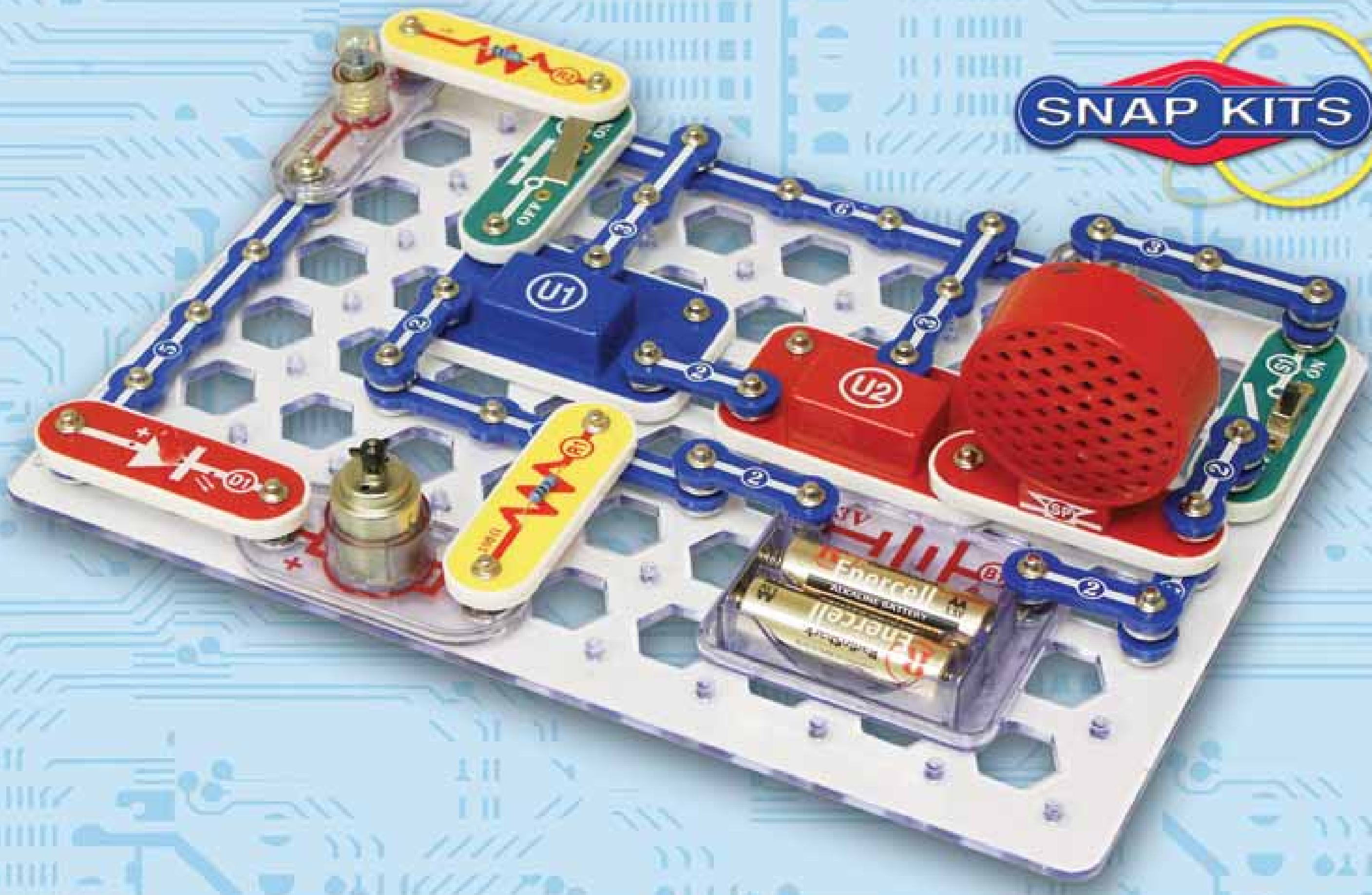
ELECTRONIC SNAP KITS™

Electronics 101



Instruction Manual

Catalog # 28-286 REV-A Revised 2005 753295

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WARNING: SHOCK HAZARD - Never connect Snap Kits™ to the electrical outlets in your home in any way!

Basic Troubleshooting

1. Most circuit problems are due to incorrect assembly, always double-check that your circuit exactly matches the drawing for it.
2. Be sure that parts with positive/negative markings are positioned as per the drawing.
3. Sometimes the light bulbs come loose, tighten them as needed. Use care since glass bulbs can shatter.
4. Be sure that all connections are securely snapped.
5. Try replacing the batteries.
6. If the motor spins but does not balance the fan, check the black plastic piece with three prongs on the motor shaft. Be sure that it is at the top of the shaft.

Radio Shack 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 6 to determine which ones need replacing.

WARNING: Always check your wiring before turning on a circuit. Never touch the motor when it is spinning at high speed. Never leave a circuit unattended while the batteries are installed. Never connect additional batteries or any other power sources to your circuits.

BATTERIES:
Use only 1.5V AA type (not included). Insert batteries with correct polarity. Non-rechargeable batteries should not be recharged. Rechargable batteries should only be charged under adult supervision, and should not be recharged while in the product. 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.

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

Important: If any parts are missing or damaged in shipping, **DO NOT RETURN TO RADIO SHACK**. Call toll-free 1-800-THE-SHACK.

Qty.	ID	Name	Symbol	Part #	Qty.	ID	Name	Symbol	Part #
☐ 1		Base Grid (11.0” x 7.7”)		6SCBG	☐ 1	D1	Red Light Emitting Diode (LED)		6SCD1
☐ 3	1	1-Snap Wire		6SC01	☐ 1	L1	2.5V Lamp Socket 3.2V Bulb (3.2V, 0.2A) R.S. p/n 272-1132		6SCL1 6SCL1B
☐ 6	2	2-Snap Wire		6SC02	☐ 1	B1	Battery Holder - uses 2 1.5V type AA (not included)		6SCB1
☐ 3	3	3-Snap Wire		6SC03	☐ 1	SP	Speaker		6SCSP
☐ 1	4	4-Snap Wire		6SC04	☐ 1	U1	Music Integrated Circuit		6SCU1
☐ 1	5	5-Snap Wire		6SC05	☐ 1	U2	Alarm Integrated Circuit		6SCU2
☐ 1	6	6-Snap Wire		6SC06	☐ 1	U3	Space War Integrated Circuit		6SCU3
☐ 1	C5	470μF Capacitor		6SCC5	☐ 1 ☐ 1	M1	Motor Fan		6SCM1 6SCM1F
☐ 1	S1	Slide Switch		6SCS1	☐ 1	R1	100Ω Resistor		6SCR1
☐ 1	S2	Press Switch		6SCS2	☐ 1	R2	1KΩ Resistor		6SCR2
☐ 1	RP	Photoresistor		6SCRP	☐ 1	Q2	NPN Transistor		6SCQ2

How To Use It

The Radio Shack Snap Kits™ has 101 projects. They are simple to build and understand.

Snap Kits™ uses building blocks with snaps to build the different electrical and electronic circuits in the projects. Each block has a function: there are switch blocks, lamp blocks, battery blocks, different length wire blocks, etc. These blocks are in different colors and have numbers on them so that you can easily identify them. The circuit you will build is shown in color and numbers, identifying the blocks that you will use and snap together to form a circuit.

For Example:

This is the switch block which is green and has the marking (S1) on it.

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.

To build each circuit, you have a power source block number (B1) that need two (2) "AA" batteries (not included with Snap Kits™).

A large clear plastic base grid is included with this kit to help keep the circuit block together. You will see evenly spaced posts that the different blocks snap into. You do not need this base to build your circuits, but it does help in keeping your circuit together neatly. 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.

The 2.5V bulb comes packaged separate from its socket. Install the bulb in the lamp socket (L1) whenever that part is used.

Place the fan on the motor (M1) whenever that part is used, unless the project you are building says not to use it.

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

About Your Snap Kits™ Parts (Part designs are subject to change without notice).

The **base grid** functions like the printed circuit boards found in most electronic products. It is a platform for mounting parts and wires (though the wires are usually “printed” on the board).

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

The **batteries (B1)** produce an electrical voltage using a chemical reaction. This “voltage” can be thought of as electrical pressure, pushing electrical “current” through a circuit. This voltage is much lower and much safer than that used in your house wiring. Using more batteries increases the “pressure” and so more electricity flows.

The **slide switch (S1)** connects (ON) or disconnects (OFF) the wires in a circuit. When ON it has no effect on circuit performance.

The **press switch (S2)** connects (pressed) or disconnects (not pressed) the wires in a circuit, just like the slide switch does.

Resistors, such as **100Ω resistor (R1) and 1KΩ resistor (R2)**, “resist” the flow of electricity and are used to control or limit the electricity in a circuit. (“K” symbolizes 1,000, so R2 is really 1,000Ω). Increasing circuit resistance reduces the flow of electricity.

The **photoresistor (RP)** is a light-sensitive resistor, its value changes from nearly infinite in total darkness to about 1000Ω when a bright light shines on it.

A light bulb, such as in the **2.5V lamp (L1)**, contains a special wire that glows bright when a large electric current passes through it. Voltages above the bulb’s rating can burn out the wire.

The **motor (M1)** converts elecricity into mechanical motion. 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. If a large electric current flows through the loops the magnetic effects become concentrated enough to move a small magnet. The motor has a magnet on a shaft so, as the electricity moves the magnet, the shaft spins.

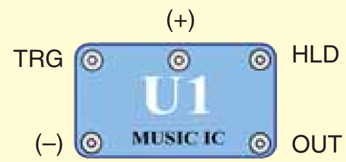
The **speaker (SP)** converts electricity into sound. It does this by using the energy of a changing electrical signal to create mechanical vibrations (using a coil and magnet similar to that in the motor), these vibrations create variations in air pressure which travel across the room. You “hear” sound when your ears feel these air pressure variations.

Capacitors, such as the **470μF capacitor (C5)**, are components that can store electrical pressure (voltage) for periods of time. Because of this storage ability they block unchanging voltage signals and pass fast changing voltages.

The **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 the LED, so the current must be limited by other components in the circuit. LEDs block electricity in the “reverse” direction.

Transistors, such as **NPN transistor (Q2)**, are components that use a small electric current to control a large current. They are used in switching, amplifier, and buffering applications. A high current may damage a transistor, so the current must be limited by other components in the circuit.

Some types of electronic components can be super-miniaturized, allowing many thousands of parts to fit into an area smaller that your fingernail. These “integrated circuits” (ICs) are used in everything from simple electronic toys to the most advanced computers. The music, alarm, and space war ICs (U1, U2, and U3) in Snap Kits 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:

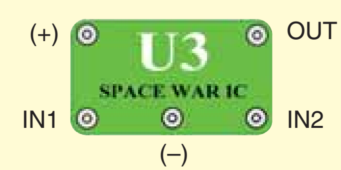
(+) - power from batteries
(–) - power return to batteries
OUT - output connection
HLD - hold control input
TRG - trigger control input

Music for ~20 sec on power-up, then hold HLD to (+) power or touch TRG to (+) power to resume music.

Alarm IC:

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:

(+) - 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.

DO's 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, lamp, motor, 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 below) 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. **Radio Shack 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.

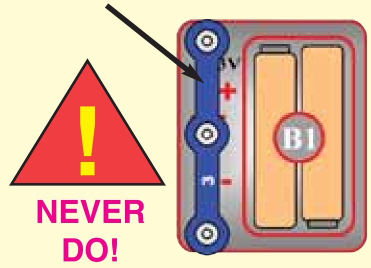
NEVER leave a circuit unattended when it is turned on.

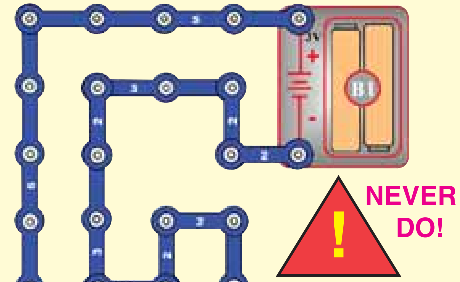
NEVER touch the motor when it is spinning at high speed.

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.

Examples of SHORT CIRCUITS - NEVER DO THESE!!!

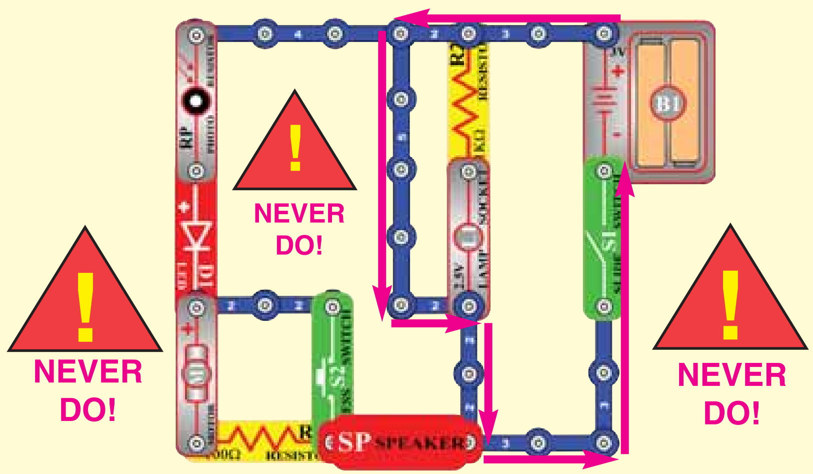
Placing a 3-snap wire directly across the batteries is a SHORT CIRCUIT.





This is also a SHORT CIRCUIT.

When the 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.



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

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

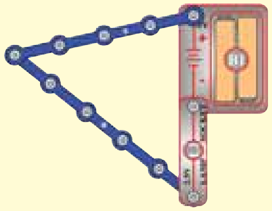
Advanced Troubleshooting (Adult supervision recommended)

Radio Shack 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 and install bulb in lamp socket. 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 batttery holder contacts, you should hear static as it touches. If none work then replace your batteries and repeat, if still bad then the battery holder is damaged.

2. **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 #7 except initially use the speaker (SP) in place of the LED, you will hear static if the resistor is good. Then replace the speaker with the LED and see that it lights. Then replace the 100Ω resistor with the 1KΩ resistor; the LED should light but not as brightly.

5. **Alarm IC (U2):** Build project #17, 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 3rd sound.

6. **Music IC (U1):** Build project #74 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 #19, both switches (S1 and S2) should change the sound. Then replace either switch with the photoresistor, waving your hand over it should change the sound.

8. **NPN transistor (Q2):** Build project #27. When both switches are on, the lamp lights and motor spins. If one switch is off, nothing happens.

9. **470μF capacitor (C5):** Build project #46, then press and release the switch. The LED should go off slowly.

For more information, contact:

Radio Shack Corporation

Fort Worth, TX 76102

Call us at

1-800-THE-SHACK

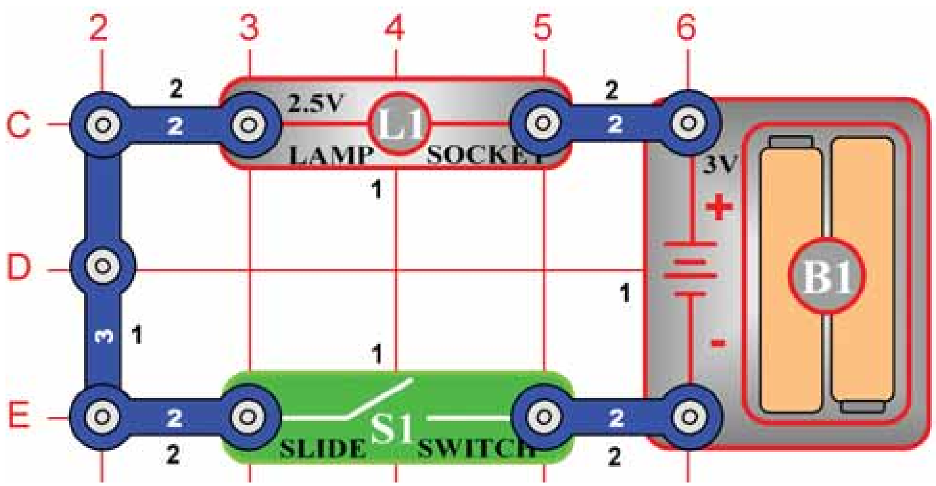
or visit us online at

www.radioshack.com

Project Listings

☐ Project #1 Electric Light & Switch

OBJECTIVE: To show how electricity is turned "ON" or "OFF" with a switch.

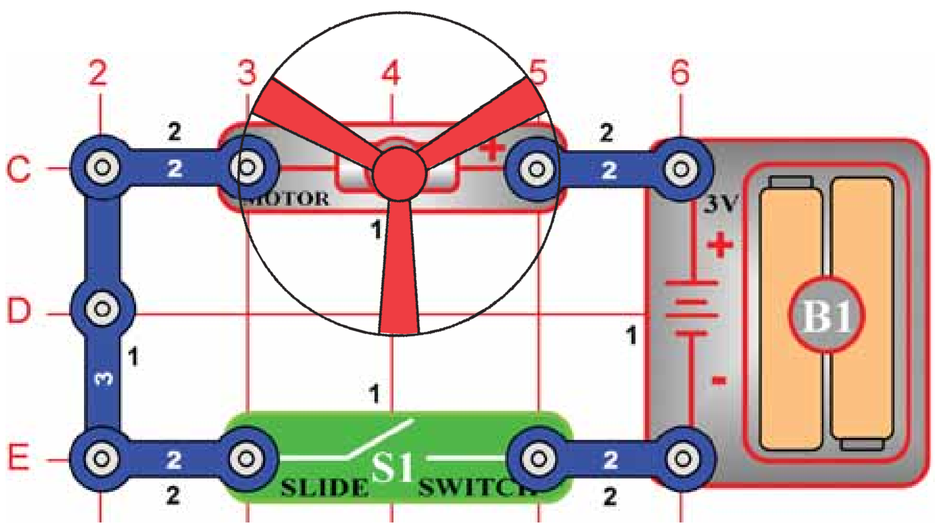


Build the circuit shown on the left by placing all the parts with a black 1 next to them on the board first. Then, assemble parts marked with a 2. Install two (2) "AA" batteries (not included) into the battery holder (B1) and screw the bulb into the lamp socket (L1) if you have not done so already.

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

☐ Project #2 DC Motor & Switch

OBJECTIVE: To show how electricity is used to run a direct current (DC) motor.



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

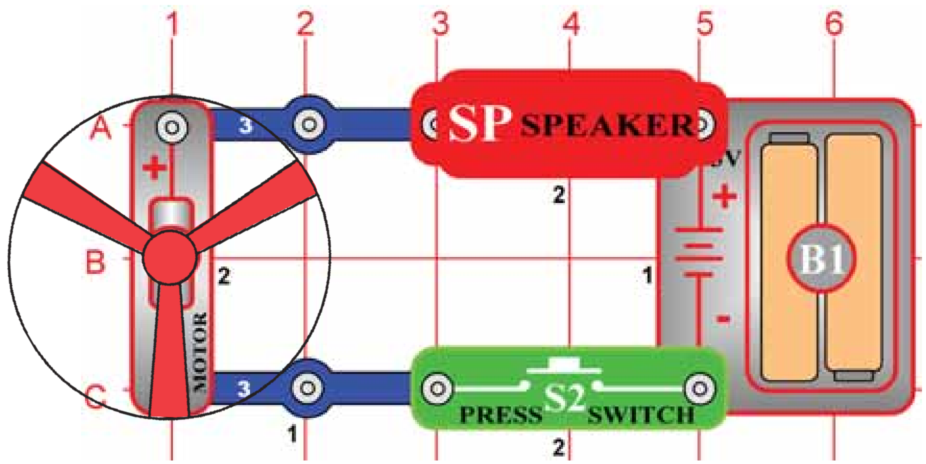
When you close the switch (S1), current flows from the batteries through the motor making it rotate. Place the fan blade on the motor shaft and close the slide switch (S1). The motor will rotate forcing the fan blade to move air past the motor.

