ELECTRONIC SNAP CIRCUITS™

Experiments 512-692

Instruction Manual

Elenco™ Electronics, Inc.

REV-A Revised 2004 753292

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

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

Basic Troubleshooting

1. **Most circuit problems are due to incorrect assembly, always double-check that your circuit exactly matches the drawing for it.**
2. **Be sure that parts with positive/negative markings are positioned as per the drawing.**
3. **Sometimes the light bulbs come loose, tighten them as needed. Use care since glass bulbs can shatter.**
4. **Be sure that all connections are securely snapped.**
5. **Try replacing the batteries.**

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

Note: If you suspect you have damaged parts, you can follow the Advanced Troubleshooting procedure on page 4 to determine which ones need replacing.

How To Use It

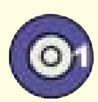
The snap circuit kit uses building blocks with snaps to build the different electrical and electronic circuits in the projects. Each block has a function: there are switch blocks, lamp blocks, battery blocks, different length wire blocks, etc. These blocks are in different colors and have numbers on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

For Example:

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

This is a wire block which is blue and comes in different wire lengths.
This one has the number 2, 3, 4, 5, 6, or 7 on it depending on the length of the wire connection required.

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



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

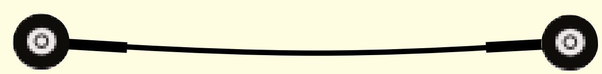
A large clear plastic base grid is included with this kit to help keep the circuit block together. You will see evenly spaced posts that the different blocks snap into. You do not need this base to build your circuits, but it does help in keeping your circuit together neatly. The base has rows labeled A-G and columns labeled 1-10.

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

The 2.5V and 6V bulbs come packaged separate from their sockets. Install the 2.5V bulb in the lamp socket L1, and the 6V bulb in the lamp socket L2 whenever those parts are used.

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

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

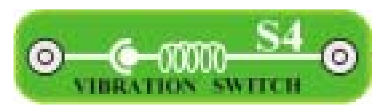
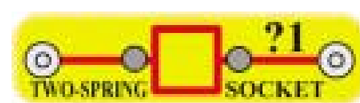


Note: While building the projects, be careful not to accidentally make a direct connection across the battery holder (a "short circuit"), as this will damage and/or quickly drain the batteries.

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

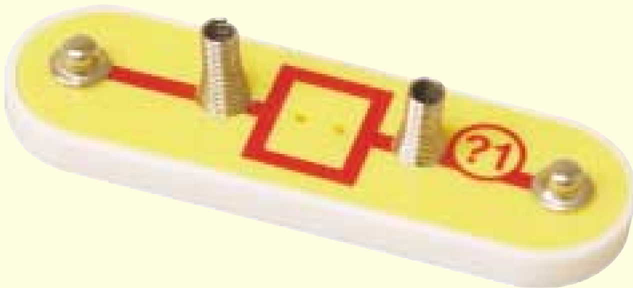
Note: There are additional part lists in your other project manuals. Part designs are subject to change without notice.

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 W. Carpenter Ave. • Wheeling, IL 60090 U.S.A.

Qty.	ID	Name	Symbol	Part #
☐ 1	B2	Solar Cell		6SCB2
☐ 1 ☐ 1	M3	Electromagnet Iron Core Rod		6SCM3 6SCM3B
☐ 1	S4	Vibration Switch		6SCS4
☐ 1		Bag of Paperclips		6SCM3P
☐ 1	?1	Two-spring Socket		6SC?1

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

About the TWO-SPRING SOCKET (?1)



The two-spring socket (?1) just has two springs, and won't do anything by itself. It is not used in any of the experiments. It was included to make it easy to connect other electronic components to your Snap Circuits. It should only be used by advanced users who are creating their own circuits.

There are many different types of electronic components and basic parts like resistors and capacitors have a wide range of available values. For example, Snap Circuits includes five fixed-value resistors (100Ω, 1KΩ, 5.1KΩ, 10KΩ, and 100KΩ). This is a very limited choice of values, and difficult to design circuits with. Snap Circuits also includes a variable resistor (RV), but it is difficult to set this part to a particular value. You can place your resistors in series and parallel to make different values (as is done with the 5.1KΩ and 10KΩ in project 166), but this is also difficult with only five values to choose from.

Many customers like to create their own circuits and asked us to include more resistor values with Snap Circuits. We could have done that, but you would never have enough. And resistors are not very exciting components by themselves. You could try to use your own resistors, but they are difficult to connect since normal electronic parts don't come with wires on them instead of snaps.

Resistor

Capacitor

The two-spring socket (?1) makes it easy to connect your own resistors (and other parts) to circuits by connecting them between the springs:

Any component with two wires coming from it (called leads) can be connected with the two-spring socket (?1), assuming the leads are long enough. Usually you will connect different values of resistors or capacitors, but other components like LEDs, diodes, or coils/inductors can also be used. You can usually find electronic components at any store specializing in electronics.

You can design your own circuits or substitute new parts into the projects in the manuals. For LEDs, diodes, or electrolytic capacitors, be sure to connect your parts using the correct polarity or you may damage them. Never exceed the voltage ratings of any parts. ELENCO™ ELECTRONICS IS NOT RESPONSIBLE FOR ANY PARTS DAMAGED BY IMPROPER CIRCUIT DESIGN OR WIRING. **The two-spring socket is only intended for advanced users.**

MORE About Your Snap Circuits Parts

(Note: There is additional information in your other project manuals).

The **solar cell (B2)** contains positively and negatively charged silicon crystals, arranged in layers that cancel each other out. When sunlight shines on it, charged particles in the light unbalance the silicon layers and produce an electrical voltage (about 3V). The maximum current depends on how the type of light and its brightness, but will be much less than a battery can supply. Bright sunlight works best, but incandescent light bulbs also work.

The **electromagnet (M3)** is a large coil of wire, which acts like a magnet when a current flows through it. Placing an iron bar inside increases the magnetic effects.

When shaken, the **vibraton switch (S4)** contains two separate contacts; and a spring is connected to one of them. A vibration causes the spring to move, briefly connecting the two contacts.

The **two-spring socket (?1)** is described on page 3.

A Note on Sun Power

The sun produces heat and light on an immense scale, by transforming Hydrogen gas into Helium gas. This "transformation" is a thermonuclear reaction, similar to the explosion of a Hydrogen bomb. The earth is protected from most of this heat and radiation by being so far away, and by its atmosphere. But even here the sun still has power, since it can spin the motor on your kit and give you sunburn on a hot day.

Nearly all of the energy in any form on the surface of the earth originally came from the sun. Plants get energy for growth from the sun using a process called photosynthesis. People and animals get energy for growth by eating plants (and other animals). Fossil fuels such as oil and coal that power most of our society are the decayed remains of plants from long ago. These fuels exist in large but limited quantity, and are rapidly being consumed. Solar cells will produce electricity as long as the sun is bright, and will have an ever-increasing effect on our lives.

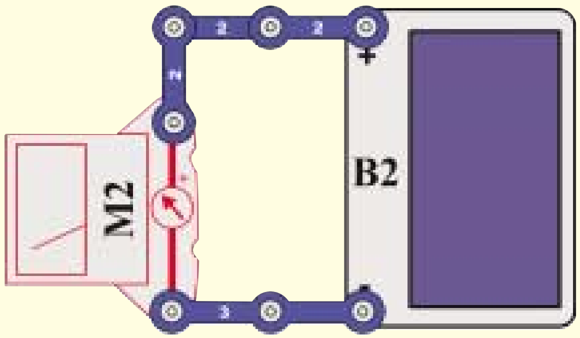
MORE Advanced Troubleshooting (Adult supervision recommended)

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

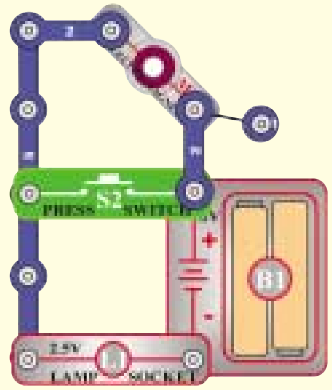
If you suspect you have damaged parts, you can follow this procedure to systematically determine which ones need replacing:

1 - 28. Refer to the other project manuals for testing steps 1-28, then continue below.

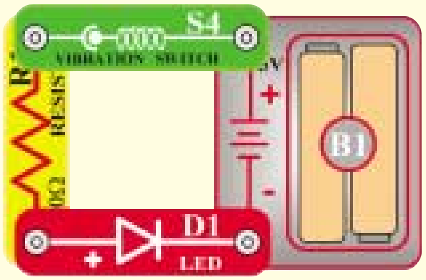
29. **Solar Cell (B2):** Connect the solar cell to the meter (M2) using snap jumpers and hold it near a lamp. The meter pointer should move.



30. **Electromagnet (M3):** Build the mini-circuit shown here. Lamp (L1) must be dim, and must get brighter when you press the switch (S2).



31. **Vibration Switch (S4):** Build the mini-circuit shown here and shake the base grid. The LED should go on and off as you shake.



MORE DO's and DON'Ts of Building Circuits

After building the circuits given in this booklet, you may wish to experiment on your own. Use the projects in this booklet as a guide, as many important design concepts are introduced throughout them. Every circuit will include a power source (the batteries), a resistance (which might be a resistor, lamp, motor, integrated circuit, etc.), and wiring paths between them and back. You must be careful not to create "short circuits" (very low-resistance paths across the batteries, see examples below) as this will damage components and/or quickly drain your batteries. Only connect the ICs using configurations given in the projects, incorrectly doing so may damage them. **Elenco™ Electronics 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, photo resistor, or fixed resistors.

ALWAYS use the **7-segment display**, LEDs, transistors, the high frequency IC, the **SCR**, 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 variable 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, the FM module, and the SCR 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.

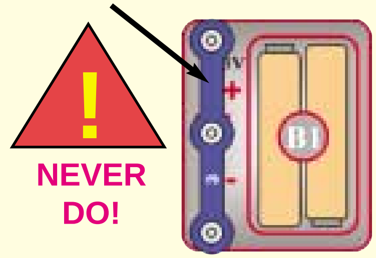
NEVER leave a circuit unattended when it is turned on.

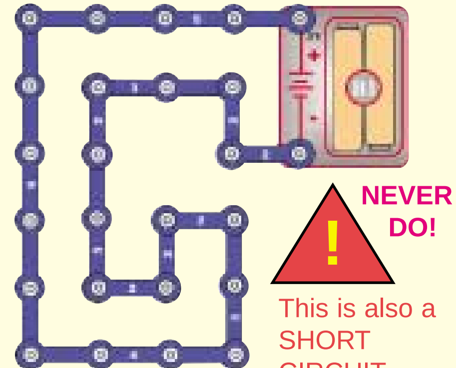
NEVER touch the motor when it is spinning at high speed.

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.

Examples of SHORT CIRCUITS - NEVER DO THESE!!!

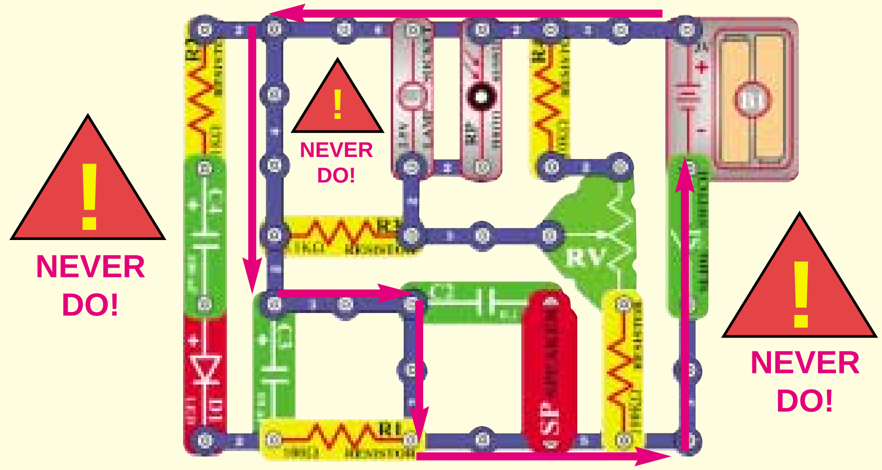
Placing a 3-snap wire directly across the batteries is a SHORT CIRCUIT.





This is also a SHORT CIRCUIT.

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



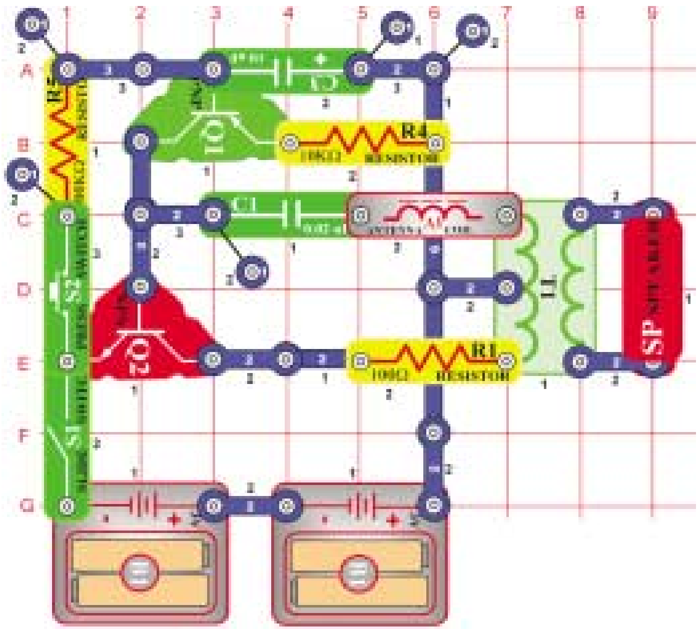
You are encouraged to tell us about new circuits you create. Upon review, we will post them with your name, age, and hometown in a special section on our website. If we use them in future manual revisions, we will send you a copy of the manual so you can show your family and friends. Send your suggestions to Elenco™ Electronics.

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

Project Listings

Project Listings

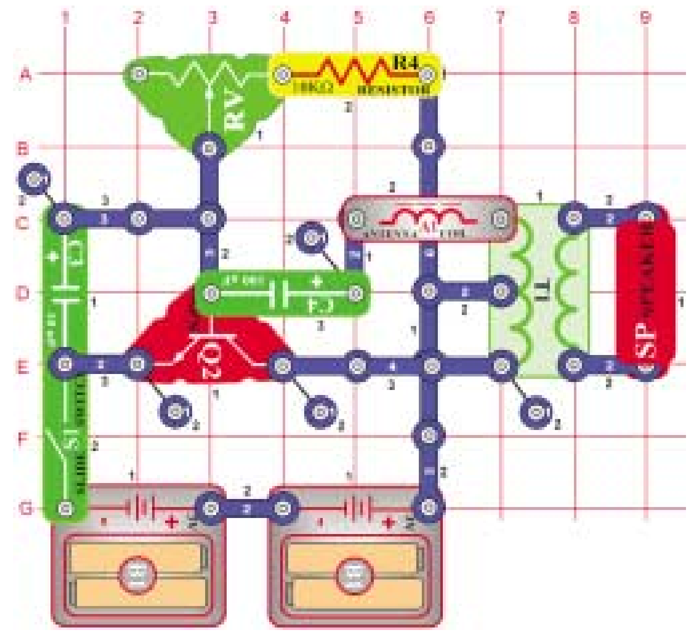
☐ Project #512 Siren



OBJECTIVE: To make a siren that slowly starts up and fades

Turn on the switch (S1), and then press the switch (S2) for a few seconds and release. A siren starts up and then slowly fades away as capacitor C3 discharges.

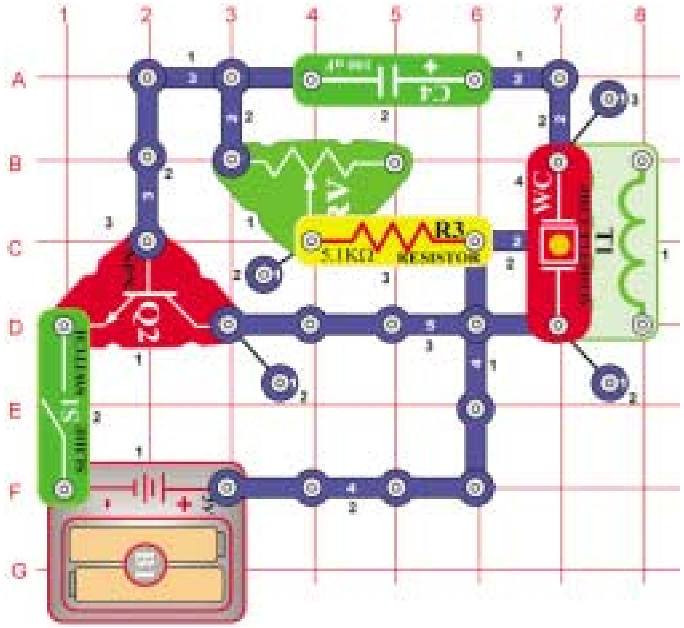
☐ Project #513 Electronic Rain



Build the circuit and turn on the switch (S1), you hear a sound like raindrops. The variable resistor (RV) controls the rain. Turn it to the left to make a drizzle and turn to the right to make the rain come pouring down.

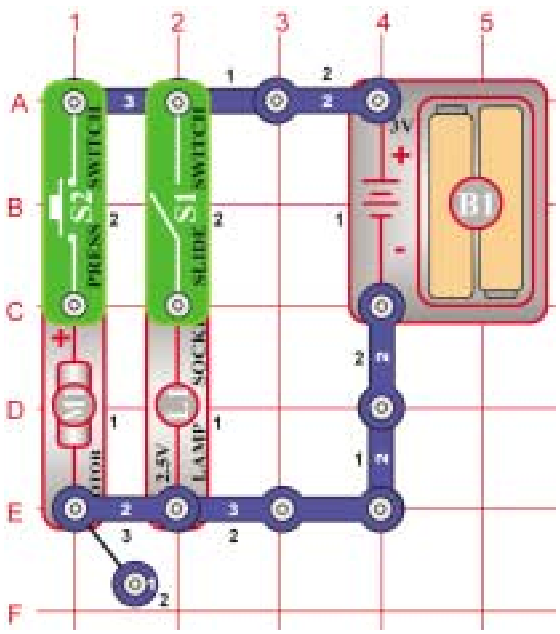
You can replace the 10KΩ resistor (R4) with the 1KΩ (R2) or 5.1KΩ (R3) resistors to speed up the rain.

☐ Project #514 — Leaky Faucet



Build the circuit and set the variable resistor (RV) control all the way to the right. Turn on the switch (S1) and you hear a sound like a faucet dripping. You can speed up the dripping by moving the variable resistor control around.

☐ Project #515 — Lamp & Fan Independent



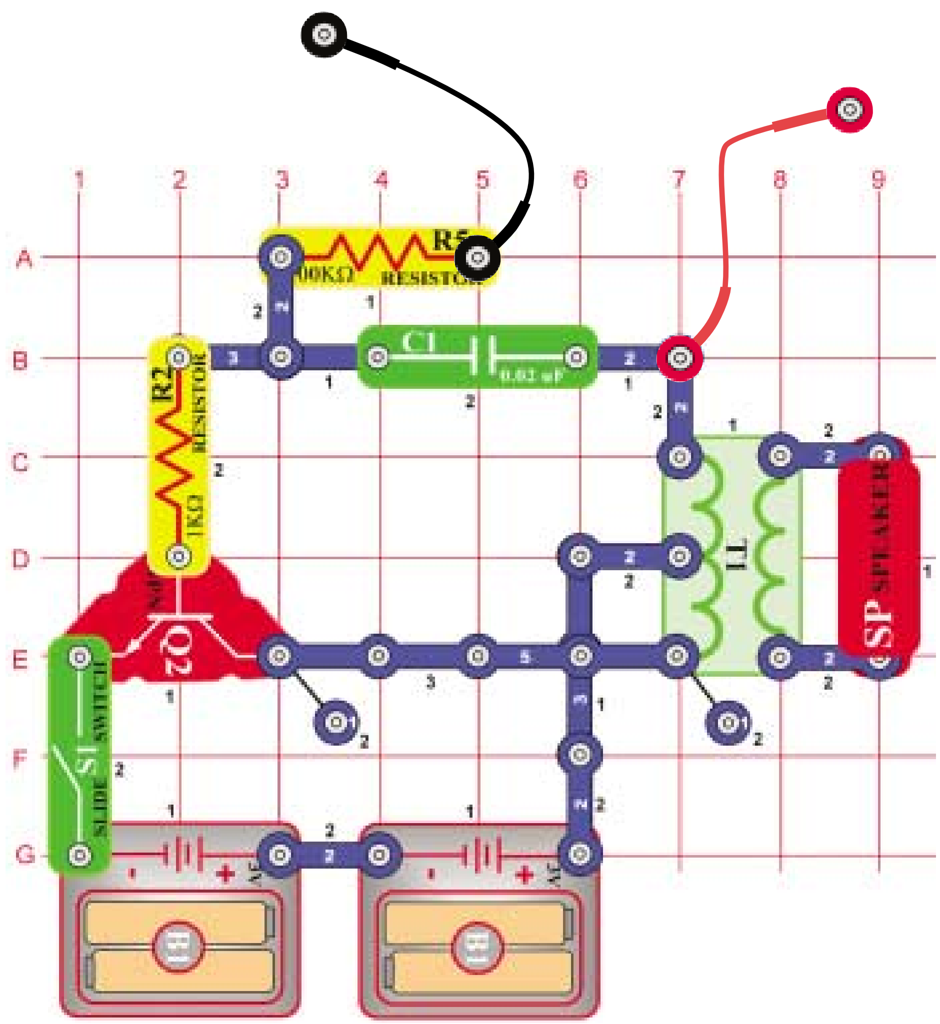
***OBJECTIVE:** To show how switches allow circuits to operate*

This circuit combines projects #1, #2, and #6 into one circuit.

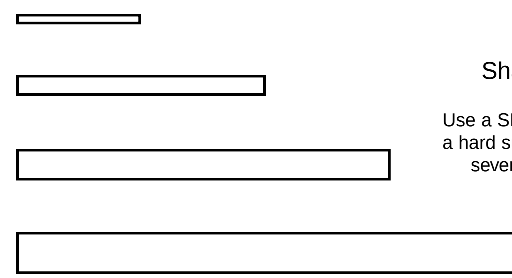
Build the circuit and place the fan on the motor (M1). Depending on which of the switches (S1 and S2) are on, you can turn on either the lamp (project #1), the motor (project #2), or both together (project #6).

This circuit was suggested by Luke S. of Westborough, MA.

☐ Project #516 Drawing Resistors (II)



You need some more parts to do this experiment, so you're going to draw them. Take a pencil (No. 2 lead is best but other types will also work), **SHARPEN IT**, and fill in the 4 rectangles you see below. You will get better results if you **place a hard, flat surface between this page and the rest of this booklet** while you are drawing. **Press hard** (but don't rip the paper) and **fill in each several times** to be sure you have a **thick, even layer of pencil** lead and try to avoid going out of the boundaries.



Shapes to be drawn.

Use a SHARP No. 2 pencil, draw on a hard surface, press hard and fill in several times for best results.

Actually, your pencils aren't made out of lead anymore (although we still call them "lead pencils"). The "lead" in your pencils is really a form of carbon, the same material that resistors are made of. So the drawings you just made should act just like the resistors in Snap Circuits.

Build the circuit shown, it is the same basic oscillator circuit you have been using. Touch the the loose ends of the jumper wires to opposite ends of the rectangles you drew, you should hear a sound like an alarm. **Note:** You may get better electrical contact between the wires and the drawings if you wet the metal with a few drops of water or saliva.

Making the drawn resistors longer should increase the resistance while making them wider should reduce the resistance. So all 4 rectangles should produce the same sound, though you will see variations due to how thick and evenly you filled in the rectangles, and exactly where you touch the wires. If your 4 shapes don't sound similar then try improving your drawings.

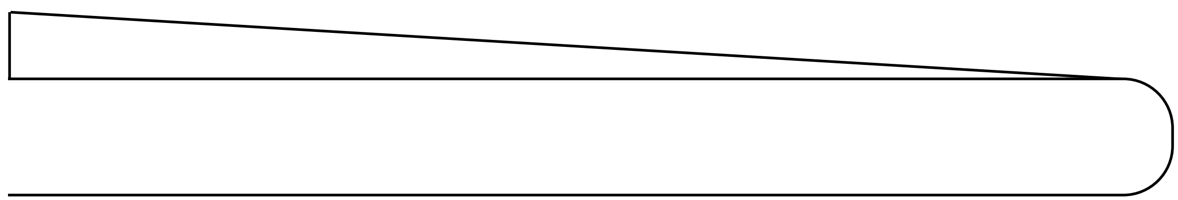
Be sure to wash your hands after this project.

Project #517 — Electronic Kazoo

Use the same circuit as project #516, but draw a new shape. A Kazoo is a musical instrument that is like a one-note flute, and you change the pitch (frequency) of the sound by moving a plunger up and down inside a tube.

As before, take a pencil (No. 2 lead is best but other types will also work), **SHARPEN IT** again, and fill in the shape you see below. For best results, **SHARPEN IT again**, **place a hard flat surface between this page and the rest of this booklet** while you are drawing. **Press hard** (but don't rip the paper). **Fill in each several times** to be sure you have a **thick, even layer of pencil** lead, and try to avoid going out of the boundaries. **Where the shape is just a line, draw a thick line and go over it several times.** The black ink in this manual is an insulator just like paper, so you have to write over it with your pencil.

Take one loose wire and touch it to the widest part of this shape, at the upper left. Take the other loose wire and touch it just to the right of the first wire. You should hear a high-pitch sound. How do you think the sound will change as you slide the second wire to the right? Do it, slowly sliding all the way around to the end. The sound changes from high frequency to low frequency, just like a kazoo. **Note:** You may get better electrical contact between the wires and the drawings if you wet the wires with a few drops of water or saliva.



Shape to be drawn.

Use a SHARP No. 2 pencil, draw on a hard surface, press hard and fill in several times for best results.

Project #518 — Electronic Kazoo (II)

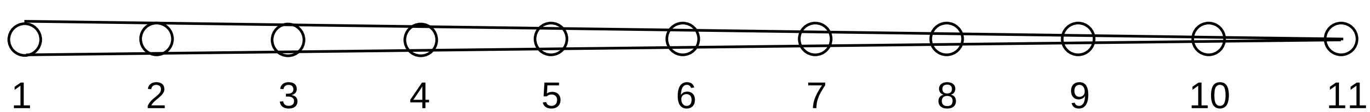
Use the same circuit as project #516, but fill in the new shape shown here.

Take one loose jumper wire and touch it to the left circle. Take the other loose wire and touch it to each of the other circles. The various circles produce different pitches in the sound, like notes. Since the circles are like keys on a piano, you now have an electronic keyboard! See what kind of music you can play with it. **Note:** You may get better electrical contact between the wires and the drawings if you wet the wires with a few drops of water or saliva.

Now take one loose wire and touch it to the right circle (#11). Take the other wire and touch it to the circles next to the numbers shown below, in order:

7 - 5 - 1 - 5 - 7 - 7 - 7
5 - 5 - 5
7 - 7 - 7
7 - 5 - 1 - 5 - 7 - 7 - 7 - 7 - 5 - 5 - 7 - 5 - 1

Do you recognize this nursery rhyme? It is "Mary Had a Little Lamb". By now you see that you can draw any shape you like and make electronic sounds with it. Experiment on your own as much as you like. Be sure to wash your hands after this test.



Shape to be drawn.

Use a SHARP No. 2 pencil, draw on a hard surface, press hard and fill in several times for best results.

Project #519

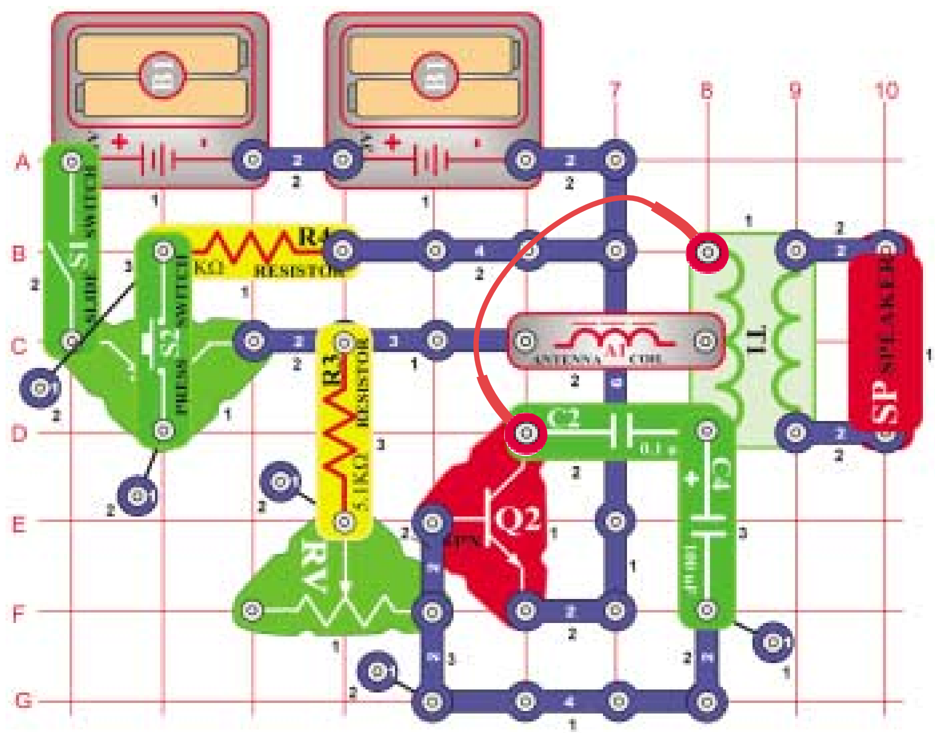
Water Resistor

Use the same circuit as project #516. Take the two loose jumper wires and touch them with your fingers. You should hear a low-frequency sound. Now place the loose jumpers in a cup of water without them touching each other. The sound will have a much higher frequency because drinking water has lower resistance than your body. You can change the sound by adding or removing water from the cup. If you add salt to the water then you will notice the frequency increase, because dissolving salt lowers the resistance of the water.

You can also make a water kazoo. Pour a small amount of water on a table or the floor and spread it with your finger into a long line. Place one of the jumper wires at one end and slide the other along the water. You should get an effect just like the kazoo you drew with the pencil, though the frequency will probably be different.

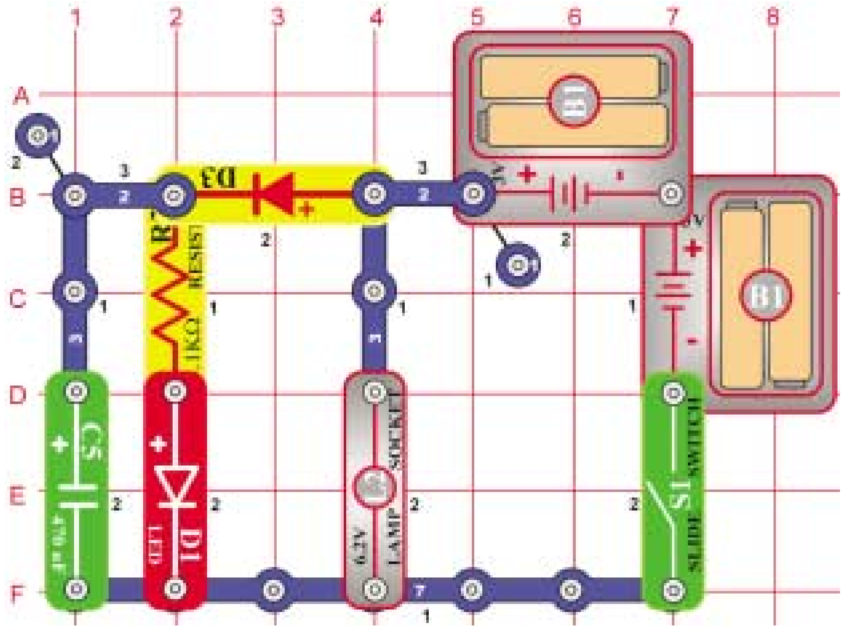
Project #520

Two-Transistor Oscillator



Build the circuit, turn on the switch (S1), and then press switch (S2). Move the control lever of the variable resistor (RV) to change the tone.

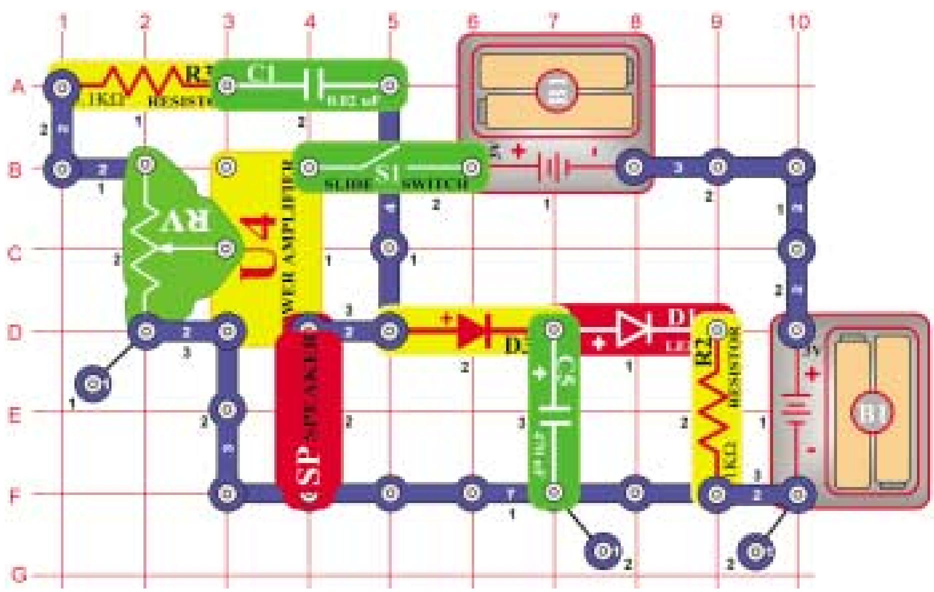
☐ Project #521 Diode



Turn on the switch (S1), the lamp (L2) will be bright and the LED (D1) will be lit. The diode (D3) allows the batteries to charge up capacitor C5 and light the LED.

Turn off the switch, the lamp will go dark immediately but the LED will stay lit for a few seconds as capacitor C5 discharges through it. The diode isolates the capacitor from the lamp; if you replace the diode with a 3-snap wire then the lamp will drain the capacitor almost instantly.

☐ Project #522 Rectifier

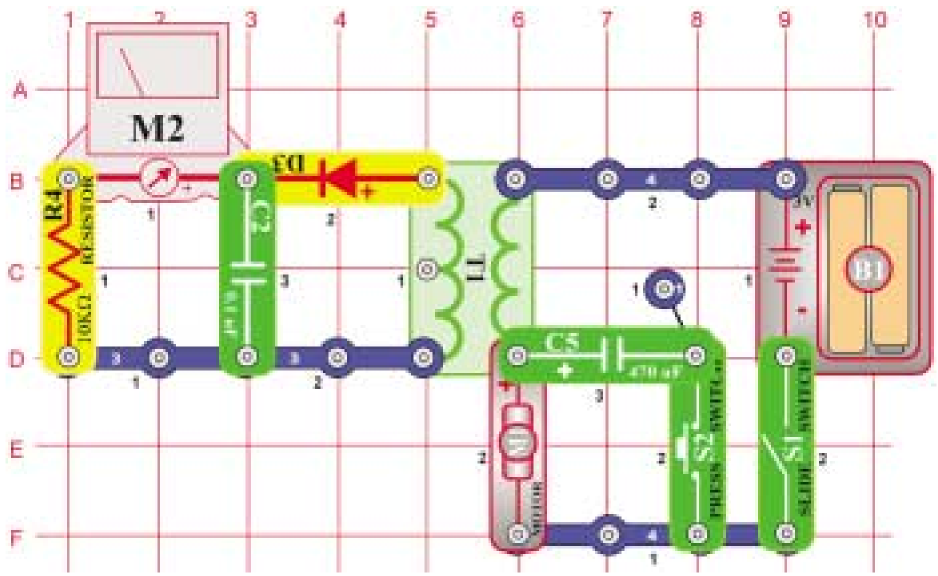


This circuit is based on the Trombone project #238. Turn on the switch (S1) and set the variable resistor (RV) for mid-range for the best sound. The LED (D1) will also be lit.

The signal from the power amplifier (U4) to the speaker (SP) is a changing (AC) voltage, not the constant (DC) voltage needed to light the LED. The diode (D3) and capacitor (C5) are a rectifier, which converts the AC voltage into a DC voltage.

The diode allows the capacitor to charge up when the power amp voltage is high, but also prevents the capacitor from discharging when the power amp voltage is low. If you replace the diode with a 3-snap or remove the capacitor from the circuit, the LED will not light.

☐ Project #523 Motor Rectifier

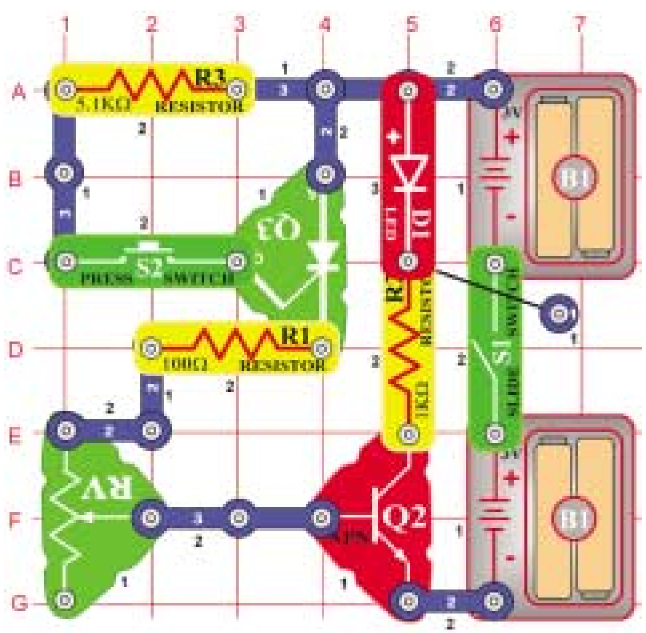


Set the meter (M2) to the 10MA scale. Place the fan on the motor (M1) and turn on the switch (S1), the meter measures the current on the other side of the transformer (T1).

As the DC voltage from the battery (B1) spins the motor, the motor creates an AC ripple in the voltage. This ripple passes through the transformer using magnetism. The diode and 0.1μF capacitor (C2) "rectify" the AC ripple into the DC current that the meter measures.

Holding down the press switch (S2) connects the 470μF capacitor (C5) across the motor. This filters out the AC ripple, so the current through the meter is greatly reduced but the motor speed is not affected.

☐ Project #524 SCR Shutdown

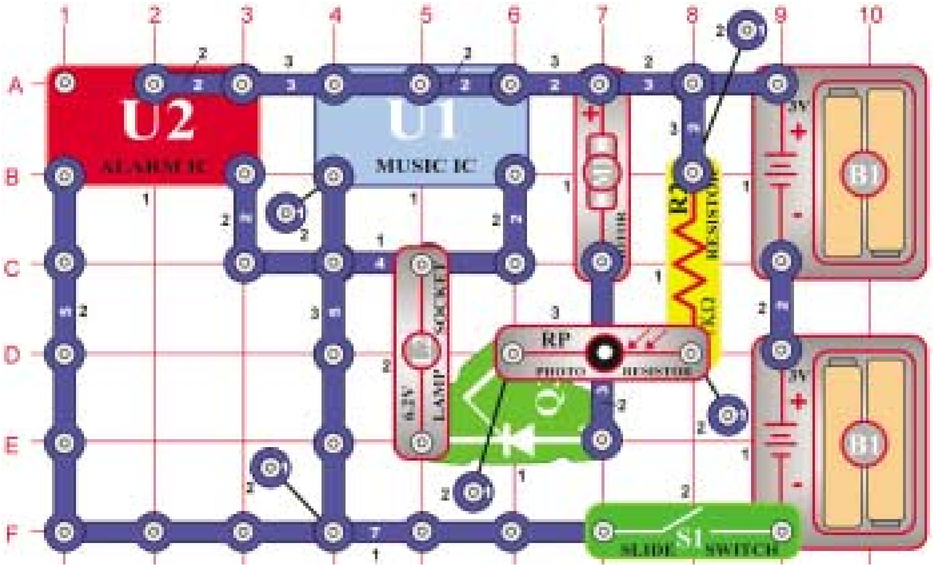


In this circuit the press switch (S2) controls an SCR (Q3), which controls a transistor (Q2), which controls an LED (D1). Set the variable resistor (RV) control lever to the top (toward the press switch).

Turn on the slide switch (S1); nothing happens. Press and release the press switch; the SCR, transistor, and LED turn on and stay on. Now move the variable resistor control down until the LED turns off. Press and release the press switch again, this time the LED comes on but goes off after you release the switch.

