SNAP CIRCUITS®

ELENCO

SNAP CIRCUITS® CLASSIC

Simply Snap Together!

Makes learning electronics a snap!

Go to shop.elenco.com/consumers/snap-circuits-classic.html to download projects 151-305

LEARN THE FUNDAMENTALS OF ELECTRICITY

ACTIVATE AERIAL STUNTS

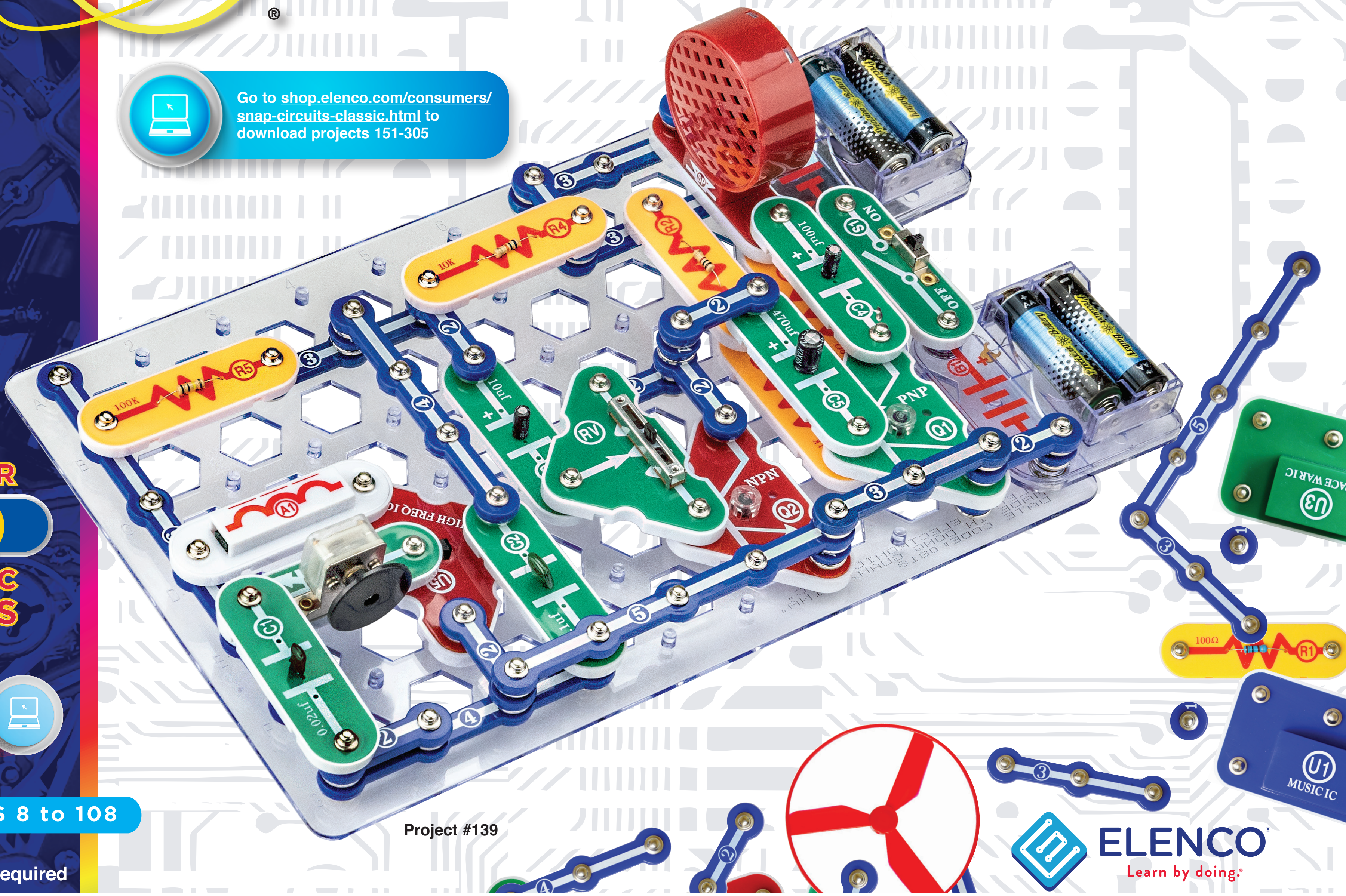
FUN SOUNDS

BUILD OVER 300 ELECTRONIC PROJECTS

PRINTED 150

150+ ONLINE

AGES 8 to 108



Project #139

ELENCO®

Learn by doing.®

Four (4) “AA” batteries required

Patent # 7144255

SOURCE CODE:SC-300V1

753114

Table of Contents

Go to shop.elenco.com/consumers/snap-circuits-classic.html to download projects 151-305

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.

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

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

Conforms to all applicable U.S. government requirements and CAN ICES-3 (B)/NMB-3 (B).

Basic Troubleshooting

1. Most circuit problems are due to incorrect assembly, always double-check that your circuit exactly matches the drawing for it.
2. Be sure that parts with positive/negative markings are positioned as per the drawing.
3. Be sure that all connections are securely snapped.
4. Try replacing the batteries.
5. 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.

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

Note: If you suspect you have damaged parts, follow the Advanced Troubleshooting procedure on page 7 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.
- When installing a battery, be sure the spring is compressed straight back, and not bent up, down, or to one side.
- Battery installation should be supervised by an adult.

How To Use It

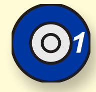
Snap Circuits® uses building blocks with snaps to build the different electrical and electronic circuits in the projects. Each block has a function: there are switch blocks, lamp blocks, battery blocks, different length wire blocks, etc. These blocks are in different colors and have numbers on them so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

For Example:

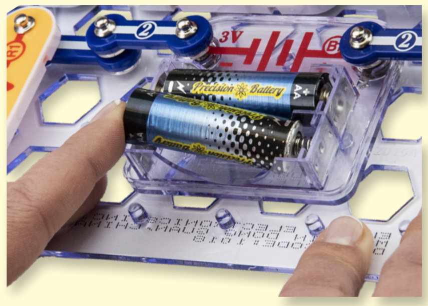
This is the switch block which is green and has the marking S1 on it as shown in the drawings. Please note that the drawing doesn't reflect the real switch block exactly (it is missing the ON and OFF markings), but gives you the general idea of which part is being used in the circuit.

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.

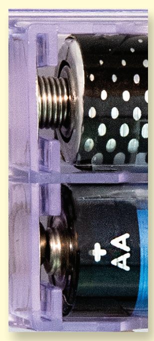
This is a 1-snap wire that is used as a spacer or for interconnection between different layers.



To build each circuit, you have a power source block number B1 that needs two (2) "AA" batteries (not included with the Snap Circuits® kit).



When installing a battery, be sure the spring is compressed straight back, and not bent up, down, or to one side. Battery installation should be supervised by an adult.

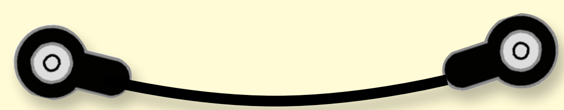


A large clear plastic base grid is included with this kit to help keep the circuit blocks properly spaced. You will see evenly spaced posts that the different blocks snap into. You do not need this base to build your circuits, but it does help in keeping your circuit together neatly. The base has rows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

Usually when the motor M1 is used, the fan will usually 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.

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

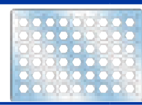
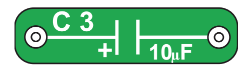
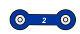
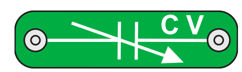
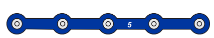
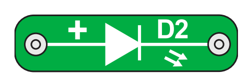
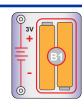


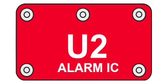
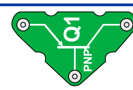
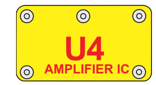
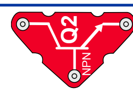
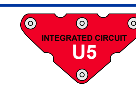
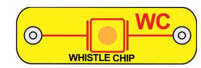
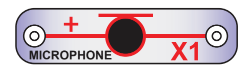
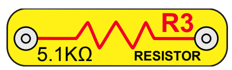
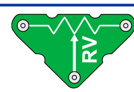
Note: While building circuits, be careful not to accidentally make a direct connection across the battery holder (a "short circuit"), as this may damage and/or quickly drain the batteries.

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

Note: If you have the more advanced Models SC-300, SC-500, or SC-750, there are additional part lists in the other project manuals.

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.

Qty.	ID	Name	Symbol	Part #	Qty.	ID	Name	Symbol	Part #
❐ 1		Base Grid (11.0” x 7.7”)		6SCBG	❐ 1	C2	0.1μF Capacitor		6SCC2
❐ 6	1	1-Snap Wire		6SC01	❐ 1	C3	10μF Capacitor		6SCC3
❐ 9	2	2-Snap Wire		6SC02	❐ 1	C4	100μF Capacitor		6SCC4
❐ 4	3	3-Snap Wire		6SC03	❐ 1	C5	470μF Capacitor		6SCC5
❐ 2	4	4-Snap Wire		6SC04	❐ 1	CV	Variable Capacitor		6SCCV
❐ 1	5	5-Snap Wire		6SC05	❐ 1	D1	Red Light Emitting Diode (LED)		6SCD1
❐ 1	6	6-Snap Wire		6SC06	❐ 1	D2	Green Light Emitting Diode (LED)		6SCD2
❐ 1	7	7-Snap Wire		6SC07	❐ 1		Jumper Wire (Black)		6SCJ1
❐ 1	A1	Antenna Coil		6SCA1	❐ 1		Jumper Wire (Red)		6SCJ2
❐ 2	B1	Battery Holder - uses 2 1.5V type AA (not Included)		6SCB1	❐ 1	L1	2.5V or 3V Lamp		6SCL1
❐ 1	C1	0.02μF Capacitor		6SCC1	❐ 1	L2	6V Lamp		6SCL2

Qty.	ID	Name	Symbol	Part #	Qty.	ID	Name	Symbol	Part #
❒ 1	(M1)	Motor		6SCM1	❒ 1	(U2)	Alarm Integrated Circuit		6SCU2
❒ 1		Fan		6SCM1F	❒ 1	(U3)	Space War Integrated Circuit		6SCU3
❒ 1	(Q1)	PNP Transistor		6SCQ1	❒ 1	(U4)	Power Amplifier Integrated Circuit		6SCU4
❒ 1	(Q2)	NPN Transistor		6SCQ2	❒ 1	(U5)	High Frequency Integrated Circuit		6SCU5
❒ 1	(R1)	100Ω Resistor		6SCR1	❒ 1	(WC)	Whistle Chip		6SCWC
❒ 1	(R2)	1kΩ Resistor		6SCR2	❒ 1	(X1)	Microphone		6SCX1
❒ 1	(R3)	5.1kΩ Resistor		6SCR3					
❒ 1	(R4)	10kΩ Resistor		6SCR4					
❒ 1	(R5)	100kΩ Resistor		6SCR5					
❒ 1	(RP)	Photoresistor		6SCRP					
❒ 1	(RV)	Adjustable Resistor		6SCRV					
❒ 1	(S1)	Slide Switch		6SCS1					
❒ 1	(S2)	Press Switch		6SCS2					
❒ 1	(SP)	Speaker		6SCSP					
❒ 1	(U1)	Music Integrated Circuit		6SCU1					

You may order additional / replacement parts at our website: www.elenco.com/replacement-parts/

About Your Snap Circuits® Parts

Our Student Guides give much more information about your parts along with a complete lesson in basic electronics. See www.elenco.com/faqs for more information.

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

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 "resist" the flow of electricity and are used to control or limit the electricity in a circuit. Snap Circuits® includes **100Ω (R1), 1KΩ (R2), 5.1KΩ (R3), 10KΩ (R4), and 100KΩ (R5) resistors** ("K" symbolizes 1,000, so R3 is really 5,100Ω). Materials like metal have very low resistance (<1Ω) and are called conductors, while materials like paper, plastic, and air have near-infinite resistance and are called insulators. Increasing circuit resistance reduces the flow of electricity.

The **adjustable resistor (RV)** is a 50KΩ resistor but with a center tap that can be adjusted between 0Ω and 50KΩ. At the 0Ω setting, the current must be limited by the other components in the circuit.

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.

The **microphone (X1)** is actually a resistor that changes in value when changes in air pressure (sounds) apply pressure to its surface. Its resistance typically varies from around 1KΩ in silence to around 10KΩ when you blow on it.

A light bulb, such as in the **2.5V and 6V lamps (L1 and L2)**, 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 electricity 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 three coils of wire with many loops. If a large electric current flows through the loops, the magnetic effects become concentrated enough to move the coils. The motor has a magnet inside so, as the electricity moves the coils to align them with the permanent 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.

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

The **red and green LEDs (D1 and D2)** are light emitting diodes, 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 for red and 2V for green); brightness then increases. A high current will burn out the LED, Snap Circuits® LEDs have internal resistors to protect them. LEDs block electricity in the "reverse" direction.

Capacitors are components that can store electrical pressure (voltage) for periods of time, higher values have more storage. Because of this storage ability they block unchanging voltage signals and pass fast changing voltages. Capacitors are used for filtering and oscillation circuits. Snap Circuits® includes **0.02μF (C1), 0.1μF (C2), 10μF (C3), 10μF (C4), 470μF (C5) capacitors, and a variable capacitor (CV).** The variable capacitor can be adjusted from .00004 to .00022μF and is used in high frequency radio circuits for tuning. The whistle chip (WC) also acts like a 0.02μF capacitor in addition to its sound properties.

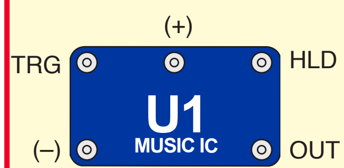
The **antenna (A1)** contains a coil of wire wrapped around an iron bar. Although it has magnetic effects similar to those in the motor, those effects are tiny and may be ignored except at high frequencies (like in AM radio).

About Your Snap Circuits® Parts

Its magnetic properties allow it to concentrate radio signals for reception. At lower frequencies the antenna acts like an ordinary wire.

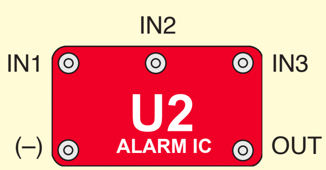
The **PNP (Q1) and NPN (Q2) transistors** are components that use a small electric current to control a large current, and are used in switching, amplifier, and buffering applications. They are easy to miniaturize, and are the main building blocks of integrated circuits including the microprocessor and memory circuits in computers. Projects #65-66 demonstrate their properties. 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 Circuits® 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:



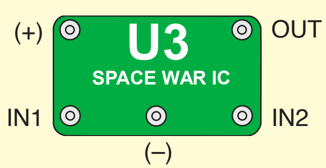
Music IC:
(+) - power from batteries
(–) - power return to batteries
OUT - output connection
HLD - hold control input
TRG - trigger control input

Music for a few seconds 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

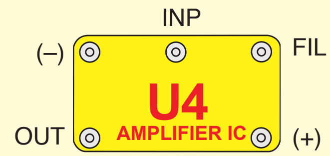
Connect control inputs to (+) power to make five alarm sounds, see project 14 for configurations.



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.

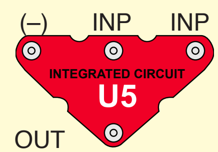
The **power amplifier IC (U4)** is a module containing an integrated circuit amplifier and supporting components that are always needed with it. A description of it is given here for those interested:



Power Amplifier IC:
(+) - power from batteries
(–) - power return to batteries
FIL - filtered power from batteries
INP - input connection
OUT - output connection

See project #52 for example of connections.

The **high frequency IC (U5)** is a specialized amplifier used only in high frequency radio circuits. A description of it is given here for those interested:



High Frequency IC:
INP - input connection (2 points are same)
OUT - output connection
(–) power return to batteries

See project #52 for example of connections.

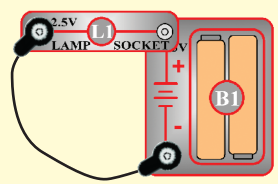
Advanced Troubleshooting (Adult supervision recommended)

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

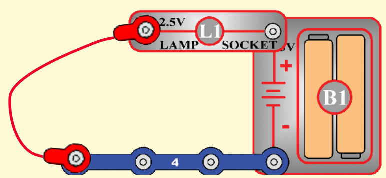
If you suspect you have damaged parts, you can follow this procedure to systematically determine which ones need replacing:

1. **2.5V/3V lamp (L1), 6V lamp (L2), motor (M1), speaker (SP), and battery holder (B1):** Place batteries in holder. Place each lamp directly across the battery holder, each should light and L1 should be brighter. 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.

2. **Jumper wires:** Use this mini-circuit to test each jumper wire, the lamp should light.



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



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

5. **100Ω (R1), 1KΩ (R2), 5.1KΩ (R3), and 10KΩ (R4) resistors, red LED (D1), and green LED (D2):** Build project #7 except initially use the speaker (SP) in place of the resistor, the red LED should light. Replace the red LED with the green LED and it should light. Then replace the speaker with each resistor; the LED should light and the brightness decreases with the higher value resistors.

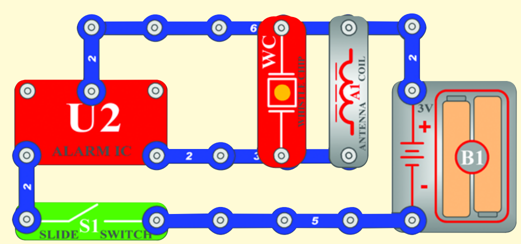
6. **Alarm IC (U2):** Build project #14, you should hear a siren. Then place a 3-snap wire between grid locations A1 and C1, the sound is different. Then move the 3-snap from A1-C1 to A3-C3 to hear a 3rd sound.

7. **Music IC (U1):** Build project #13. Turn it on and the sound plays 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 sound resumes for a while.

8. **Space war IC (U3) and photoresistor (RP):** Build project #15, both switches (S1 and S2) should change the sound. Then replace the slide switch with the photoresistor, waving your hand over it should change the sound.

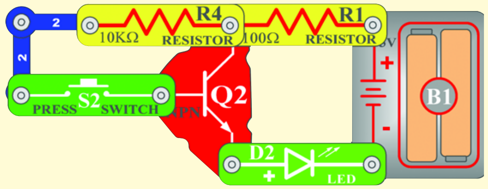
9. **Whistle chip (WC):** Build project #35 and if there is light on the photoresistor (RP) then you will hear sound from the whistle chip.

10. **Antenna (A1):** Build the mini-circuit shown here, you should hear sound.

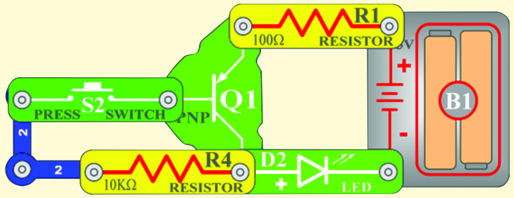


Advanced Troubleshooting (Adult supervision recommended)

11. **NPN transistor (Q2):** Build the mini-circuit shown here. The LED (D2) should only be on if the press switch (S2) is pressed. If otherwise, then the NPN is damaged.



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



13. **Adjustable resistor (RV):** Build project #65, the resistor control can turn the Lamp (L2) on and off.

14. **100ΩK resistor (R5) and 0.02μF (C1), 0.1μF (C2), and 10μF (C3) capacitors:** Build project #147, it makes sound unless the resistor is bad. Place the 0.02μF capacitor on top of the whistle chip (WC) and the sound changes (pitch is lower). Replace the 0.02μF with the 0.1μF and the pitch is even lower. Replace the 0.1μF with the 10μF and the circuit will “click” about once a second.

15. **100μF (C4) and 470μF (C5) capacitors:** Build project #120, press the press switch (S2) and turn on the slide switch (S1). The LED (D1) should be lit for about 15 seconds then go out (press the press switch again to reset this). Replace the 470μF with the 100μF and the LED is only lit for about 4 seconds now.

16. **Power Amplifier IC (U4):** Build project 124, adjusting RV should change the sound.

17. **Microphone (X1):** Build project #23, blowing into the microphone should turn off the lamp (L2).

18. **Variable Capacitor (CV):** Build project #113 and place it near an AM radio, tune the radio and the capacitor to verify you hear the music on your radio.

19. **High Frequency IC (U5):** Build project #52 and adjust the variable capacitor (CV) and adjustable resistor (RV) until you hear a radio station.

ELENCO®

150 Carpenter Avenue
Wheeling, IL 60090 U.S.A.

Phone: (847) 541-3800
Fax: (847) 520-0085
e-mail: help@elenco.com
Website: www.elenco.com

You may order additional / replacement parts at:
www.elenco.com/replacement-parts/

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, 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. **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, whistle chip, capacitors, ICs (which must be connected properly), motor, microphone, photoresistor, or resistors (the adjustable resistor doesn't count if it's set at/near minimum resistance).

ALWAYS use transistors, the high frequency IC, the antenna, 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 connect the adjustable resistor so that if set to its 0 setting, the current will be limited by other components in the circuit.

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

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

NEVER try to use the high frequency IC as a transistor (the packages are similar, but the parts are different).

NEVER use the 2.5V lamp in a circuit with both battery holders unless you are sure that the voltage across it will be limited.

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.

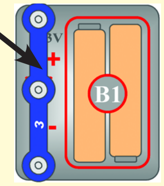
For all of the projects given in this book, the parts may be arranged in different ways without changing the circuit. For example, the order of parts connected in series or in parallel does not matter — what matters is how combinations of these sub-circuits are arranged together.

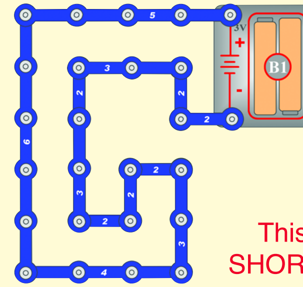
Warning to Snap Circuits® owners: Do not connect additional voltage sources from other sets, or you may damage your parts. Contact ELENCO® if you have questions or need guidance.

Examples of SHORT CIRCUITS - NEVER DO THESE!!!

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

NEVER DO!



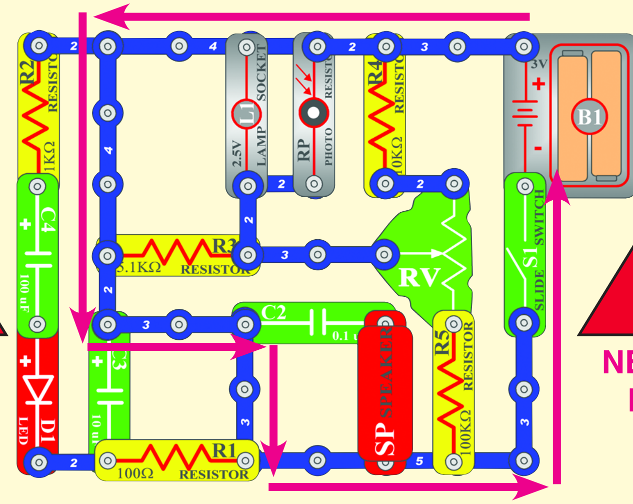


NEVER DO!

This is also a SHORT CIRCUIT.

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

NEVER DO!



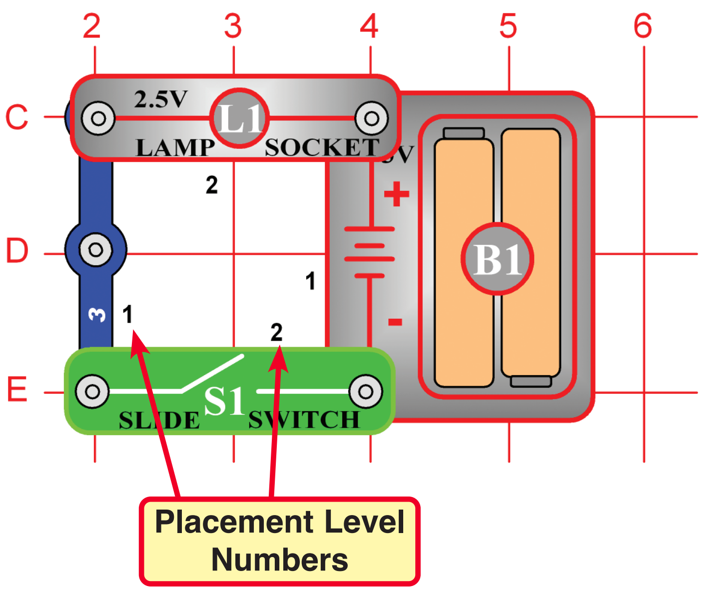
NEVER DO!

You are encouraged to tell us about new circuits you create. If they are unique, we will post them with your name and state on our website at **www.elenco.com/for-makers**. Send your suggestions to Elenco@elenco.com.