In this project, you changed electrical power into mechanical power. DC motors are used in all the battery powered equipment requiring rotary motion, such as a cordless drill, electric tooth brush, and toy trains that run on batteries just to name a few. An electric motor is much easier to control than gas or diesel engines.

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

Project #3 — Hear the Motor

OBJECTIVE: To show how a motor works.



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

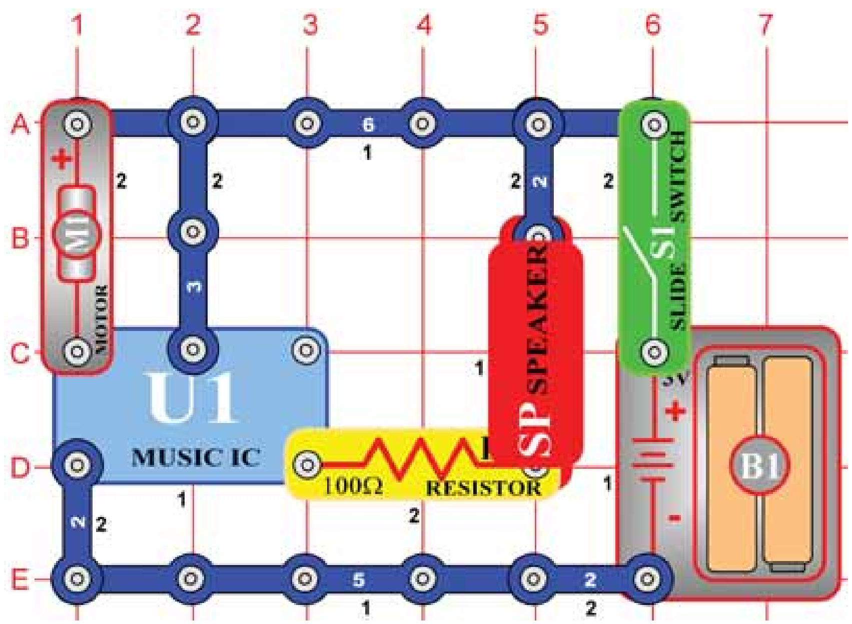
A motor uses magnetism to convert electrical energy into mechanical spinning motion. As the motor shaft spins around it connects/disconnects several sets of electrical contacts to give the best magnetic properties. As these contacts are switched, an electrical disturbance is created, which the speaker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

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

Project #4 — Adjusting Sound Level

OBJECTIVE: To show how resistance can change the sound from the speaker.



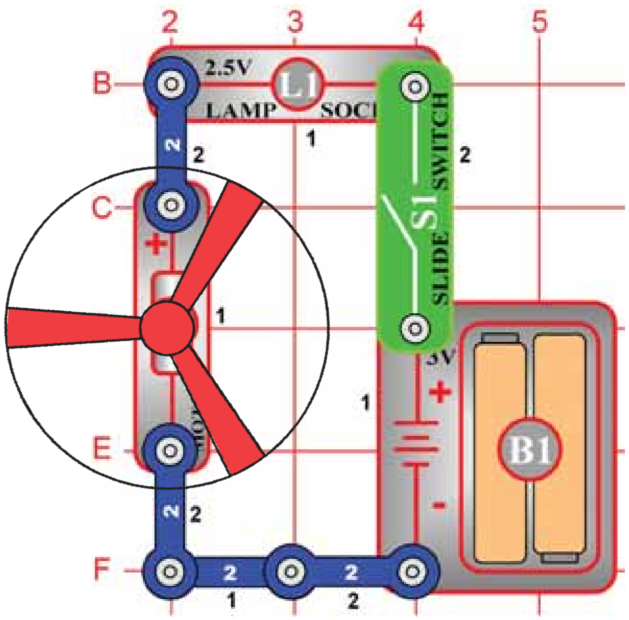
Build the circuit shown on the left, but leave the fan off the motor (M1). When you close the slide switch (S1), the music may play for a short time and then stop. After the music has stopped, spin the motor with your fingers. The music should play again for a short time, then stop.

Now replace the 100Ω resistor 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 and increased the sound output of the speaker. Resistors are used throughout electronics to limit the amount of current that flows.

☐ Project #5

Lamp & Fan in Series



OBJECTIVE: To show how a lamp can indicate when a fan is running.

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. Finally, place the fan blade on the motor.

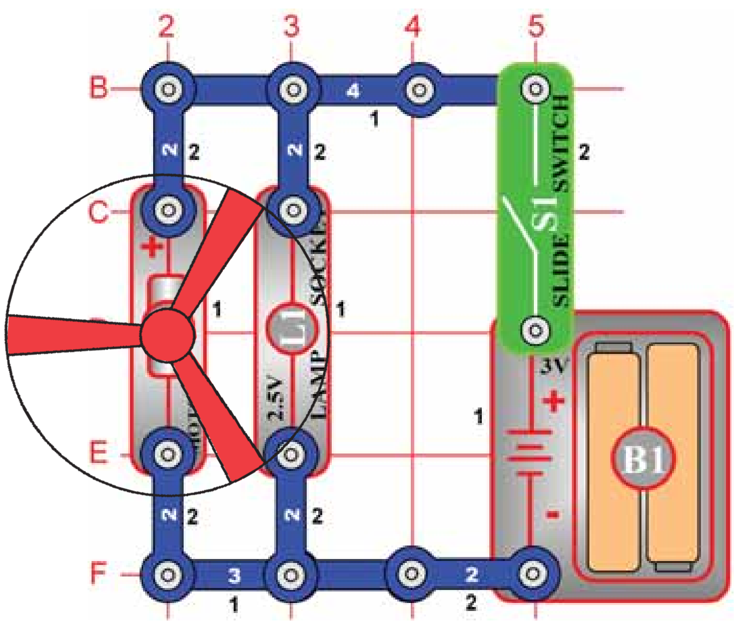
When you close the slide switch (S1), the fan will spin and the light should turn on. The fan will take a while to start turning due to inertia. Inertia is the property that tries to keep a body at rest from moving and tries to keep a moving object from stopping.

The light helps protect the motor from getting the full voltage when the switch is closed. Part of the voltage goes across the light and the rest goes across the motor. Remove the fan and notice how the light 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 #6

Lamp & Fan in Parallel



OBJECTIVE: To show how an indicator light can be connected without affecting the current in the motor.

Build the circuit shown on the left.

When you close the slide switch (S1), both the fan and the light 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. The motor should start a little faster than in project #5.

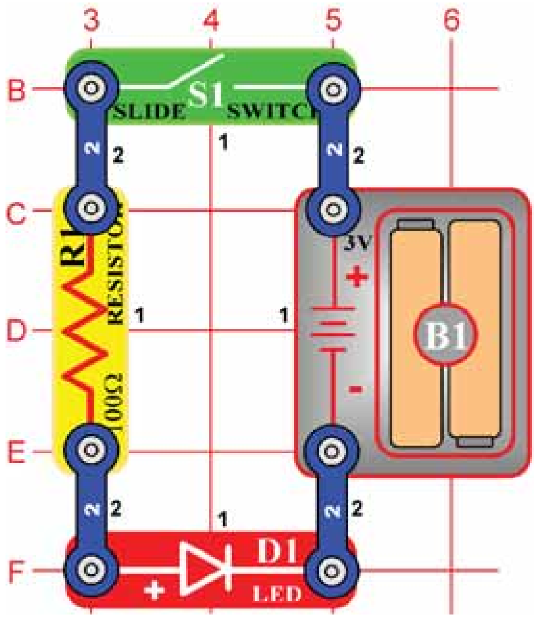
Remove the fan and notice how the light does not change in brightness as the motor picks up speed. It has its own path to the battery.

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

☐ Project #7

Light Emitting Diode

OBJECTIVE: To show how a resistor and LED are wired to emit light.



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

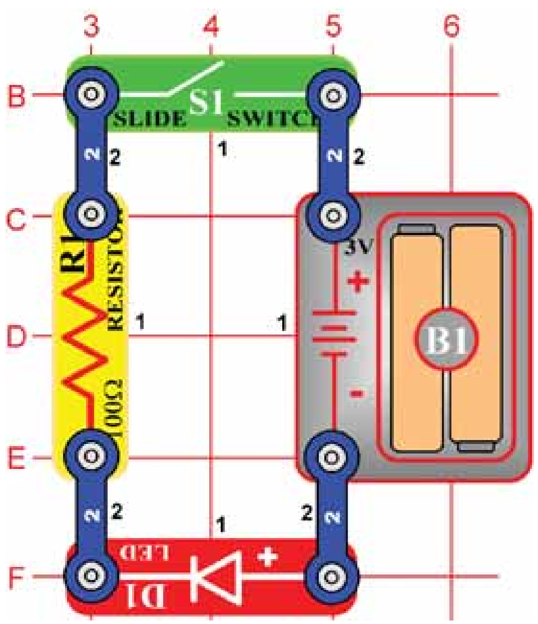
When you close the slide switch (S1), current flows from the batteries through the switch, through the resistor, through the LED (light emitting diode) and back to the battery. The closed switch completes the circuit. The resistor limits the current and prevents damage to the LED. NEVER PLACE AN LED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

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

☐ Project #8

One Direction for LED

OBJECTIVE: To show how electricity can only pass in one direction through an LED.



Rebuild the circuit used in project #7 but put the LED in as shown on the left.

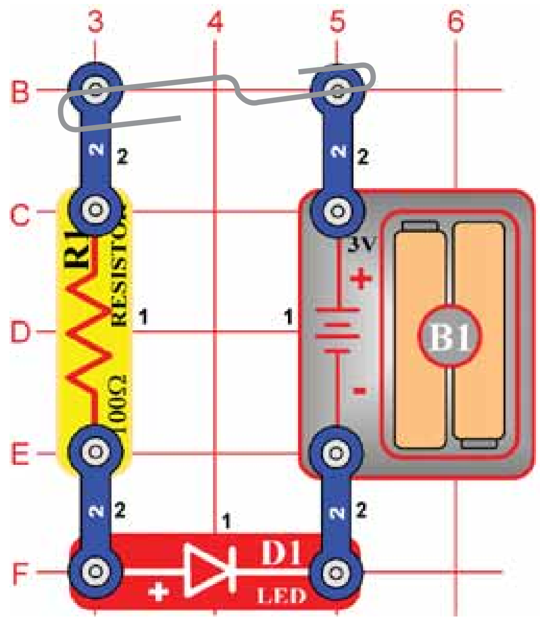
When you close the slide switch (S1), current should flow from the batteries through the resistor and then through the LED. When current flows through an LED, it lights up. Since the LED is in backwards, current cannot flow. The LED is like a check valve that lets current flow in only one direction.

In this project, you changed the direction for current through the LED. 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 #9

Conduction Detector

OBJECTIVE: To make a circuit that detects the conduction of electricity in different materials.



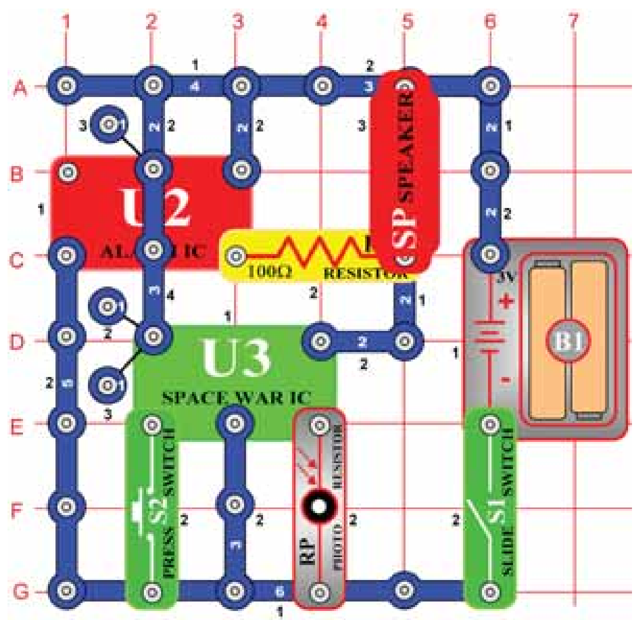
Rebuild the circuit from project #7 but leave the on-off switch out as shown on the left.

When you place a paper clip across the terminals as shown in the picture on the left, current flows from the batteries through the resistor, through the LED, and back to the battery. The paper clip completes the circuit and current flows through the LED. Place your fingers across the terminals and the LED does not light. Your body is too high of a resistance to allow enough current to flow to light the LED. If the voltage, which is electrical pressure, was higher, current could be pushed through your fingers and the LED would light. This detector can be used to see if a material like plastic is a good conductor or a poor conductor.

☐ Project #10

Space War Alarm Combo

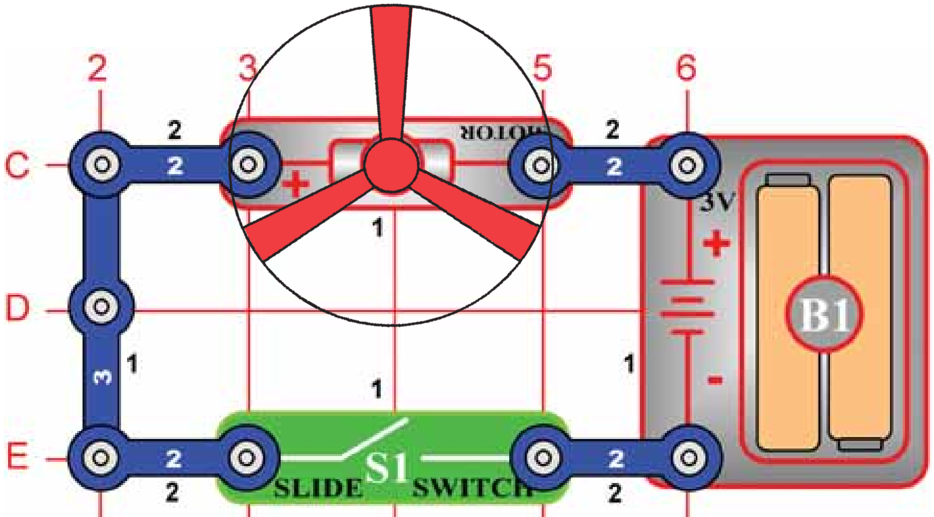
OBJECTIVE: To combine the sounds from the space war and alarm integrated circuits.



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 louder by replacing the 100Ω resistor (R1) with the 2.5V lamp (L1).

Project #11 Flying Saucer

OBJECTIVE: To make a circuit that launches the fan blade to simulate a flying saucer.



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

WARNING: Do not lean over the motor.

Rebuild the circuit from project #2, but reverse the polarity on the motor so the negative (–) on the motor goes to the positive (+) on the battery.

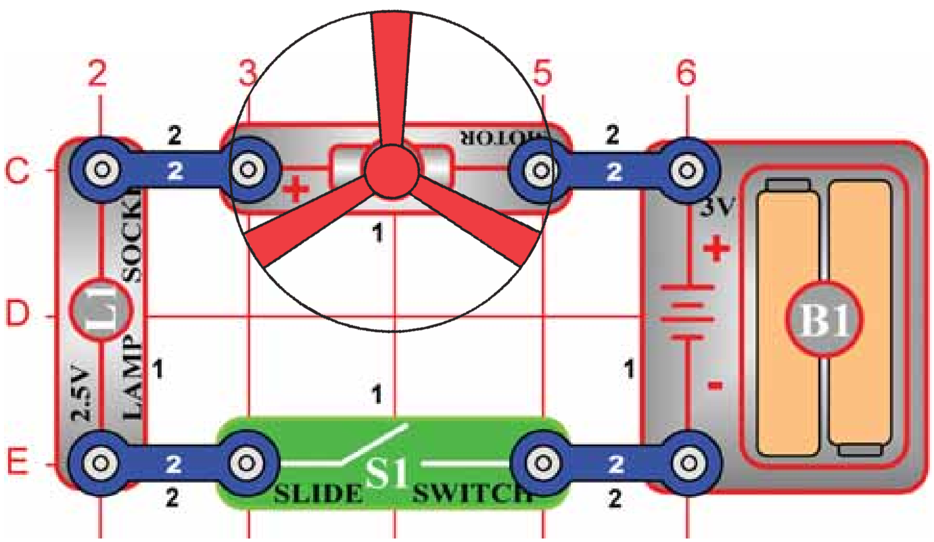
When you close the slide switch (S1), the motor will slowly increase in speed. When the motor has reached maximum rotation, turn the slide switch (S1) off. The fan blade should rise and float through the air like a flying saucer. Be careful not to look directly down on fan blade when it is spinning.

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 motor shaft because it does not have enough lift to propel it. The motor will spin faster when both batteries are new.

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

Project #12 Decreasing Saucer Lift

OBJECTIVE: To show how voltage affects speed of a DC motor and can decrease the lift of the saucer.



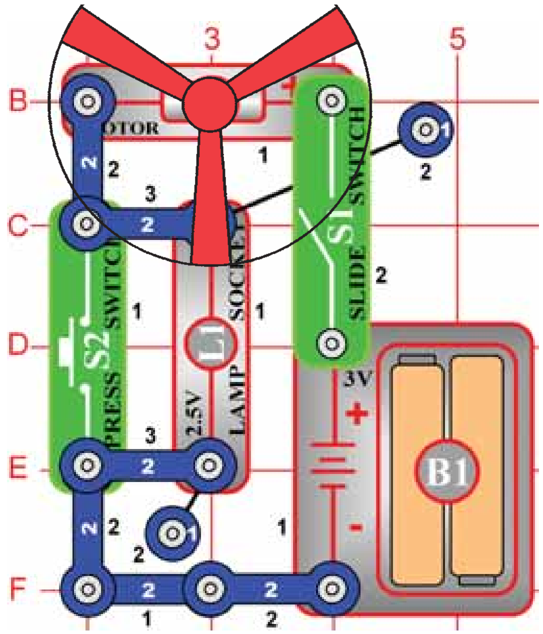
Change the circuit in project #11 by adding the lamp (L1) in series with the motor as shown in the diagram on the left.

When you place the lamp in series with any electronic device, it will draw less current because it adds resistance. In this case, the lamp in series reduces the current through the motor, and that reduces the top speed of the motor. Close the slide switch (S1), and wait until the fan reaches maximum speed. Open the switch and observe the difference in the height due to the lamp. In most cases, it may not even launch.

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

WARNING: Do not lean over the motor.

Project #13 Two-Speed Fan



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

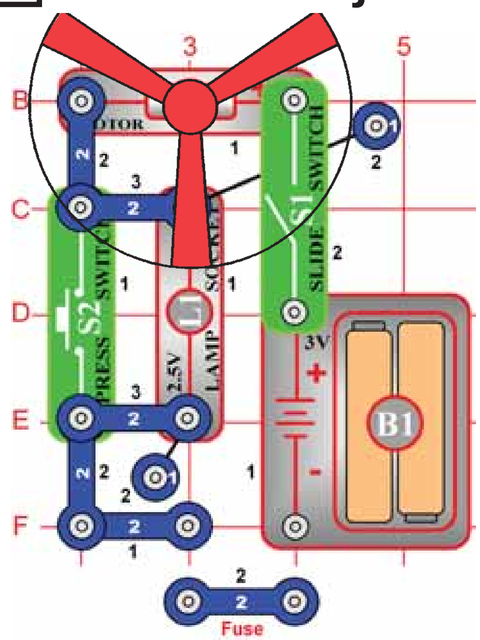
OBJECTIVE: To show how switches can increase or decrease the speed of an electric fan.

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 for level 2. Finally, add the 2-snap wires that are marked for level 3.

