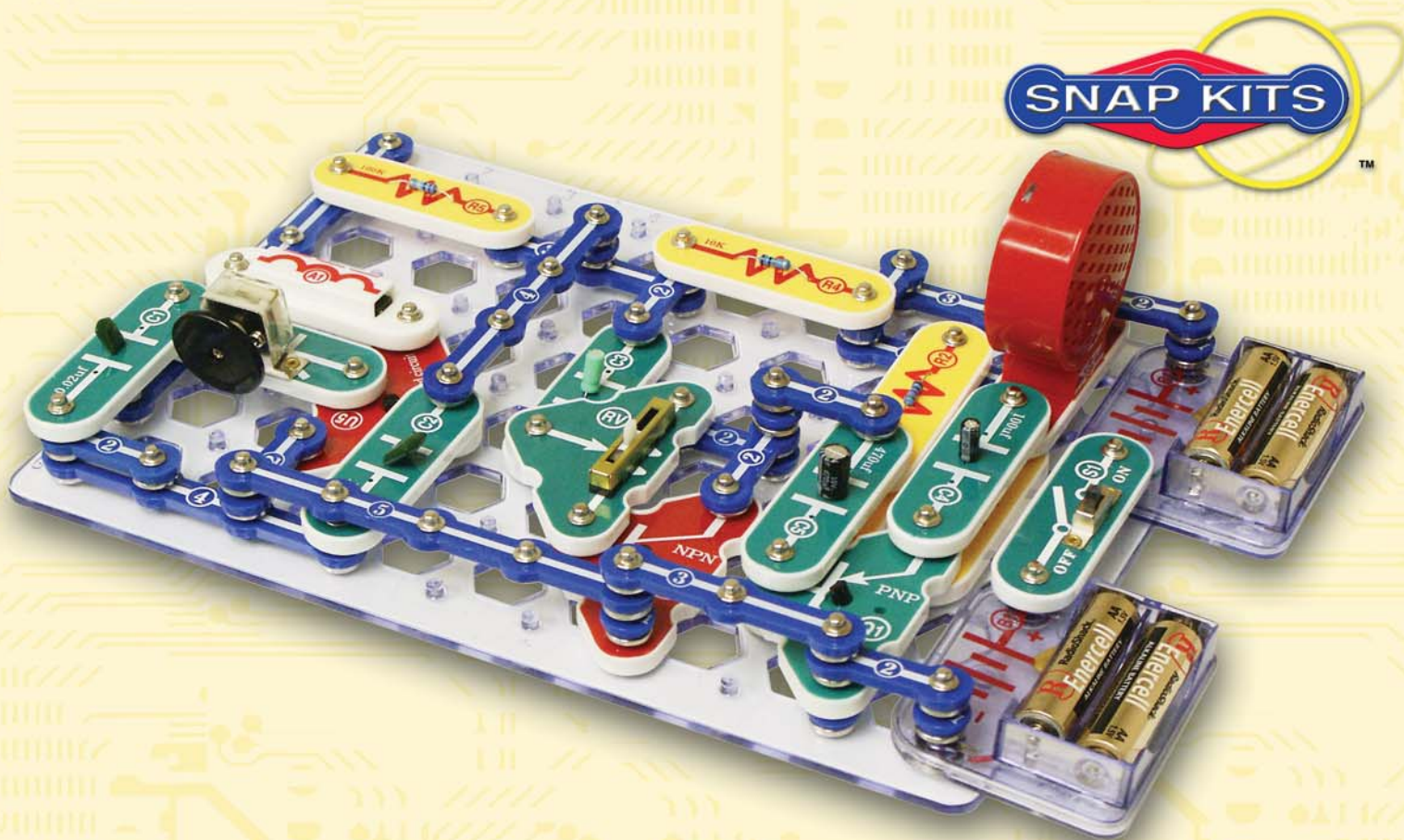


ELECTRONIC SNAP KITS™

Electronics 202



Instruction Manual

Table of Contents

Basic Troubleshooting	1	About the TWO-SPRING SOCKET (?1)	10
How to Use It	2	About the THREE-SPRING SOCKET (?Q)	11
Parts List	3, 4	Project Listings	12 - 14
About Your Snap Kits™ Parts	5, 6	Projects 1 - 303	15 - 126
Advanced Troubleshooting	7, 8	Snap Kits™ Experiment Shapes	128
DO's and DON'Ts of Building Circuits	9	Other Radio Shack Projects	130

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

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

Basic Troubleshooting

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

Radio Shack is not responsible for parts damaged due to incorrect wiring.