If the current through an SCR (anode-to-cathode) is above a threshold level, then the SCR stays on. In this circuit you can set the variable resistor so that the SCR (and the LED it controls) just barely stays on or shuts off.

☐ Project #525 SCR Motor Control

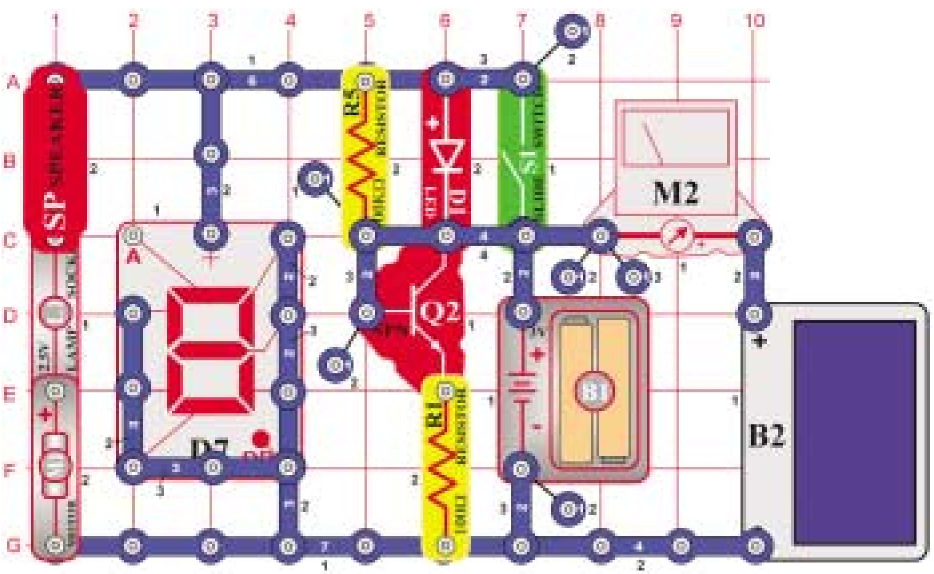


SCRs are often used to control the speed of a motor. The voltage to the gate would be a stream of pulses, and the pulses are made wider to increase the motor speed.

Place the fan on the motor (M1) and turn on the switch (S1). The motor spins and the lamp (L2) lights. Wave your hand over the photoresistor (RP) to control how much light shines on it, this will adjust the speed of the motor. By moving your hand in a repetitive motion, you should be able spin the motor at a slow and steady speed.

☐ Project #526 Output Forms

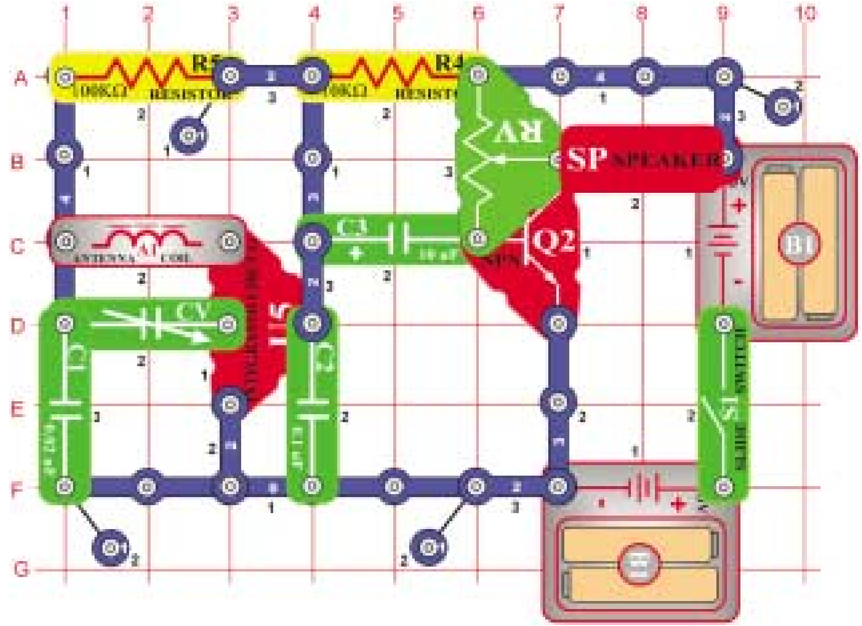
OBJECTIVE: To show the different types of output from Snap



Set the meter (M2) to the 10MA scale. This circuit uses all six forms of output available in Snap Circuits - speaker (sound), lamp (light), LED (light), motor (motion), 7-segment display (light), and meter (motion of pointer).

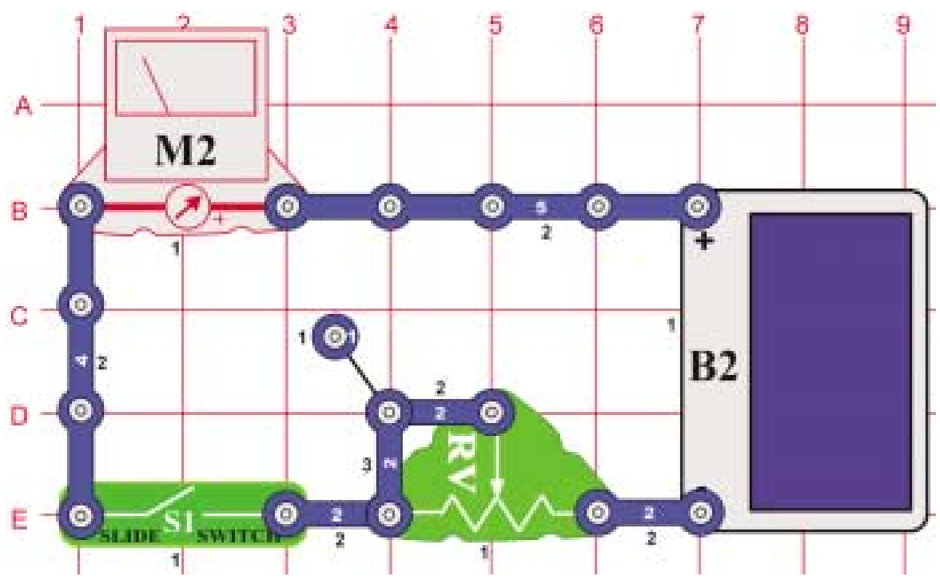
Place the fan on the motor (M1), turn on the switch (S1), and shine light on the solar cell (B2). There will be activity from all six forms of output.

Project #527 Transistor AM Radio



This AM radio circuit uses a transistor (Q2) in the amplifier that drives the speaker (SP). Turn on the switch (S1) and adjust the variable capacitor (CV) for a radio station, then adjust the loudness using the variable resistor (RV).

Project #528 Adjustable Solar Power Meter

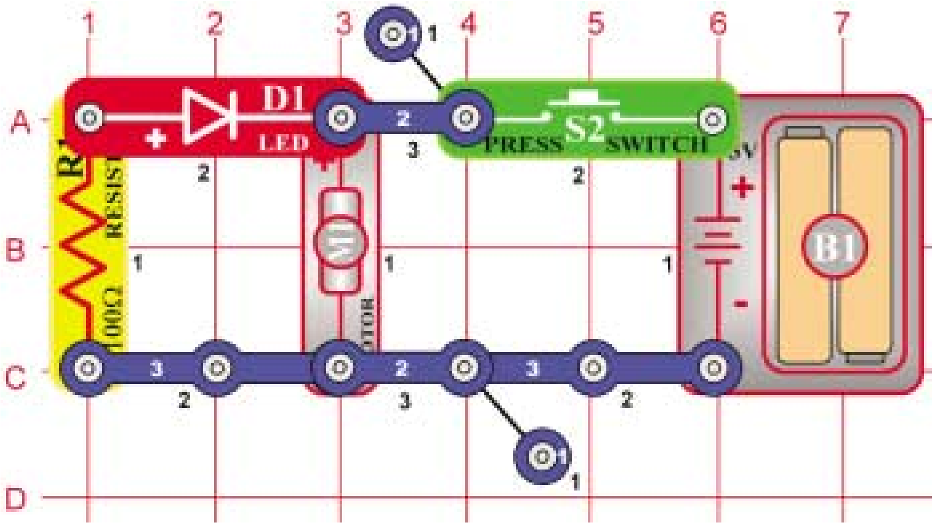


Set the variable resistor (RV) for mid-range and the meter (M2) for 10MA setting. Turn on the switch (S1) and let light shine on the solar cell (B2). Move the solar cell around different light sources and adjust the variable resistor to change the reading on the meter.

Place your hand to cover half of the solar cell, the meter reading should drop by half. When you reduce the light to the solar cell, the current in the circuit is reduced.

Place a sheet of paper over the solar cell and see how much it changes the reading on the meter. Then add more sheets until the meter reads zero.

Project #529 Fan Blade Storing Energy



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

Do you know why the LED lights? It lights because the mechanical energy stored in the fan blade makes the motor act like a generator. When the switch is released, this energy creates a brief current through the LED. If you remove the fan blade from the circuit then the LED will never light, because the motor shaft alone does not store enough mechanical energy.

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

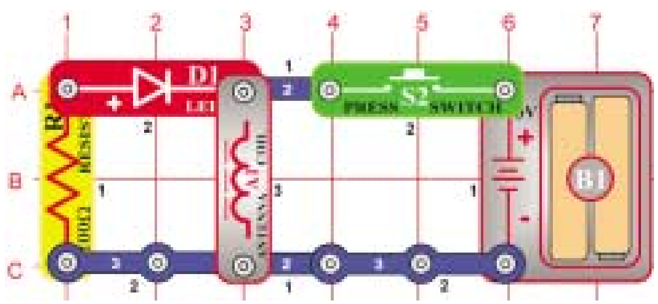
This circuit was suggested by Mike D. of Woodhaven, NY.

Project #530 Speaker Storing Energy

Modify project #529 by replacing the motor (M1) with the speaker (SP), and watch the LED (D1) closely. The LED will light, but dimly and briefly. The speaker stores some energy, but much less than the fan blade did.

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

Project #531 Antenna Storing Energy



This circuit is based on one suggested by Mike D. of Woodhaven, NY.

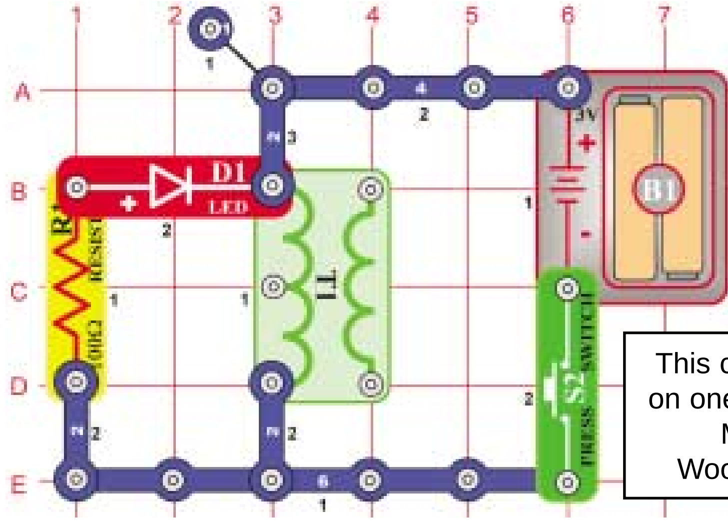
Hold down the press switch (S2) and then watch the LED (D1) as you release the switch. The LED lights briefly but only after the batteries (B2) are disconnected from the circuit.

This circuit is different from the Fan Blade Storing Energy project, because energy in the antenna coil (A1) is stored in a magnetic field. When the switch is released, this field creates a brief current through the LED.

Note that the energy stored in a magnetic field acts like mechanical momentum, unlike capacitors which store energy as an electrical charge across a material. You can replace the antenna with any of the capacitors but the LED will not light. Energy stored in the magnetic fields of coils was called electrical momentum in the early days of electronics.

Project #532 Transformer Storing Energy

OBJECTIVE: To show that the transformer stores electrical



This circuit is based on one suggested by Mike D. of Woodhaven, NY.

Hold down the press switch (S2) and then watch the LED (D1) as you release the switch. The LED lights briefly but only after the batteries (B1) are disconnected from the circuit.

This circuit is similar to the Antenna Storing Energy project, and shows how the coils in the transformer (T1) also store energy in magnetic fields. When the switch is released, this energy creates a brief current through the LED.

If you flip the transformer around (so that the 2-snap side is on the left) then the LED will barely light at all. This is because the coil on that side has less windings, and therefore stores less energy.

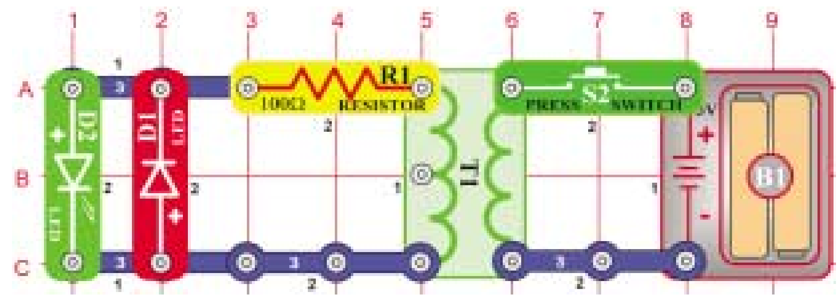
Project #533 Relay Storing Energy

Modify project #532 by replacing the transformer (T1) with the relay (S3), position it with the 3-snap sides to top and right (as in project #341).

Hold down the press switch (S2) and then watch the LED (D1) as you release the switch. The LED lights briefly but only after the batteries (B1) are disconnected from the circuit.

The relay has a coil similar to the one in the transformer, and stores energy in the same way.

Project #534 Transformer Lights



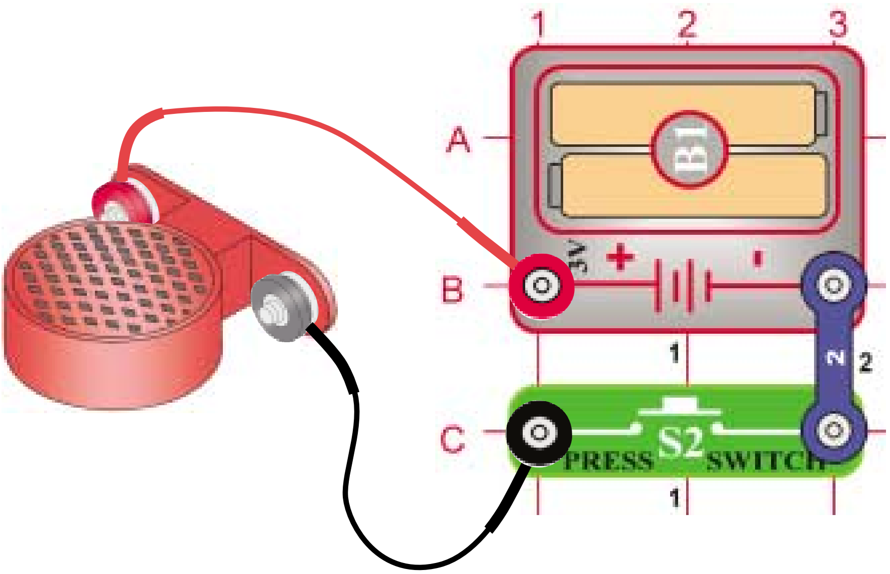
Watch the LEDs (D1 and D2) as you press or release the switch (S2). The red LED (D1) lights briefly just as you press the switch and the green LED (D2) lights briefly just after you release it, but neither lights while you hold the switch down. Why?

When you press the switch, a surge of currrent from the battery charges a magnetic field in the transformer (T1), which stays constant as the switch is held down. Charging the magnetic field induces an opposing current on the other side of the transformer, which lights the red LED until the magnetic fields stabilize.

When you release the switch (removing the current from the battery), the magnetic field discharges. Initially the transformer tries to maintain the magnetic field by inducing a current on the other side, which lights the green LED until the resistor (R1) absorbs the remaining energy.

Note that this project is different from the Antenna Storing Energy project because there is a magnetic connection across the transformer, not an electrical connection.

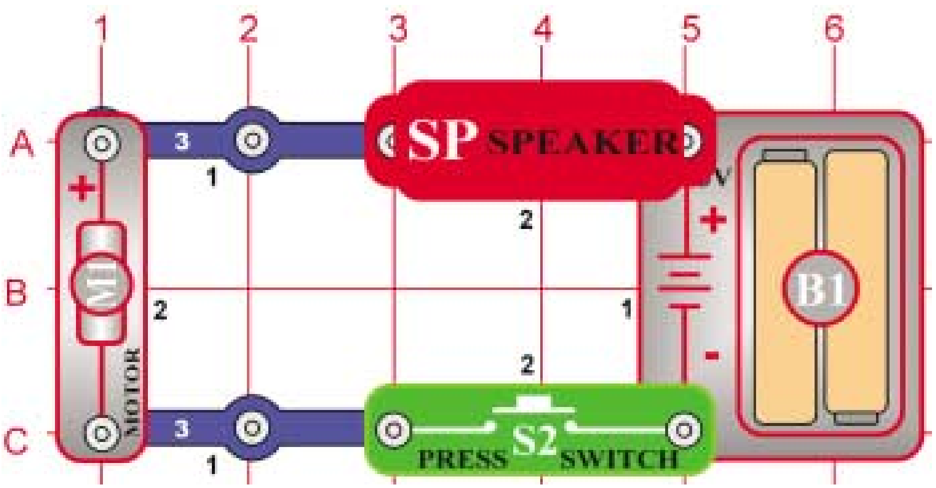
☐ Project #535 Hear the Speaker



Hold the speaker (SP) up to your ear and press the switch (S2) several times. You hear a click each time you press or release the switch, but hear nothing while you are holding it down. Do you know why?

The speaker contains a coil of wire wrapped around a small magnet. Whenever the voltage to the speaker changes, magnetic effects from the coil move the magnet. This creates a change in air pressure that your ears feel and recognize as sound. The magnet only moves when the voltage changes, and the voltage only changes when you press or release the switch.

☐ Project #536 Hear the Motor



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

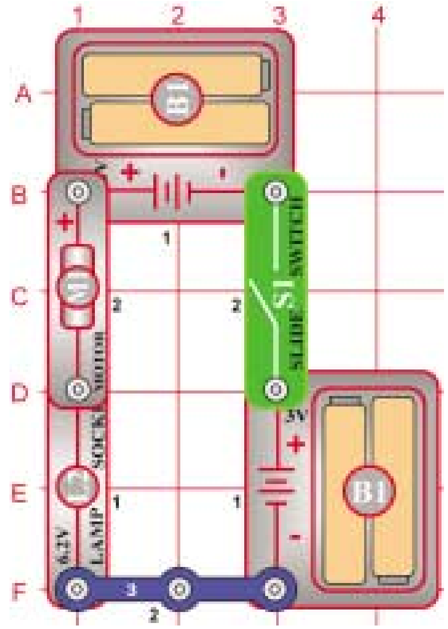
A motor uses magnetism to convert electrical energy into mechanical spinning motion. As the motor shaft spins around it connects/disconnects several sets of electrical contacts to give the best magnetic properties. As these contacts are switched, an electrical disturbance is created, which the speaker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

If you replace the motor with the 2.5V lamp (L1), then it will work the same as the Hear the Speaker project, because the lamp doesn't make any noise.

This circuit was suggested by Andrew M. of Cochrane, Alberta, Canada

Project #537 — Back EMF

WARNING: Do not touch the motor!



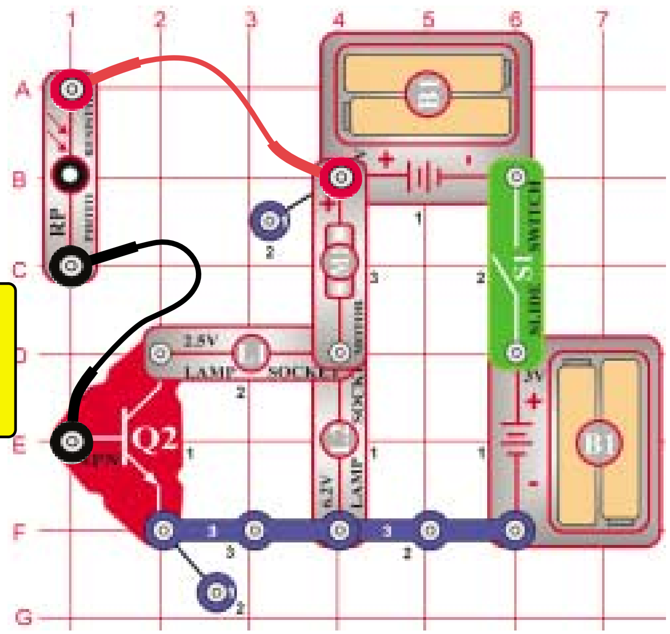
The voltage produced by a motor when it is spinning is called its *Back Electro-Motive-Force* (Back EMF); this may be thought of as the motor's electrical resistance. The motor's *Front Electro-Motive-Force* is the force it exerts in trying to spin the shaft. This circuit demonstrates how the Back EMF increases and the current decreases as the motor speeds up.

Place the fan on the motor (M1) and turn on the switch (S1). The 6V bulb (L2) will be bright, indicating that the Back EMF is low and the current is high.

Turn off the switch, remove the fan, and turn the switch back on. The lamp is bright when the motor starts and the lamp dims as the motor speeds up. Now the Back EMF is high and the current is low. BE CAREFUL NOT TO TOUCH THE MOTOR WHILE IT SPINS.

Project #538 — Back EMF (II)

OBJECTIVE: To demonstrate how the motor draws more current



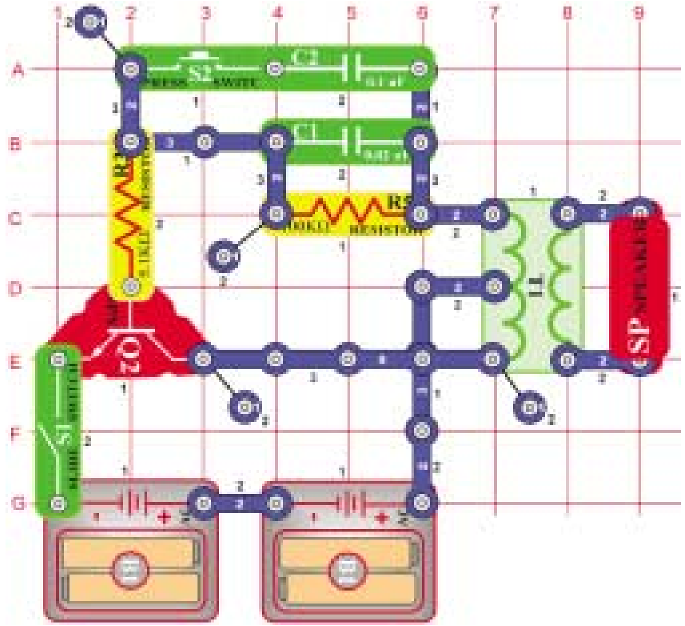
WARNING: Do not touch the motor!

Do not place the fan on the motor (M1) this time, but BE CAREFUL NOT TO TOUCH THE MOTOR except as instructed here. Connect the photoresistor (RP) with the jumper wires as shown, and hold it next to the 6V bulb (L2) so the light shines on it.

Turn on the switch and watch how the 6V bulb is bright at first but gets dim as the motor speeds up. Place the bottom of a small cylinder (such as the eraser side of a pencil or a spare "AA" battery) directly over the shaft of the motor and gently press down until the motor barely spins. By moving the photoresistor (RP) next to or away from the 6V bulb, you should be able to change the motor speed.

When you push on the motor shaft to slow it down, the motor's Back EMF drops and the current increases. The extra current makes the 6V lamp brighter. When the photoresistor is held next to the 6V bulb, transistor Q2 (with lamp L1) will try to keep the motor at a constant speed as you slow down the shaft.

Project #539 Electronic Sound

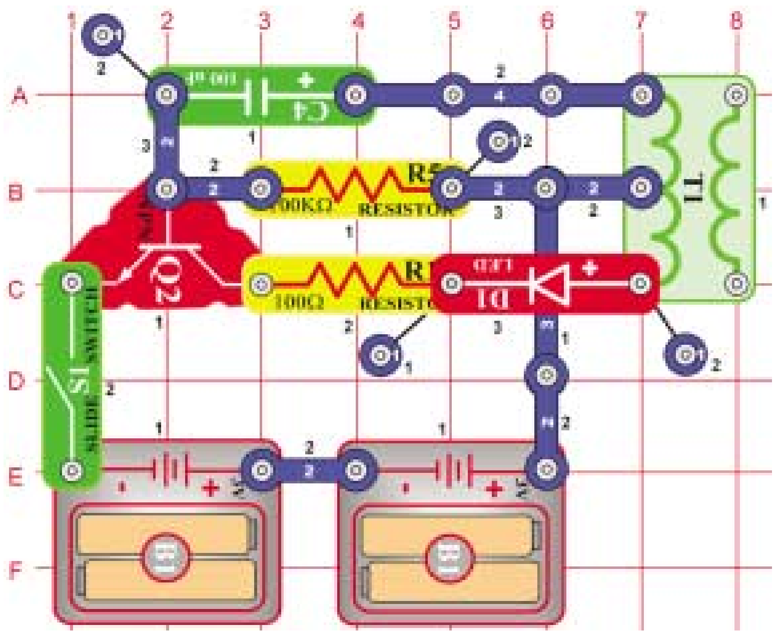


Build the circuit and turn on the slide switch (S1), you hear a high-frequency tone. Press the switch (S2) to lower the frequency by increasing the capacitance in the oscillator. Replace the 0.1µF capacitor (C2) with the 10µF capacitor (C3) to further lower the frequency of the tone.

Project #540 Electronic Sound (II)

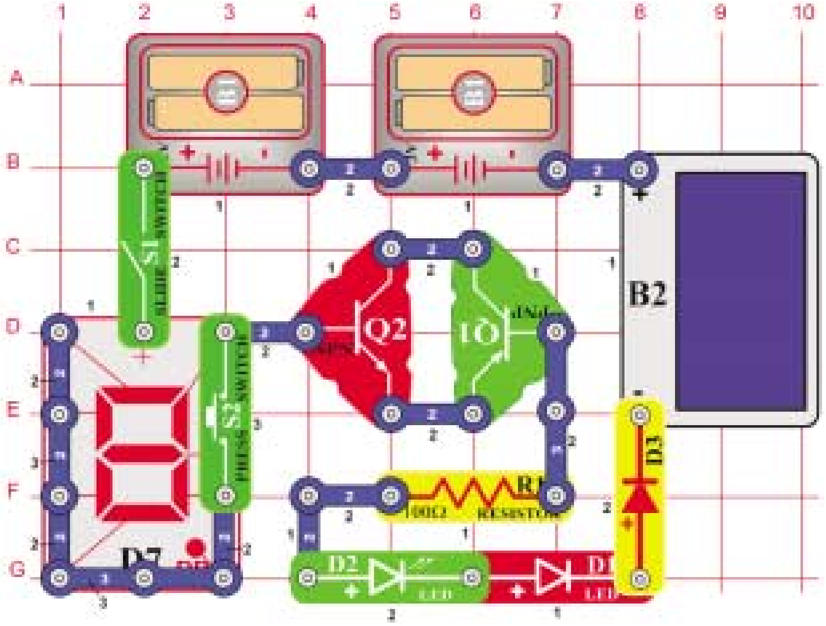
You can also change the frequency by changing the resistance in the oscillator. Replace the 100KΩ resistor (R5) with the 10KΩ resistor

Project #541 Lighthouse



Build the circuit and turn on the switch (S1), the LED (D1) flashes about once a second.

☐ Project #542 Diode Wonderland



Cover the solar cell and turn on the slide switch (S1), there should be little or no light from the LEDs (results depend on your batteries). Shine a bright light on the solar cell (B2) and the red (D1) and green (D2) LEDs should be bright, along with one segment of the 7-segment display (D7).

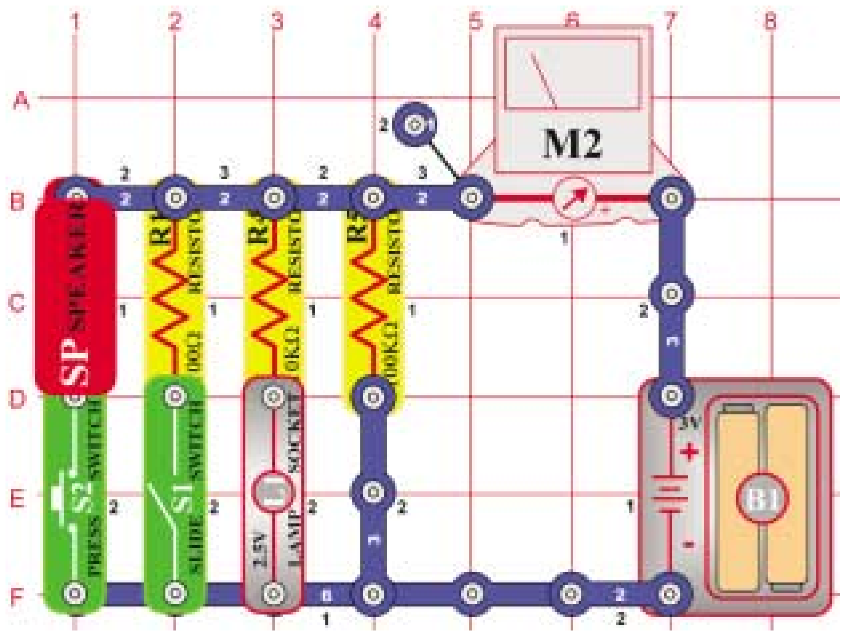
This circuit shows how it takes a lot of voltage to turn on a bunch of diodes connected in a series. Since the transistors (Q1 and Q2) are used as diodes here, there are six diodes total (D1, D2, D3, D7, Q1, and Q2). The voltage from the batteries (B1) alone is not enough to turn them all on at the same time, but the extra voltage produced by the solar cell is enough to make them bright.

Now push the press switch (S2) and D7 will display “0”, but it will be dim unless the light on the solar cell is very bright. With S2 off, all the current through D7 goes through segment B and makes it bright. With S2 on, the current through D7 divides evenly between several segments.

Note that this circuit appears to violate the Do’s & Don’ts of Building Circuits rules (on page 5) because there is no component to limit the current through the LEDs. However the solar cell itself will limit the current.

☐ Project #543 Meter Ranges

OBJECTIVE: To show the difference between the low and high



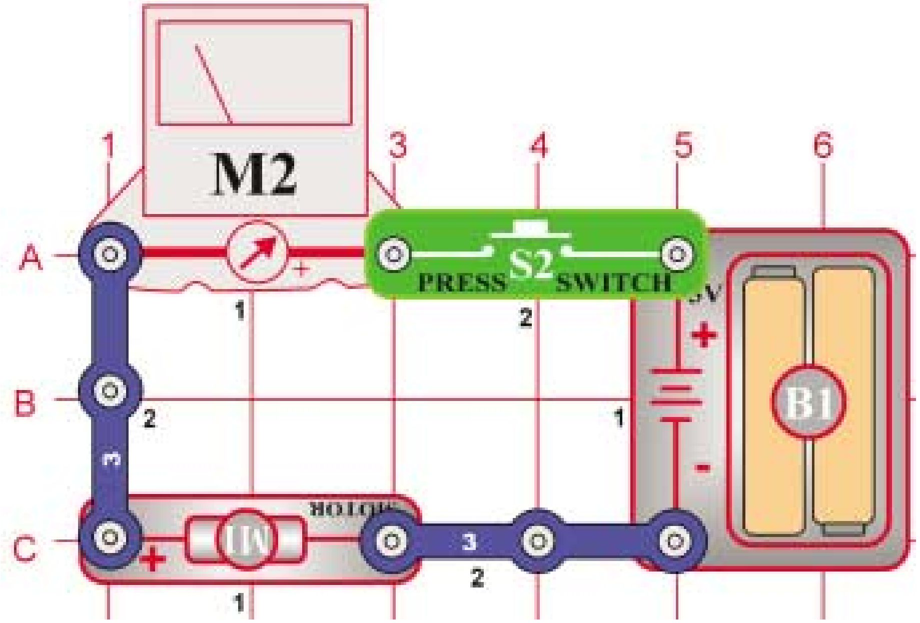
Use the 10MA setting on the meter (M2), turn off the switch (S1), and unscrew the 2.5V bulb (L1). The meter should measure about 2, since the 100KΩ resistor (R5) keeps the current low. Results will vary depending on how good your batteries are.

Screw in the 2.5V bulb to add the 10KΩ resistor (R4) to the circuit, now the meter reading will be about 10.

Now turn on the switch (S1) to add the 100Ω resistor (R1) to the circuit, the meter reading should be off the scale to the right. Change the meter to the high-current 1A setting, it should read just above zero.

Now press the switch (S2) to add the speaker (SP) to the circuit. The meter reading will be about 5, since the speaker has only about 8Ω resistance.

☐ Project #544 Motor Current



Use the 1A setting on the meter (M2) and place the fan on the motor (M1). Press the switch (S2), the meter will measure a very high current because it takes a lot of power to spin the fan.

Remove the fan and press the switch again. The meter reading will be lower since spinning the motor without the fan takes less power.

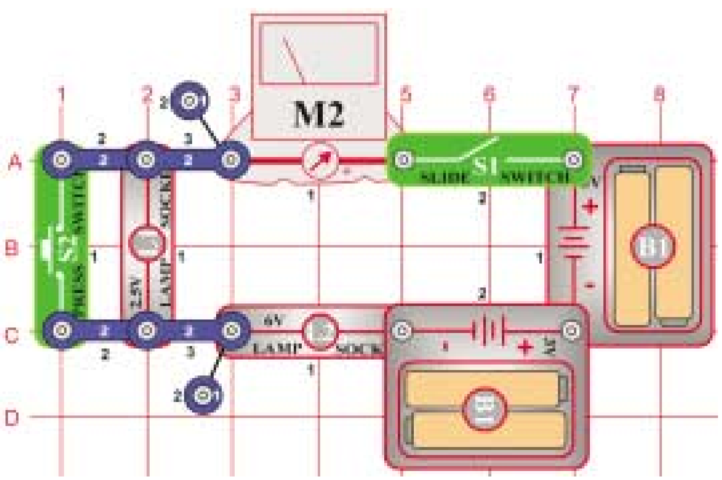
☐ Project #545 2.5V Lamp Current

Use the circuit from project #544, but replace the motor with the 2.5V lamp (L1). Measure the current using the 1A setting on the meter.

☐ Project #546 6V Lamp Current

Use the circuit from project #544 but replace the motor with the 6V lamp (L2). Measure the current using the 1A setting on the meter. Compare the lamp brightness and meter reading to that for the 2.5V lamp.

☐ Project #547 Combined Lamp Circuits

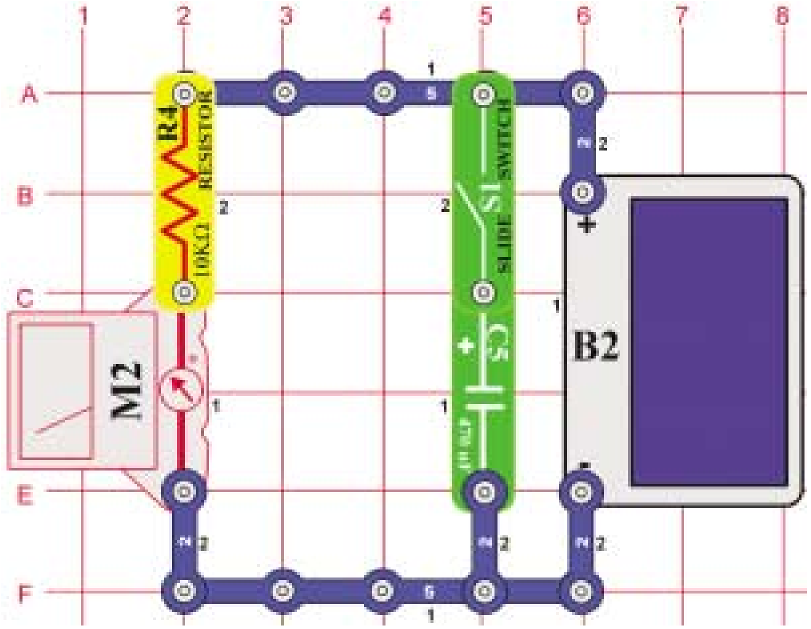


Use the 1A setting on the meter (M2) and turn on the slide switch (S1). Both lamps are on and the meter measures the current.

Now turn on the press switch (S2) to bypass the 2.5V lamp (L1). The 6V lamp (L2) is brighter now, and the meter measures a higher current.

Project #548 Rechargeable Battery

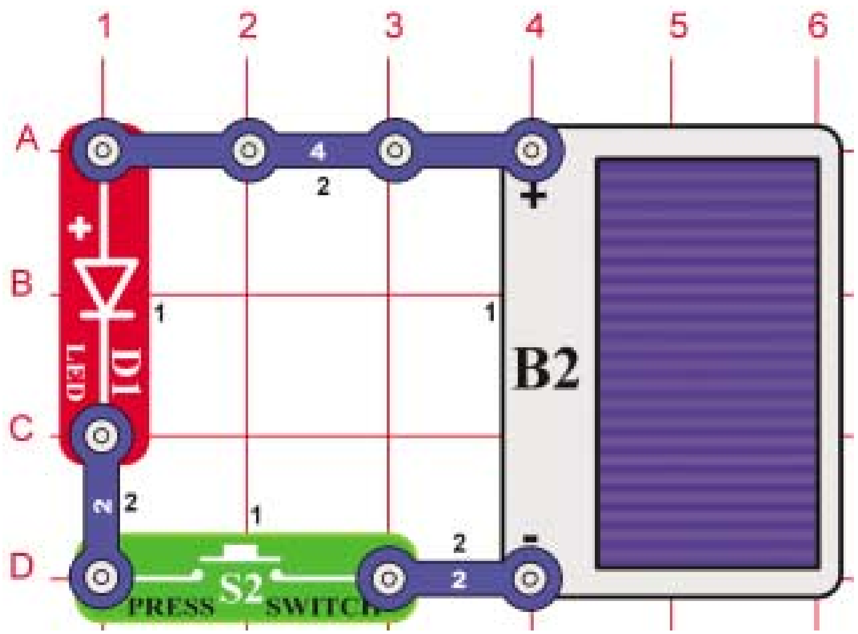
OBJECTIVE: To show how a capacitor is like a rechargeable



Use the 10MA scale on the meter (M2) and turn the switch (S1) off. Vary the current measured on the meter by moving your hand over the solar cell (B2) to block some of the light to it. If you cover the solar cell, then the current immediately drops to zero.

Now turn the switch on and watch the meter again as you move your hand over the solar cell. Now the meter current drops slowly if you block the light to the solar cell. The 470µF capacitor (C5) is acting like a rechargeable battery. It keeps a current flowing to the meter when something (such as clouds) blocks light to the solar cell that is powering the circuit.

Project #549 Solar Batteries

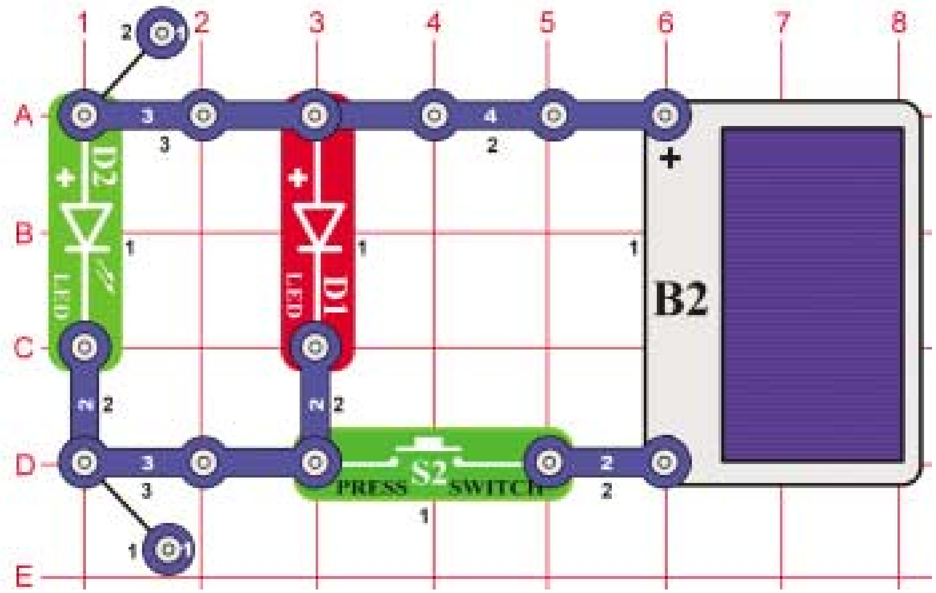


Place this circuit near different types of lights and press the switch (S2). If the light is bright enough, then the LED (D1) will be lit. Find out what types of light sources make it the brightest.