Elenco® provides a circuit designer so that you can make your own Snap Circuits® drawings. This Microsoft® Word document can be downloaded from **www.elenco.com/for-makers.**

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

Project #1



Electric Light & Switch

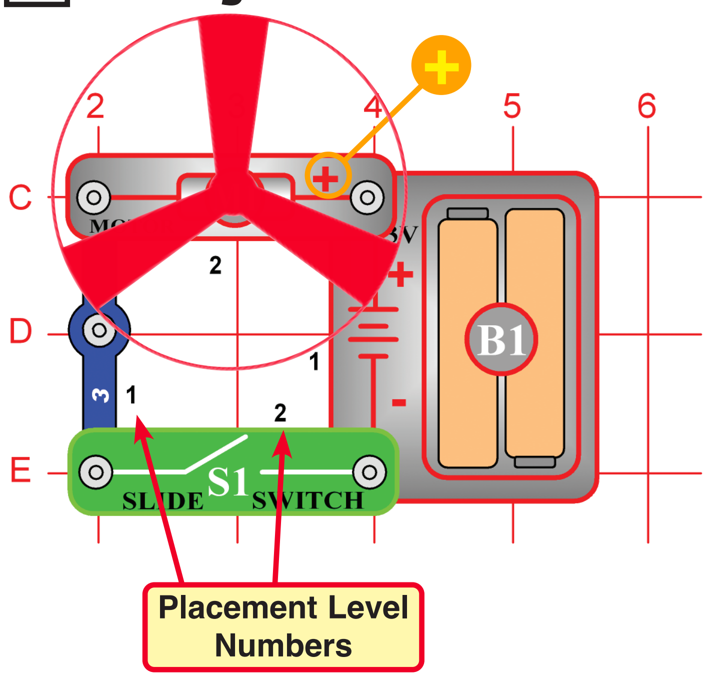
OBJECTIVE: To show how electricity is turned "ON" or "OFF" with a switch.

Build the circuit shown on the left by placing all the parts with a black 1 next to them on the base grid first. Then, assemble parts marked with a 2. Install two (2) "AA" batteries (not included) into the battery holder (B1). **When installing a battery, be sure the spring is compressed straight back, and not bent up, down, or to one side. Battery installation should be supervised by an adult.**

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 slide 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.

You may have received a 3V lamp instead of a 2.5V lamp or socket, this will not affect any of your circuits.

Project #2



DC Motor & Switch

OBJECTIVE: To show how electricity is used to run a Direct Current (DC) Motor.

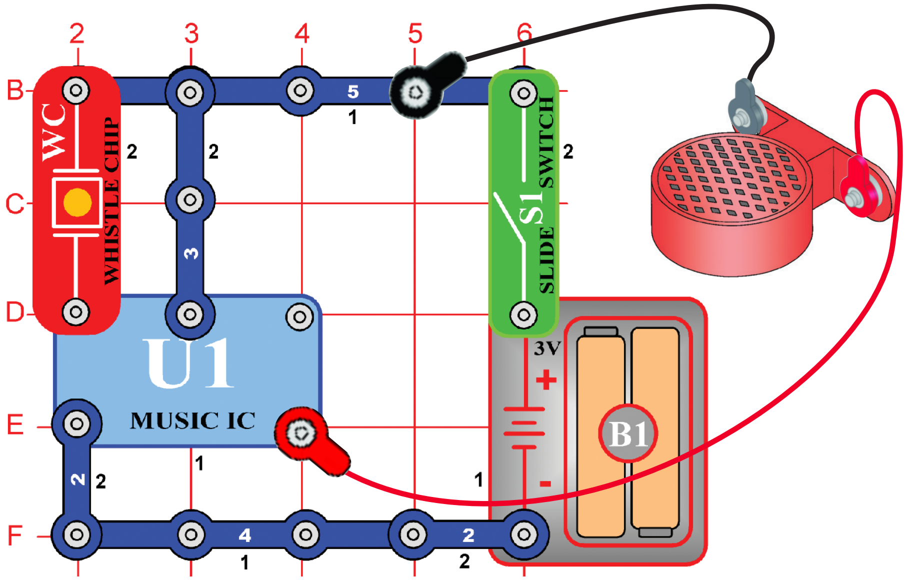
Build the circuit shown on the left by placing all the parts with a black 1 next to them on the base grid first. Then, assemble parts marked with a 2.

When you close the slide switch (S1), current flows from the batteries (B1) through the motor (M1) making it rotate. Place the fan blade on the motor shaft and close the slide switch. 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 toothbrush, 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. Do not lean over the motor.

☐ Project #3



Sound Activated Switch

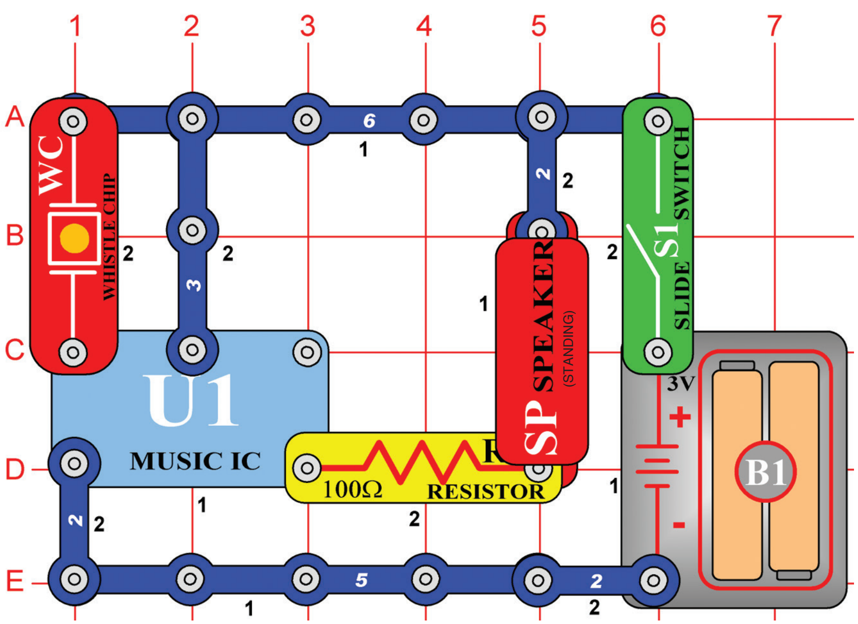
OBJECTIVE: To show how sound can turn "ON" an electronic device.

Build the circuit shown on the left by placing all the parts with a black **1** next to them on the base grid first. Then, assemble parts marked with a **2**. Finally, lay the speaker (SP) on the table and connect it to the circuit using the jumper wires as shown.

When you close the slide switch (S1), the music may play for a short time, and then stop. After the music has stopped, tap on the whistle chip (WC) and the music should play again. You may also be able to re-start the sound by clapping loudly next to the whistle chip or by blowing on it.

You could connect the speaker using snap wires instead of the jumper wires, but then the speaker may create enough sound vibrations to re-activate the whistle chip.

☐ Project #4



Adjusting Sound Level

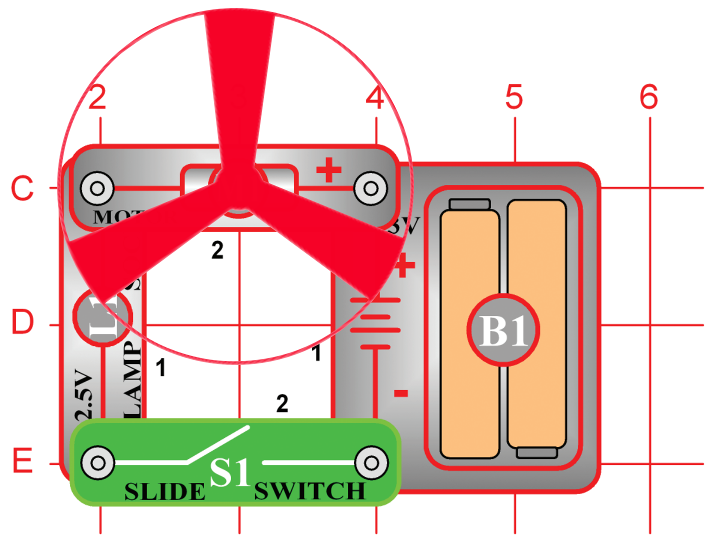
OBJECTIVE: To show how resistance can lower the sound from the speaker.

Build the circuit shown on the left. When you close the slide switch (S1), the music may play for a short time and then stop. After the music has stopped, tap on the whistle chip (WC) and the music should play again. You may also be able to re-start the sound by clapping loudly next to the whistle chip or by blowing on it.

In this project, you changed the amount of current that goes through the speaker (SP) and reduced 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 base grid first. Then, assemble parts marked with a 2. Finally, place the fan blade on the motor (M1).

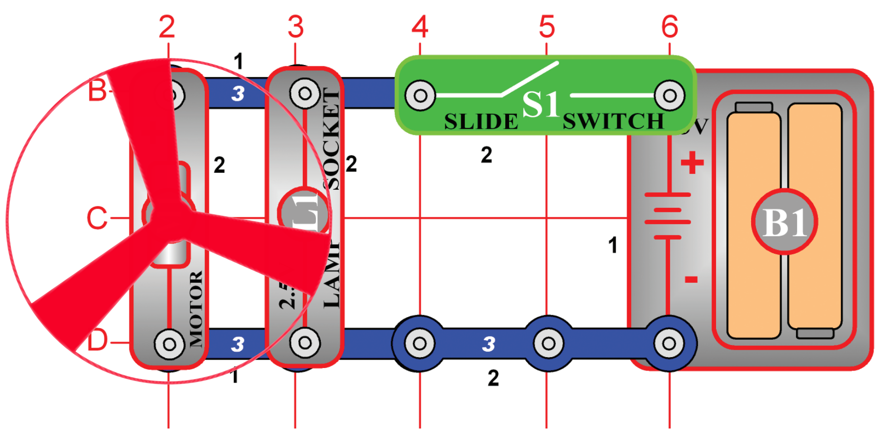
When you close the slide switch (S1), the fan will spin and the lamp (L1) should turn on. The fan will take a while to start turning due to inertia. Inertia is the property that tries to keep a body at rest from moving and tries to keep a moving object from stopping.

The light helps protect the motor from getting the full voltage when the slide switch is closed. 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. Do not lean over the motor.

☐ Project #6

Lamp & Fan in Parallel



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

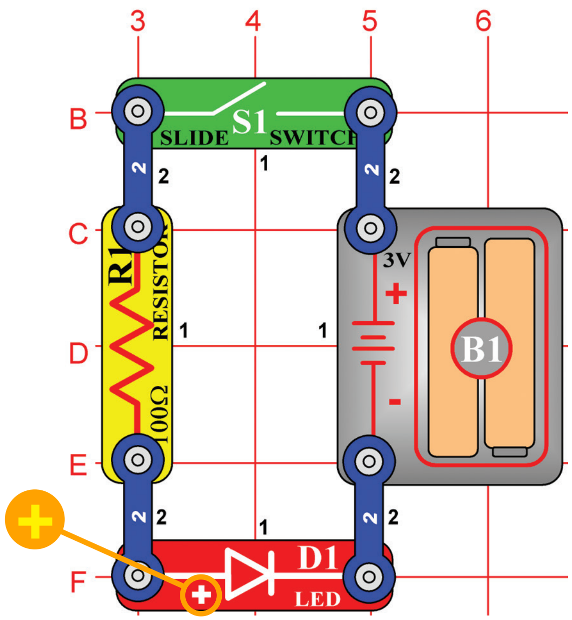
Build the circuit shown on the left.

When you close the slide switch (S1), both the fan and the 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 #5.

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. Do not lean over the motor.

Project #7



Light Emitting Diode

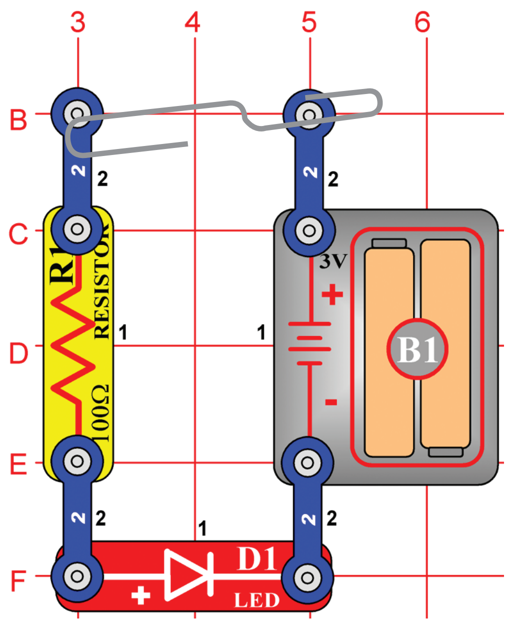
OBJECTIVE: To show how a resistor and LED are wired to emit light.

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

When you close the slide switch (S1), current flows from the batteries (B1) through the slide switch, through the resistor (R1), through the LED (light emitting diode, D1) and back to the battery. The closed slide 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



Conduction Detector

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

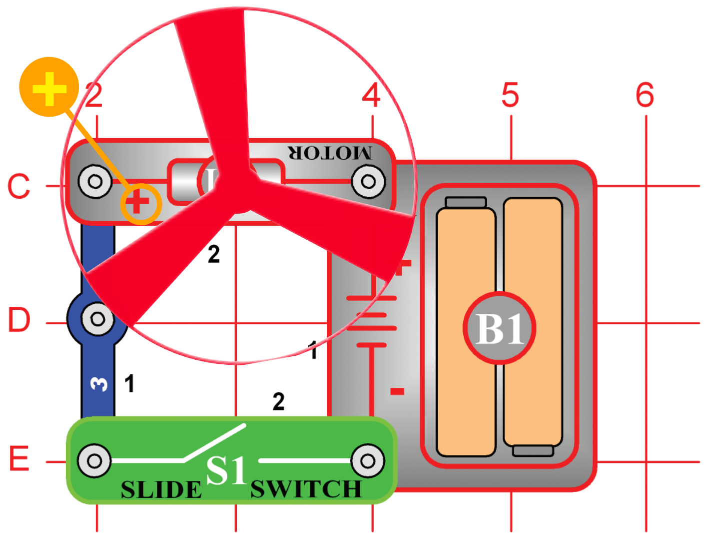
Rebuild the circuit from Project #7 but leave the slide switch (S1) out as shown on the left.

When you place a metal paper clip across the terminals as shown in the picture on the left, current flows from the batteries (B1) through the 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 has 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 #9

Flying Saucer

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



Rebuild the circuit from Project #2, but reverse the polarity on the motor (M1) so the negative (–) on the motor goes to the positive (+) on the battery (B1). New alkaline batteries are recommended for this project.

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 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.

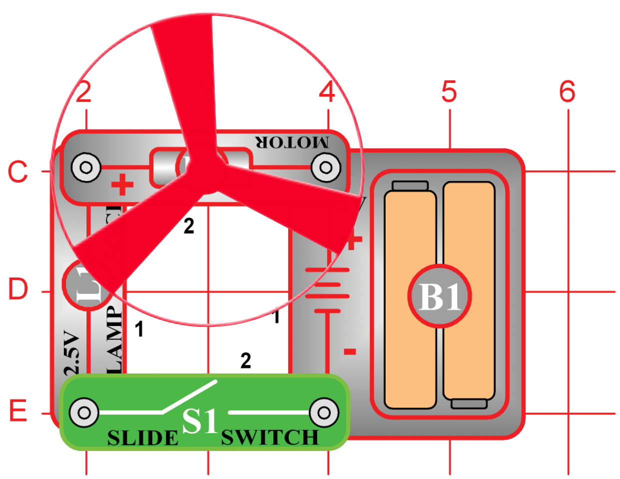
WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

WARNING: Fan may not rise until switch is released.

☐ Project #10

Decreasing Saucer Lift

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



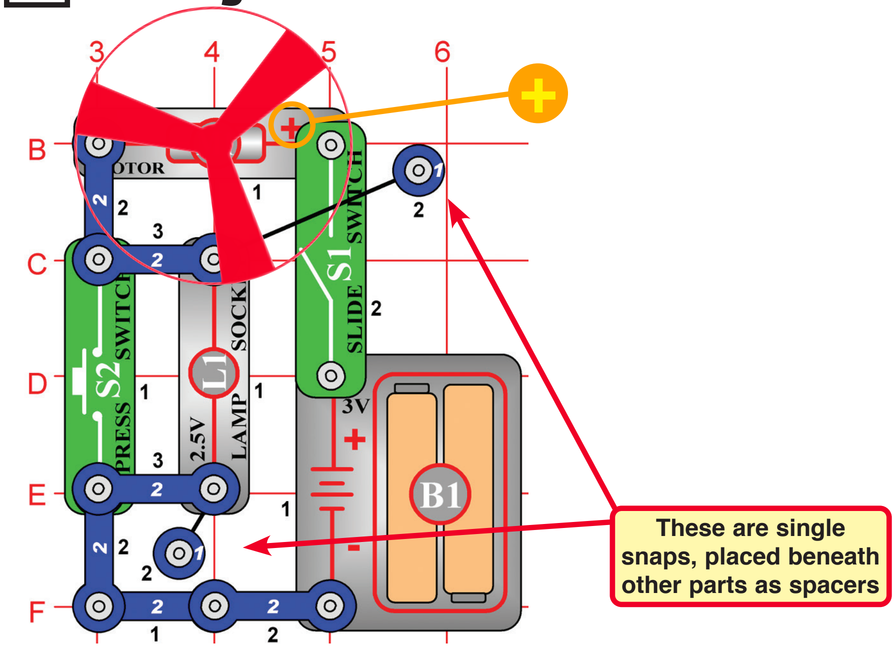
Change the circuit in Project #9 by adding the lamp (L1) in series with the motor as shown in the diagram on the left.

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. Do not lean over the motor.

WARNING: Fan may not rise until switch is released.

Project #11 — Two-Speed Fan



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

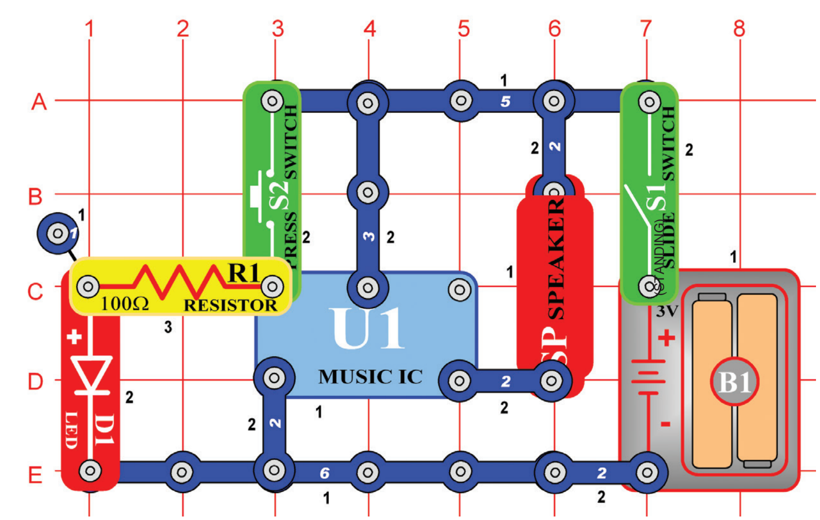
Build the circuit shown on the left by placing all the parts with a black 1 next to them on the board first. Then, assemble parts marked with a 2. Finally, add the 2-snap wires that are marked for level three.

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.

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

Project #12 — Musical Doorbell

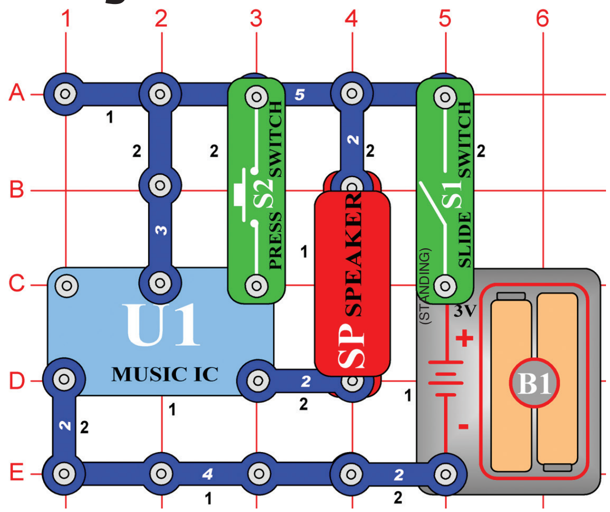


OBJECTIVE: To show how an integrated circuit can be used as a musical doorbell.

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 #13

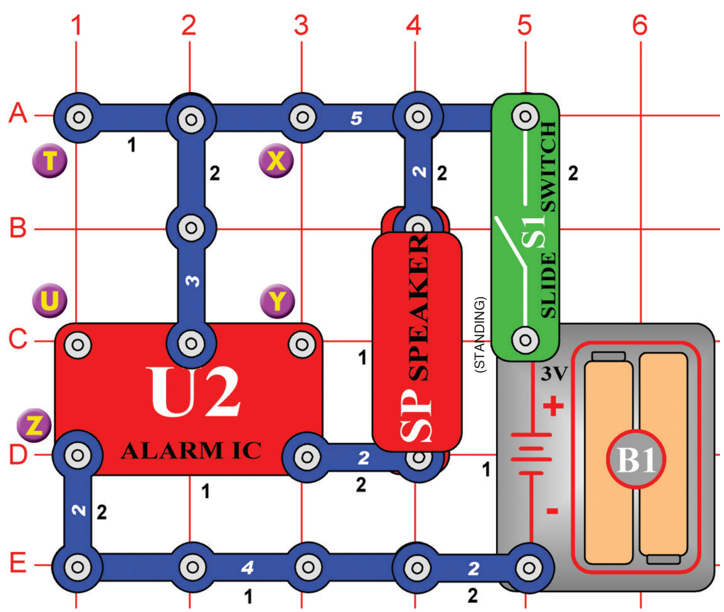


Momentary Alarm

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

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 #14



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 (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.

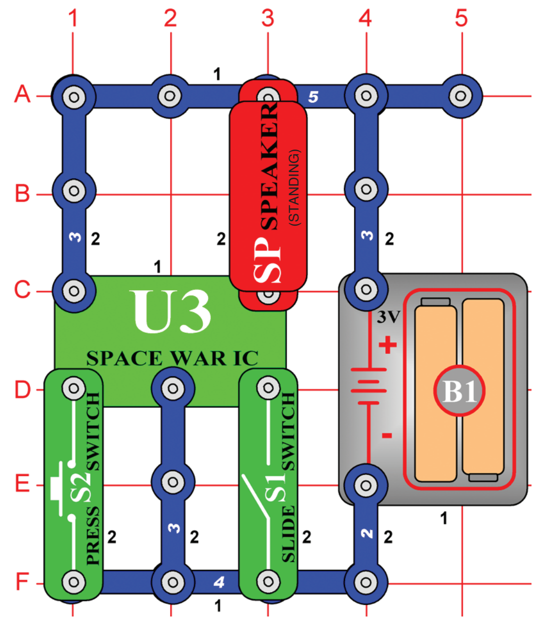
If the alarm sound was passed through an amplifier and installed into a police car, it would also serve as a good police siren.

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

Option B: 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.

Option C: 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 #15



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

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

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

Project #16
Light Switch

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

Use the circuit from Project #15 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".

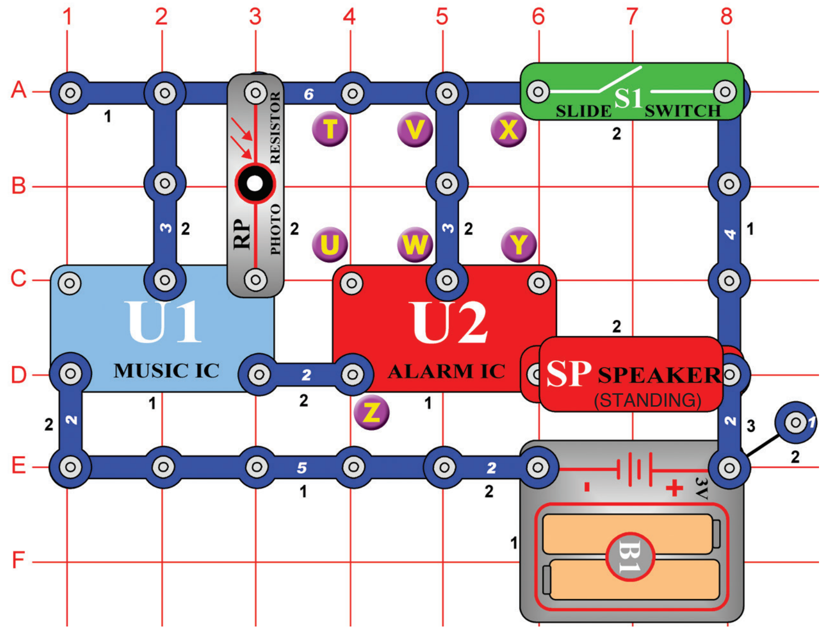
The photoresistor contains material that changes its resistance when it is exposed to light. As it gets more light, the resistance of the photoresistor decreases. Parts like this are used in a number of ways that affect our lives. For example, you may have streetlights in your neighborhood that turn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

Project #17
Paper Space War

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

Use the same circuit as for Project #16. 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 #18



Light Police Siren

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

Cover the photoresistor (RP) and turn on the slide 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 #19 More Loud Sounds

Modify the Project #18 by connecting points X & Y. The circuit works the same way but now it sounds like a machine gun with music.