Note: If you suspect you have damaged parts, you can follow the Advanced Troubleshooting procedure on page 7 to determine which ones need replacing.

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

Batteries:

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

How To Use It

The Radio Shack Snap Kits™ has 303 projects. They are simple to build and understand.

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

For Example:

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



This is a wire block which is blue and comes in different wire lengths.

They have the number (2), (3), (4), (5), (6), or (7) on them 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 needs two (2) "AA" batteries (not included with Snap Kits™).

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

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

The 6V bulb comes packaged separate from its socket. Install the bulb in the lamp socket (L2) whenever that part is used.




















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

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

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

Note: If you have model RS-303, then there are additional part lists in your other project manuals.




















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

Qty.	ID	Name	Symbol	Part #	Qty.	ID	Name	Symbol	Part #
□ 1		Base Grid (11.0" x 7.7")		6SCBG	□ 1	(S1)	Slide Switch		6SCS1
□ 6	(1)	1-Snap Wire		6SC01	□ 1	(S2)	Press Switch		6SCS2
□ 9	(2)	2-Snap Wire		6SC02	□ 2	(B1)	Battery Holder - uses two 1.5V type AA (not included)		6SCB1
□ 4	(3)	3-Snap Wire		6SC03	□ 1	(SP)	Speaker		6SCSP
□ 2	(4)	4-Snap Wire		6SC04	□ 1	(U1)	Music Integrated Circuit		6SCU1
□ 1	(5)	5-Snap Wire		6SC05	□ 1	(U2)	Alarm Integrated Circuit		6SCU2
□ 1	(6)	6-Snap Wire		6SC06	□ 1	(U3)	Space War Integrated Circuit		6SCU3
□ 1	(7)	7-Snap Wire		6SC07	□ 1 □ 1	(L2)	6V Lamp Socket 6V Bulb (6.2V, 0.3A) (R. S. p/n 272-1130)		6SCL2 6SCL2B
□ 1	(RP)	Photoresistor		6SCRP	□ 1	(A1)	Antenna Coil		6SCA1
□ 1 □ 1	(M3)	Electromagnet Iron Core Rod		6SCM3 6SCM3B	□ 2	(?1)	Two-spring Socket		6SC?1

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

Note: If you have model RS-303, then there are additional part lists in your other project manuals.

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

Qty.	ID	Name	Symbol	Part #	Qty.	ID	Name	Symbol	Part #
<input type="checkbox"/> 1 <input type="checkbox"/> 1	(M1)	Motor Fan		6SCM1 6SCM1F	<input type="checkbox"/> 1	(RV)	Adjustable Resistor		6SCRV
<input type="checkbox"/> 1	(D1)	Red Light Emitting Diode (LED)		6SCD1	<input type="checkbox"/> 1	(R1)	100Ω Resistor		6SCR1
<input type="checkbox"/> 1	(D2)	Green Light Emitting Diode (LED)		6SCD2	<input type="checkbox"/> 1	(R2)	1KΩ Resistor		6SCR2
<input type="checkbox"/> 1	(C1)	0.02μF Capacitor		6SCC1	<input type="checkbox"/> 1	(R3)	5.1kΩ Resistor		6SCR3
<input type="checkbox"/> 1	(C2)	0.1μF Capacitor		6SCC2	<input type="checkbox"/> 1	(R4)	10kΩ Resistor		6SCR4
<input type="checkbox"/> 1	(C3)	10μF Capacitor		6SCC3	<input type="checkbox"/> 1	(R5)	100kΩ Resistor		6SCR5
<input type="checkbox"/> 1	(C4)	100μF Capacitor		6SCC4	<input type="checkbox"/> 1	(U5)	High Frequency Integrated Circuit		6SCU5
<input type="checkbox"/> 1	(C5)	470μF Capacitor		6SCC5	<input type="checkbox"/> 1	(Q1)	PNP Transistor		6SCQ1
<input type="checkbox"/> 1	(CV)	Variable Capacitor		6SCCV	<input type="checkbox"/> 1	(Q2)	NPN Transistor		6SCQ2
<input type="checkbox"/> 1	(?Q)	Three-spring Socket		6SC?Q					

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

Note: If you have Model RS-303, there is additional information in your other project manual.

