W, then make a connection between T & U. The circuit works the same way but now it sounds like a familiar song but with static.

Project #48 Wave & Watch

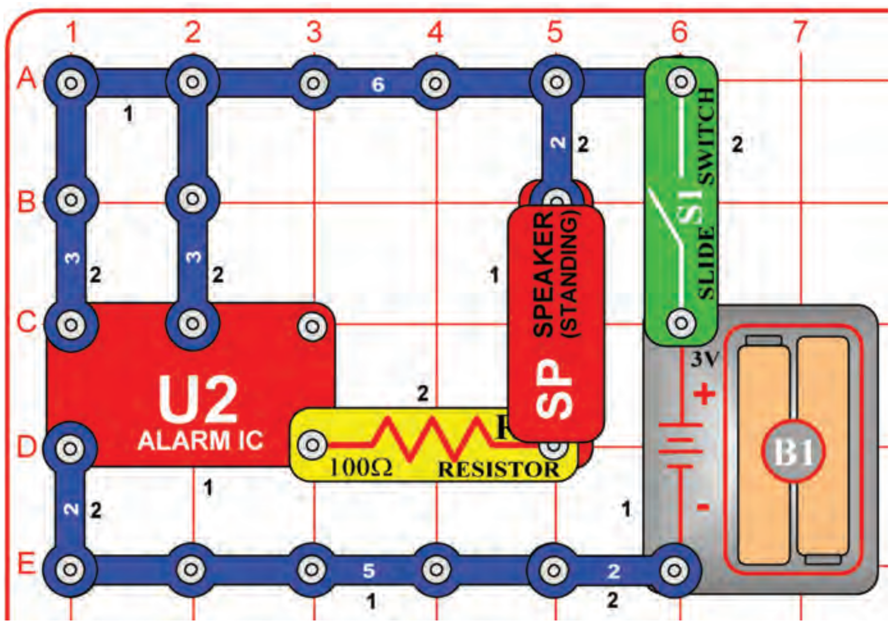


This circuit does not use the noisy speaker (SP) but instead uses a nice quiet LED (D1). Turn on the slide switch (S1), the LED flickers. Wait a few seconds, and then cover the photoresistor (RP), and the flicker stops. The flicker is controlled by the photoresistor; uncover it and the flicker resumes.

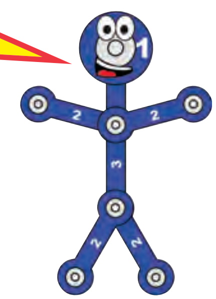
People that are deaf need lights to tell them when a doorbell is ringing. They also use circuits like this to tell them if an alarm has been triggered or an oven is ready.

Can you think of other uses?

Project #49 Switching Sounds

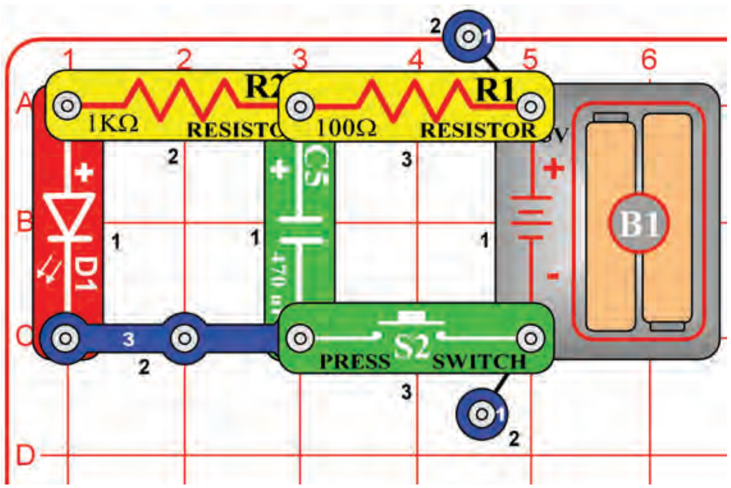


Build the circuit shown on the left. When you close the slide switch (S1), the integrated circuit (U2) should start sounding an up-down siren. This is just one more sound effect that this integrated circuit is designed to produce. Switch the sound on and off quickly and see if you can create even different effects. This mode will create many robotic sounds if switched quickly.



Different sounds that can easily be changed are very important when designing games and toys.

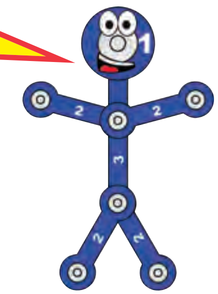
Project #50 Lingering Light



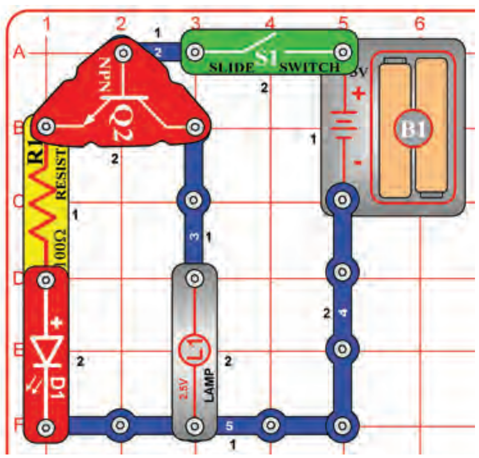
Build the circuit and press the switch (S2). You see that the LED (D1) turns off slowly after you release the switch.

This delay in turning off the LED is caused by the 470μF capacitor (C5).

Capacitors can store electricity and are used to delay changes in voltage. They can block unchanging voltages while passing fast-changing voltages.

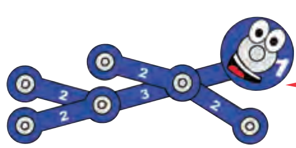


Project #51 Current Splitter

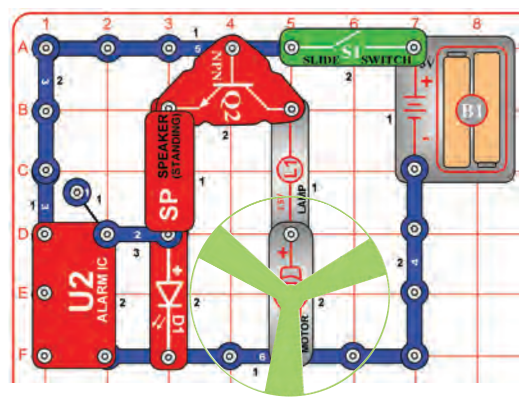


Turn on the switch (S1), the LED (D1) and lamp (L1) are bright. This is an unusual circuit which uses the NPN transistor (Q2) as two connected diodes to split the current from the batteries into the paths with the LED and lamp. If the LED (D1) does not light, you may have weak batteries in need of replacement.

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 #52 Light Up & Listen

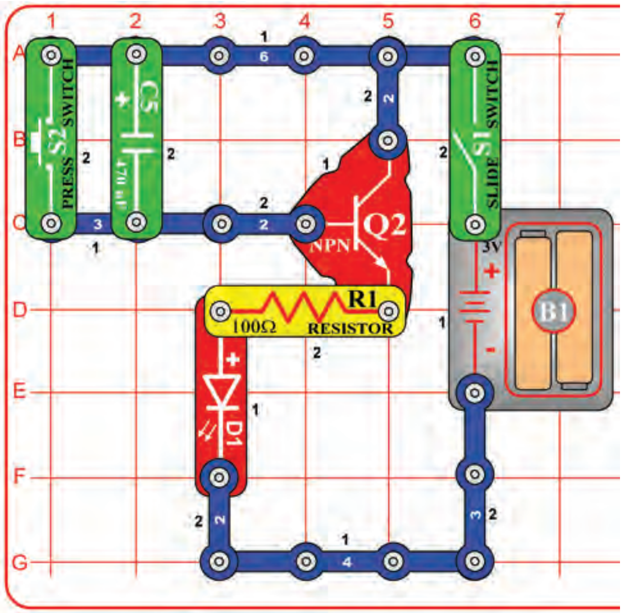


This circuit has four different types of output. Flip the switch (S1) several times. The LED (D1) and lamp (L1) light up, the motor (M1) spins, and the speaker (SP) makes a siren sound. If the LED does not light, you may have weak batteries that need replacement.

This is an unusual circuit which uses the NPN transistor (Q2) as two connected diodes, to split the current from the batteries (B1) into the paths with the LED and lamp.

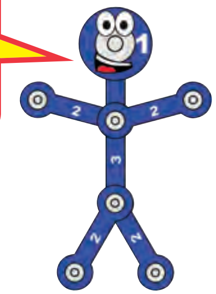
WARNING: Moving parts. Do not touch the fan or motor during operation.

Project #53 Auto-Off Night Light

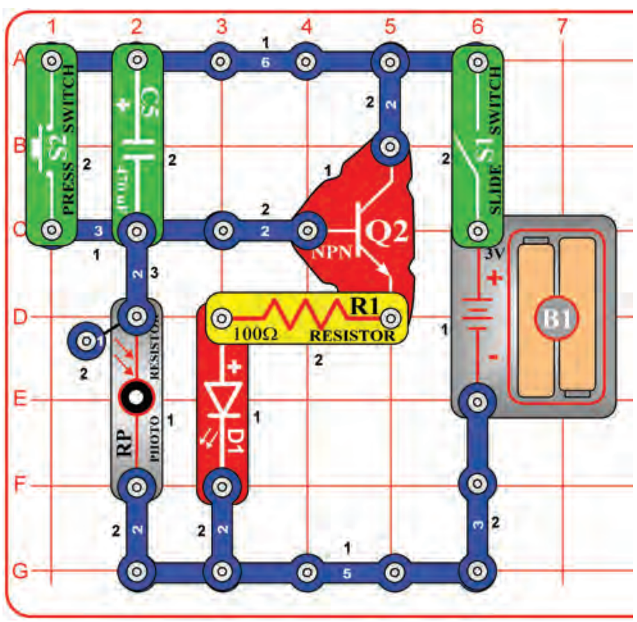


Build the circuit to the left. When you turn on the slide switch (S1) the first time the LED (D1) will come on and very slowly get dimmer and dimmer. If you turn the slide switch (S1) off and back on after the LED goes out it will NOT come on again. The 470μF capacitor (C5) has charged up and the NPN transistor amplifier (Q2) can get no current at its input to turn it on. To discharge the capacitor (C5) and reset the circuit, press and release the switch (S2).

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 even if left on all night.



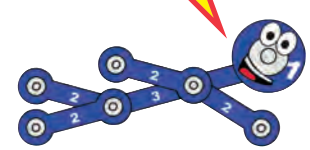
Project #54 Auto-Off Day Light



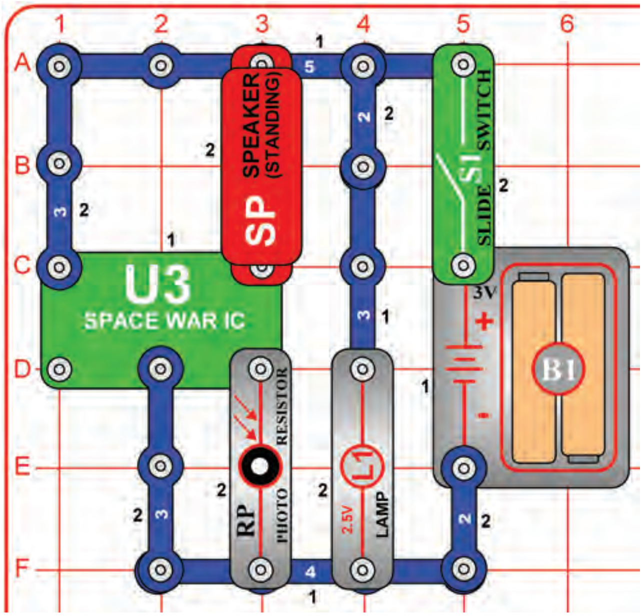
Cover the photoresistor (RP) and turn on the slide switch (S1). The LED (D1) is bright, but it will very slowly get dimmer and dimmer as the 470μF capacitor (C5) charges up. If you turn the slide switch (S1) off and back on after the light goes out it will NOT come on again. Push the press switch (S2) to discharge the capacitor and reset the circuit.

If you uncover the photoresistor and to 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.

This circuit would make a good day light. It would quickly turn off the lights when you opened the shades and let the sunlight in.

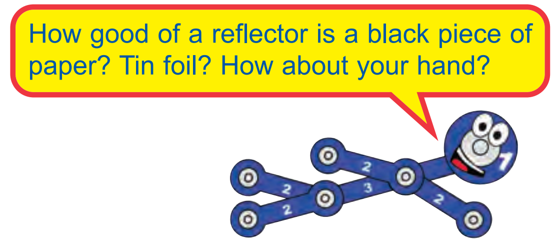


Project #55 — Reflection Detector

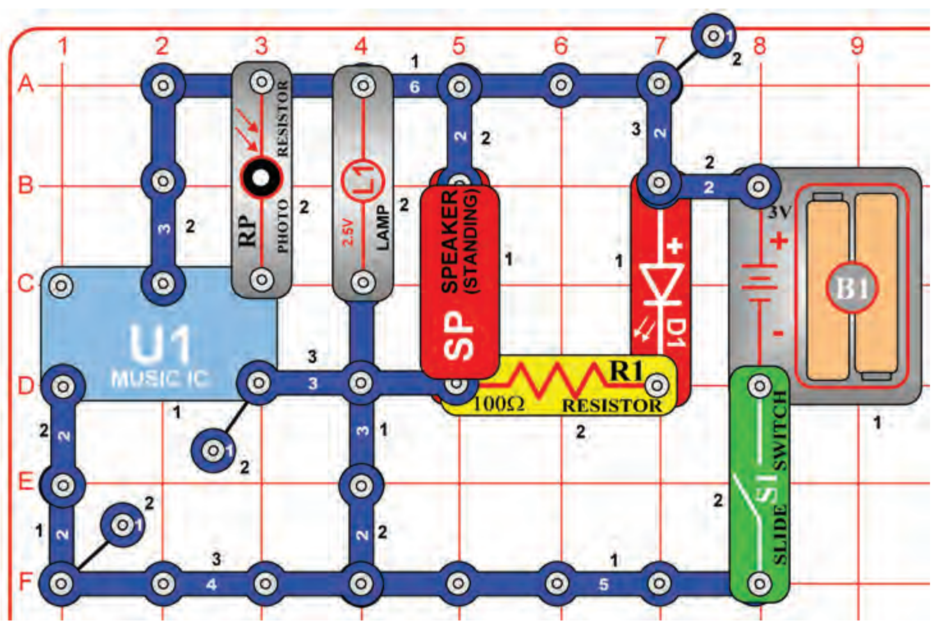


Build the circuit to the left. Place it where there won't be any room light hitting the photoresistor (RP) (such as in a dark room or under a table), and then turn it on. The 2.5V lamp (L1) will be bright, but there should be no sound.

Take a small mirror and hold it over the lamp and photoresistor. You should hear sound now. You have a reflection detector! You can also use a white piece of paper instead of a mirror, since white surfaces reflect light.



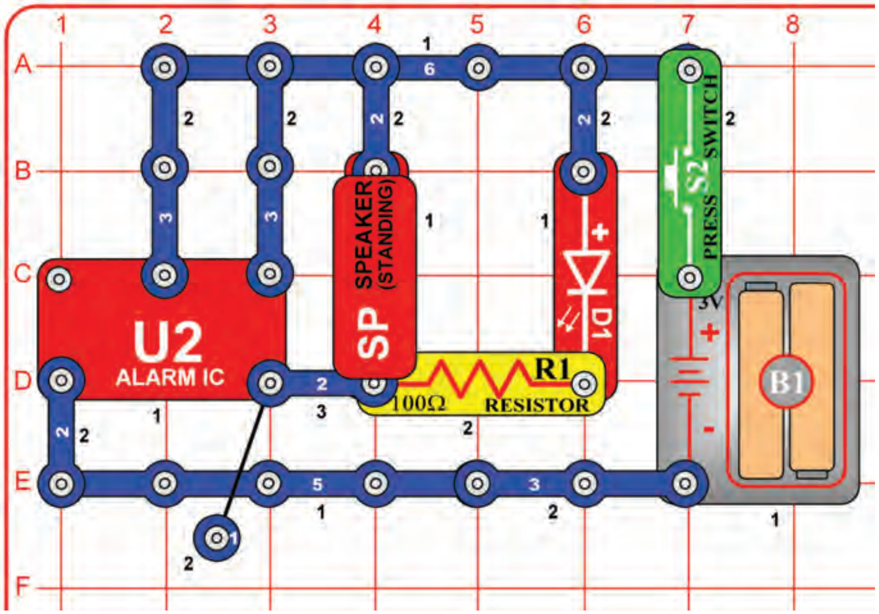
Project #56 — Music Reflection Detector



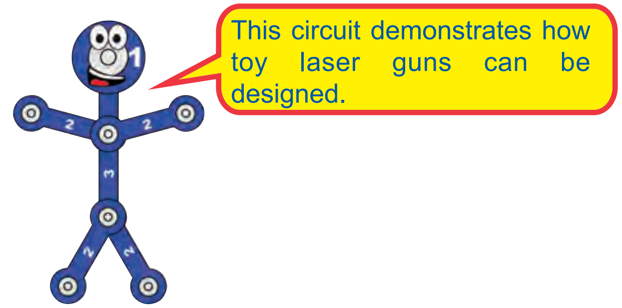
Build the circuit to the left. Place it where there won't be any room light hitting the photoresistor (RP) (such as in a dark room or under a table), and then turn it on. The 2.5V lamp (L1) will be bright, and one song may play, but then there should be no sound.

Take a small mirror and hold it over the lamp and photoresistor. You should hear sound now. You have a music reflection detector! You can also use a white piece of paper instead of a mirror, since white surfaces reflect light.