Project #20 More Loud Sounds (II)

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.

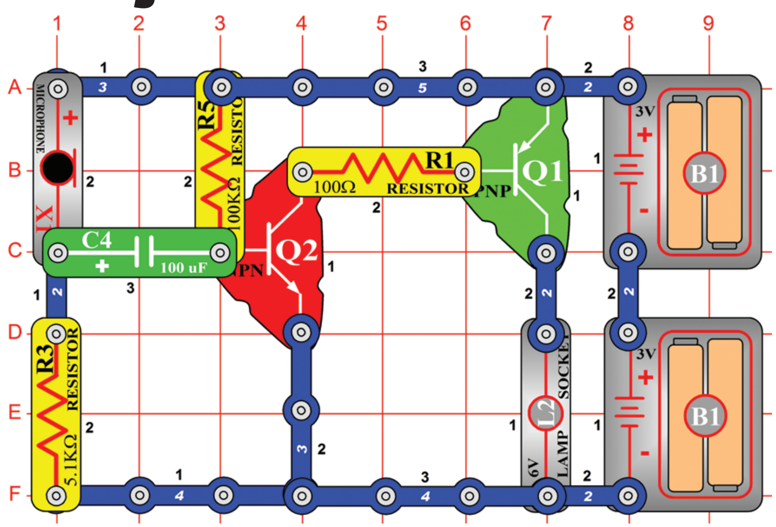
Project #21 More Loud Sounds (III)

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 #22 More Loud Sounds (IV)

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 #23

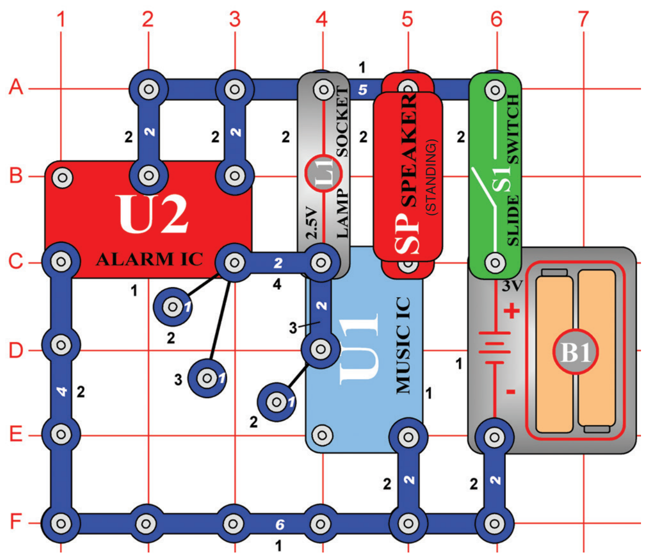


Blowing Off the Electric Light

OBJECTIVE: To show how light is stimulated by sound.

Install the parts. The lamp (L2) will be on. It will be off as long as you blow on the mic (X1). Speaking loud into the mic will change the brightness of the lamp.

Project #24



Periodic Sounds

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

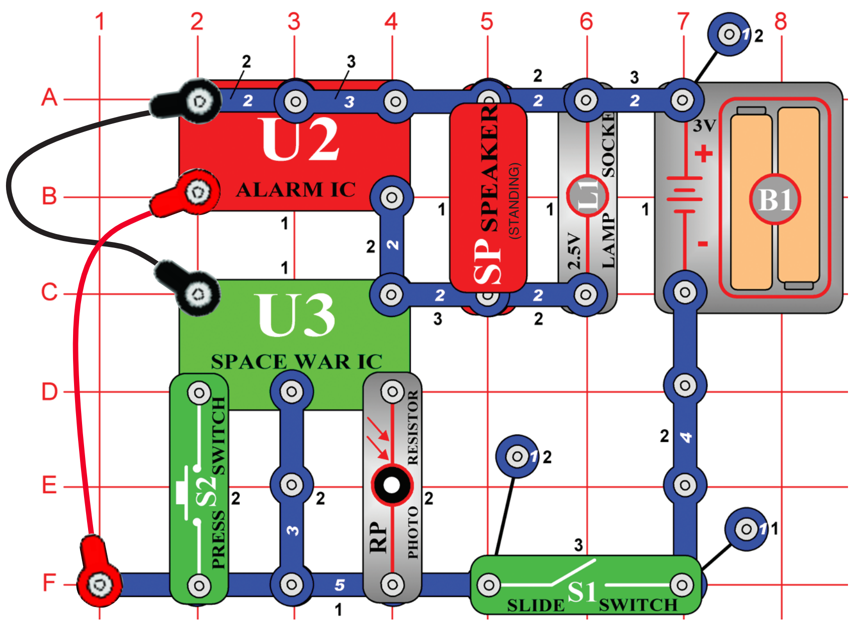
Build the circuit shown on the left and turn it on. The lamp (L1) alternates between being on and off while the speaker (SP) alternates between two musical tones... like someone is flipping a switch, but at a very consistent rate. Periodic signals like this are very important in electronics. The lamp may not be very bright.

Project #25 Blinking Double Flashlight

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

In the circuit at left, replace the speaker (SP) with the color LED (D8, "+" on top). The lamp alternates between being on and off while the LED alternates between being dimmer and brighter.

Project #26

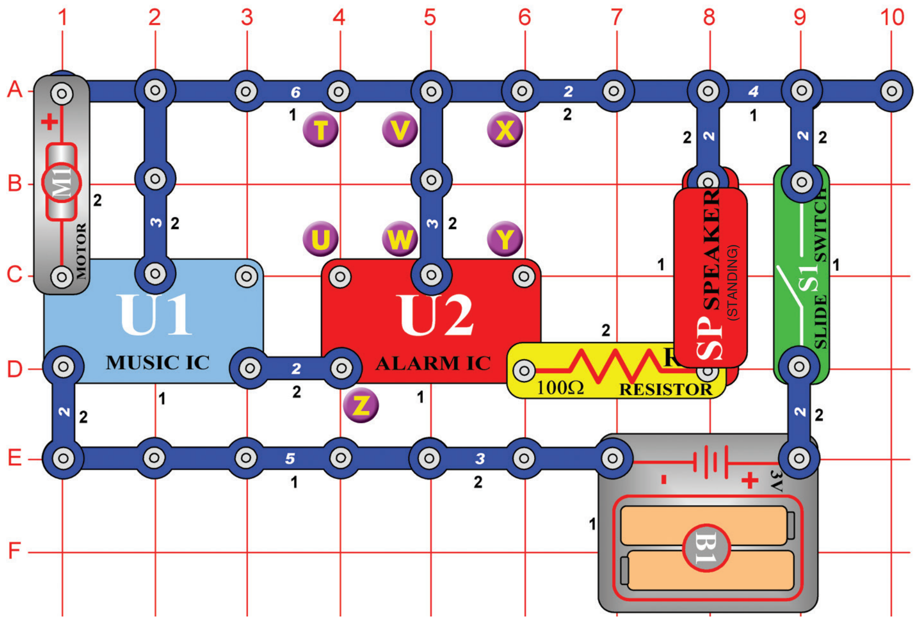


Space War Alarm Combo

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

Build the circuit shown and add the jumpers to complete it. Turn it on, press the press switch (S2) several times, and wave your hand over the photoresistor (RP) to hear all the sound combinations. If the sound is too loud you may replace the speaker (SP) with the whistle chip (WC).

Project #27 Motor-Controlled Sounds



OBJECTIVE: To show how motion can trigger electronic circuits.

This circuit is controlled by spinning the motor (M1) with your hands. Turn on the slide switch (S1). 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 #28 More Motor Sounds

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

Project #29 More Motor Sounds (II)

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

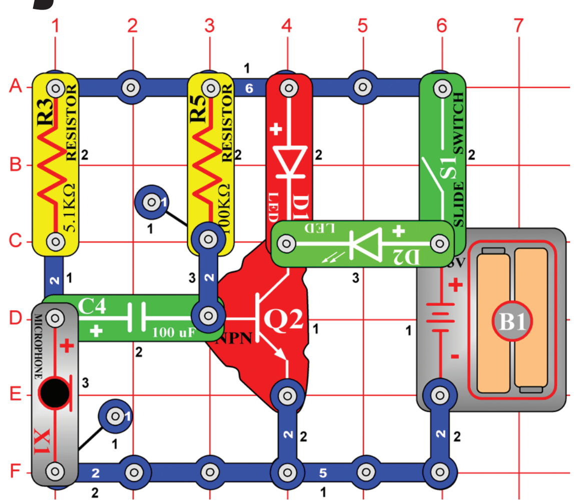
Project #30 More Motor Sounds (III)

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 #31 More Motor Sounds (IV)

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.

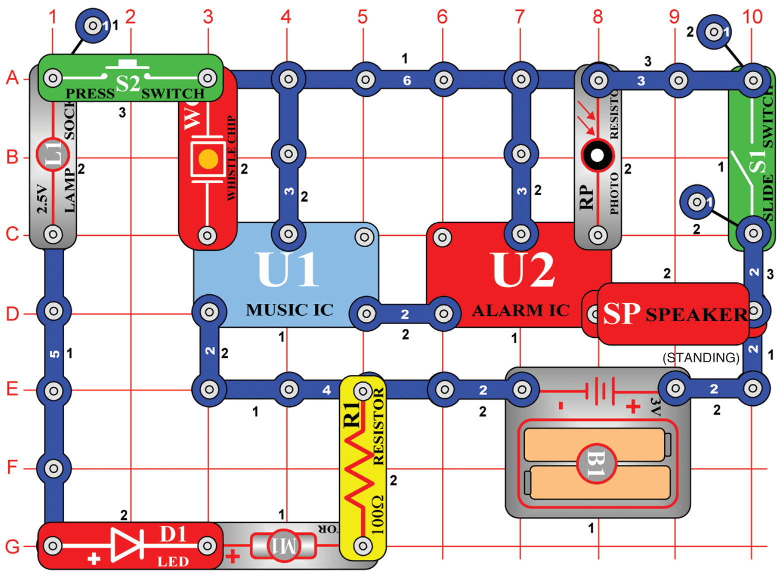
Project #32 Voice-controlled Rays of Light



OBJECTIVE: To show how light is stimulated by sound.

Turn the slide switch (S1) on. There will be only a weak light emitting from the green LED (D2). By blowing on the mic (X1) or putting it near a radio or TV set, the green LED will emit light, and its brightness changes as the loudness changes.

Project #33



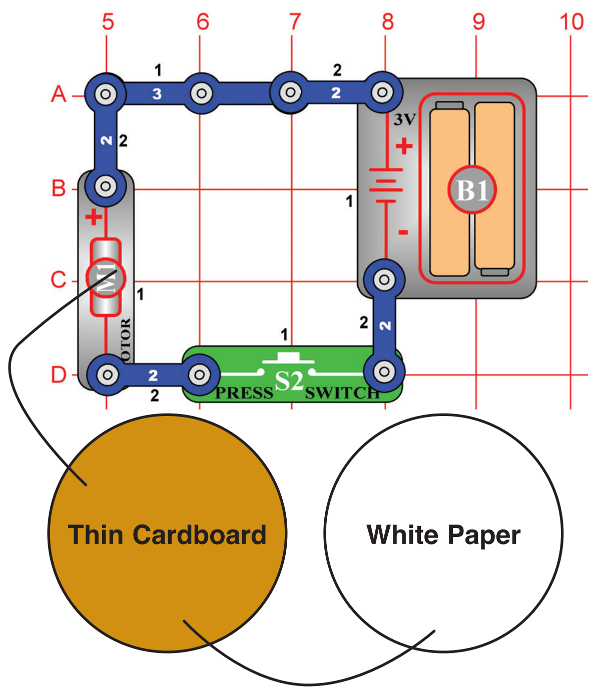
Using Parts as Conductors

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

Turn on the slide switch (S1) and tap the whistle chip (WC), it makes a machine gun sound (with music in the background). Thoroughly cover the photoresistor (RP) with your hand and the sound becomes a siren. After a while the sound will stop, tap the whistle chip and it resumes.

Press the press switch (S2) and 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 #34



Spin Draw

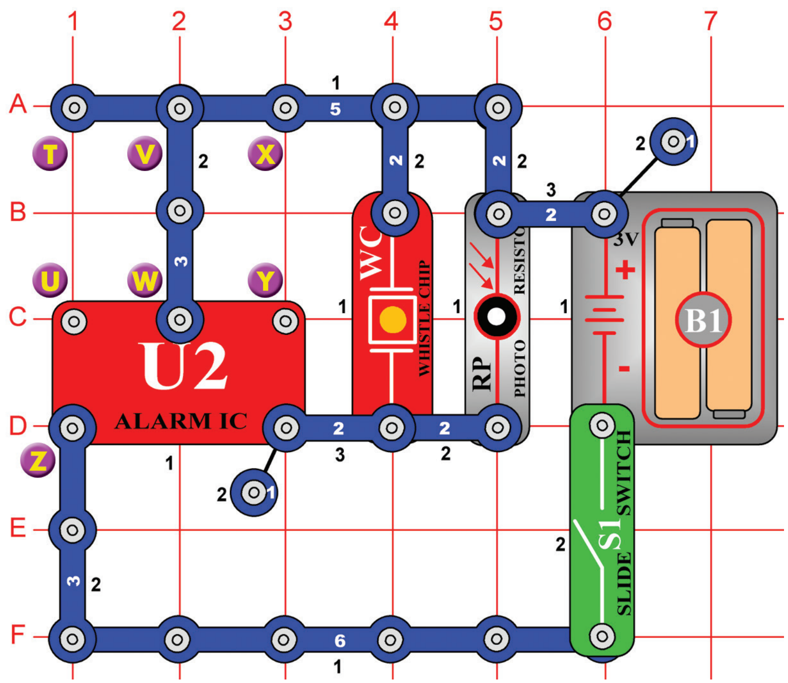
OBJECTIVE: To produce circular artistic drawings.

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 and as the motor (M1) 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 #35 Light-Controlled Sounds



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

Turn on the slide switch (S1), a police siren is hear. 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.

☐ Project #36 Light-Controlled Sounds (II)

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

☐ Project #37 Light-Controlled Sounds (III)

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.

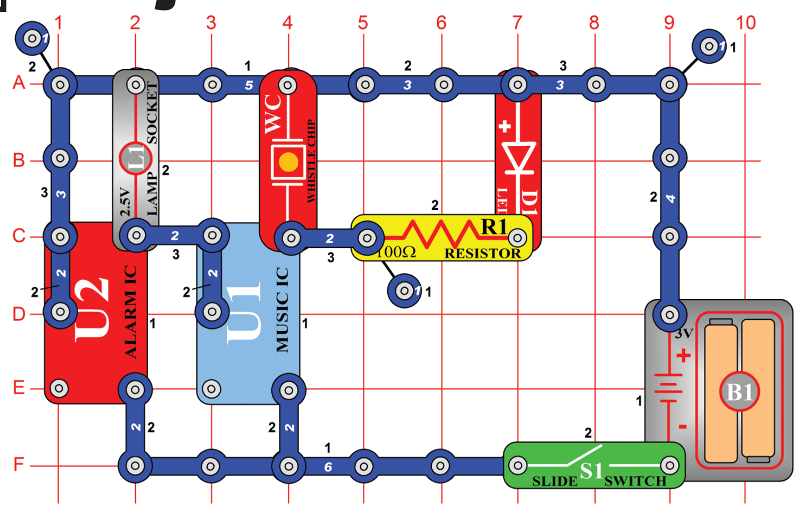
☐ Project #38 Light-Controlled Sounds (IV)

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 #39 Light-Controlled Sounds (V)

Now remove the connection between U & Z, add a 1-snap at Z (on level 3), add a second 3-snap between V & W (on level 3), and finally place the music IC (U1) directly over the alarm IC (U2) on level 4. Listen to the sounds.

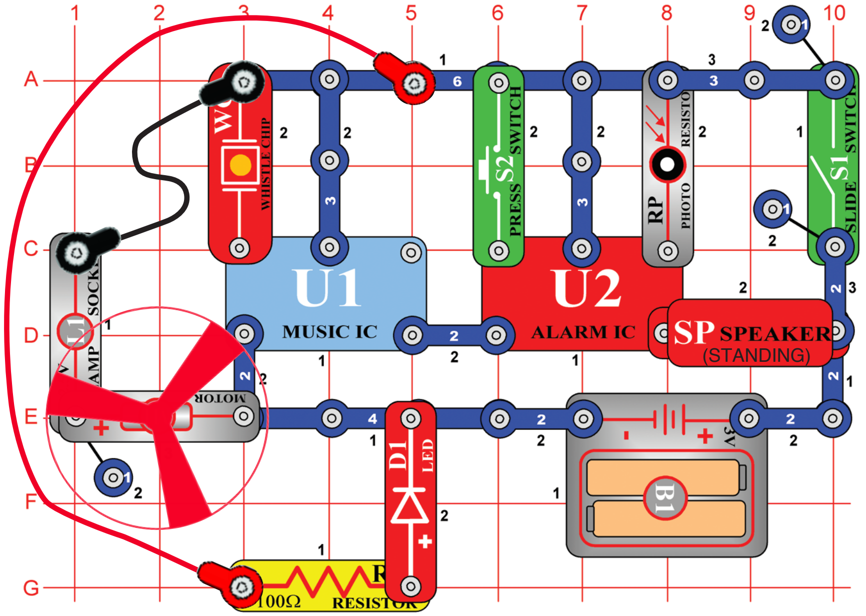
☐ Project #40 Flash and Tone



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

Turn the slide 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 #41 Fun with the Alarm IC



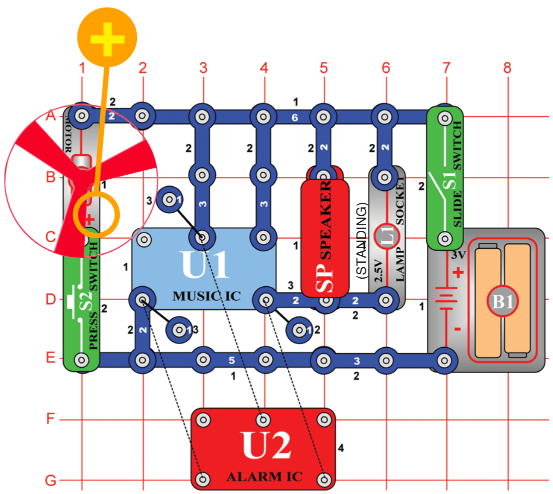
OBJECTIVE: To show some new ways of using the alarm IC.

Build the circuit shown and place the fan on the motor (M1), but leave the jumpers off for the time being. Turn on the slide switch (S1) and tap the whistle chip (WC), it makes a machine gun sound (with music in the background). Thoroughly cover the photoresistor (RP) with your hand and the sound becomes a siren. With the photoresistor covered, press the press switch (S2) and the sound becomes that of an ambulance. Uncover the photoresistor and the sound remains that of a machine gun whether the press switch is pressed or not. After a while the sound will stop, tap the whistle chip and it resumes.

Connect the two jumpers as shown and tap the whistle chip to resume the sound. The lamp (L1) and LED (D1) light and the motor spins. The sound continues, but it may become distorted as the motor speeds up. The motor draws a lot of power from the batteries (B1), and this may reduce the voltage to the music (U1) and alarm (U2) ICs, distorting the sound. The sound may even stop if your batteries are weak.

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

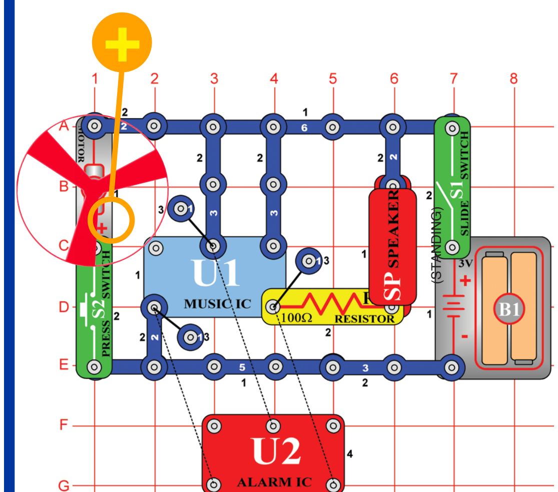
☐ Project #42 Motor Sounds Combo



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 (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 press switch.

☐ Project 43 Motor Sounds Combo (II)

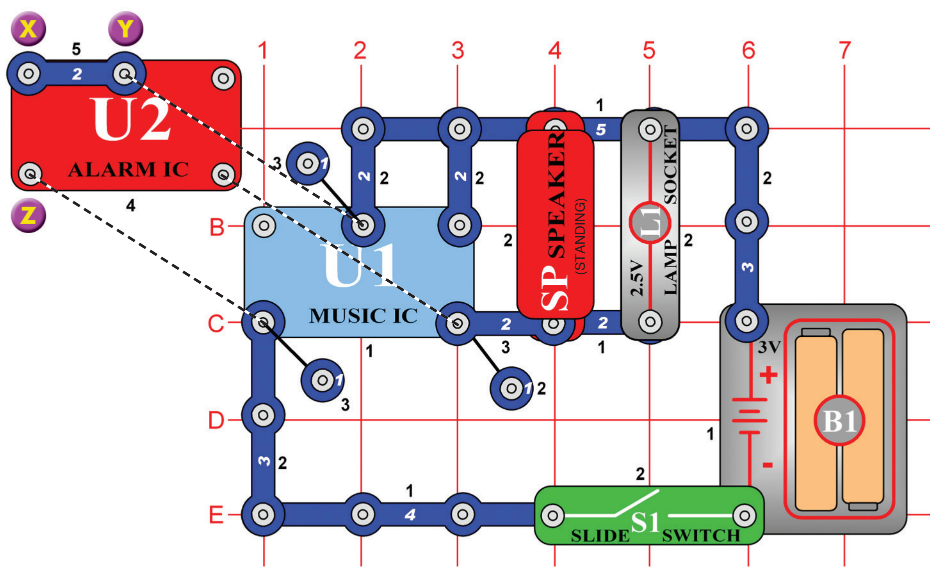


OBJECTIVE: To connect multiple devices together.

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 #42, but the fan will fly a little higher since the sound circuit no longer drives the lamp (L1) and therefore uses less battery power.

☐ Project #44 Wacky Sounds



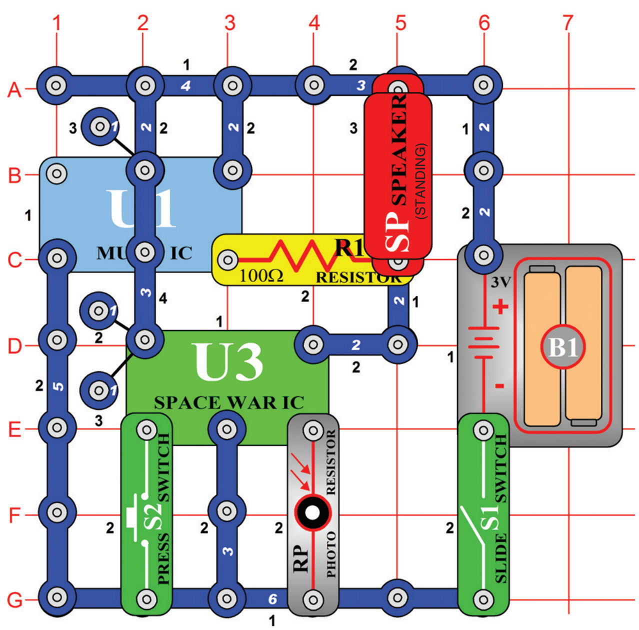
OBJECTIVE: To combine different sounds.

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. There is also a 2-snap on top of the alarm IC. Turn on the switch (S1) and you will hear a siren and music together while the lamp (L1) varies in brightness.

☐ Project #45 Wackier Sounds

Now remove the 2-snap connection between X & Y and then make a 2-snap connection between X & Z (on level 5). The circuit works the same way but has different sounds.