Solar cells work best with bright sunlight, but incandescent light bulbs (used in house lamps) also work well. Fluorescent lights (the overhead lights in offices and schools) do not work as well with solar cells. Although the voltage produced by your solar cell is 3V just like the batteries, it cannot supply nearly as much current. If you replace the LED with the 2.5V lamp (L1) then it will not light, because the lamp needs a much higher current.

The solar cell (B2) is made from silicon crystals. It uses the energy in sunlight to make an electric current. Solar cells produce electricity that will last as long as the sun is bright. They are pollution-free and never wear out.

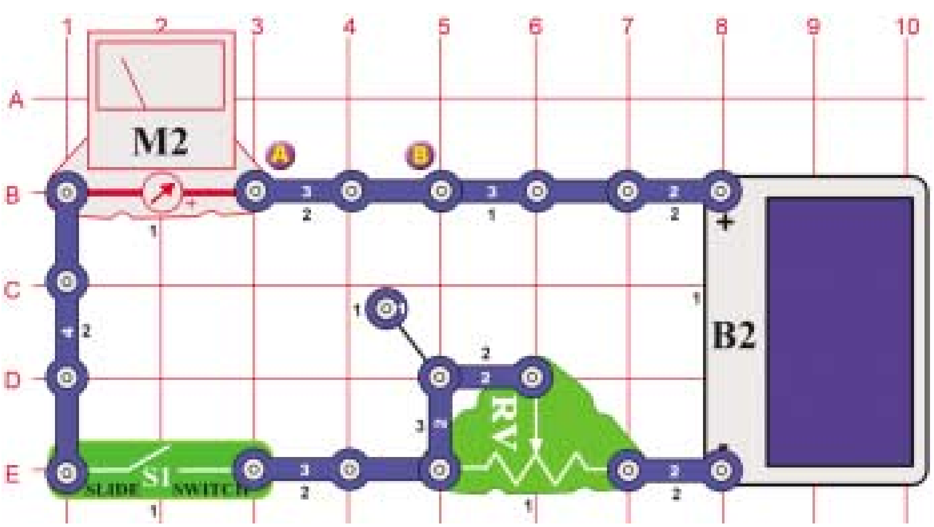
☐ Project #550 Solar Batteries (II)



Place this circuit near different types of lights and press the switch (S2), if the light is bright enough then the LEDs (D1 and D2) will be lit. Find out what types of light sources make it brightest.

The LEDs will be dimmer than in project #549, since the limited current from the solar cell is divided between them. The LEDs don't need a resistor in the circuit, because the solar cell cannot supply enough electric current to damage them.

☐ Project #551 Solar Resistance Meter



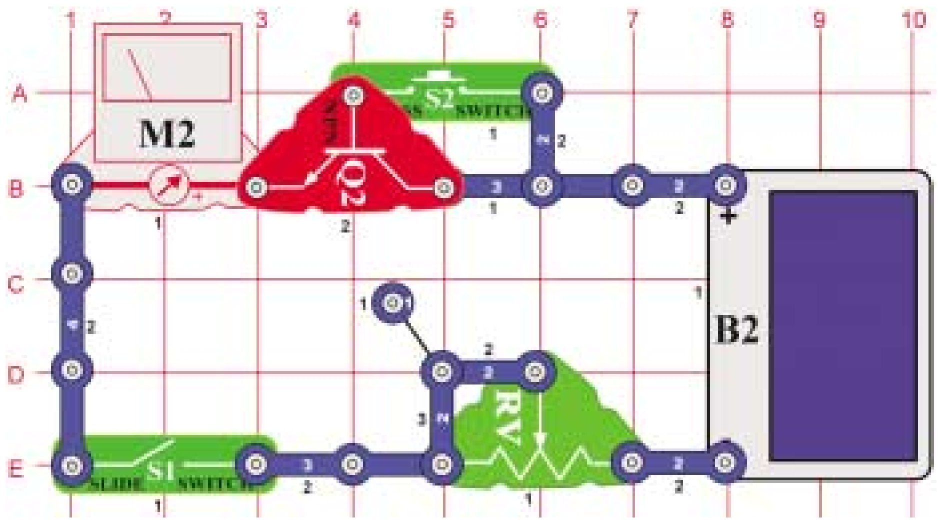
Place the circuit near a bright light and set the variable resistor (RV) so that the meter (M2) reads "10" on the 10MA setting. Now replace the 3-snap between points A and B with another component to test, such as a resistor, capacitor, motor, photoresistor, or lamp. The 100μF (C4) or 470μF (C5) capacitors will give a high reading that slowly drops to zero.

You can also use the two-spring socket (?1) and place your own components between its springs to test them.

☐ Project #552 Solar Diode Tester

Use the same circuit to test the red and green LEDs (D1 and D2), and the diode (D3). The diode will give a higher meter reading than the LEDs, and all three will block current in one direction.

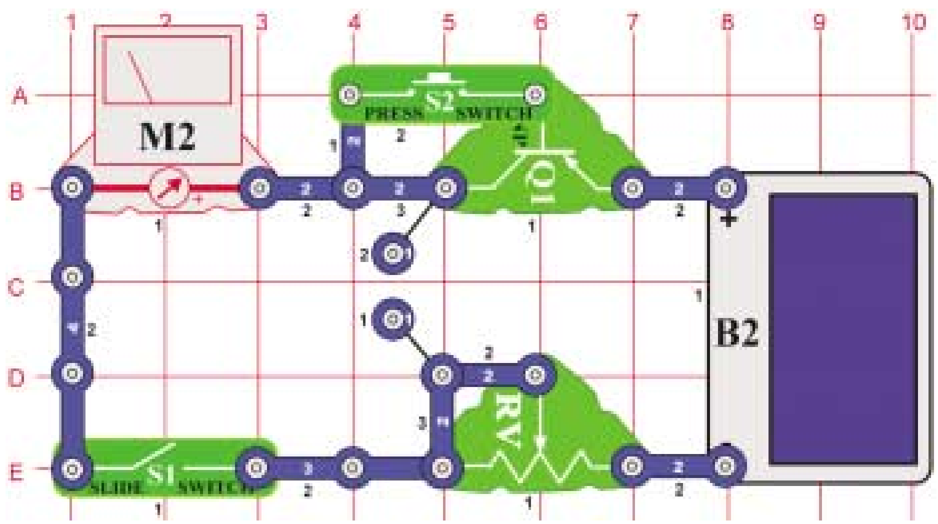
☐ Project #553 Solar NPN Transistor Tester



This circuit is just like the one in project #551, but tests the NPN transistor (Q2). The meter will read zero unless both switches (S1 and S2) are on, then the variable resistor (RV) sets the current. If you have the same light and RV setting as project #552 with the diode (D3), then the meter (M2) reading will be higher with the transistor.

You can replace the NPN transistor with the SCR (Q3), it works the same way in this circuit.

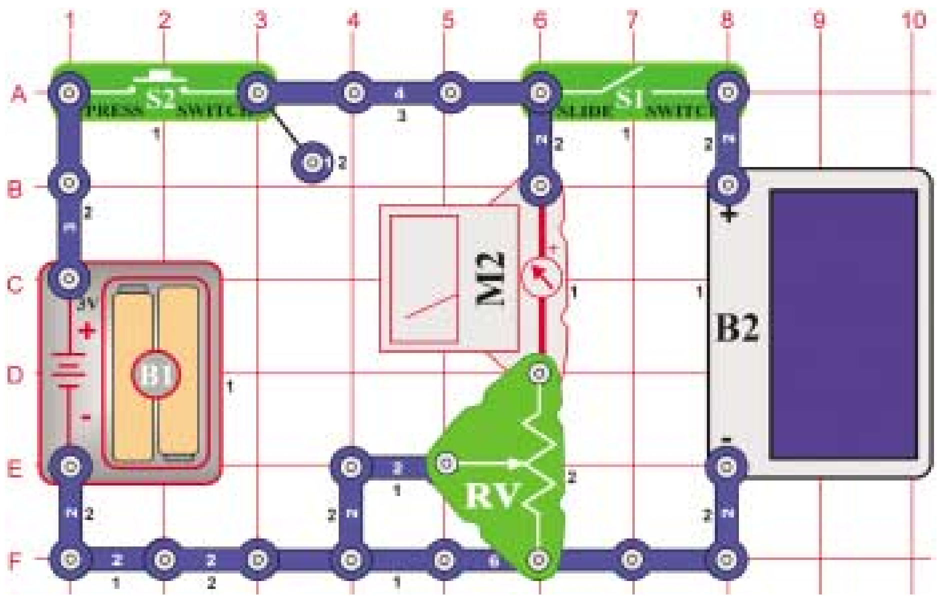
☐ Project #554 Solar PNP Transistor Tester



This circuit is just like the one in project #551, but tests the PNP transistor (Q1). The meter (M2) will read zero unless both switches (S1 and S2) are on, then the variable resistor (RV) sets the current. If you have the same light and RV setting as project #552 with the diode (D3), then the meter reading will be higher with the transistor.

☐ Project #555 Solar Cell vs. Battery

OBJECTIVE: *To compare the voltage of the solar cell to the*

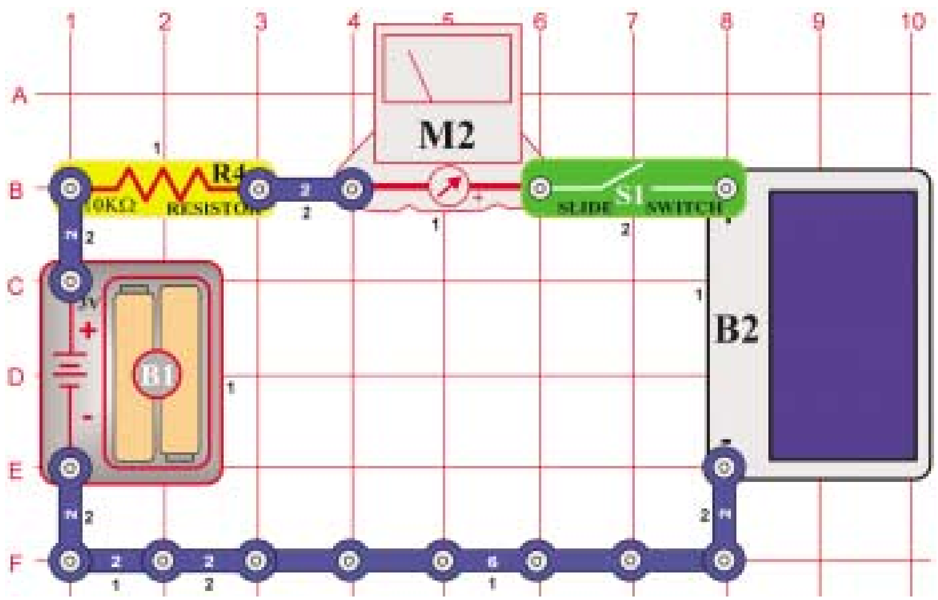


Set the meter (M2) to the 10MA scale. Push the press switch (S2) and set the variable resistor (RV) so that the meter reads “5”, then release it.

Now turn on the slide switch (S1) and vary the brightness of light to the solar cell (B2). Since the voltage from the batteries is 3V, if the meter reads higher than “5”, then the solar cell voltage is greater than 3V. If the solar cell voltage is greater and you have rechargeable batteries (in B1), then turning on both switches at the same time will use the solar cell to recharge your batteries.

☐ Project #556 Solar Cell vs. Battery (II)

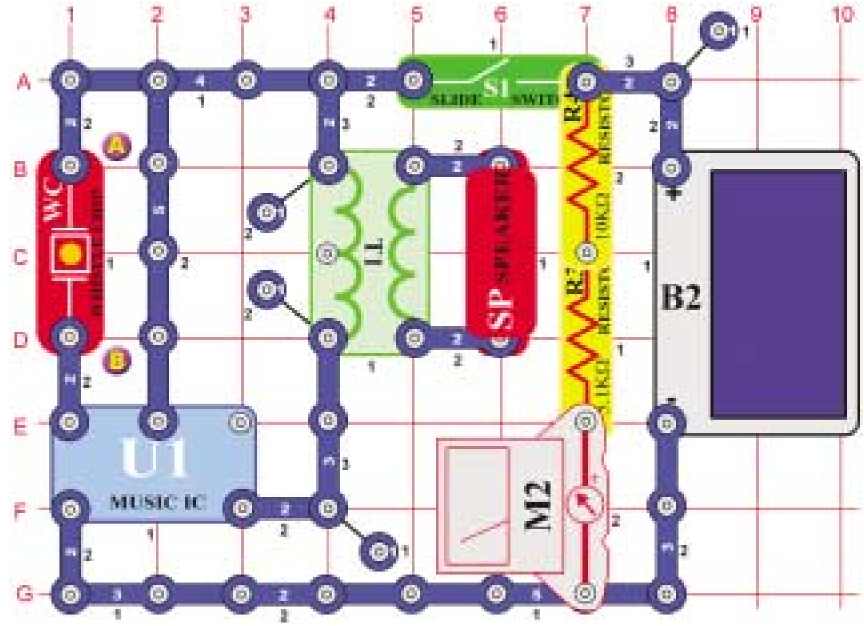
OBJECTIVE: *To compare the voltage of the solar cell to the*



Set the meter (M2) to the 10MA scale. Turn on the slide switch (S1) and vary the brightness of light to the solar cell (B2). If the meter reads less than zero, then the battery voltage is higher than the voltage produced by the solar cell.

If the meter reads greater than zero then the solar cell voltage is higher. If the batteries are rechargeable then the solar cell will recharge them until the voltages are equal.

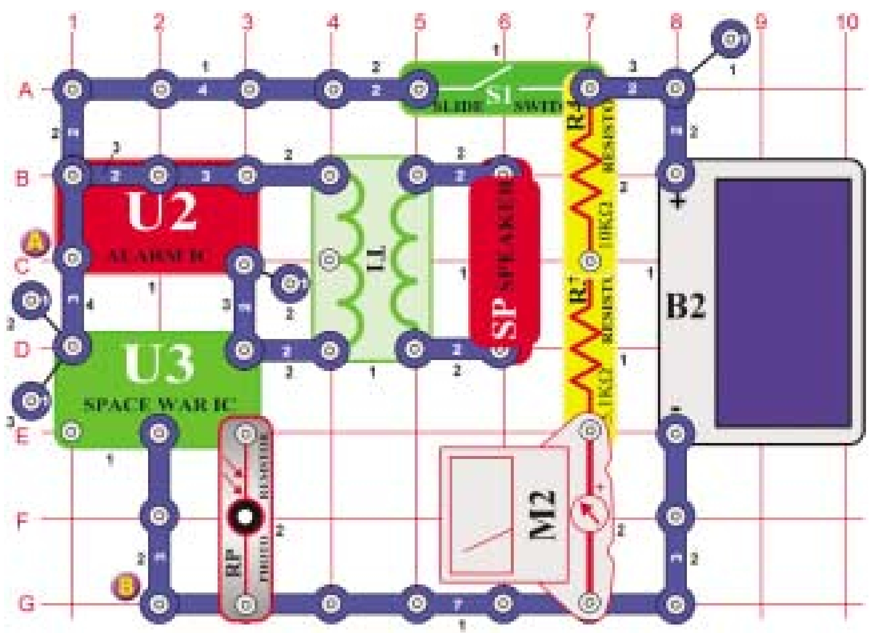
Project #557 Solar Music



Set the meter (M2) to the 10MA scale. With the slide switch (S1) off, make sure you have enough light on the solar cell for the meter to read 7 or higher. Now turn on the switch and listen to the music. When it stops, clap your hands and it should resume.

The meter is used to measure if the solar cell can supply enough current to operate the music IC (U1).

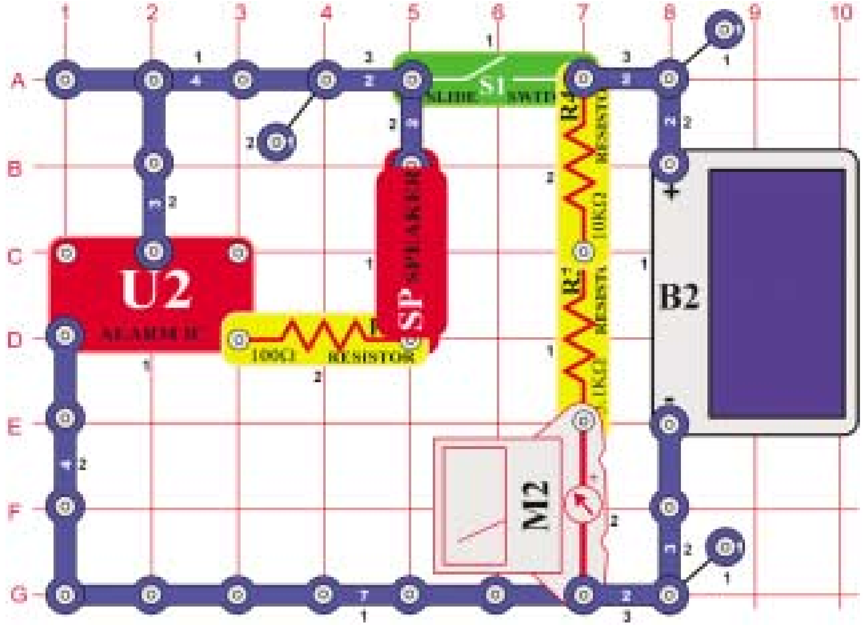
Project #558 Solar Sounds Combo



Set the meter (M2) to the 10MA scale. With the slide switch (S1) off, make sure you have enough light on the solar cell for the meter to read 9 or higher. Now turn on the switch and listen to sounds from the alarm (U2) and space war (U3) ICs. Wave your hand over the photoresistor (RP) to change the sounds.

The meter is used to measure if the solar cell (B2) can supply enough current to operate the alarm and space war ICs. This project needs more light than project #557, since two ICs are used here.

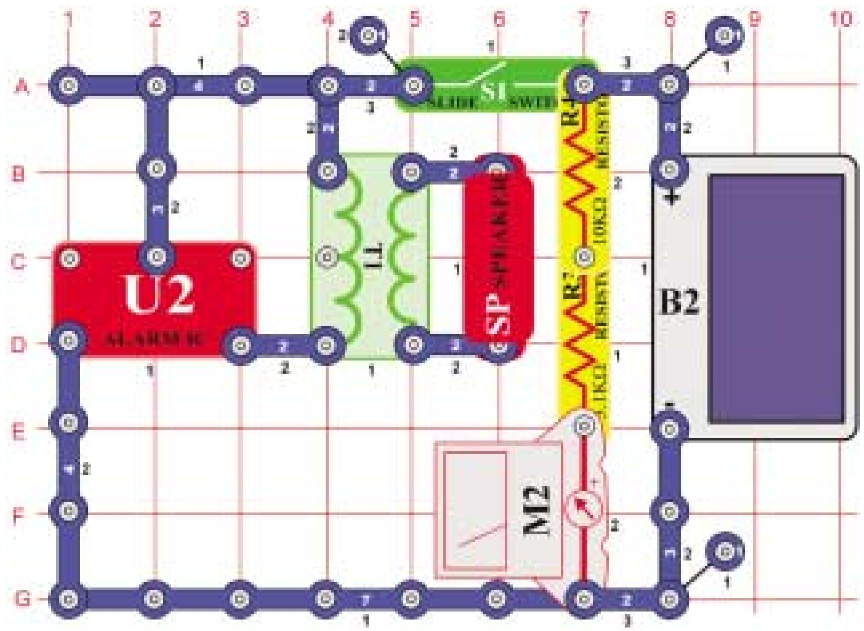
Project #559 Solar Alarm



Set the meter (M2) to the 10MA scale. With the slide switch (S1) off, make sure you have a bright light on the solar cell (B2) so the meter reads 10 or higher. Now turn on the switch and listen to the music.

The meter is used to measure if the solar cell can supply enough current to operate the alarm IC (U2). Some types of light are better than others, but bright sunlight is best.

Project #560 Better Solar Alarm

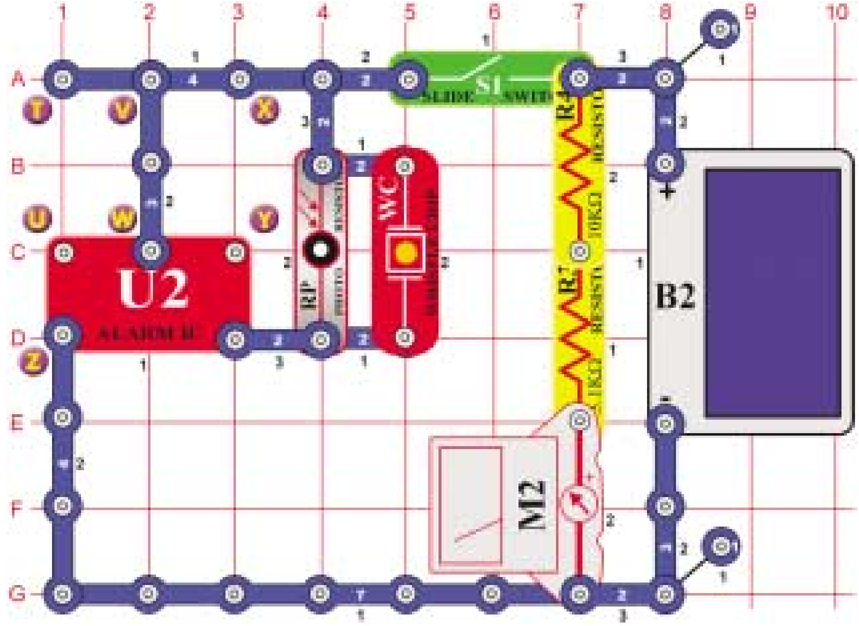


Set the meter (M2) to the 10MA scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 8 or higher. Now turn on the switch and listen to the music.

This circuit uses the transformer (T1) to boost the current to the speaker (SP), allowing it to operate with less power from the solar cell. Compare how much light it needs to project #559, which doesn't have a transformer.

You can change the sound from the alarm IC (U2) using the same variations listed in projects #61-65.

Project #561 — Photo Solar Alarm

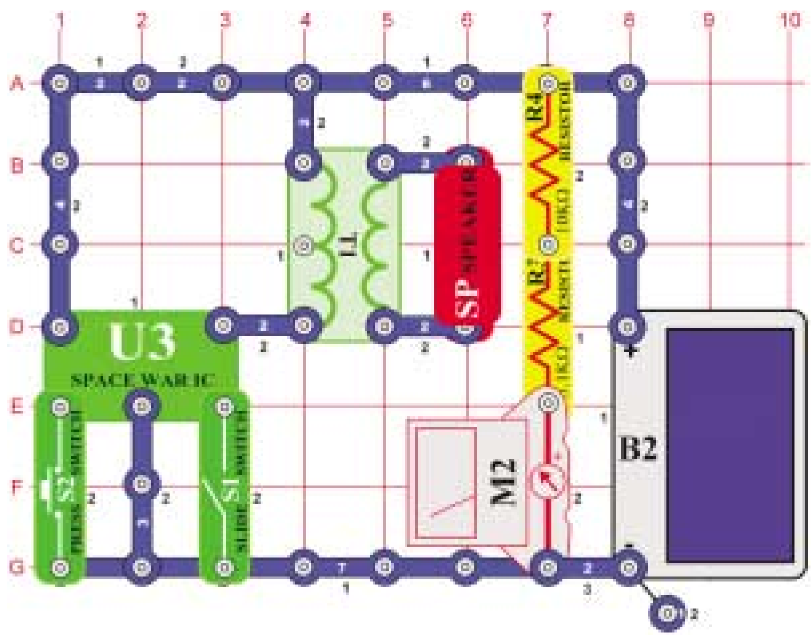


Set the meter (M2) to the 10MA scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 6 or higher. Now turn on the switch and listen to the alarm. Cover the photoresistor (RP) to stop the alarm.

The whistle chip (WC) needs less power to make noise than the speaker (SP), so this circuit can operate with less light on the solar cell than projects #559 and #560. But the sound from the circuits with the speaker is louder and clearer.

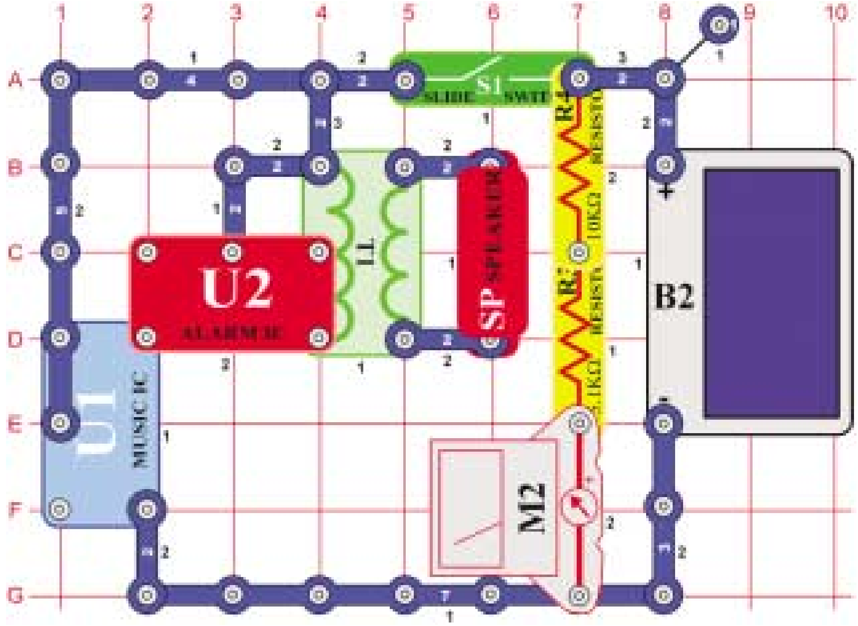
You can change the sound from the alarm IC (U2) using the same variations listed in projects #61-65.

Project #562 — Solar Space War



Set the meter (M2) to the 10MA scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 8 or higher. Now turn on the switch and listen to the space war sounds.

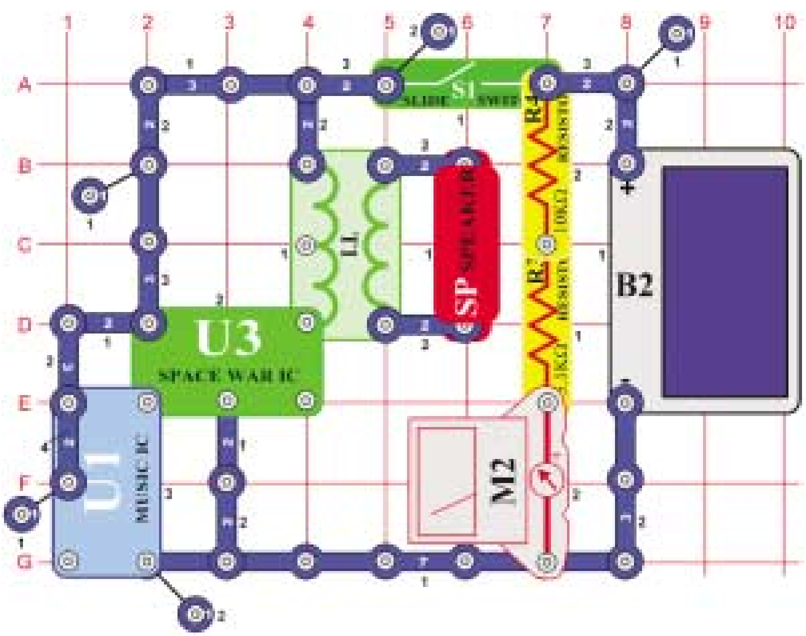
Project #563 Solar Music Alarm Combo



Set the meter (M2) to the 10MA scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 8 or higher. Now turn on the switch and listen to the music.

The meter is used to measure if the solar cell can supply enough current to operate the ICs (U1 and U2).

Project #564 Solar Music Space War Combo

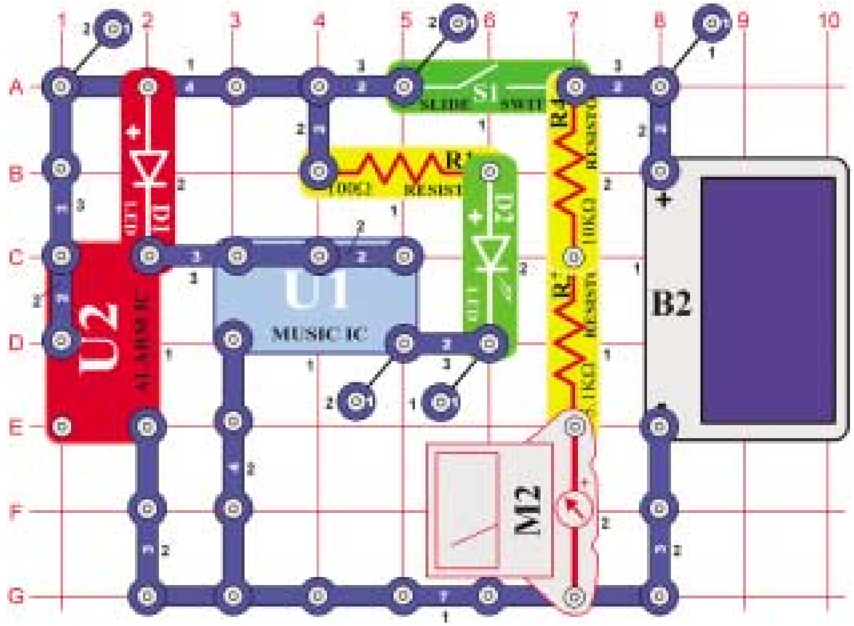


Set the meter (M2) to the 10MA scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 8 or higher. Now turn on the switch and listen to the music.

Project #565 Solar Music Space War Combo (II)

Use the circuit from project #564 but replace the speaker (SP) with the whistle chip (WC). Now the light on the solar cell (B2) doesn't have to be as bright for this circuit to work. You can also modify this circuit by replacing the music IC (U1) with the alarm IC (U2).

☐ Project #566 Solar Periodic Lights

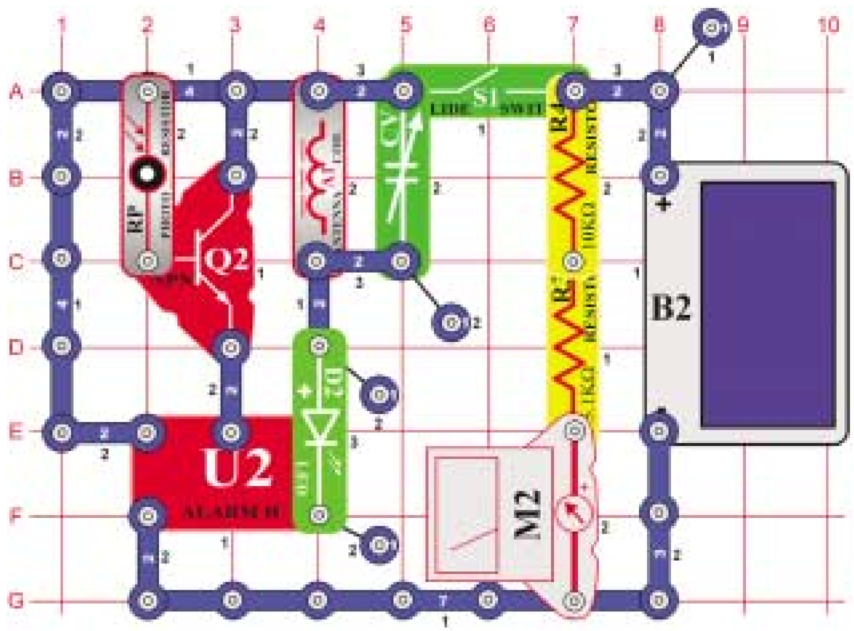


Set the meter (M2) to the 10MA scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 9 or higher. Now turn on the switch and the LEDs (D1 and D2) will alternate being on and off.

☐ Project #567 Solar Periodic Lights (II)

Use the circuit in project #566, except remove the 3-snap between the music (U1) and alarm (U2) ICs (base grid locations C2-C4) and add a 2-snap between the music IC and the 100Ω resistor (R1) (base grid B4-C4). The circuit works the same way but the LED flashing patterns are different.

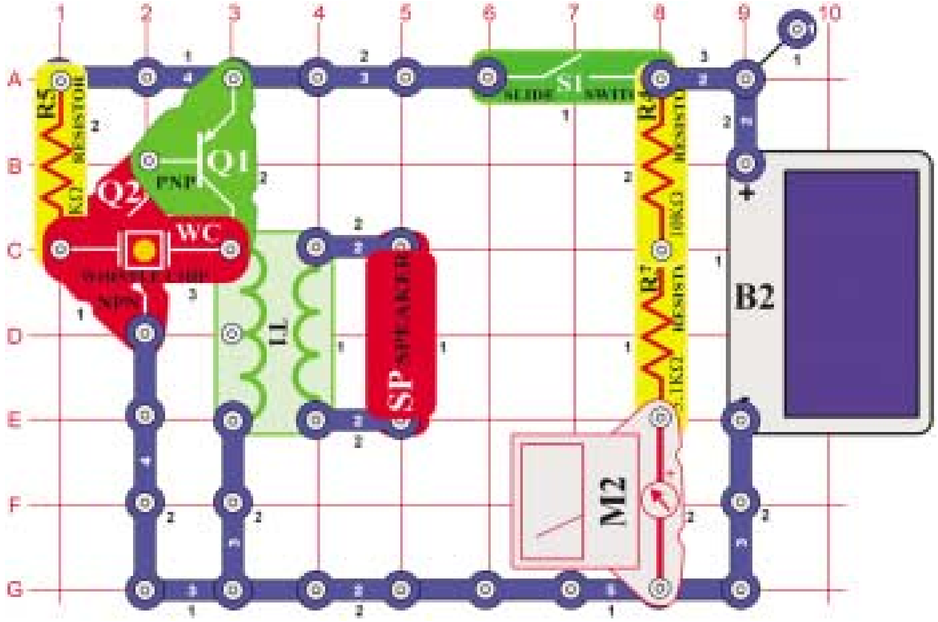
☐ Project #568 Solar AM Radio Transmitter



You need an AM radio for this project. Place it next to your circuit and tune the frequency to where no other station is transmitting.

Set the meter (M2) to the 10MA scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 9 or higher. Turn on the switch and adjust the variable capacitor (CV) for the best sound on the radio. Cover the photoresistor (RP) to change the sound pattern.

Project #569 Low Light Noisemaker



Set the meter (M2) to the 10MA scale. With the slide switch (S1) off, make sure you have light on the solar cell (B2) for the meter to read at least 5 but less than 10.

Turn on the switch and it should make a whining sound, adjust the amount of light to the solar cell to change the frequency of the sound. Use a brighter light or partially cover the solar cell if there is no sound at all.

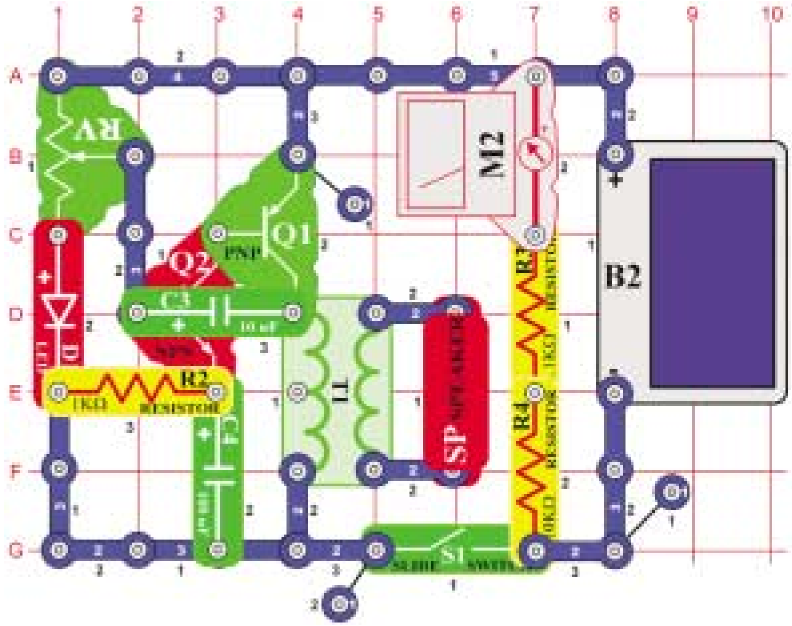
Project #570 Low Light Noisemaker (II)

Use the circuit from project #569 but replace the whistle chip (WC) with the 0.1µF capacitor (C2) to lower the frequency of the sound. The circuit works the same way.

Project #571 Low Light Noisemaker (III)

Use the circuit from project #569 but replace the whistle chip (WC) with the 10µF capacitor (C3) to lower the frequency of the sound. The circuit works the same way but you hear a ticking sound instead of a whining sound.

Project #572 Solar Oscillator



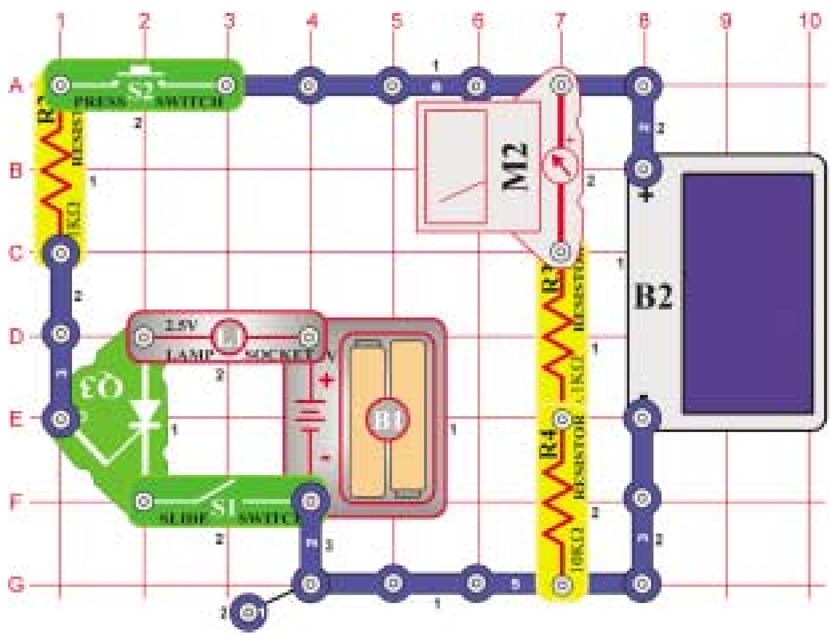
Set the meter (M2) to the 10MA scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 8 or higher. Now turn on the switch and adjust the variable resistor (RV).

You will hear a clicking sound like raindrops or a whine, depending upon how much light there is.

Project #573 Solar Oscillator (II)

Use the circuit from project #572 but replace the 10µF capacitor (C3) with the 0.02µF or 0.1µF capacitors (C1 and C2) to make the sound a high-pitch whine.

Project #574 Daylight SCR Lamp

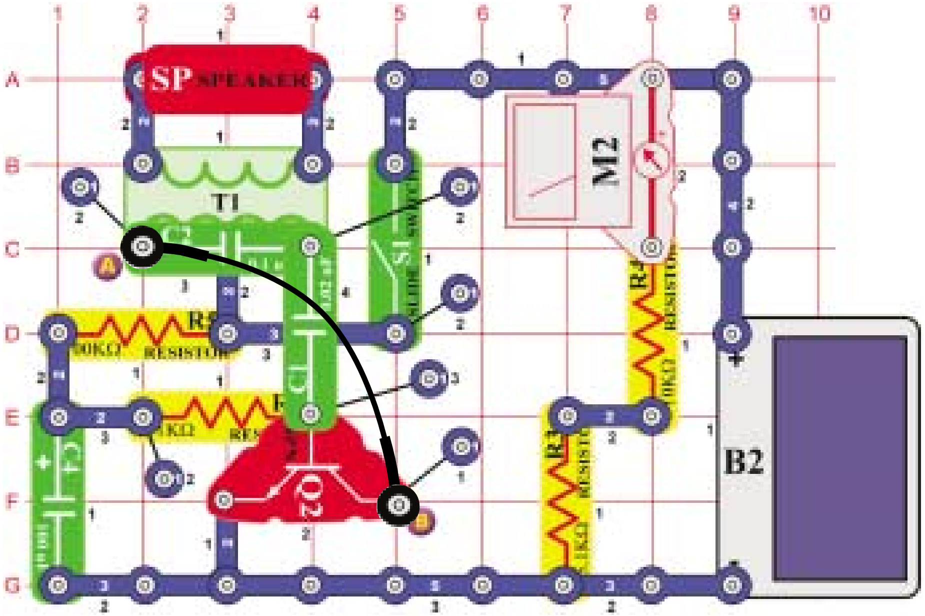


Set the meter (M2) to the 10MA scale. Make sure you have enough light on the solar cell (B2) for the meter to read 3 or higher.

Turn on the slide switch (S1), the lamp (L1) stays off. Push the press switch (S2) and the SCR (Q3) turns on the lamp and keeps it on. You must turn off the slide switch to turn off the lamp.