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 #14 The Fuse



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

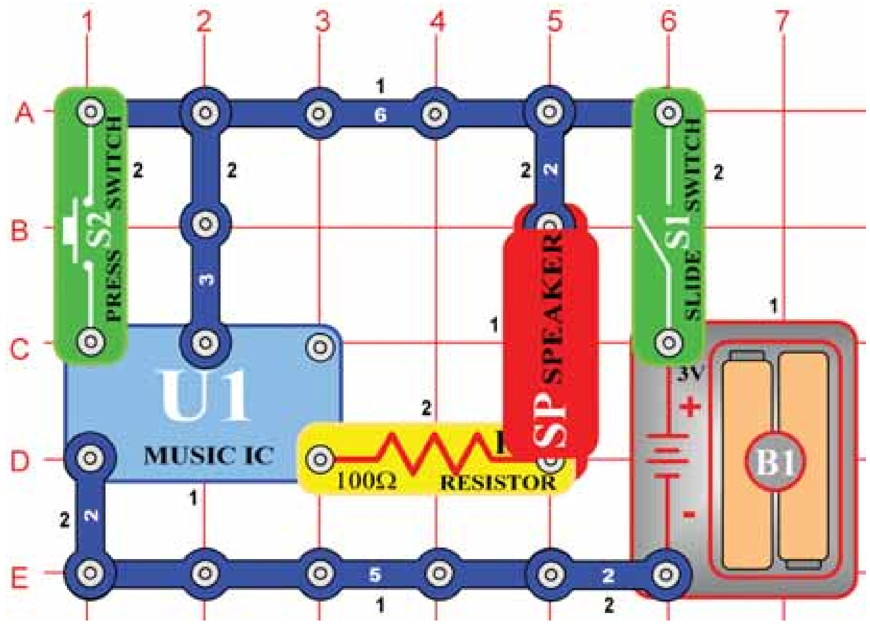
OBJECTIVE: To show how a fuse is used to break all current paths back to the voltage source.

Use the circuit built in project #13.

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 #15 — Musical Doorbell

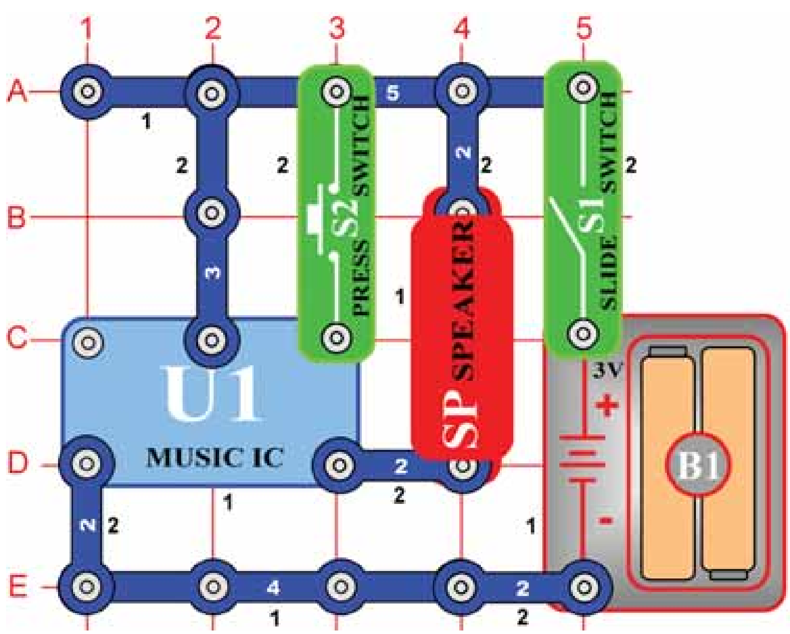


OBJECTIVE: To show how an integrated circuit can be used as a musical doorbell.

Build the circuit shown on the left. When you close 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 #16 — Momentary Alarm

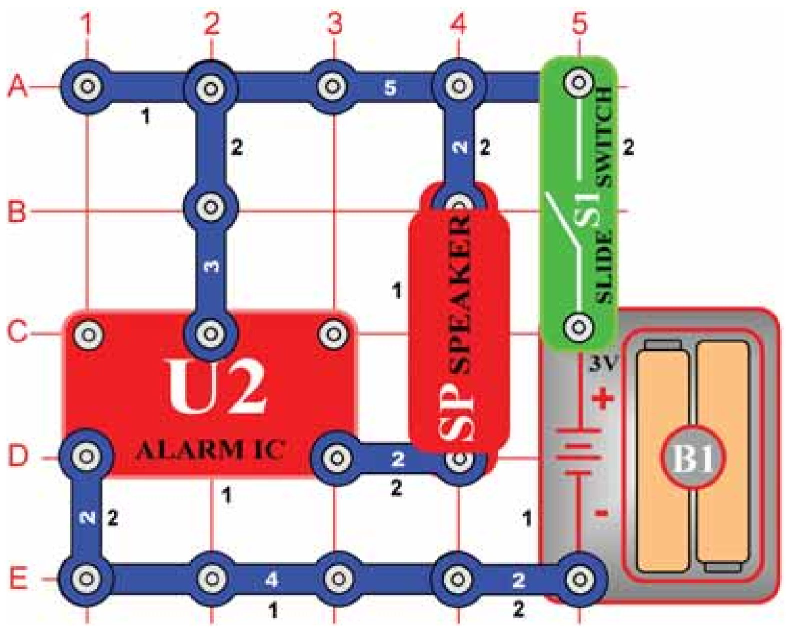


OBJECTIVE: To show how integrated circuits can also create loud alarm sounds in case of emergencies.

Modify the circuit used in project #15 to look like the one shown on the left.

When you close 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.

Project #17 Alarm Circuit



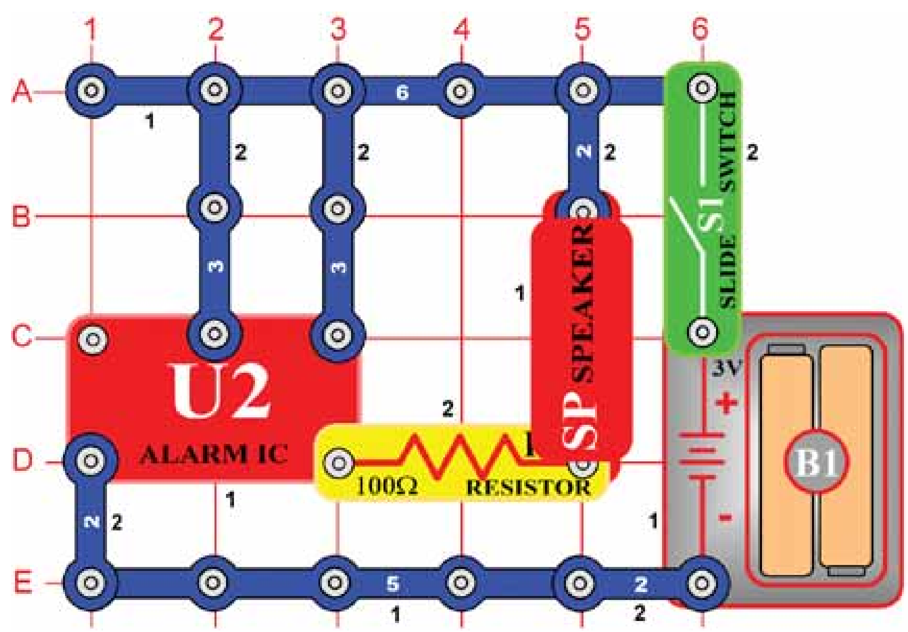
OBJECTIVE: To show how an integrated circuit can be used to make real alarm sounds.

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

When you close the slide switch (S1), the integrated circuit 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 was passed through an amplifier and installed into a police car, it would also serve as a good police siren.

Project #18 Laser Gun

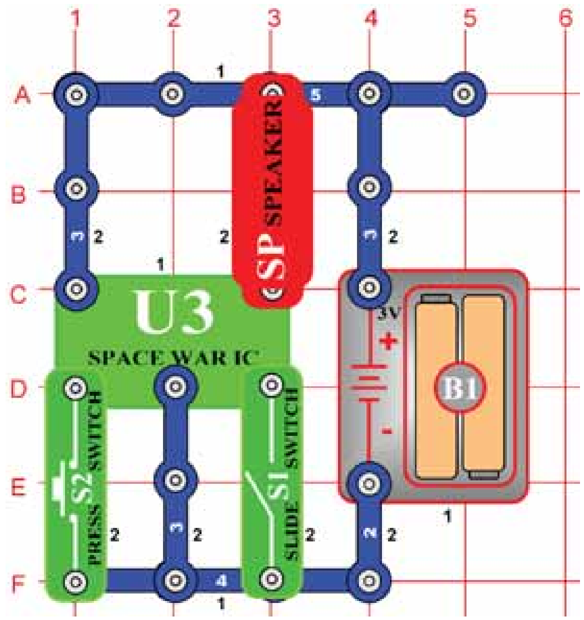


OBJECTIVE: To show how integrated circuits sound can easily be changed to exciting space war sounds.

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

When you close the slide switch (S1), the integrated circuit 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.

Project #19 Space War



OBJECTIVE: To introduce you to the space war integrated circuit and the sounds it can make.

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

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

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

Project #20 Light Switch

OBJECTIVE: To show how light can control a circuit using a photoresistor.

Use the circuit from project #19 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.

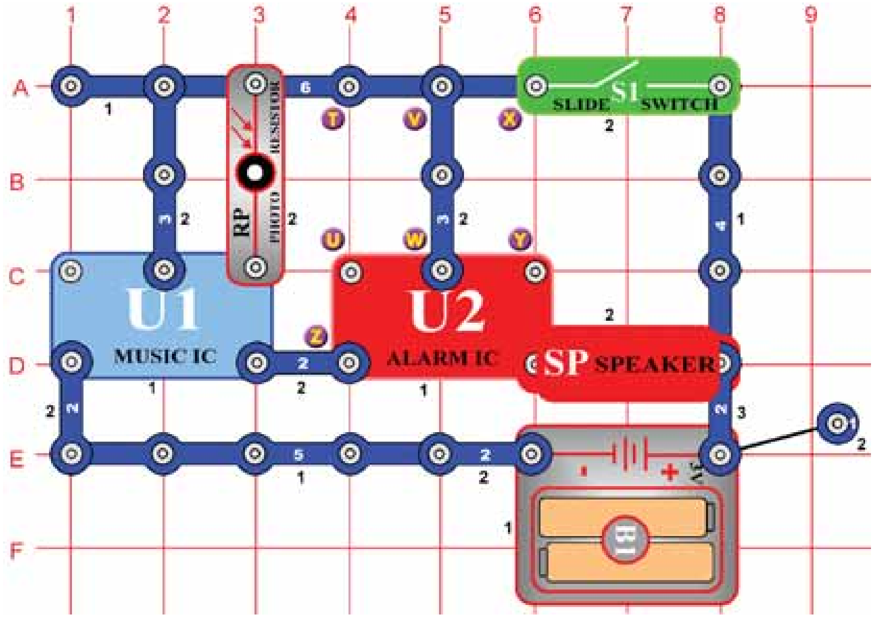
Project #21 Paper Space War

OBJECTIVE: To give a more dramatic demonstration of using the photoresistor.

Use the same circuit as for project #20. 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 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 #22 Light Police Siren

OBJECTIVE: To build a police siren that is controlled by light.



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. Finally, insert the parts with a 3 last on level 3.

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

☐ Project #23 More Loud Sounds

OBJECTIVE: To show variations of the circuit in project #22.

Modify the project #22 by connecting points X & Y. The circuit works the same way but now it sounds like a machine gun with music.

☐ Project #24 More Loud Sounds (II)

OBJECTIVE: To show variations of the circuit in project #22.

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 with music.

☐ Project #25 More Loud Sounds (III)

OBJECTIVE: To show variations of the circuit in project #22.

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 with music.

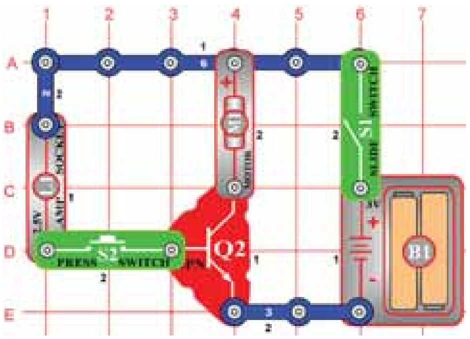
☐ Project #26 More Loud Sounds (IV)

OBJECTIVE: To show variations of the circuit in project #22.

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 #27
The Transistor

OBJECTIVE: To compare transistor circuits.



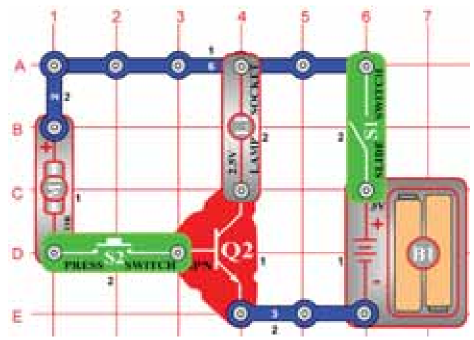
Place the fan on the motor and turn on the slide switch (S1) - nothing happens. Push the press switch (S2), the lamp lights and the motor spins.

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 #28
The Transistor (II)

OBJECTIVE: To compare transistor circuits.



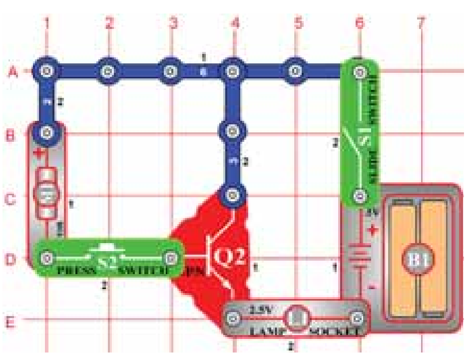
Compare this circuit to project #27. It works the same way, but the lamp is brighter here and the motor is slower.

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 #29
The Transistor (III)

OBJECTIVE: To compare transistor circuits.

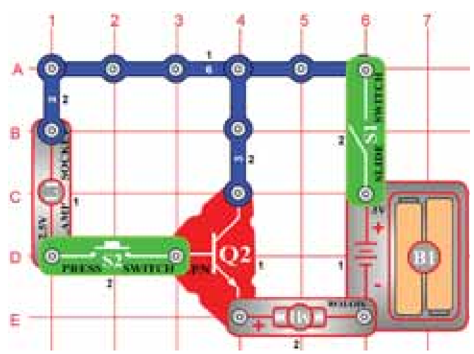


Compare this circuit to project #28. It works in a similar way, but the motor does not spin even though the lamp is bright. But the lamp is not as bright here as in project #28.

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 #30
The Transistor (IV)

OBJECTIVE: To compare transistor circuits.



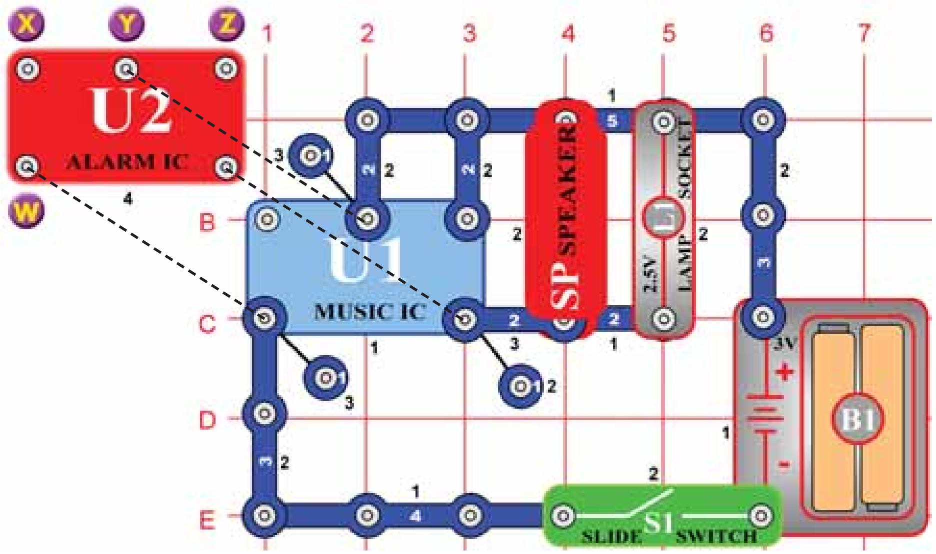
Compare this circuit to project #29. It works in a similar way, the lamp is off but the motor spins. But the motor does not spin as fast as in project #27.

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 #31 Sound Mixer

OBJECTIVE: To connect two sound ICs together.



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 #32 Sound Mixer (II)

OBJECTIVE: To connect two sound ICs together.

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 #33 Sound Mixer (III)

OBJECTIVE: To connect two sound ICs together.

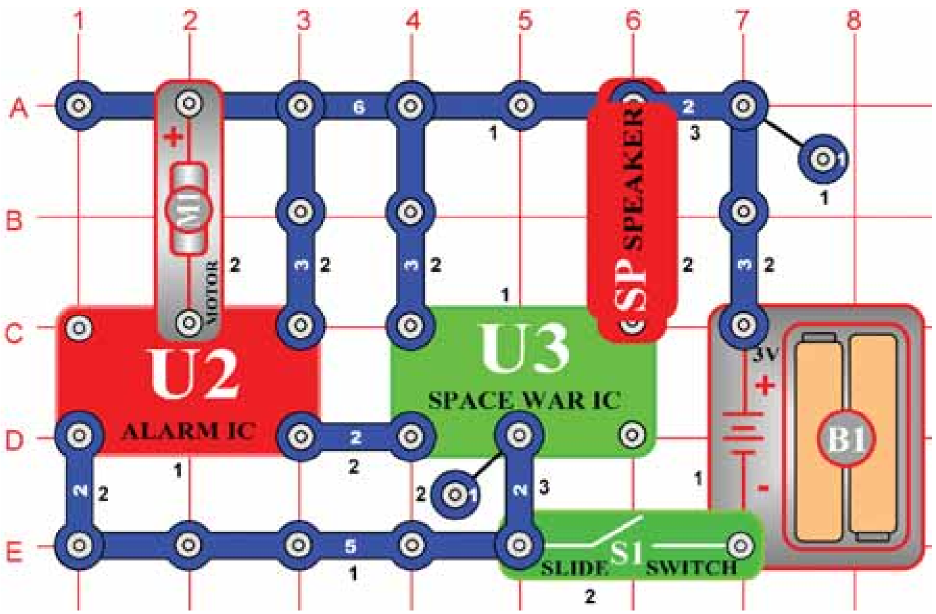
Now remove the 2-snap connection between Y & Z and then make a 2-snap connection between X & Y (on level 5). The circuit works the same way but now it sounds like a fire engine with music.

Project #34 Sound Mixer (IV)

OBJECTIVE: To connect two sound ICs together.

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 #35 Space Battle



OBJECTIVE: To show another way of using the space war integrated circuit.

Build the circuit shown on the left, which is based on the circuit in the Space War project #19. Turn on the switch and you will hear exciting sounds, as if a space battle is raging!