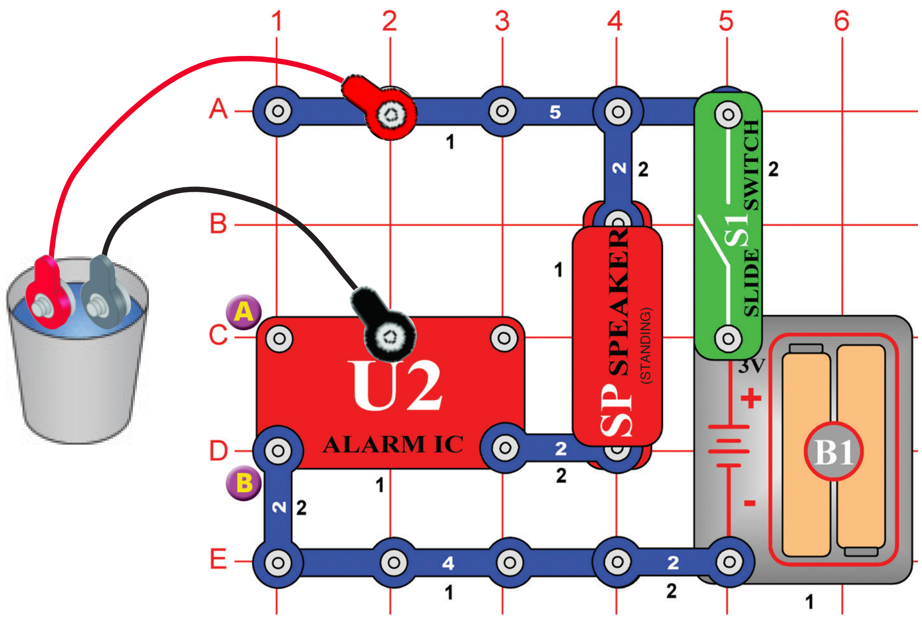
☐ Project #46 Really Wacky Sounds



OBJECTIVE: To combine different sounds.

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 lamp (L1).

☐ Project #47 Simple Water Alarm



OBJECTIVE: To sound an alarm when water is detected.

Build the circuit shown but initially leave the jumper wires outside the cup. Turn on the slide switch (S1); nothing happens. Place the jumper wires into a cup of water and an alarm sounds!

You could use longer wires and lay them on your basement floor, if your basement floods during a storm, then this circuit will sound an alarm.

☐ Project #48 Simple Salt Water Alarm

Add salt to the water and the tone of the alarm is louder and faster, telling you that salt is in the water you detected. Also, try holding the jumper wires with your fingers to see if your body can set off the alarm.

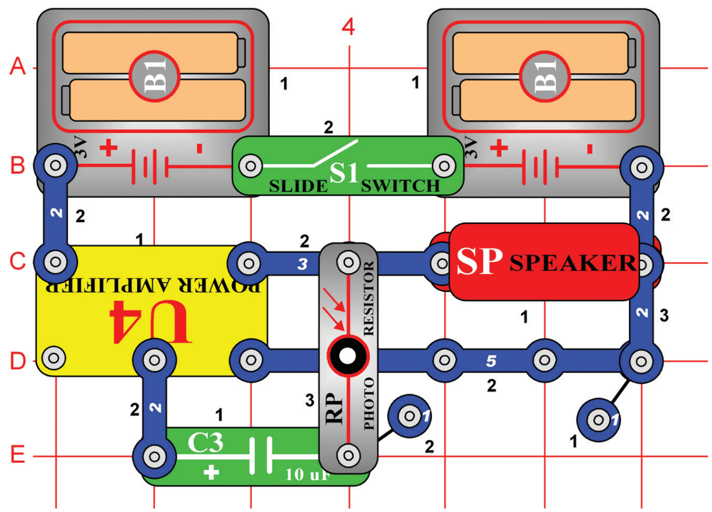
☐ Project #49 Ambulance Water Alarm

Modify the circuit in Project #47 by making a connection between A & B. The water alarm works the same way but now it sounds like an ambulance.

☐ Project #50 Ambulance Contact Alarm

The same circuit also detects if the jumper wires get touched together, so connect them to each other. The tone of the sound is now much different. Therefore, this circuit will tell you if there is water between the jumper wires or if the wires are touching each other.

☐ Project #51 Ticking Screecher



OBJECTIVE: To make fun sounds using light.

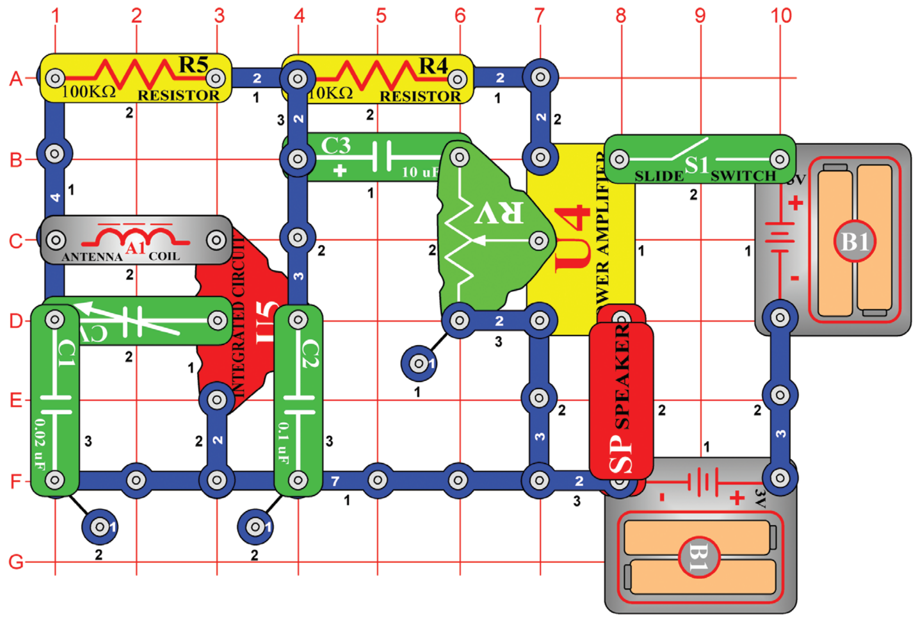
Build the circuit as shown, and turn on the slide switch (S1). Vary the amount of light to the photoresistor (RP) by partially covering it with your hand. You can make screeching sounds by allowing just a little light to reach the photoresistor.

If you replace the 10μF capacitor (C3) with a 3-snap wire or any of the other capacitors (C1, C2, C4, or C5), then the sound will be a little different.

☐ Project #52

AM Radio

OBJECTIVE: To make a complete working AM radio.

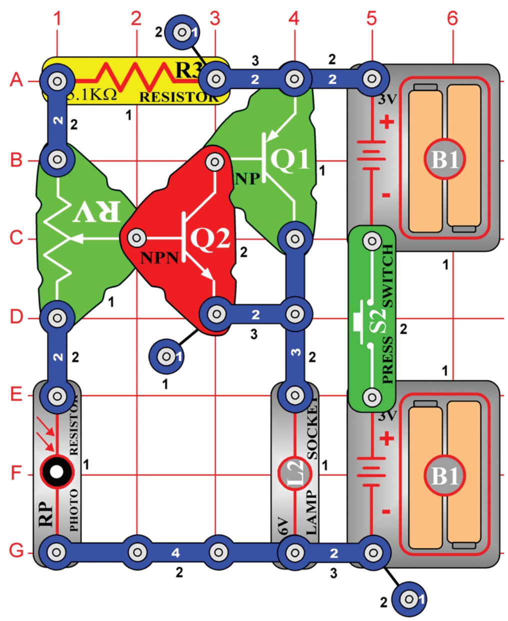


When you turn on the slide switch (S1), the integrated circuit (U5) should amplify and detect the AM radio waves all around you. The variable capacitor (CV) can be tuned to the desirable station. Varying the adjustable resistor (RV) will make the audio louder or softer. The power amplifier IC (U4) drives the speaker (SP) to complete the AM radio project.

☐ Project #53

Automatic Street Lamp

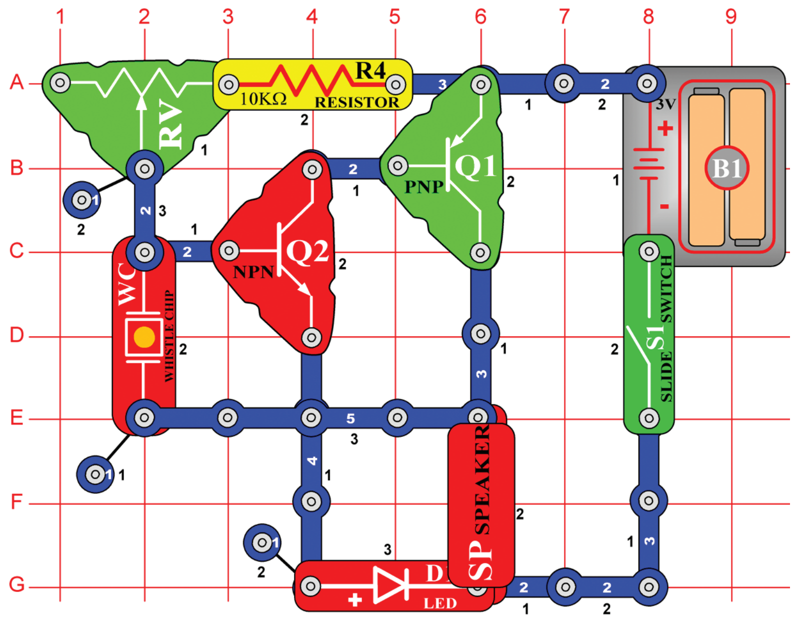
OBJECTIVE: To show how light is used to control a street lamp.



Press the press switch (S2) on and set the adjustable resistor (RV) so the lamp (L2) just lights. Slowly cover the photoresistor (RP) and the lamp brightens. If you place more light at the photoresistor the light dims.

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

☐ Project #54



Adjustable Tone Generator

OBJECTIVE: To show how resistor values change the frequency of an oscillator.

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

☐ Project #55

Photosensitive Electronic Organ

OBJECTIVE: To show how resistor values change the frequency of an oscillator.

Use the circuit from project #54 shown above. Replace the 10kΩ resistor (R4) with the photoresistor (RP). Turn on the slide switch (S1). The speaker (SP) will sound and the LED (D1) will light. Move your hand up and down over the photoresistor and the frequency changes. Decreasing the light on the photoresistor increases the resistance and causes the circuit to oscillate at a lower frequency. Notice that the LED flashes also at the same frequency as the sound.

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

☐ Project #56

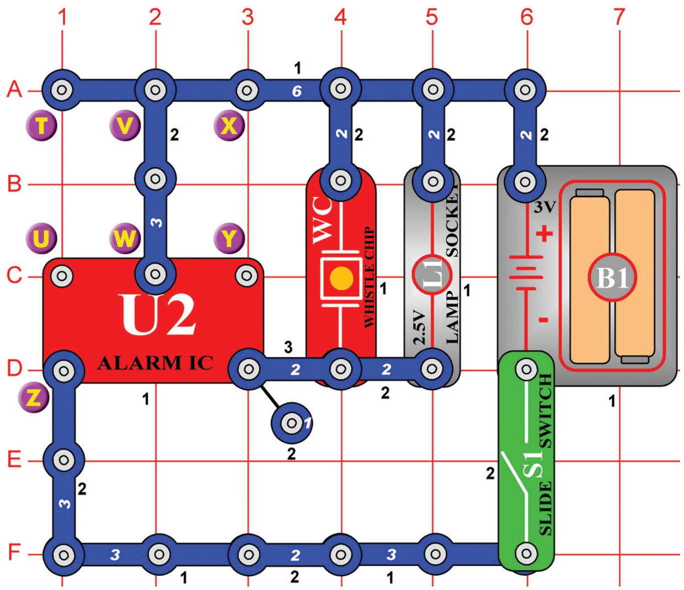
Electronic Cicada

OBJECTIVE: To show how capacitors in parallel change the frequency of an oscillator.

Use the circuit from project #54 shown above, replace the photoresistor (RP) back to the 10kΩ resistor (R4). Place the 0.02μF capacitor (C1) on top of the whistle chip (WC). Place the slide switch (S1) on and adjust the adjustable resistor (RV). The circuit produces the sound of the cicada insect. By placing the 0.02μF capacitor on top of the whistle chip, the circuit oscillates at a lower frequency. Notice that the LED (D1) flashes also at the same frequency.

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

Project #57



Light & Sounds

OBJECTIVE: To build a police siren with light.

Turn on the slide switch (S1). A police siren is heard and the lamp (L1) lights.

Project #58 More Light & Sounds

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

Project #59 More Light & Sounds (III)

Now remove the connection between X & Y and then make a connection between T & U. Now it sounds like a fire engine.

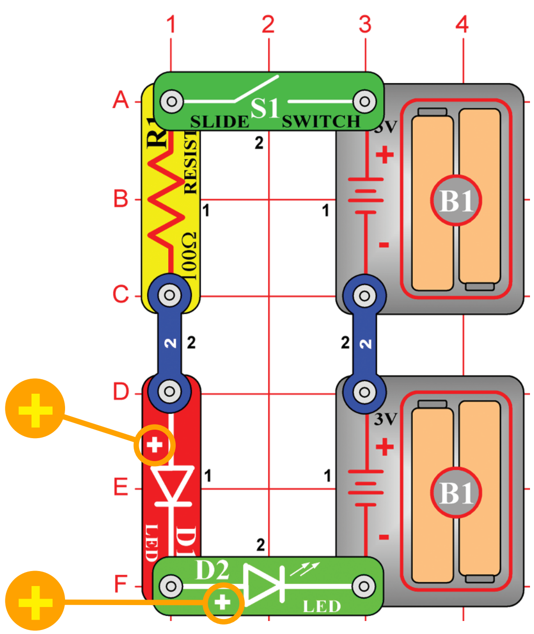
Project #60 More Light & Sounds (IV)

Now remove the connection between T & U and then make a connection between U & Z. Now it sounds like an ambulance.

Project #61 More Light & Sounds (V)

Now remove the connection between U & Z, then place the 470μF capacitor (C5) between X & Y ("+" side to X). The sound changes after a few seconds.

Project #62



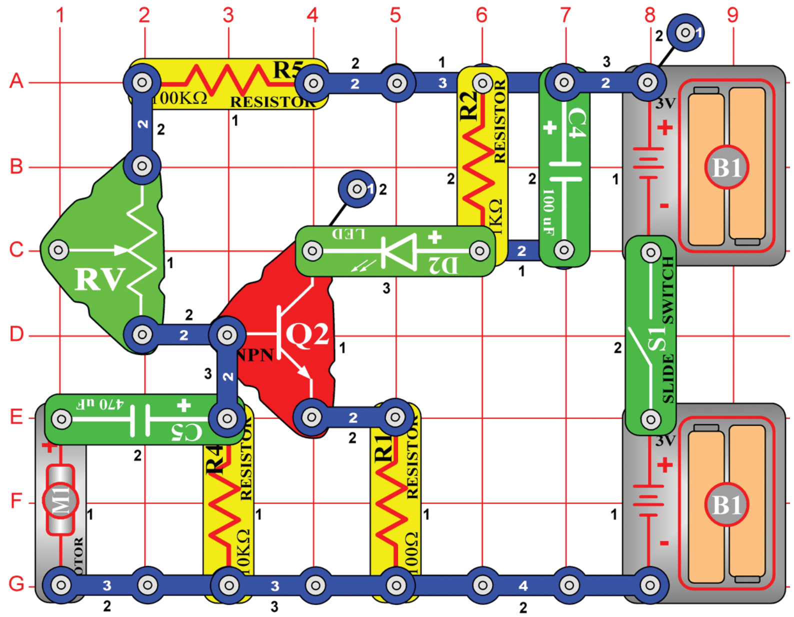
Batteries in Series

OBJECTIVE: To show the increase in voltage when batteries are connected in series.

When you turn on the slide switch (S1), current flows from the batteries through the slide switch, the 100Ω resistor (R1), the LED (D1), through the LED (D2), and back to the second group of batteries (B1). Notice how both LEDs are lit. The voltage is high enough to turn on both LEDs when the batteries are connected in series. If only one set of batteries is used, the LEDs will not light up.

Some devices use only one 1.5 volt battery, but they make hundreds of volts electronically from this small source. A flash camera is an example of this.

Project #63



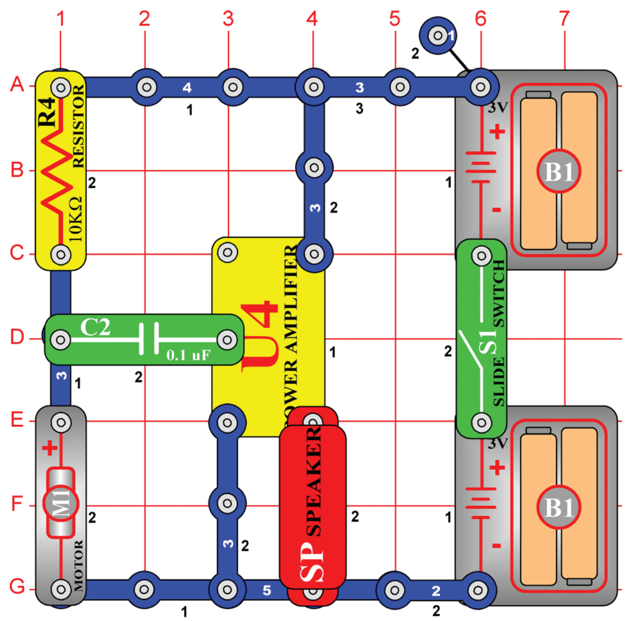
Motor Speed Detector

OBJECTIVE: To show how to make electricity in one direction.

When building the circuit, be sure to position the motor (M1) with the positive (+) side snapped to the 470μF capacitor (C5). Turn on the slide switch (S1), nothing will happen. It is a motor speed detector, and the motor isn't moving. Watch the LED (D2) and give the motor a good spin CLOCKWISE with your fingers (don't use the fan blade); you should see a flash of light. The faster you spin the motor, the brighter the flash will be. As a game, see who can make the brightest flash.

Now try spinning the motor in the opposite direction (counter-clockwise) and see how bright the flash is — it won't flash at all because the electricity it produces, flows in the wrong direction and won't activate the diode. Flip the motor around (positive (+) side snapped to the 3-snap wire) and try again. Now the LED lights only if you spin the motor counter-clockwise.

Project #64



Old-Style Typewriter

OBJECTIVE: To show how a generator works.

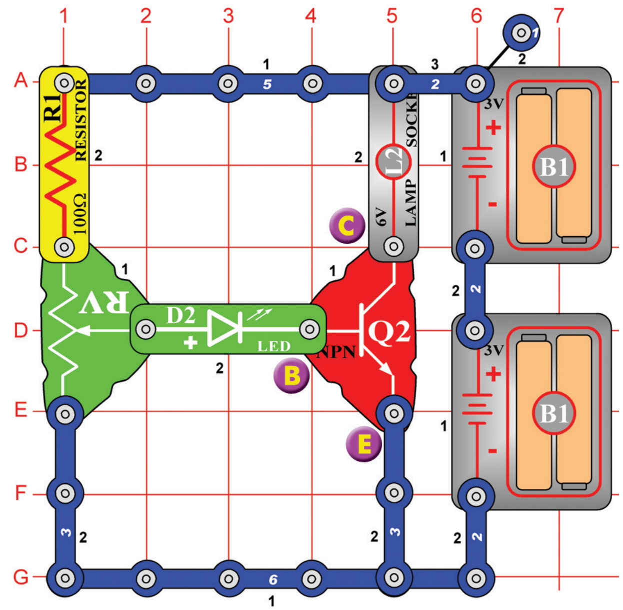
Turn on the slide switch (S1), nothing will happen. Turn the motor (M1) slowly with your fingers (don't use the fan blade), you will hear a clicking that sounds like an old-time manual typewriter keystrokes. Spin the motor faster and the clicking speeds up accordingly.

This circuit works the same if you spin the motor in either direction (unlike the Motor Speed Detector project).

By spinning the motor with your fingers, the physical effort you exert is converted into electricity. In electric power plants, steam is used to spin large motors like this, and the electricity produced is used to run everything in your town.

☐ Project #65

NPN Amplifier

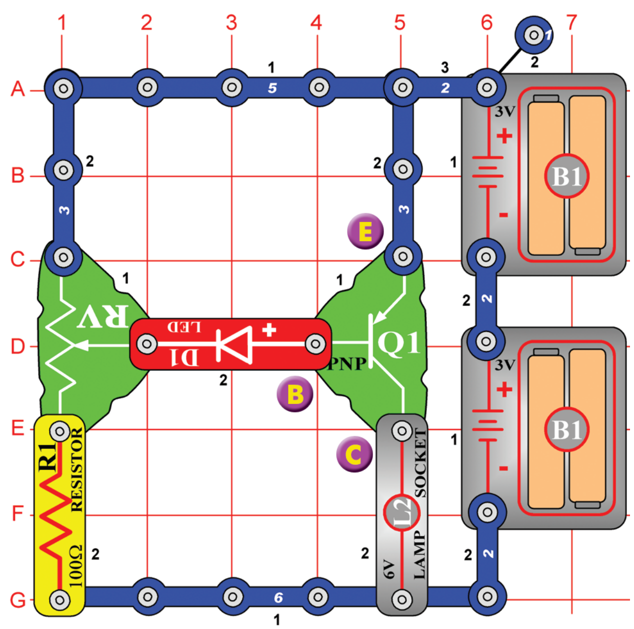


OBJECTIVE: To compare transistor circuits.

There are three connection points on an NPN transistor (Q2), called base (marked B), emitter (marked E), and collector (marked C). When a small electric current flows from the base to the emitter, a larger (*amplified*) current will flow from the collector to the emitter. Build the circuit and slowly move up the adjustable resistor (RV) control. When the LED (D2) becomes bright, the lamp (L2) will also turn on and will be much brighter.

☐ Project #66

PNP Amplifier

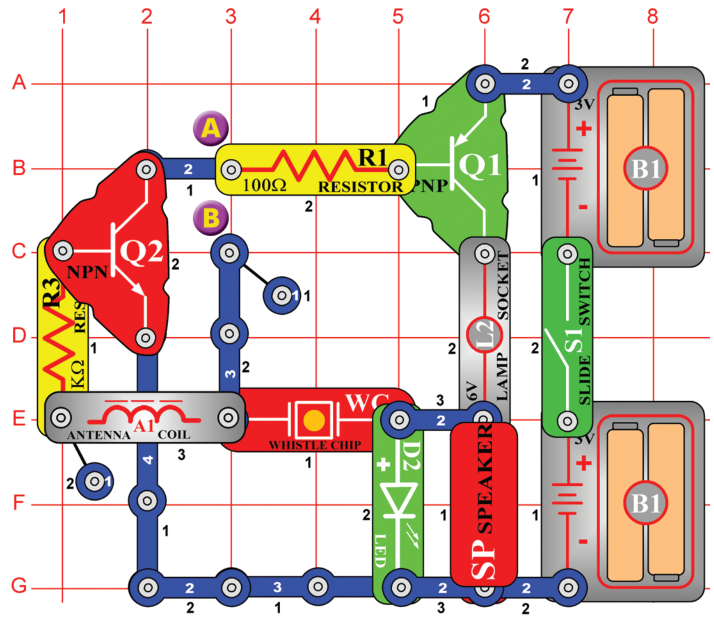


OBJECTIVE: To compare transistor circuits.

The PNP transistor (Q1) is similar to the NPN transistor (Q2) in project #65, except that the electric currents flow in the opposite directions. When a small electric current flows from the emitter to the base, a larger (*amplified*) current will flow from the emitter to the collector. Build the circuit and slowly move up the adjustable resistor (RV) control. When the LED (D1) becomes bright, the lamp (L2) will also turn on and will be much brighter.

☐ Project #67

The Lie Detector



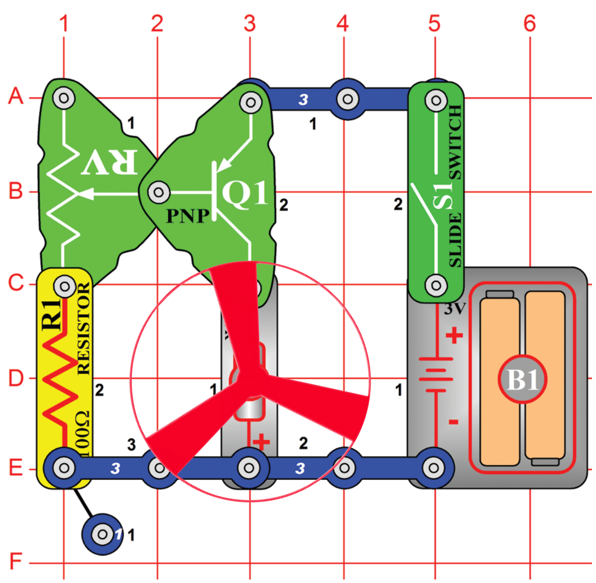
OBJECTIVE: To show how sweat makes a better conductor.