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

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

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

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

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

Resistors “resist” the flow of electricity and are used to control or limit the electricity in a circuit. Snap Kits™ includes **100Ω (R1), 1KΩ (R2), 5.1KΩ (R3), 10KΩ (R4), and 100KΩ (R5) resistors** (“K” symbolizes 1,000, so R2 is really 1,000Ω). Increasing circuit resistance reduces the flow of electricity.

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

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

A light bulb, such as in the **6V lamp (L2)**, contains a special wire that glows bright when a large electric current passes through it. Voltages above the bulb’s rating can burn out the wire.

The **motor (M1)** converts electricity into mechanical motion. Electricity is closely related to magnetism, and an electric current flowing in a wire has a magnetic field similar to that of a very, very tiny magnet. Inside the motor is three coils of wire with many loops. If a large electric current flows through the loops, the magnetic effects become concentrated enough to move the coils. The motor has a magnet inside so, as the electricity moves the coils to align them with the permanent magnet, the shaft spins.

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

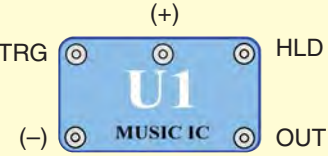
The **red LED (D1) and green LED (D2)** are light emitting diodes, and may be thought of as special one-way light bulbs. In the “forward” direction (indicated by the “arrow” in the symbol) electricity flows if the voltage exceeds a turn-on threshold (about 1.5V); brightness then increases. A high current will burn out an LED, so the current must be limited by other components in the circuit. LED’s block electricity in the “reverse” direction.

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

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

Some types of electronic components can be super-miniaturized, allowing many thousands of parts to fit into an area smaller than your fingernail. These “integrated circuits” (IC’s) are used in everything from simple electronic toys to the most advanced computers. The music, alarm, and space war IC’s (U1, U2, and U3) in Snap Kits™ are actually modules containing specialized sound-generation IC’s and other supporting components (resistors, capacitors, and transistors) that are always needed with them. This was done to simplify the connections you need to make to use them. The descriptions for these modules are given here for those interested, see the projects for connection examples:


Music IC:



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

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

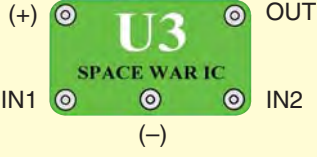
Alarm IC:



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

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

Space War IC:



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

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

The **antenna (A1)** contains a coil of wire wrapped around an iron bar. Although it has magnetic effects similar to those in the motor, those effects are tiny and may be ignored except at high frequencies (like in AM radio). Its magnetic properties allow it to concentrate radio signals for reception. At lower frequencies the antenna acts like an ordinary wire.

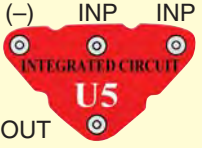
The **PNP (Q1) and NPN (Q2) transistors** are components that use a small electric current to control a large current, and are used in switching, amplifier, and buffering applications. They are easy to miniaturize, and are the main building blocks of integrated circuits including the microprocessor and memory circuits in computers. Projects #124-125 and #128-133 demonstrate their properties. A high current may damage a transistor, so the current must be limited by other components in the circuit.

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. Note that magnets can erase magnetic media like floppy disks.

The **two-spring socket (?1)** and **3-spring socket (?Q)** are described on pages 11-12.

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

High Frequency IC:



INP - input connection (2 points are same)
 OUT - output connection
 (-) - power return to batteries

See project #224 for example of connections.