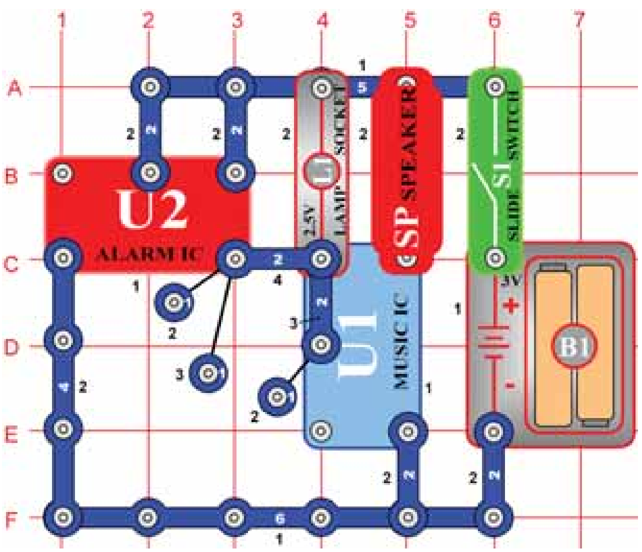
The motor is used here as a 3-snap wire, and will not spin.

☐ Project #36 Silent Space Battle

OBJECTIVE: To show another way of using the space war part.

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 #37 Periodic Sounds



OBJECTIVE: To build a circuit with light and sound that change and repeat.

Build the circuit shown on the left and turn it on. The lamp alternates between being on and off while the speaker 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.

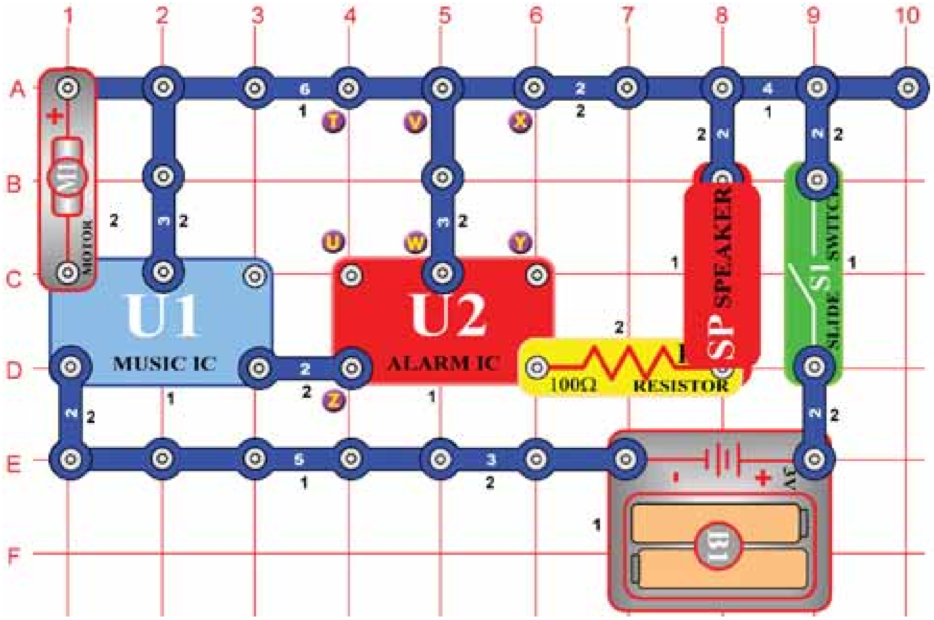
☐ Project #38 Blinking Double Flashlight

OBJECTIVE: To build a circuit with two lights that alternate.

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 alternates between being on and off while the LED alternates between being dimmer and brighter.

Project #39 Motor-controlled Sounds

OBJECTIVE: To show how motion can trigger electronic circuits.



This circuit is controlled by spinning the motor 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.

Project #40 More Motor Sounds

OBJECTIVE: To show how motion can trigger electronic circuits.

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 #41 More Motor Sounds (II)

OBJECTIVE: To show how motion can trigger electronic circuits.

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 #42 More Motor Sounds (III)

OBJECTIVE: To show how motion can trigger electronic circuits.

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

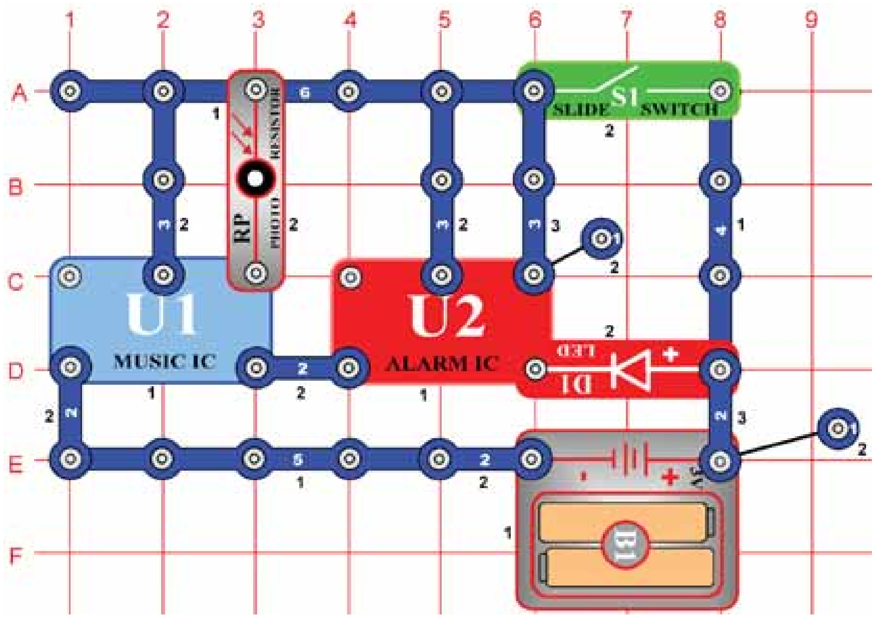
Project #43 More Motor Sounds (IV)

OBJECTIVE: To show how motion can trigger electronic circuits.

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 #44 — Light-controlled Flicker

OBJECTIVE: To make a circuit that uses light to control the blinking of another light.



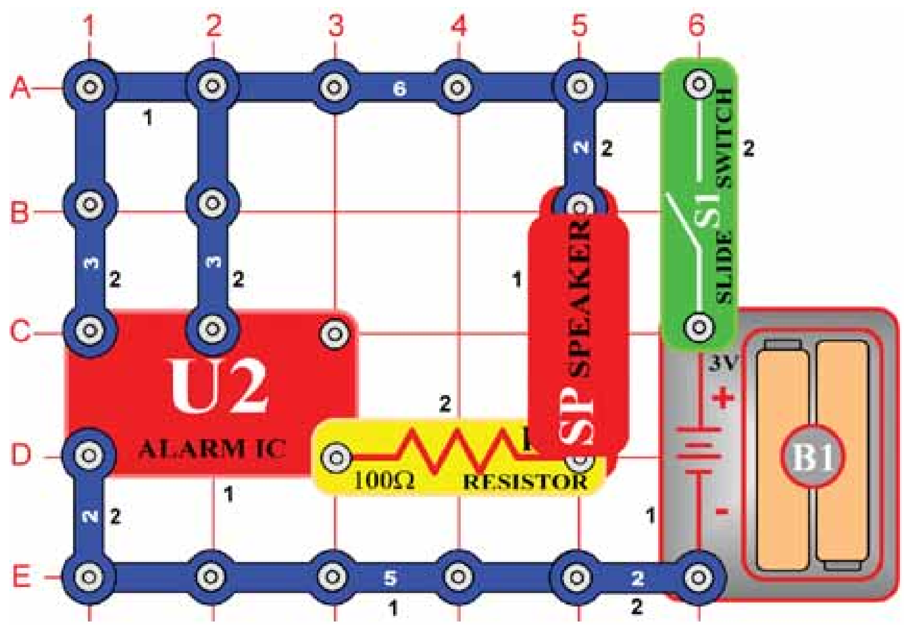
This circuit does not use the noisy speaker it uses a nice quiet LED. Turn on the switch, the LED flickers. Wait a few seconds, and then cover the photoresistor, and the flicker stops. The flicker is controlled by the photoresistor; uncover it and the flicker resumes.

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 #45 — More Sound Effects

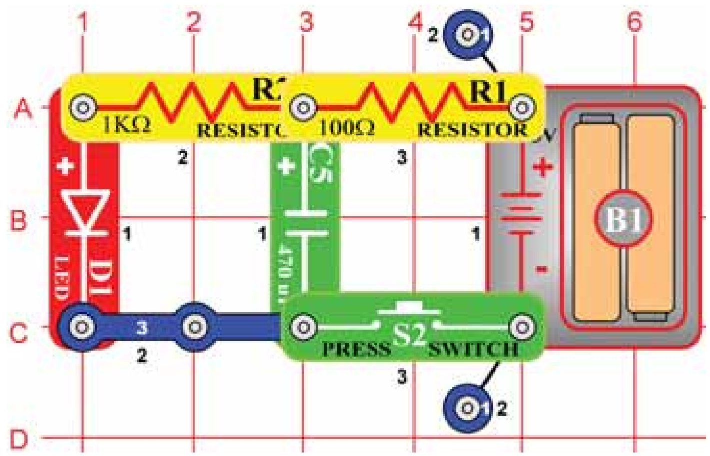
OBJECTIVE: To investigate the different sound effects available from the alarm integrated circuit.



Build the circuit shown on the left. When you close the slide switch (S1), the integrated circuit should start sounding an up-down siren. This is just one more sound effect that this integrated circuit is designed to produce. Different sounds that can easily be changed are very important when designing games and toys. 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.

Project #46 Slow Off Switch

OBJECTIVE: To learn about a device that is used to delay actions in electronics.

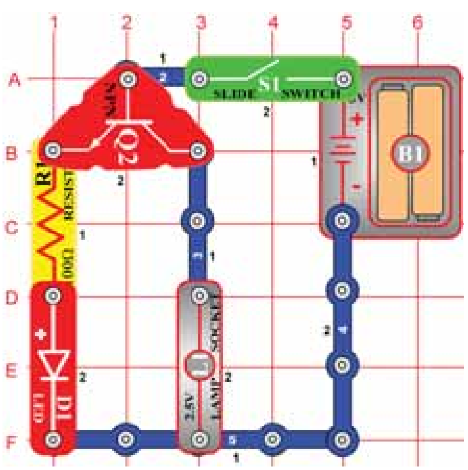


Build the circuit and press the switch (S2). You see that the LED (D1) turns off slowly after you release the switch.

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 #47 Transistor Diodes

OBJECTIVE: To learn about transistors.

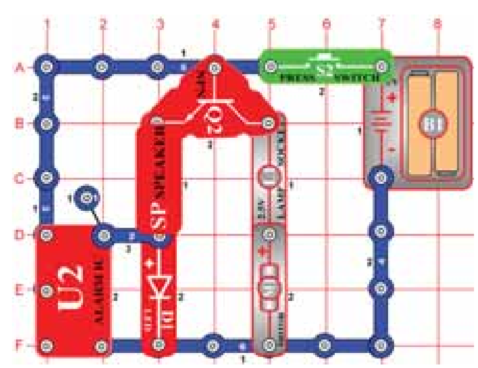


Turn on the switch (S1), the LED (D1) and lamp (L1) are bright. This is an unusual circuit which uses the NPN transistor (Q2) as two connected diodes to split the current from the batteries into the paths with the LED and lamp. If the LED (D1) does not light, you may have weak batteries in need of replacement.

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 #48 Four Outputs

OBJECTIVE: To learn about transistors.



This circuit has four different types of output. Do not place the fan on the motor (M1). Press the switch (S2) several times. The LED (D1) and lamp (L1) are bright, the motor spins, and the speaker (SP) makes a static sound. If the LED does not light, you may have weak batteries that need replacement.

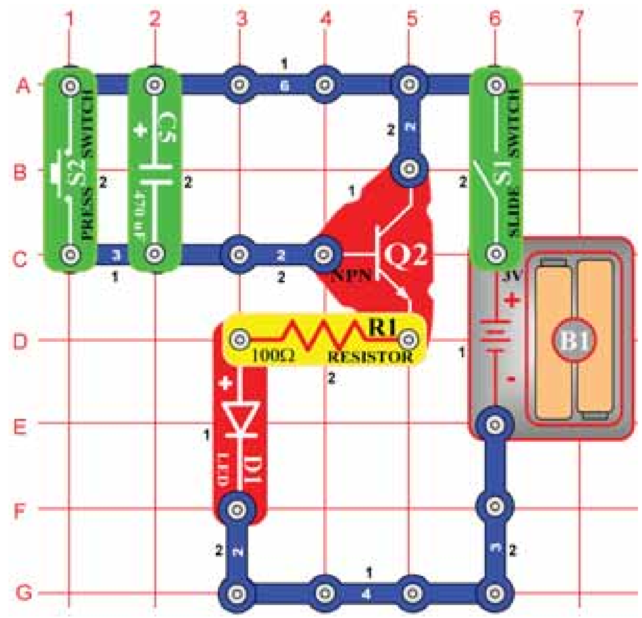
This is an unusual circuit which uses the NPN transistor (Q2) as two connected diodes, to split the current from the batteries (B1) into the paths with the LED and lamp.

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

☐ Project #49

Auto-Off Night Light

***OBJECTIVE:** To learn about one device that is used to delay actions in electronics.*



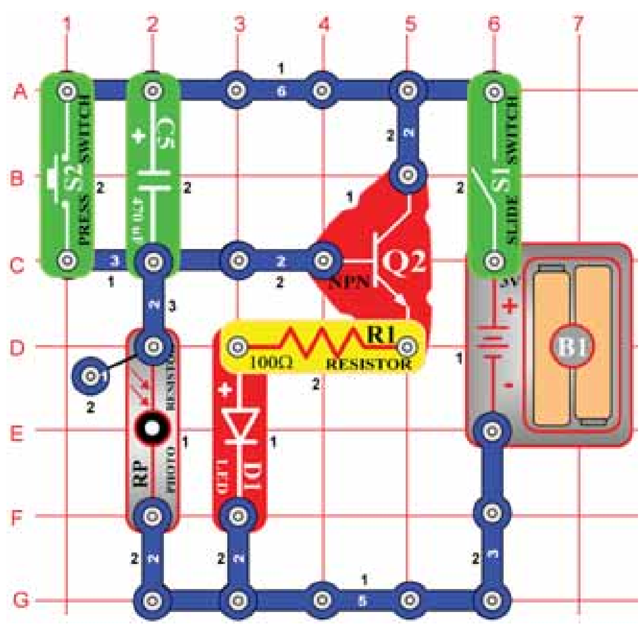
When you turn on the slide switch (S1) the first time the light will come on and very slowly get dimmer and dimmer. If you turn the slide switch (S1) off and back on after the light goes out it will NOT come on again. The 470μF capacitor (C5) has charged up and the NPN transistor amplifier (Q2) can get 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 #50

Auto-Off Night Light (II)

***OBJECTIVE:** To learn about one device that is used to delay actions in electronics.*

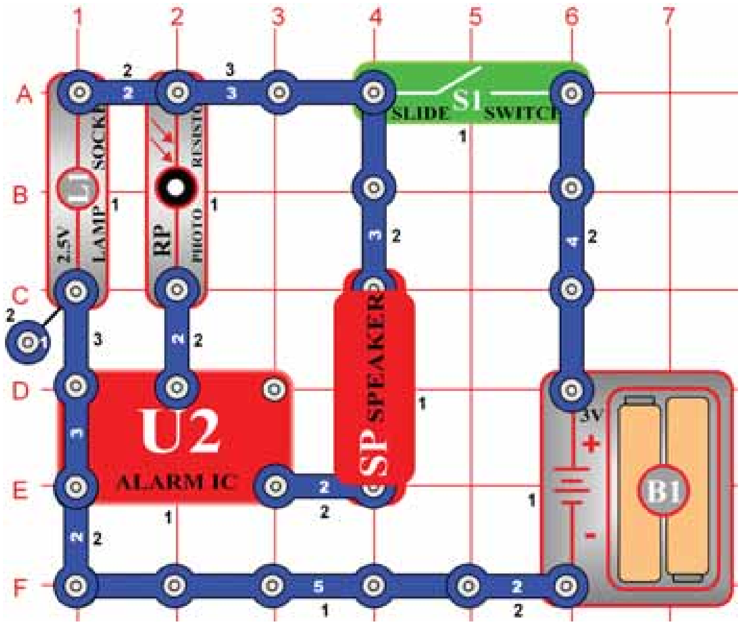


Cover the photoresistor (RP) and turn on the slide switch (S1). The LED (D1) is bright, but it will very slowly get dimmer and dimmer as the 470μF capacitor (C5) charges up. If you turn the slide switch (S1) off and back on after the light goes out it will NOT come on again. Push the press switch (S2)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

☐ Project #51 — Reflection Detector

OBJECTIVE: To detect if a mirror is present.

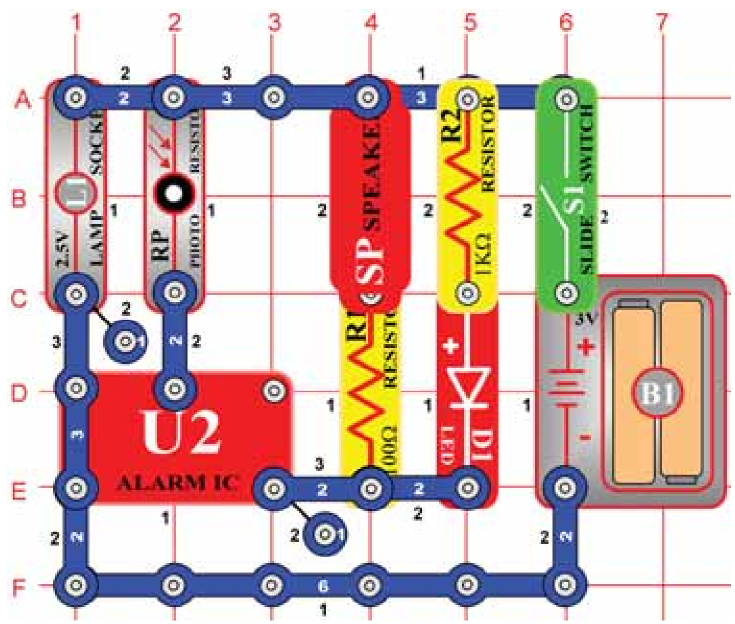


Build the circuit at left. Place it where there won't be any room light hitting the photoresistor (RP) (such as in a dark room or under a table), and then turn it on. The 2.5V lamp (L1) will be bright but there should be little or no sound.

Take a small mirror and hold it over the lamp and photoresistor. You should hear sound now. You have a reflection detector! The more light that gets reflected like this, the louder the sound. You can try holding the mirror at different angles and distances and see how the sound changes. You can also hold a white piece of paper over them, since white surfaces reflect light.

☐ Project #52 — Quieter Reflection Detector

OBJECTIVE: To detect a mirror.



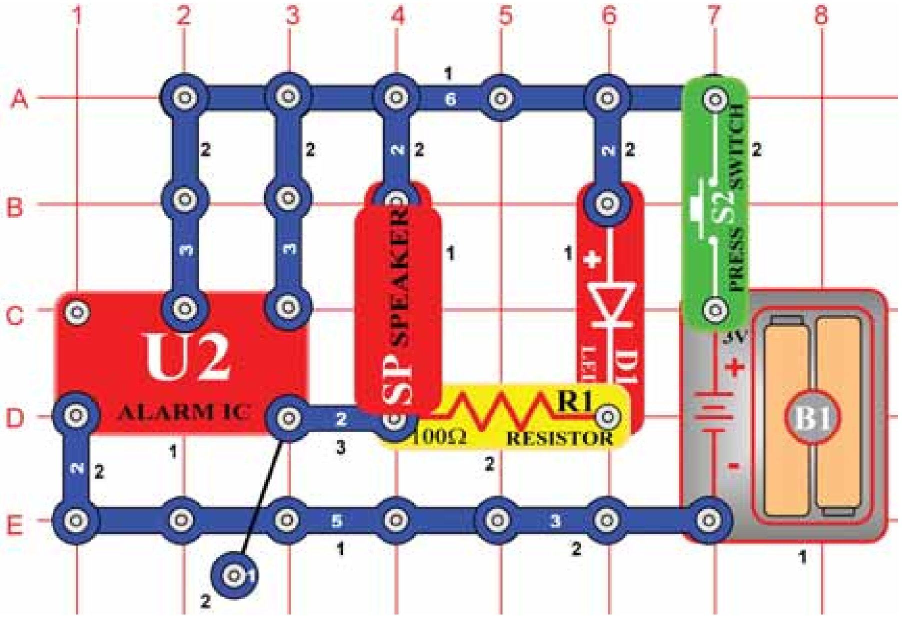
Let's modify the reflection detector circuit so that it is not so loud and annoying. We'll also put a lamp on it that can be seen in a noisy room. Build the circuit at left. Place it somewhere where there won't be any room light hitting the photoresistor (such as in a dark room or under a table), and then turn it on. The 2.5V lamp will be bright but there should be little or no sound.