Turn on the slide switch (S1) and place your finger across points A & B. The speaker (SP) will output a tone and the LED (D2) will flash at the same frequency. Your finger acts as a conductor connecting points A & B. When a person is lying, one thing the body starts to do is sweat. The sweat makes the finger a better conductor by reducing its resistance.

As the resistance drops, the frequency of the tone increases. Lightly wet your finger and place it across the two points again. Both the output tone and LED flashing frequency increase, and the lamp (L2) may begin to light. If your finger is wet enough, then the lamp will be bright and the sound stops - indicating you are a big liar! Now change the wetness of your finger by drying it and see how it affects the circuit. This is the same principle used in lie detectors that are sold commercially.

☐ Project #68

Sucking Fan



OBJECTIVE: To adjust the speed of a fan.

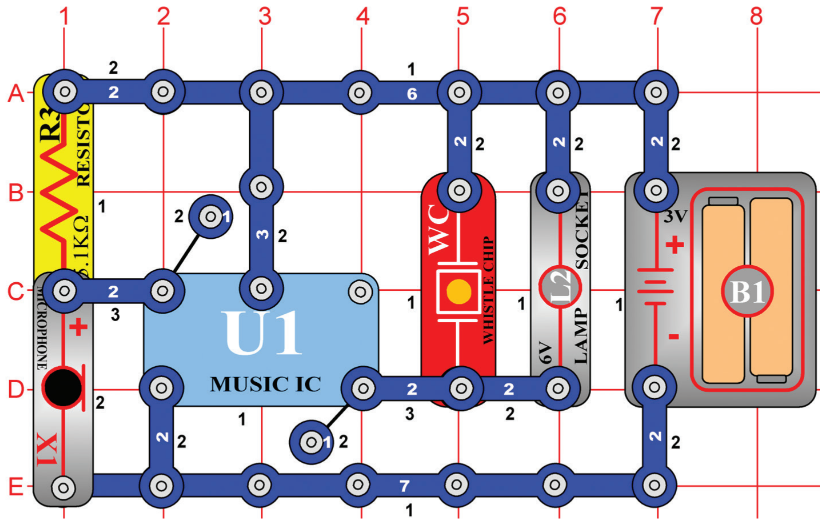
Build the circuit, and be sure to orient the motor (M1) with the positive (+) side down as shown. Turn it on, and set the adjustable resistor (RV) for the fan speed you like best. If you set the speed too fast then the fan may fly off the motor. Due to the shape of the fan blades and the direction the motor spins, air is sucked into the fan and towards the motor. Try holding a piece of paper just above the fan to prove this. If this suction is strong enough then it can lift the fan blades, just like in a helicopter.

The fan will not move on most settings of the resistor, because the resistance is too high to overcome friction in the motor. If the fan does not move at any resistor setting, then replace your batteries.

Modify the circuit by reversing the position of the motor (M1), so the positive (+) side is towards the PNP (Q1). Turn it on, and set the adjustable resistor (RV) for the fan speed you like best. Set it for full speed and see if the fan flies off - it won't! The fan is blowing air upward now! Try holding a piece of paper just above the fan to prove this.

☐ Project #69

High Sensitivity Voice Doorbell



OBJECTIVE: To build a highly sensitive voice-activated doorbell.

Build the circuit and wait until the sound stops. Clap or talk loud a few feet away and the music plays again. The microphone (X1) is used here because it is very sensitive.

☐ Project #70 Louder Doorbell

Replace the 6V lamp (L2) with the antenna coil (A1), the sound is louder now.

☐ Project #71 Very Loud Doorbell

Replace the antenna coil (A1) with the speaker (SP), the sound is now louder.

☐ Project #72 Doorbell with Button

Replace the microphone (X1) with the press switch (S2) and wait until the music stops. Now you have to push the press the switch to activate the music, just like the doorbell on your house.

☐ Project #73 Darkness Announcer

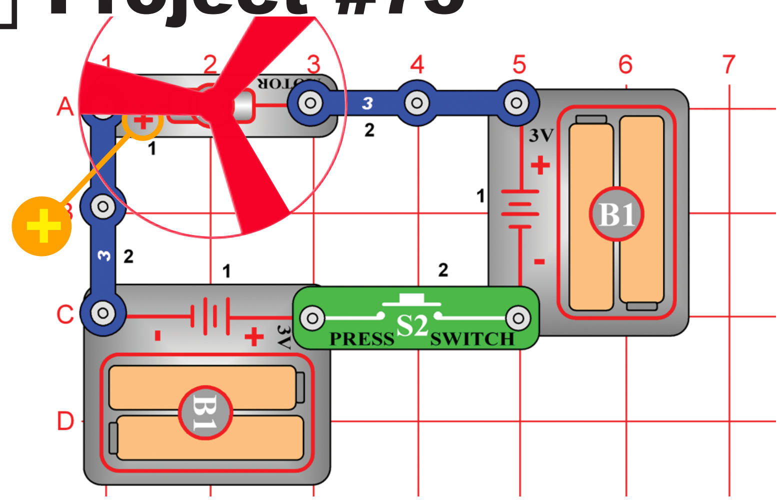
Replace the press switch (S2) with the photoresistor (RP) and wait until the sound stops. If you cover the photoresistor now the music will play once, signaling that it has gotten dark. If the speaker (SP) is too loud then you may replace it with the antenna coil (A1).

☐ Project #74 Musical Motion Detector

Replace the photoresistor (RP) with the motor (M1), oriented in either direction. Now spinning the motor will re-activate the music.

☐ Project #75

Super Flying Saucer

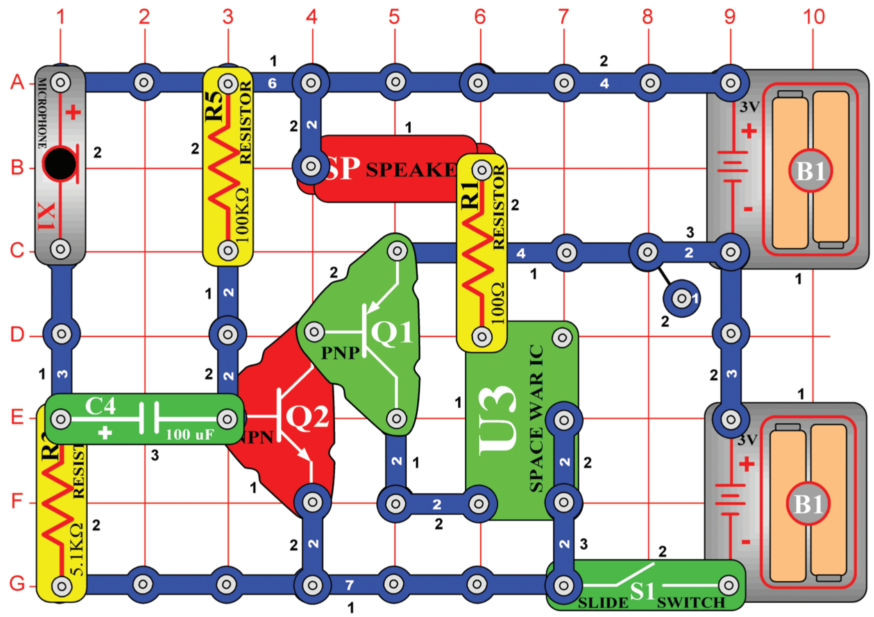


OBJECTIVE: To make the fan blade fly.

This circuit will make the fan spin faster and fly higher than the preceding circuit, making it easy to lose your fan.

Push the press switch (S2) until the motor reaches full speed, then release it. 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.

Project #76 Blow Off a Space War

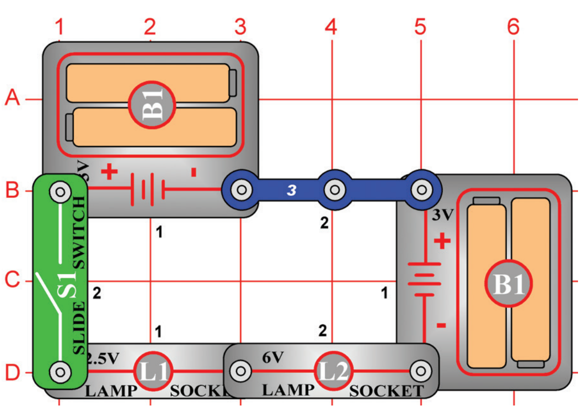


OBJECTIVE: To turn off a circuit by blowing on it.

Build the circuit and turn it on, you hear a space war. Since it is loud and annoying, try to shut it off by blowing into the microphone (X1). Blowing hard into the microphone stops the sound, and then it starts again.

Project #77 Series Lamps

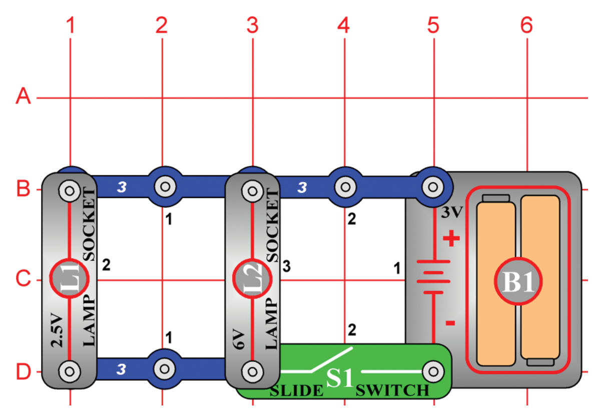
OBJECTIVE: To compare types of circuits.



Turn on the slide switch (S1) and both lamps (L1 & L2) will light. If one of the bulbs is broken then neither will be on, because the lamps are in series. An example of this is the strings of small Christmas lights; if one bulb is damaged then the entire string does not work.

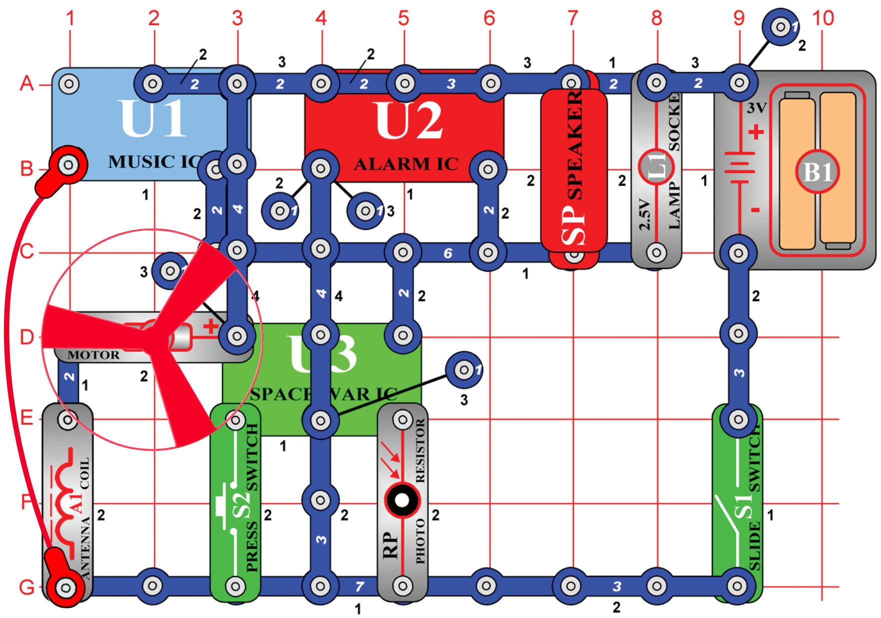
Project #78 Parallel Lamps

OBJECTIVE: To compare types of circuits.



Turn on the slide switch (S1) and both lamps (L1 & L2) will light. If one of the bulbs is broken then the other will still be on, because the lamps are in parallel. An example of this is most of the lights in your house; if a bulb is broken on one lamp then the other lamps are not affected.

Project #79



Fire Fan Symphony

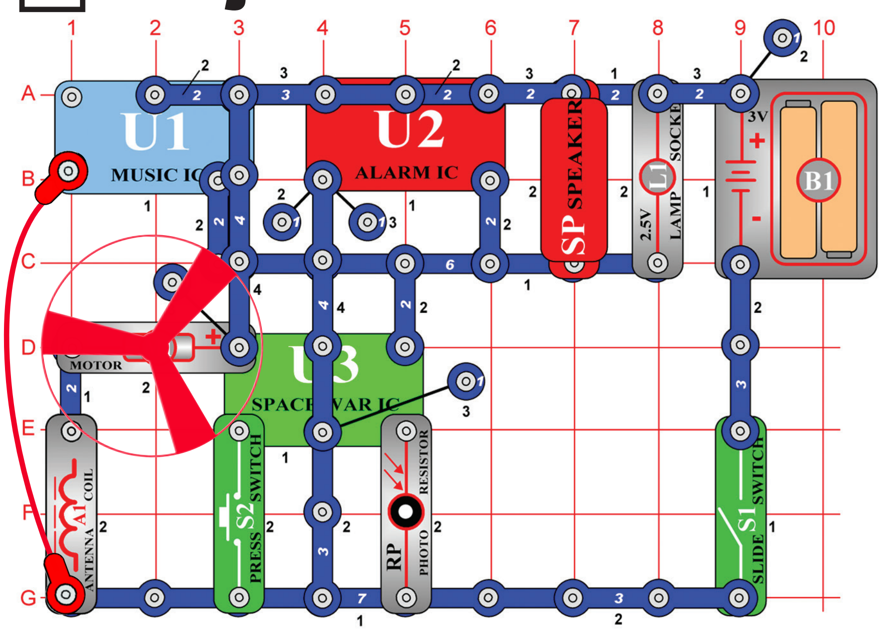
OBJECTIVE: To combine sounds from the music, alarm, and space war integrated circuits.

Build the circuit shown and add the jumper to complete it. Note that in one place two (2) single snaps are stacked on top of each other. Also, note that there is a 2-snap wire on layer 2 that does not connect with a 4-snap wire that runs over it on layer 4 (both touch the music IC). Turn it on and press the press switch (S2) several times and wave your hand over the photoresistor (RP) to hear the full spectrum of sounds that this circuit can create. Have fun!

Project #80 Fire Fan Symphony (II)

The preceding circuit may be too loud, so replace the speaker (SP) with the whistle chip (WC).

Project #81



Fan Symphony

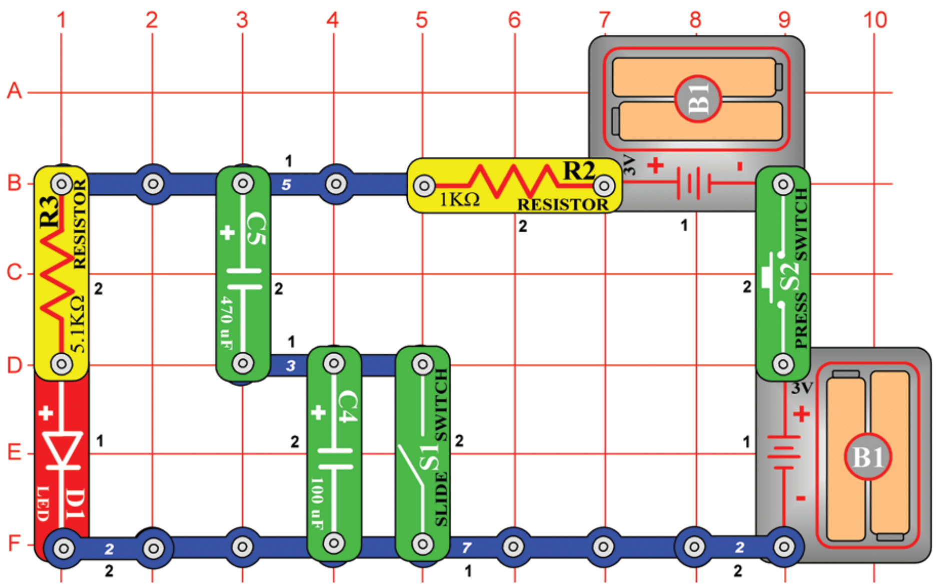
OBJECTIVE: To combine sounds from the music, alarm, and space war integrated circuits.

Modify the circuit from project #79 to match the circuit shown on the left. The only differences are the connections around the alarm IC (U2). It works the same way.

Project #82 Fan Symphony (II)

The preceding circuit may be too loud, so replace the speaker (SP) with the whistle chip (WC).

☐ Project #83 Capacitors in Series

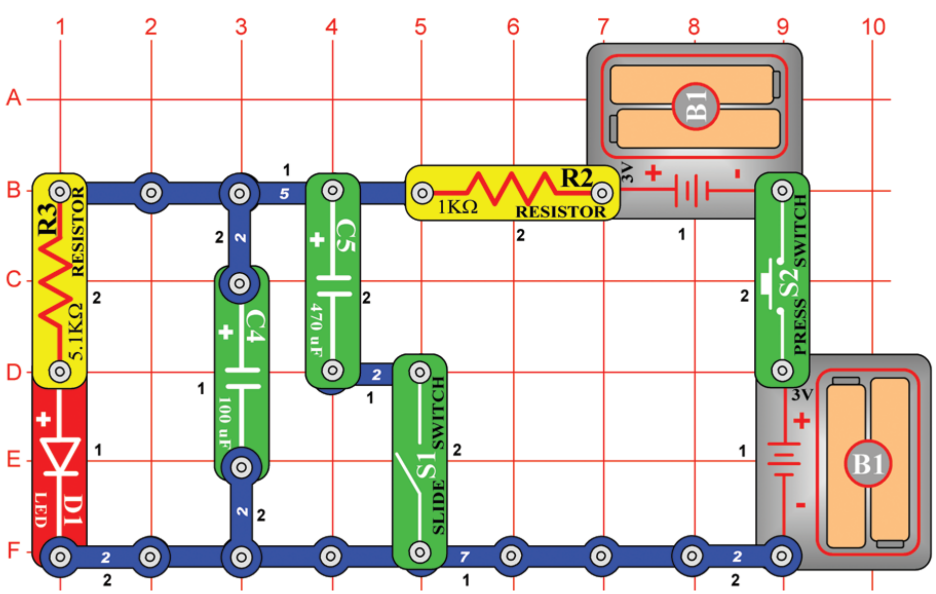


OBJECTIVE: To compare types of circuits.

Turn on the slide switch (S1), then press and release the press switch (S2). The LED (D1) becomes bright when the 470μF capacitor charges up with the press switch on, then the LED slowly gets dim after you release the press switch.

Now turn off the slide switch. Repeat the test with the slide switch off; you'll notice the LED goes out much faster after you release the press switch. The much smaller 100μF capacitor (C4) is now in series with the 470μF and so reduces the total capacitance (electrical storage capacity), and they discharge much faster. (Note that this is opposite to how resistors in series work).

☐ Project #84 Capacitors in Parallel



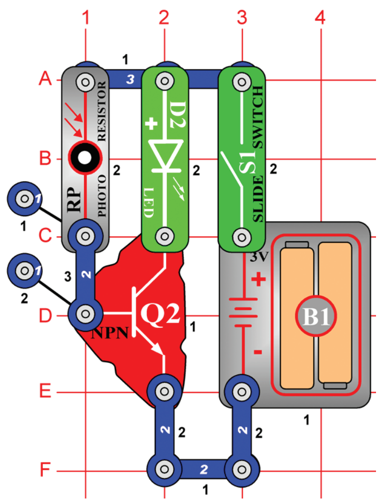
OBJECTIVE: To compare types of circuits.

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

Now turn on the slide switch and repeat the test; you'll notice the LED goes out much slower after you release the press switch. The much larger 470μF capacitor (C5) is now in parallel with the 100μF and so increases the total capacitance (electrical storage capacity), and they discharge much slower. (Note that this is opposite to how resistors in parallel work.)

☐ Project #85
NPN Light Control

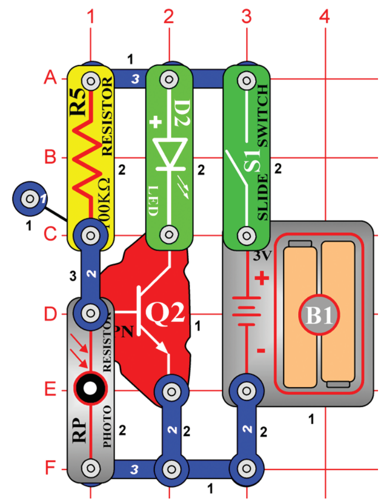
OBJECTIVE: To compare transistor circuits.



Turn on the slide switch (S1), the brightness of the LED (D2) depends on how much light shines on the photoresistor (RP). The resistance drops as more light shines, allowing more current to the NPN (Q2).

☐ Project #86
NPN Dark Control

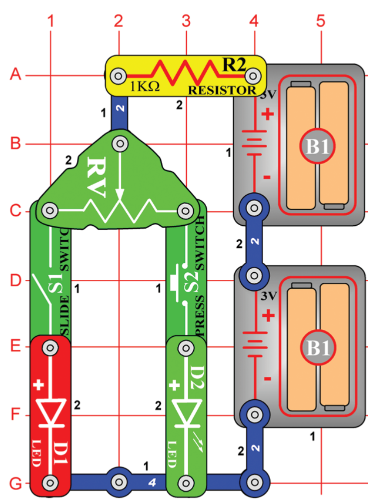
OBJECTIVE: To compare transistor circuits.



Turn on the slide switch (S1), the brightness of the LED (D2) depends on how LITTLE light shines on the photoresistor (RP). The resistance drops as more light shines, diverting current away from the NPN (Q2).

☐ Project #87
Red & Green Control

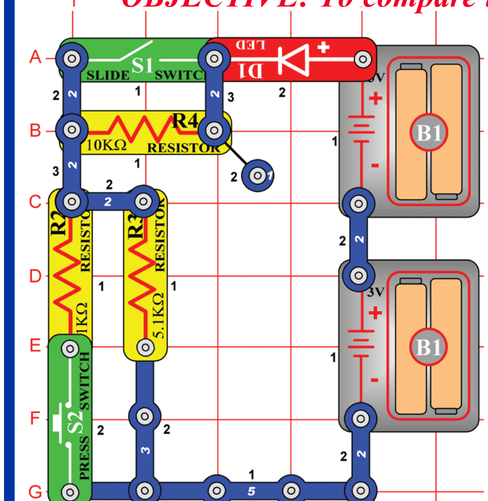
OBJECTIVE: To show how the adjustable resistor works.



Turn on the circuit using the slide switch (S1) and/or the press switch (S2) and move the adjustable resistor's (RV) control lever around to adjust the brightness of the LEDs (D1 & D2). When the adjustable resistor is set to one side, that side will have low resistance and its LED will be bright (assuming the switch on that side is ON) while the other LED will be dim or OFF.

☐ Project #88
Current Controllers

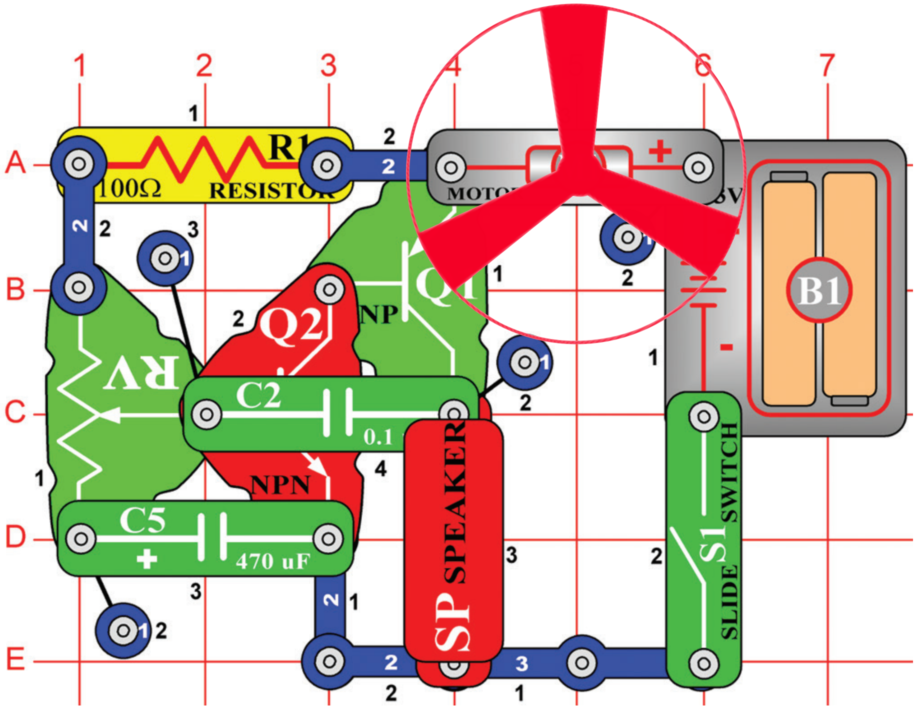
OBJECTIVE: To compare types of circuits.