The SCR is a controlled diode. It lets current flow in one direction, and only after a voltage pulse is applied to its control pin. This circuit has the control pin connected to the press switch (S2) and solar cell, so you can't turn it on if the room is dark.

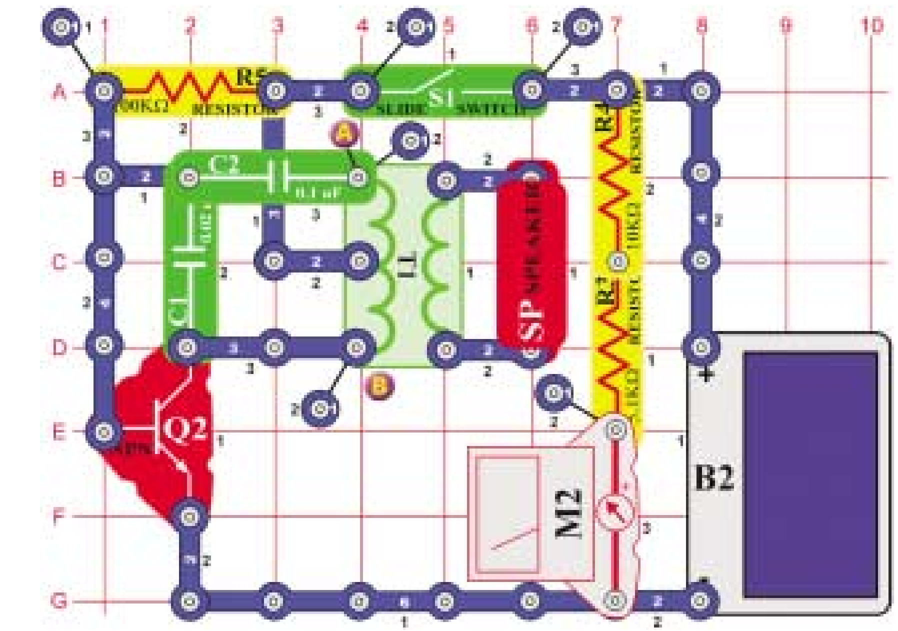
Project #575 Solar Bird Sounds



Set the meter (M2) to the 10MA scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 8 or higher. Now turn on the switch and listen to the sound.

For variations on this circuit, replace the 100µF capacitor (C4) with the 10µF capacitor (C3) or replace the speaker (SP) with the whistle chip (WC).

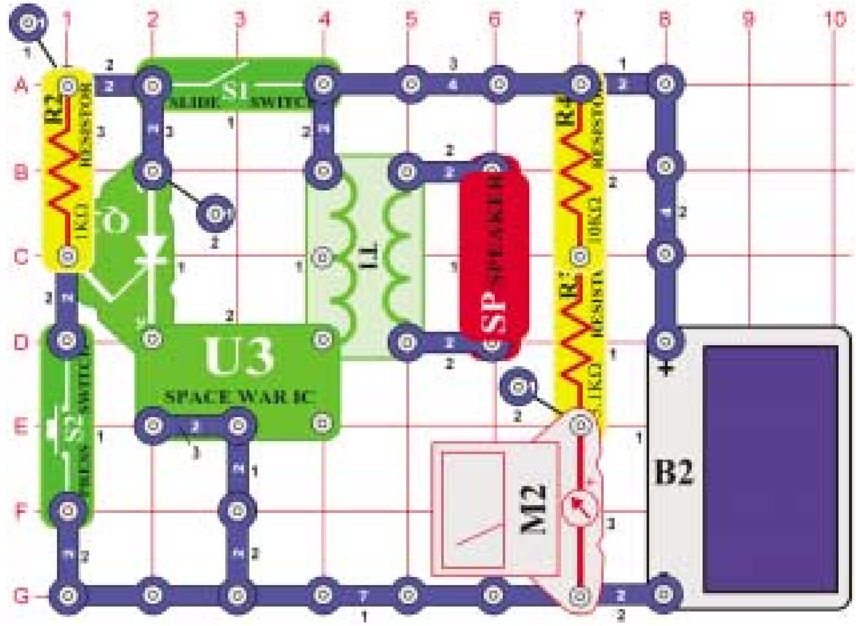
Project #576 Solar Bird Sounds (II)



Set the meter (M2) to the 10MA scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 8 or higher. Now turn on the switch and listen to the sound.

For variations on this circuit, install the whistle chip (WC) above the 0.02µF capacitor (C1), or install it across points A and B and remove the speaker (SP).

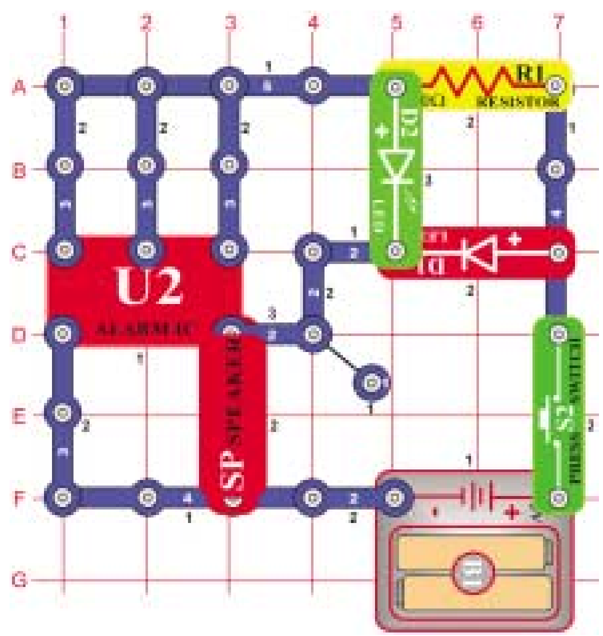
Project #577 SCR Solar Bomb Sounds



Set the meter (M2) to the 10MA scale. With the slide switch (S1) off, make sure you have enough light on the solar cell (B2) for the meter to read 8 or higher. You hear an explosion of sounds except when you push the press switch (S2).

Pushing the press switch shuts off the SCR (Q3), which controls the circuit. You could replace the SCR with the NPN transistor (Q2), since it would work the same way in this circuit.

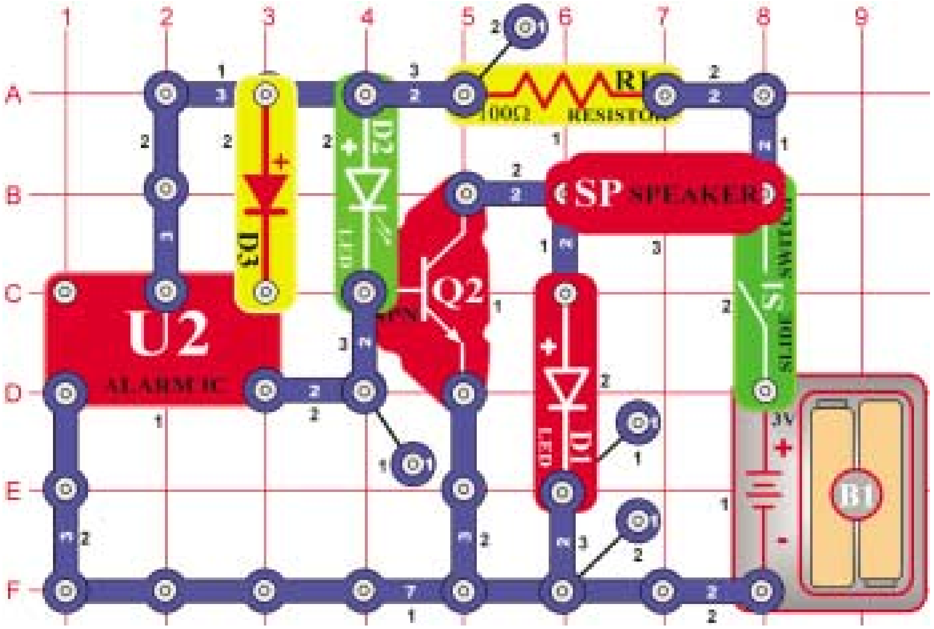
Project #578 Flashing Laser LEDs with Sound



When you press the switch (S2) the integrated circuit (U) should sound like a laser gun. The red (D1) and green (D2) LEDs will flash simulating a burst of light. You can shoot long repeating laser burst, or short zaps by tapping the switch.

☐ Project #579

U2 with Transistor Amplifier



Turn the switch (S1) on and the LEDs (D1 and D2) flash as the speaker (SP) sounds. The output pulses from U2 turns transistor Q2 on and off rapidly. As the transistor turns on, the speaker shorts to ground and a current flows through it. The current flow through the speaker causes it produce a sound. The LEDs show the pulsing signal from U2 that is turning Q2 on and off.

☐ Project #580

U2 with Transistor Amplifier (II)

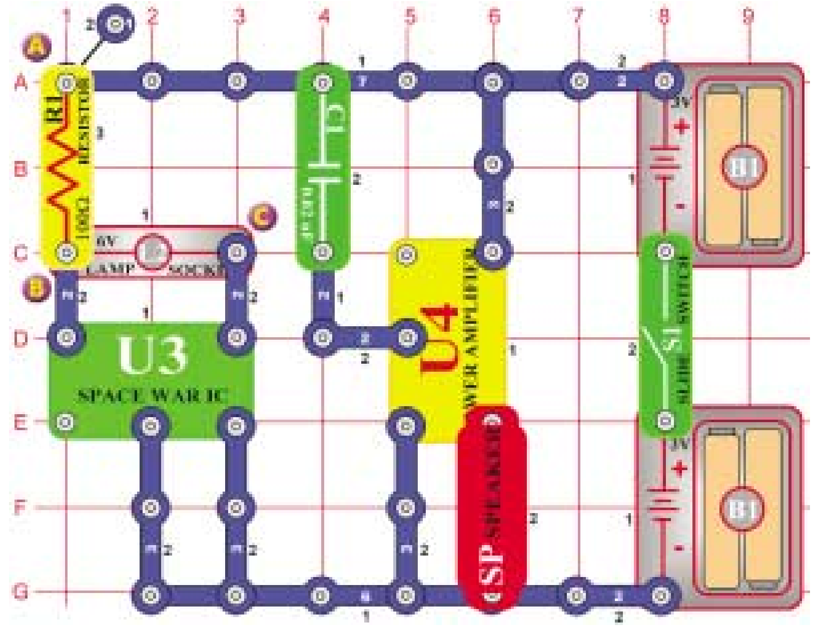
Using project #579, remove the diode (D3) to create a different sound.

☐ Project #581

U2 with Transistor Amplifier (III)

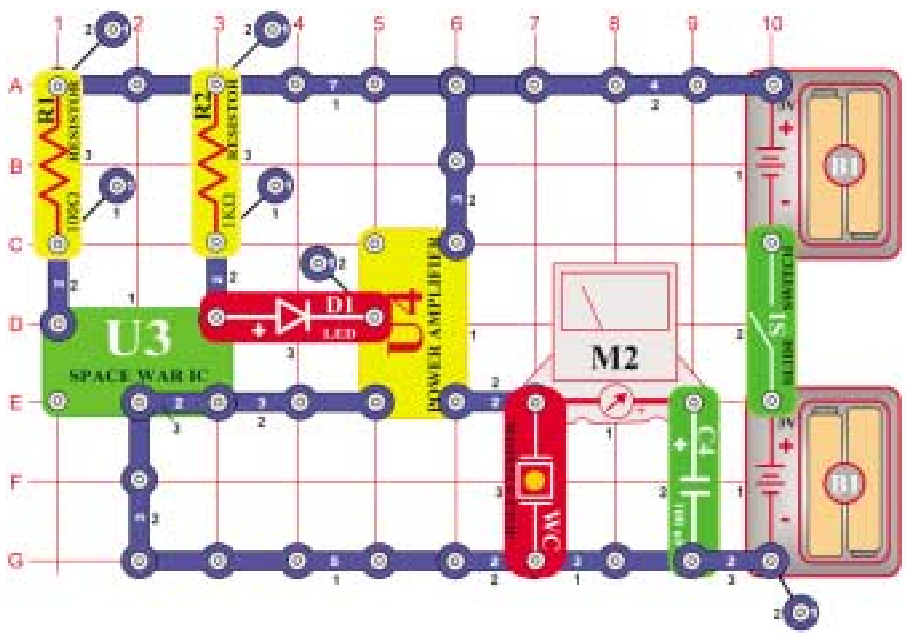
Using the project #579, replace U2 with U1. The circuit will now play “Happy Birthday”.

Project #582 — Loud Sounds



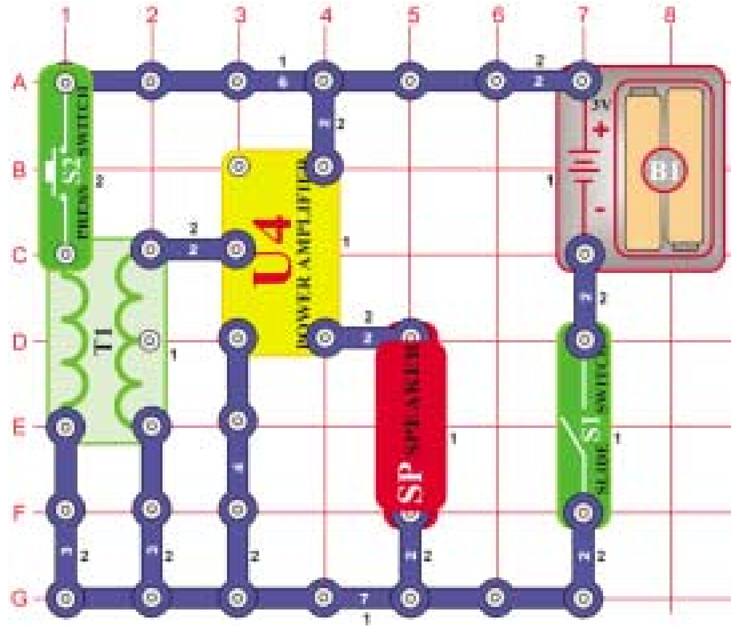
Turn the switch (S1) on and you should hear a tone from the speaker (SP). Connect the jumper wire from A to B, the lamp (L2) lights and the tone changes. Move the jumper wire from B to C to hear an assortment of sounds.

Project #583 — Swinging Meter with Sound



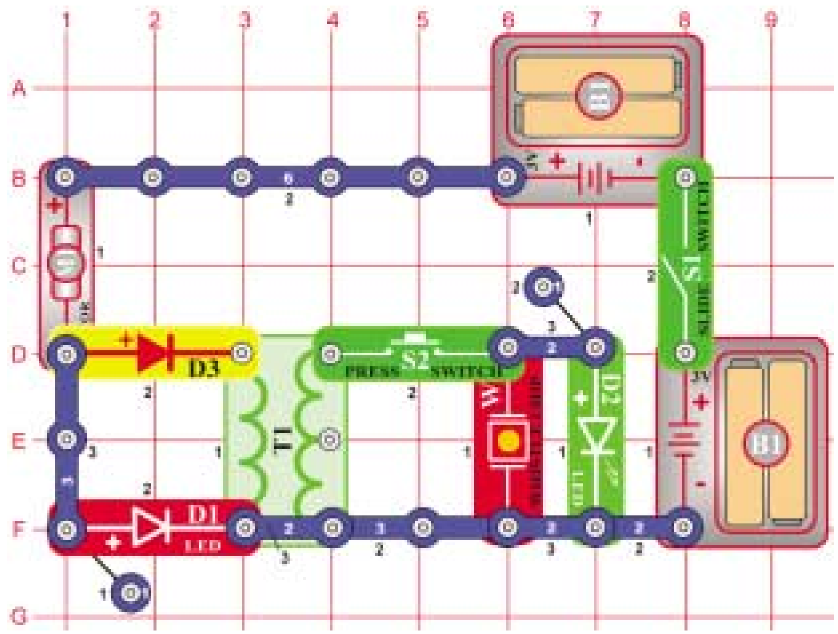
Set the meter (M2) to the 10MA scale. In this project, you will see and hear the output from the space war IC (U3). The power amplifier IC (U4) amplifies the signal from U3 in order to drive the whistle chip (WC) and meter. Turn on the switch (S1). The meter deflects back and forth, as the LED (D1) flashes and the whistle chip sounds. Replace the whistle chip with the speaker (SP) for a louder sound. Note that the meter will not deflect now. Almost all the signal is across the speaker due to its low resistance.

☐ Project #584 — Motor Sound Using Transformer



Turn the switch (S1) on and then rapidly turn on and off the switch (S2). This causes a magnetic field to expand and collapse in the transformer (T1). The small voltage generated is then amplified by U2 and the speaker (SP) sounds. Replace switch S2 with the motor (M1) and you can hear how fast the motor spins.

☐ Project #585 — Motor Sound with LED

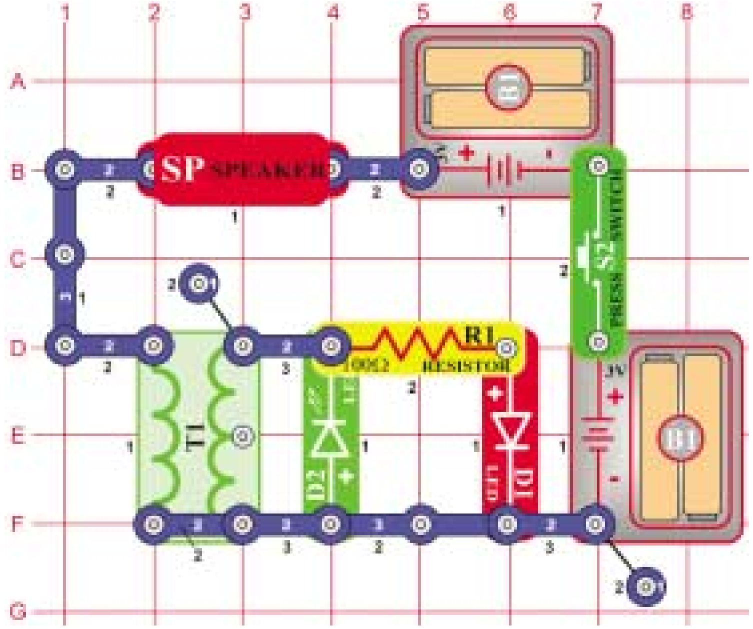


In this project, you will drive the speaker (SP) and LEDs using the motor (M1) and transformer (T1). Turn the switch (S1) on. The motor begins spinning and the red LED (D1) lights. Now press the switch (S2), the voltage generated from the transformer is now across the whistle chip (WC) and green LED (D2). The whistle chip sounds as the green LED lights.

☐ Project #586 — Motor Sound (III)

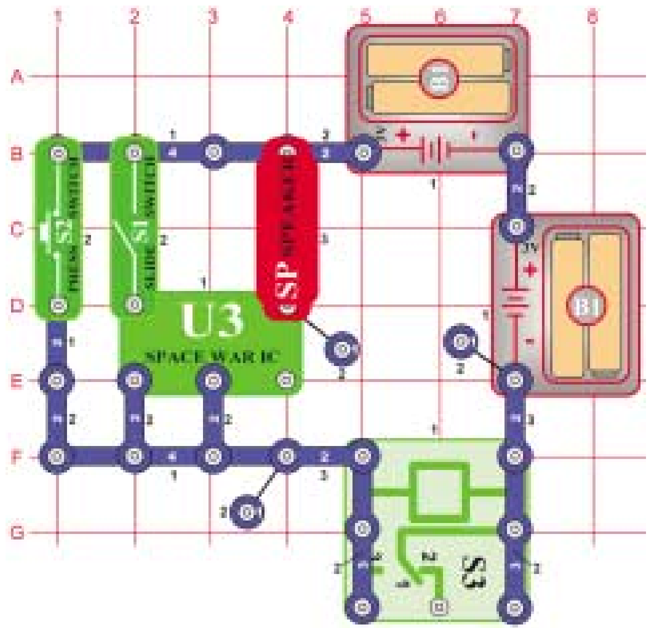
Modify project #585 by replacing the 6-snap with the speaker (SP), a 2-snap, and a 3-snap. Now the speaker will also output sound.

☐ Project #587 — AC & DC Current



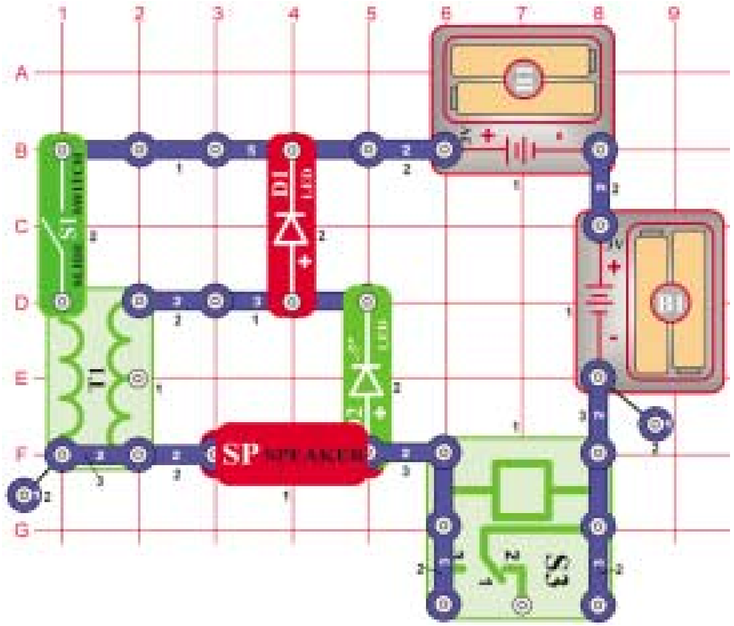
This circuit creates an AC and DC current. Press the switch (S2) a few times and the LEDs flash back and forth. Turning the switch on and off causes the magnetic field in the transformer (T1) to expand (green LED D2 lights) and collapse (red LED D1 lights) and current flows in two directions. Hold the switch down and the green LEDs flashes once. Remove the 3-snap connecting the speaker (SP) to the transformer and replace it with the motor (M1). Press the switch to see the red LED flicker and the speaker sound, due to the small current change from the motor spinning.

☐ Project #588 — Noisemaker



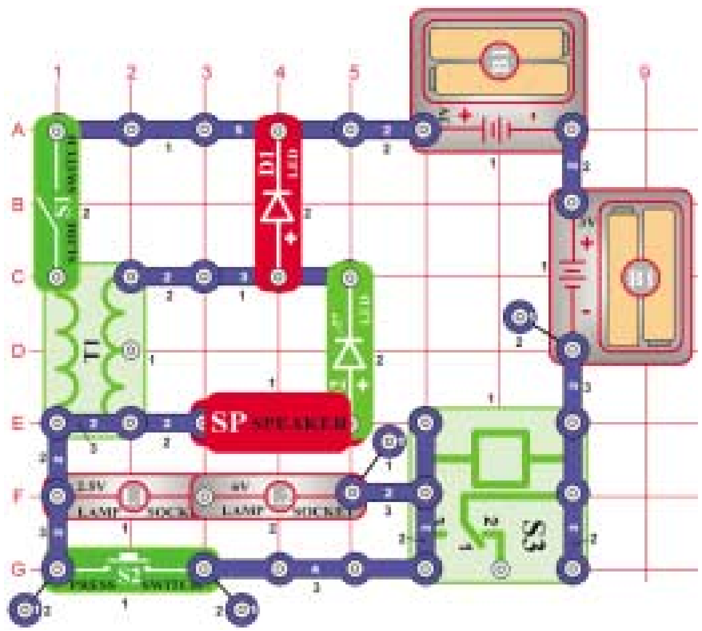
Turn on the switch (S1) and the relay (S3) generates a buzzing noise. Increase the voltage across the relay by pressing the switch (S2). The tone is higher because the relay's contacts are opening and closing faster.

☐ Project #589 AC Voltage



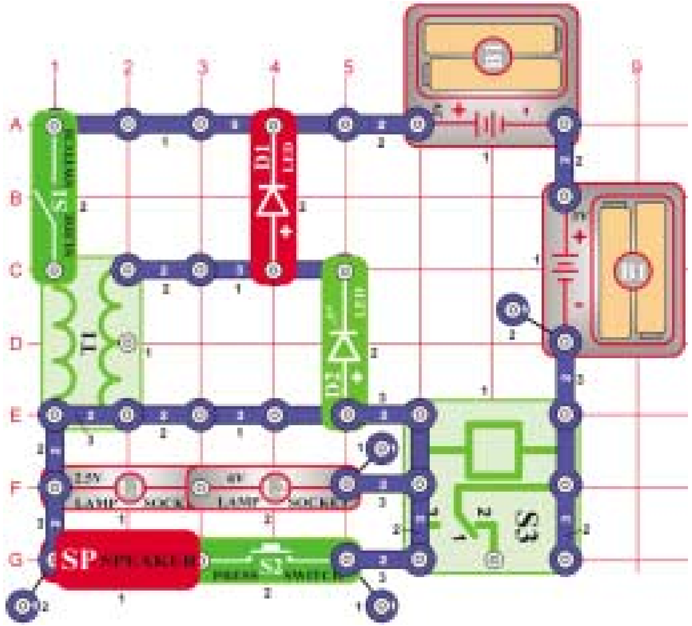
Turn the switch (S1) on and the LEDs (D1 and D2) flash as the speaker (SP) sounds. As in other projects, the relay's (S3) contacts open and close rapidly. This causes the magnetic field in the transformer (T1) to expand and collapse, creating an AC voltage lighting the LEDs.

☐ Project #590 AC Voltage (II)



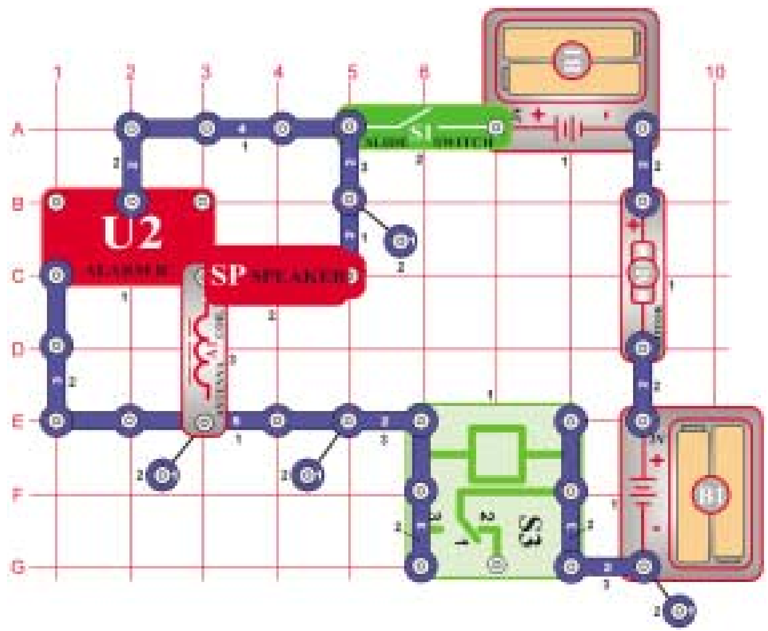
You can modify project #589 by adding a switch (S2) and two light bulbs (L1 and L2). When the switch (S1) is turned on, the relay (S3) sounds and the light bulbs and LEDs (D1 and D2) flash. Pressing the switch (S2) shorts the light bulbs and speaker (SP).

☐ Project #591 AC Voltage (III)



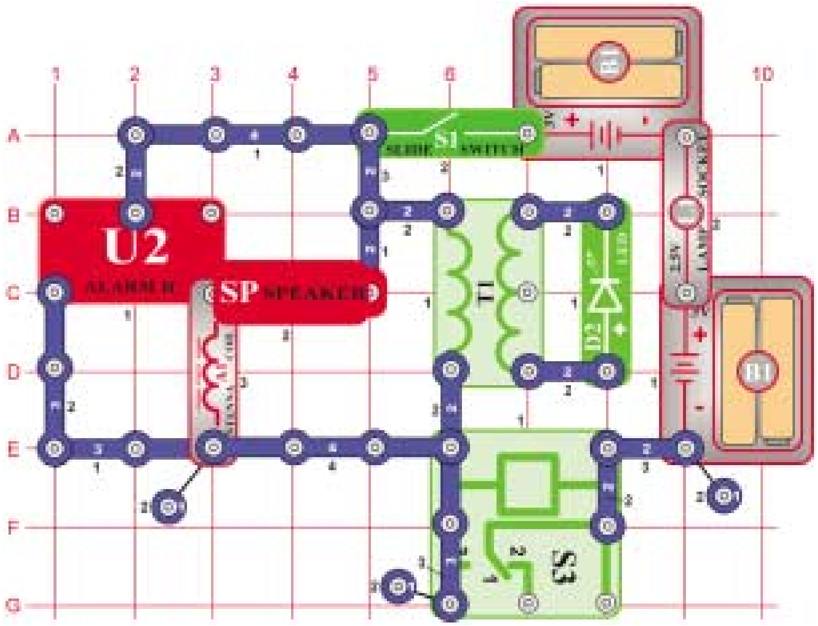
This project is similar to project #589. When the switch (S1) is turned on, the relay (S3) sounds and the light bulbs (L1 and L2) and LEDs (D1 and D2) flash. Now when the switch (S2) is pressed, the speaker (SP) also sounds.

☐ Project #592 Noisemaker (II)



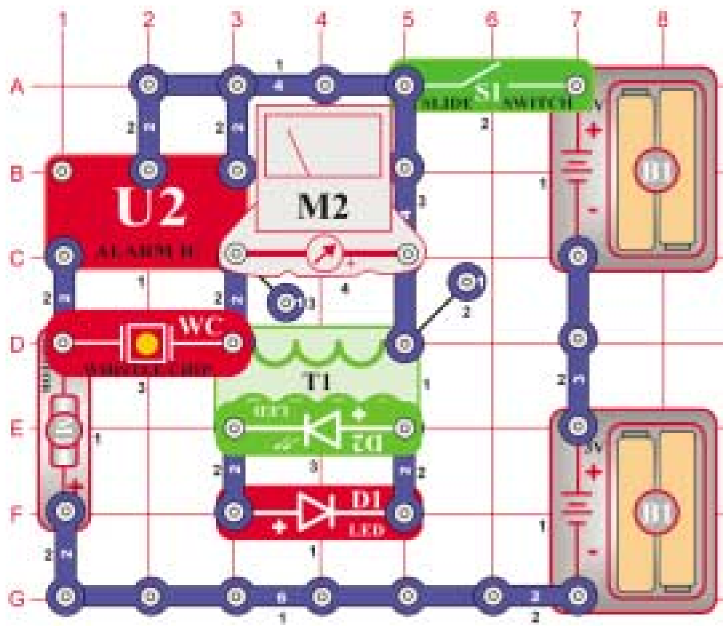
Turn on the switch (S1) and the relay (S3) generates a buzzing noise. Increase the voltage across the relay by pressing the switch (S2). The tone is higher because the relay's contacts are opening and closing faster.

☐ Project #593 Noisemaker (III)



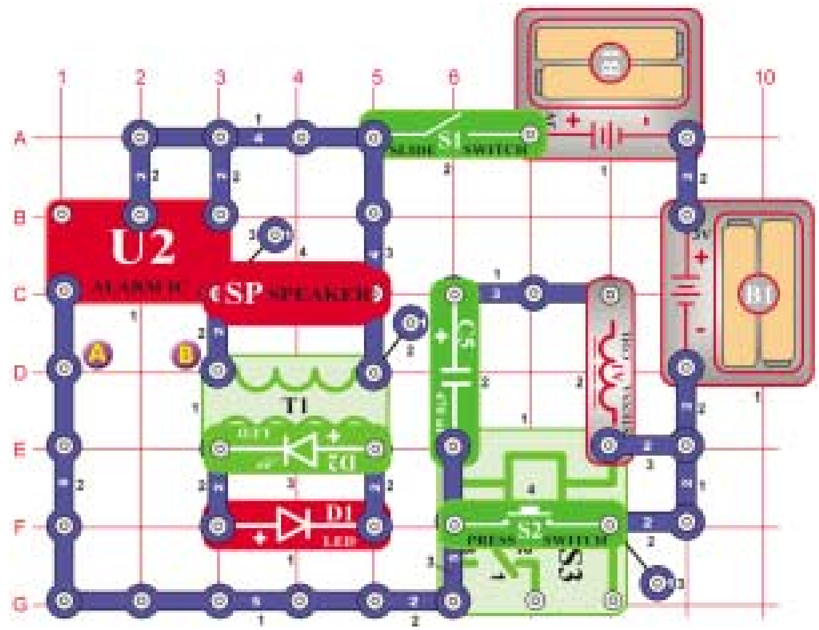
Turn the switch (S1) on and the speaker (SP) sounds as the motor (M1) spins. The relay's (S3) contacts rapidly open and close the battery connection to the circuit causing the alarm IC (U2) sound to be different.

☐ Project #594 Pulsing Motor



Turn on the switch (S1) and now you have a pulsing motor and LEDs circuit. Replace the meter (M2) with the 470μF capacitor (C5) to change the rate the LEDs (D1 and D2) flash.

Project #595 Noisemaker (IV)



OBJECTIVE: To create a sound

In this project, you'll see and hear the output of the alarm IC (U2). Turn on the switch (S1), the LEDs (D1 and D2) flash, and the speaker (SP) sounds as the relay (S3) chatters. Now press the switch (S2) and see what happens when you remove the relay from the circuit.

Project #596 Noisemaker (V)

OBJECTIVE: To create a

Modify the sound of project #595 by adding capacitor C4 across points A and B (+ of C4 on left).

Project #597 Noisemaker (VI)

OBJECTIVE: To create a sound circuit.

Modify project #596 by replacing the capacitor C4 with the motor (M1). Turn on the switch (S1), the LEDs flash, and the speaker (SP) sounds as the relay (S3) chatters. Now press the switch (S2) removing the relay from the circuit, providing a constant connection to the battery. The motor speeds up and the sound from the speaker is not distorted.

Project #598 Noisemaker (VII)

OBJECTIVE: To create a

Modify project #595 replacing the speaker (SP) with the whistle chip (WC) and placing the motor (M1) with fan (+ of on left) across points A and B. Turn on the switch (S1) and the fan spins, lights flash, and the relay (S3) chatters. Now launch the fan by pressing the switch (S2) down for about five seconds and releasing it.

Project #599 Noisemaker (VIII)

OBJECTIVE: To create a

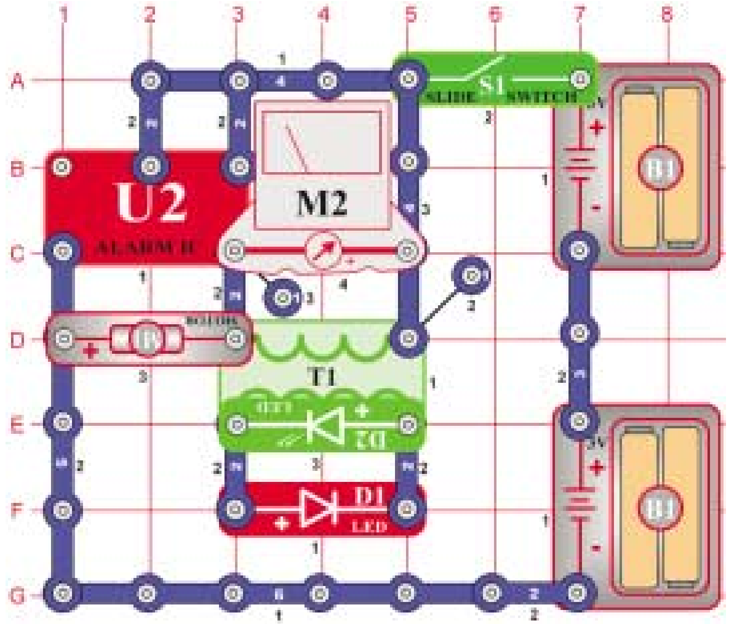
Modify the sound of project #595 by placing a jumper wire across points A and B. Turn on the switch (S1) and hear the new sound.

Project #600 Noisemaker (IX)

OBJECTIVE: To create a

Modify the sound of project #595 by replacing the speaker (SP) with the meter (M2). Set the meter to 10MA. Turn on the switch (S1) and as the LEDs flash the meter deflects.

☐ Project #601 Alarm Power



In this project, the alarm IC (U2) powers the motor (M1), meter (M2) and LEDs (D1 and D2). Set the meter to the 10MA position and turn on the switch (S1). The circuit pulses the meter, motor, LEDs, and whistle chip (WC). You can replace the meter with the speaker (SP) for a louder sound.

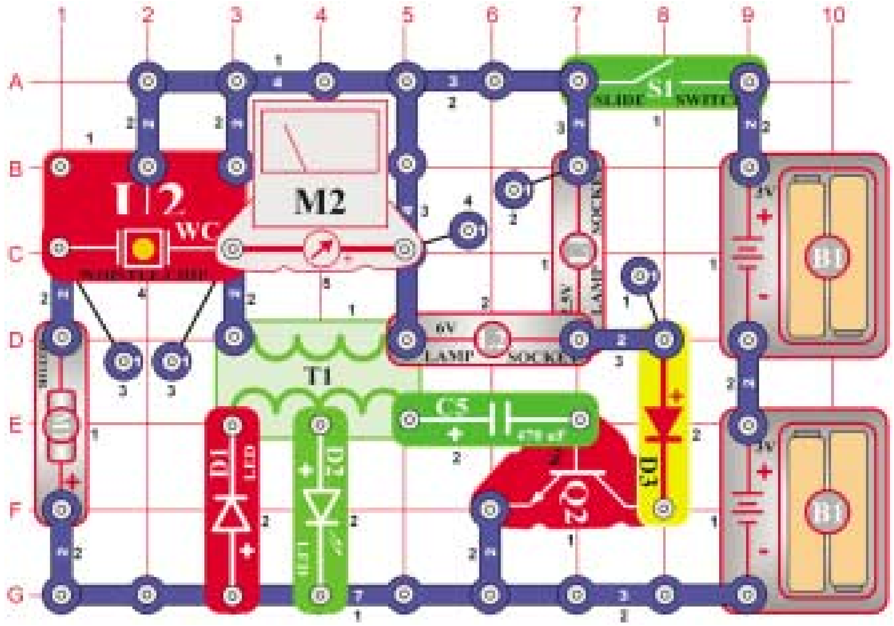
☐ Project #602 Alarm Power (II)

Remove the motor (M1) from the circuit and now the circuit pulses around 1Hz.

☐ Project #603 Night Sounds

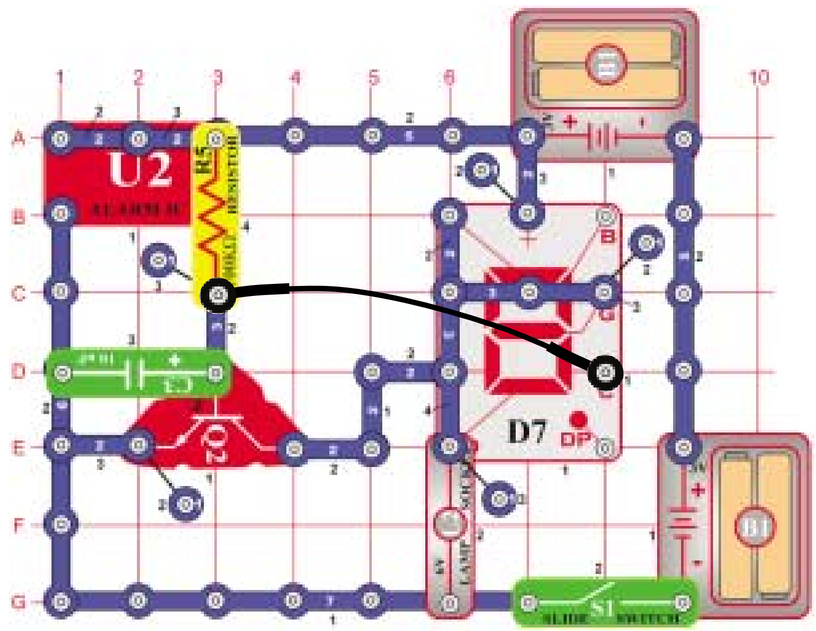
Simulate the sound of a forest at night by replacing the motor (M1) with the whistle chip (WC) as in project #601.