Take a small mirror and hold it over the lamp and photoresistor. You should hear sound now as the mirror onto the photoresistor reflects light from the lamp. The more light that gets reflected like this, the louder the sound. You can also hold a white piece of paper over the circuit, since white surfaces reflect light.

Project #53

Flashing Laser Light with Sound

OBJECTIVE: To build the circuit used in a toy laser gun with flashing laser light and trigger.

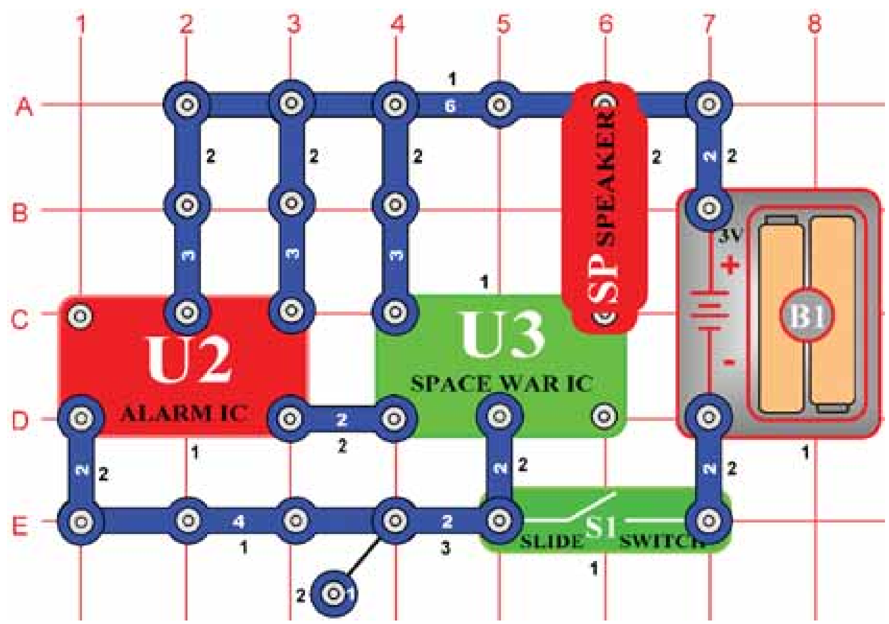


When you press the press switch (S2), the integrated circuit should start sounding a very loud laser gun sound. The red LED will flash simulating a burst of laser light. You can shoot long repeating laser burst, or short zaps by tapping the trigger switch.

Project #54

Space War Flicker

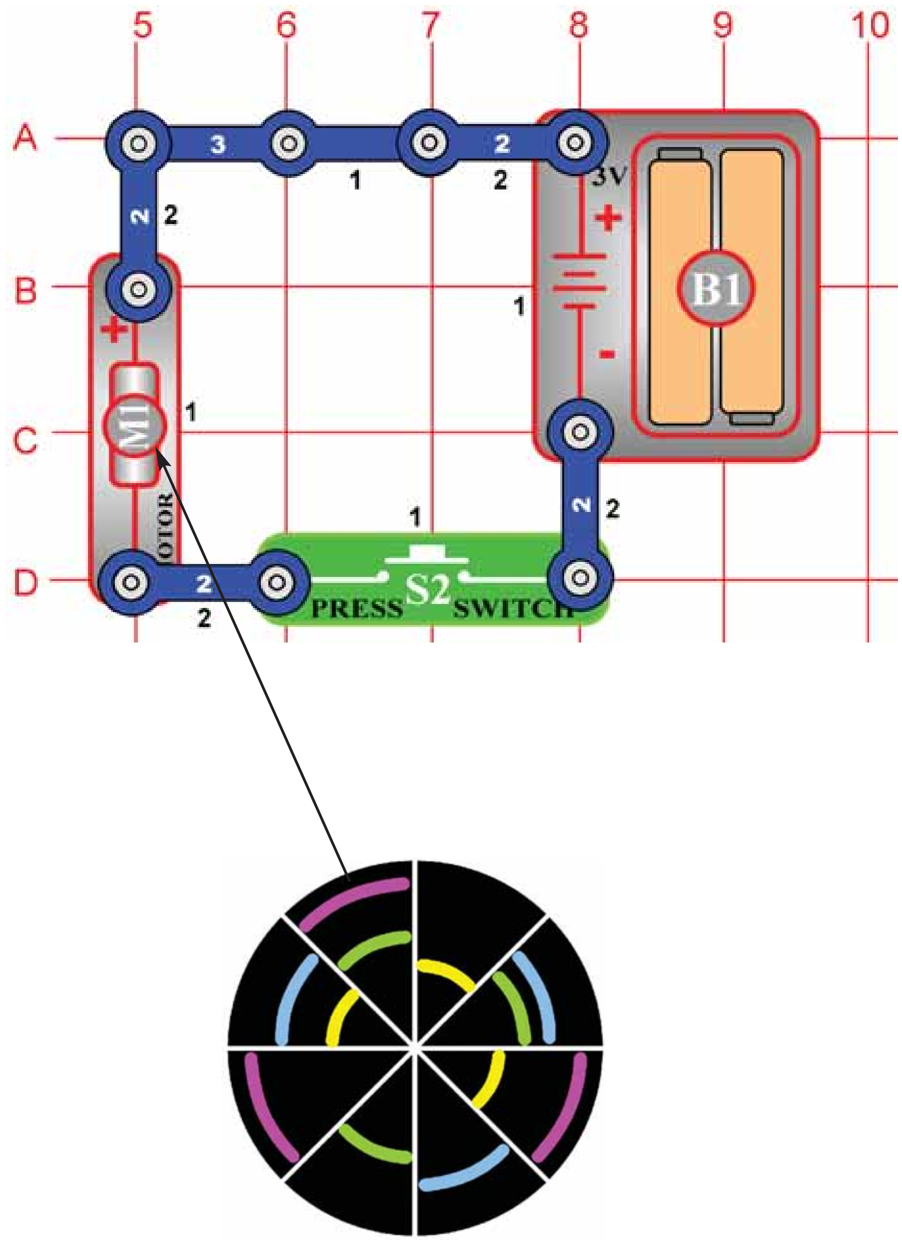
OBJECTIVE: To build a circuit using the space war IC to make exciting sounds.



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 #55

Spinning Rings

OBJECTIVE: *To build an electronic spinner.*

Setup: Cut out the disc on page #49 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 #56

Strobe the House Lights

OBJECTIVE: *To use the spinner to see strobe effect due to 60 cycles.*

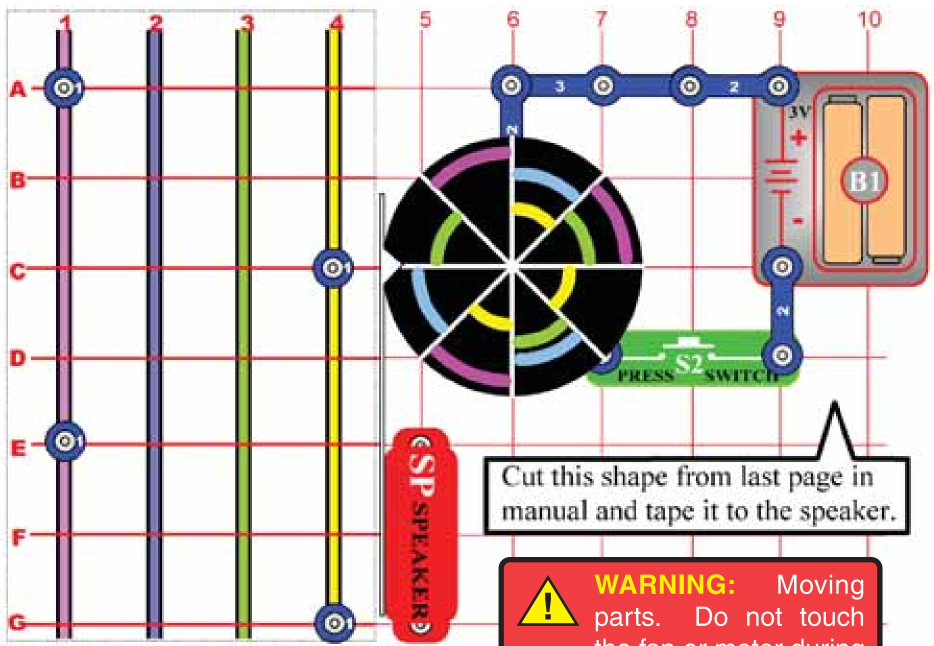
Use the circuit from project #55.

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.

Project #57
Race Game

OBJECTIVE: Build an electronic game for racing.



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

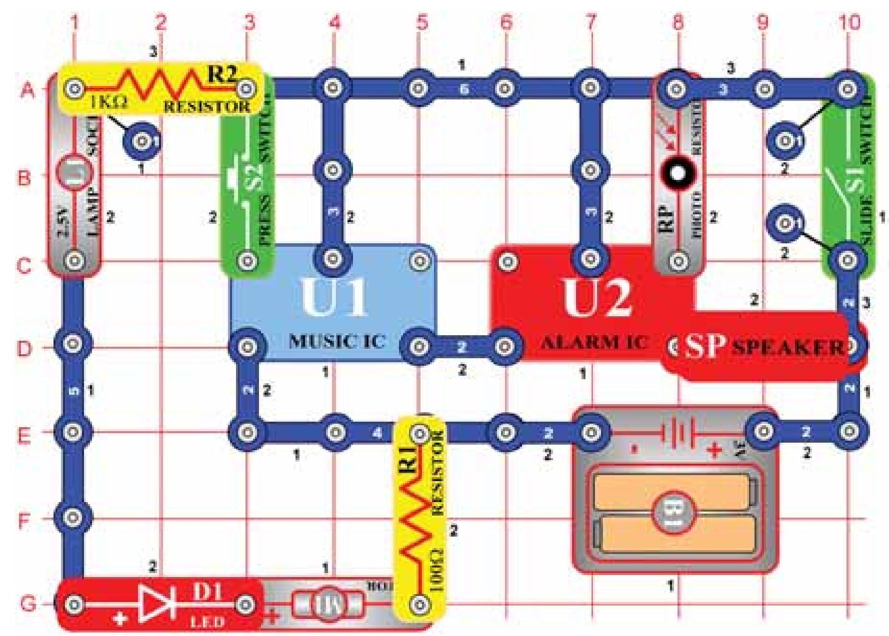
Modify project #56 by adding the pointer as shown on the left. The paper should be cut from page 49 and taped high enough on the speaker so the pointer will stick over the fan with paper. Bend the pointer at a right angle as shown on the left.

Setup: Cut out the grid with four (4) colors from page 49 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.

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.

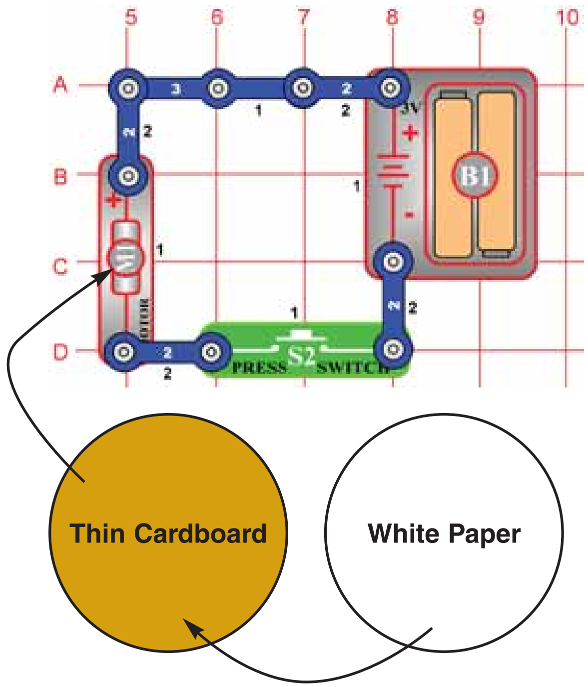
Project #58
Using Parts as Conductors

OBJECTIVE: To show that motors and lamps may sometimes be used as ordinary 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.



Project #59

Spin Draw

OBJECTIVE: To produce circular artistic drawings.

Rebuild the simple motor connection as shown on the left. This is the same setup as project #57.

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.

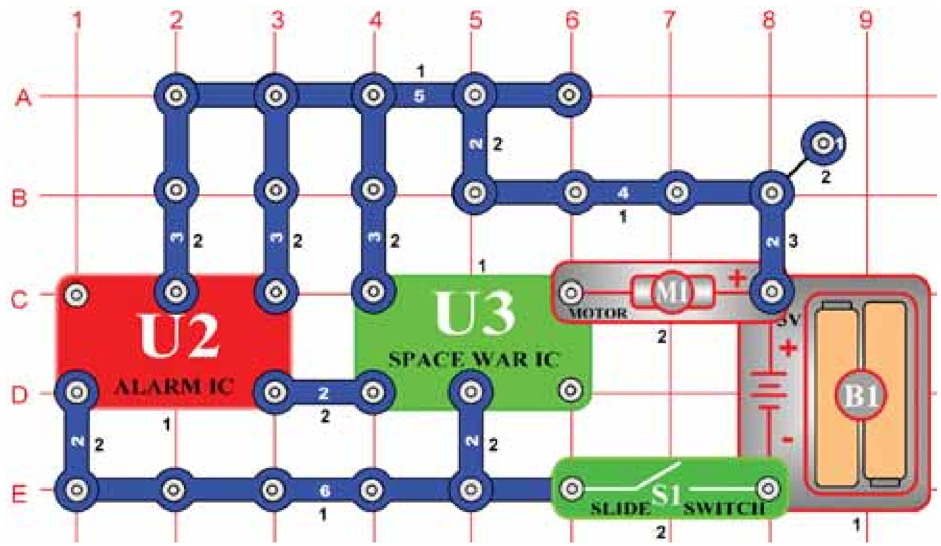
Drawing: To make a ring drawing obtain some thin and thick marking pens as drawing tools. Spin the paper by pressing and holding press switch (S2) down. Press the marker on the paper to form rings. To make spiral drawings, release press switch (S2) and as the motor approaches a slow speed move the marker 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 #60

Space War Flicker Motor

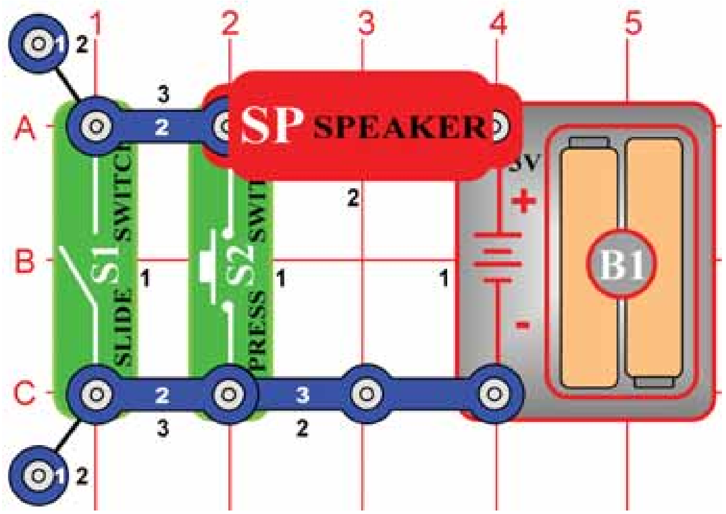
OBJECTIVE: To run the motor using the space war IC.



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.

Project #61 Speaker Static

OBJECTIVE: To learn about the speaker.



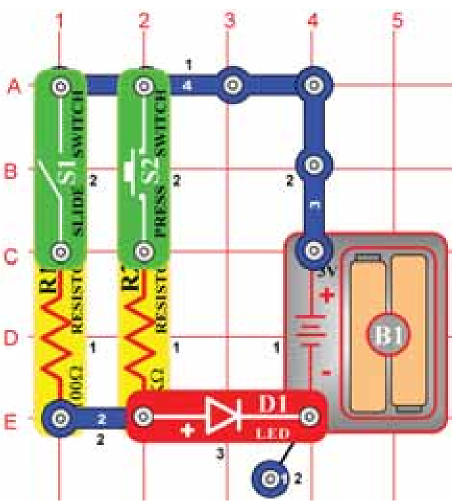
Turn off the slide switch (S1) and push the press switch (S2) several times. You hear static from the speaker when you press or release the switch, but hear nothing while you hold it down.

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.

You also hear a mechanical click when you push the press switch. Turn on the slide switch and push the press switch a few more times. Now the speaker is quiet, and you can hear how much of the noise was from the switch itself.

Project #62 Parallel Resistors

OBJECTIVE: To learn about resistors.

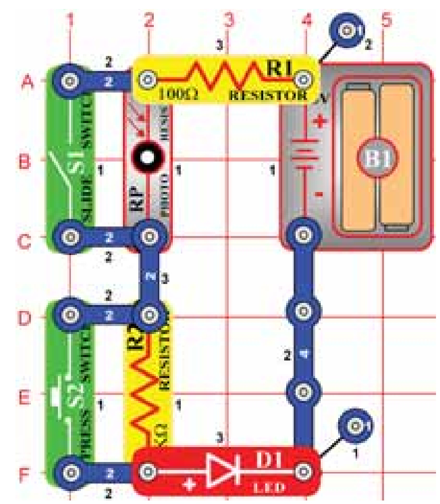


Turn on either or both switches and compare the LED brightness.

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 #63 Series Resistors

OBJECTIVE: To learn about resistors.

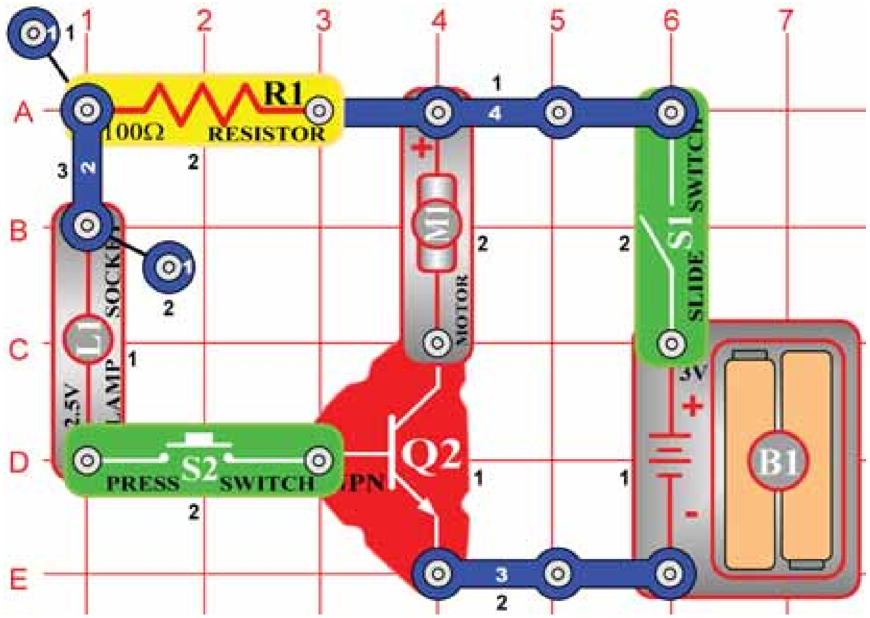


Turn on either or both switches and compare the LED brightness.