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

With the slide switch on, the 5.1KΩ resistor (R3) controls the current. Turning on the press switch places the 1KΩ resistor (R2) in parallel with it to decrease the total circuit resistance. Turning off the slide switch places the 10KΩ resistor (R4) in series with R2/R3 to increase the total resistance.

Project #89 Screaming Fan



OBJECTIVE: To have an adjustable resistance control a fan and sounds.

Build the circuit on the left and place the fan onto the motor (M1). Turn on the slide switch (S1) and move the setting on the adjustable resistor (RV) across its range. You hear screaming sounds and the fan spins.

Project #90 Whining Fan

Replace the 0.1μF capacitor (C2) with the 0.02μF capacitor (C1). The sounds are now a high-pitch whine and the motor (M1) starts a little sooner.

Project #91 Light Whining

Replace the 100Ω resistor (R1) at the upper-left of the circuit (points A1 & A3 on the base grid) with the photoresistor (RP), and wave your hand over it. The whining sound has changed a little and can now be controlled by light.

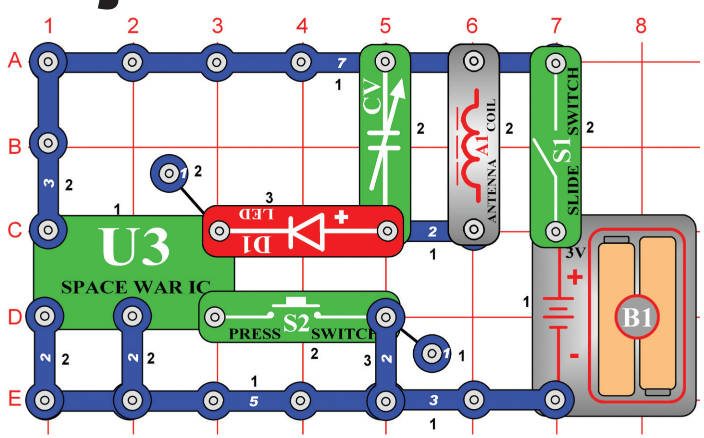
Project #92 More Light Whining

Replace the 0.02μF capacitor (C1) with the 0.1μF capacitor (C2). The sounds are lower in frequency and you can't make the fan spin now.

Project #93 Motor That Won't Start

Replace the 0.1μF capacitor (C2) with the 10μF capacitor (C3), put the positive (+) side towards the left). It now makes clicking sounds and the fan moves only in small bursts, like a motor that won't start.

Project #94 Space War Radio

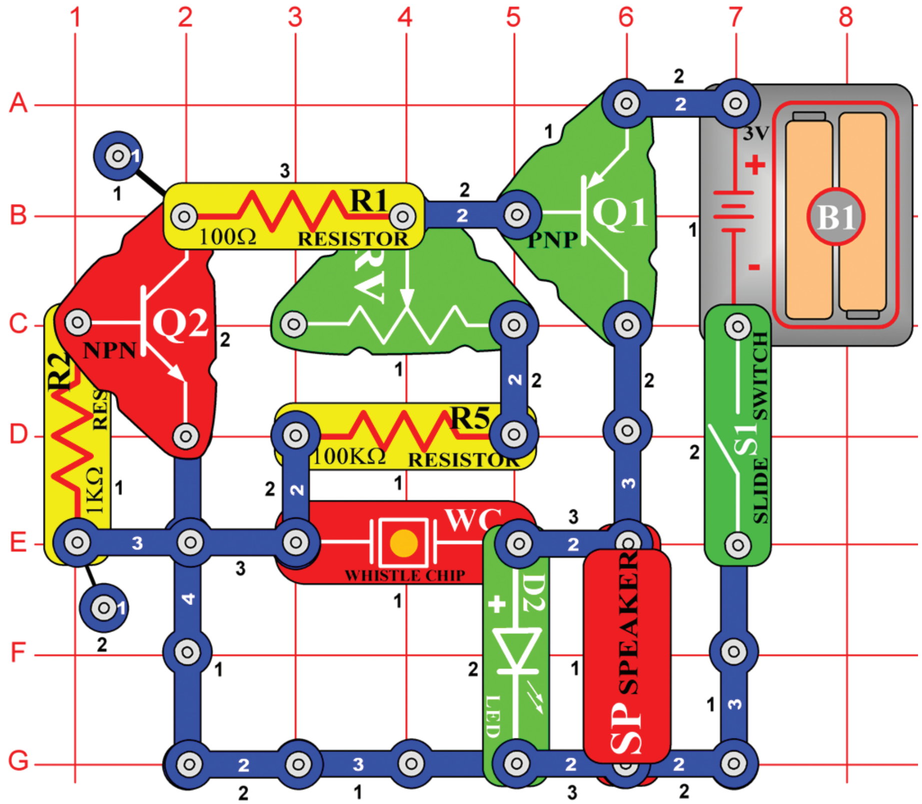


OBJECTIVE: To transmit Space War sounds to a AM radio.

Place the circuit next to an AM radio. Tune the radio so no stations are heard and turn on the slide switch (S1). You should hear the space war sounds on the radio. The red LED (D1) should also be lit. Adjust the variable capacitor (CV) for the loudest signal. Push the press switch (S2) to change the sound.

You have just performed the experiment that took Marconi (who invented the radio) a lifetime to invent. The technology of radio transmission has expanded to the point that we take it for granted. There was a time, however, when news was only spread by word of mouth.

☐ Project #95 Whiner



OBJECTIVE: To build a circuit that makes a loud whine.

Build the circuit, turn it on, and move the setting on the adjustable resistor (RV). It makes a loud, annoying whine sound. The green LED (D2) appears to be on, but it is actually flashing at a very fast rate.

☐ Project #96 Lower Pitch Whiner

Place the 0.02μF capacitor (C1) above the whistle chip (WC) and vary the adjustable resistor (RV) again. The frequency (or pitch) of the whine has been reduced by the added capacitance.

☐ Project #97 Hummer

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

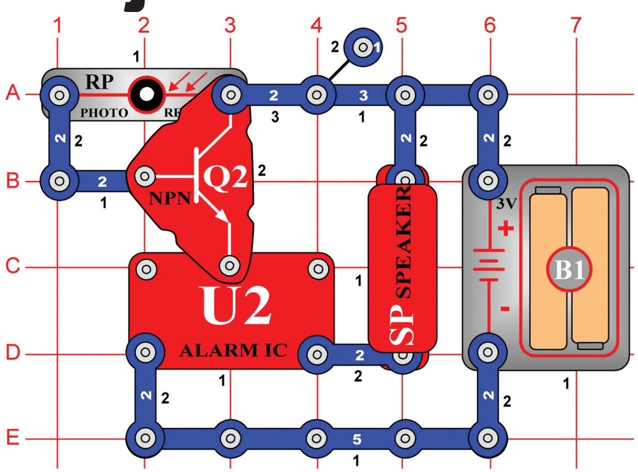
☐ Project #98 Adjustable Metronome

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

☐ Project #99 Quiet Flasher

Leave the 10μF capacitor (C3) connected but replace the speaker (SP) with the 2.5V lamp (L1).

☐ Project #100 Light-controlled Alarm

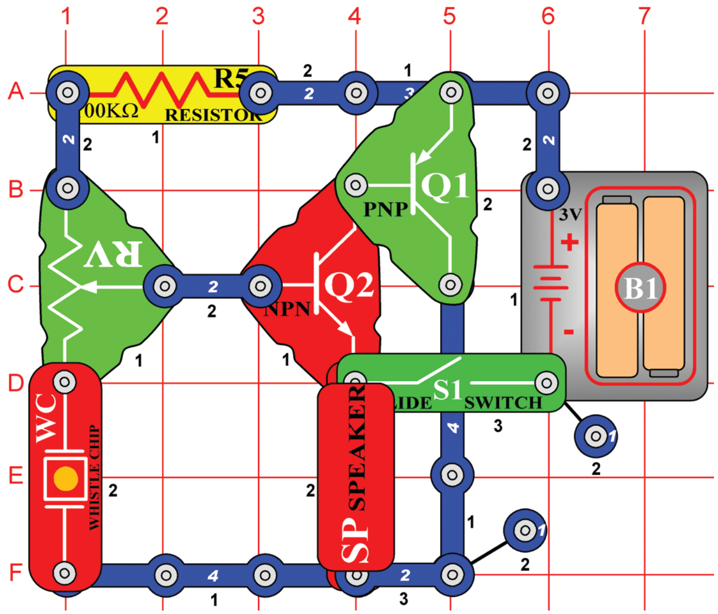


OBJECTIVE: To show how light is used to turn an alarm.

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 #101 Hissing Foghorn



OBJECTIVE: To build a transistor oscillator that can make a foghorn sound.

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

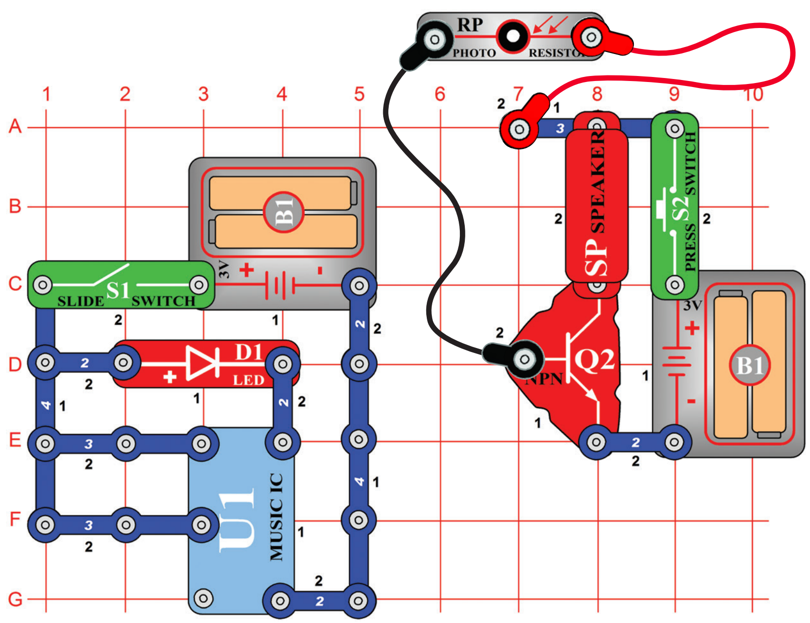
☐ Project #102 Hissing & Clicking

Modify the circuit in project #101 by replacing the 100kΩ resistor (R5) with the photoresistor (RP). Move the adjustable resistor (RV) setting until you hear hissing sounds, and then shield the photoresistor while doing so and you hear clicking sounds.

☐ Project #103 Video Game Engine Sound

Remove the photoresistor (RP) from the circuit in project #102 and instead touch your fingers between the contacts at points A4 and B2 on the base grid while moving the adjustable resistor (RV). You hear a clicking that sounds like the engine sound in auto-racing video games.

☐ Project #104 Optical Transmitter & Receiver

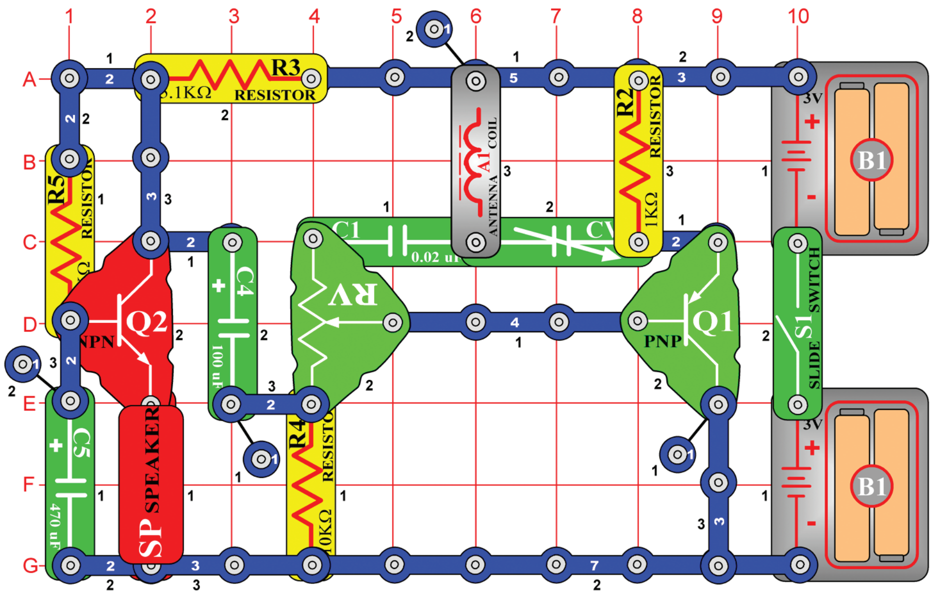


OBJECTIVE: To show how information can be transmitted using light.

Build the circuit shown. Connect the photoresistor (RP) to the circuit using the red & black jumper wires. Place the photoresistor upside down over the red LED (D1), so the LED goes inside the photoresistor. Turn on both switches (hold down the press switch button). Music plays on the speaker, even though the two parts of the circuit are not electrically connected.

The left circuit, with the LED and music IC (U1) creates a music signal and transmits it as light. The right circuit, with the photoresistor and speaker, receives the light signal and converts it back to music. Here the photoresistor has to be on top of the LED for this to work, but better communication systems (such as fiber optic cables), can transmit information over enormous distances at very high speeds.

☐ Project #105 Radio Announcer

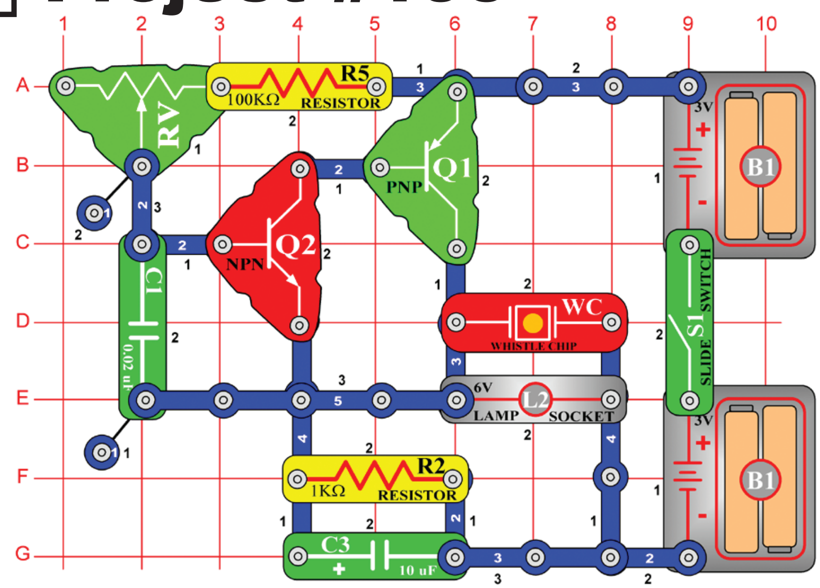


OBJECTIVE: To hear your voice on the radio.

You need an AM radio for this project. Build the circuit shown but do not turn on the slide switch (S1). Place it within a foot of your AM radio and tune the radio frequency to the middle of the AM band (around 1000 kHz), where no other station is transmitting. Turn the volume up so you can hear the static. Set the adjustable resistor (RV) control to the middle setting. Turn on the slide switch and slowly tune the adjustable capacitor (CV) until the static on the radio becomes quiet. You may hear a whistle as you approach the proper tuning. In some cases you may also need to set the adjustable resistor slightly off-center.

When the radio static is gone, tap on the speaker (SP) with your finger and you should hear the sound of tapping on the radio. Now talk loudly into the speaker (used here as a microphone) and you will hear your voice on the radio. Set the adjustable resistor for best sound quality at the radio.

☐ Project #106 Pitch



Note: If you have the adjustable resistor (RV) set to the right and light shining on the photoresistor, then you may not get any sound because the total resistance is too low for the circuit to operate.

OBJECTIVE: To show how to change the pitch of a sound.

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

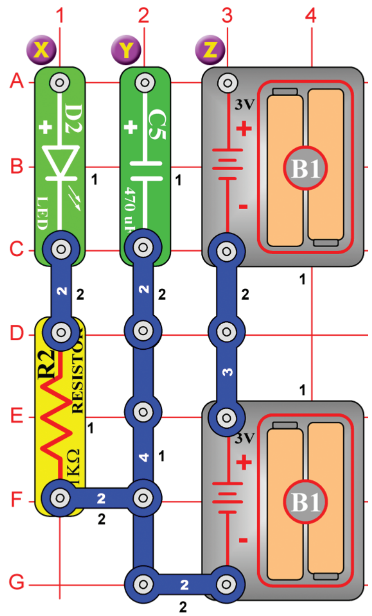
☐ Project #107 Pitch (II)

We've seen we can adjust the frequency by varying the resistance in the adjustable resistor. You can also change frequency by changing the capacitance of the circuit. Place the 0.1μF capacitor (C2) on top of the 0.02μF capacitor (C1); notice how the sound has changed.

☐ Project #108 Pitch (III)

Remove the 0.1μF (C2) capacitor and replace the 100kΩ resistor (R5) with the photoresistor (RP). Wave your hand up and down over the photoresistor to change the sound. Changing the light on the photoresistor changes the circuit resistance just like varying the adjustable resistance does.

Project #109



Make Your Own Battery

OBJECTIVE: To demonstrate how batteries can store electricity.

Build the circuit, then connect points Y & Z (use a 2-snap wire) for a moment. Nothing appears to happen, but you just filled up the 470μF capacitor (C5) with electricity. Now disconnect Y & Z and instead touch a connection between X & Y. The green LED (D2) 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 kept the LED lit for with how your batteries run all of your projects! That is because a capacitor stores electrical energy while a battery stores chemical energy.

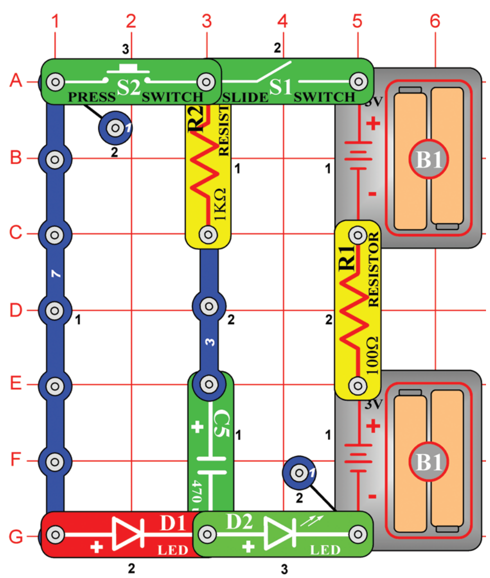
☐ Project #110 Make Your Own Battery (II)

In the preceding circuit, replace the 470μF capacitor (C5) with the 100μF capacitor (C3) and repeat the test. You see that the LED (D2) goes out faster, because the 100μF capacitor does not store as much electricity as the 470μF.

☐ Project #111 Make Your Own Battery (III)

Now replace the 1kΩ resistor (R2) with the 100Ω resistor (R1) and try it. The LED (D2) gets brighter but goes out faster because less resistance allows the stored electricity to dissipate faster.

Project #112



Capacitor Charge & Discharge

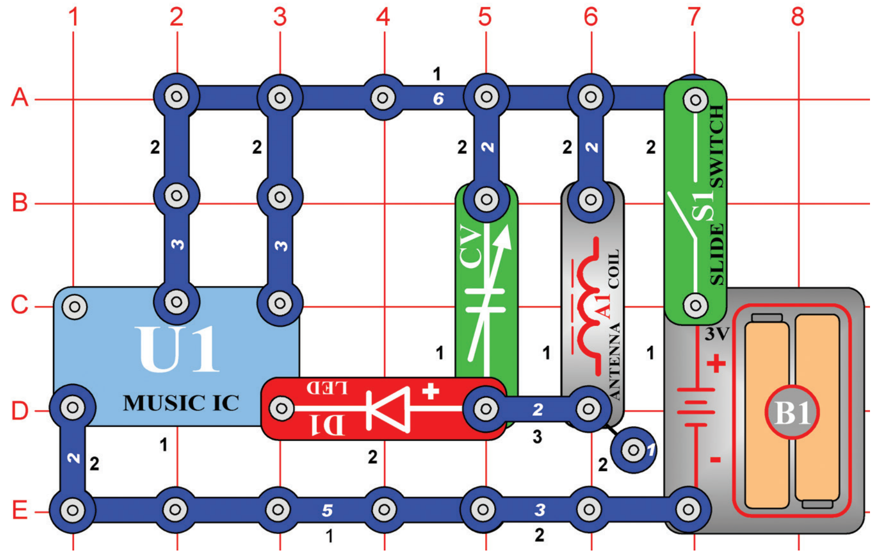
OBJECTIVE: To show how capacitors store and release electrical charge.

Turn on the slide switch (S1) for a few seconds, then turn it off. The green LED (D2) is initially bright but goes dim as the batteries (B1) charge up the 470μF capacitor (C5). The capacitor is storing electrical charge.

Now press the press switch (S2) for a few seconds. The red LED (D1) is initially bright but goes dim as the capacitor discharges itself through it.

The capacitor value (470μF) sets how much charge can be stored in it, and the resistor value (1kΩ) sets how quickly that charge can be stored or released.

☐ Project #113



Music Radio Station

OBJECTIVE: To create music and transmit it to a radio.

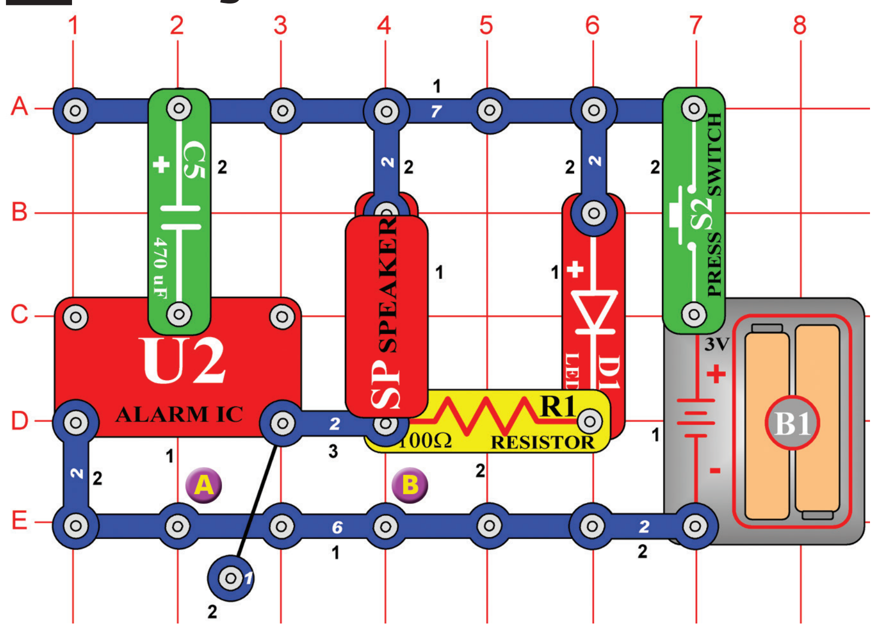
You need an AM radio for this project. Build the circuit shown on the left and turn on the slide switch (S1). Place it next to your AM radio and tune the radio frequency to where no other station is transmitting.

Then, tune the variable capacitor (CV) until your music sounds best on the radio.

☐ Project #114 Alarm Radio Station

Replace the music IC (U1) with the alarm IC (U2), and then you will hear a machine gun sound on the radio. You may need to re-tune the variable capacitor (CV).

☐ Project #115



Fading Siren

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

Press the press switch (S2), the alarm IC (U2) 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.

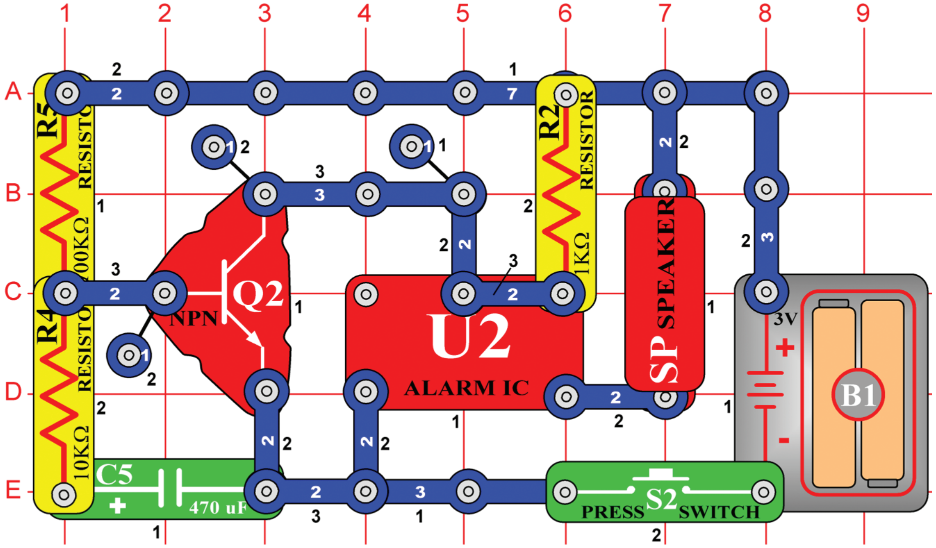
To repeat this effect you must release the press switch, remove the capacitor, and discharge it by placing it across the snaps on the bottom bar marked A & B. Then, replace the capacitor and press the switch again.