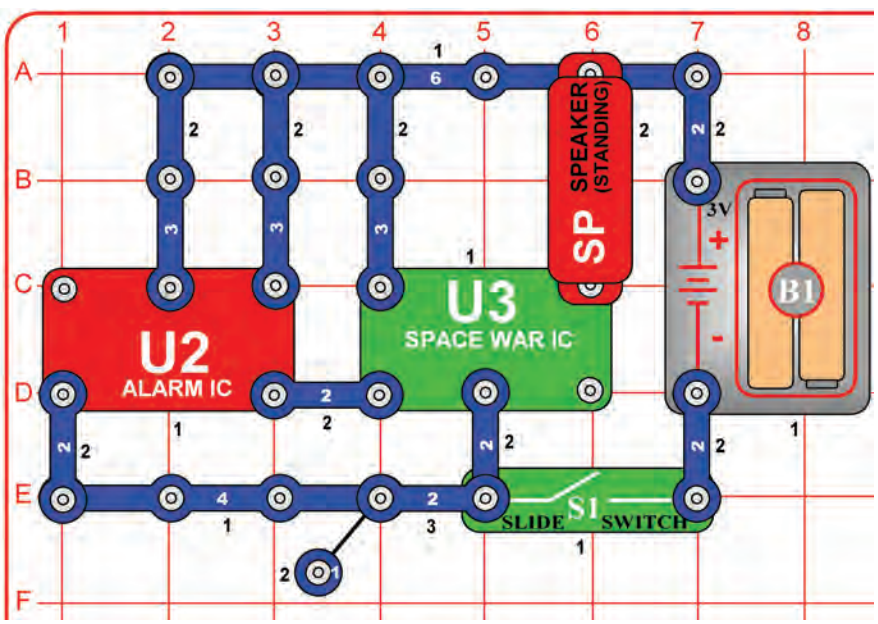
Project #57 Laser Flasher



When you press the press switch (S2), the integrated circuit should start sounding a very loud laser gun sound. The red LED will flash simulating a burst of laser light. You can shoot long repeating laser burst, or short zaps by tapping the press switch.



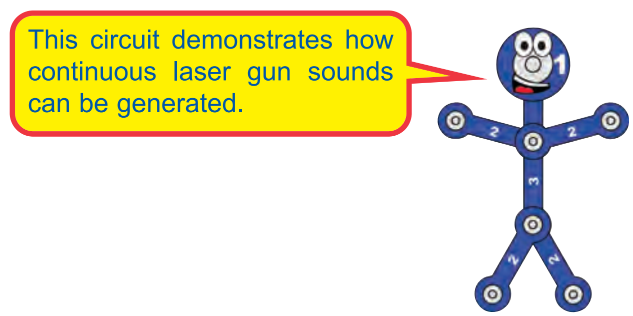
Project #58 Flash & Flicker

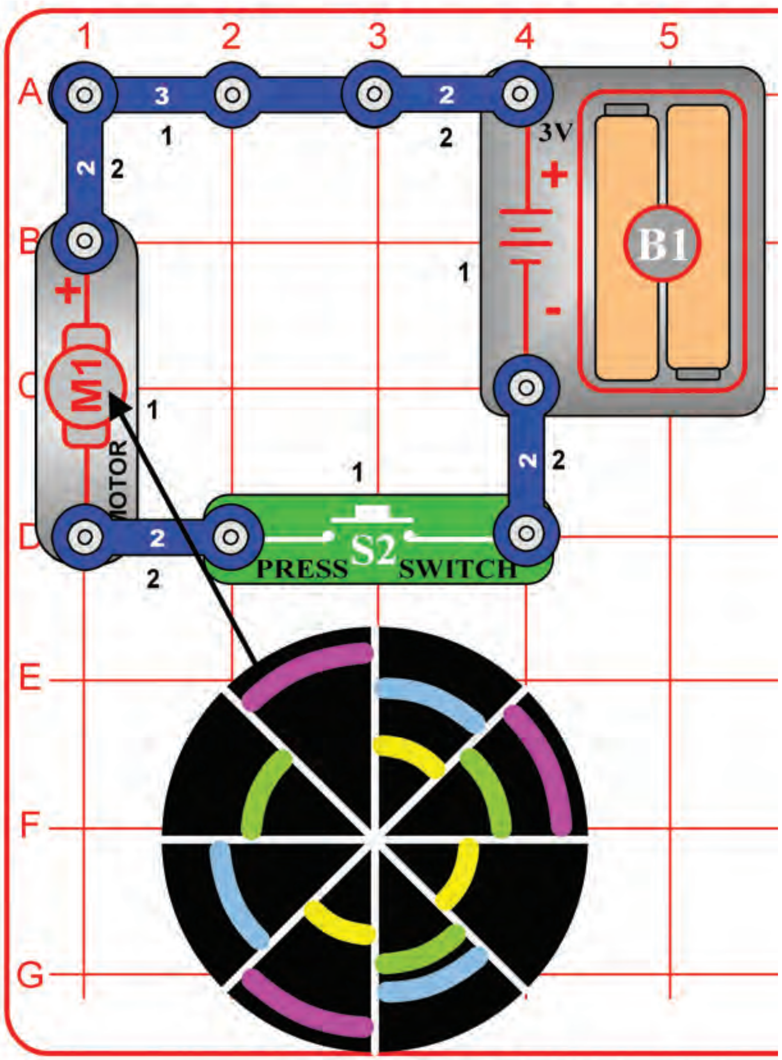


Build the circuit shown on the left, which uses the Space War integrated circuit.

Set the switch on and the speaker makes exciting sounds. The output of the IC can control lights, speakers, and other low power devices.

You may replace the speaker (SP) with the 2.5V lamp (L1), and the bulb will flicker. You can also use the LED (D1) in place of the lamp (position it with the "+" side towards the 6-snap).





Project #59

Spinning Rings

Setup: Cut out the disc on page #62 that looks like the one shown here. Using Scotch tape, attach the disc with the printed side up on the top of the fan blade. Place the blade on the motor as shown to the left and below.

When the press switch (S2) is pressed, the arcs will turn into colored rings with a black background. Notice how the color drops in brightness when it is stretched to make a complete circle.

WARNING: Moving parts. Do not touch the fan or motor during operation.

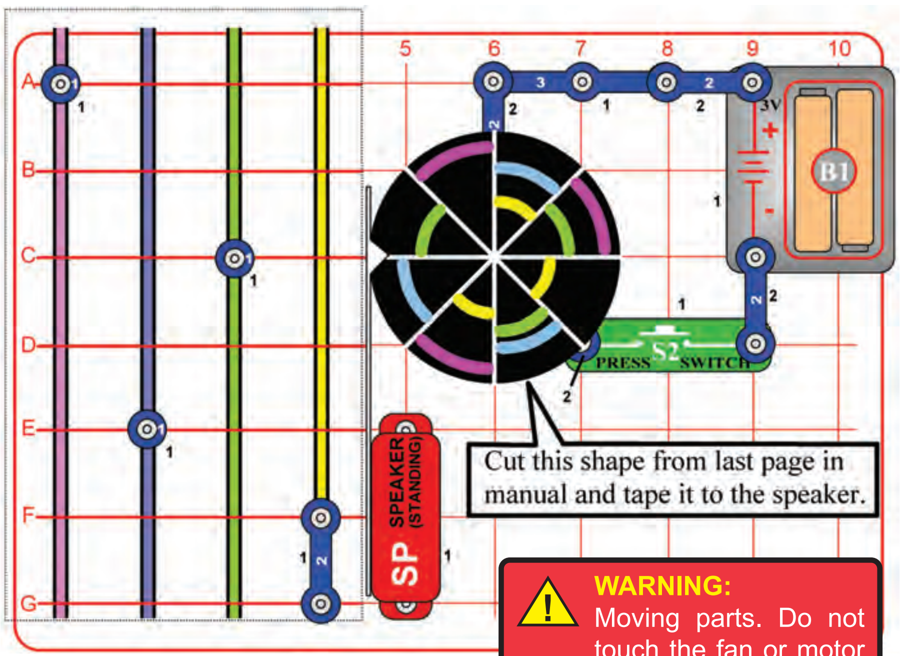
Project #60

Strobe the House Lights

Use the circuit from Project #59.

Setup: Place the spinning rings under a fluorescent light that runs on normal house current. Start the disc spinning and release the press switch (S2). As the speed changes you will notice the white lines first seem to move in one direction then they start moving in another direction. This effect is because the lights are blinking 60 times a second and the changing speed of the motor is acting like a strobe light to catch the motion at certain speeds. To prove this, try the same test with a flashlight. The light from a flashlight is constant and if all other lights are out, you will not see the effect that looks like a helicopter blade in a movie. Some fluorescent lights use an electronic ballast and they also produce a constant light.

WARNING: Moving parts. Do not touch the fan or motor during operation.



WARNING:
Moving parts. Do not touch the fan or motor during operation.

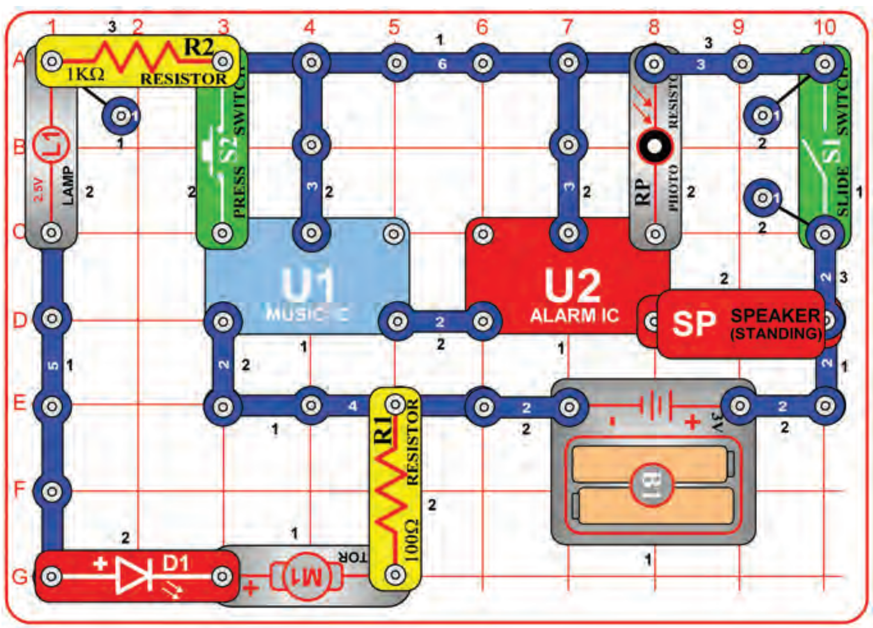
Project #61
Race Game

Modify Project #59 by adding the pointer as shown on the left. The paper should be cut from page #62 and taped high enough on the speaker so the pointer will stick over the fan with paper. Bend the pointer at a right angle as shown on the left.

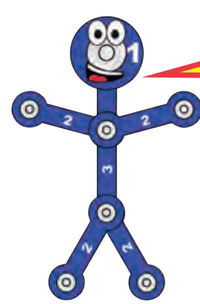
Setup: Cut out the grid with four (4) colors from page #62 and place it under the base as shown on the left. Each player picks a color (or two colors if only 2 people are playing) and places a single snap on row G. The purple player in column 1, the blue player in column 2, the green player in column 3, and the yellow player in column 4. Spin the wheel by closing the press switch (S2). The first single color wedge that the pointer points to is the first player to start. In some models you only have three 1-snaps, so use a 2-snap if you have four players.

The Play: Each player gets a turn to press the press switch. They release the press switch and when the pointer points to a wedge, the players that match the colors on the wedge get to move up one space. If a liner comes up like the one shown on the left then the players on each side of the line get to move up two (2) spaces. The first player to reach the top row (A) wins. If two players reach the top row at the same time they must both drop down to row “D” and play continues.

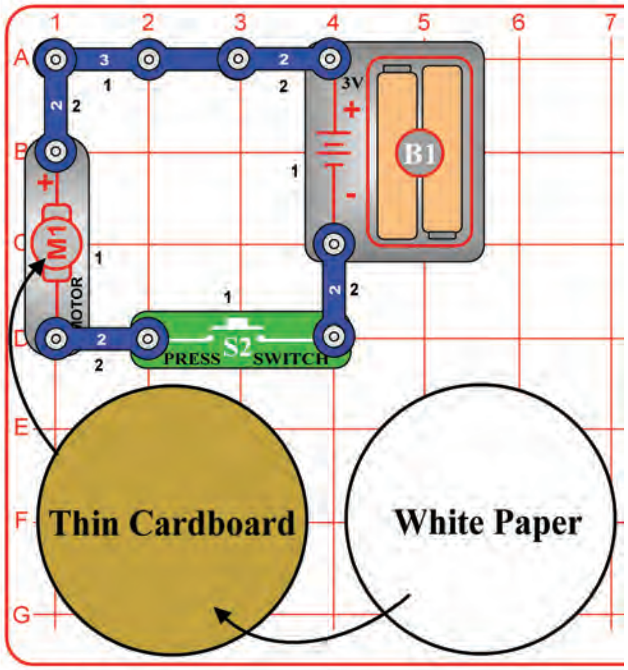
Project #62
Using Parts as Conductors



Turn on the slide switch (S1) and push the press switch (S2), you hear a machine gun sound (with music in the background). Thoroughly cover the photoresistor with your hand and the sound becomes a siren. After a while the sound will stop, push the press switch and it resumes.



Note that the LED (D1) lights, but the lamp (L1) does not light and the motor (M1) does not spin. Electricity is flowing through the lamp and motor, but not enough to turn them on. So in this circuit they are acting like 3-snap wires. You could replace D1 or L1 with a 3-snap and the circuit would work the same.



Project #63
Spin Draw

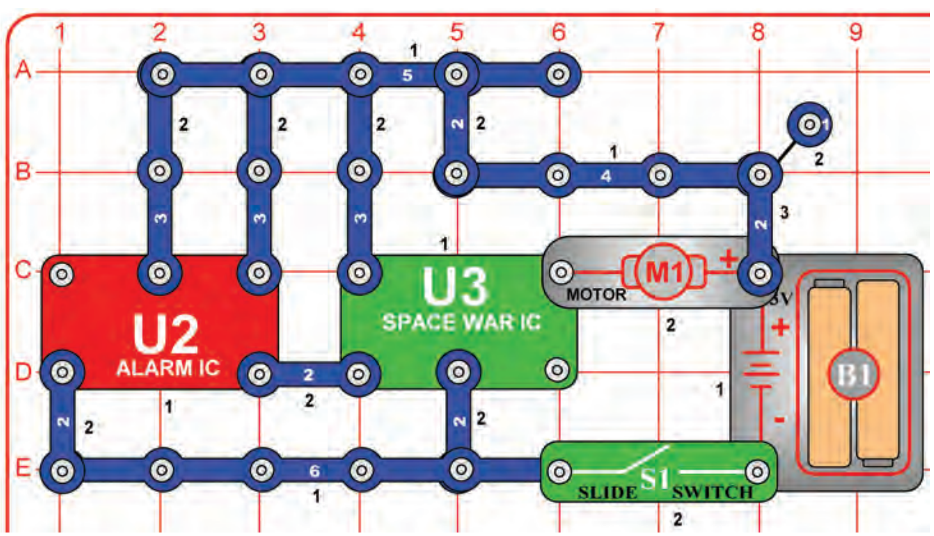
Rebuild the simple motor connection as shown on the left. This is the same setup as Project #59.

Setup: Cut out a circular piece of thin cardboard from the back of an old spiral notebook or note pad. Use the fan blade as a guide. Place the fan on the cardboard and trace around it with a pencil or pen. Cut the cardboard out with scissors and tape it to the fan blade. Do the same thing with a piece of white paper, but tape the paper on top of the cardboard so it can be removed easily later.

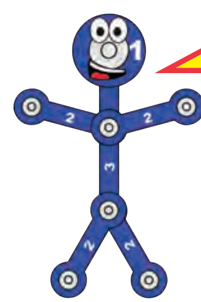
Drawing: To make a ring drawing obtain some thin and thick marking pens as drawing tools. Spin the paper by pressing and holding press switch (S2) down. Press the marker on the paper to form rings. To make spiral drawings, release press switch (S2) and as the motor approaches a slow speed move the marker from the inside outward quickly.

Change the colors often and avoid using too much black to get hypnotic effects. Another method is to make colorful shapes on the disc then spin the disc and watch them blend into each other. When certain speeds are reached under fluorescent lights without electronic ballasts, the strobe principle shown in another project will produce strange effects and backward movement. Make a wheel with different colored spokes to see this strange effect. Adding more spokes and removing spokes will give different effects at different motor speeds.

Project #64
Singing Motor

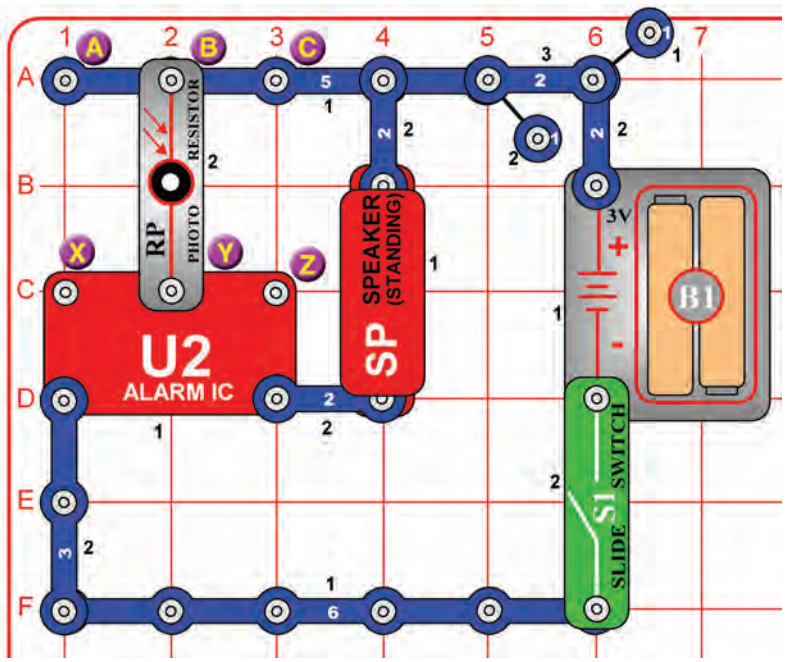


Turn on the switch and the motor spins (you may need to give it a push with your finger to get it started). The sounds from the IC are used to drive the motor. Because the motor uses magnets and a coil of wire similar to a speaker, you may even hear the space war sounds coming faintly from the motor.