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 controls the brightness in this arrangement (the resistance of the photoresistor will be much higher than the others, unless the light is very bright).

Project #64 The Transistor (V)

OBJECTIVE: To compare transistor circuits.



Place the fan on the motor (M1) and turn on the slide switch (S1), then compare this circuit to project #27. Push the press switch (S2), the lamp doesn't light now but the motor still spins.

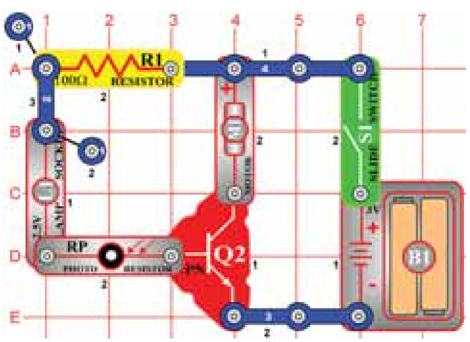
The lamp is dark because the 100Ω resistor (R1) limits the current through it. The NPN transistor (Q2) uses the small lamp current to create a large current that spins the motor.

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.

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

Project #65 The Transistor (VI)

OBJECTIVE: To compare transistor circuits.



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

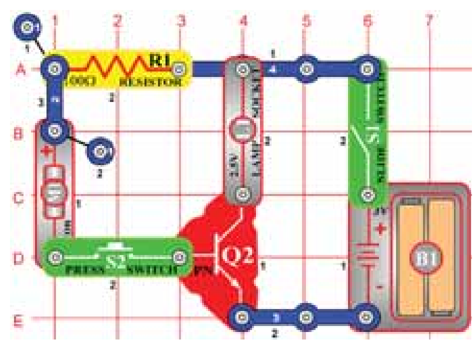
Compare this circuit to project #64. It uses the photoresistor (RP) to control the current to the NPN transistor (Q2), instead of the press switch (S2). You can adjust the speed of the motor by changing how much light shines on the photoresistor.

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.

Project #66 The Transistor (VII)

OBJECTIVE: To compare transistor circuits.



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

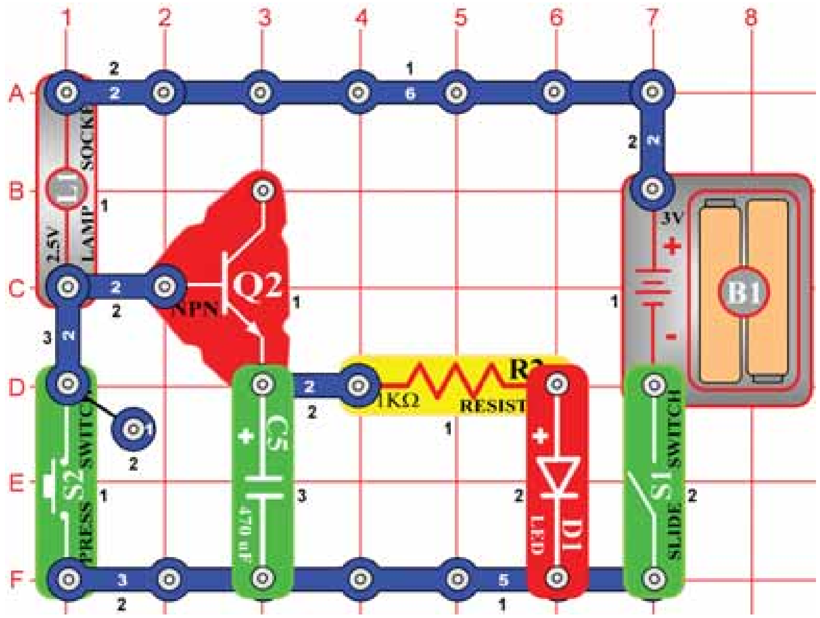
Compare this circuit to project #28. Push the press switch (S2), the motor doesn't spin now but the lamp still lights.

The motor doesn't spin because the 100Ω resistor (R1) limits the current through it. The NPN transistor 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 (S2) 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.

Project #67 Simple Rectifier



OBJECTIVE: To convert a changing voltage into a constant voltage.

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.

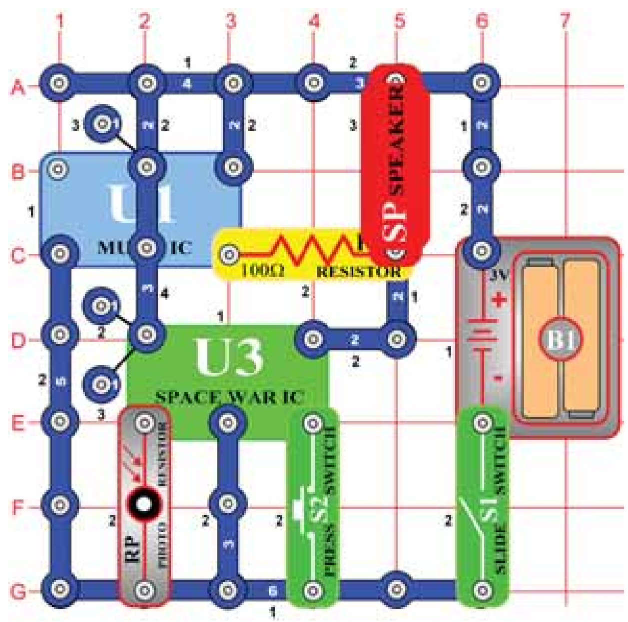
Push the press switch many times quickly - the lamp still goes on and off but the LED stays on. Next, remove the 470μF capacitor (C5) from the circuit - the LED goes on and off now. Why?

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.

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.

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.

Project #68 Space War Music Combo

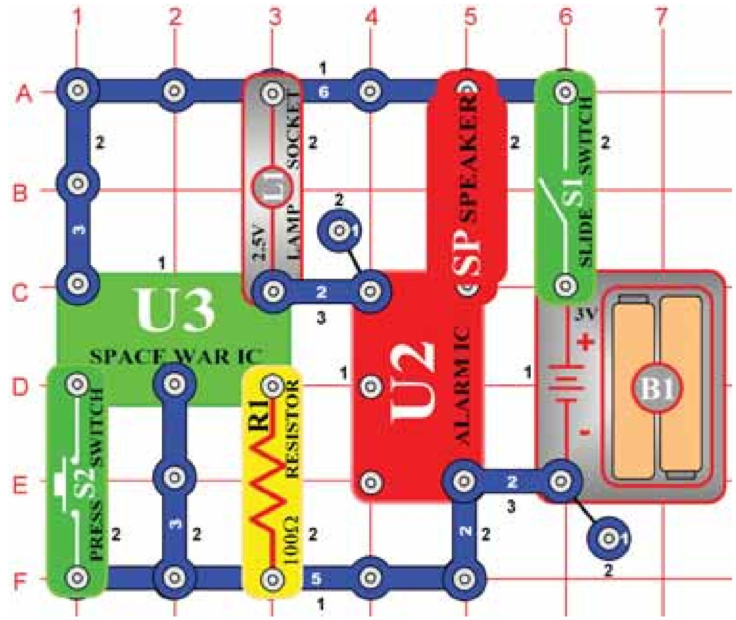


OBJECTIVE: To combine the sounds from the space war and music integrated circuits.

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).

☐ Project #69 — Space War Siren

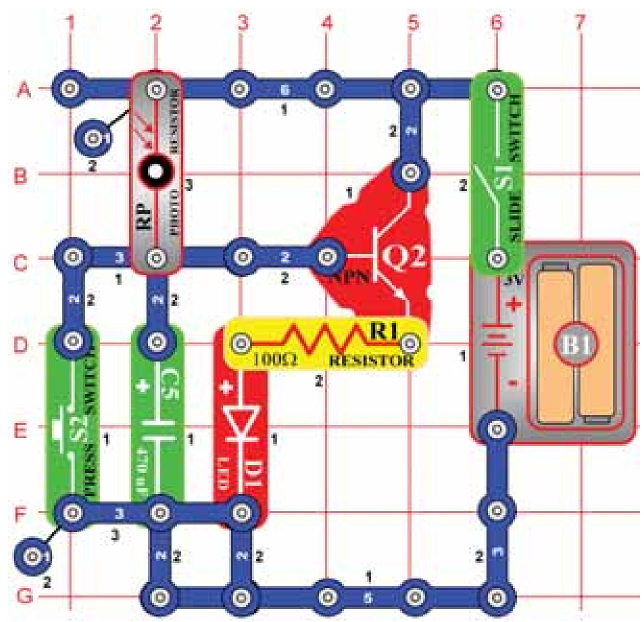
OBJECTIVE: To combine effects from the space war and alarm integrated circuits.



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 brighter.

☐ Project #70 — Sunrise Light

OBJECTIVE: To learn about one device that is used to delay actions in electronics.

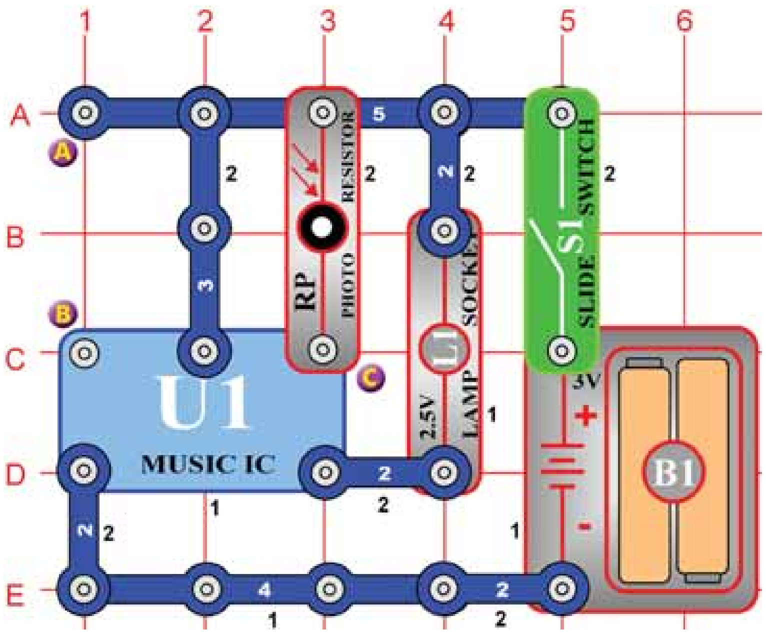


Cover the photoresistor (RP) and turn on the slide switch (S1). The LED (D1) is off, but if you wait a long time then it will eventually light up. Uncover the photoresistor and the LED will light up in just a few seconds. Push the press switch (S2) and reset the circuit.

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

Project #71 Light-controlled Lamp

OBJECTIVE: To turn a lamp on and off using light.



Cover the unit, turn the switch on, and notice that the lamp is off after a few seconds. Place the unit near a light and the lamp turns on. Cover the photoresistor and place it in the light again. The lamp will not turn on. 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.

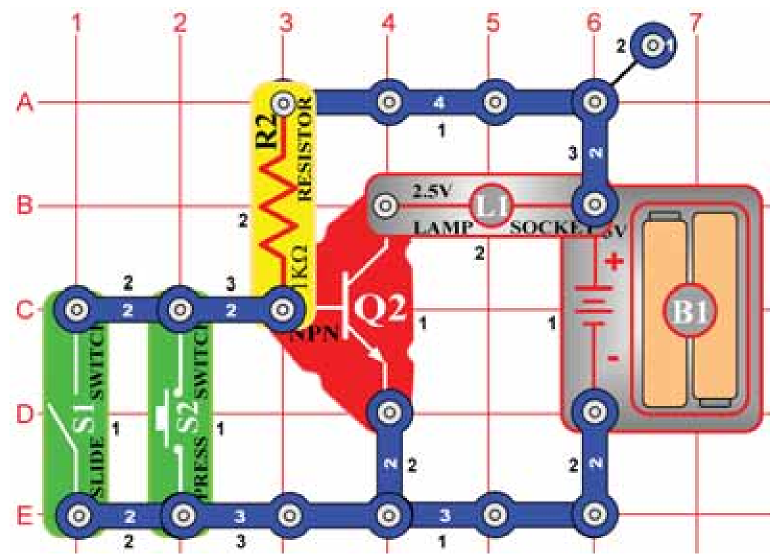
Project #72 Motor-controlled Lamp

OBJECTIVE: To turn a lamp on and off using the voltage generated when a motor rotates.

Use the circuit from project #71. Remove the photoresistor (RP) and connect the motor (M1) across points A & B. Turn the switch 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.

Project #73 Light NOR Gate

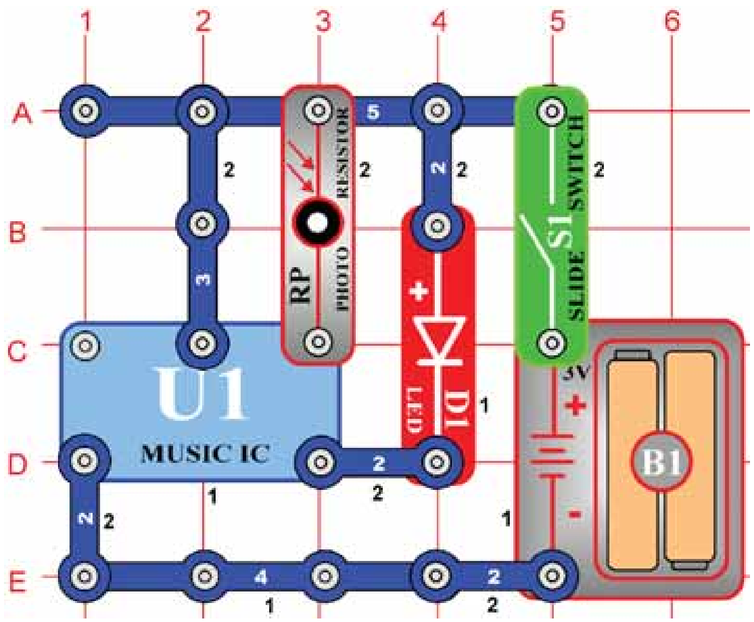
OBJECTIVE: To build a NOR gate.



Build the circuit on the left. You will find that the lamp is on when neither the slide switch (S1) NOR the press switch (S2) are on. This is referred to as an NOR gate in electronics and is important in computer logic.

Example: If neither condition X <u>NOR</u> condition Y are true, then execute instruction Z.

Project #74   Light-controlled LED



OBJECTIVE: To control an LED using light.

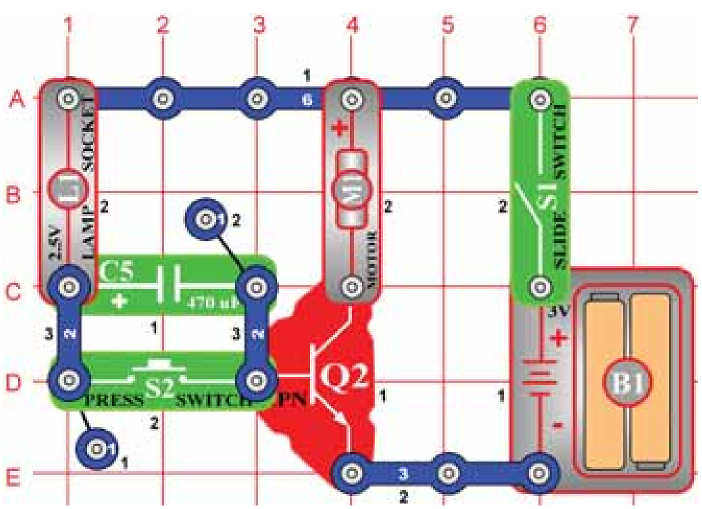
Cover the unit, turn the switch on, and notice that the LED is on for a few seconds and then goes off. Place the unit near a light and the LED will light. Cover the photoresistor (RP) and place it near the light again. The LED will not turn on. The resistance of the photoresistor decreases as the light increases.

Project #75   Motor-controlled Time Delay LED

OBJECTIVE: To control an LED using a motor.

Use the circuit from project #74. Connect the motor (M1) across points A1 and C1 on the base grid, then remove the photoresistor (RP). Turn the switch on and turn the shaft of the motor and the LED will light. 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 across its terminals. The voltage then activates the music IC.

Project #76   Capacitor Slow-down



OBJECTIVE: To learn about a device that is used to delay actions in electronics.

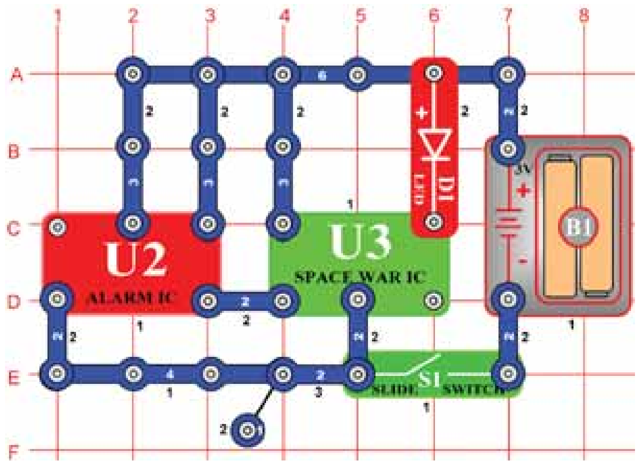
Place the fan on the motor and turn on the slide switch (S1). The motor spins briefly as the 470μF capacitor (C5) charges up. Turn off the slide switch and push the press switch (S2) to discharge the capacitor and reset the circuit.

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 #77

Space War Flicker LED

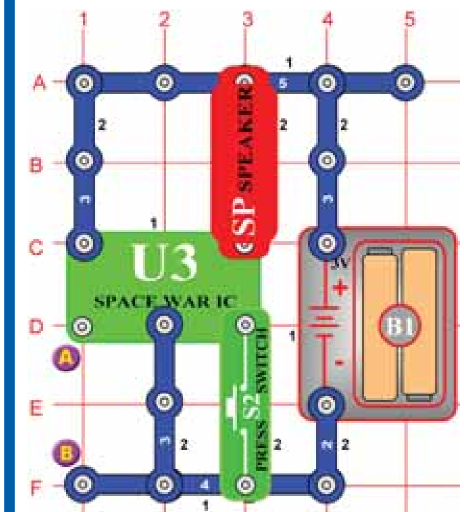


OBJECTIVE: Flash an LED using the space war IC.

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

Project #78

Human Space War



OBJECTIVE: To use your body to control the space war IC.

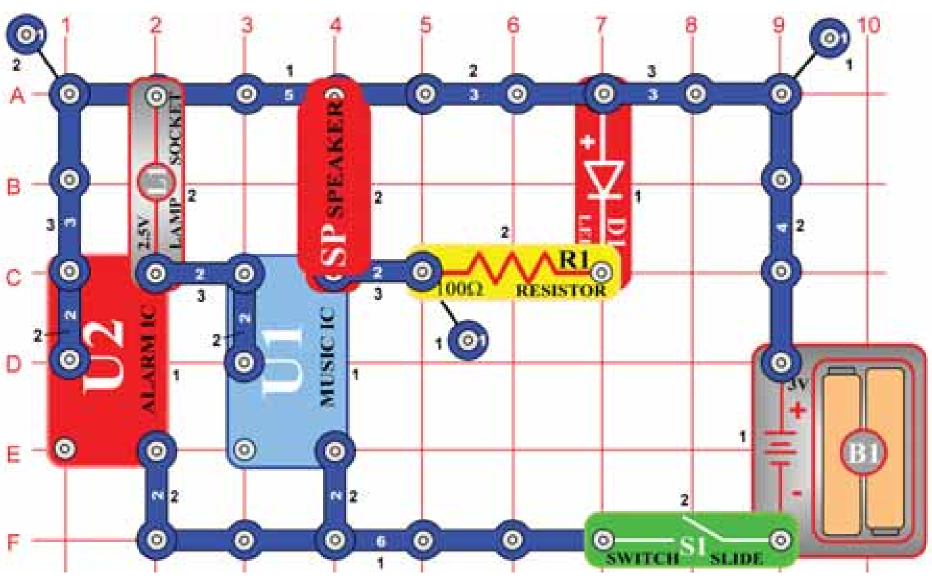
Wet your fingers with some water or saliva and touch them across points A and B several times to hear some space war sounds. Push the press switch (S2) to hear more sounds at the same time.