☐ Project #116 Fast Fade Siren

Replace the 470μF capacitor (C5) with the 100μF capacitor (C4), the siren fades faster.

☐ Project #117

Laser Gun with Limited Shots

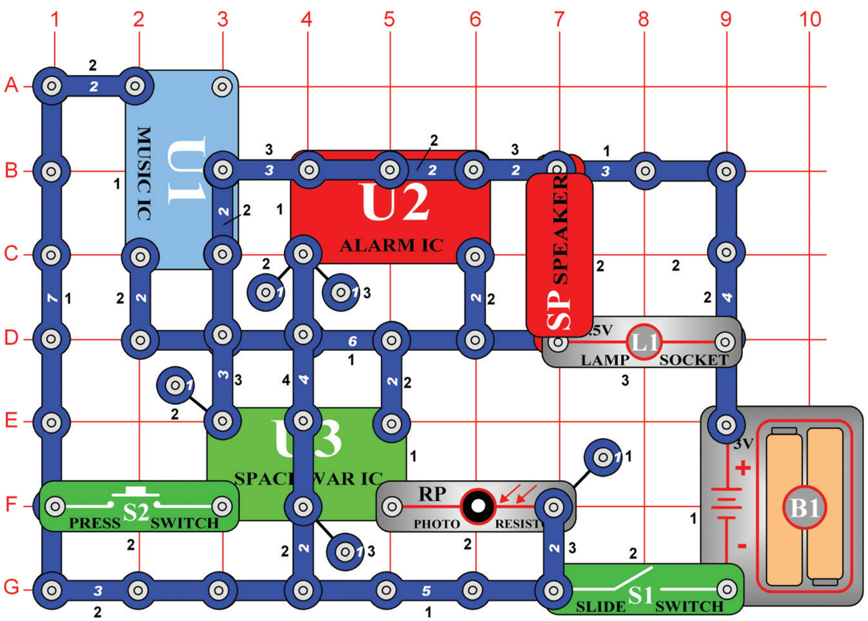


OBJECTIVE: To build a circuit with laser gun sounds and a limited amount of shots.

When you press the press switch (S2), the alarm IC (U2) should start sounding a very loud laser gun sound. The speaker (SP) will sound, simulating a burst of laser energy. You can shoot long repeating laser burst, or short zaps by tapping the trigger switch. But be careful, this gun will run out of energy and you will have to wait for the energy pack (C5) to recharge. This type of gun is more like a real life laser gun because power would run out after a few shots due to energy drain. In a real laser, the energy pack would have to be replaced. Here you only have to wait a few seconds for recharge.

☐ Project #118

Symphony of Sounds



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

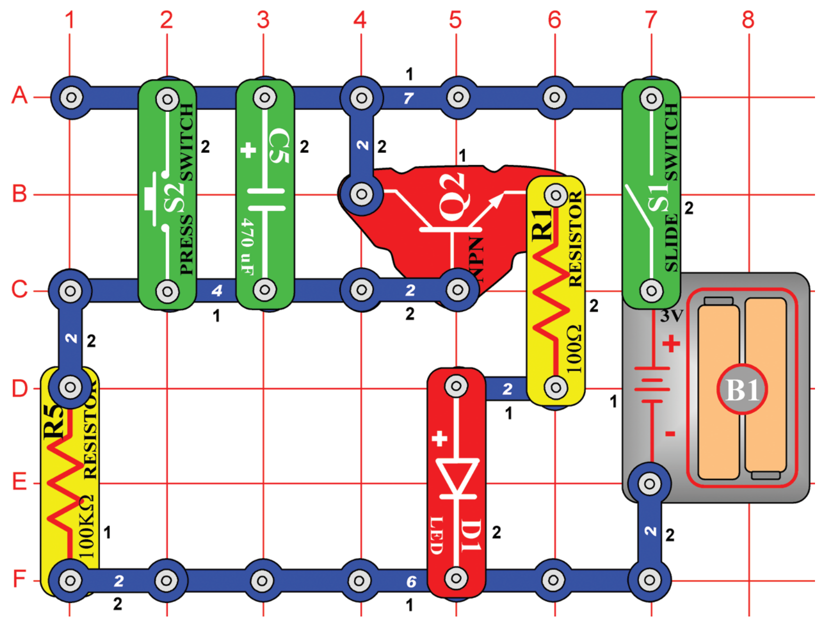
Build the circuit shown. Turn it on and press the press switch (S2) several times and wave your hand over the photoresistor (RP) to hear the full symphony of sounds that this circuit can create. Have fun!

☐ Project #119 Symphony of Sounds (II)

The preceding circuit may be too loud, so replace the speaker (SP) with the whistle chip (WC).

Project #120

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 LED (D1) will come on and very slowly get dimmer and dimmer. If you turn the slide switch (S1) off and back on after the light goes out it will NOT come on again. The 470μF capacitor (C5) has charged up and the NPN transistor amplifier (Q2) can get no current at its input to turn it on.

This circuit would make a good night-light. It would allow you to get into bed, and then it would go out. No further current is taken from the battery so it will not drain the batteries (B1) even if left on all night.

Project #121

Discharging Caps

OBJECTIVE: To show how capacitor delays can be repeated by discharging the capacitor.

Use the circuit from project #120 shown above.

When you first turned on the slide switch (S1) in project #120, the LED (D1) came on and very slowly got dimmer and dimmer. When you turned the slide switch (S1) off and back on after the light went out, it did NOT come on again. The 470μF capacitor (C5) was charged and everything stopped. This time turn the slide switch off. Then press the press switch (S2) for a moment to discharge the 470μF capacitor. Now when you turn the slide switch back on the delay repeats. Shorting a capacitor with a low resistance will allow the charges on the capacitor to leave through the resistance. In this case, the low resistance was the press switch.

Project #122

Changing Delay Time

OBJECTIVE: To show how the size of the capacitor effects the delay time.

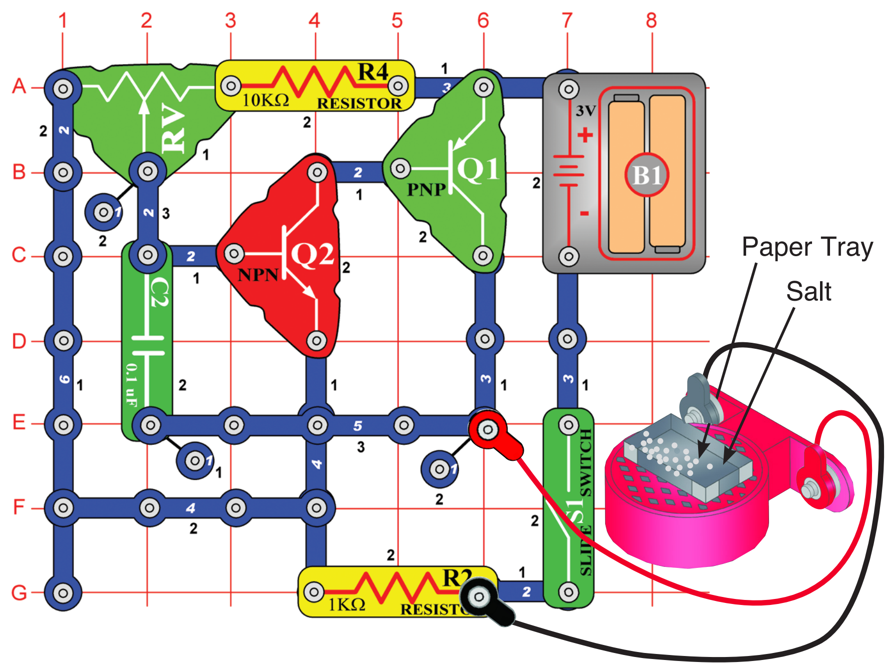
Use the circuit from project #120 shown above.

Change the 470μF capacitor (C5) to the 100μF capacitor (C4). Make sure the capacitor (C4) is fully discharged by pressing the press switch (S2) before closing the on-off slide switch (S1). When slide switch is turned on, notice how much quicker the LED (D1) goes out. Since 100μF is approximately 5 times smaller than 470μF, the LED will go out 5 times faster. The bigger the capacitor the longer the delay.

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

☐ Project #123

Sound Wave Magic



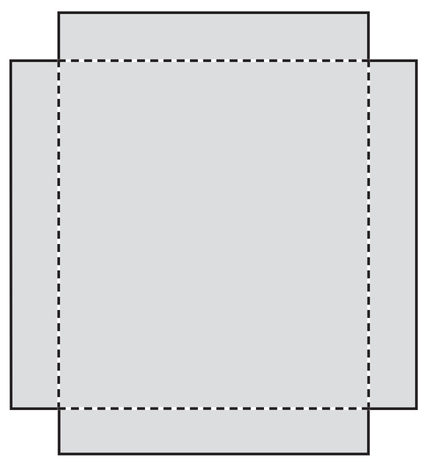
OBJECTIVE: To show how sound waves travel on a paper surface.

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

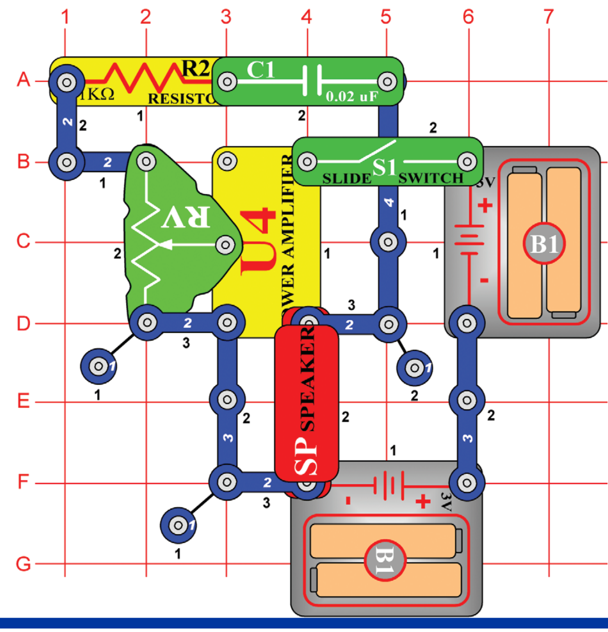
Setup: Use some paper and scissors to cut out a rectangular pattern. Use the one shown below as a guide. Use colored paper if available. Fold at the points shown. Scotch tape the corners so the tray has no cracks at the corners. Place the tray over the speaker and sprinkle a small amount of white table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

Sound Magic: Turn on the circuit by turning on the slide switch (S1). Adjust the adjustable resistor (RV) for different pitches and watch the salt particles. Particles that bounce high are directly over the vibrating paper and ones that do not move are in the nodes where the paper is not vibrating. Eventually, all the salt will move to the areas that have no vibration, and stay there. Change the position of the tray and the material used to create different patterns due to the sound. Try sugar and coffee creamer, for example, to see if they move differently due to the sound waves.

Sample Cut-out Pattern



☐ Project #124 Trombone



OBJECTIVE: To build an electronic trombone that changes pitch of note with slider bar.

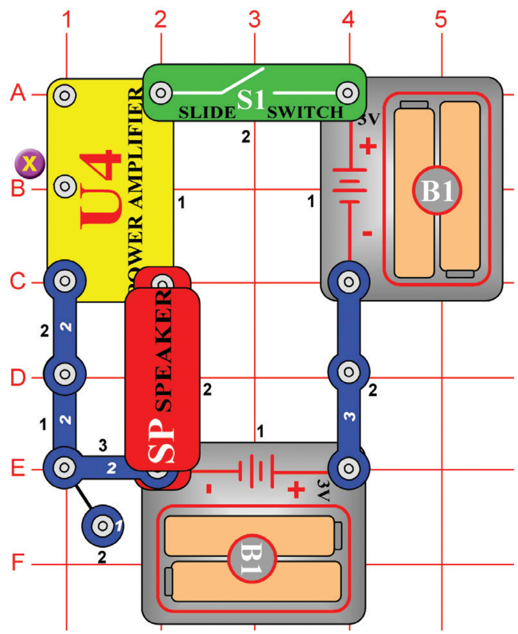
When you turn on the slide switch (S1) the trombone should start playing. To change the pitch of the note, simply slide the adjustable resistor (RV) control back and forth. By turning the slide switch on and off and moving the slider, you will be able to play a song much like a trombone player makes music. The switch represents air going through the trombone, and the adjustable resistor control is the same as a trombone slider bar. The circuit may be silent at some positions of the resistor control.

☐ Project #125 Race Car Engine

Use the circuit from project #124 shown on the left, but change the 0.02μF capacitor (C1) to a 10μF capacitor (C3). Make sure the positive (+) mark on the capacitor is NOT on the resistor (R2) side when you snap it in.

When the slide switch (S1) is turned on, you should hear a very low frequency oscillation. By sliding the adjustable resistor (RV) control up and down, you should be able to make the sound of a race car engine as it's motor speeds up and slows down.

☐ Project #126 Power Amplifier



OBJECTIVE: To check stability of power amplifier with open input.

When you turn on the slide switch (S1), the power amplifier IC (U4) should not oscillate. You should be able to touch point X with your finger and hear static. If you do not hear anything, listen closely and wet your finger that touches point X. High frequency clicks or static should be coming from speaker (SP) indicating that the amplifier is powered on and ready to amplify signals.

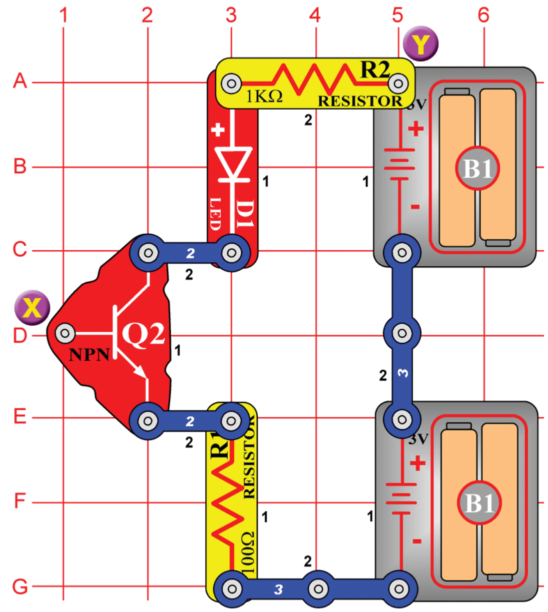
The power amplifier may oscillate on its own. Do not worry, this is normal with high gain high-powered amplifiers.

☐ Project #127 Feedback Kazoo

Use the circuit from project #126. When you place one finger on point X and a finger from your other hand on the speaker (SP) snap that is not connected to the battery (B1), what happens? If the amplifier starts to oscillate it is due to the fact that you just provided a feedback path to make the amplifier into an oscillator. You may even be able to change the pitch of the oscillation by pressing harder on the snaps. This is the principle used to make an electronic kazoo. If you practice and learn the amount of pressure required to make each note, you may even be able to play a few songs.

Project #128

Two-Finger Touch Lamp



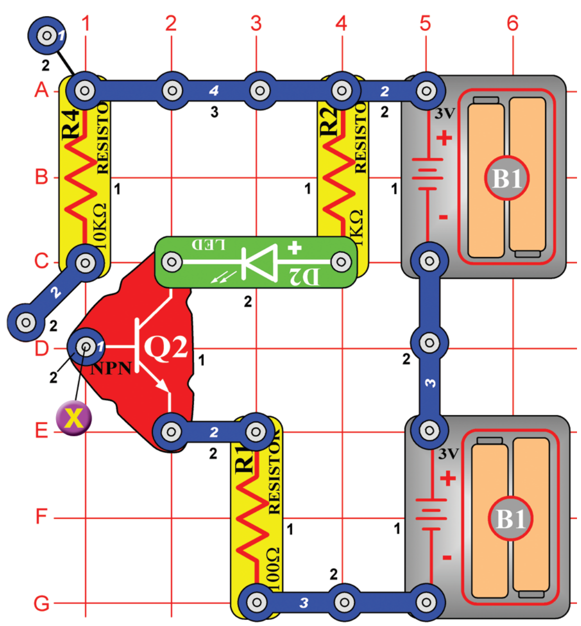
OBJECTIVE: To show that your body can be used as an electronic component.

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.

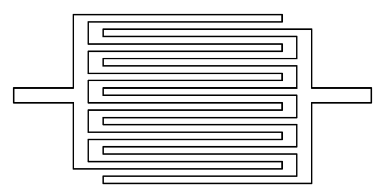
Project #129

One-Finger Touch Lamp



OBJECTIVE: To show you how finger touch lamps work.

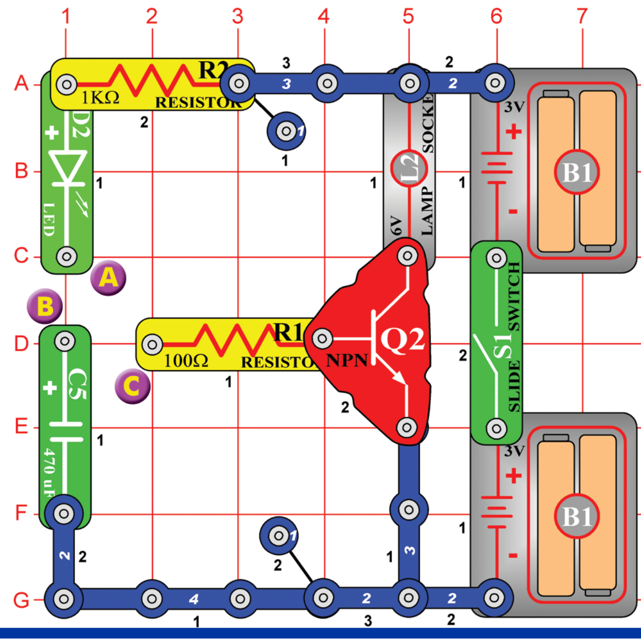
The touch lamps you see in stores only need to be touched by one finger to light, not two. So let's see if we can improve the last circuit to only need one finger. Build the new circuit, note that near point X there is a 2-snap wire that is only mounted on one side, swing it so the plastic touches point X. Wet a large area of one of your fingers and touch it to both metal contacts at point X at the same time; the LED (D2) lights. To make it easier for one finger to touch the two contacts, touch lamps or other touch devices will have the metal contacts interweaved as shown below and will also be more sensitive so that you don't have to wet your finger to make good contact.



☐ Project #130

Storing Electricity

OBJECTIVE: To store electricity in a capacitor.



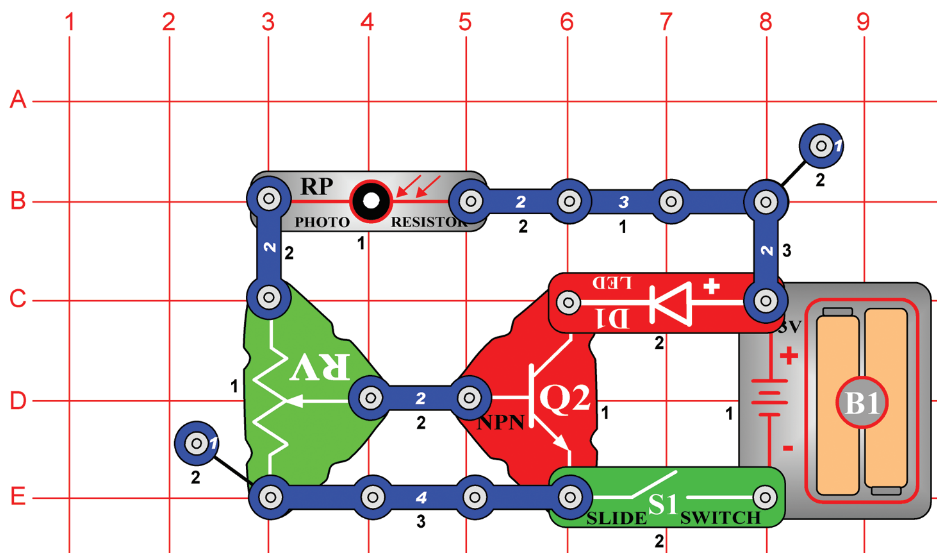
Turn the slide switch (S1) on and connect points A & B with a 2-snap wire. The green LED (D2) will flash and the 470µF capacitor (C5) will be charged with electricity. The electricity is now stored in the capacitor. Disconnect points A & B. Connect points B & C and there will be a flash from the 6V lamp (L2).

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

☐ Project #131

Motion Detector

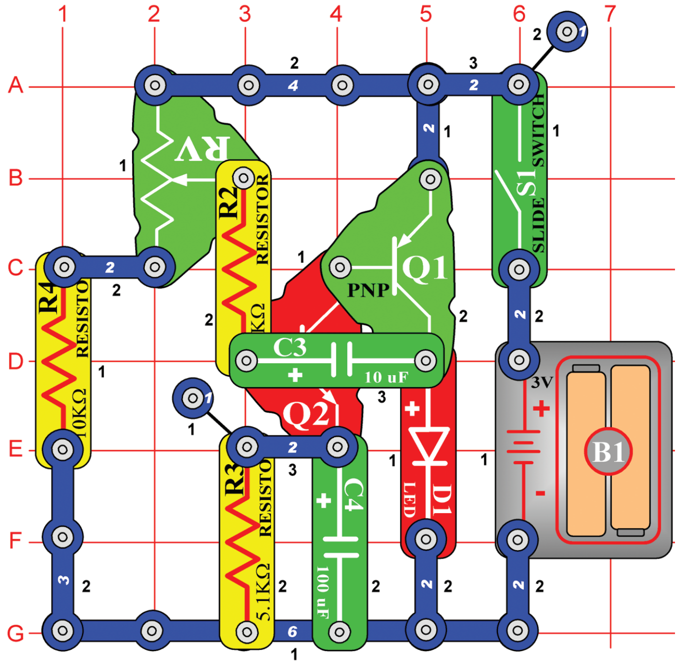
OBJECTIVE: Build a circuit that detects motion.



Set the adjustable resistor (RV) to the center position. Turn the slide switch (S1) on and the LED (D1) lights. Wave your hand over the photoresistor (RP) and the LED turns off and on. The resistance changes as the amount of light strikes the photoresistor. As the light decreases, the resistance increases. The increased resistance lowers the voltage at the base of the NPN transistor (Q2). This turns off the transistor, preventing current flowing through the LED to the negative (–) side of the battery (B1). Wave your hand over photoresistor at different distances. The LED gets brighter the farther away your hand is.

☐ Project #132

Oscillator 0.5 - 30Hz



OBJECTIVE: To build a 0.5Hz - 30Hz oscillator that will light an LED.

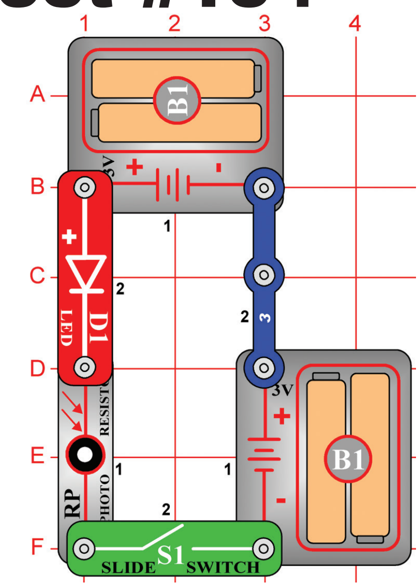
Set the adjustable resistor (RV) to the bottom position and then turn the slide switch (S1) on. The LED (D1) will start flashing at a frequency of 0.5Hz (once every two seconds). Slowly adjust the adjustable resistor and the LED flashes faster. As the frequency increases, the LED flashes faster. Eventually, the LED flashes so fast, it looks like it is on all of the time.

☐ Project #133 Sound Pulse Oscillator

Use the circuit from project #132.
Connect a single snap under the speaker (SP) and then connect it across the LED (on level 4). Turn the slide switch (S1) on and now you can hear the oscillator. Adjust the adjustable resistor (RV) to hear the different frequencies. Now you can hear and see the frequencies. Note: You may not hear sounds at all settings of the adjustable resistor.