Project #604 — Mega Pulser & Flasher



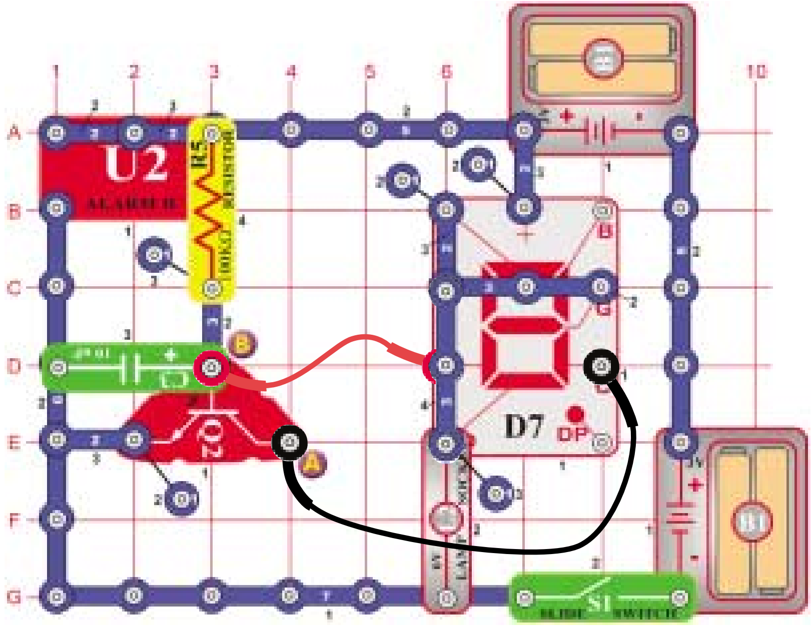
In this circuit, you will power many devices using the alarm IC (U2). Set the meter (M2) to 10MA and turn on the switch (S1). The LEDs (D1 and D2) and bulbs (L1 and L2) flash, the meter deflects, the whistle chip (WC) sounds, and the motor (M1) spins.

Project #605 — "E" & "S" Blinker



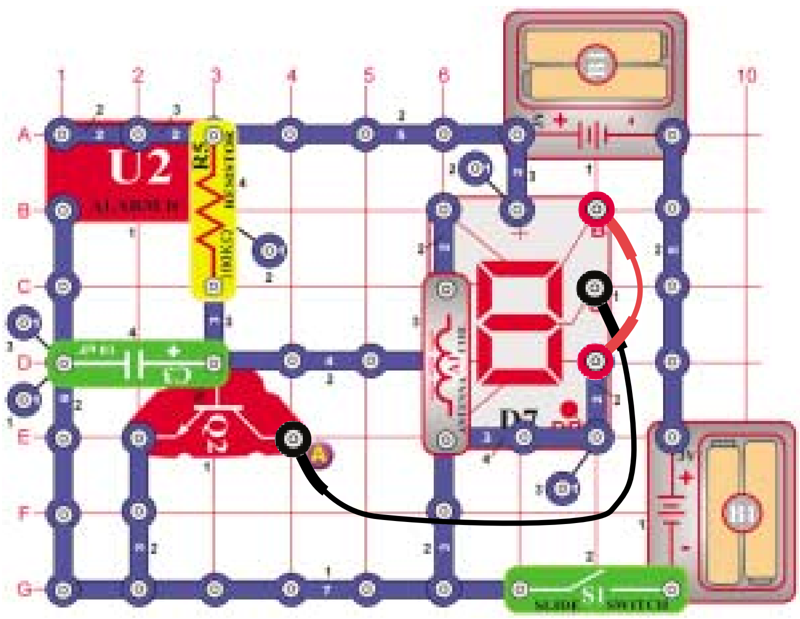
This circuit alternately displays letters "E" and "S" by switching segments "E" and "C" on and off. Segments A, D, F, and G are connected to ground so they are always lit. Segment "E" is connected to the base of Q2 and output of U2. The segment C is connected to the collector of Q2. When the output of U2 is low, segment "E" is on and C is off. When the U2's output is high, the transistor (Q2) turns on and segment "E" turns off. When the transistor connects the "E" segment to ground the segment lights, displaying the letter "S".

☐ Project #606 “2” & “3” Blinker



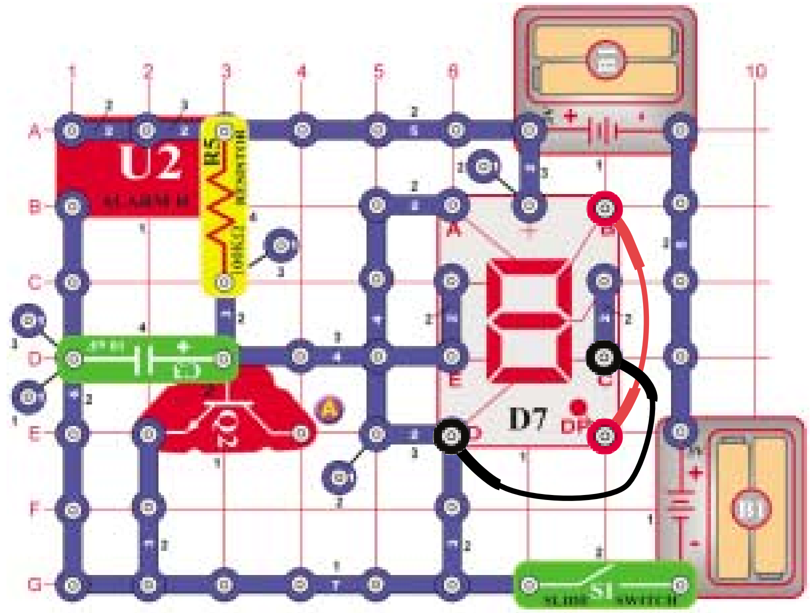
The circuit switches between numbers “2” and “3” on the display. Place jumpers from point A to segment C and point B to segment E.

☐ Project #607 “9” & “0” Blinker



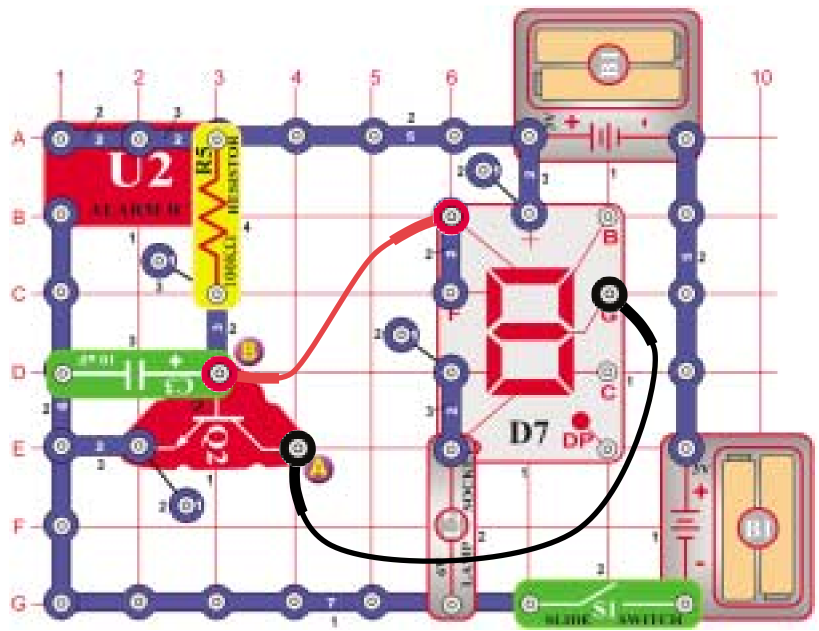
The circuit switches between numbers “9” and “0” on the display. Place a jumper from point A to segment G and point B to segment E.

☐ Project #608 "3" & "6" Blinker



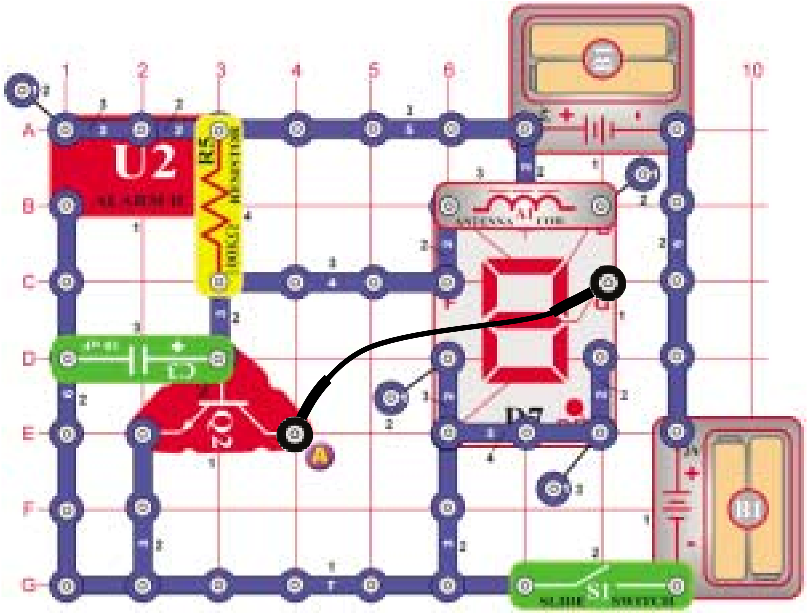
The circuit switches between numbers "3" and "6" on the display. Place a jumper from segment C to segment D and segment B to segment DP.

☐ Project #609 "c" & "C" Blinker



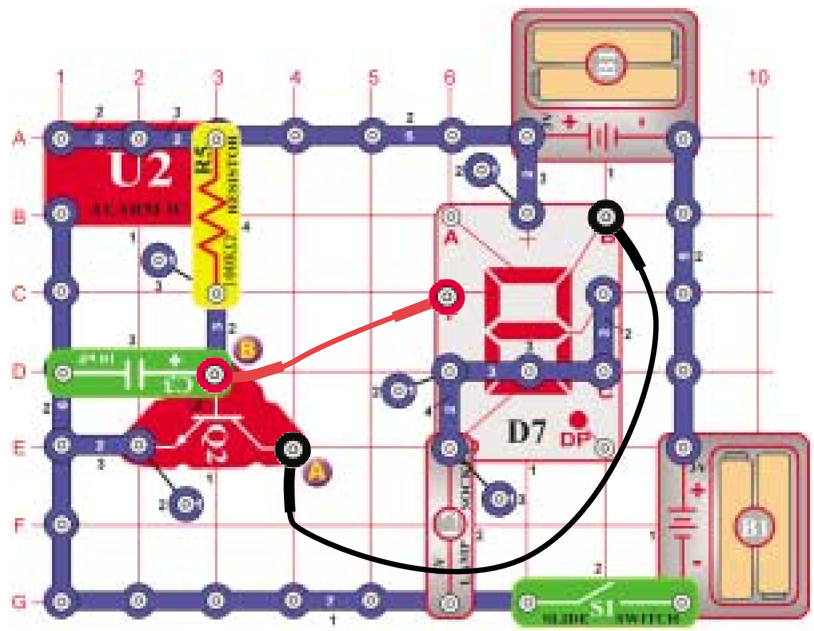
The circuit switches between letters "c" and "C" on the display. Place a jumper from point A to segment G and point B to segment A.

☐ Project #610 — "O" & "o" Blinker



The circuit switches between upper case "O" and lower case "o". Place a jumper from point A to segment G. The DP segment will also light.

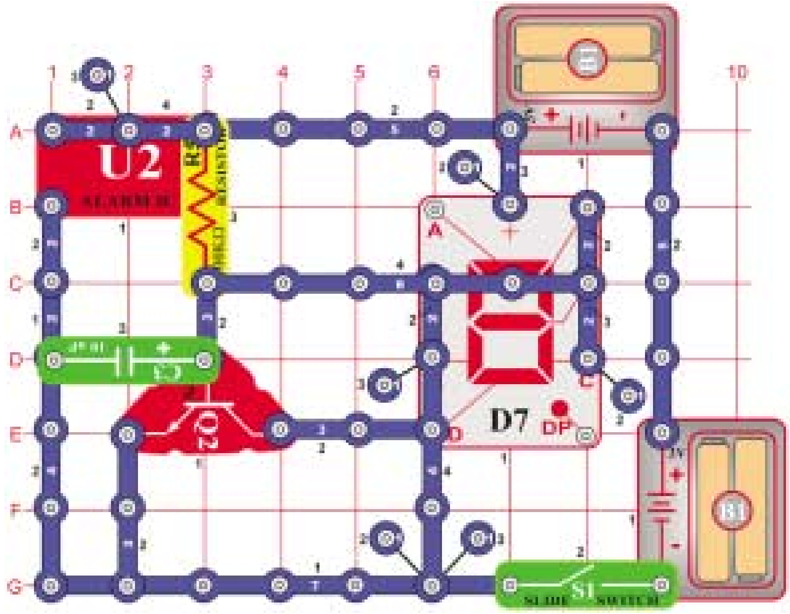
☐ Project #611 — "b" & "d" Blinker



The circuit switches between letters "b" and "d" on the display. Place a jumper from point A to segment B and point B to segment F.

☐ Project #612 “H” & “L” Blinker

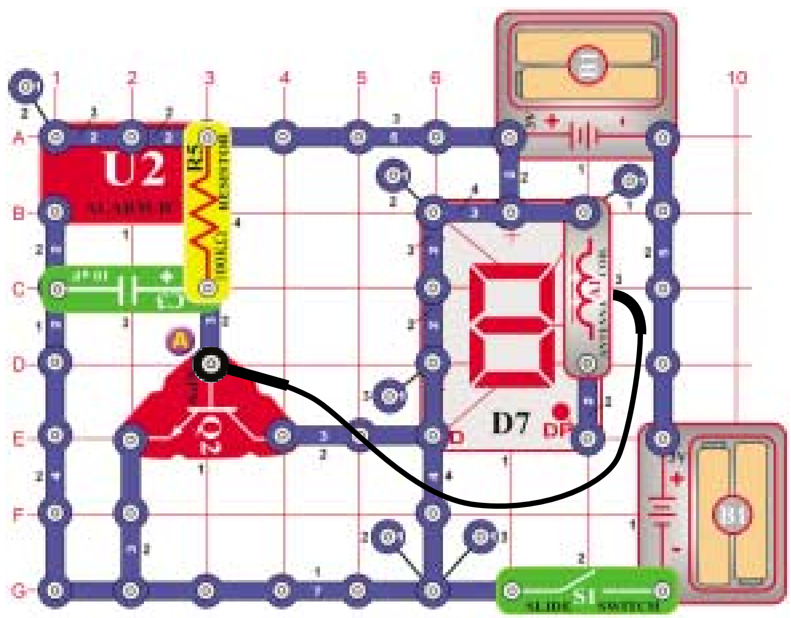
OBJECTIVE: To use the alarm IC to flash between “H” and



The circuit switches between letters “H” and “L” on the display.

☐ Project #613 “A” & “O” Blinker

OBJECTIVE: To use the alarm IC to flash between “A” and

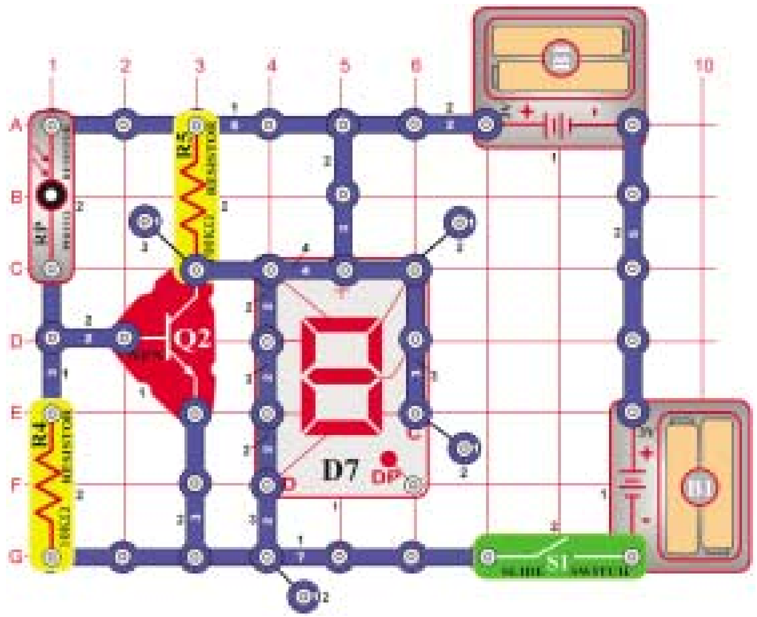


The circuit switches between letters “A” and “O” on the display. Place a jumper from point A to segment G. The DP segment will also light.

☐ Project #614

Open & Closed Indicator

***OBJECTIVE:** To construct a circuit that indicates if a door is*

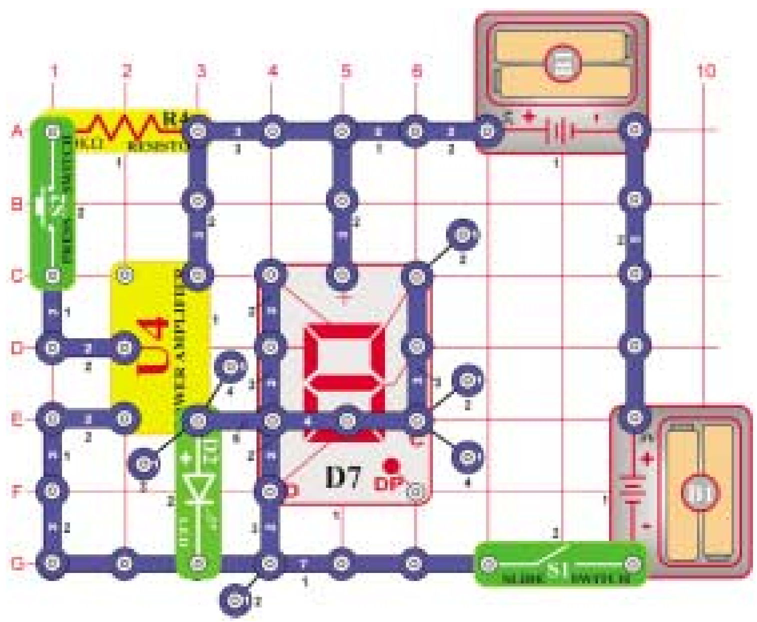


Switching from letters “O” to “C” requires turning off segments B and C. Turn on the switch (S1), the display lights an “O” indicating an open door. Cover the photo resistor (RP) with your hand (closed door) and the letter “C” lights. The photo resistor turns Q2 on and off depending on the amount of light. When Q2 is on (light on RP) the voltage at the collector is low, lighting segments B and C. Covering the RP turns Q2 off and the collector voltage is high now. Segments B and C turn off and the letter “C” lights.

☐ Project #615

Open & Closed Indicator (II)

***OBJECTIVE:** To construct a circuit that indicates if a switch is*



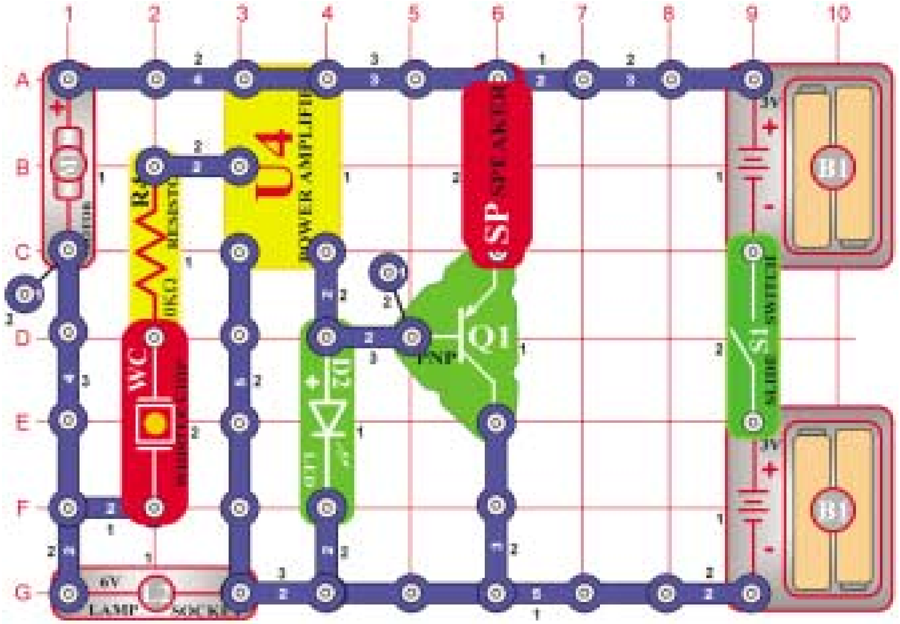
As in project #614, the display will light an “O” or “C” indicating if the switch (S2) is on or off. Turn on the switch (S1), the LED (D2) and letter “O” lights. With no input to U4 the LED lights and the voltage decreases enough so segments B and C light. Press switch S2, the LED turns off and the letter “C” lights. The voltage at U4’s output increased enough turning the segments off.

☐ Project #616

Vibration Indicator

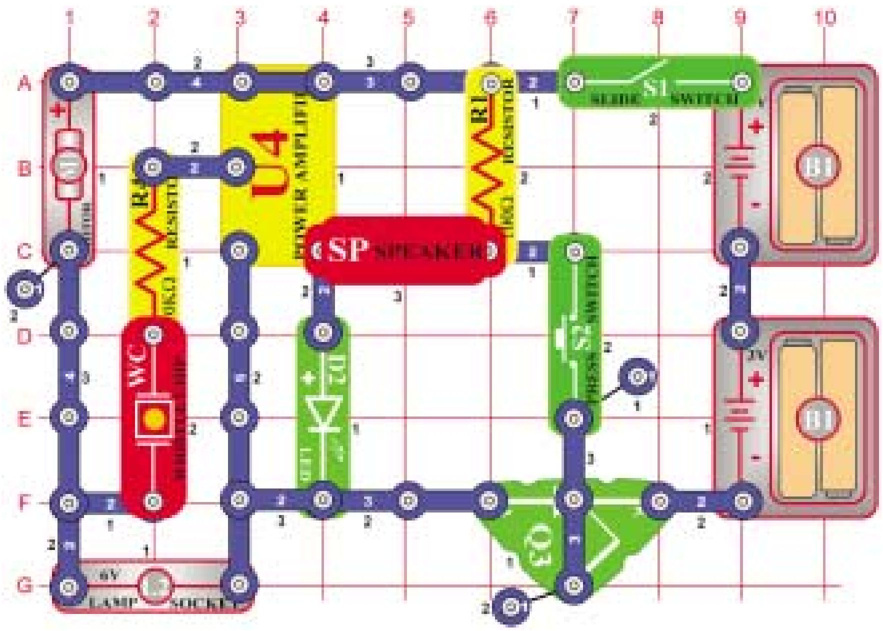
Modify project #615 by replacing the switch (S2) with the whistle chip (WC). As you tap the whistle chip, U4’s output voltage changes, lighting the LED (D2) and changing the display from “C” to “O”.

Project #617 Vibration Sounder



As the motor (M1) spins it generates an AC voltage amplified by U4. The output from U4 lights the LED (D2) and drives the transistor (Q1), sounding the speaker (SP). With the fan not installed, turn on the switch (S1) and you hear the high tone of the spinning motor. Now, install the fan and hear the difference.

Project #618 SCR Noise Circuit

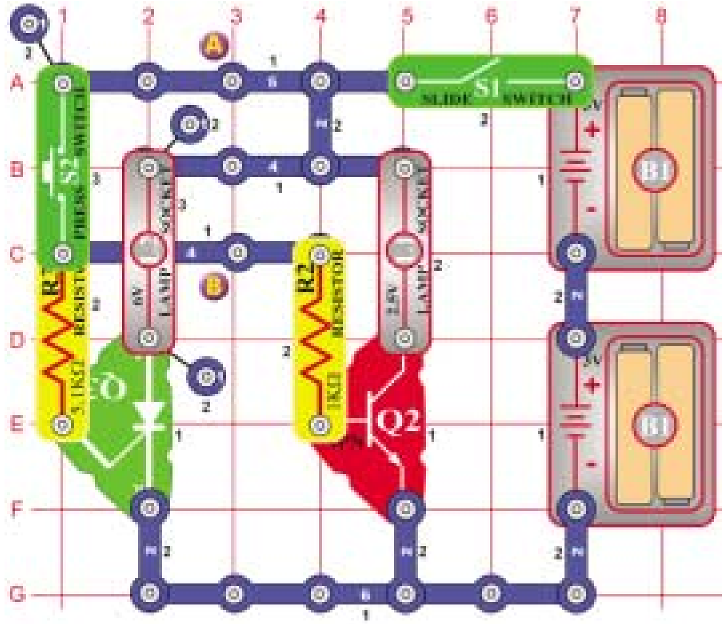


Turn on the switch (S1) and nothing happens. The SCR (Q3) connects the circuit to the batteries and, until the SCR's gate goes high, the circuit is off. Press th switch (S2) and the motor (M1) spins and the LED (D2) and bulb (L2) light. Increase the sound from the speaker (SP) by pressing S2.

☐ Project #619

SCR & Transistor Switch

OBJECTIVE: Control bulbs L1 and L2 with an SCR and

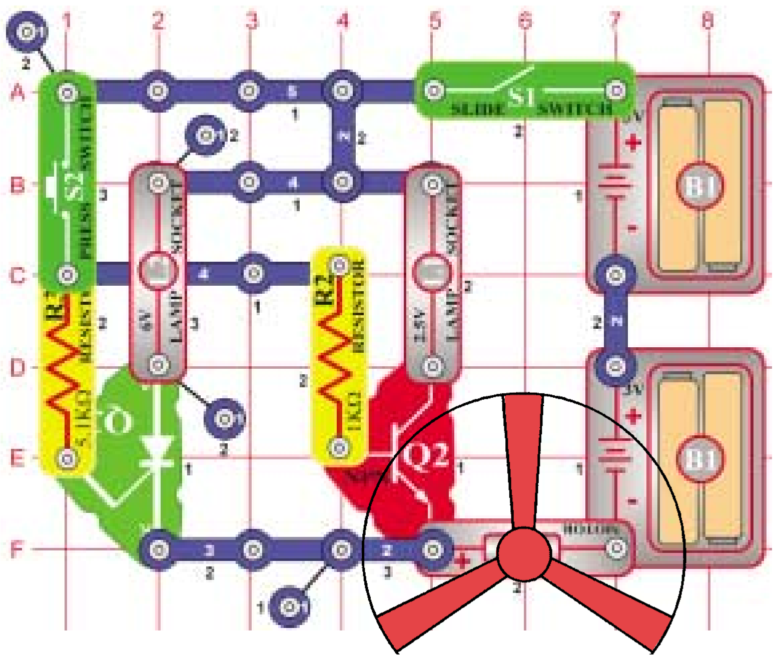


Turn the switch (S1) on and then press the switch (S2), both bulbs (L1 and L2) light, but only L2 stays on when S2 is released. To stay on, the transistor (Q2) requires a continuous voltage but the SCR only needs a pulse. Add the 470μF capacitor (C5) across points A and B (make sure the "+" is connected to point A). The capacitor charges up when S2 is pressed. Now as S2 is released, L1 slowly turns off now. As the capacitor discharges, it keeps the transistor on longer.

☐ Project #620

Two-speed Motor

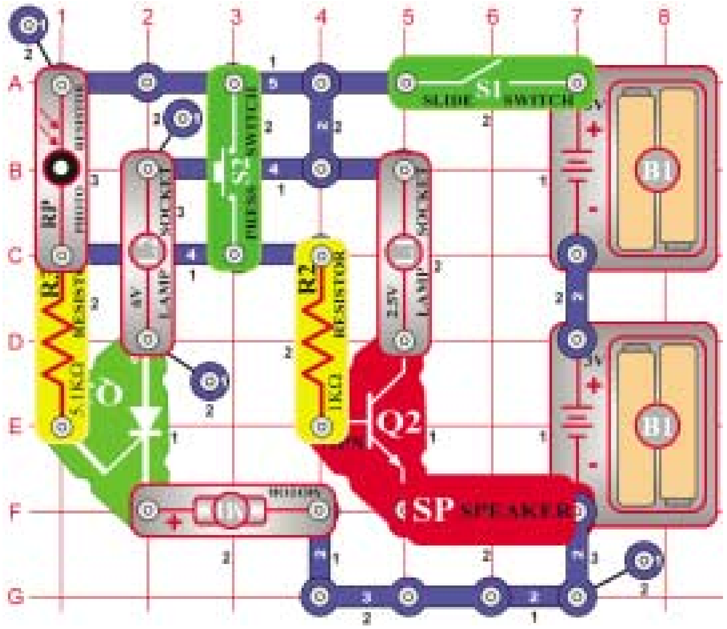
OBJECTIVE: Increase the speed of a motor using an SCR and



Turning the switch (S1) on triggers the SCR (Q3) and the motor (M1) starts spinning. To increase the motor's speed, press down the switch (S2). This turns on the transistor (Q2) increasing the voltage across the motor.

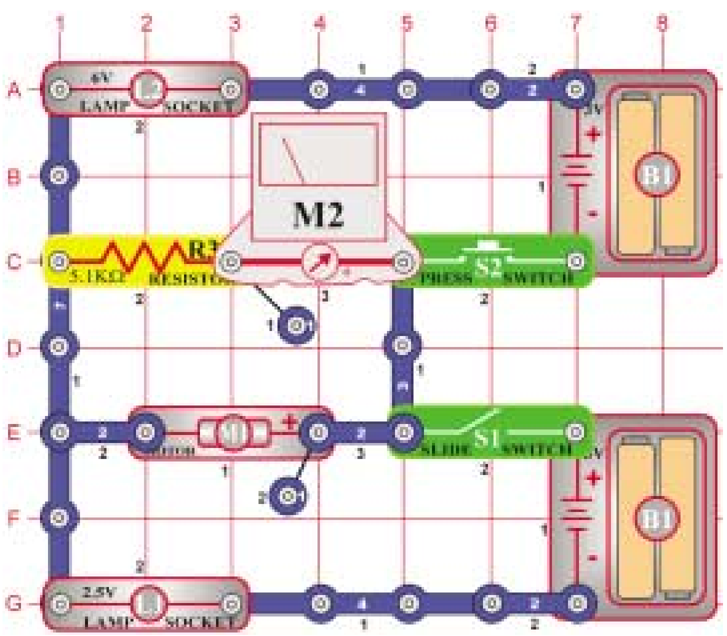
☐ Project #621 — Two-speed Motor (II)

OBJECTIVE: To decrease the speed of a motor using an SCR



Instead of increasing the motor's speed as in project #620, pressing the switch (S2) decreases the speed. In this circuit, the transistor (Q2) is in parallel with the SCR (Q3). Pressing S2 turns on Q2 and the voltage across the motor (M1) decreases.

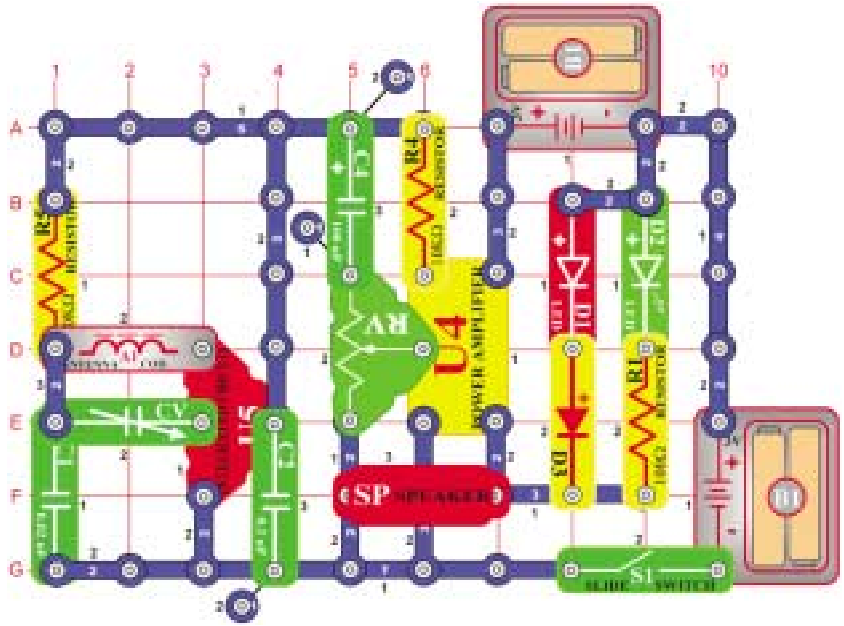
☐ Project #622 — Current Flow



Set the meter (M2) to the 10MA position. Turning on the switch (S1) connects the motor (M1), meter and 2.5V lamp (L1) to the lower battery (B1) back. The motor rotates clockwise and the meter deflects right. Now turn off the switch (S1) and press the switch (S2). Now, current from the upper battery causes the motor to rotate in the opposite direction. If you place the batteries in series by turning on the switch (S1) and then pressing S2, only the bulbs (L1 and L2) light.

Project #623

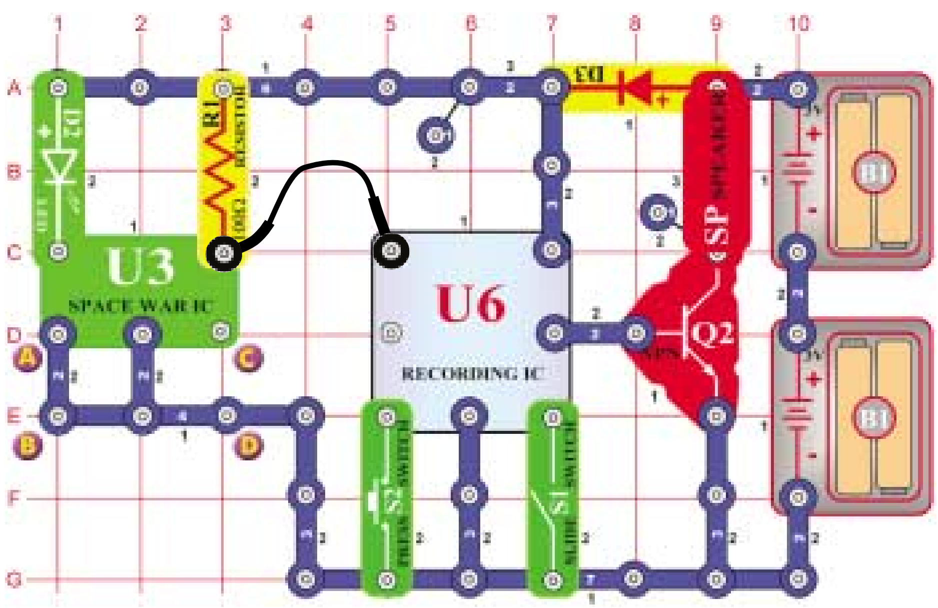
AM Radio with Power LEDs



Set the variable resistor (RV) to the middle position and turn the switch (S1) on. Tune the radio by adjusting the variable capacitor (CV). The LEDs (D1 and D2) flicker as the sound is heard.

Project #624

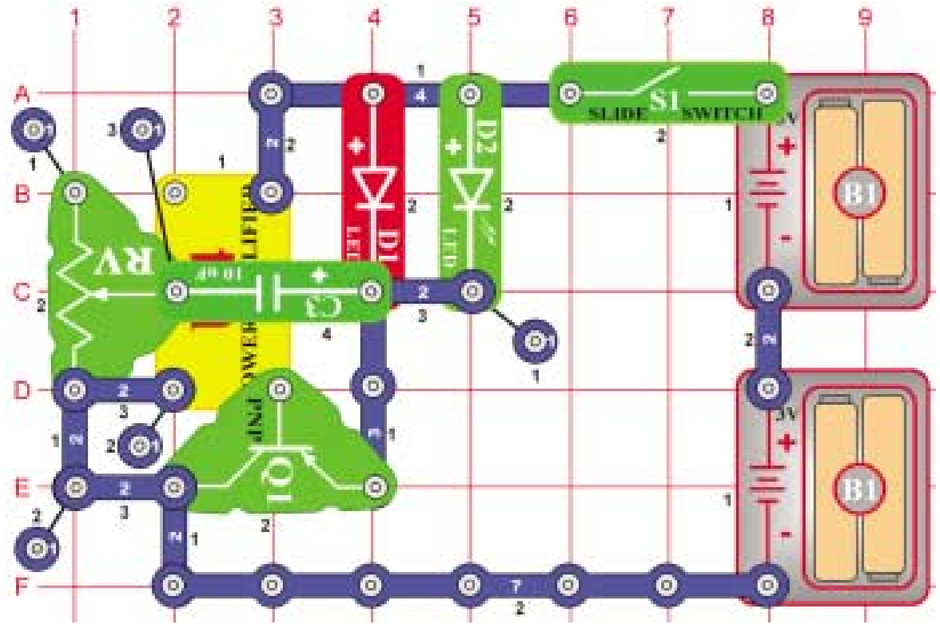
Space War IC Recording



The circuit records the sounds from the space war IC (U3) into the recording IC (U6). Turn on the switch (S1) and the first beep indicates that the IC has begun recording. When you hear two beeps, the recording has stopped. Turn off the switch (S1) and press the switch (S2). You will hear the recording of the space war IC before each song is played.

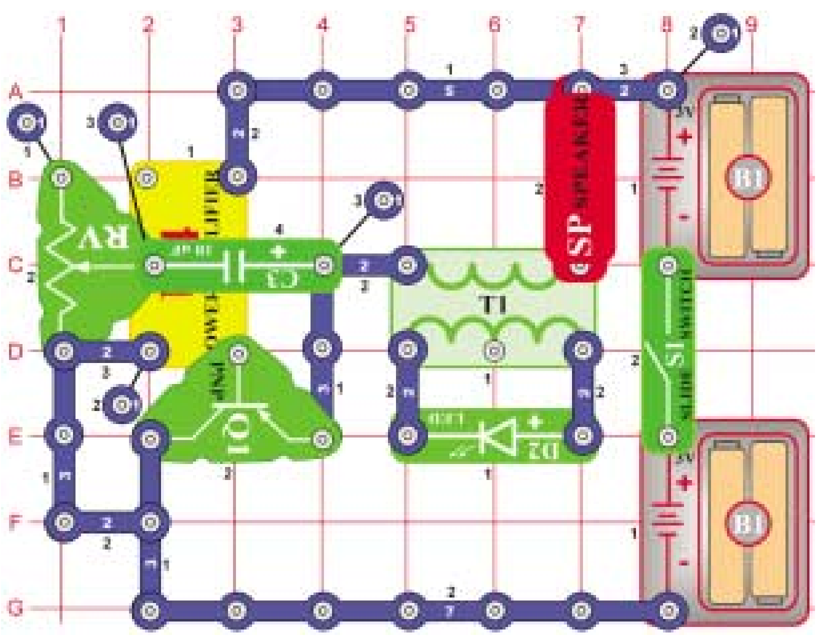
Place the 2-snap from points A and B onto C and D. Now record a different sound from U3.

☐ Project #625 LED Flasher



Set the variable resistor (RV) to the top position and then turn on the switch (S1). The LEDs (D1 and D2) flash at a rate of once per second. As you adjust RV's knob down, the LEDs flash faster. When RV is at the bottom the LEDs turn off.

☐ Project #626 LED Flasher with Sound

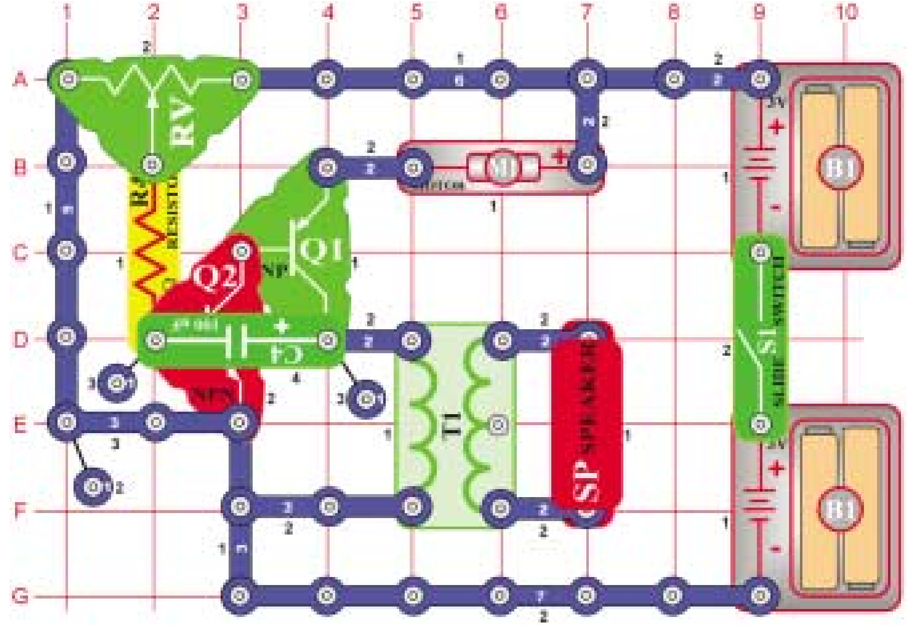


You can modify project #625 by adding a transformer (T1) to drive a speaker (SP). Set the variable resistor (RV) to the top position and turn on the switch (S1). The speaker sounds as the LED (D2) flashes at a rate of one per second. Increase the rate by moving RV's knob down.