The motor has a coil and a magnet similar to the speaker. An electrical signal in the coil creates a magnetic field, which makes the shaft spin. Normally the motor is used with a stable electrical signal, but in this project it is used with a changing signal from the space war IC. This creates mechanical vibrations, which create air pressure variations that sound like the speaker does, though not as efficiently.

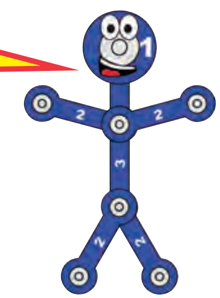
Project #65 Visual Volume



Build the circuit shown on the left.

Turn on the slide switch (S1), a police siren is heard. The loudness of the sound depends on how much light reaches the photoresistor (RP). Try partially shielding it or placing near a very bright light, and compare the sound.

The photoresistor contains material that changes its resistance when it is exposed to light. As it gets more light, the resistance of the photoresistor decreases. Parts like this are used in a number of ways that affect our lives. For example, you may have streetlights in your neighborhood that turn on when it starts getting dark and turn off in the morning.



Project #66 Daylight Alarm

Modify the last circuit by connecting the photoresistor to points A & X. The circuit works the same way but now it sounds link an ambulance when enough light reaches the photoresistor.

Project #67 Bang-Bang Bright

Now remove the photoresistor from points A & X and connect it to points C & Z. The circuit works the same way but now it sounds like a machine gun when enough light reaches the photoresistor.

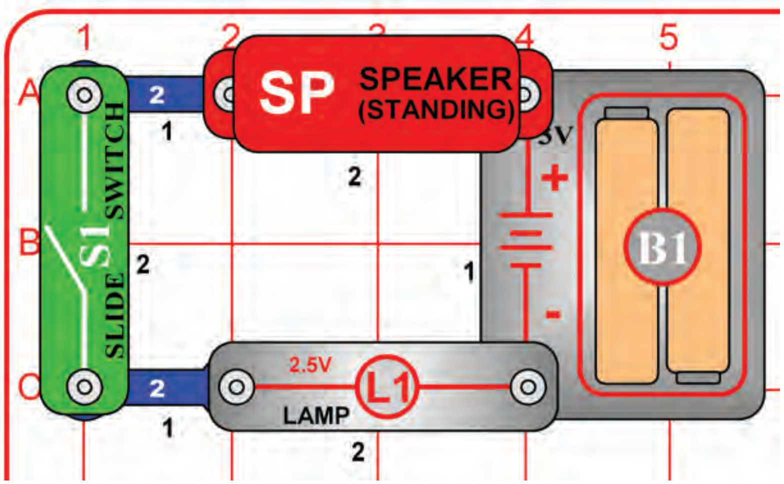
Project #68 Daylight Danger

Now connect a 3-snap to make a connection between A & X. Keep the photoresistor connected between points C & Z. Now depending on how much light reaches the photoresistor, you will hear either an ambulance or machine gun sound.

Project #69 Crooks & Cars

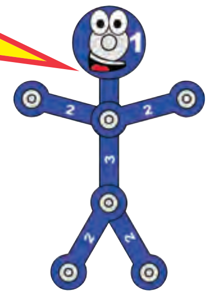
Now remove the connection between A & X and then make a connection between B & Y. The circuit works the same way but now depending on how much light reaches the photoresistor you will hear either a police siren or machine gun sound.

Project #70 Pop On, Pop Off

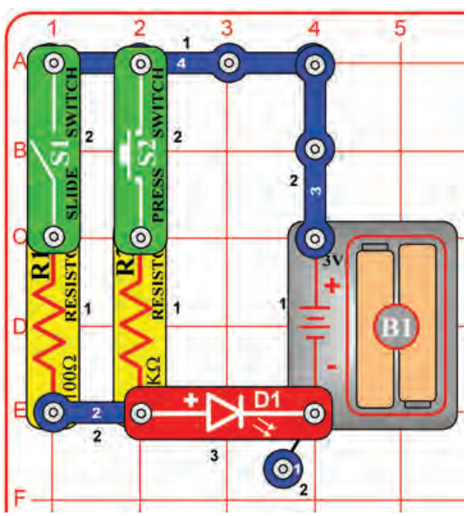


Turn the slide switch (S1) on and off several times. You hear static from the speaker (SP) when you turn off the switch.

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.



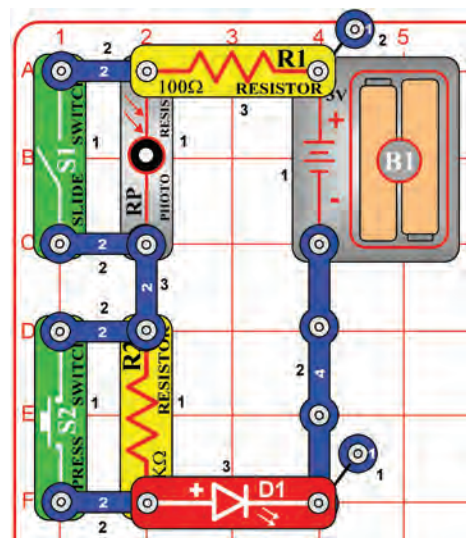
Project #71 Little R Rules



Turn on either or both switches and compare the LED brightness.

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

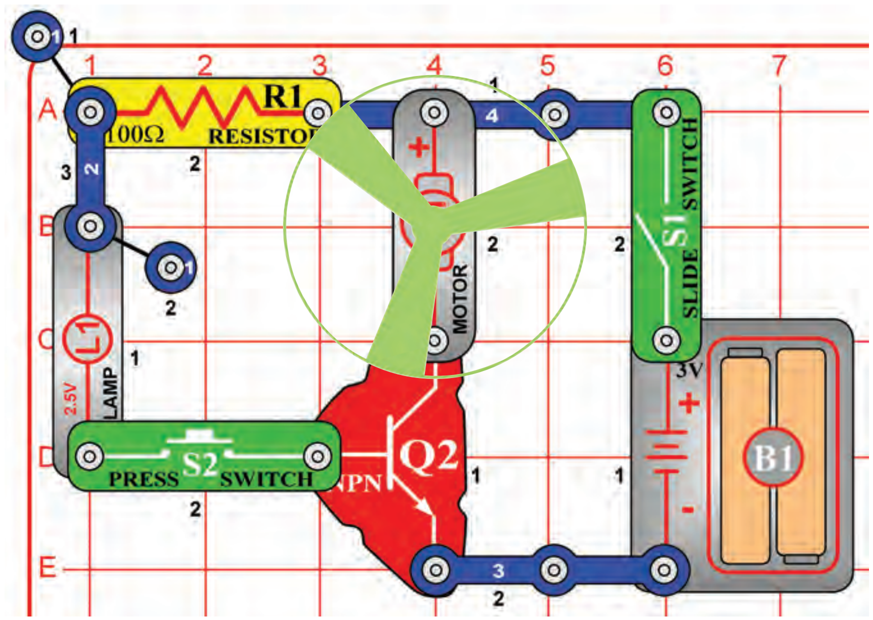
Project #72 Big R Rules



Turn on either or both switches and compare the LED 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 limits the brightness in this arrangement (the resistance of the photoresistor will be much higher than the others, unless the light is very bright).

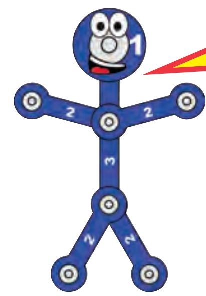
Project #73 Little to Big



Place the fan on the motor (M1) and turn on the slide switch (S1), then compare this circuit to Project #31. Push the press switch (S2), the lamp doesn't light now but the motor still spins.

The lamp is dark because the 100Ω resistor (R1) limits the current through it. The NPN transistor (Q2) uses the small lamp current to create a large current that spins the motor.

Now replace the 100Ω resistor (R1) with the larger 1KΩ resistor (R2). The motor spins more slowly now, because the transistor cannot create as large of a motor current from such a small controlling current.

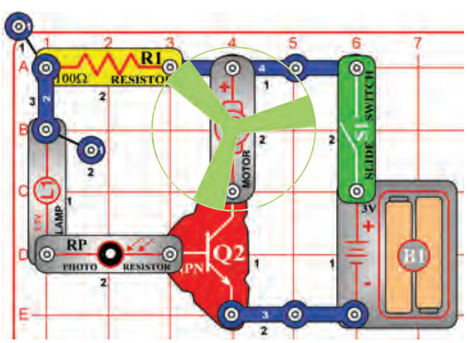


Transistors, such as the NPN transistor (Q2), can amplify electric currents. In this circuit, the small current through the resistor is used to control a larger current through the motor. A large resistor value limits the current through the lamp, making it very dim, but the transistor amplified current is large enough to still spin the motor.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

WARNING: Fan may not rise until switch is released.

Project #74 Luminate & Rotate



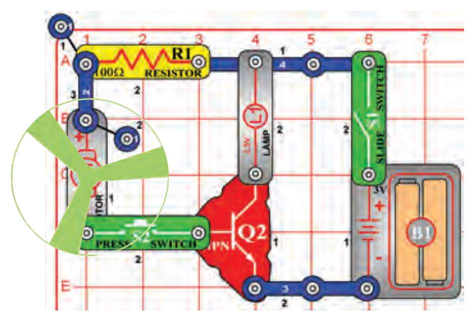
Compare this circuit to Project #73. It uses the photoresistor (RP) to control the current to the NPN transistor (Q2), instead of the press switch (S2). You can adjust the speed of the motor (M1) by changing how much light shines on the photoresistor.

The lamp is dark because the photoresistor limits the current through it. The NPN transistor uses the small lamp current to create a large current that spins the motor.

If you tried to control the motor speed by placing the photoresistor in series with the motor, the motor would not spin because the photoresistor would limit the current. But the photoresistor can control the motor speed with help from the transistor. You may need to shine a light on the photoresistor (RP) if the motor does not spin.

WARNING: Moving parts. Do not touch the fan or motor during operation.

Project #75 Light to Light



Compare this circuit to Project #32. Push the press switch (S2), the motor (M1) doesn't spin now but the lamp (L1) still lights.

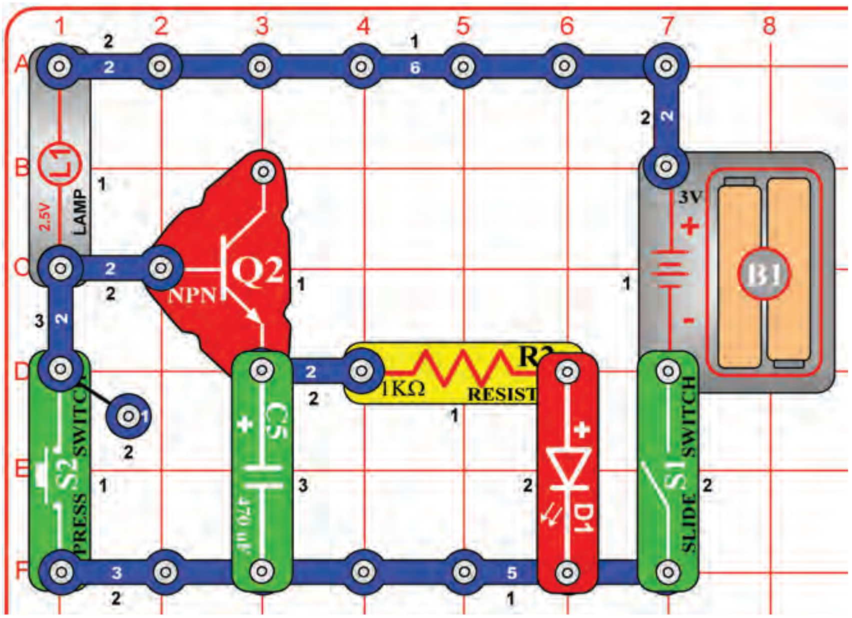
The motor doesn't spin because the 100Ω resistor (R1) limits the current through it. The NPN transistor (Q2) uses the small motor current to create a large current that lights the lamp.

Now replace the 100Ω resistor (R1) with the larger 1KΩ resistor (R2). The lamp is only slightly less bright even though the motor current is much lower.

Now place the 100Ω resistor back in the circuit and replace the press switch with the photoresistor (RP). A bright light on the photoresistor will turn the lamp on. But if the light is dim, then the photoresistor has high resistance, so little current flows through the transistor and the lamp is off.

WARNING: Moving parts. Do not touch the fan or motor during operation.

Project #76 Switch & Store

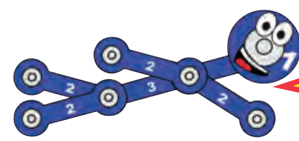


Turn on the slide switch (S1) and the LED (D1) lights; it will not be very bright so turn off the room lights or hold your fingers around it to see it better. Push the press switch (S2) several times slowly; the LED and lamp (L1) go on and off.

Push the press switch many times quickly - the lamp still goes on and off but the LED stays on. Next, remove the 470μF capacitor (C5) from the circuit - the LED goes on and off now. Why?

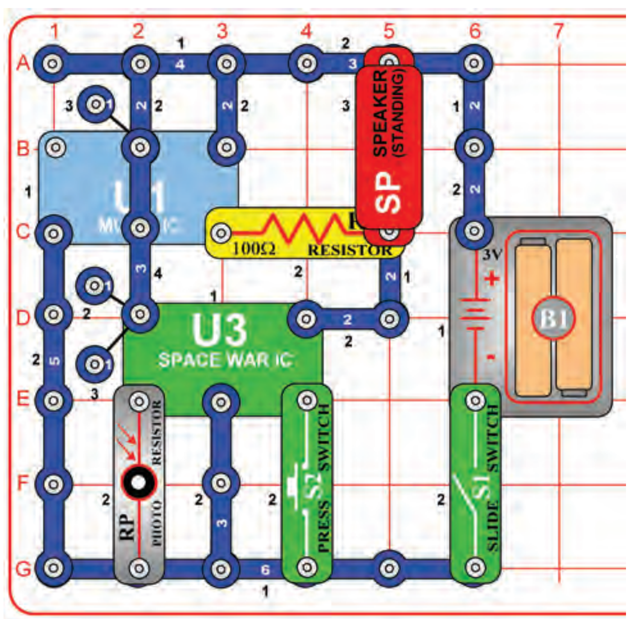
Pressing the switch quickly simulates a changing voltage, which turns the LED on and off. The 470μF capacitor can store electricity, and it combines with the NPN transistor (Q2) to simulate a rectifier. This rectifier converts the changing voltage at the press switch into a constant voltage, which keeps the LED on.

You can replace the 1KΩ resistor (R2) with the 100Ω resistor (R1). This makes the LED a little brighter but you have to press the switch faster to keep it on, because the lower resistance drains the capacitor faster.



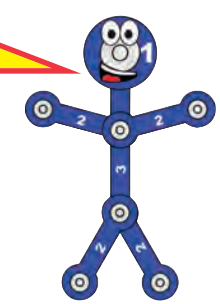
The electricity supplied to your home by your electric company is actually a changing voltage. Many electronic products use rectifier circuits to convert this into a constant voltage like a battery provides.

Project #77 Crazy Combo

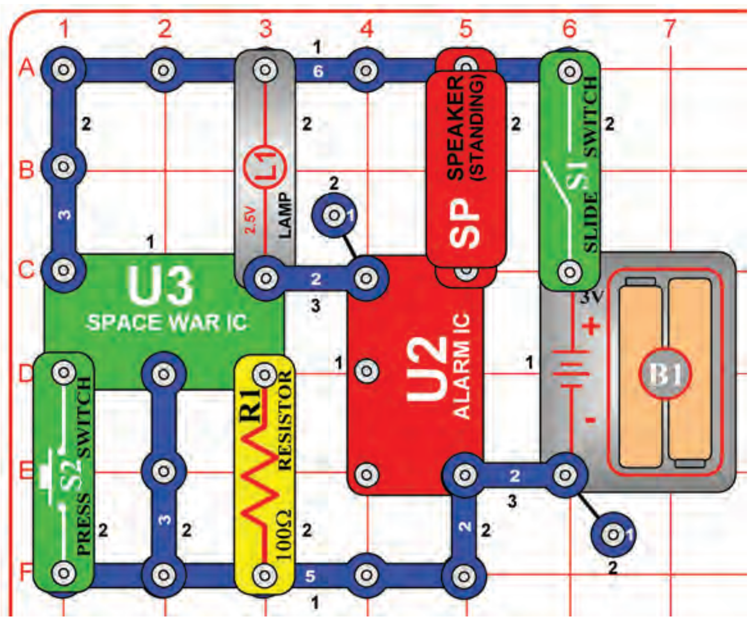


Build the circuit shown. Turn it on, press the press switch (S2) several times, and wave your hand over the photoresistor to hear all the sound combinations. You can make the sound from the music IC louder by replacing the 100Ω resistor (R1) with the 2.5V lamp (L1).