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 #79

Flash & Tone

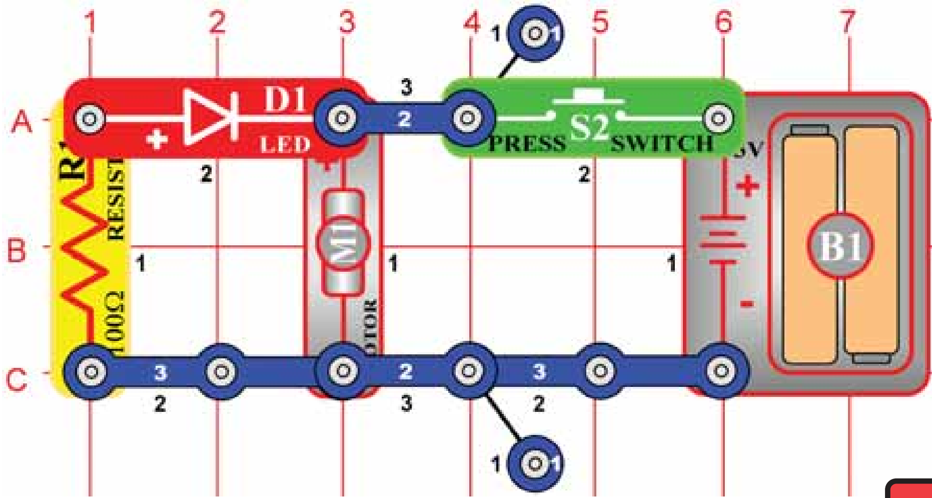
OBJECTIVE: Build a circuit that flashes light and plays sounds.



Turn the switch on and the lamp and LED starts flashing. You hear two different tones driving LED and lamp. IC's can be connected to control many different devices at the same time.

☐ Project #80 Fan Blade Storing Energy

OBJECTIVE: To show that the fan blade stores 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 lights briefly but only after the batteries (B1) are disconnected from the circuit.

Do you know why the LED lights? It lights 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 remove the fan blade from the circuit then the LED will never light, because the motor shaft alone does not store enough mechanical energy.

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.

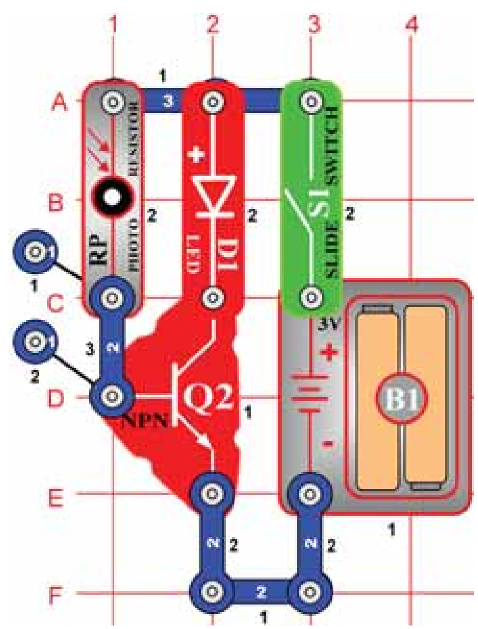
☐ Project #81 Speaker Storing Energy

Modify project #80 by replacing the motor (M1) with the speaker (SP), and watch the LED (D1) closely. The LED will light, but dimly and briefly. The speaker stores some energy, but much less than the fan blade did.

Modify the circuit again by replacing the speaker with the 2.5V lamp (L1). The LED will not light now, because the lamp does not store energy.

☐ Project #82 NPN Light Control

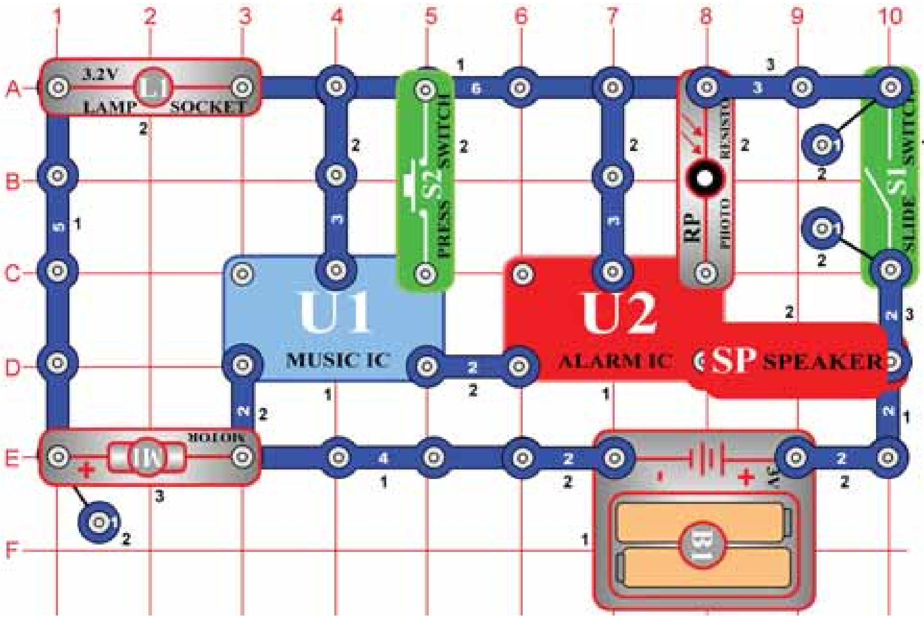
OBJECTIVE: To compare transistor circuits.



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

Project #83 — Fun with the Alarm IC

OBJECTIVE: To show some new ways of using the alarm IC.

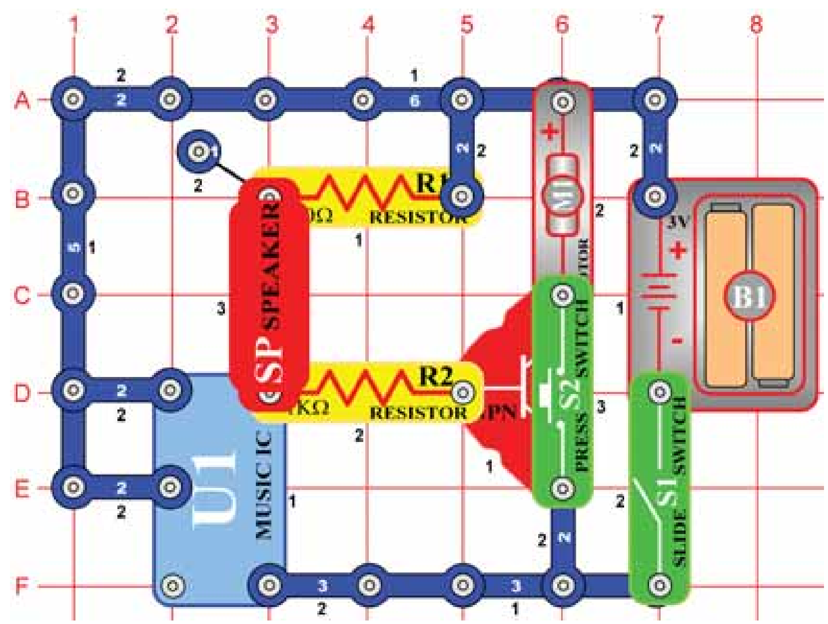


Place the fan on the motor and turn on the slide switch (S1). The lamp lights, the motor spins, and you hear a machine gun sound (with music in background). Thoroughly cover the photoresistor (RP) with your hand and the sound becomes a siren. After a while the sound will stop, hold down the press switch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

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

Project #84 — Musical Motor

OBJECTIVE: To use the music IC to control the speed of a fan.



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.

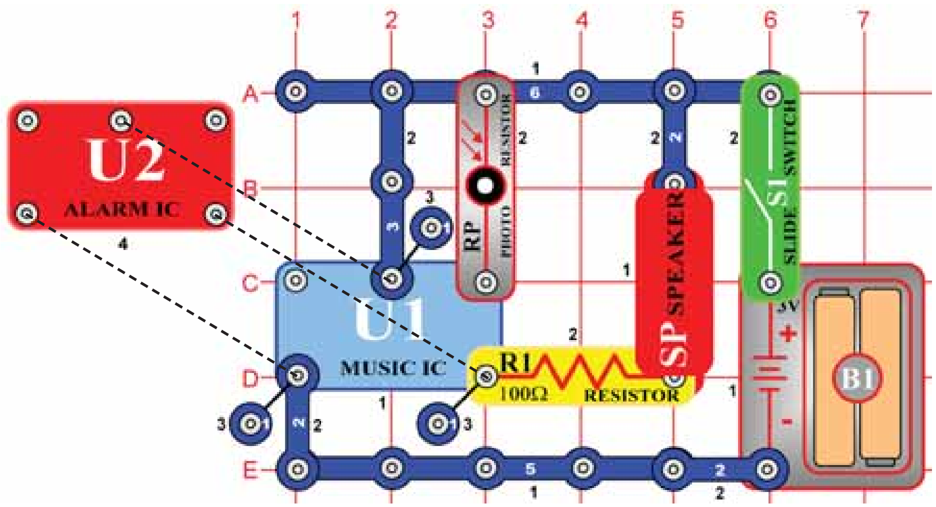
Project #85 — Musical Light

OBJECTIVE: To use the music IC to control a lamp.

Use the circuit in project #84. Replace the motor (M1) with the 2.5V lamp (L1). Now the music IC and press switch control the lamp brightness.

☐ Project #86 Music Alarm Combo

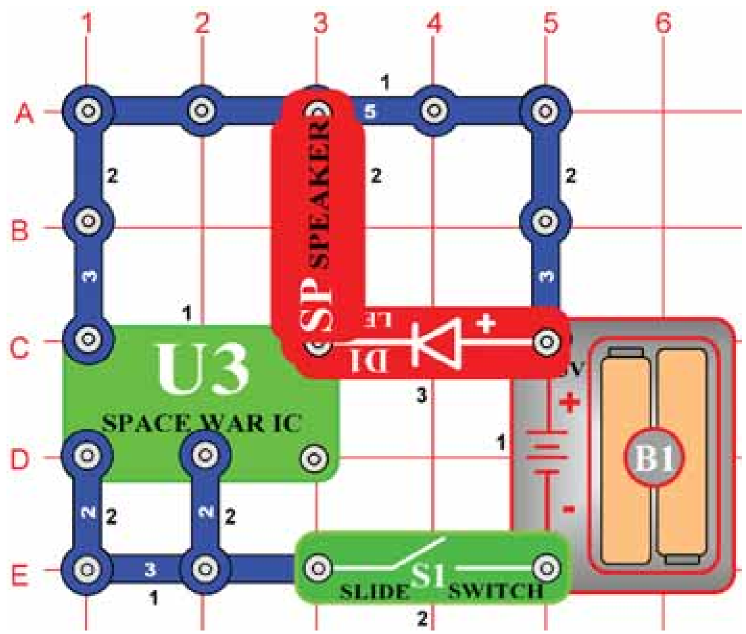
OBJECTIVE: To combine the sounds from the music and alarm integrated circuits.



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 switch 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 #87 Bomb Sound

OBJECTIVE: Build a circuit that sounds like a bomb dropping.



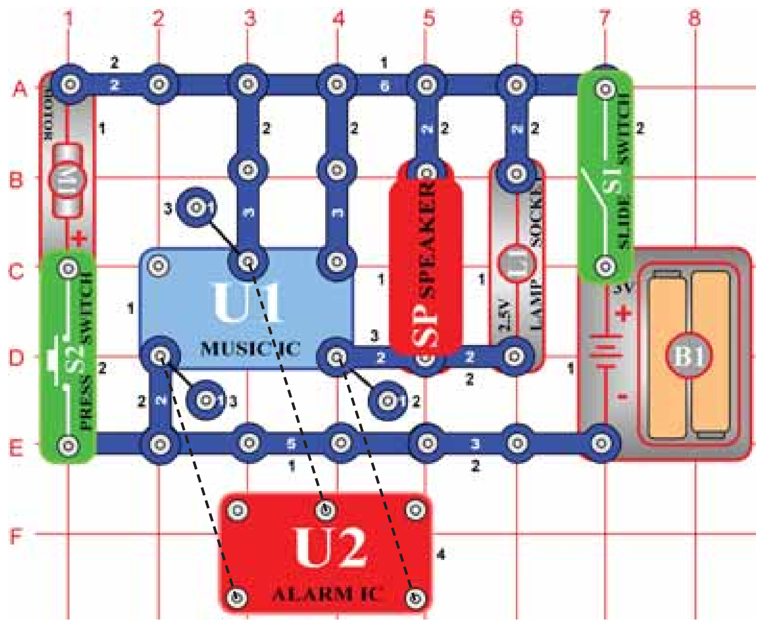
Turn the switch on and you hear the sound of a bomb dropping and then exploding. The LED lights and then flashes as the bomb explodes. This is one sound generated from the space war IC.

☐ Project #88 Bomb Sound (II)

OBJECTIVE: Build a circuit that sounds like bombs dropping.

Use the circuit from project #87. Replace the switch with the motor (M1). Turn the shaft on the motor and now it sounds like a bunch of bombs dropping.

☐ Project #89 Motor Sounds Combo



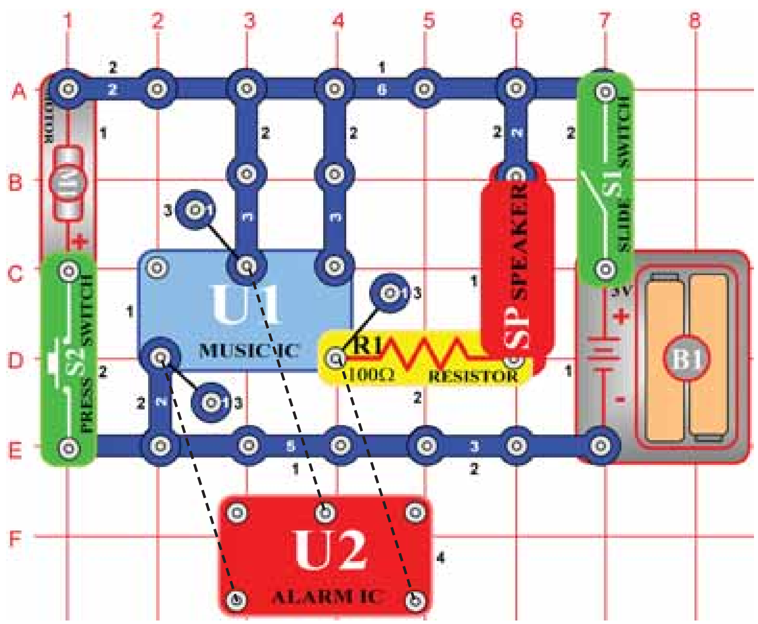
OBJECTIVE: To connect multiple devices together.

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 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 #90 Motor Sounds Combo (II)



OBJECTIVE: To connect multiple devices together.

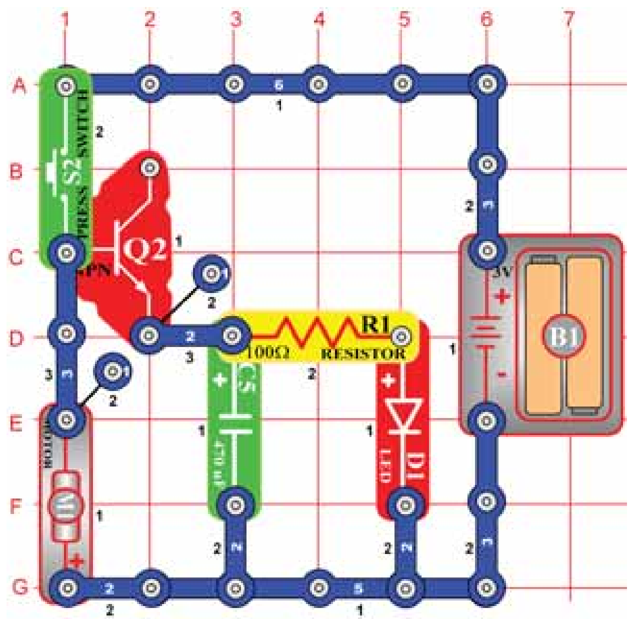
In the circuit, the outputs from the alarm and music ICs are connected together. Build the circuit shown and then place the alarm IC (U2) directly over the music IC (U1), resting on three 1-snaps. Turn on the slide switch (S1) and you will hear a siren and music together. Push the press switch (S2) and 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 #89, 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 #91 Fan Detector



OBJECTIVE: To make a circuit that detects if the fan is on the motor.

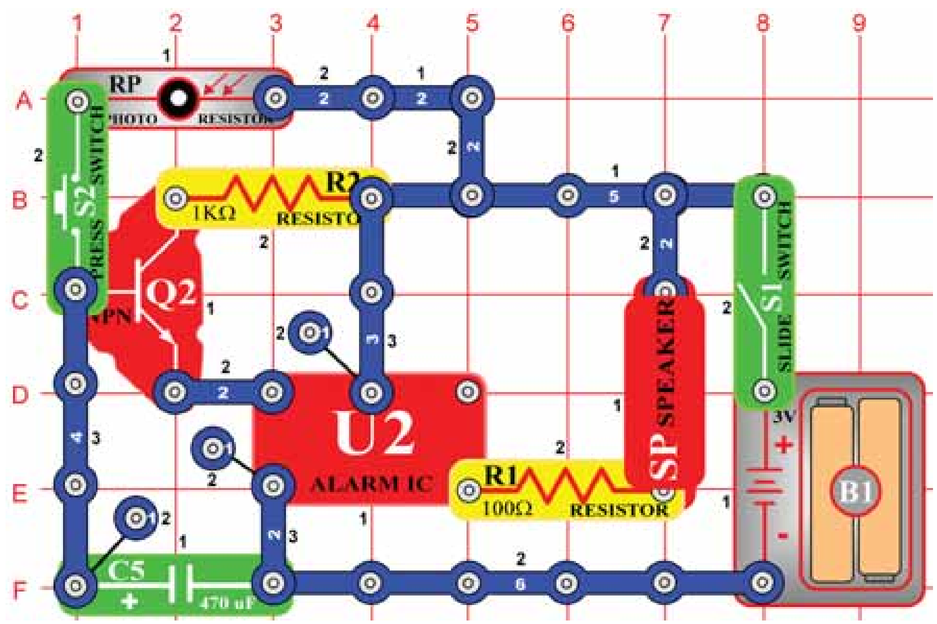
Push the press switch (S2). If the fan is off the motor (or flies off) then the LED will light.