☐ Project #134

Photoresistor Control



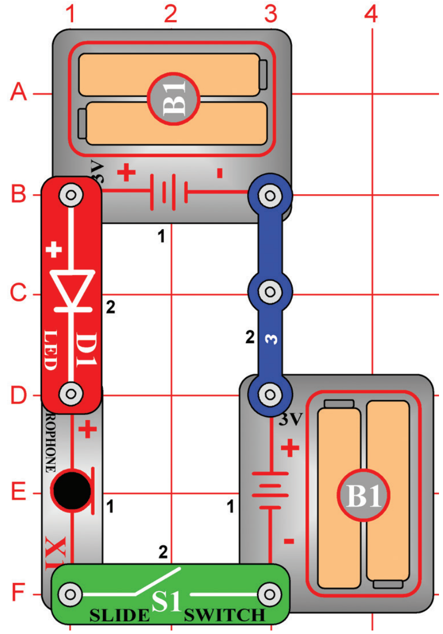
OBJECTIVE: To use a photoresistor to control the brightness of an LED.

In this circuit, the brightness of the LED (D1) depends on how much light shines directly on the photoresistor (RP). If the photoresistor were held next to a flashlight or other bright light, then the LED would be very bright.

The resistance of the photoresistor decreases as more light shines on it. Photoresistors are used in applications such as streetlamps, which come on as it gets dark due to night or a severe storm.

☐ Project #135

Microphone Control



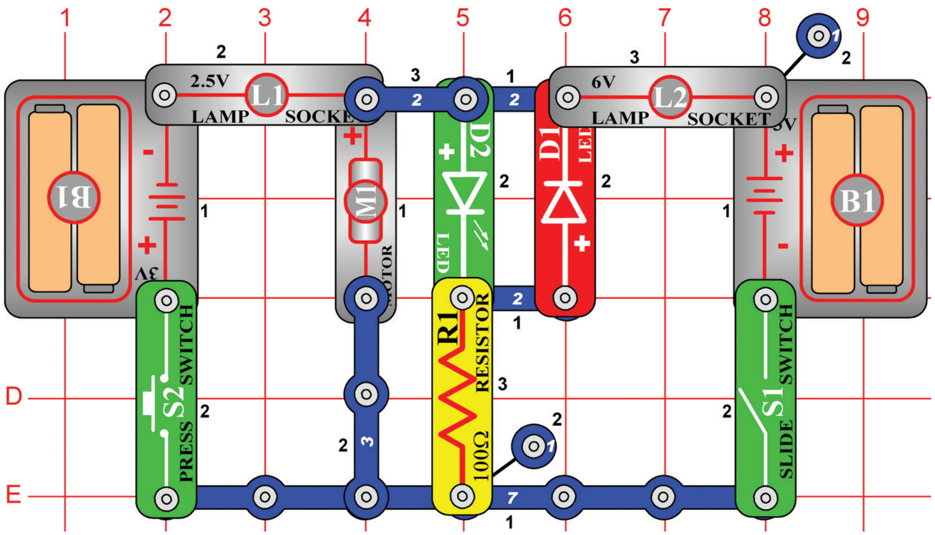
OBJECTIVE: To use a microphone to control the brightness of an LED.

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

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

☐ Project #136

LED Fan Rotation Indicator



OBJECTIVE: To build an LED fan rotation indicator.

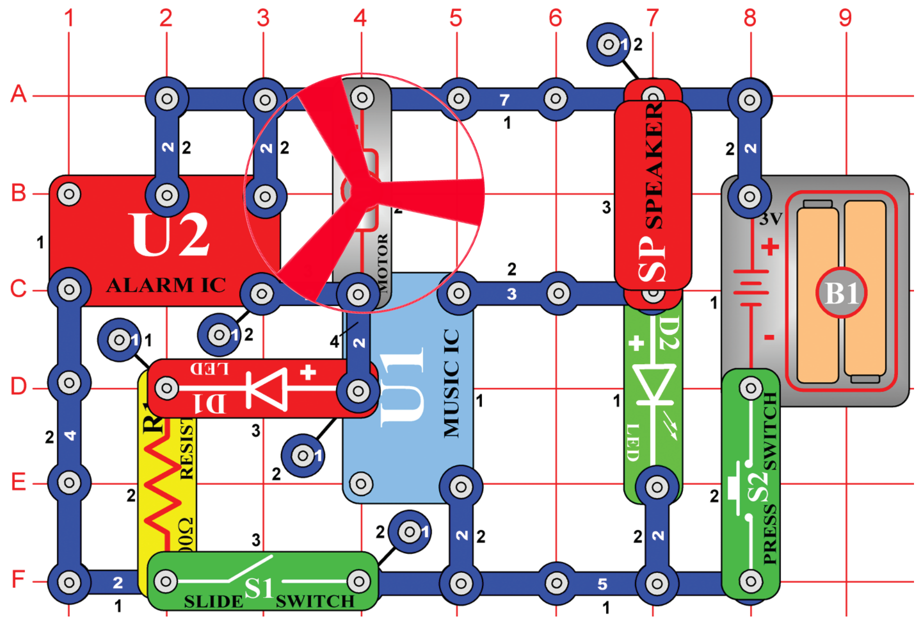
Do not place the fan onto the motor (M1). Turn the slide switch (S1) on. The motor rotates clockwise, and the green LED (D2) lights. When you connect the positive (+) side of the battery (B1) to the positive (+) side of the motor, it spins clockwise. Turn the slide switch off and press the press switch (S2). Now the fan spins the other way and the red LED (D1) lights. The positive (+) side of the battery is connected to the negative (–) side of the motor. The polarity on the motor determines which way it rotates.

Now place the fan on the motor, and turn on S1 or S2 (not both). Now one of the lamps (L1 or L2) lights as the motor spins, but the LED is dim.

The motor needs a lot of current to spin the fan, but only a little current to spin without it. In this circuit, a lamp lights when the motor current is high, and an LED lights when the motor current is low. The lamps also prevent a short circuit if both switches are on.

☐ Project #137

Sound Mixer Fan Driver



OBJECTIVE: To connect two sound ICs together to drive two LEDs and a motor.

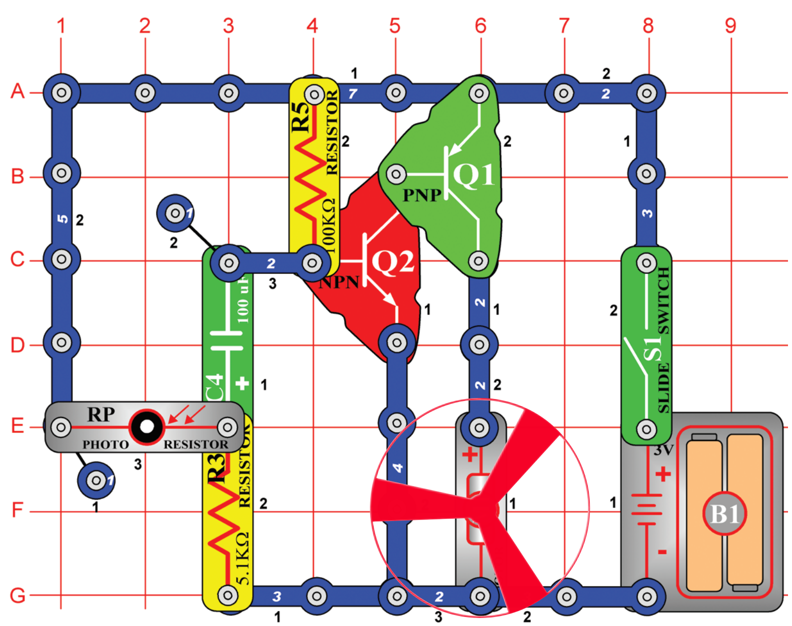
Build the circuit shown on the left. Place the fan onto the motor (M1).

In the circuit, the alarm IC (U2) and the music IC (U1) are connected together. The sounds from both ICs can be played at the same time. Press the press switch (S2). The music IC plays and the green LED (D2) lights. Now turn on the slide switch (S1) and press the press switch again. You should hear the sounds from both ICs playing. As the alarm IC plays, it also drives the fan and the red LED (D1).

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

☐ Project #138

Start-Stop Delay



OBJECTIVE: To start and stop a motor with light.

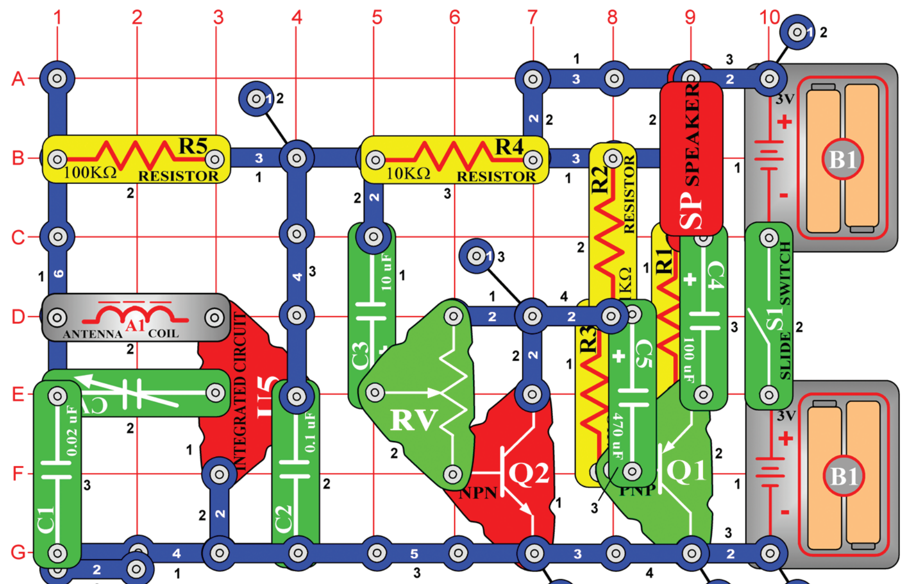
Place the fan on the motor (M1). Turn on the slide switch (S1), the motor starts spinning. As you move your hand over the photoresistor, (RP) the motor slows. Now place a finger on top of the photoresistor to block the light. The motor slows down. In a few seconds the motor speeds up again.

The fan will not move on most settings of the resistor, because the resistance is too high to overcome friction in the motor. If the fan does not move at any resistor setting, then replace your batteries.

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

☐ Project #139

AM Radio with Transistors



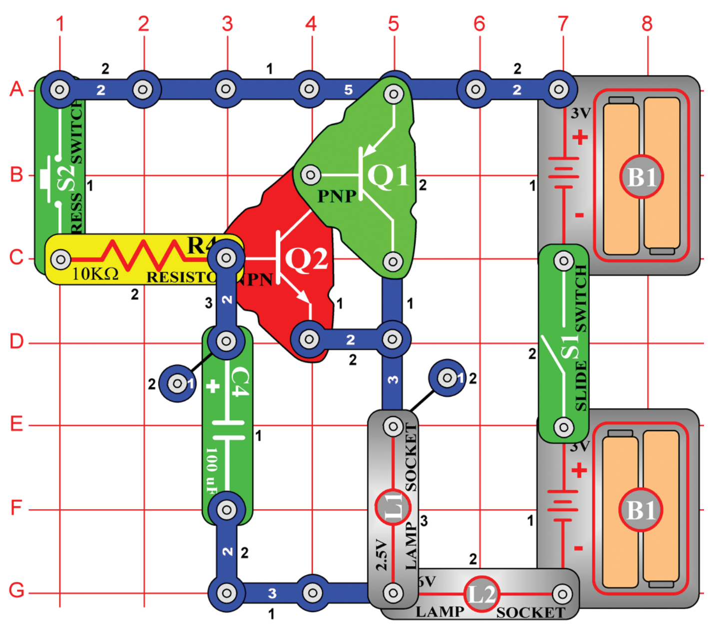
Note: 5-snap wire is connected from base grid locations G3 to G7.

OBJECTIVE: To build a complete, working AM radio with transistor output.

When you turn on the slide switch (S1), the integrated circuit (U5) should amplify and detect the AM radio waves. Tune the variable capacitor (CV) to the desirable station. Set the adjustable resistor (RV) for the best sound. The two transistors (Q1 & Q2) drive the speaker (SP) to complete the radio. The radio will not be very loud.

☐ Project #140

Delayed Action Lamp



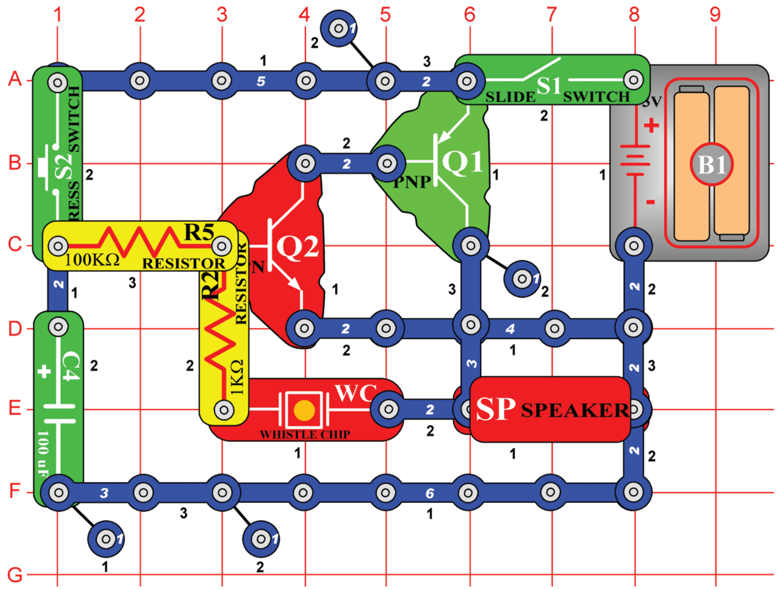
OBJECTIVE: To build a lamp that stays on for a while.

Turn on the slide switch (S1) and press the press switch (S2). The lamps (L1 & L2) turn on slowly, but stay on for a while after you release the press switch.

☐ Project 141 Delayed Action Fan

Replace the lamp (L1) with the motor (M1), positive (+) side up. Be sure to put on the fan. Turn on the slide switch (S1) and press the press switch (S2). The fan turns on slowly but stays on for a while after you release the press switch.

Project #142 Lasting Doorbell



OBJECTIVE: To build a doorbell that stays on for a while.

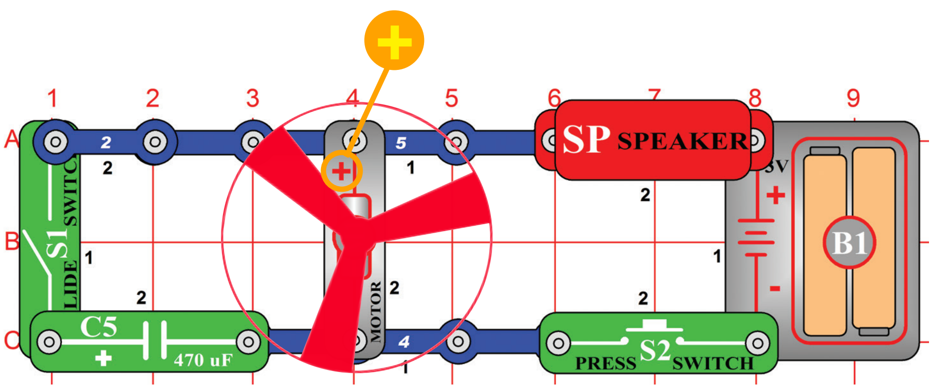
Build the circuit at left, note that there is a 4-snap wire on layer 1 that is not connected to a 3-snap wire that runs over it on layer 3. Turn on the slide switch (S1), then press and release the press switch (S2). There is a doorbell sound that slowly fades away.

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

Project #143 Lasting Clicking

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

Project #144 Quieting a Motor



OBJECTIVE: To show how capacitors can filter out electrical disturbances.

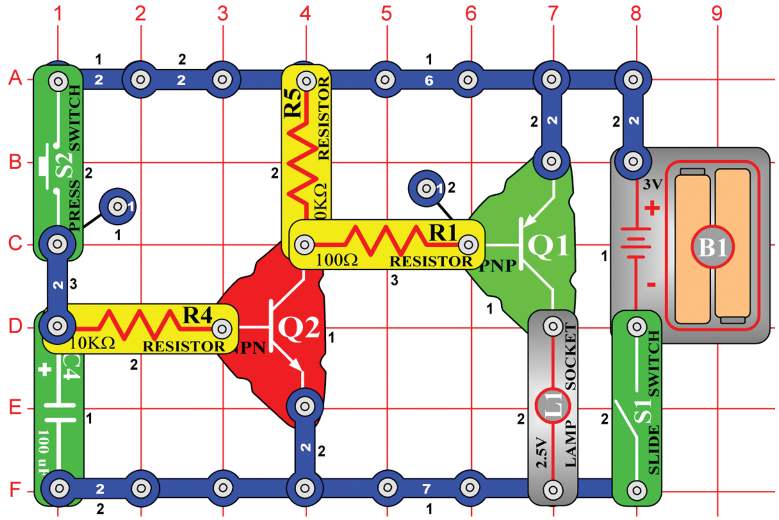
Place the fan on the motor (M1) and turn off the slide switch (S1). Press the press switch (S2) and listen to the motor.

As the motor shaft spins around it connects/ disconnects several sets of electrical contacts. As these contacts are switched, an electrical disturbance is created, which the speaker converts into sound.

Turn on the slide switch and push the press switch again. The fan spins just as fast, but the sound is not as loud. Capacitors, like the 470μF capacitor (C5), are often used to filter out undesired electrical disturbances. If you replace C5 with one of the other capacitors in your set then the sound will not be changed as much.

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

☐ Project #145 Watch Light



OBJECTIVE: To build a lamp that stays on for a while.

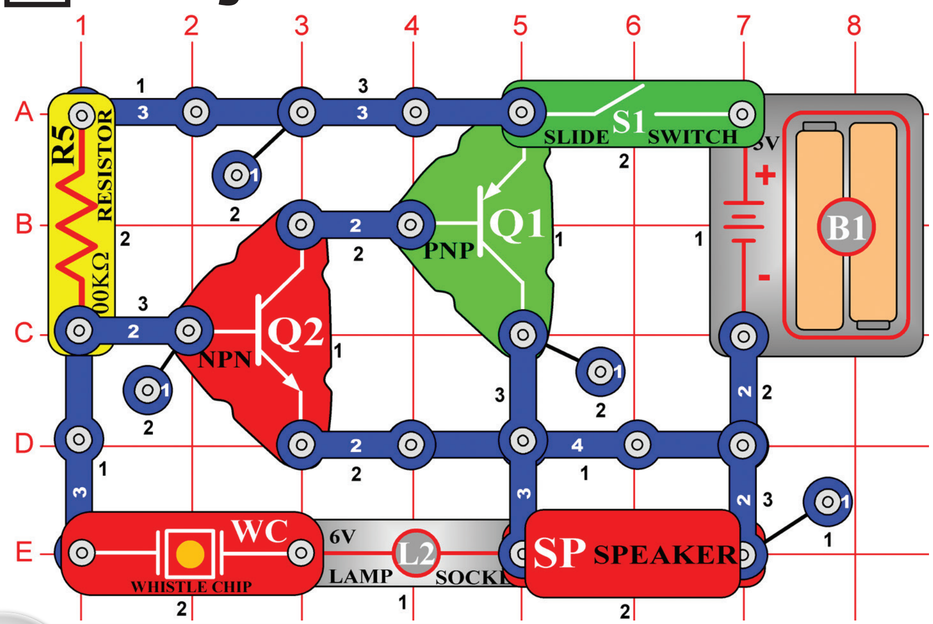
Turn on the switch and press the press switch (S2). The lamp stays on for a few seconds after you release the press switch.

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

☐ Project #146 Delayed Bedside Fan

Replace the lamp (L1) with the motor (M1, positive (+) side up), be sure to put on the fan. Turn on the switch and press the press switch (S2). The fan stays on for a while after you release the press switch. This could have a longer delay and be near your bed, to turn off after you fall asleep.

☐ Project #147 Tone Generator



OBJECTIVE: To build a high-frequency oscillator.

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

☐ Project #148 Tone Generator (II)

Place the 0.02μF capacitor (C1) on top of the whistle chip (WC) in the preceding circuit, you hear a middle-frequency sound. Why? The whistle chip is used here as a capacitor and by placing the 0.02μF on top (in parallel) we have increased the capacitance, and doing so lowers the frequency.

☐ Project #149 Tone Generator (III)

Next, replace the 0.02μF capacitor (C1) and the whistle chip (WC) with the larger 0.1μF capacitor (C2). You now hear a low frequency sound, due to yet more capacitance.

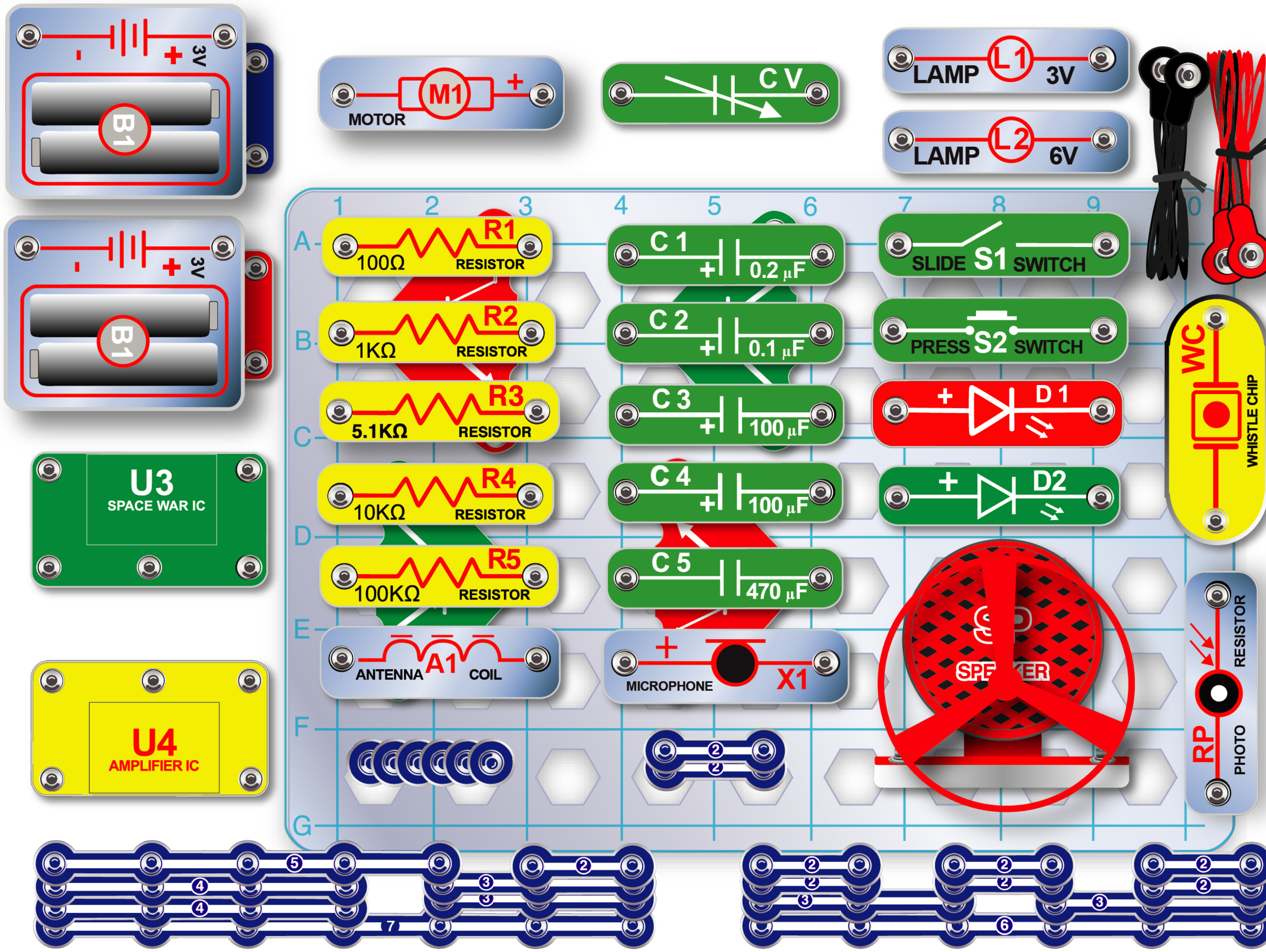
☐ Project #150 Tone Generator (IV)

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

Go to shop.elenco.com/consumers/snap-circuits-classic.html to download projects 151-305

SC-300 Snap Circuits® 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.



Go to shop.elenco.com/consumers/snap-circuits-classic.html to download projects 151-305