The music and space war ICs (U1 and U3) 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.

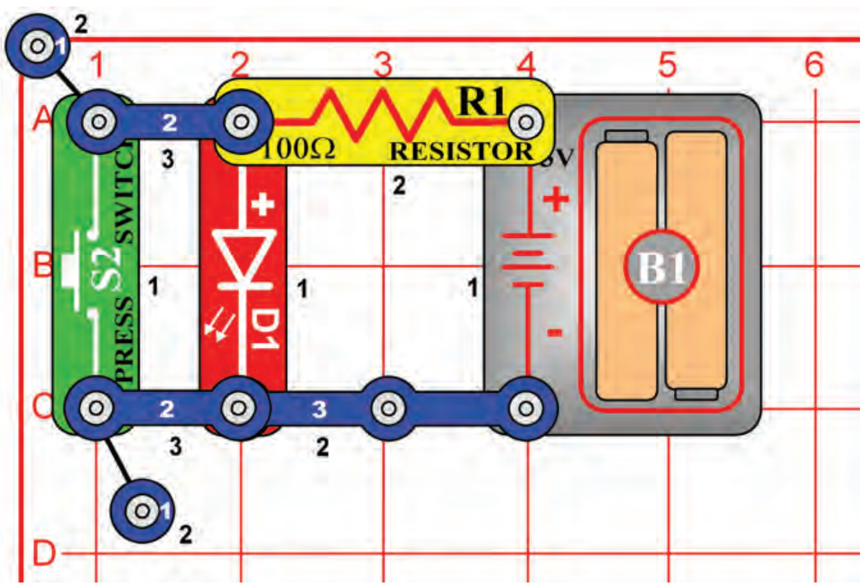


Project #78 Alien Alarm



Build the circuit shown on the left and turn on the slide switch (S1). Press and hold the press switch (S2) to make the lamp (L1) brighter.

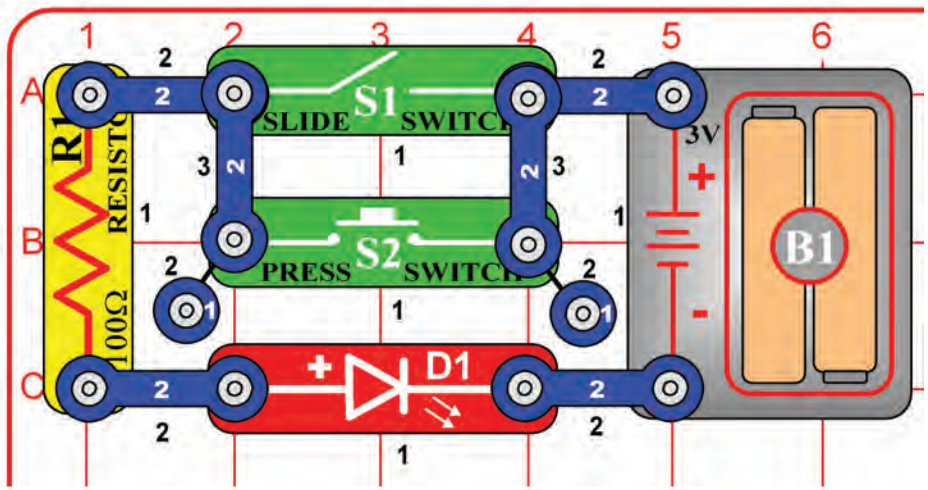
Project #79 Same or "NOT"



Build the circuit shown. Notice that when the press switch (S2) is pressed, the LED (D1) goes off. This is an example of an inverter circuit, or NOT gate. Whenever the input is high (switch is on), the output is low (LED is off) and whenever the input is low (switch is off) the output is high (LED is on). Disassemble the circuit when finished to avoid draining your batteries.

Although this circuit seems simple, inverters or NOT gates are very important in digital logic circuits.

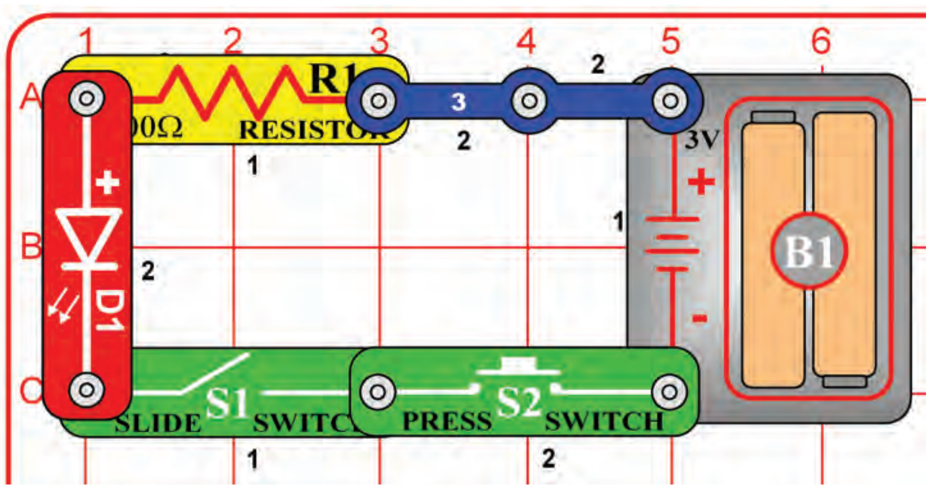
Project #80 — This OR That



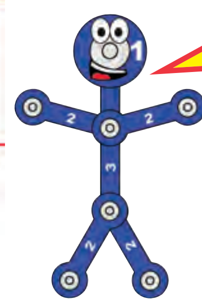
Build the circuit shown. Notice that if you turn on the slide switch (S1) <u>OR</u> press the press switch (S2) the LED (D1) lights up. There is no partially lit state here, the diode is either totally on or totally off. While this may seem very simple and boring, it represents an important concept in 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.

This circuit is commonly called an OR gate. OR gates are used in digital logic circuits to perform logical additions. When one of the inputs is high (one of the switches is on) the output is high (LED on). The output will only be low (LED off) if both inputs are low (both switches are off).

Project #81 — This AND That

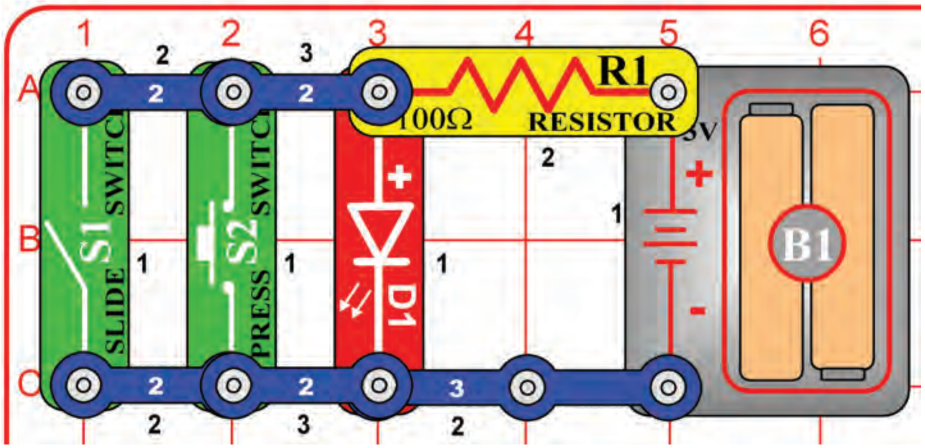


Build the circuit shown. Notice that if you turn on the slide switch (S1) <u>AND</u> press the press switch (S2) the LED (D1) lights up. Once again, there is no partially lit state here, the LED is either totally on or totally off. Two switches like this may be used to turn on the same light in your 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.



This circuit is commonly called an AND gate. AND gates are used in digital logic circuits to perform logical multiplies. When one of the inputs is low (one of the switches is off) the output is low (LED off). The output will only be high (LED on) if both inputs are high (both switches are on). 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.

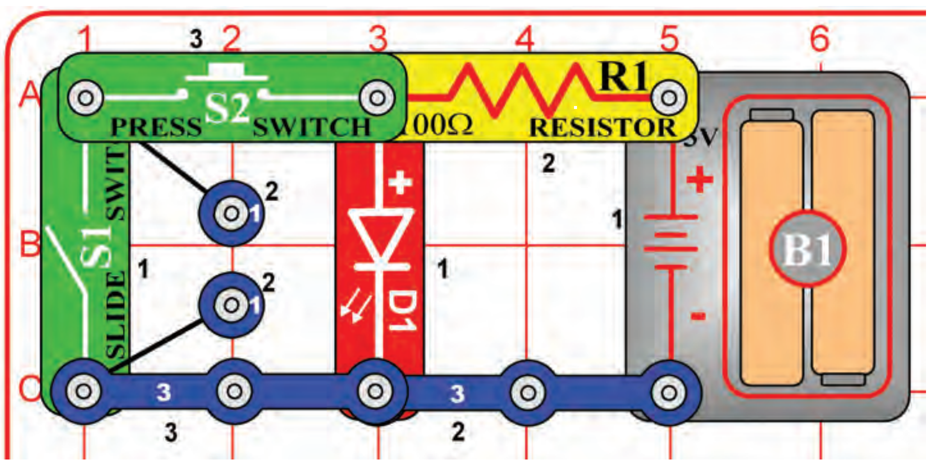
Project #82 — Neither This NOR That



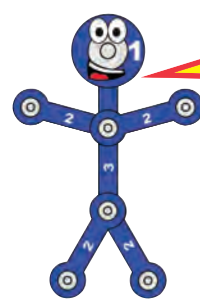
Build the circuit at left and test the combinations of the slide switch (S1) and press switch (S2). If you compare it to the OR circuit in Project #80, you can see the LED (D1) lights in the opposite combinations of that circuit. Hence, we refer to it as a <u>NOR</u> circuit (short for "NOT this OR that"). Like the OR and AND, it is an important building block in computers.

This circuit is commonly called a NOR gate. NOR gates are used in digital logic circuits to perform an inverted logical add. When one of the inputs is high (one of the switches is on) the output is low (LED off). The output will only be high (LED on) if both inputs are low (both switches are off).

Project #83 — NOT This AND That

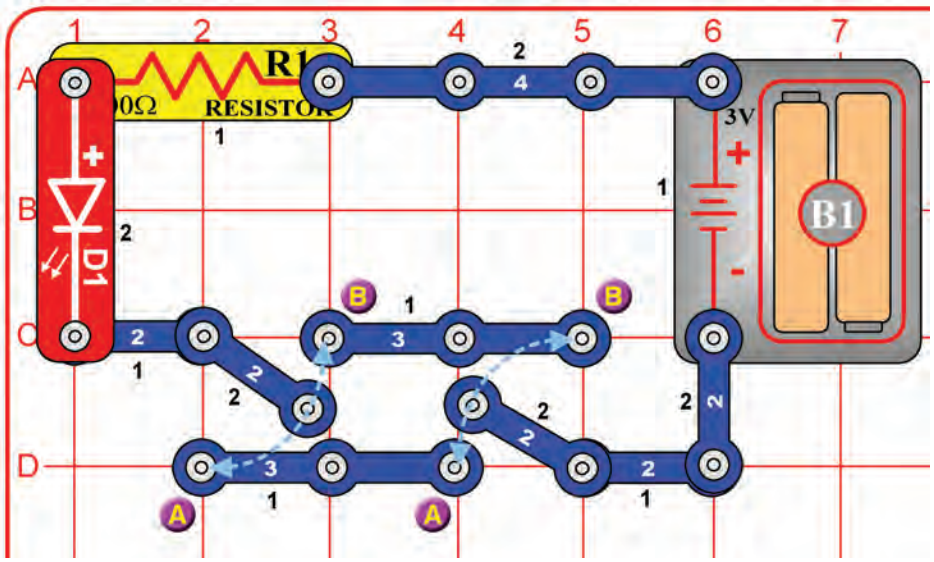


Build the circuit at left and test the combinations of the slide switch (S1) and press switch (S2). If you compare it to the AND circuit in Project #81, you can see the LED (D1) lights in the opposite combinations of that circuit. Hence, we refer to it as a <u>NAND</u> circuit (short for "NOT this AND 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 <u>NOT</u> circuit. Like the OR, AND, and NOR, NAND and NOT are important building blocks in computers.



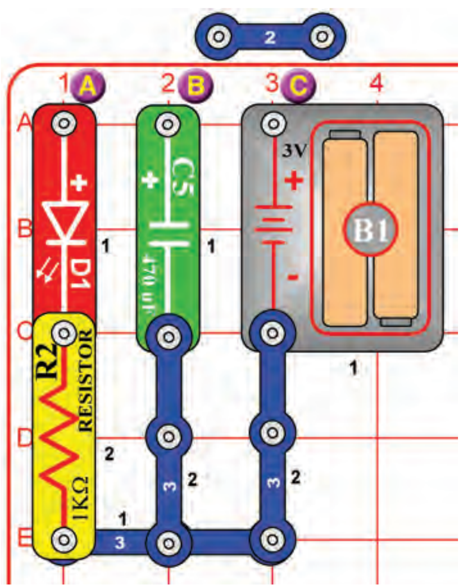
This circuit is commonly called a NAND gate. NAND gates are used in digital logic circuits to perform an inverted logical multiply. When one of the inputs is low (one of the switches is off) the output is high (LED on). The output will only be low (LED off) if both inputs are high (both switches are on).

☐ # Project #84 Two-way Light Switch

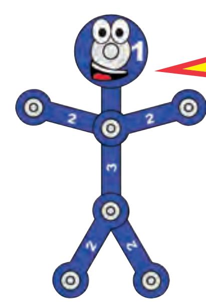


Build the circuit on the left. Note that two of the 2-snaps are left unconnected on one end because they will be used as switches in this project. If you connect the free ends of each of these 2-snaps both to the "high bar" or positions B in the figure or both to the "low bar" or positions A in the figure, the LED (D1) lights up. But if you connect the free end of one of the 2-snaps to the "high bar" and the free end of the other 2-snap to the "low bar", then the LED does not light up.

☐ # Project #85 Electron Warehouse

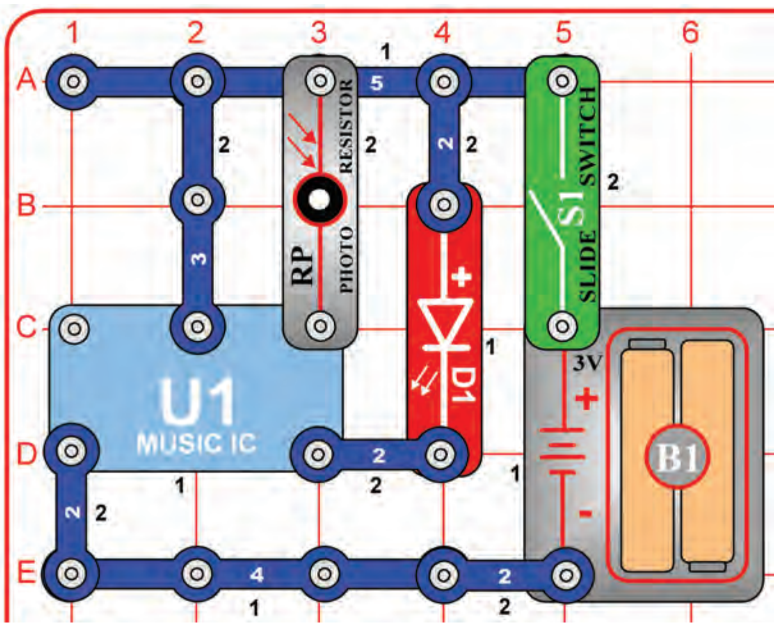


Build the circuit, then connect points B & C (use a 2-snap wire) for a moment. Nothing appears to happen, but you just filled up the 470μF capacitor (C5) with electricity. Now disconnect B & C and instead touch a connection between A & B. The red LED (D1) will be lit and then go out after a few seconds 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 470μF capacitor kept the LED lit with how your batteries run all of your projects! That is because a capacitor stores electrical energy while a battery stores chemical energy.

Project #86 — Light Makes Light

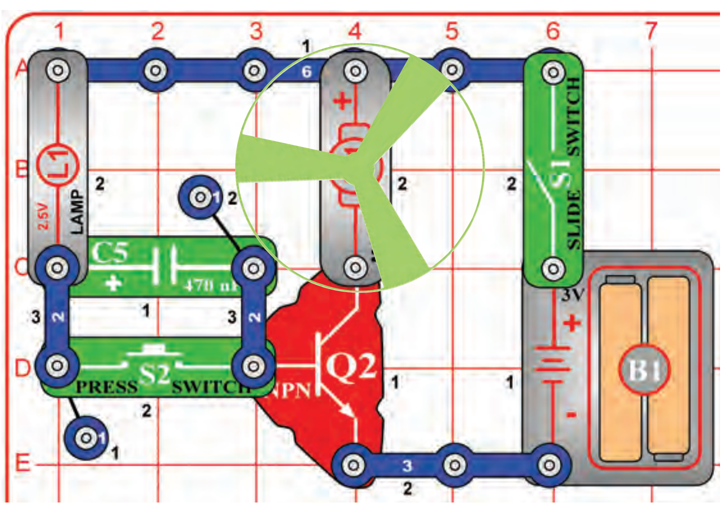


Build the circuit to the left. Cover the photoresistor, turn the switch on, and notice that the LED is on for several seconds and then goes off. Uncover the photoresistor and place the unit near a light and the LED will light. Cover the photoresistor (RP) again and the LED will turn off. The resistance of the photoresistor decreases as the light increases activating the U1 IC that varies the voltage to the LED making it light.