☐ Project #627 LED Flasher with Sound (II)

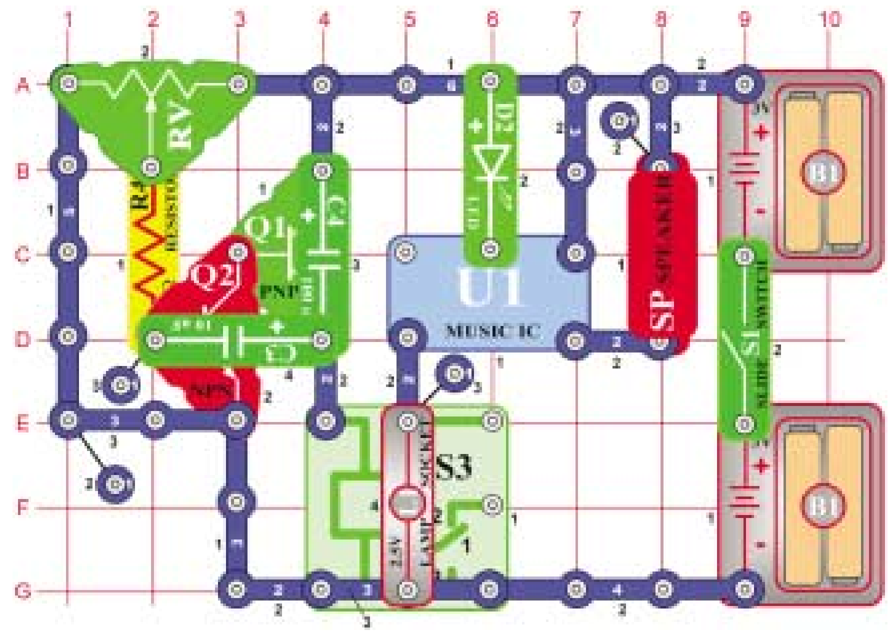
Modify the frequency by replacing the 10μF capacitor (C3) with the 0.1μF capacitor (C2).

Project #628 Stepper Motor



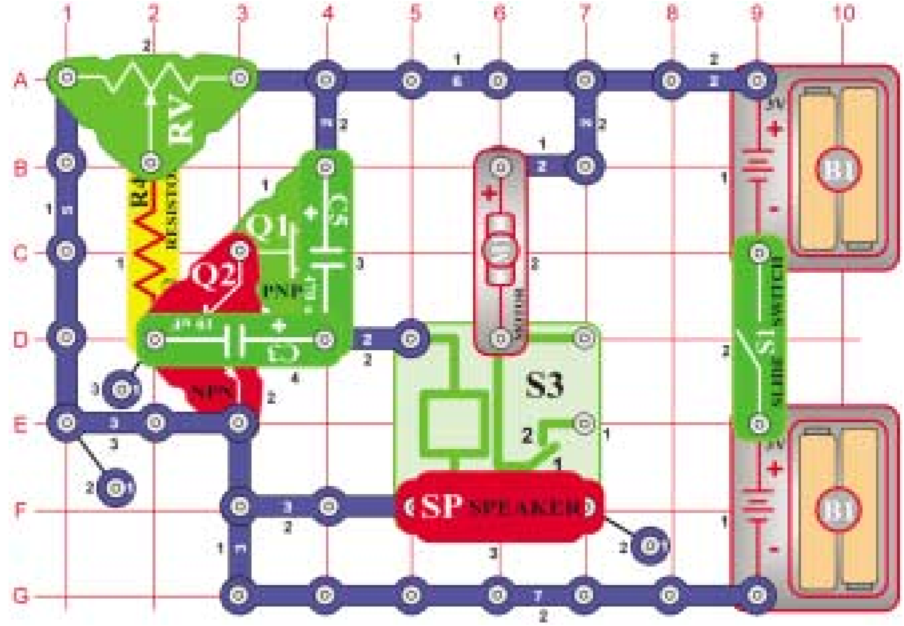
Adjust the variable resistor (RV) to the middle position and turn on the switch (S1). As the circuit oscillates, the motor (M1) moves a short distance as the speaker (SP) sounds. Adjust the variable resistor to different positions seeing how it affects the motor and speaker.

Project #629 Crazy Music IC



Set the variable resistor (RV) to the far left position and turn the switch (S1) on. The relay's (S3) contacts open and close shorting U1 to ground, causing the sound level to change.

Project #630 Stepper Motor w/ Sound

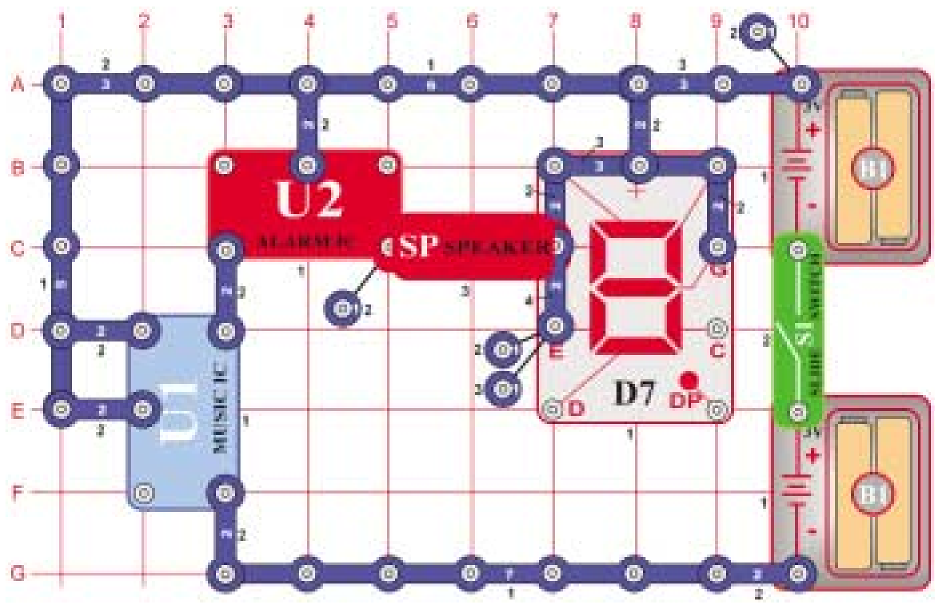


Set the variable resistor (RV) to the middle position. Turn the switch (S1) on and the motor (M1) pulses on and off as the speaker (SP) sounds. As the circuit oscillates, the relay's (S3) contacts open and close shorting the motor and speaker to ground. See how much you can adjust the variable resistor before the motor turns off or continuously spins.

Project #631 Stepper Motor w/ Light

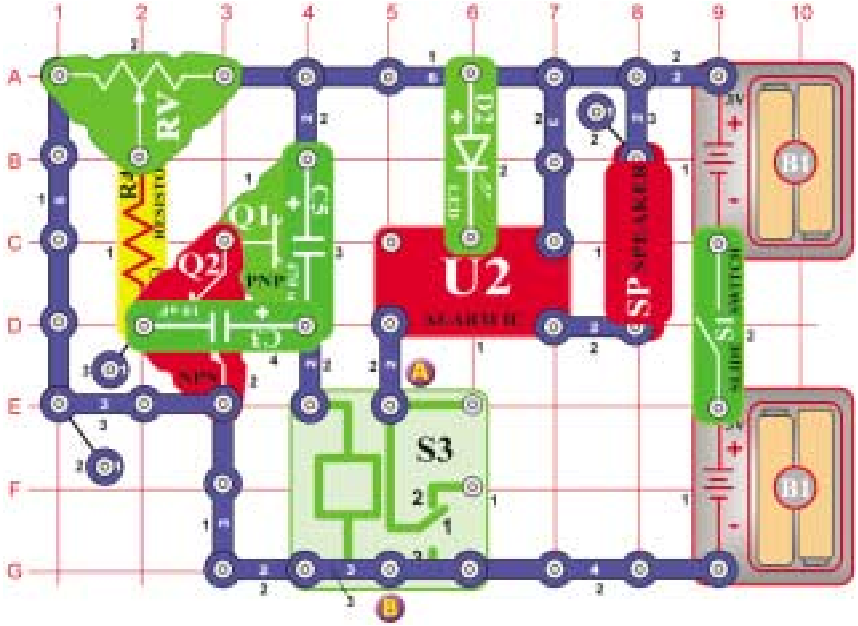
Modify project #630 by removing the speaker (SP) and replacing it with the lamp (L1). Now when you turn the switch (S1) on, the lamp lights as the motor spins.

Project #632 Police Siren with Display



Turn the switch (S1) on and the speaker (SP) sounds as the letter "P" lights. You also hear the music IC (U1) playing. The alarm IC (U2) plays as long as the music IC is on since U2 is connected to U1's output. After 20 seconds, the circuit turns off for 5 seconds and then starts again.

Project #633 Oscillator Alarm

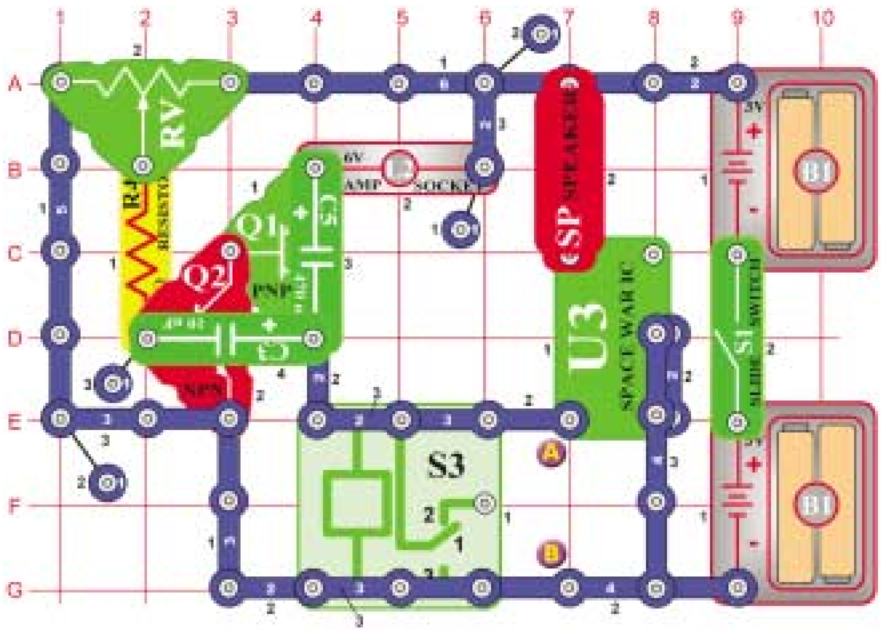


Set the variable resistor (RV) to the far left and turn the switch (S1) on. The speaker (SP) sounds only once. Slowly move the variable resistor to the right, the speaker momentarily sounds. As you move the variable resistor to the right, the alarm is on continuously. The variable resistor controls the frequency of the oscillator circuit (C3, C5, Q1, Q2) by adjusting the voltage at Q2's base. The relay (S3) switches the alarm IC (U2) on and off.

Project #634 Oscillator Alarm (II)

Connect the red LED (D1) across points A and B. Turn the switch (S1) on and the circuit has a different sound now.

Project #635 Tapping U3

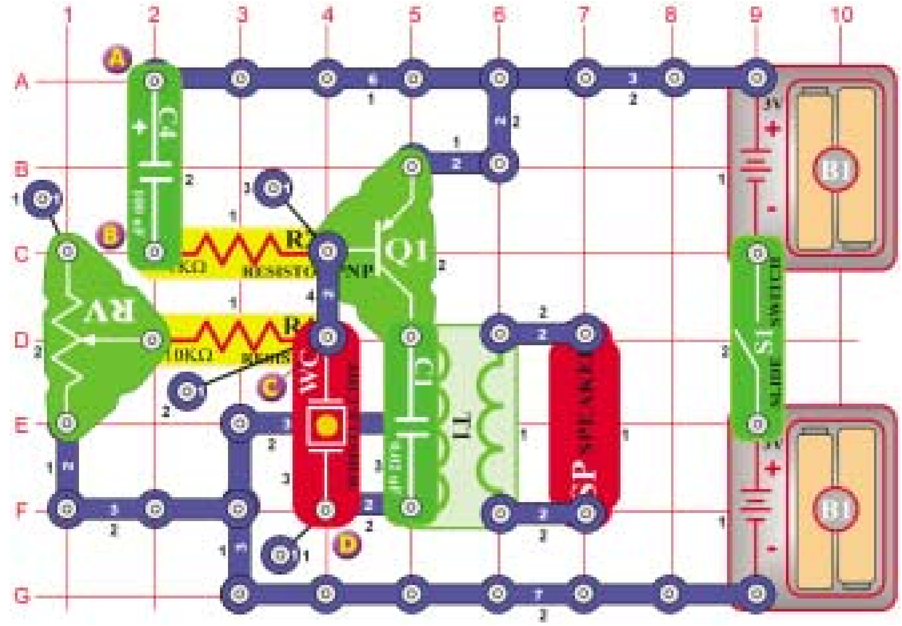


Set the variable resistor (RV) to the middle position and turn the switch (S1) on. This is another example using the oscillator that switches the power on and off creating sound. Alter the sound by adjusting the variable resistor.

Project #636 Tapping U3 (II)

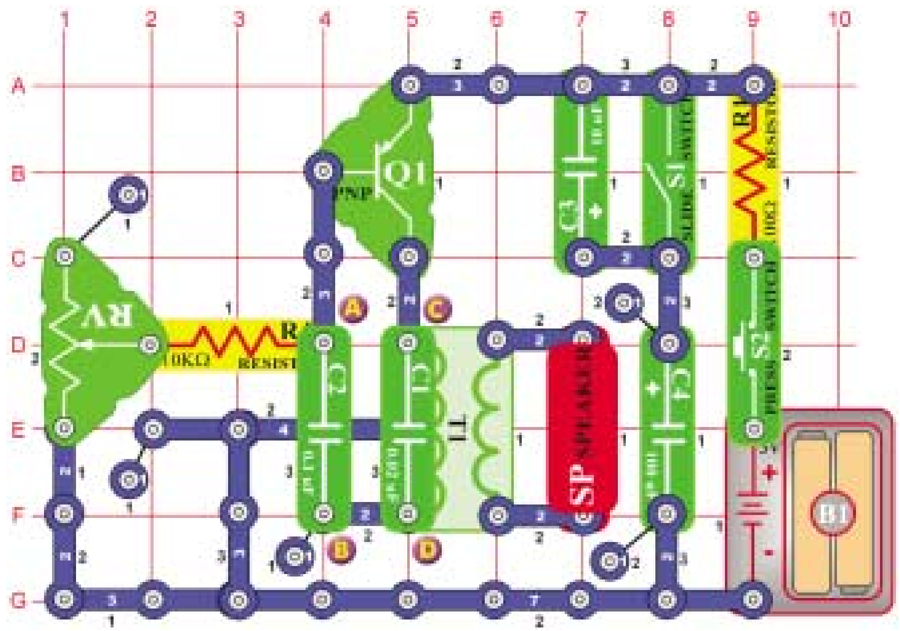
Connect the motor (M1) across points A and B. Set the variable resistor (RV) to the middle position and turn the switch (S1) on. Now you hear random noise and static from the speaker (SP). The motor causes the random static and noise from the speaker.

Project #637 Adjustable Beeper



Turn the switch (S1) on and this simple oscillator circuit outputs a beep from the speaker (SP). Change the frequency by adjusting the variable resistor (RV).

Project #638 Electronic Cat

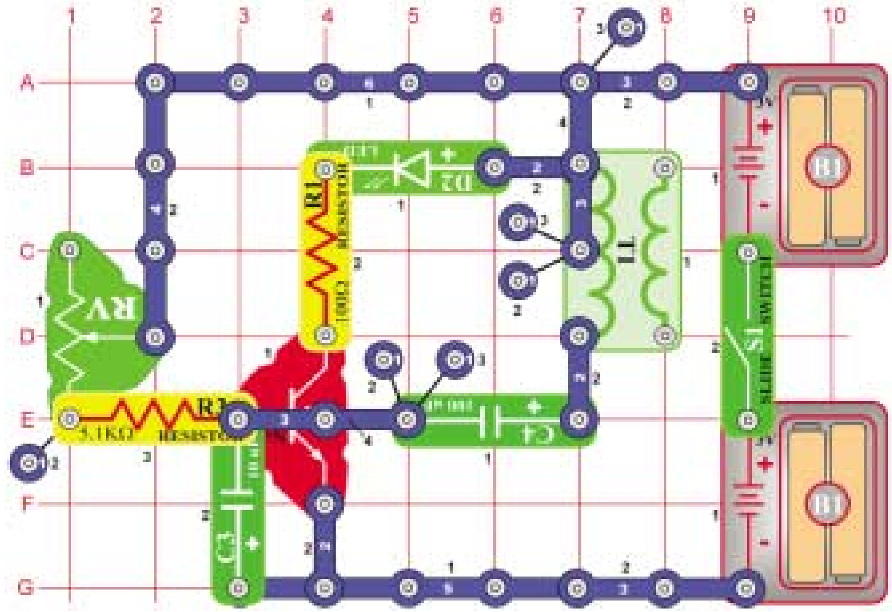


Turn off the switch (S1) and then press and release the switch (S2). You hear a “cat’s meow” from the speaker (SP). Now turn the switch (S1) on and the sound is lower and lasts longer. Adjust variable resistor (RV) while the sound is fading away.

Project #639 Electronic Cat (II)

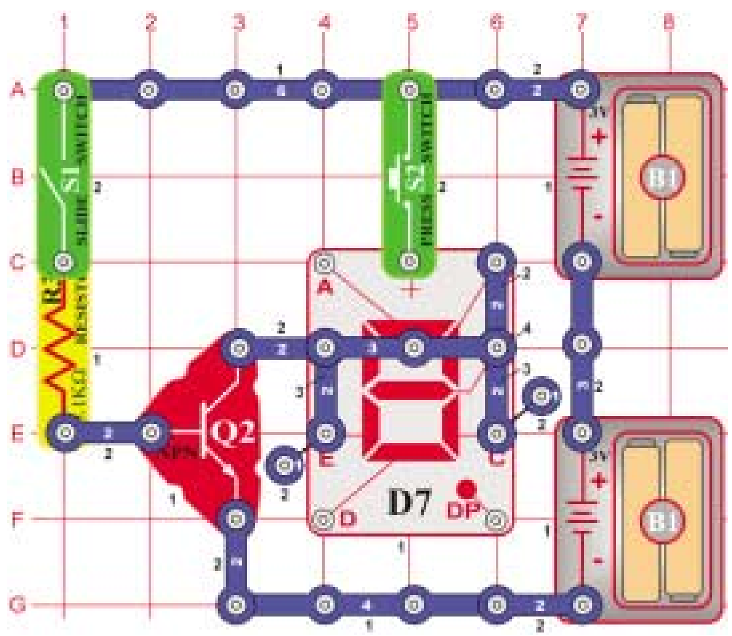
Replace the 10KΩ resistor (R4) with the photo resistor (RP). Wave your hand over photo resistor as you press down on the switch (S2).

Project #640 Strobe Light



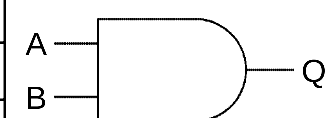
This is an example of how a large strobe light works. Turn the switch (S1) on and the LED (D2) flashes at a certain frequency. Adjust the frequency by adjusting the variable resistor (RV). Now add sound by replacing the 100Ω resistor (R1) with the speaker (SP). Each time the LED lights, the speaker sounds.

Project #641 AND Gate



In digital electronics, there are two states, 0 and 1. The **AND gate** performs a logical "and" operation on two inputs, A and B. If A **AND** B are both 1, then Q should be 1. The logic table below shows the state of "Q" with different inputs and the symbol for it in circuit diagrams.

A	B	Q	D7
0	0	0	–
1	0	0	–
0	1	0	–
1	1	1	"H"

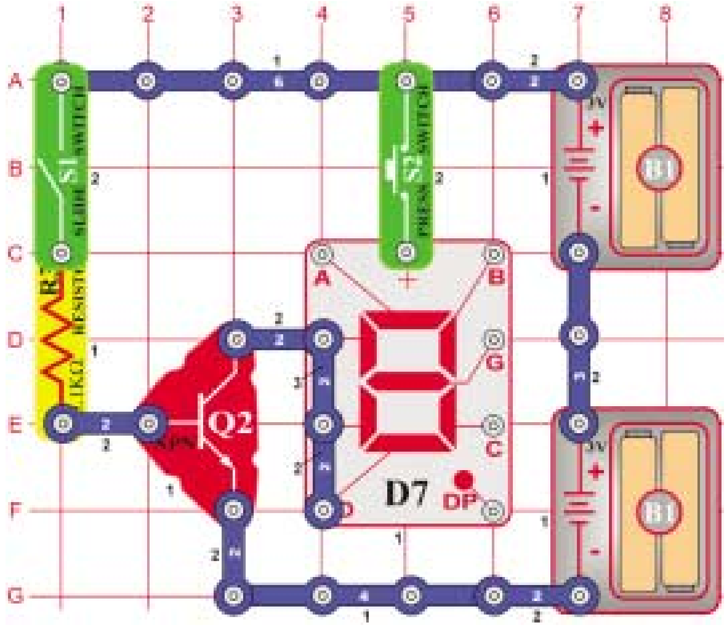


AND Gate

Turn switch S1 on and the display does not light. Turn switch S1 off and then press switch S2 and still the display does not light. Turn switch S1 on and press switch S2 down. Now, the LED and the letter "H" light.

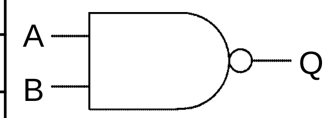
☐ Project #642

NAND Gate



The NAND gate works the opposite of the AND as shown in the logic chart.

A	B	Q	D7
0	0	1	–
1	0	1	–
0	1	1	–
1	1	0	“L”

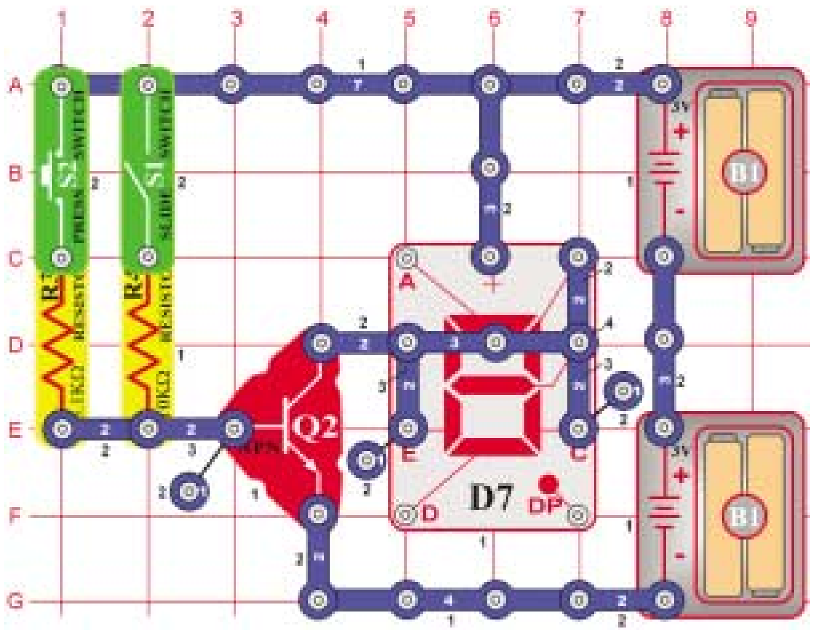


NAND Gate

Using the chart set the switches to the different states. When you a have logic “0” the display lights the letter “L”.

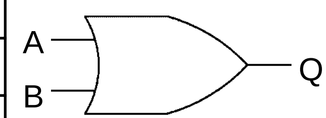
☐ Project #643

OR Gate



The basic idea of an OR gate is: If A OR B is 1 (or both are 1), then Q is 1.

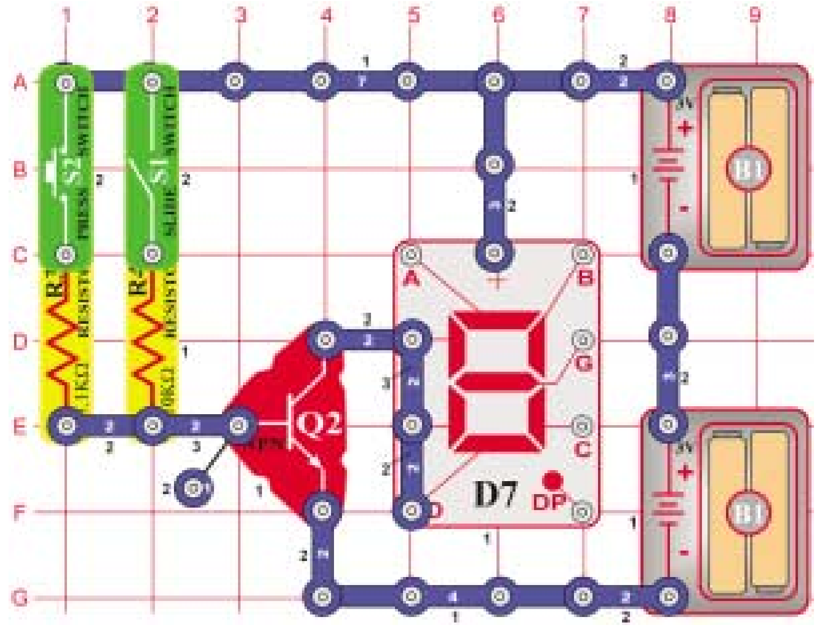
A	B	Q	D7
0	0	0	–
1	0	1	“H”
0	1	1	“H”
1	1	1	“H”



OR Gate

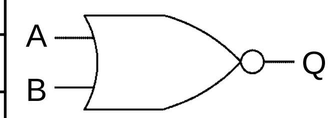
Using the chart set the switches to the different states. Only when you a have logic “0” the display does not light the “H”.

Project #644 NOR Gate



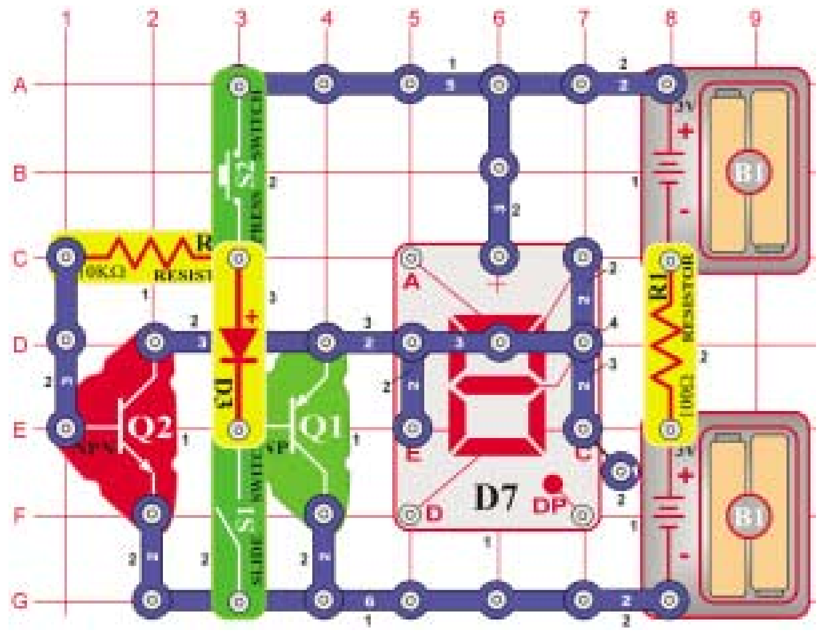
The NOR gate works the opposite of the OR. Using the chart set the switches to the different states. The display lights the letter “L” when either switch is turned on.

A	B	Q	D7
0	0	1	–
1	0	0	“L”
0	1	0	“L”
1	1	0	“L”



NOR Gate

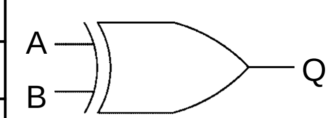
Project #645 XOR Gate



OBJECTIVE: To demonstrate the operations of the “exclusive

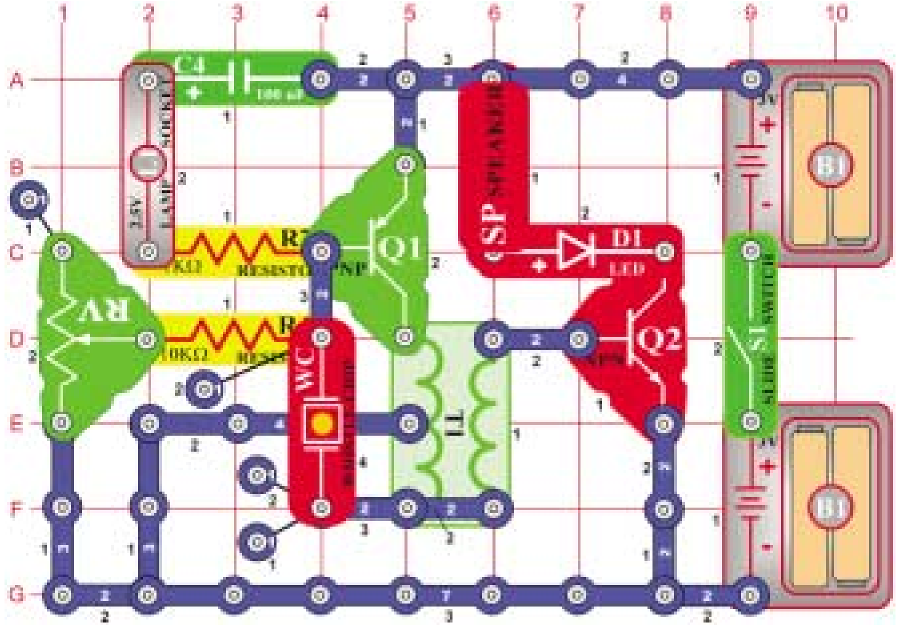
In an XOR gate the output “Q” is only high when inputs “A” or “B” is set high (1).
Using the chart set the switches to the different states. The display lights the letter “H” only when either switch is turned on.

A	B	Q	D7
0	0	0	–
1	0	1	“H”
0	1	1	“H”
1	1	0	–



XOR Gate

Project #646 High Pitch Oscillator



Set the variable resistor (RV) to the top position and then turn the switch (S1) on. You hear a high pitch sound and the LED (D1) flashes at the same rate. Change the oscillator frequency by adjusting RV.

Project #647 Low Pitch Oscillator

Replace the whistle chip (WC) with the .1μF capacitor (C2). Turn the switch (S1) on and now the circuit oscillates at a lower frequency.

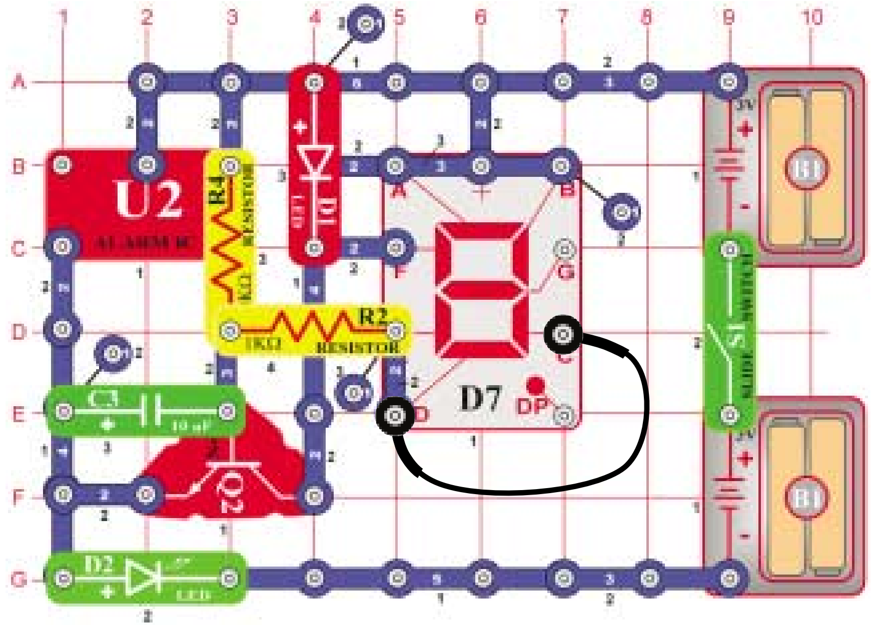
Project #648 Low Pitch Oscillator (II)

Replace the whistle chip (WC) with the 100μF capacitor (C4) placing the + sign towards the top. Turn the switch (S1) on, now the circuit oscillates at a lower frequency.

Project #649 Low Pitch Oscillator (III)

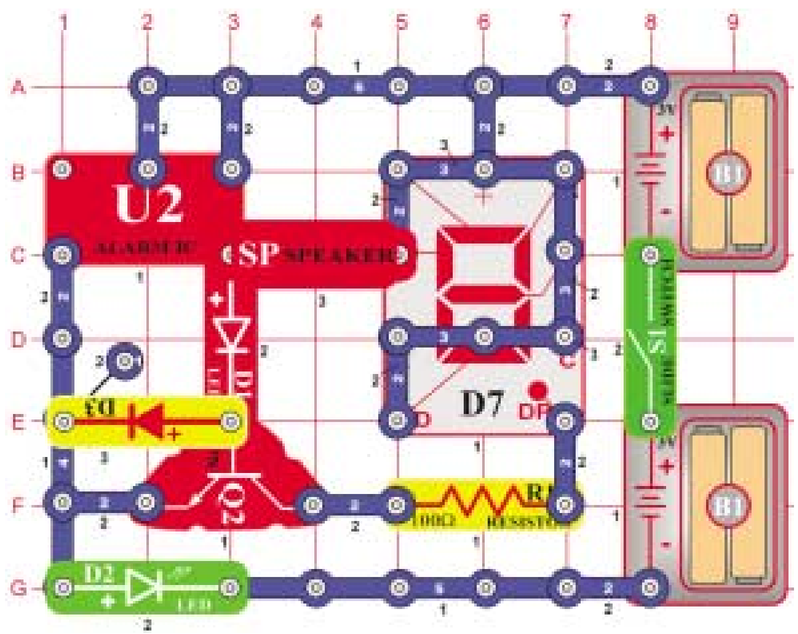
Replace the 100μF capacitor (C4) with the 470μF capacitor (C5) placing the + sign towards top. Turn the switch (S1) on and the circuit oscillates at a lower frequency now.

Project #650 Segment Jumper



Turn the switch (S1) on, segments A, B, and F light and then segments C, D, and E. The two groups of segments are connected to different voltages. As the voltage changes from high to low, the segments toggle back and forth.

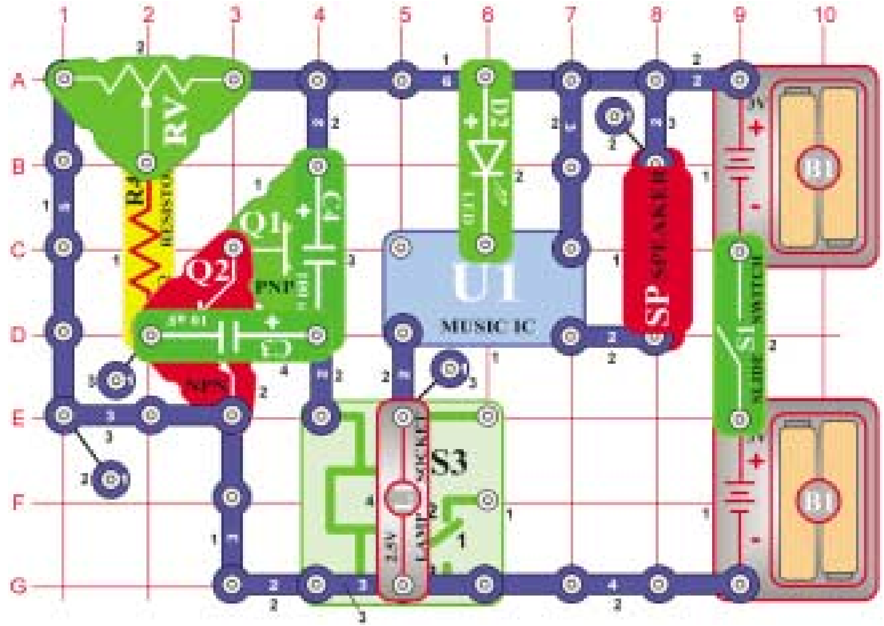
Project #651 DP & Zero Flasher



As in project #650, we use the alarm IC (U2) to flash segments and LEDs. Turn the switch (S1) on and the number “0” and green LED (D2) flash as the speaker (SP) sounds. When they turn off, the DP segment lights.

Project #652

Stepper Motor with Lamp & LEDs

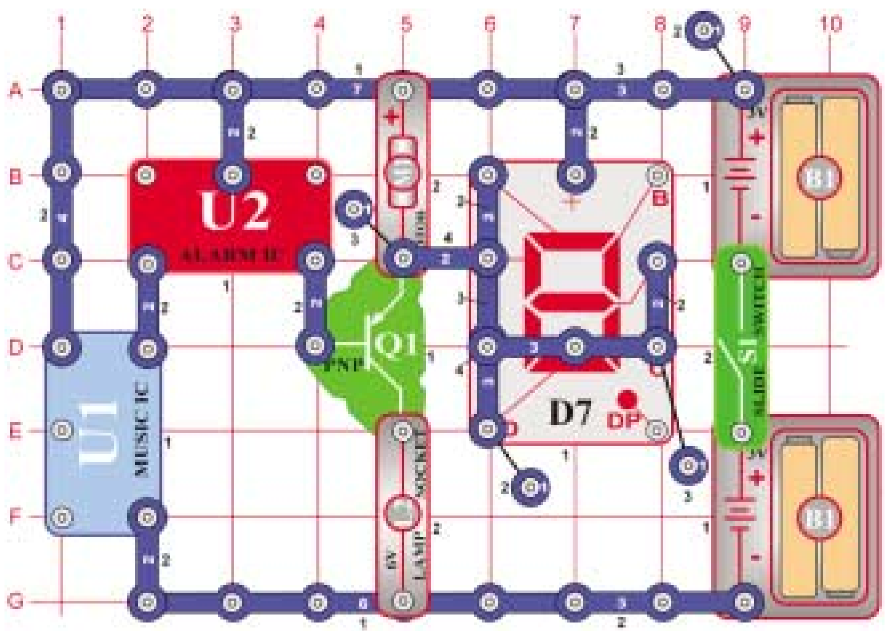


The circuit works the same as project #631 except now the green LED (D2) lights when the motor (M1) and bulb (L1) are off. Set the variable resistor (RV) to the middle position. Turn the switch (S1) on, the motor spins, the bulb lights, and then turn off as the green LED lights. Even though the motor is connected to the LED, it will not spin because the series resistor limits the current.

Project #653

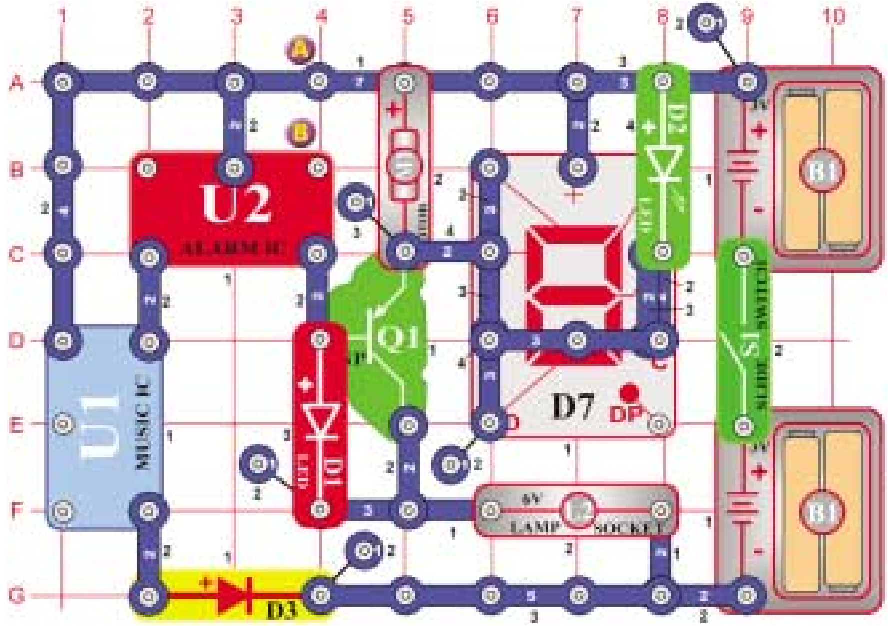
IC Start & Stop

OBJECTIVE: To drive the motor and display with two IC



Turn the switch (S1) on. As the output from the IC (U2) drives the transistor (Q1), the motor (M1) spins and the display (D7) lights the letter “S” and then turns off.