It takes a lot of current to spin the motor when the fan is on it, and the voltage drops because the batteries 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 #92 Slow Siren Changer



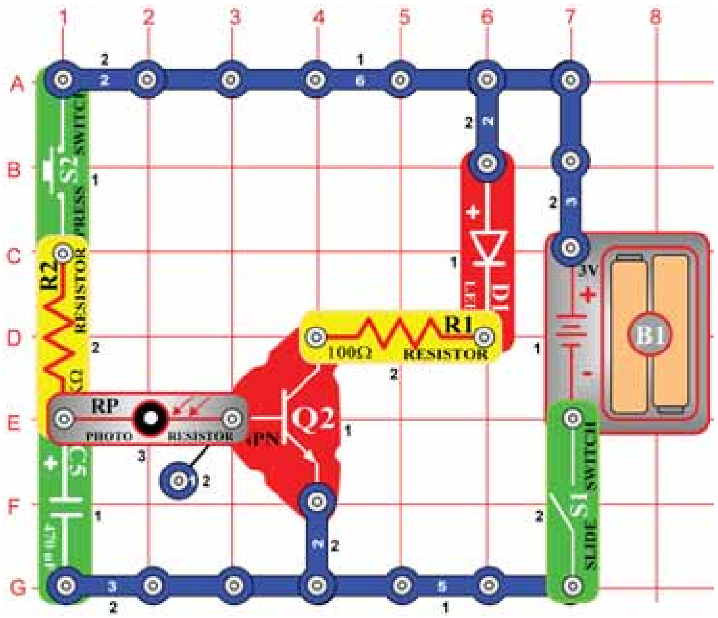
OBJECTIVE: To change siren sounds with a delay.

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 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).

Project #93 — Capacitor Photo Control

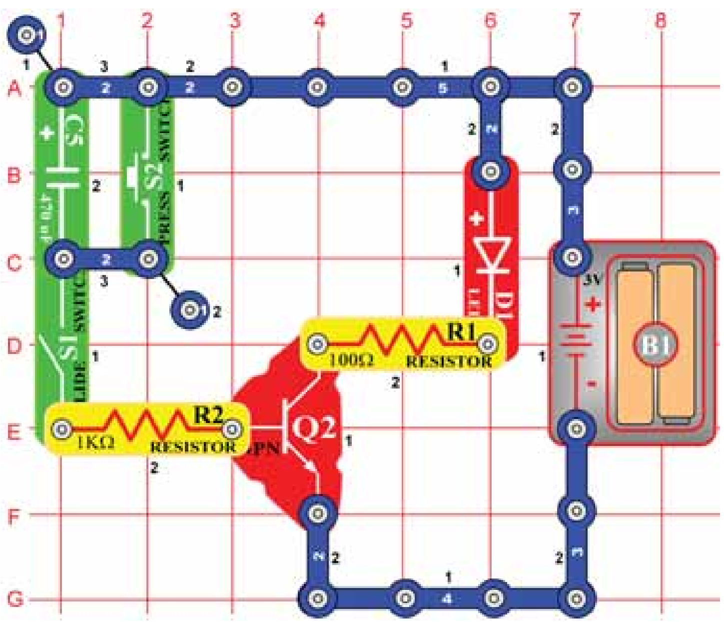


***OBJECTIVE:** To learn about a device that is used to delay actions in electronics.*

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 #94 — Capacitor Control



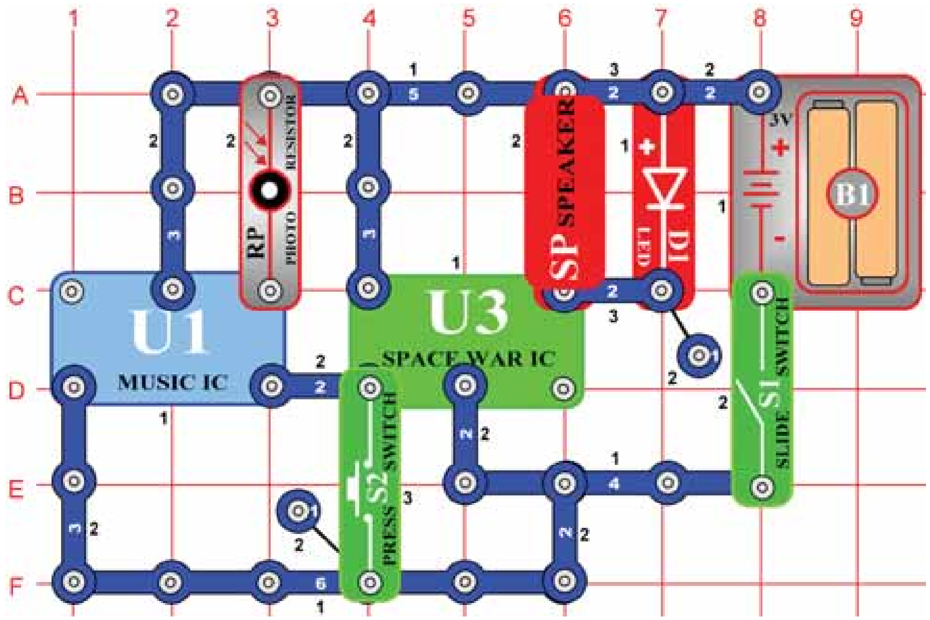
***OBJECTIVE:** To learn about a device that is used to delay actions in electronics.*

Build the circuit and turn on the slide switch (S1). The LED 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 #95

Photo Space War with LED

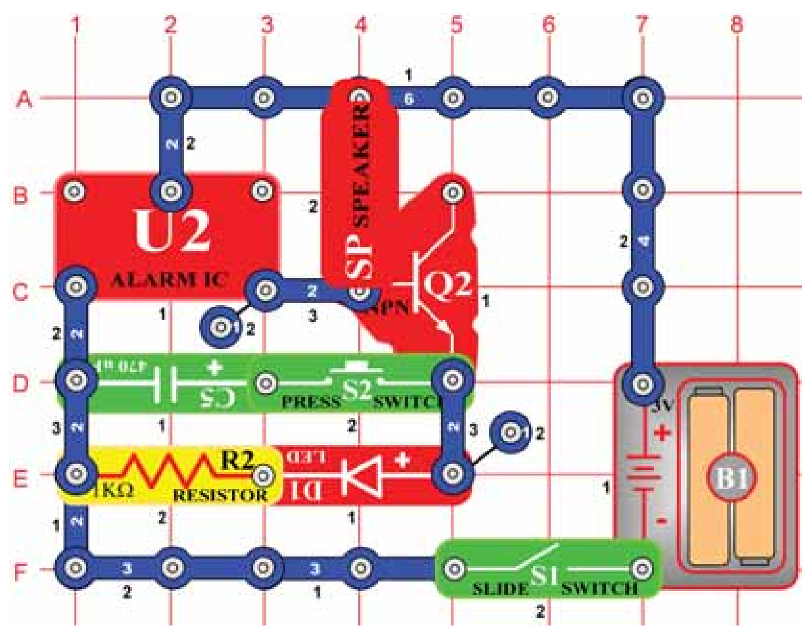


OBJECTIVE: To build a circuit that uses a programmed sound IC.

Set the slide switch on, a space war sound plays and the LED flashes. Push the press switch (S2) to change the sound. If the photoresistor (RP) is covered then the sound may stop, shine light on it and action resumes. See how many sounds are programmed into the space war sound IC (U3).

☐ Project #96

Alarm Rectifier

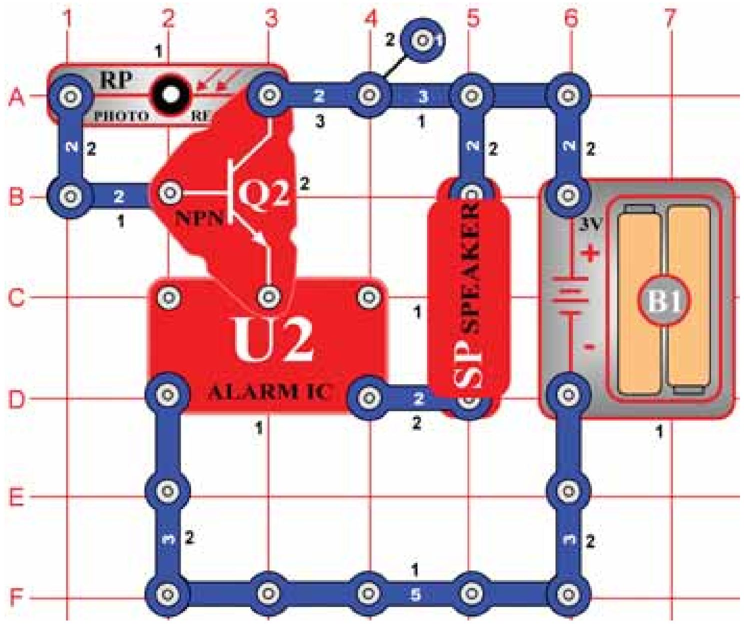


OBJECTIVE: To convert a changing voltage into a constant voltage.

Build the circuit and turn on the slide switch (S1). The LED is flashing and the speaker makes a siren sound. Now push the press switch (S2) to connect the 470µF capacitor (C5) to the circuit. The LED is brighter and stopped 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 instead of flashing

Project #97 — Light-controlled Alarm

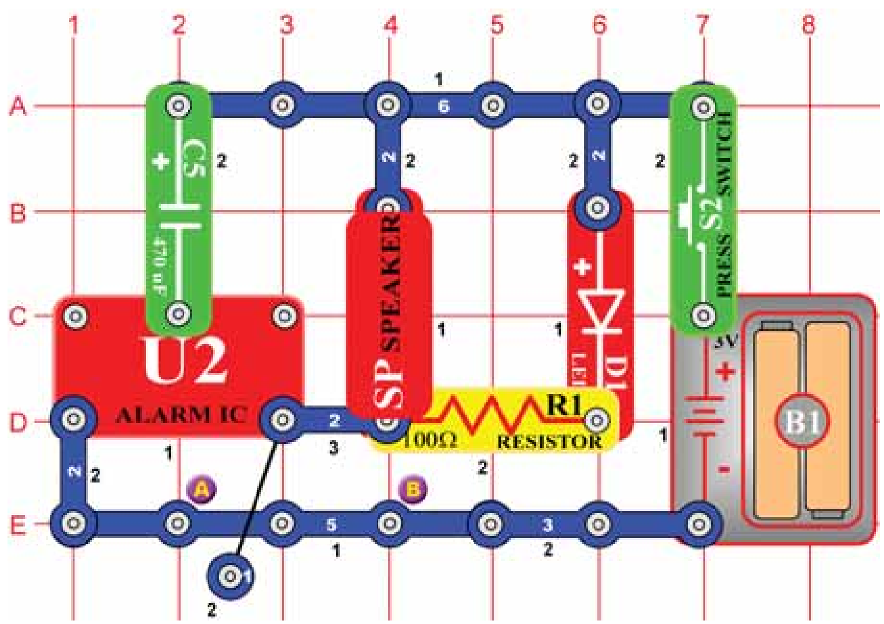


OBJECTIVE: To show how light is used to turn an alarm.

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 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 #98 — Fading Siren

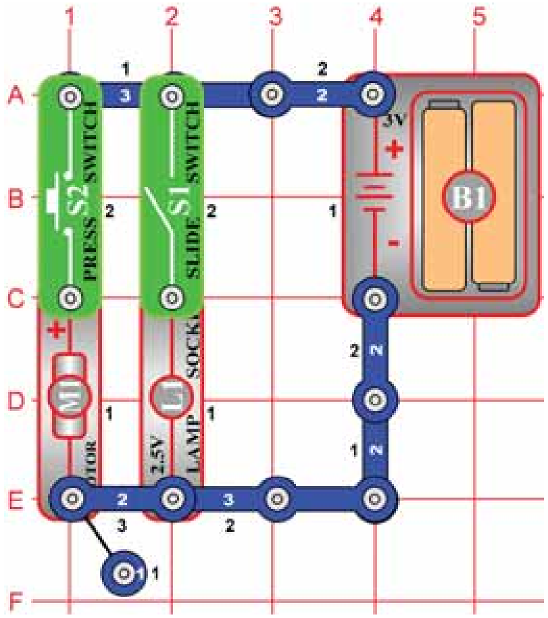


OBJECTIVE: To produce sound of a siren driving away into the distance.

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 #99 Lamp & Fan Independent



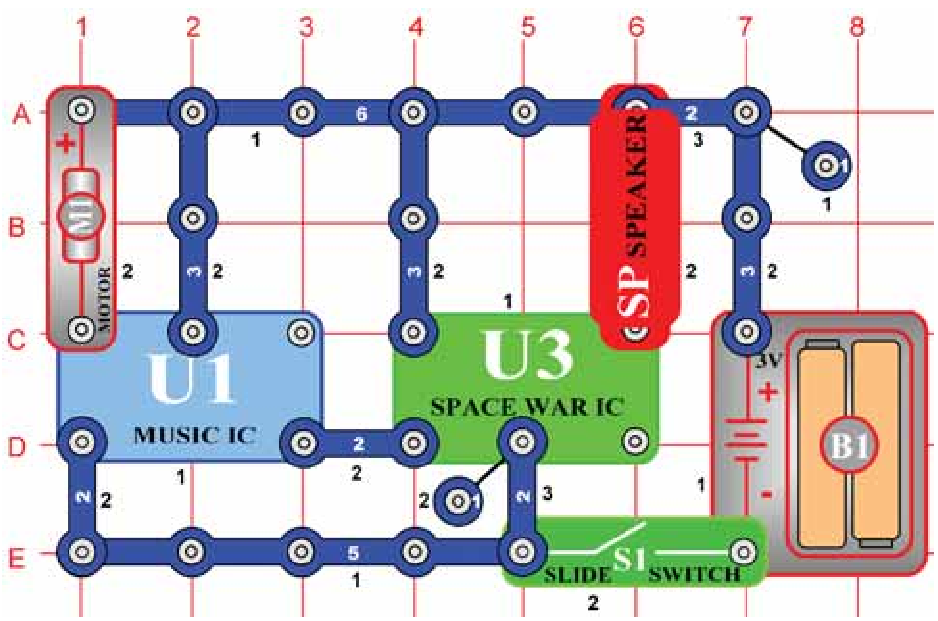
OBJECTIVE: To show how switches allow circuits to operate independently even though they have the same power source.

This circuit combines projects #1, #2, and #6 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 (project #1), the motor (project #2), or both together (project #6).

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

Project #100 Motor Space Sounds



OBJECTIVE: To build a circuit that uses a motor to activate space war sounds.

Turn it on and wait for any sounds to stop then spin the motor 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 #101 Motor Space Light

OBJECTIVE: To build a circuit that uses a motor to activate a light diode.

This circuit is loud and may bother other people around you so replace the speaker with the LED (D1), (position it like in project #77); the circuit operates in the same manner.

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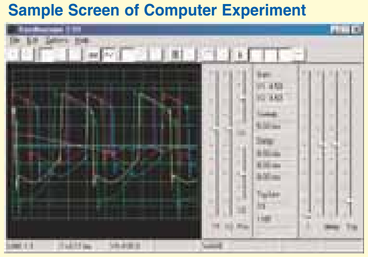

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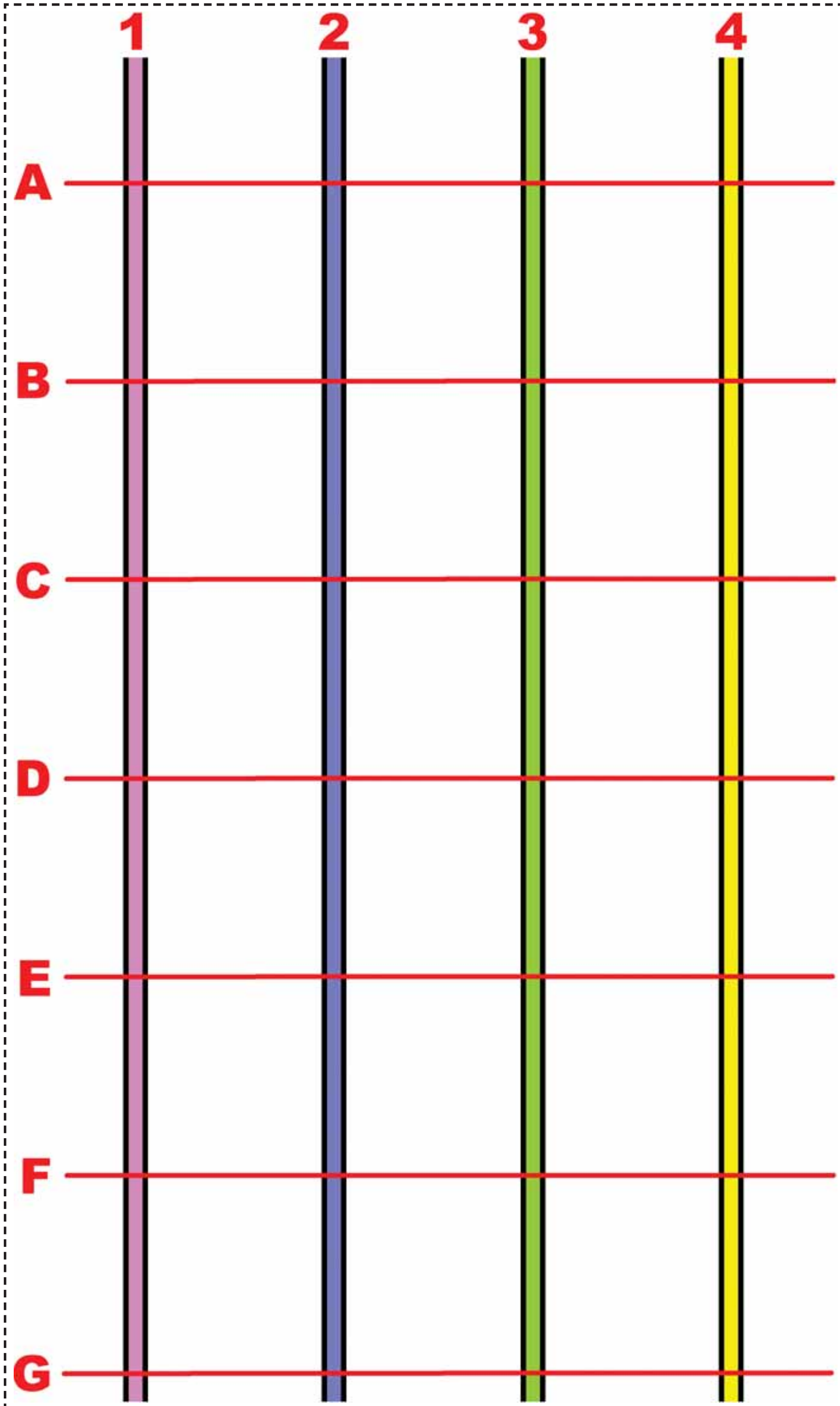
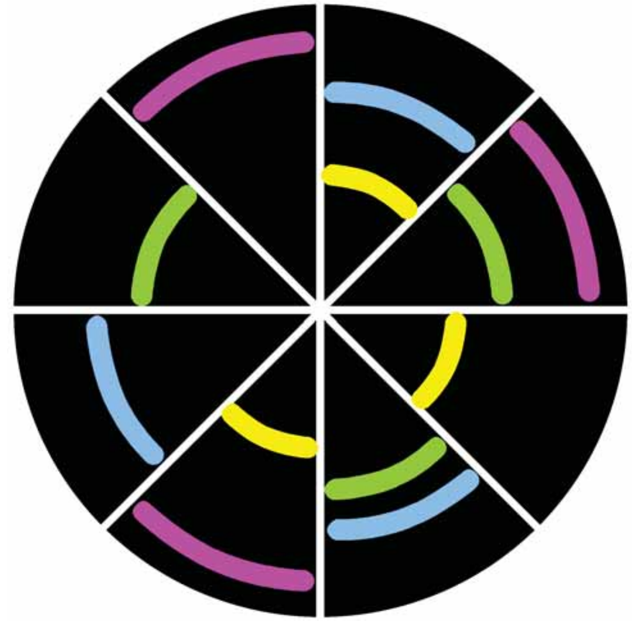
Requires "9V" and 6 "AA" batteries, not included.





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