Project #87 — Go & Glow

Use the circuit from Project #86. Connect the motor (M1) across points A1 and C1 on the base grid, and remove the photoresistor (RP). Turn the switch on and the LED (D1) lights for several seconds then goes out. Turn the shaft of the motor and the LED will light again. As the motor turns, it produce a voltage. There is a magnet and a coil inside the motor. When the axis turns the magnetic field will change and generate a small current through its terminals. This voltage then activates the music IC.

Project #88 — Spin & Stop

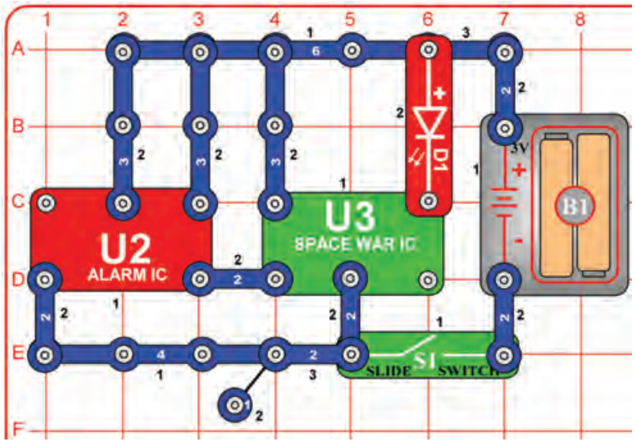


Place the fan on the motor and turn on the slide switch (S1). The motor spins briefly as the 470μF capacitor (C5) charges up. Turn off the slide switch and push the press switch (S2) to discharge the capacitor and reset the circuit.

You can bypass the capacitor by pushing the press switch while the slide switch is on. This lets the motor spin at full speed and also lights the lamp.

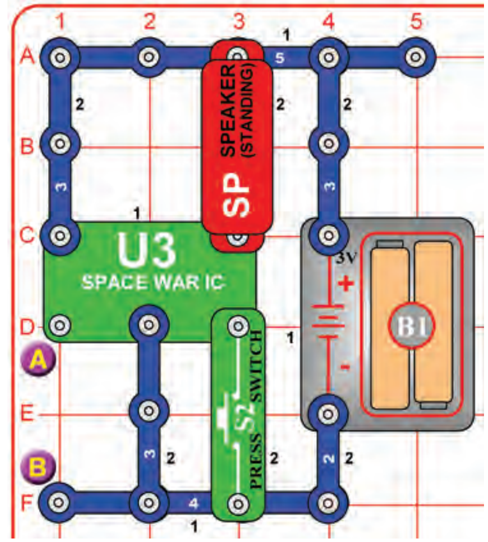
WARNING: Moving parts. Do not touch the fan or motor during operation.

Project #89
Flashing Flare



Build the circuit shown on the left. The circuit uses the Alarm and Space War ICs to flash the LED (D1). Turn the switch on and the LED starts flashing.

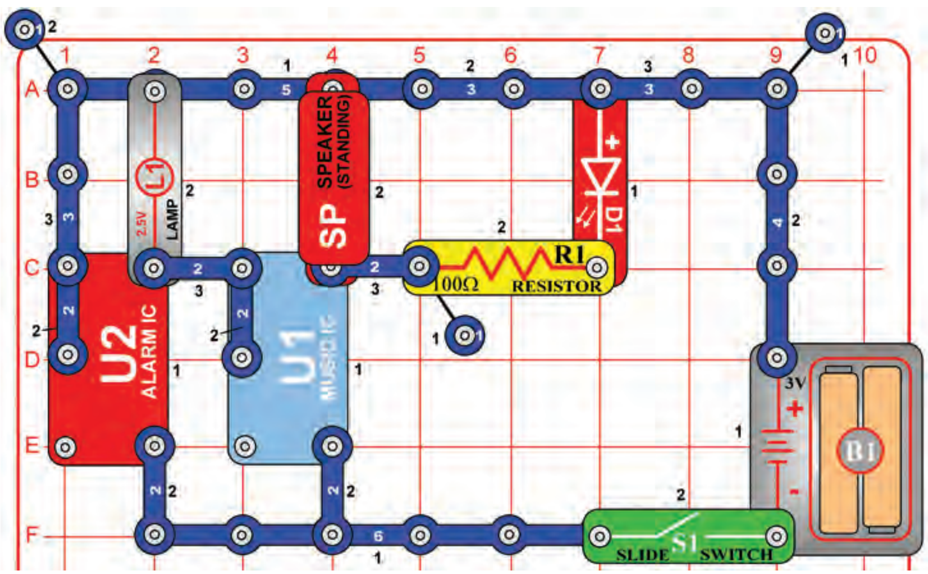
Project #90
Touch & Go



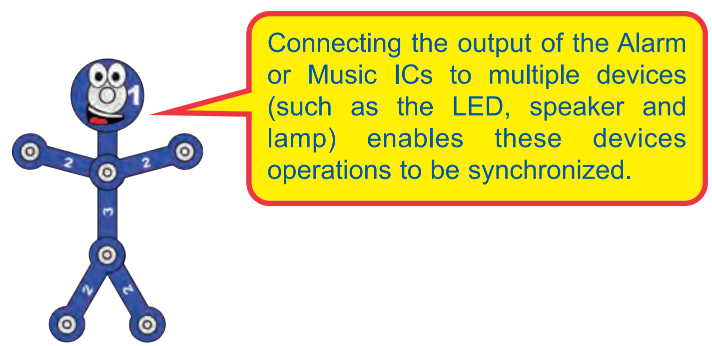
Wet your fingers with some water or saliva and touch them across points A and B several times to hear some space war sounds. Push the press switch (S2) to hear more sounds at the same time.

This circuit uses your body to conduct electricity, and turn on the circuit. Wetting your fingers improves the connection between the metal and your finger.

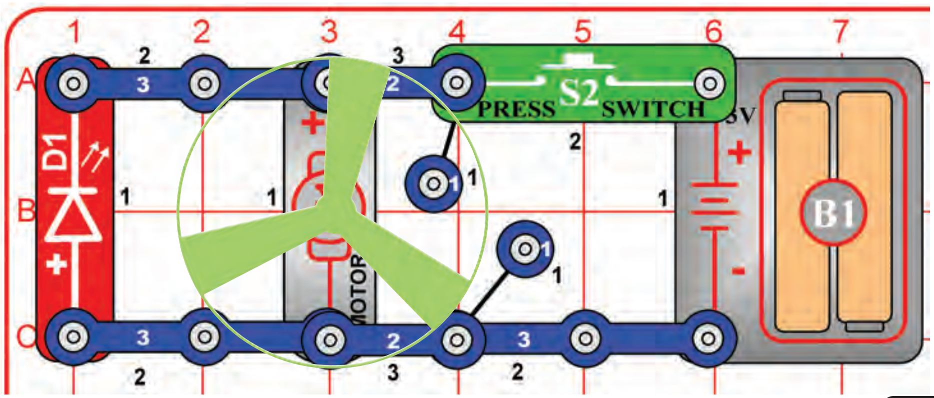
Project #91
Two-Tone Twinkler



Turn the switch (S1) on and the lamp (L1) and LED (D1) start flashing. You hear two different tones driving the LED and lamp. ICs can be connected to control many different devices at the same time.



Project #92 Fan Flash Energy



Place the fan on the motor (M1). Hold down the press switch (S2) for a few seconds and then watch the LED (D1) as you release the switch. The LED flashes briefly but only after the batteries (B1) are disconnected from the circuit.

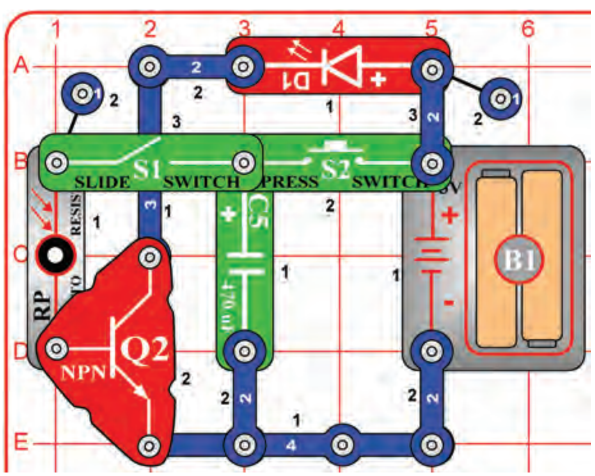
Do you know why the LED flashes? It flashes because the mechanical energy stored in the fan blade makes the motor act like a generator. When the switch is released, this energy creates a brief current through the LED.

If you reverse the motor direction, then the LED will light the same way, but the fan may fly off after the LED lights.

WARNING: Moving parts. Do not touch the fan or motor during operation.

WARNING: Do not lean over the motor.

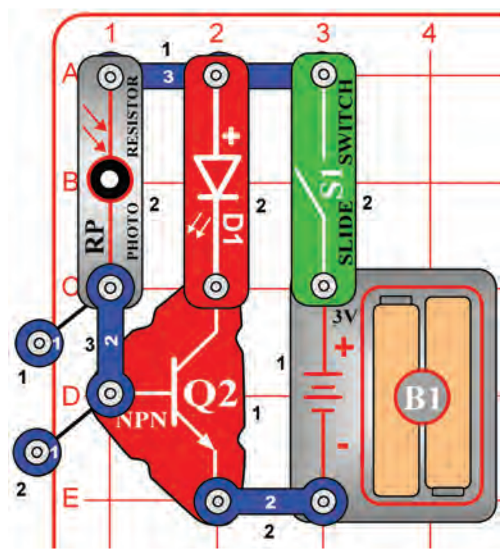
Project #93 Photo Timer Light



Press and release the press switch (S2), then turn on the slide switch (S1). The LED will light for a while when there is room light on the photoresistor (RP) and slowly dims.

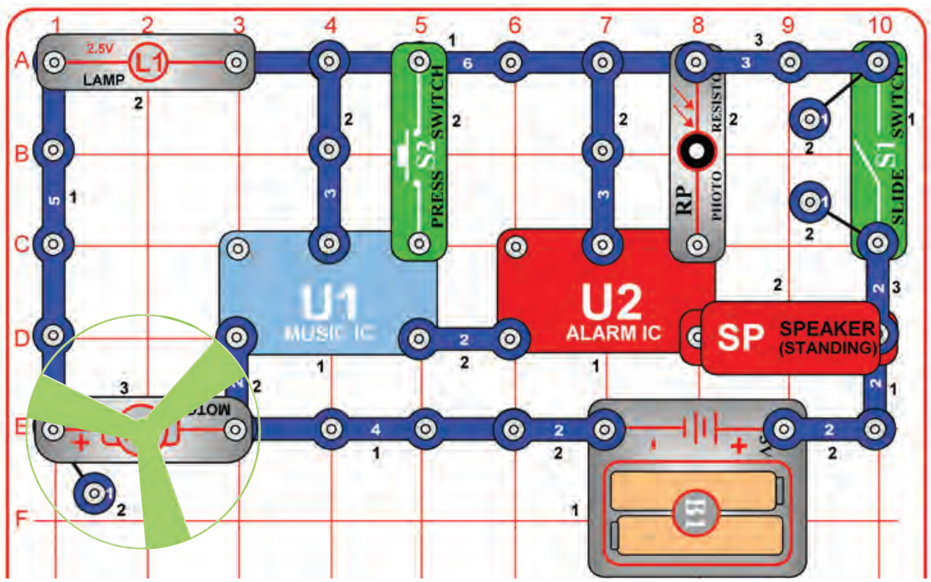
The capacitor (C5) will store energy until a light shines on the photo resistor to release the energy, which activates the NPN transistor (Q2) and turns on the LED (D1). Press the press switch again to recharge the capacitor.

Project #94 Room Light to Red Light



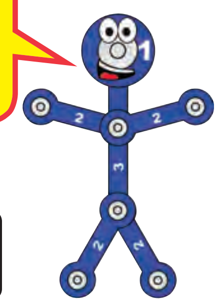
Turn on the switch, the brightness of the LED depends on how much room light shines on the photoresistor. The resistance drops as more light shines, allowing more current to the NPN.

Project #95 Fun with the Alarm IC



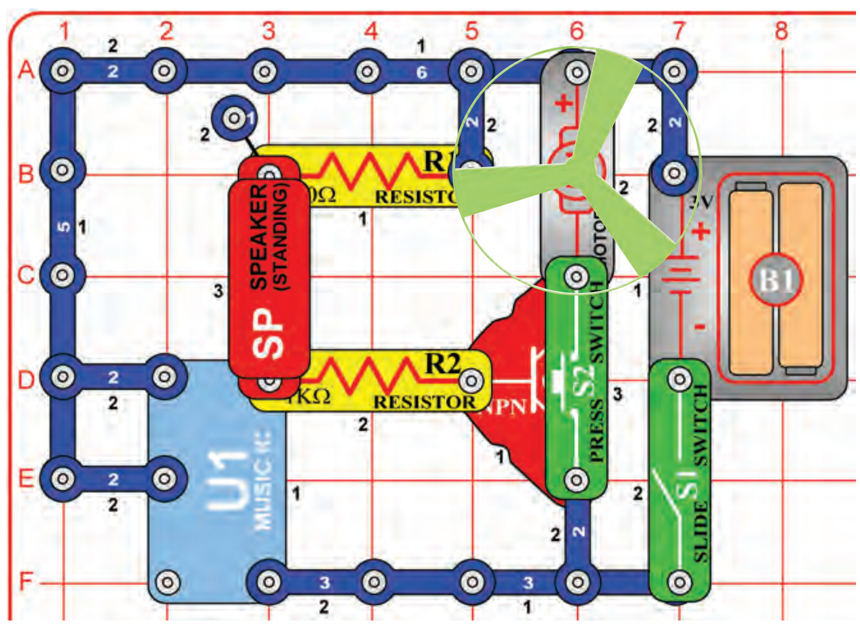
Place the fan on the motor (M1) and turn on the slide switch (S1). The lamp (L1) lights, the motor spins, and you hear a machine gun sound (with very faint music in background). Thoroughly cover the photoresistor (RP) with your hand and the sound becomes a siren. After a while the sound will stop, hold down the press switch (S2) and the sound resumes.

Photoresistors can be used to control many devices such as street lights, clock radio alarms, night lights, etc.



WARNING: Moving parts. Do not touch the fan or motor during operation.

Project #96 Dancing Motor



Place the fan on the motor (M1) and turn on the slide switch (S1). A song is heard and the fan spins unevenly. The fan speed is being controlled by the music IC (U1).

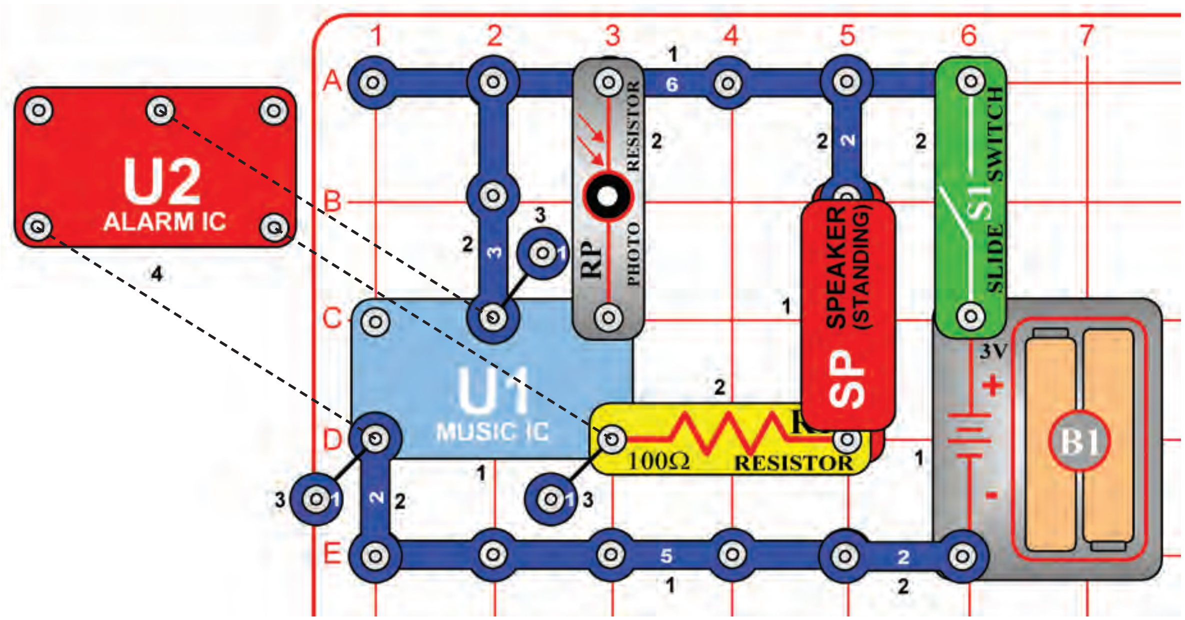
Now push the press switch (S2) to control the motor directly, and the motor spins much faster.

WARNING: Moving parts. Do not touch the fan or motor during operation.