Project #654 IC Motor Speed

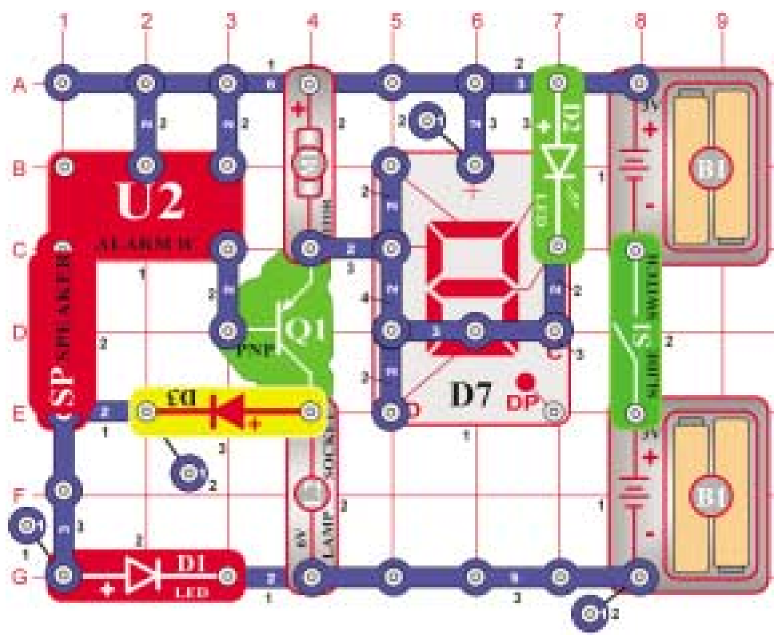


Turn the switch (S1) on. As the output from the IC (U2) drives the transistor (Q1), the motor (M1) spins and the display (D7) lights the letter "S". Instead of turning off as in project #653, the motor slows down and the red LED (D1) lights.

Modify the circuit by placing a jumper wire across points A and B. Now the circuit pulses and then runs consciously for a short time.

Project #655 Sound & Light Flasher

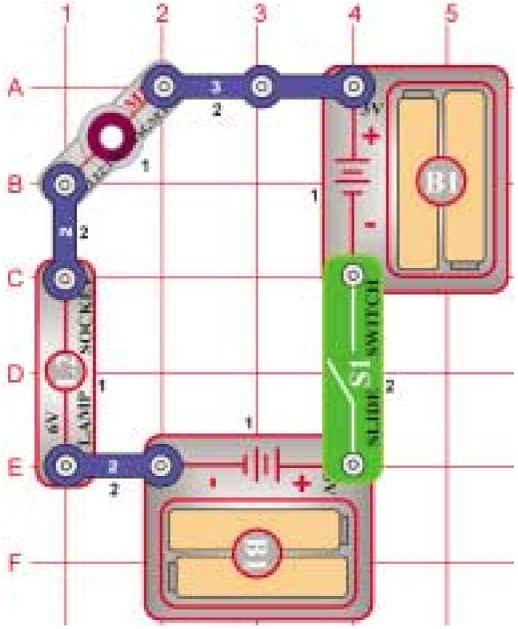
OBJECTIVE: To use the alarm IC to drive the motor, speaker,



Turn the switch (S1) on and the speaker (SP) outputs the sounds from the alarm IC (U2). The IC also drives the transistor (Q1) causing the motor (M1) to spin and lights to flash.

☐ Project #656

Electromagnet Delayer



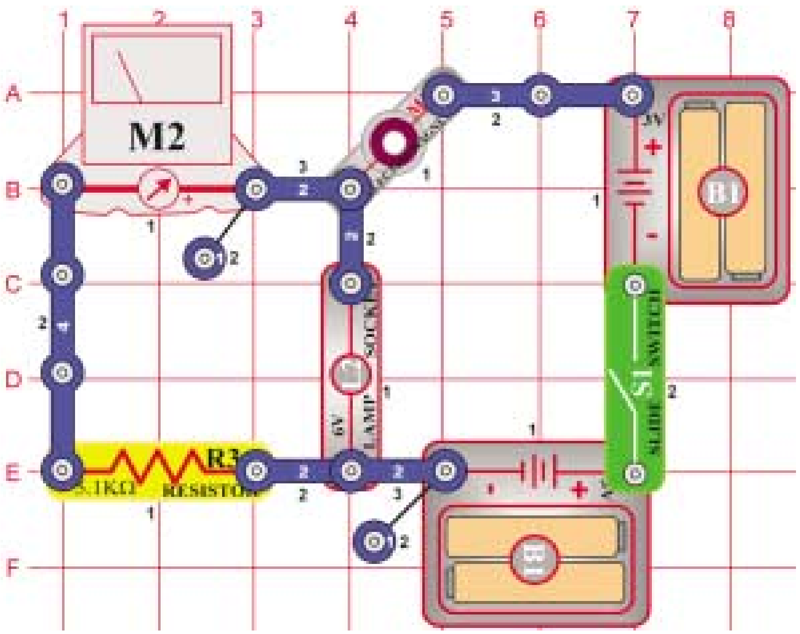
Build the circuit and turn it on. After a delay of about 2 seconds, the lamp (L2) will light but be dim. Replace your batteries if it does not light at all.

Why does the electromagnet (M3) delay the lamp turn-on? The electromagnet (M3) contains a large coil of wire, and the batteries have to fill the coil with electricity before the lamp can turn on. This is like using a long hose to water your garden - when you turn on the water it takes a few seconds before water comes out the other end.

Once the lamp is on, the resistance of the wire in the coil keeps the lamp from getting bright. You can replace the 6V lamp with the 2.5V lamp (L1), because the coil will protect it from the full battery voltage.

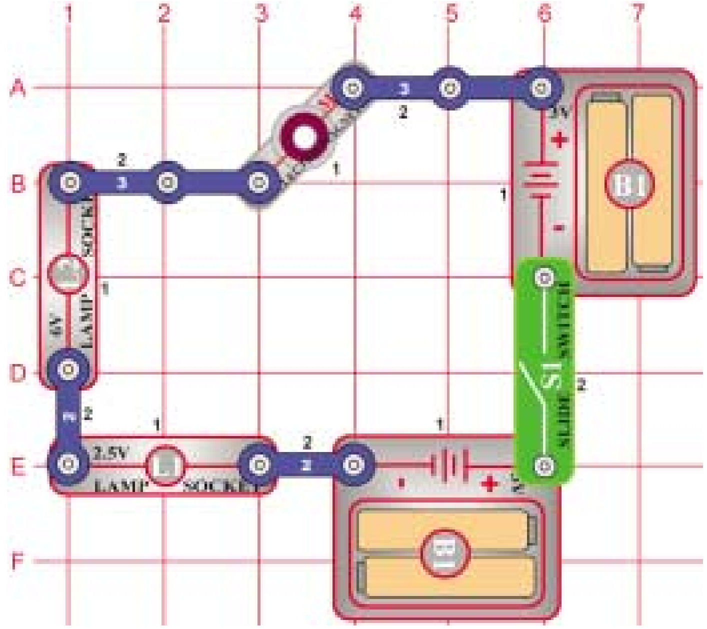
☐ Project #657

Electromagnet Delayer (II)



Use the 10MA setting on the meter (M2) and turn on the switch (S1). The meter shows how the current slowly rises. After a delay of about 2 seconds, the lamp (L2) will light but be dim.

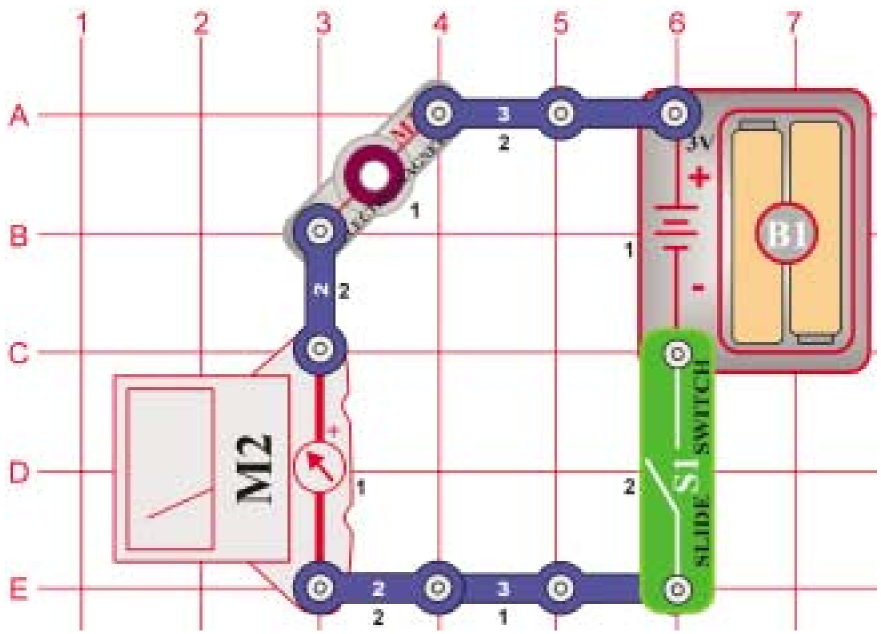
Project #658 Two-Lamp Electromagnet Delayer



Build the circuit and turn it on. First the 2.5V lamp (L1) turns on, and then the 6V lamp (L2) turns on. Both may be dim, replace your batteries if they do not light at all.

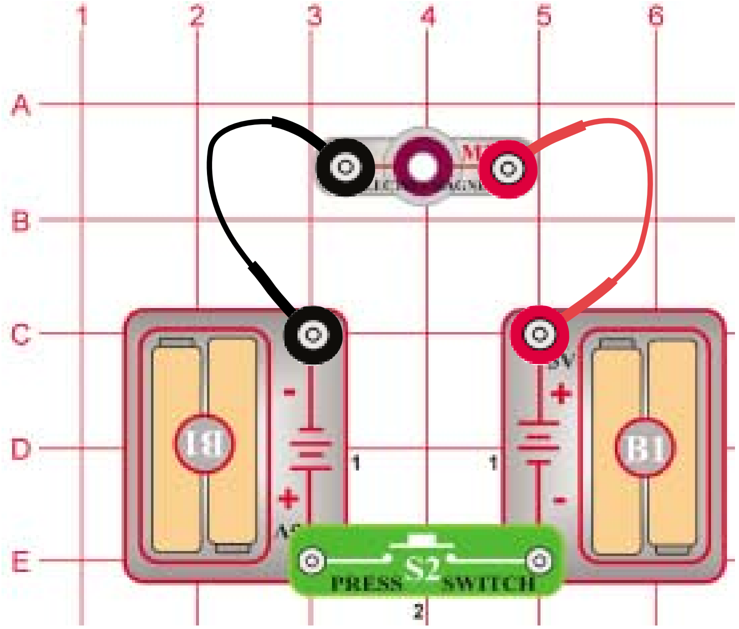
The electromagnet (M3) stores energy, and the batteries must fill it up before the lamps become bright. The smaller bulb turns on sooner because it needs less current to light.

Project #659 Electromagnet Current



Use the 1A setting on the meter (M2) to measure the electromagnet (M3) current. Compare to the meter reading to that for the motor and lamp current in projects #544-546. Insert the iron core rod into the electromagnet and see if it changes the meter reading.

Project #660 Electromagnetism



OBJECTIVE: To learn how electricity and magnetism are

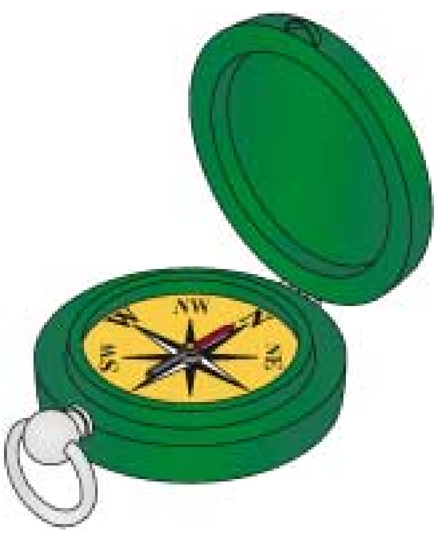
Put the iron core rod into the electromagnet (M3). Press the switch (S2) and place the electromagnet (M3) near some iron objects like a refrigerator or a hammer, it will be attracted to them. You can use it to pick up iron objects, such as nails.

Electricity and magnetism are closely related, and an electric current flowing in a coil of wire has a magnetic field just like a normal magnet. Placing an iron rod through the coil magnifies this magnetic field. Notice that when the electromagnet is attracted to an iron object, its attraction is strongest at the ends of the iron core rod. If you remove the iron core rod from the electromagnet then its magnetic properties are greatly reduced - try this.

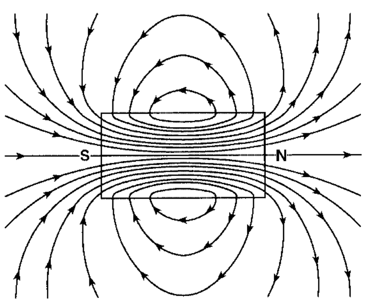
If you place the electromagnet upside down under a large object like a table, you can suspend it there. Be careful though, since it will fall when you release the switch.

You can use this circuit to see which things are made of iron. Other metals like copper or aluminum will not be attracted to the electromagnet.

Project #661 Electromagnetism & Compass



Compass



Magnetic Field

OBJECTIVE: To learn how electricity and magnetism are

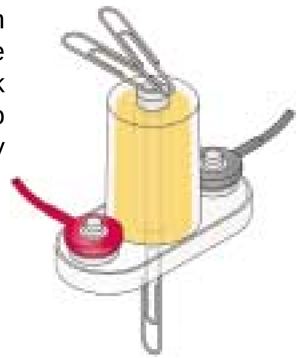
You need a compass for this project (not included). Use the circuit from project #660, with the iron core rod in the electromagnet (M3). You may want to use the slide switch (S1) in place of the press switch (S2), but only turn it on as needed or you will quickly drain your batteries.

Turn on the switch and move the compass around near the edges of the electromagnet, it will point toward ends of the iron core rod. By slowly moving the compass around the electromagnet, you can see the flow of its magnetic field.

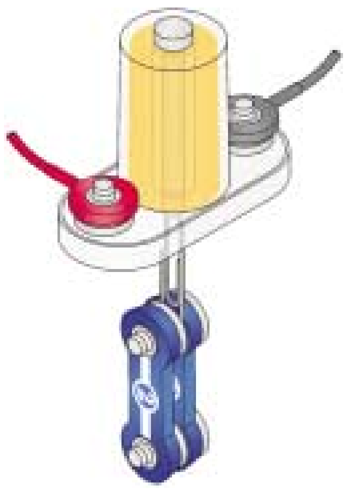
The earth has a similar magnetic field, due to its iron core. A compass points north because it is attracted to this magnetic field. The electromagnet creates its own magnetic field, and attracts the compass in a similar way.

☐ Project #662 Electromagnetism & Paperclips

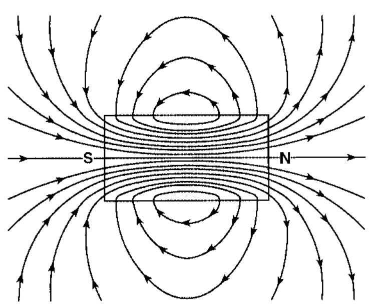
Use the circuit from project #660, with the iron core rod in the electromagnet (M3). Press the switch (S2) and use the electromagnet to pick up some paperclips, they will be attracted to both ends of the iron core rod. See how many paperclips you can lift at once.

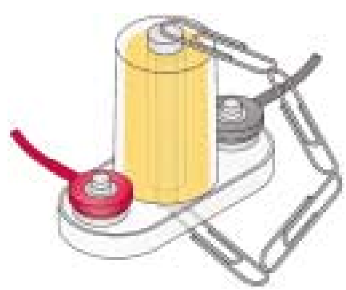


Snap two 2-snaps around a paperclip and lift them with the electromagnet, as shown here on the left.



The magnetic field created by the electromagnet occurs in a loop, and is strongest in the iron core rod in the middle. You can see this loop with some paperclips:

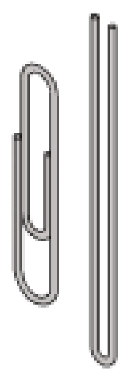




You can also use the paperclip to lift the iron core rod up from the electromagnet.

See what other small objects you can pick up. You can only pick up things made of iron, not just any metal.

☐ Project #663 Electromagnet Suction



An electric current flowing in a coil of wire has a magnetic field, which tries to suck iron objects into its center. You can see this using the circuit from project #660.

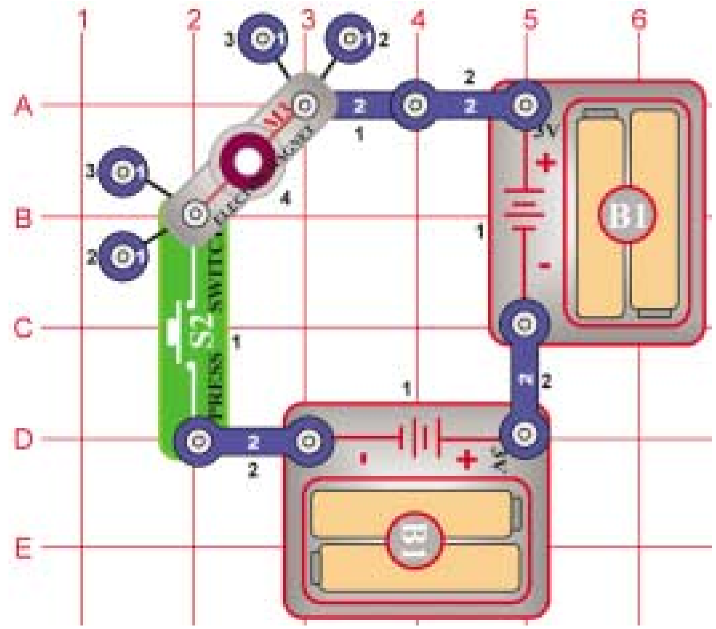
Lay the electromagnet on its side with the iron core rod sticking out about half way, and press the switch. The iron rod gets sucked into the center.

A lighter iron object will show this better. Take a paperclip and straighten it out, then bend it in half.

Place the bent paperclip next to the electromagnet and turn on the switch to see it get sucked in. Gently pull it out to feel how much suction the electromagnet has.

Try sucking up other thin iron objects, like nails.

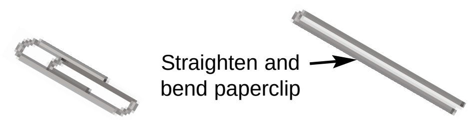
☐ Project #664 — Electromagnet Tower

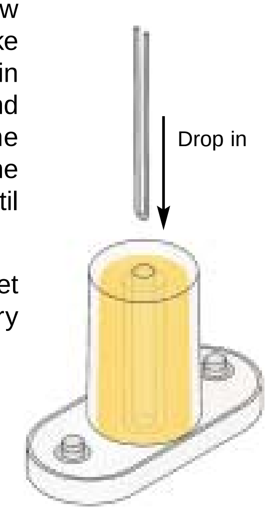


***OBJECTIVE:** To show how electricity can lift things using*

This circuit gives a dramatic demonstration of how the electromagnet can suck up a paperclip. Take a paperclip and straighten it out, then bend it in half. Drop it into the electromagnet center, and then press the switch several times. The paperclip gets sucked into the center of the electromagnet and stays suspended there until you release the switch.

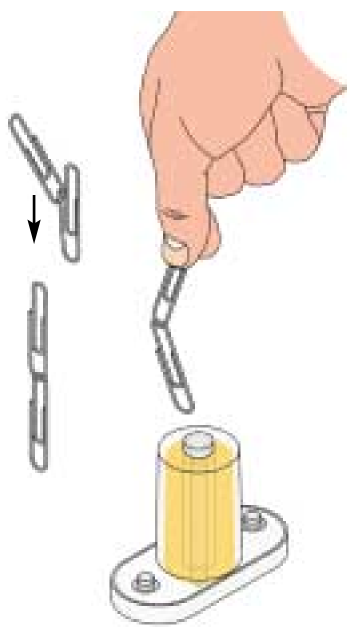
Add two more 1-snaps under the electromagnet to make it higher, and try this again. Then try sucking up other thin iron objects, like nails.





☐ Project #665 — Paperclip Compass

***OBJECTIVE:** To learn how electricity and magnetism are*



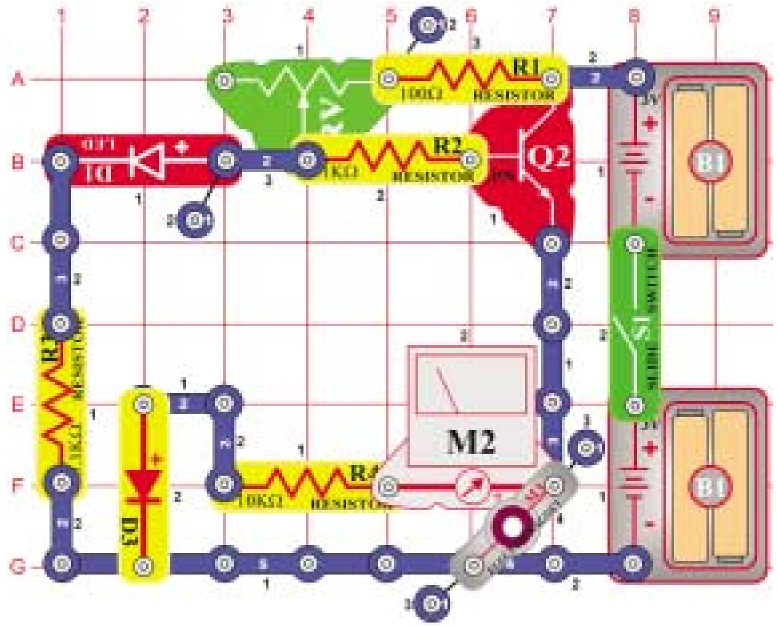
Use the circuit from project #664, but place the iron core rod in the electromagnet. You may want to use the slide switch (S1) in place of the press switch (S2), but only turn it on as needed or you will quickly drain your batteries.

Slide two paperclips together, using their loops.

Turn on the switch and hold the paperclips just above the electromagnet, without them touching the iron core rod. Watch how the lower paperclip is drawn toward the iron core rod, and will point towards it just like a compass.

☐ Project #666

Adjustable Paperclip Suspension



OBJECTIVE: To show how electricity can lift things using

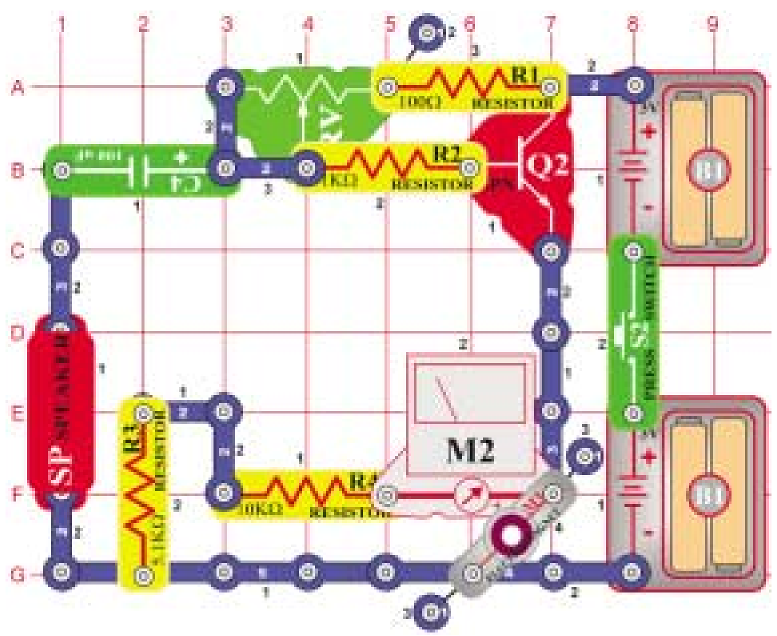
Use the 10MA setting on the meter (M2). Take a paperclip and straighten it out, bend it in half, and drop it into the electromagnet (M3) center. Turn on the switch (S1) and set the variable resistor (RV) control lever all the way to the right. The paperclip gets sucked into the center of the electromagnet and stays suspended there.

Now very slowly move the variable resistor lever to the left, and watch the paperclip and the meter reading. The paperclip slowly gets lower, as the meter shows the current dropping. When the current is at zero, the paperclip is resting on the table.

Add two more 1-snaps under the electromagnet to make it higher, and try this again. Or try using a different iron object in place of the paperclip.

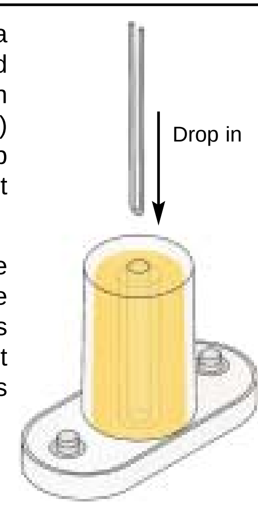
☐ Project #667

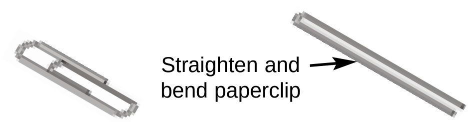
Adjustable Paperclip w/ Delay



Use the 10MA setting on the meter (M2). Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the switch (S2) and set the variable resistor (RV) control lever all the way to the right. The paperclip gets sucked into the center of the electromagnet and stays suspended there.

Now quickly slide the variable resistor lever all the way to the left, and watch the paperclip and the meter reading. The paperclip slowly gets lower, as the meter shows the current dropping. This circuit is similar to project #666, but the capacitor delays the effect of changing the variable resistor setting.

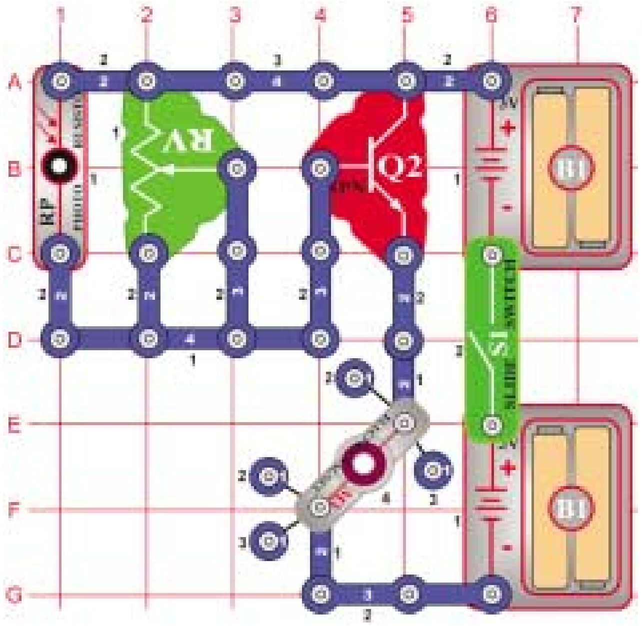


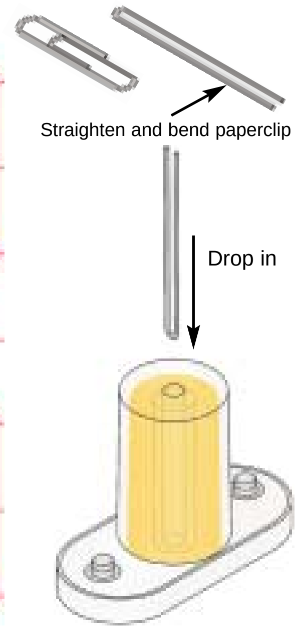


☐ Project #668

Photoresistor Paperclip Suspension

***OBJECTIVE:** To show how electricity can lift things using*





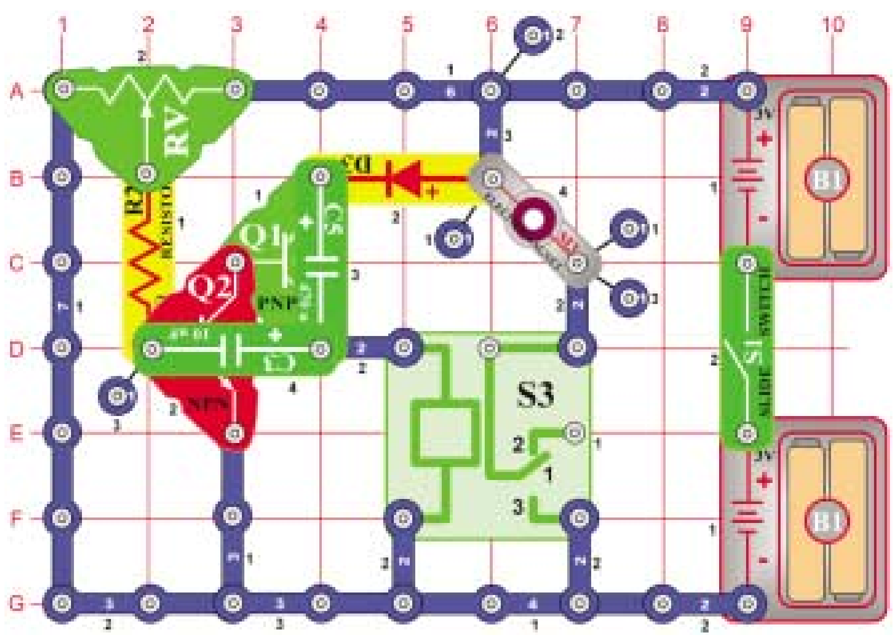
Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the switch (S1), the paperclip gets sucked into the center of the electromagnet and stays suspended there.

Now move the variable resistor (RV) control lever around while waving your hand over the photoresistor (RP). Depending on the variable resistor setting, sometimes covering the photoresistor causes the paperclip to fall and sometimes it doesn't. You can also adjust the light to set the paperclip to different heights.

☐ Project #669

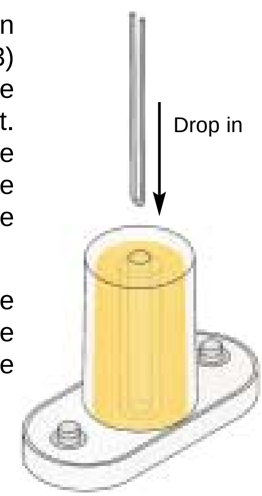
Paperclip Oscillator

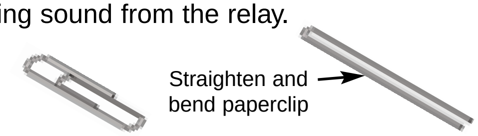
***OBJECTIVE:** To show how electricity can lift things using*



Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the switch (S1), and set the variable resistor (RV) control lever to the right. The paperclip gets sucked into the center of the electromagnet and stays suspended there. Move the variable resistor lever to the left, and the paperclip falls.

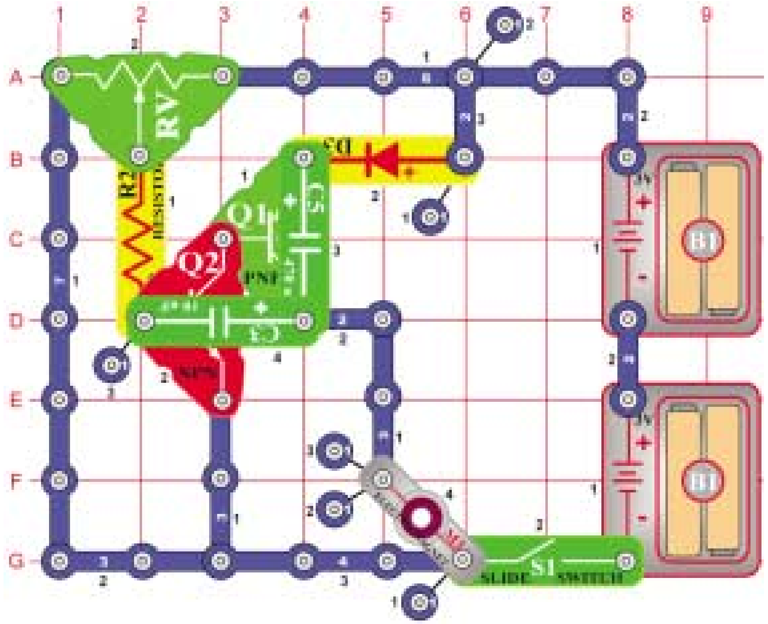
Now for the fun part: Slowly slide the variable resistor lever until you find a spot where the paperclip is bouncing up and down. There will be a clicking sound from the relay.





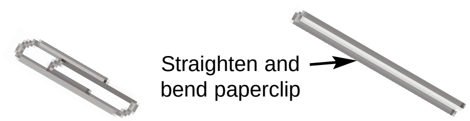
Project #670 — Paperclip Oscillator (II)

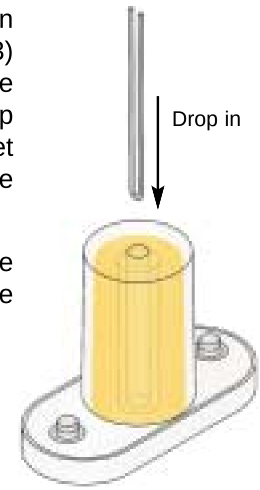
OBJECTIVE: To show how electricity can lift things using



Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the switch, and set the variable resistor control lever to the right. The paperclip gets sucked into the center of the electromagnet and stays suspended there. Move the variable resistor lever to the left, and the paperclip falls.

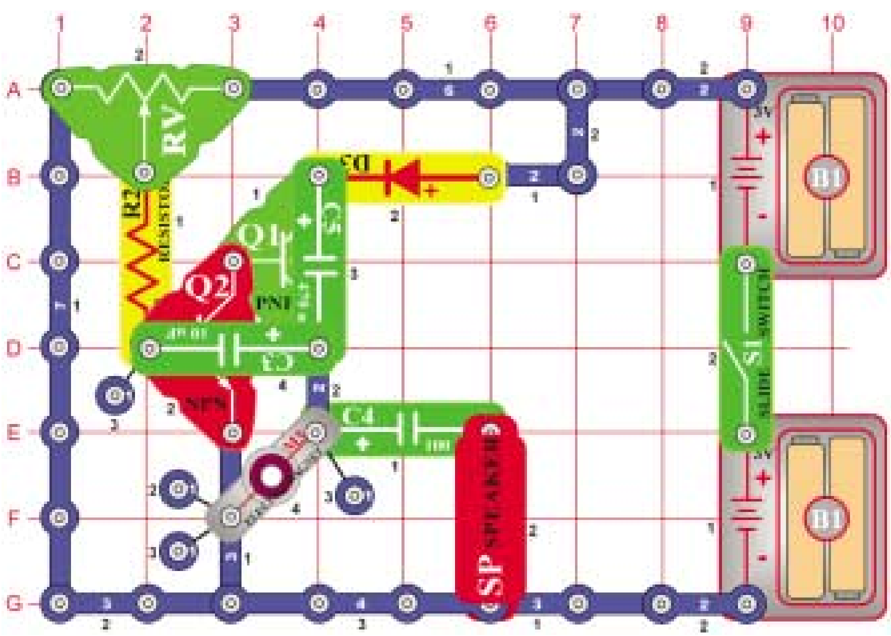
Now for the fun part: Slowly slide the variable resistor lever until you find a spot where the paperclip is bouncing up and down.





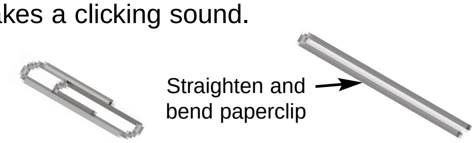
Project #671 — Paperclip Oscillator (III)

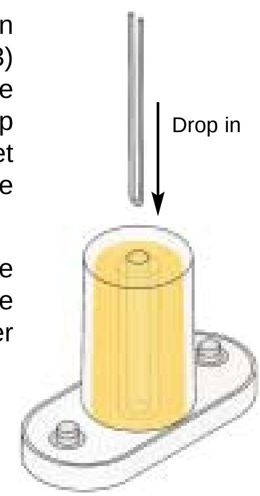
OBJECTIVE: To show how electricity can lift things using



Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the switch, and set the variable resistor control lever to the right. The paperclip gets sucked into the center of the electromagnet and stays suspended there. Move the variable resistor lever to the left, and the paperclip falls.

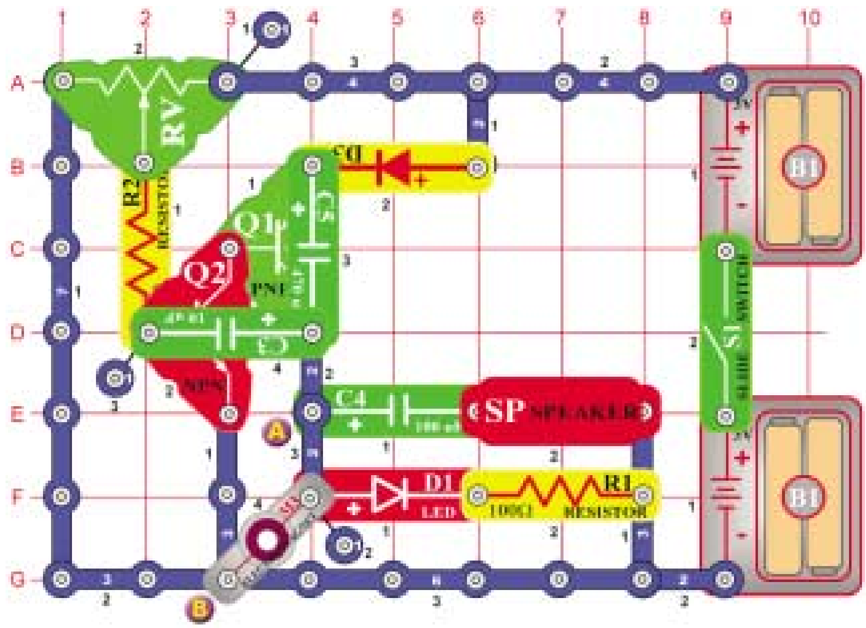
Now for the fun part: Slowly slide the variable resistor lever until you find a spot where the paperclip is bouncing up and down. The speaker makes a clicking sound.





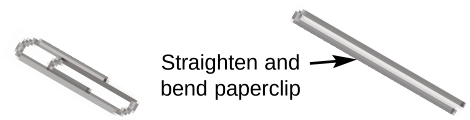
☐ Project #672 Paperclip Oscillator (IV)

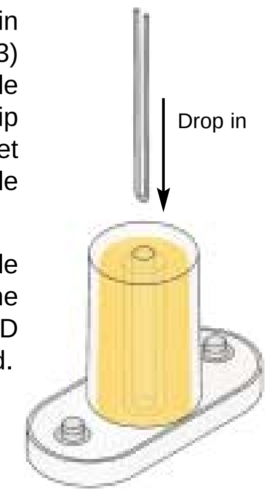
***OBJECTIVE:** To show how electricity can lift things using*



Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the switch, and set the variable resistor control lever to the right. The paperclip gets sucked into the center of the electromagnet and stays suspended there. Move the variable resistor lever to the left, and the paperclip falls.

Now for the fun part: slowly slide the variable resistor lever until you find a spot where the paperclip is bouncing up and down. The LED flashes and the speaker makes a clicking sound.





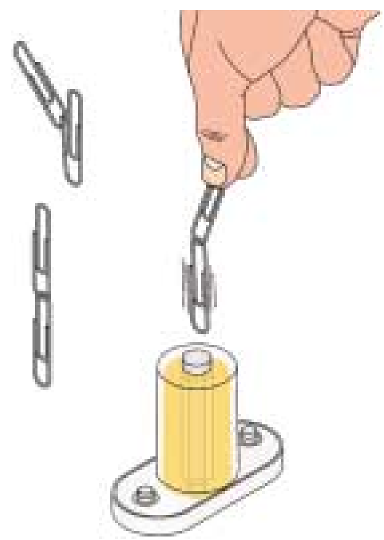
☐ Project #673 Strobe Light

***OBJECTIVE:** To show how electricity can*

Use the circuit from project #672, but replace the 100µF capacitor with a 3-snap wire and replace the speaker with the 2.5V lamp (L1). The circuit works the same way, but the lamp flashes like a strobe light.