Project #97 Musical Light

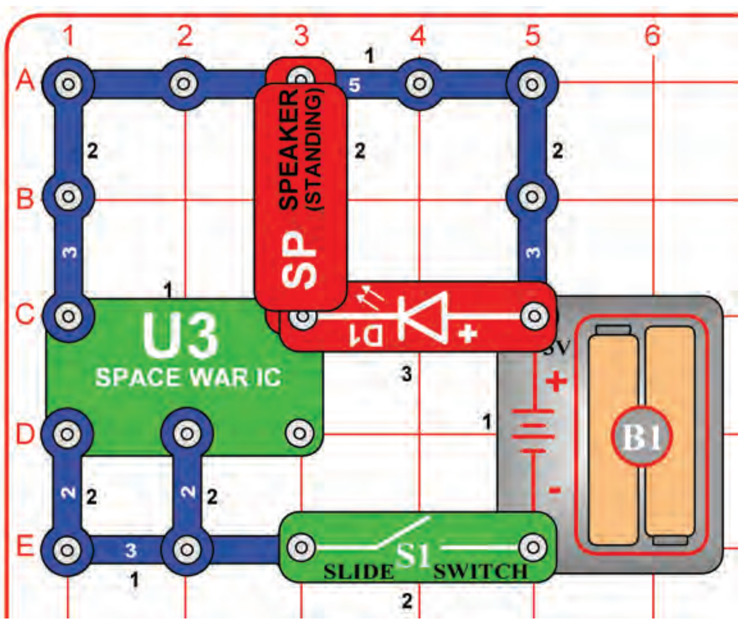
Use the circuit in Project #96. Replace the motor (M1) with the 2.5V lamp (L1). Now the music IC (U1) and press switch (S2) control the lamp brightness.

Project #98 Music Alarm Combo



Build the circuit shown and then place the alarm IC (U2) directly over the music IC (U1), resting on the three 1-snaps. Turn on the slide switch (S1) and you will hear a siren and music together. After a few seconds, covering the photoresistor (RP) will stop the music (but the siren continues).

Project #99 Hit the Target

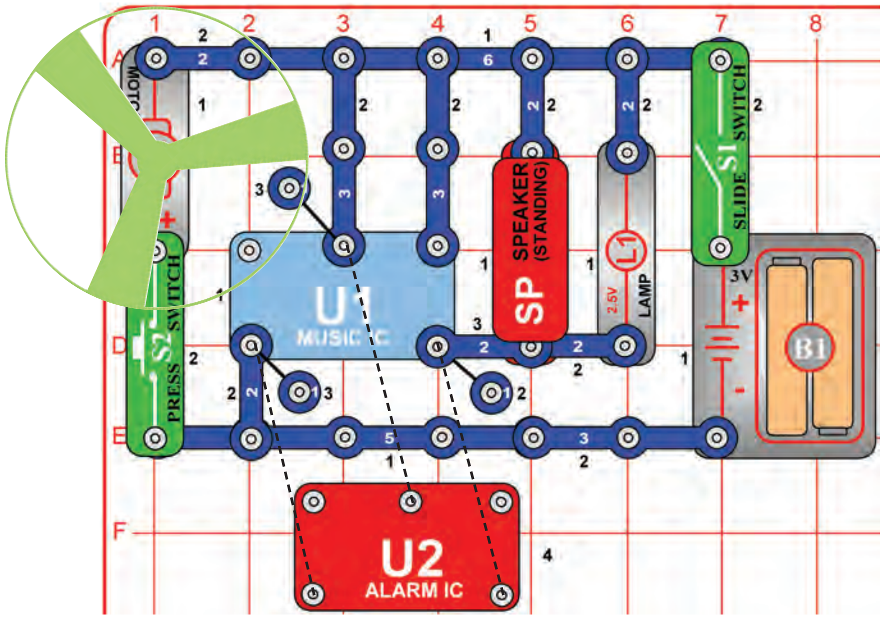


Turn the slide switch (S1) on and you hear the sound of a bomb dropping and then exploding. The LED (D1) lights and then flashes as the bomb explodes. This is one sound generated from the space war IC (U3).

Project #100 Many Missiles

Use the circuit from Project #99. Replace the slide switch (S1) with the motor (M1). Turn the shaft on the motor and now it sounds like a bunch of bombs dropping.

☐ Project #101 — Sing & Fling

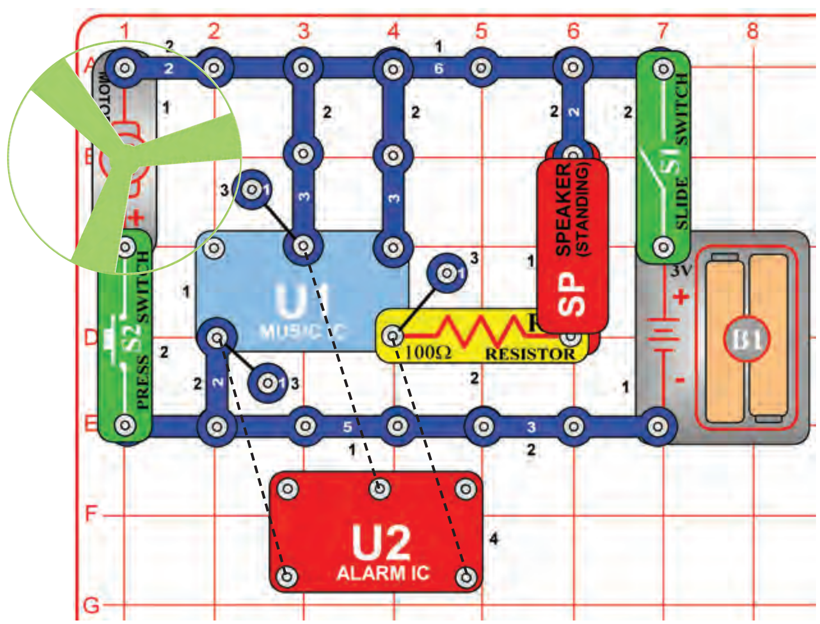


In the circuit, the outputs from the alarm and music ICs are connected together. Build the circuit shown and then place the alarm IC (U2) directly over the music IC (U1), resting on two 1-snaps and a 2-snap. Turn on the slide switch (S1) and you will hear a siren and music together while the lamp (L1) varies in brightness. Push the press switch (S2) and the fan spins, while the sound may not be as loud. The fan may rise into the air when you release the switch.

WARNING: Moving parts. Do not touch the fan or motor during operation.

WARNING: Do not lean over the motor.

☐ Project #102 — Power Pitch



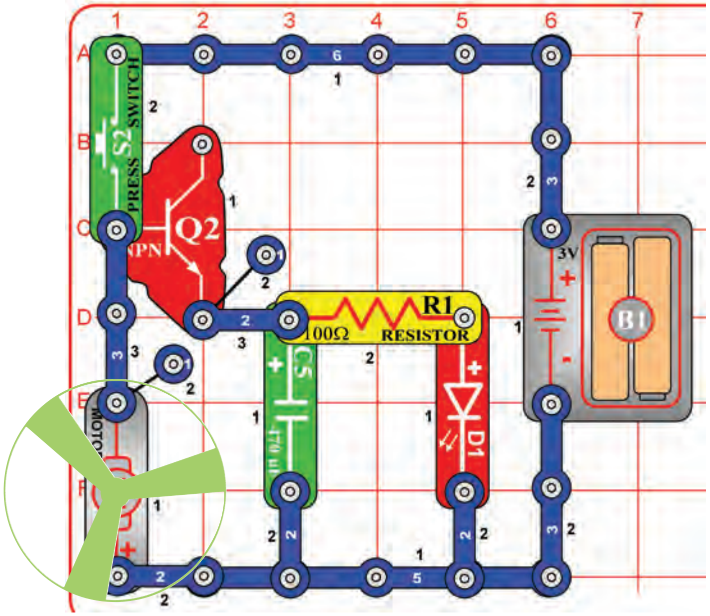
In the circuit, the outputs from the alarm (U2) and music ICs are connected together. Build the circuit shown and then place the alarm IC (U2) directly over the music IC (U1), resting on three 1-snaps. Turn on the slide switch (S1) and you will hear a siren and music together. Push the press switch (S2) and the fan spins, while the sound may not be as loud. The fan may rise into the air when you release the switch.

This circuit is similar to Project #101, but the fan will fly a little higher since the sound circuit no longer drives the lamp (L1) and therefore uses less battery power.

WARNING: Moving parts. Do not touch the fan or motor during operation.

WARNING: Do not lean over the motor.

Project #103 Long Gone Light



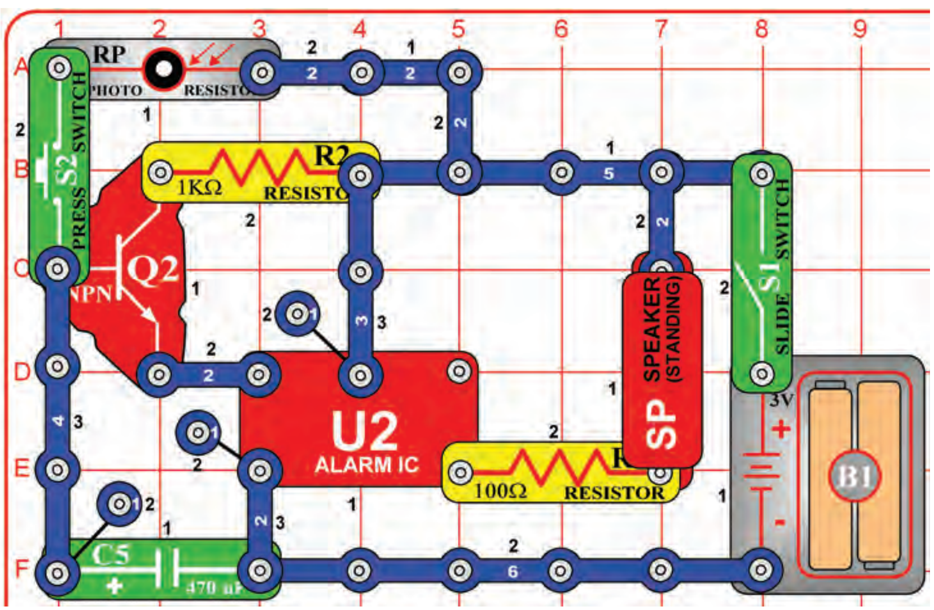
Push the press switch (S2). If the fan is off the motor (M1) (or flies off) then the LED (D1) will be bright.

It takes a lot of current to spin the motor when the fan is on it, and the voltage drops because the batteries (B1) cannot supply enough. When the fan flies off, the current drops and the voltage rises. The NPN transistor (Q2, used here as a diode) and 470μF capacitor (C5) are a detector circuit, which measures the voltage at the motor.

WARNING: Moving parts. Do not touch the fan or motor during operation.

WARNING: Do not lean over the motor.

Project #104 Slow Siren Changer

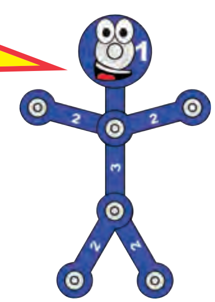


Turn on the slide switch (S1) and you hear a siren sound.

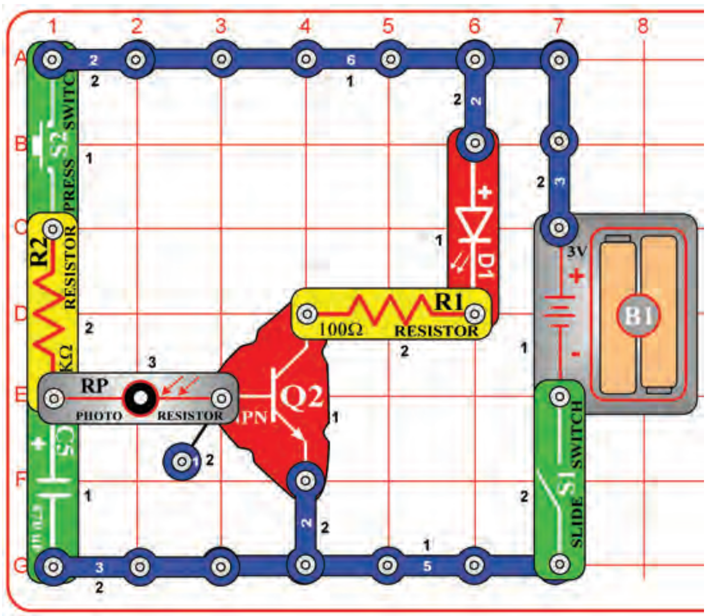
Now hold down the press switch (S2) until the sound becomes a fire engine sound. This delay is due to the 470μF capacitor (C5) charging up and is controlled by the photoresistor (RP). If there is bright light on the photoresistor, then the delay will be only a few seconds.

Release the press switch and after a while the sound will be a siren again. The capacitor slowly discharges through the NPN transistor (Q2).

This circuit demonstrates how capacitors store up energy when S2 is pressed, and then discharge energy when S2 is released.



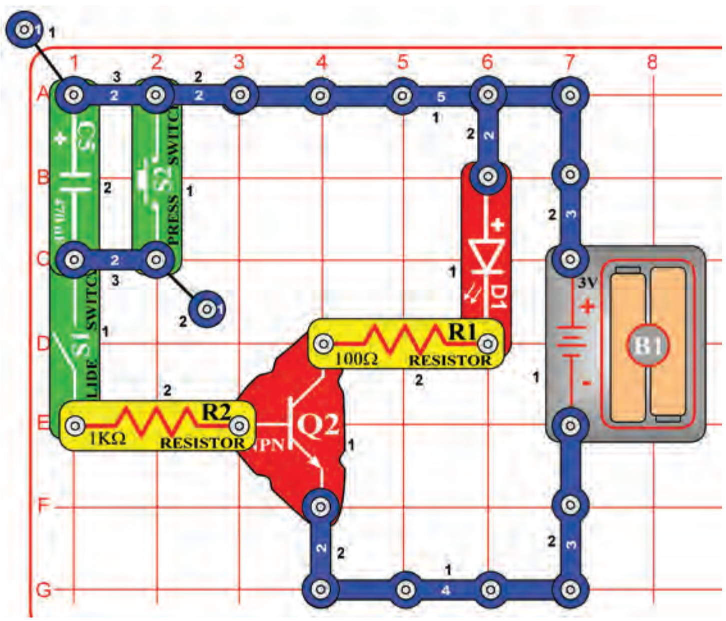
Project #105 The Dark Dimmer



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

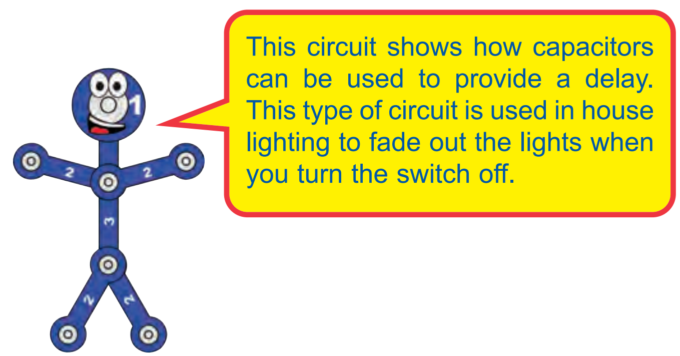
The energy stored in the 470μF capacitor (C5) keeps the controlling current to the NPN transistor (Q2) on even though the press switch was turned off. If it is dark, the high resistance of the photoresistor shuts off the current to the transistor.

Project #106 Lagging Light

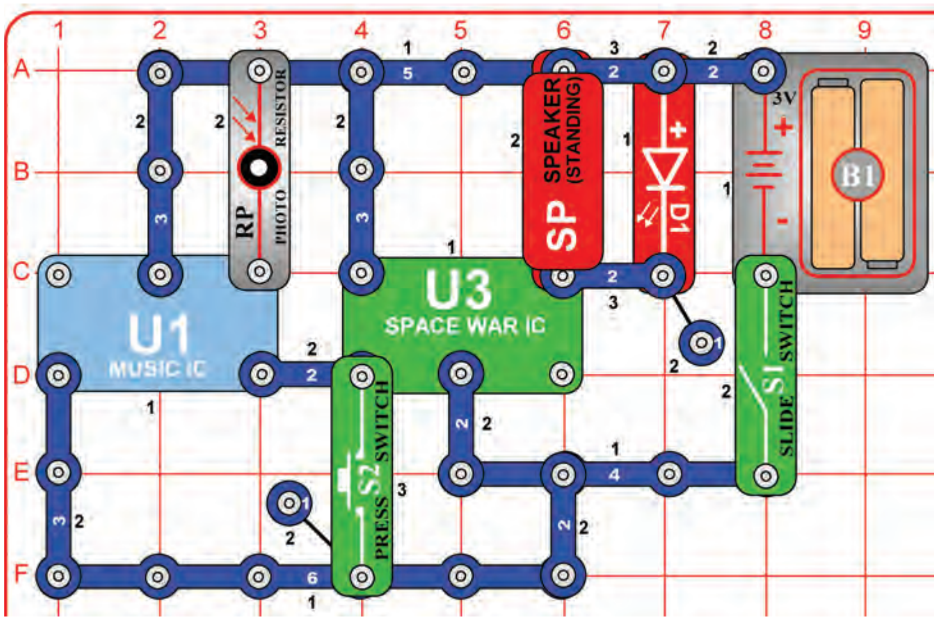


Build the circuit and turn on the slide switch (S1). The LED (D1) is bright but slowly gets dark as the 470μF capacitor (C5) charges up.

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

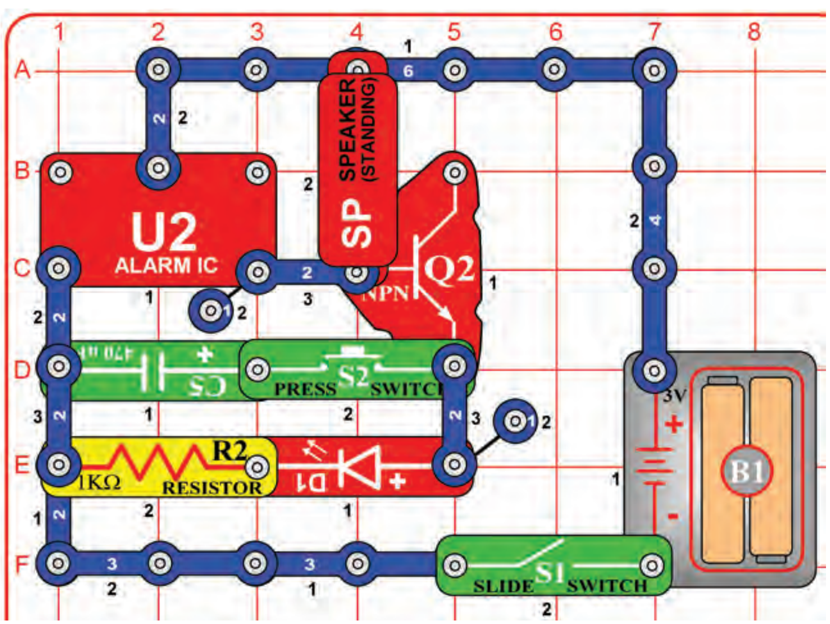


Project #107 Sonic Flasher



Set the slide switch (S1) on, a space war sound plays and the LED (D1) flashes. Cover the photoresistor (RP) and press the press switch (S2) to change the sound. See how many sounds are programmed into the space war sound IC (U3).

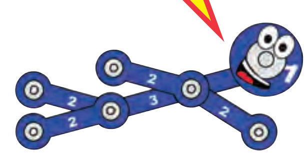
Project #108 Stay or Blink



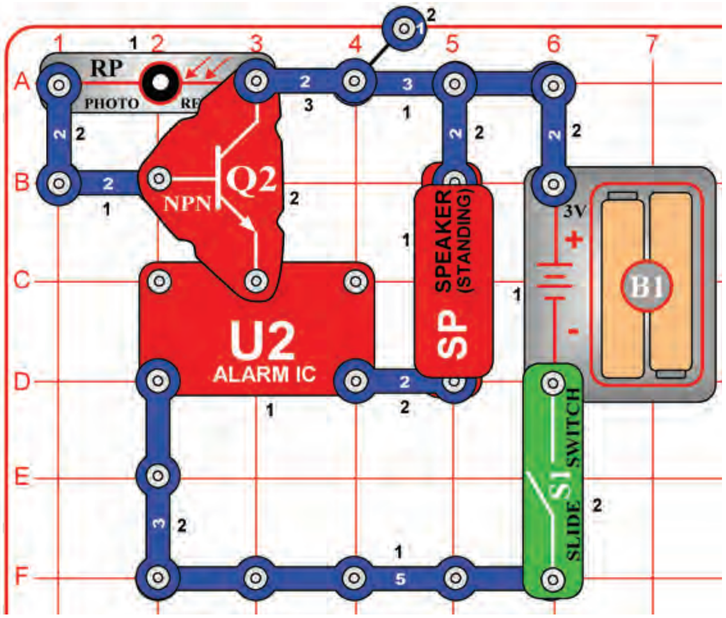
Build the circuit and turn on the slide switch (S1). The LED (D1) is dim, and is actually flashing very quickly, and the speaker (SP) makes a siren sound. Now push the press switch (S2) to connect the 470μF capacitor (C5) to the circuit. The LED is brighter and stops flashing.

The signal from the alarm IC (U2) to the speaker is a changing voltage, which is why the LED was flashing. The 470μF capacitor can store electricity, and it combines with the NPN transistor (Q2) to make a rectifier. A rectifier converts a changing voltage into a constant voltage, so the LED stays on constantly instead of flashing.

Rectifiers are used to convert the AC voltage from the outlets in your house to a DC voltage used by most of the devices in your house.

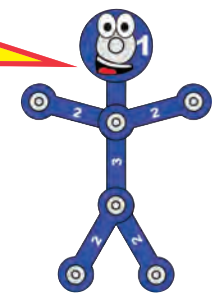


Project #109 Glow & Go

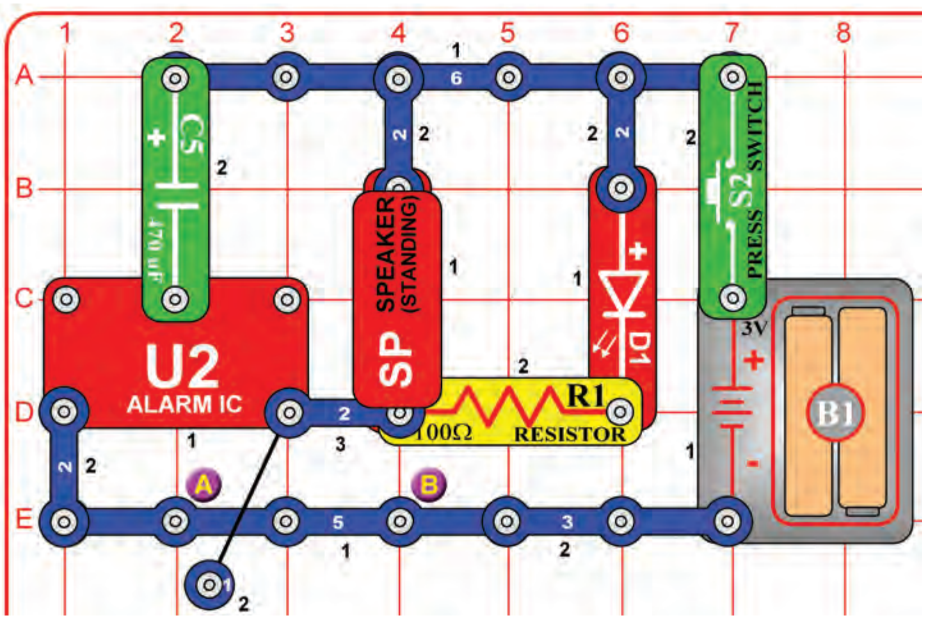


Build the circuit to the left. Turn on the slide switch (S1). The alarm will sound, as long as light is present. Slowly cover the photoresistor (RP), and the volume goes down. If you turn off the lights, the alarm will stop. The amount of light changes the resistance of the photoresistor (less light means more resistance). The photoresistor and NPN transistor (Q2) act like a dimmer switch, adjusting the voltage applied to the alarm.

This type of circuit is used in alarm systems to detect light. If an intruder turned on a light or hit the sensor with a flashlight beam, the alarm would trigger and probably force the intruder to leave.



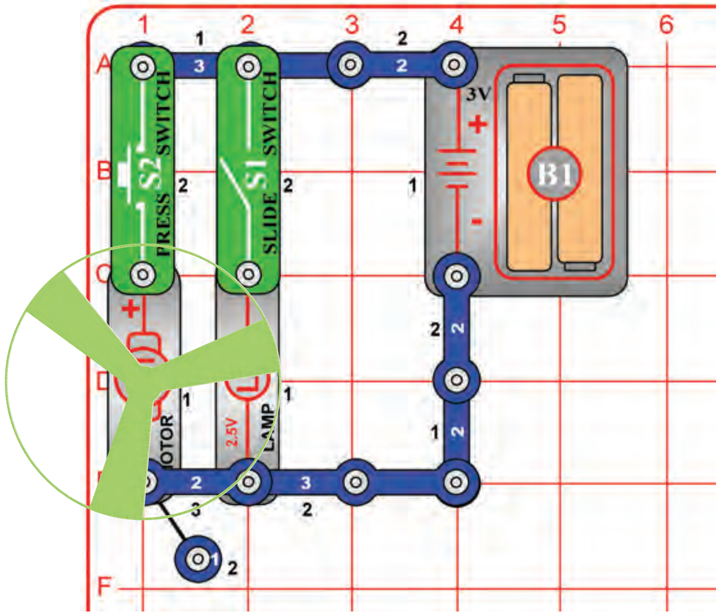
Project #110 Fading Siren



First, place the 470μF capacitor (C5) across points A & B to discharge it. Then build the circuit as shown on the left. Press the switch (S2), the integrated circuit should make the sound of an up-down siren that gets weaker with time. The fading is produced by the charging of the 470μF capacitor (C5). After it is charged, the current stops and the sound is very weak.

To repeat this effect you must release the press switch (S2), remove the capacitor (C5), and discharge it by placing it across the snaps on the bottom bar marked A & B. Then, replace the capacitor (C5) and press the switch again.

☐ Project #111 Light the Motor

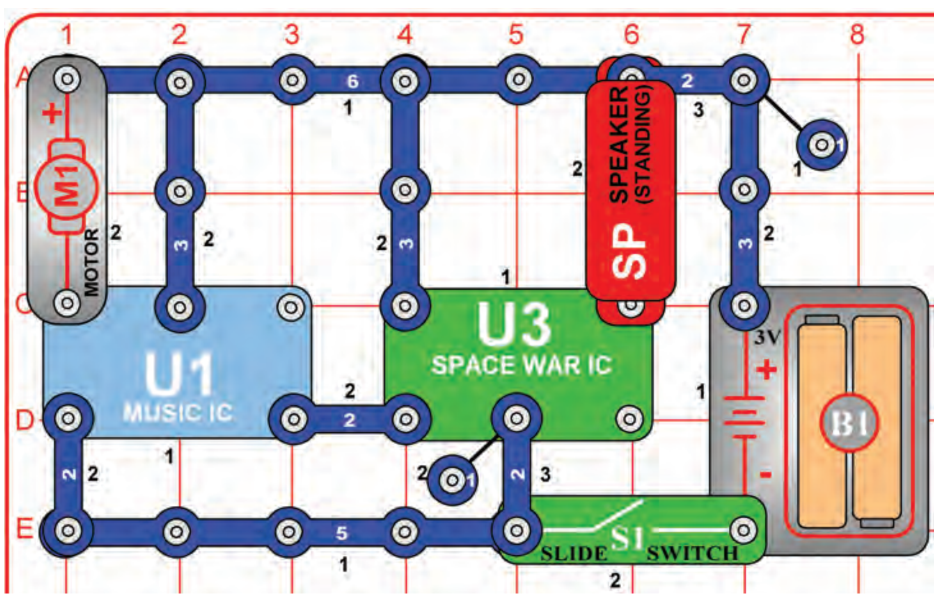


This circuit combines Projects #1, #2, and #10 into one circuit.

Build the circuit and place the fan on the motor (M1). Depending on which of the switches (S1 and S2) are on, you can turn on either the lamp (L1) (Project #1), the motor (M1) (Project #2), or both together (Project #10).

WARNING: Moving parts. Do not touch the fan or motor during operation.

☐ Project #112 Motor Space Sounds



Turn it on and wait for any sounds to stop. Then, spin the motor (M1) and the sounds play again.

Do you know why turning the motor makes the sound play? Actually, the DC motor is also a DC generator and when you turn it, the motor generates a voltage that triggers the sound circuits.

☐ Project #113 Twist & Blink

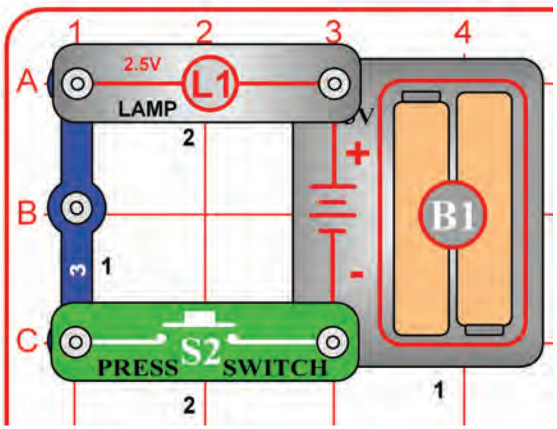
This circuit is loud and may bother other people around you so replace the speaker (SP) with the LED (D1), (position it like in Project #89); the circuit operates in the same manner but now the LED flashes instead of the speaker making sounds.

Project #114 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 below. 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.

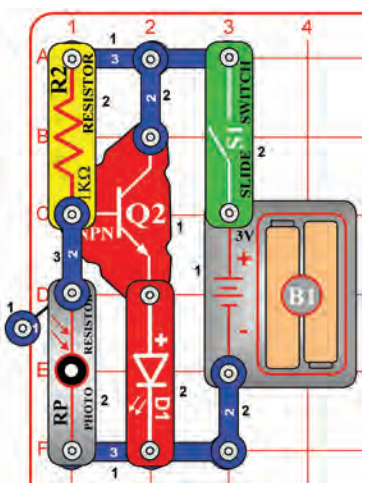


Morse Code: The forerunner of today's telephone system was the telegraph, which was widely used in the latter half of the 19th century. It only had two states - on or off (that is, transmitting or not transmitting), and could not send the range of frequencies contained in human voices or music. A code 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

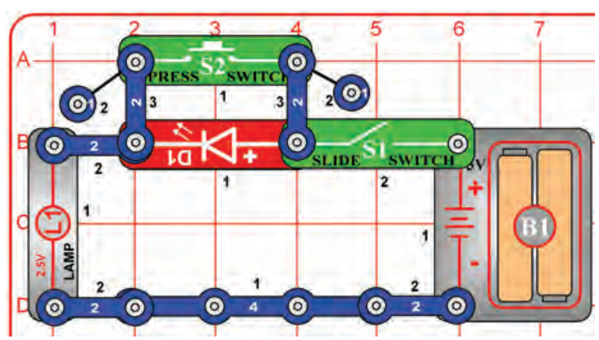
A	._	N	_.	Period	._._._
B	_...	O	___	Comma	__..__
C	_._.	P	.__.	Question	..__..
D	_..	Q	__._	1	.____
E	.	R	._.	2	..___
F	.._.	S	...	3	...__
G	__.	T	_	4	...._
H	....	U	.._	5	.....
I	..	V	..._	6	_....
J	.___	W	.__	7	__...
K	_._	X	_.._	8	___..
L	._..	Y	_.__	9	____.
M	__	Z	__..	0	_____

Project #115 Light to Dark



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 transistor (Q2).

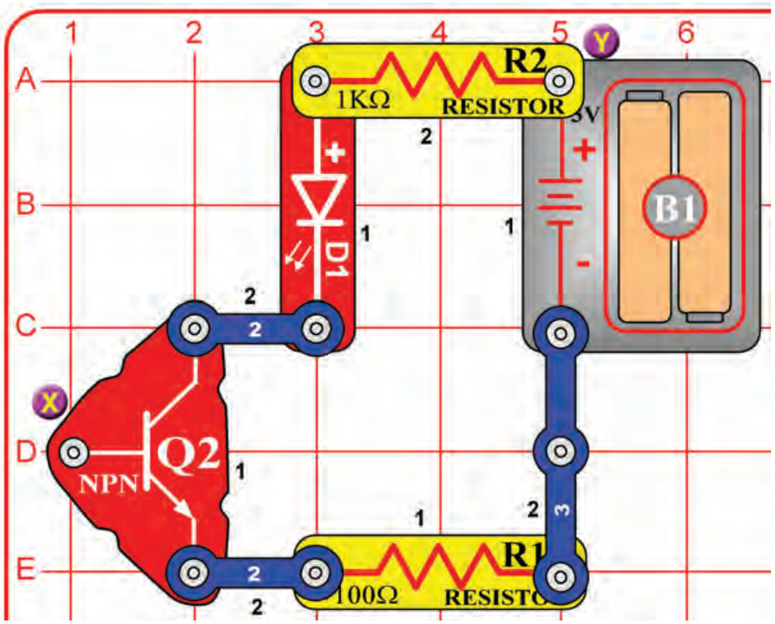
Project #116 Power Shifter



When you turn on the slide switch (S1), the LED (D1) is on and the lamp (L1) is off.

Push the press switch (S2) to bypass the LED. The lamp turns on and the LED turns off. This shows how switches can be used to shift power between different devices.

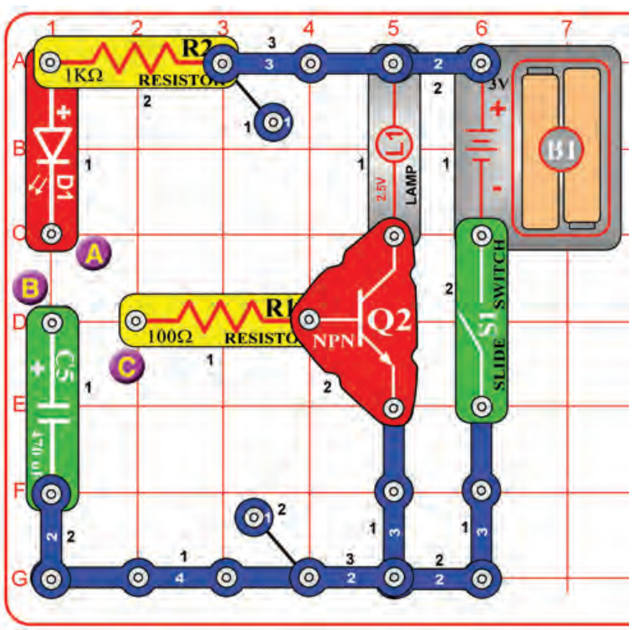
Project #117 Touch of Light



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.

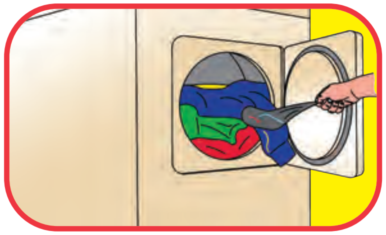
Project #118 Change & Charge



Turn the slide switch (S1) on and connect points A & B with a 2-snap wire. The LED (D1) will flash and the 470μF capacitor (C5) 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 2.5V lamp (L1).

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 (B1). The light will go out after the capacitor discharges, because there is no more current at the base of the transistor.

Project #119 Electricity You Can Wear



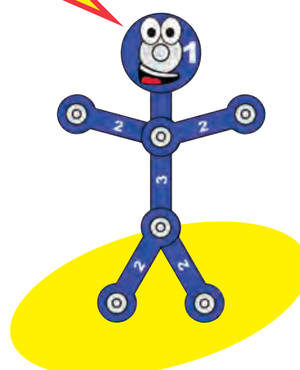
Find some clothes that cling together in the dryer, and try to uncling them.