☐ Project #674 Oscillating Compass

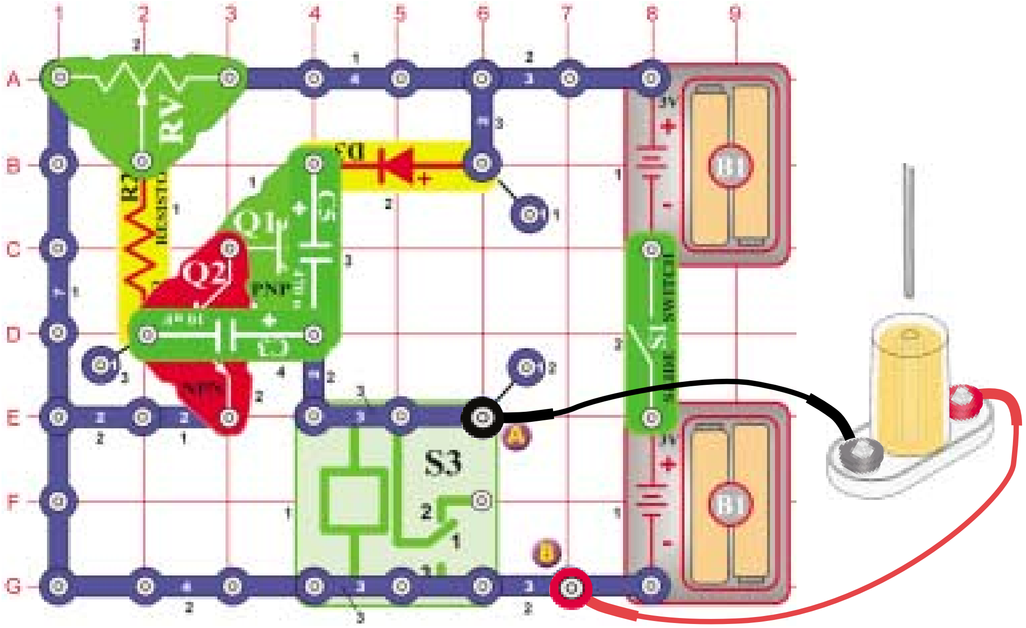
***OBJECTIVE:** To learn how electricity and*



Use the circuit from project #672, but replace the 100µF capacitor (C4) with a 3-snap wire and replace the speaker (SP) with the 2.5V lamp (L1). Place the iron core rod in the electromagnet and don't use the bent paperclip. Slide two paperclips together, using their loops.

Turn on the switch and hold the paperclips just above the electromagnet, without them touching the iron core rod. Watch how the lower paperclip is drawn toward the iron core rod. Notice that the lower paperclip is vibrating, due to the changing magnetic field from this oscillator circuit. Compare this circuit to project #665 (Paperclip Compass).

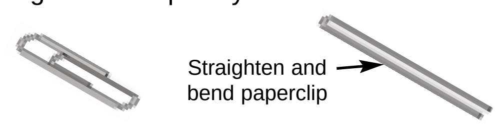
Project #675 High Frequency Vibrator



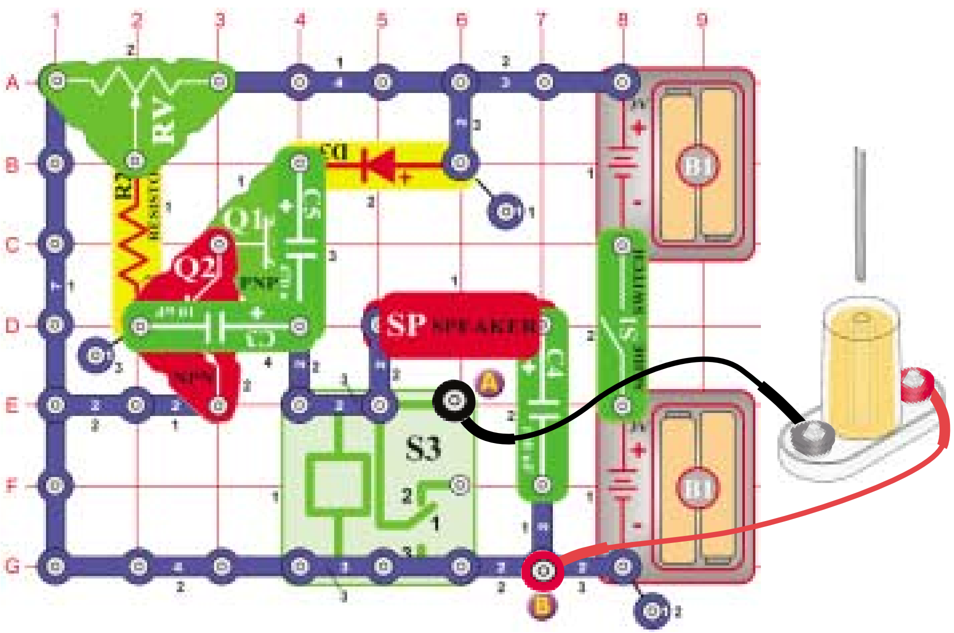
Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Connect the electromagnet to points A and B with the jumper wires and hold it about 1 inch above the table. Slide the variable resistor (RV) control lever around slowly, you will hear a clicking sound from the relay.

Adjust the electromagnet height and resistor control lever until the paperclip vibrates up and down on the table. It will vibrate at a fast rate but will not move very high. Usually this works best with the electromagnet about one inch above the table and the resistor control about mid-way to the right side, but your results may vary. See how high you can make the paperclip bounce.

Adjust the electromagnet height and resistor control lever to change the height and frequency of the vibration.



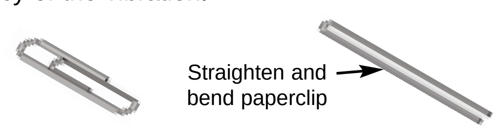
Project #676 High Frequency Vibrator (II)



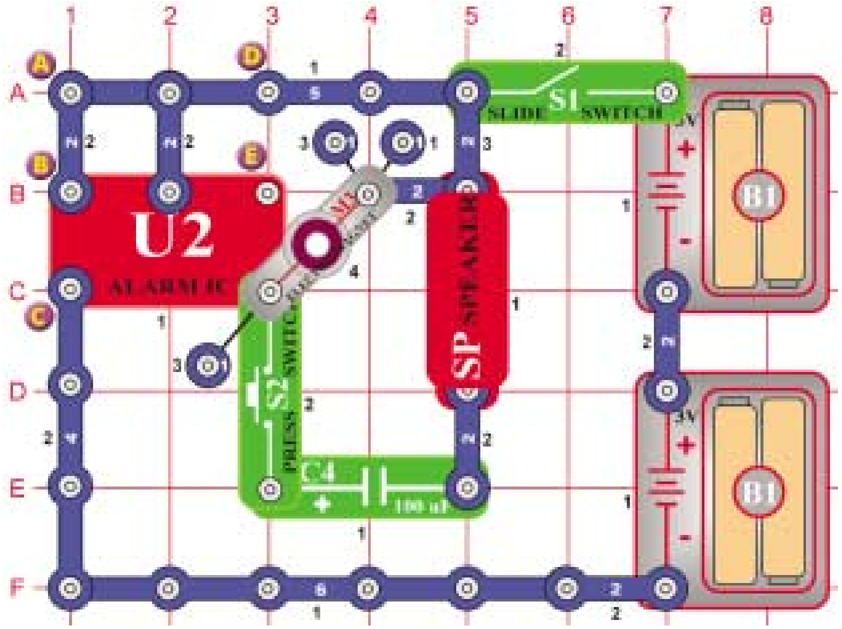
Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Connect the electromagnet to points A and B with the jumper wires and hold it about 1 inch above the table. Slide the variable resistor (RV) control lever around slowly, you will hear a clicking sound from the relay and speaker.

Adjust the electromagnet height and resistor control lever until the paperclip vibrates up and down on the table. It will vibrate at a fast rate but will not move very high. Usually this works best with the electromagnet about one inch above the table and the resistor control about mid-way to the right side, but your results may vary. See how high you can make the paperclip bounce.

Adjust the electromagnet height and resistor control lever to change the height and frequency of the vibration.



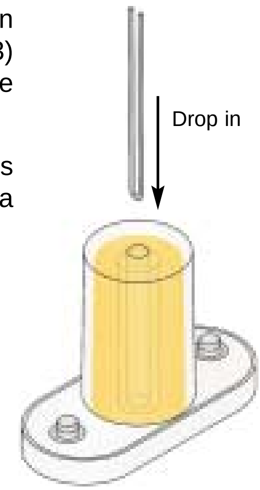
Project #677 Siren Paperclip Vibrator

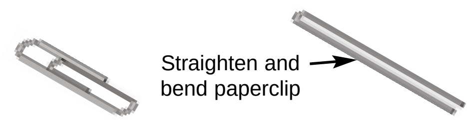


OBJECTIVE: To show how electricity can move things using

Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the slide switch (S1), and the paperclip should vibrate.

Now push the press switch (S2), the paperclip is suspended in the air by the electromagnet and a siren alarm sounds.





Project #678 Alarm Paperclip Vibrator

OBJECTIVE: To show how electricity can move things using

Use the circuit from project #677, remove the connection between points A and B and make a connection between points B and C. The sound and vibration are different now. Compare the vibration height and frequency to project #677.

Project #679 Machine Gun Paperclip Vibrator

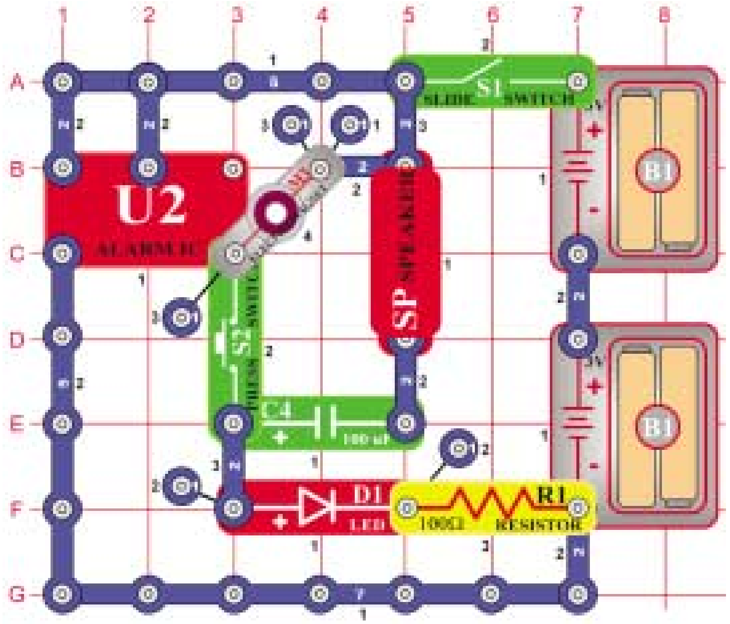
OBJECTIVE: To show how electricity can move things using

Now remove the connection between points B and C and make a connection between points D and E. The sound and vibration are different now. Compare the vibration height and frequency to projects #677 and #678.

Project #680

Alarm Vibrator w/ LED

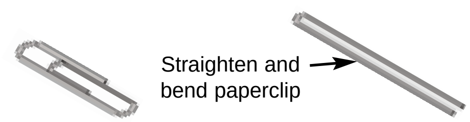
OBJECTIVE: To show how electricity can move things using

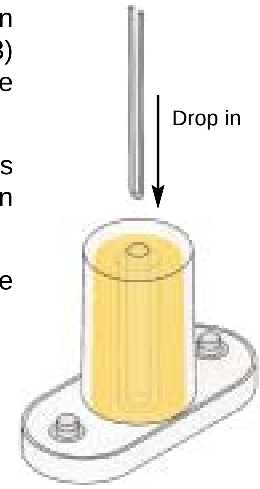


Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the slide switch (S1), and the paperclip should vibrate and LED (D1) flashes.

Now push the press switch (S2), the paperclip is sucked up by the electromagnet and a siren alarm sounds.

You can replace the speaker (SP) with the whistle chip (WC) to change the sound.

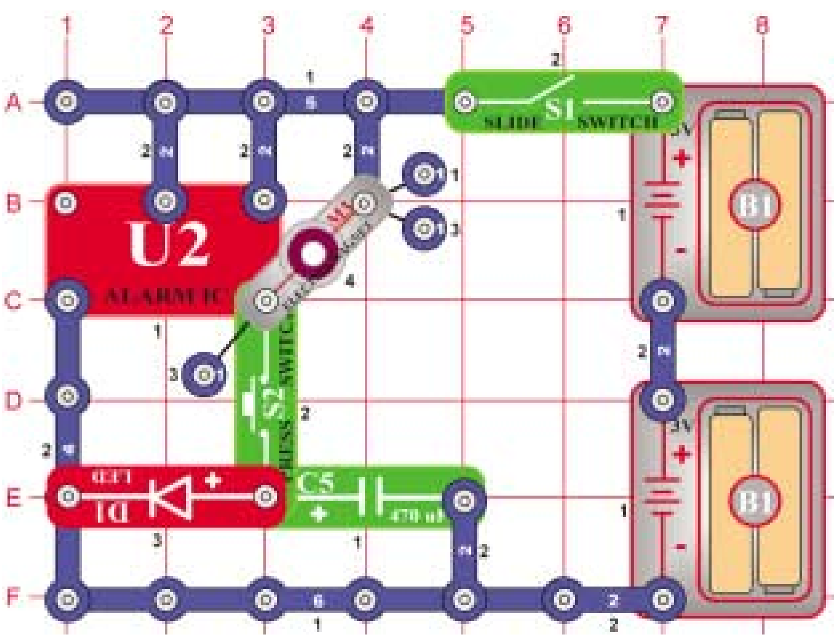




Project #681

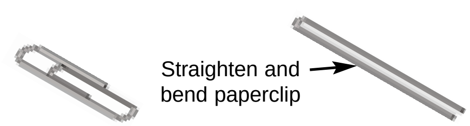
Alarm Vibrator w/ LED (II)

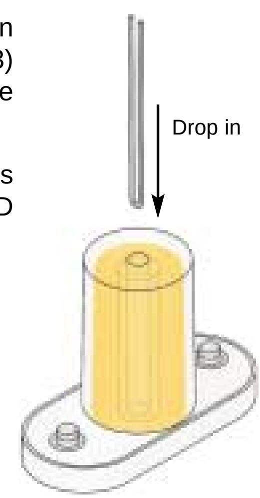
OBJECTIVE: To show how electricity can move things using



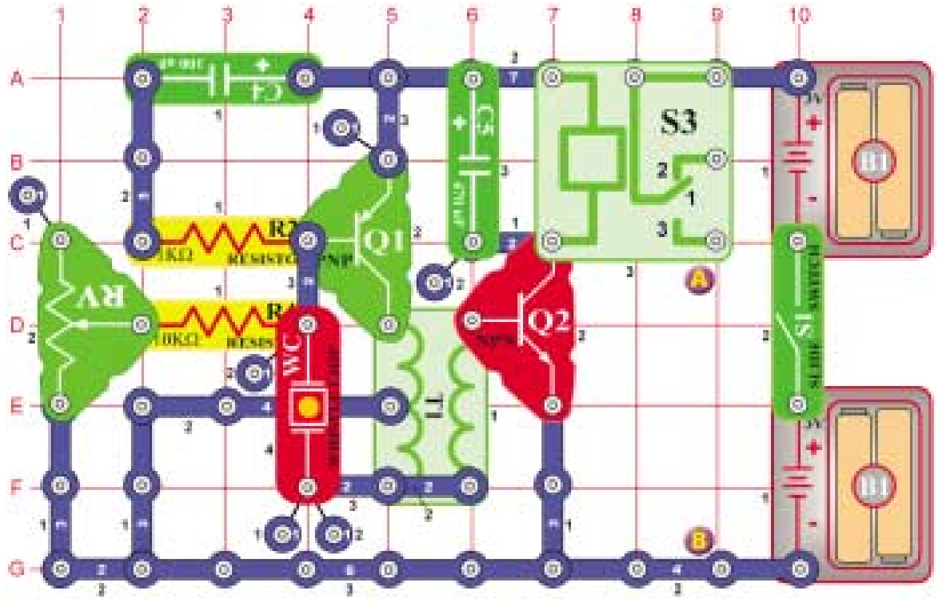
Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the slide switch (S1), and the paperclip should vibrate.

Now push the press switch (S2), the paperclip is sucked up by the electromagnet and the LED (D1) flashes.





Project #682 Relay-Whistle Vibrator

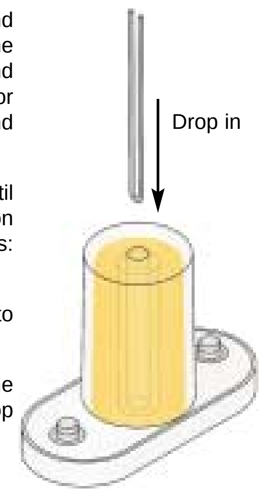


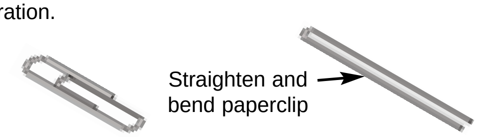
Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Connect the electromagnet to points A and B with the jumper wires and hold it about 1 inch above the table. Slide the variable resistor (RV) control lever around slowly, you will hear a clicking sound from the relay (S3) and buzzing from the whistle chip (WC).

Adjust the electromagnet height and resistor control lever until the paperclip vibrates up and down on the table. The vibration pattern may seem complex because it is due to two sources: the whistle chip and the relay.

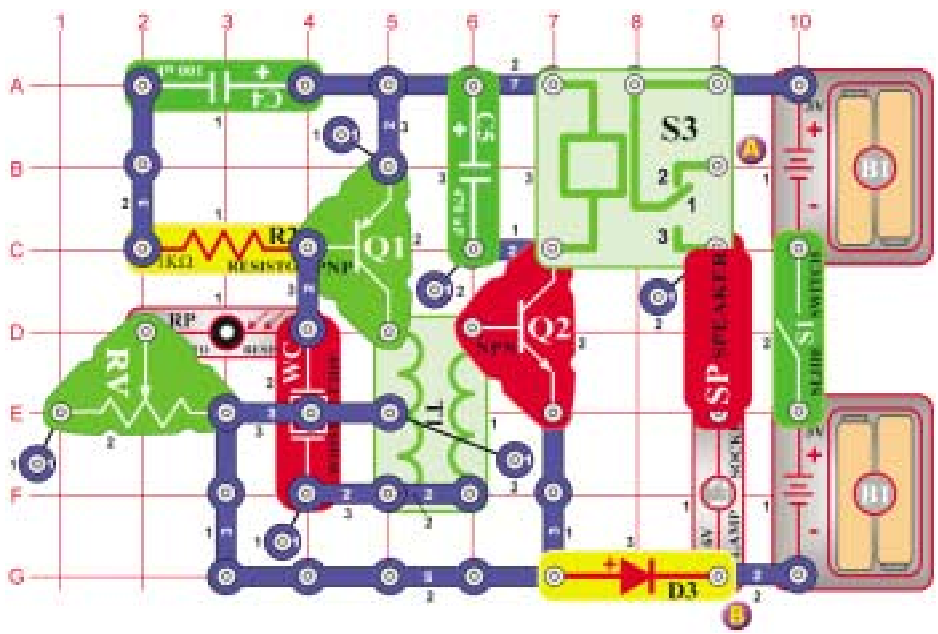
Adjust the electromagnet height and resistor control lever to change the height and frequency of the vibration.

You can also replace the 10KΩ resistor (R4) with the photoresistor (RP). Waving your hand over it will start or stop the vibration.





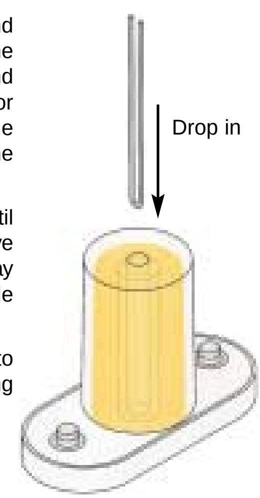
Project #683 Relay-Whistle Photo Vibrator

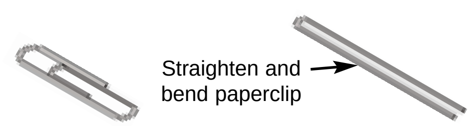


Take a paperclip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Connect the electromagnet to points A and B with the jumper wires and hold it about 1 inch above the table. Slide the variable resistor (RV) control lever around slowly without covering the photoresistor (RP), you will hear a clicking sound from the relay (S3) and buzzing from the whistle chip (WC).

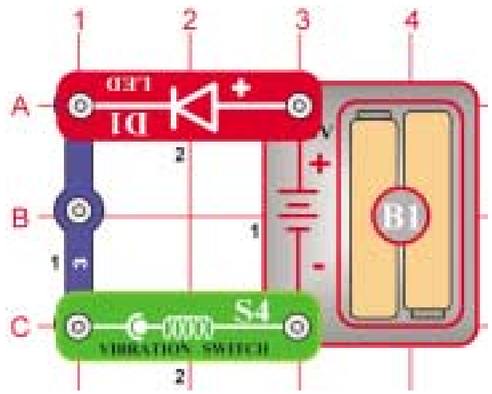
Adjust the electromagnet height and resistor control lever until the paperclip vibrates up and down on the table. Then wave your hand over the photoresistor. The vibration pattern may seem complex because it is due to three sources: the whistle chip, the relay, and the photoresistor.

Adjust the electromagnet height and resistor control lever to change the height and frequency of the vibration. Covering the photoresistor stops the vibration.





Project #684 Vibration LED



The vibration switch contains two separate contacts; a spring is connected to one of the contacts. A vibration causes the spring to move briefly shorting the two contacts. This simple circuit demonstrates how the vibration switch works. Build the circuit and the LED does not light. Tap the vibration switch or table and the LED lights for every tap. It acts like a temporary switch connecting the battery to the LED.

Although there is no resistor to limit the current through the LED, the LED is not damaged because the vibration switch only allows a temporary current to it.

Project #685 Vibration Speaker

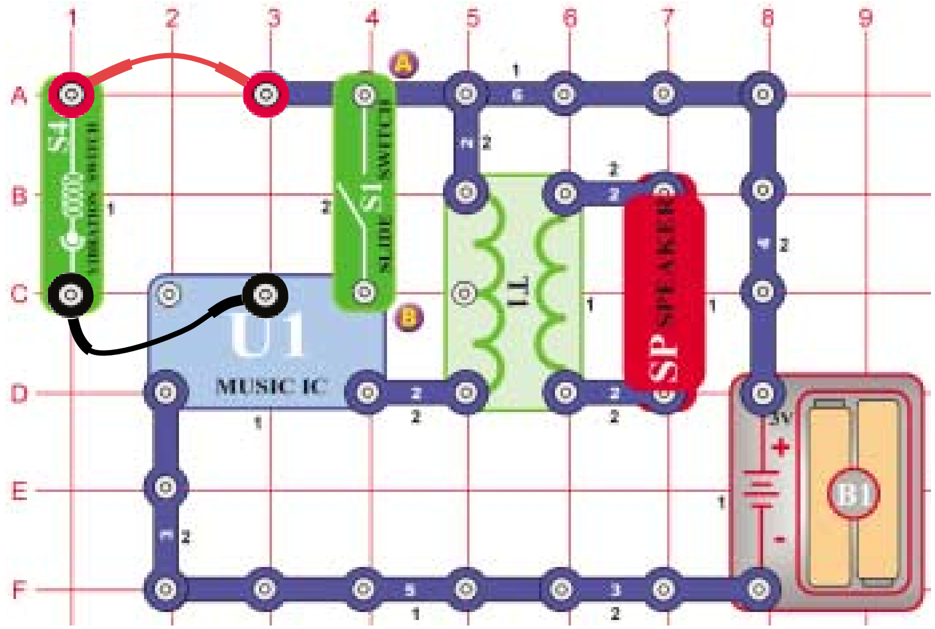
Modify project #684 by replacing the LED with speaker. Now when you tap on the switch, the speaker sounds.

Project #686 Measure the Vibration as You Tap the Switch

Replace the speaker with the meter. Use the 10MA setting on the meter. Tap the vibration switch and the meter deflects to the right. Tap harder on the switch; the switch closes longer and the meter deflect more to the right.

☐ Project #687 Shaky Birthday Song

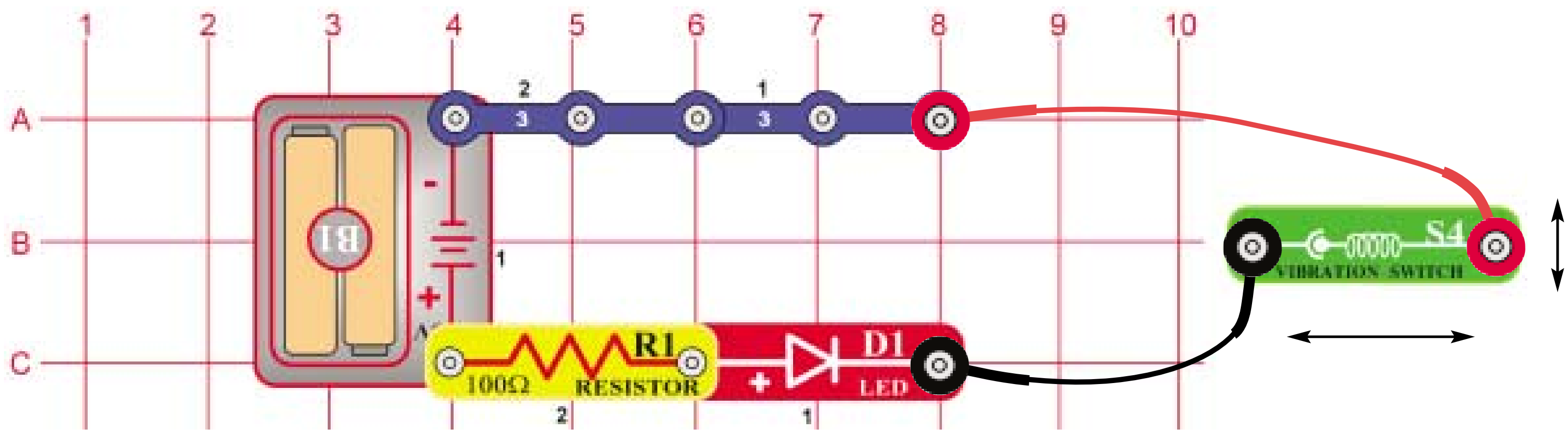
OBJECTIVE: To turn the music IC on and off using the



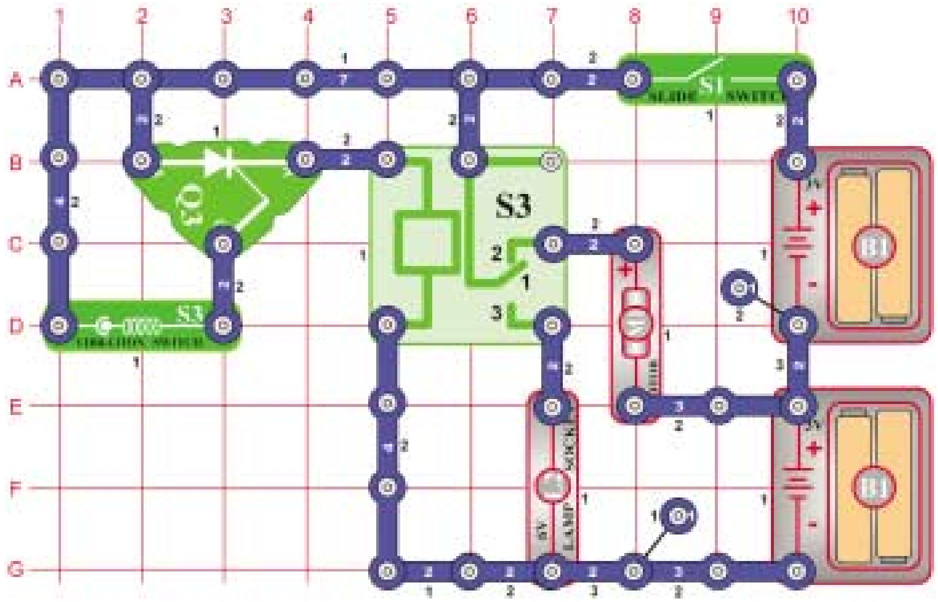
Connect the vibration switch to the circuit using the red and black jumpers. Hold the vibration switch steady in your hand and the music should not play. Now move your hand, the music should briefly play. If you continuously shake the switch, the music keeps playing. Turn switch S1 on and the music plays. Change the sound by shaking the vibration switch.

☐ Project #688 Vibration Direction

Connect the vibration switch to the circuit using the black and red jumper wires. Place the switch horizontally on the table. Rapidly move the switch from left to right and notice that the LED does not light. There is not enough force to expand the internal spring to close the switch. Now move the switch up and down and see that the LED easily lights. It requires less force to move the spring back and force.



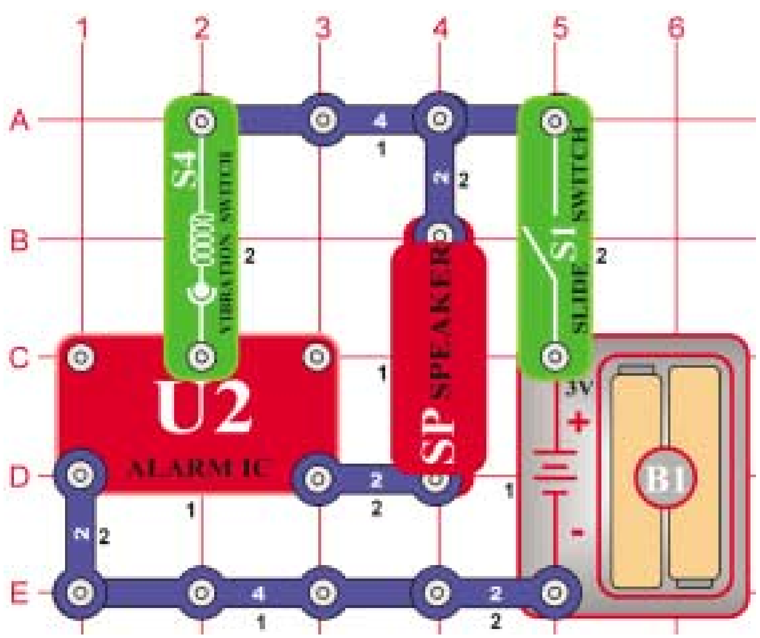
☐ Project #689 Out of Balance



The vibration switch triggers the SCR connecting the relay's coil to the battery. The relay's contacts switch, turning the motor off, and lighting the bulb. The bulb will stay lit until switch S1 is turned off.

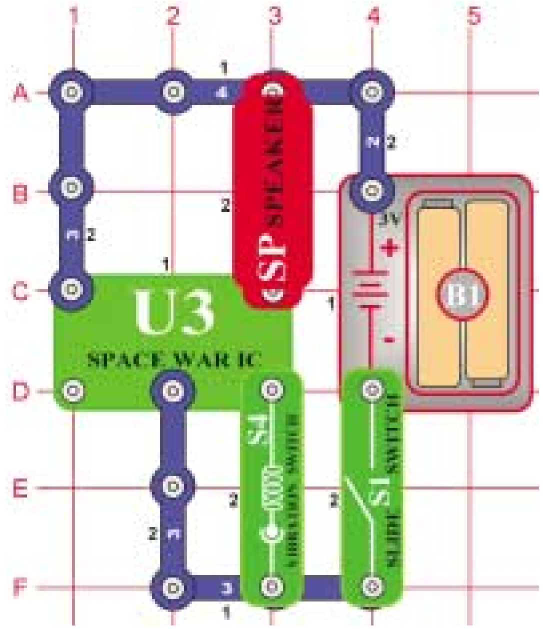
Turn switch S1 on and the motor starts to spin. If the motor generates enough vibration, the switch (S3) will trigger the SCR turning off the motor and lighting the bulb. If the motor keeps spinning, tap on the table to trigger the vibration switch.

☐ Project #690 Vibration Alarm



Turn on the slide switch (S1) and shake the circuit or bang on the table, an alarm will sound. Try banging on the table in a regular pattern, and see if you can make the alarm sound continuously.

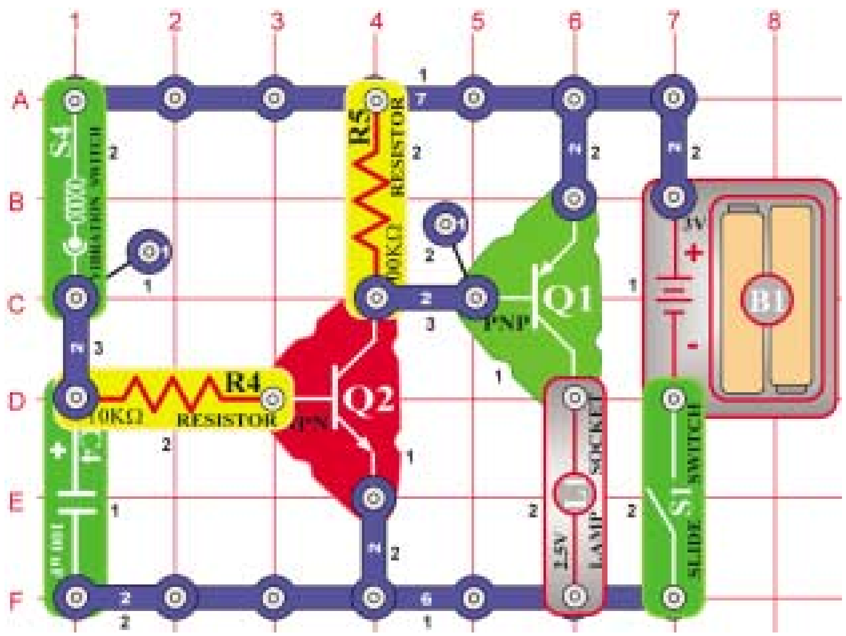
☐ Project #691 — Vibration Space War



Turn on the slide switch (S1) and shake the circuit or bang on the table, you will hear different sounds. Try banging on the table in a regular pattern, and see if you can make the sounds continuous.

When the vibration switch (S4) is shaken, the circuit plays out one of eight sounds.

☐ Project #692 — Vibration Light



Turn on the slide switch (S1) and shake the base grid or bang on the table. The lamp turns on when there is vibration, and stays on for a few seconds.

OTHER FUN ELENCO™ PRODUCTS!

For a listing of local toy retailers who carry our products, visit our website: www.elenco.com or call us toll-free at 1-800-533-2441.

Radio-Controlled Race Car

Model AK-870

The purpose of this project is to expand your understanding of basic transmitters, receivers and electronic switching theories. Your Turbo King Car will be built from the ground up. You'll learn all about gears, motors, printed circuit boards, and integrated circuits from our detailed assembly and training manual. You will construct each section, explore the circuitry and troubleshoot it.
Requires 1 9V and 4 "AA" batteries.

Deluxe Telephone Kit

Model AK-750

- Fully Modular
- Last Number Redial
- Desk/Wall Mount
- Tone/Pulse Switchable
- Ringer with ON/OFF Switch
- Neon Lights Flash when Phone Rings
- Hearing Aid Compatible
- Full-color Assembly Manual
- Lighted Dial Keypad
- Transparent Blue Case
- FCC Approved

35mm Camera Kit with Flash Kit

Model FUN-555

Now you can learn all about photography with our new Camera Kit. Our training manual will teach you everything you need to know about light, film, speed, exposure, development, and much more. And best of all, you will have a working camera "you built" when you are finished.

Talking Clock Kit

Model AK-220

This easy-to-build kit will teach you how electronic voices are made. No soldering is required and our full color assembly manual takes you step-by-step in putting it together. Features hourly reports and rooster crow for alarm. Requires 2 "AA" batteries.

Solar Deluxe Educational Kit

Model SK-40

By solar power, harness the power of the sun with this environment-friendly D.I.Y. kit!

You can do a series of do-it-yourself experiments to acquire the basic knowledge of solar energy.

You can learn how to make an electrical circuit, make a solar circuit, how to increase voltage and current, and how to use solar power to produce energy for a radio, calculator, battery charger, a cassette player and more!

Cola Clock Kit

Model FUN-285

Cola not only quenches your thirst, but can power a clock too! Build this kit and amaze your family and friends with this cola-powered clock.

Learn how batteries work when you use cola to make a chemical reaction that powers a clock. Completely safe and doesn't require batteries! Parts are easily identified and assembled with full color manual.

No batteries required!

OTHER FUN ELENCO™ PRODUCTS!

Robot Kits

Soldering Required

Line Tracking Mouse Kit
Model 21-880

How Magical! A smart Robot Mouse tracks a black line using a photo interrupter for its eyes.

How Funny! Create a twisting and turning road layout yourself with black tape on a white background. See how it tracks the black line to find the target. Soldering required.

Features
- Sound activated.
- Uses three photo interrupters to detect a black line.
- Two sets of gear motors (unassembled).
- Programmed IC.

Requires four (4) "AA" batteries (part # 590001).

Sound Reversing Car Kit
Model 21-881

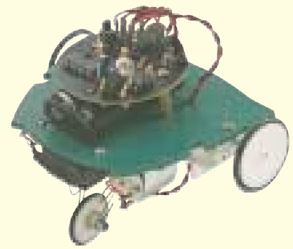
A Robot Car with a sensor to detect noise (like a clap) or physical contact for its reaction. It moves forward when it detects noise and reverses when it touches obstacles.
Soldering required.

Features
- Uses a microphone as a sound sensor.

Requires two (2) "AA" batteries (part # 590001).

Turning Frog Kit
Model 21-882

This is an interesting robot kit. When it detects sounds, it will move and repeat the following steps sequentially: Start (move forward), Stop, Left Turn, Stop, Right Turn, Stop.
Soldering required.



Features
- Two sets of gear motors (unassembled).

Requires one (1) 9V (part # 590009) and two (2) "AA" batteries (part # 590001).

Hexapod Monster Kit
Model 21-883

The Hexapod Monster is a robot that uses an infrared emitting diode for its eyes, and moves by its six legs. It turns left when it detects obstacles, and keeps moving forward if there is no shade in front of the sensor. Soldering required.

Features
- Uses an infrared emitting diode as its sensor.
- Two sets of gear motors (unassembled).

Requires one (1) 9V (part # 590009) and two (2) "AA" batteries (part # 590001).

2-in-1 Gearbox (unassembled)
Model 21-130

We provide the motor, two sets of gears, metal shafts, gearbox, and other accessories in this kit. Use a different gear setting and you will have a different speed (see the table for details).

Gear Set 1:

Gear Ratio	Gear	Teeth	I.D.
1:60	Pinion Gear	10T	1.9mm
	Face Gear	36T/14T	2.05mm
	Double Spur Gear	36T/14T	3.05mm
	Double Spur Gear	36T/14T	2.05mm
	Spur Gear	36T/0T	2.9mm
Reduction RPM	41.6		

Gear Set 2:

Gear Ratio	Gear	Teeth	I.D.
1:288	Pinion Gear	8T	1.9mm
	Face Gear	36T/10T	2.05mm
	Double Spur Gear	40T/10T	3.05mm
	Double Spur Gear	40T/10T	2.05mm
	Spur Gear	40T/0T	2.9mm
Reduction RPM	41.6		

iBOTZ Non-soldering

iBOTZ Soundtracker Kit
Model MR-1001 (Sound Sensor)

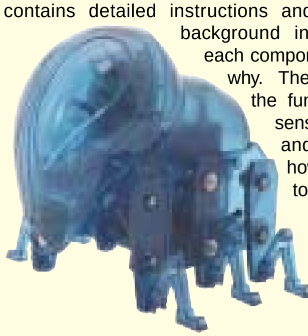
The Soundtracker will react to sound impulses and objects in its way. It will reverse away from a sound or obstruction, then move forward. Kit contains detailed instructions and educational background information on each component used and why. The kit will teach the fundamentals of sensor technology and show you how it all goes together.
No soldering required.

Movement: Three (3) wheels driven by a DC motor.
Control: Sound sensor including condenser microphone.
Dimensions: 3 3/4" (H) x 5 1/2" (W) x 4 15/16" (L)

Requires two (2) "AA" batteries (part # 590001).

iBOTZ Antoid Kit
Model MR-1002 (Infrared Sensor)

The Antoid will react to obstacles in its way by means of its electronic "eye". To build this educational robot requires only basic hand tools. Kit contains detailed instructions and educational background information on each component used and why. The kit will teach the fundamentals of sensor technology and show you how it all goes together.
No soldering required.



Movement: Six (6) legs driven by two (2) DC motors.
Control: Infrared sensor.
Dimensions: 6 1/8" (H) x 7 1/16" (W) x 5 29/32" (L)

Requires one (1) 9V (part # 590009) and two (2) "AA" batteries (part # 590001).

iBOTZ Hydrazoid Kit
Model MR-1004 (Sound Sensor)

Hydrazoid is a cool alien creature that is fun to build. Hydrazoid moves in a spellbinding way in response to sound. To build this educational robot requires only basic hand tools. Kit contains detailed instructions and educational background information on each component used and why. The kit will teach the fundamentals of sensor technology and show you how it all goes together.
No soldering required.

Movement: Four (4) legs driven by a DC motor.
Control: Sound sensor including condenser microphone.
Dimensions: 2 3/4" (H) x 1 3/4" (W) x 2 5/32" (L)

Requires two (2) "AA" batteries (part # 590001).

iBOTZ TriBotz Kit
(Infrared, Sound & Touch Sensors) Model MR-1005

TriBotz is three robots in one package. It uses sensors to avoid objects, follow a line and respond to sound. The TriBotz will react to sound impulses and objects in its way. It will reverse away from a sound or obstruction, then move forward. Make a path with a black felt tip marker or black tape and watch how infrared sensors allow the TriBotz to make corrections.
No soldering required.

Movement: Two (2) wheels driven by two (2) DC motors.
Control: Sound sensor including condenser microphone, infrared light sources and light detectors.
Dimensions: 3 15/16" (H) x 5 7/8" (W) x 5 1/2" (L)

Requires two (2) "AA" batteries (part # 590001).

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