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

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.

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.

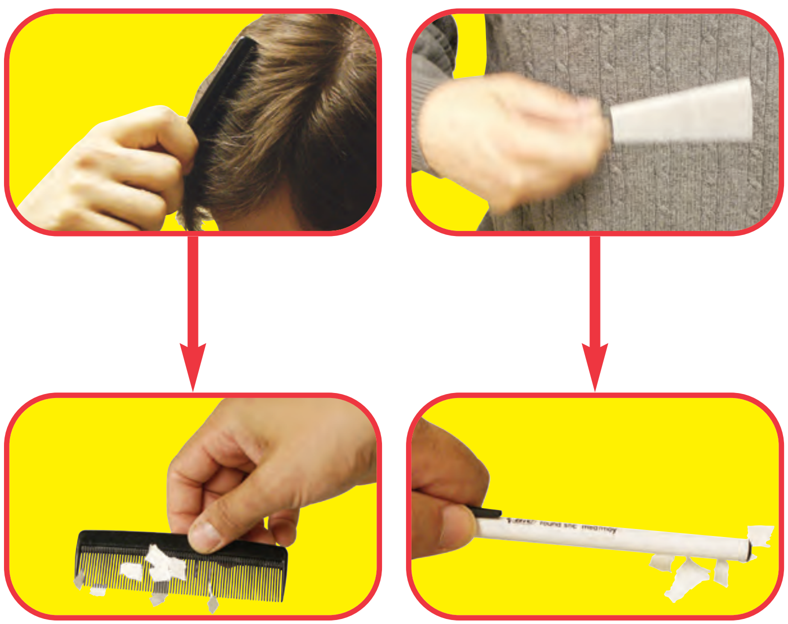
Snappy says: clothes can cling together because electricity is all around us.



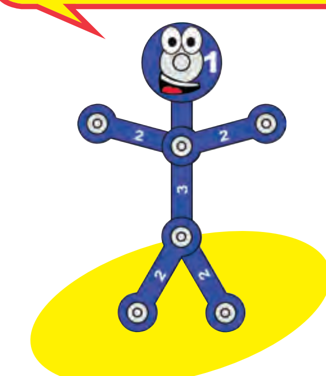
Did you ever wonder why clothes cling together when they come out of the dryer? Did you ever hear a crackling sound when you take off a sweater? (If the room is dark you might even see sparks.) Did you ever feel a “zap” when you touch someone wearing a sweater on a dry day?

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 #120 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.



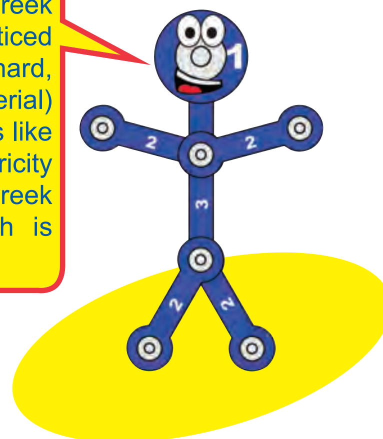
You need a comb (or a plastic ruler) and some paper for this project. Rip up the paper into small pieces. Run the comb through your hair several times then hold it near the paper pieces to pick them up. You can also use a pen or plastic ruler, rub it on your clothes (wool works best).

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 #121 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.



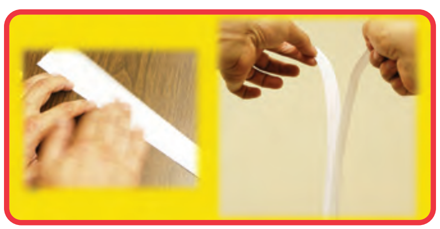
You need a comb (or plastic ruler) and a water faucet for this project. Run the comb through your hair several times then hold it next to a slow, thin stream of water from a faucet. The water will bend towards it. You can also use a plastic ruler. Rub it on your clothes (wool works best).

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 #122 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:

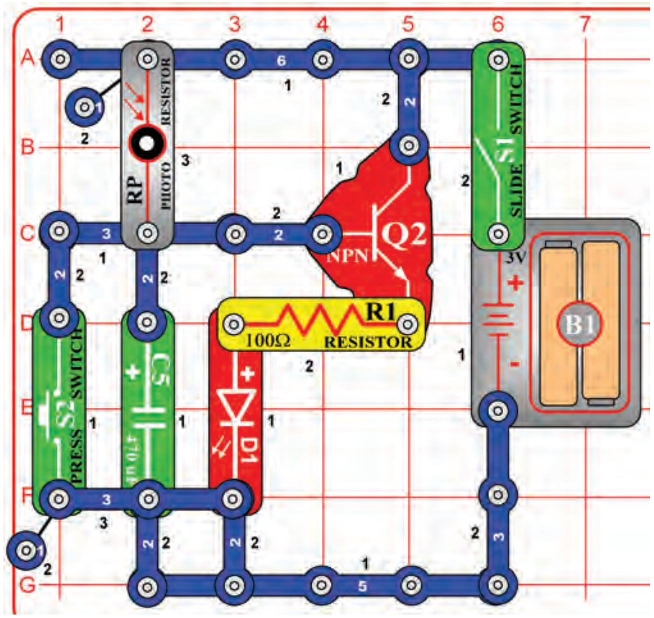
Electricity is immensely more powerful than gravity (gravity is what causes things to fall to the ground when you drop them). However electrical attraction is so completely balanced out that you don't notice it, while gravity's effects are always apparent because they are not balanced out.

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**

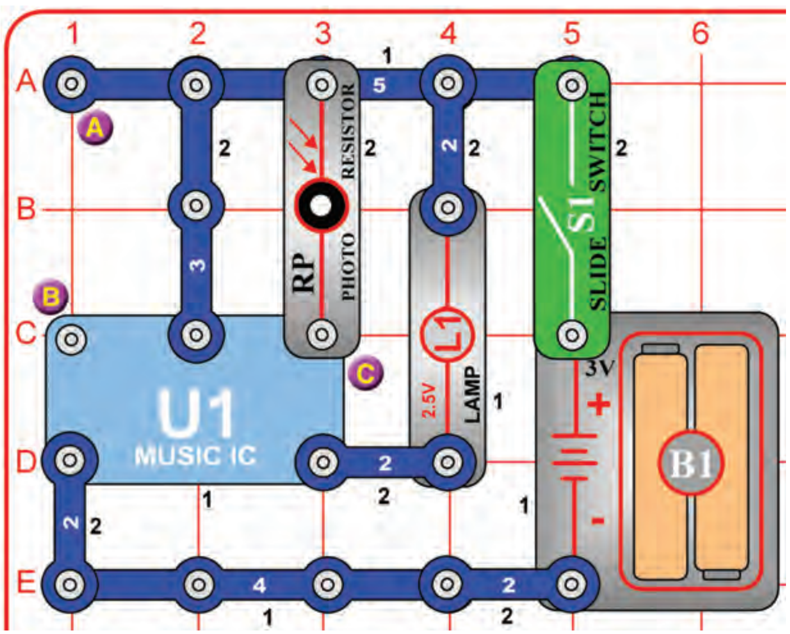
Project #123 Sunrise Light



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. Push the press switch (S2) and reset the circuit.

The resistance of the photoresistor controls how long it takes to charge up the 470μF capacitor (C5). Once the capacitor is charged, current can flow into the NPN transistor (Q2) and turn on the LED. Pushing the press switch discharges the capacitor.

Project #124 Light-controlled Lamp



Build the circuit to the left. Cover the photoresistor (RP), turn the slide switch (S1) on, and notice that the lamp (L1) is off after several seconds. Place the unit near a light and the lamp turns on. Cover the photoresistor again. The lamp turns off. The resistance of the photoresistor decreases as the light increases. The low resistance acts like a wire connecting point C to the positive (+) side of the battery activating the music IC (U1).

Project #125 Motor-controlled Lamp

Use the circuit from Project #124. Remove the photoresistor (RP) and connect the motor (M1) across points A & B. The lamp (L1) lights for a few seconds and then turns off. Turn the slide switch (S1) on and turn the shaft of the motor and the lamp will light. As the motor turns, it produces a voltage. This is because there is a magnet and a coil inside the motor. When the axis turns the magnetic field will change and generate a small current in the coil and a voltage across its terminals. The voltage then activates the music IC (U1).

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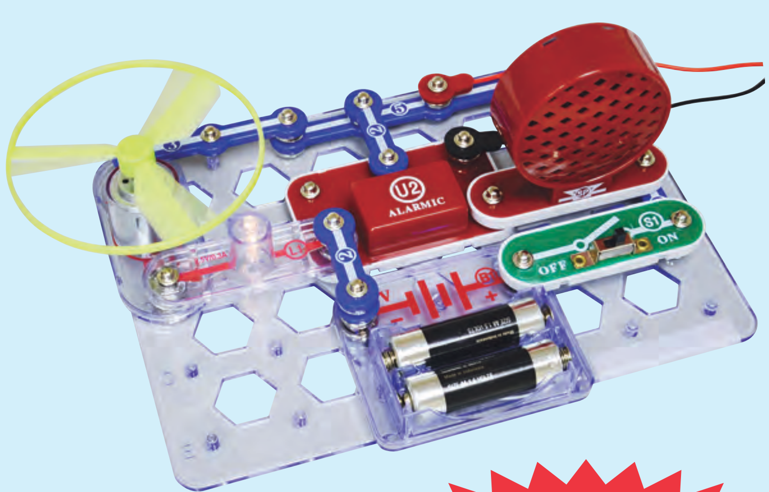

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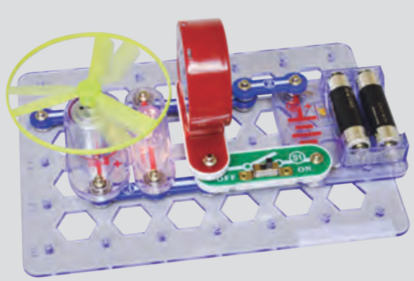
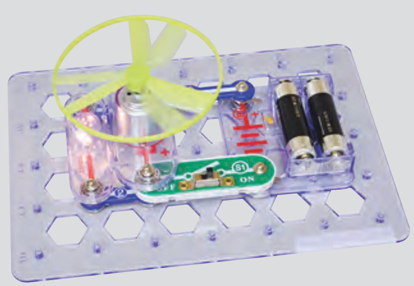


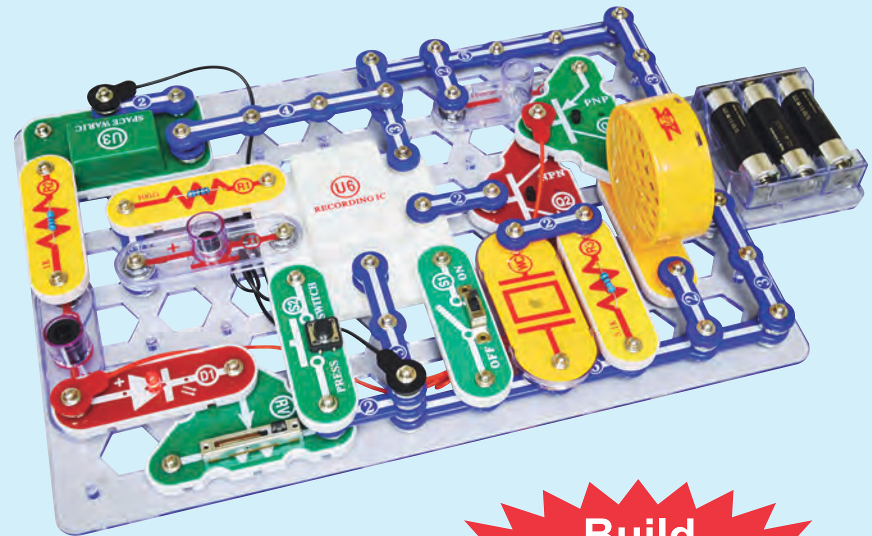
All at Once



Light Fan Launcher

Circuit Maker Sound Plus 200

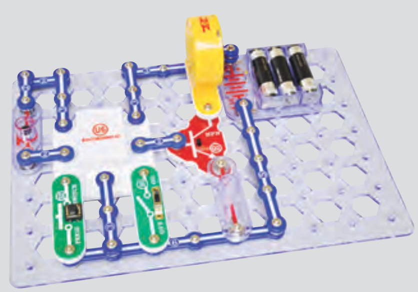
Model CM-200



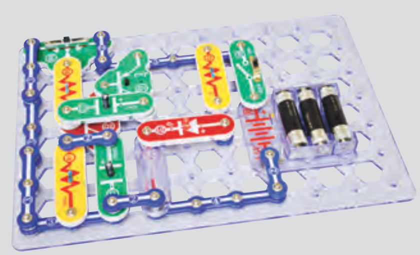
Contains over **40** parts!

Build over **200** unique projects!

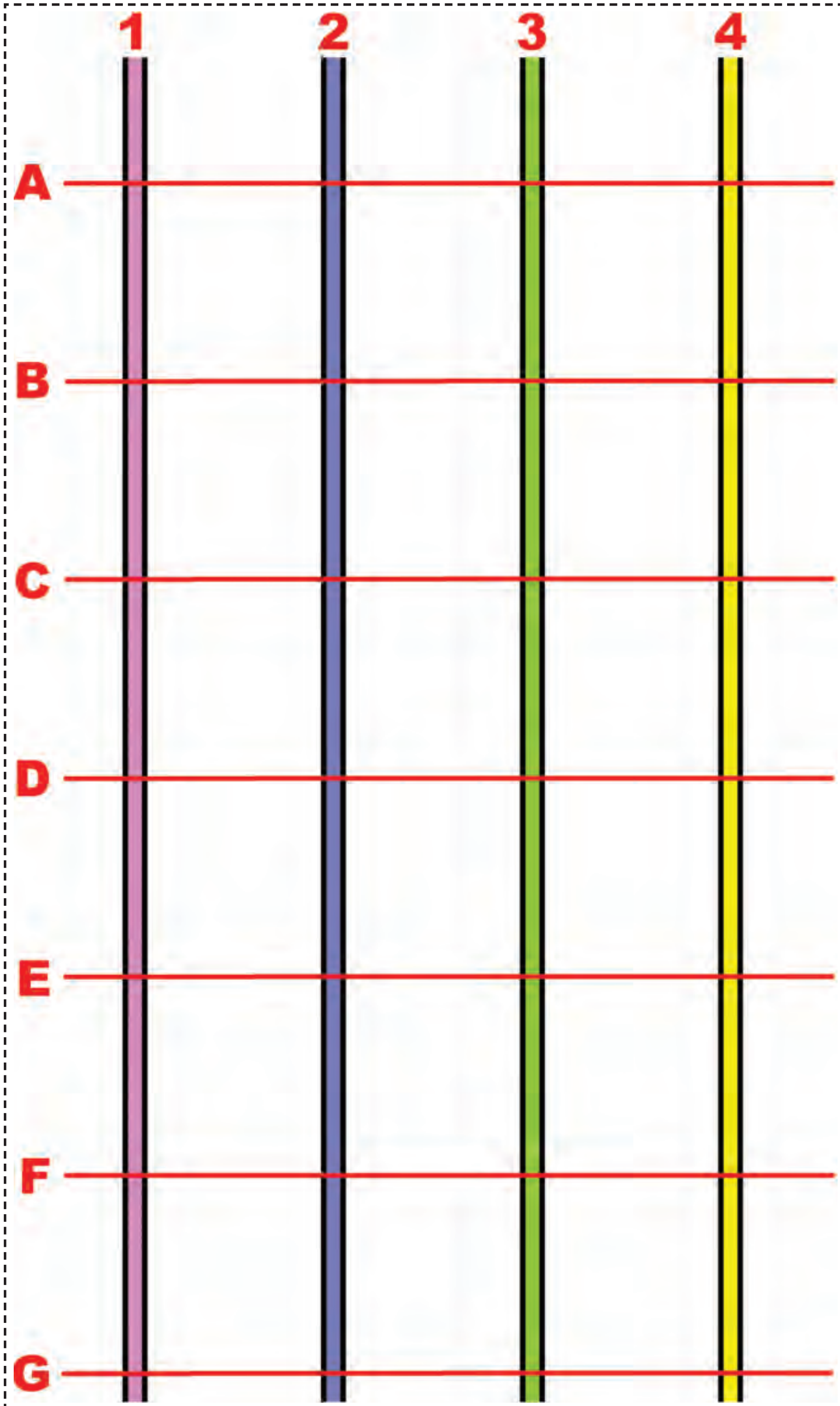
Sample projects



Playback & Record



Synchronized Flasher



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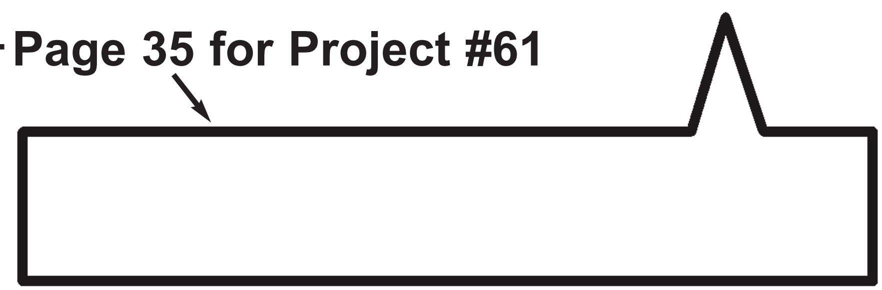

CM-125 Block Layout

Important: If any parts are missing or damaged, **DO NOT RETURN TO RETAILER.**
Call toll-free (800) 533-2441 or e-mail us at: help@elenco.com. Customer Service • 150 Carpenter Ave. Wheeling, IL 60090 U.S.A.

Note: A complete parts list is on page 2 in this manual.