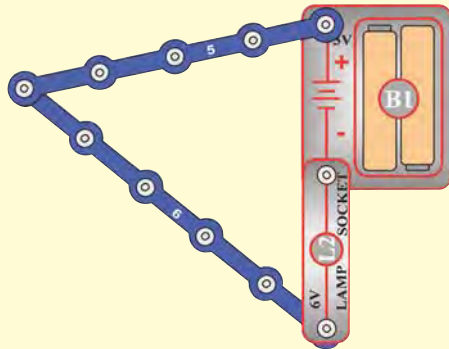
Advanced Troubleshooting (Adult supervision recommended)

Radio Shack is not responsible for parts damaged due to incorrect wiring.

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

1. **6V lamp (L2), motor (M1), speaker (SP), and battery holder (B1):** Place batteries in holder and install bulb in lamp socket. Place the 6V lamp directly across the battery holder, it should light. Do the same with the motor (motor + to battery +), it should spin to the right at high speed. "Tap" the speaker across the battery holder contacts, you should hear static as it touches. If none work, then replace your batteries and repeat. If still bad, then the battery holder is damaged.

2. **Snap wires:** Use this mini-circuit to test the 5-snap and 6-snap wires. The lamp should light. Then test each of the 1-snap, 2-snap, 3-snap, 4-snap, and 7-snap wires by connecting them between the ends of the 5-snap and 6-snap.



3. **Slide switch (S1) and Press switch (S2):** Build project #1, if the lamp (L2) doesn't light then the slide switch is bad. Replace the slide switch with the press switch to test it.

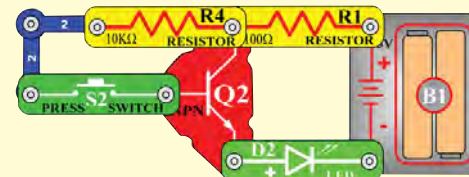
4. **LED's (D1 & D2) and 100Ω (R1), 1KΩ (R2), 5.1KΩ (R3), and 10KΩ (R4) resistors:** Build project #7 except initially use the speaker (SP) in place of the LED, you will hear static if the resistor is good. Then replace the speaker with the LED and see if it lights. Then, replace the 100Ω resistor with each of the other resistors, the LED should light, but the brightness decreases with the higher value resistors. Test the green LED in the same manner.

5. **Alarm IC (U2):** Build project #17, you should hear a siren. Then place a 3-snap wire between grid locations A1 & C1, the sound is different. Then move the 3-snap from A1-C1 to A3-C3 to hear a third sound.

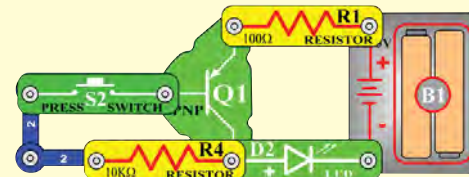
6. **Music IC (U1):** Build project #74 but use the press switch (S2) in place of the photoresistor (RP). Turn it on and the LED (D1) flickers for a while and stops. It resumes if you press and hold down the press switch. Then, touch a 3-snap wire across base grid points A1 & C1 and the flickering resumes for a while.

7. **Space war IC (U3) and photoresistor (RP):** Build project #19, both switches (S1 & S2) should change the sound. Then replace either switch with the photoresistor, waving your hand over it should change the sound.

8. **NPN transistor (Q2):** Build the mini-circuit shown here. The LED (D2) should be on only when the press switch (S2) is pressed.



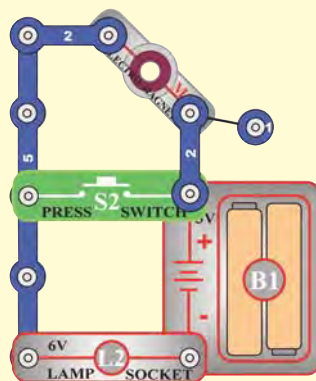
9. **PNP transistor (Q1):** Build the mini-circuit shown here. The LED (D2) should be on only when the press switch (S2) is pressed.



10. **Antenna (A1):** Build project #246, the LED (D1) should flash when you release the press switch (S2).

Advanced Troubleshooting (continued) (Adult supervision recommended)

11. **Adjustable resistor (RV):** Build project #204 but use the $1\text{K}\Omega$ resistor (R2) in place of the photoresistor (RP). Turn on the slide switch (S1), the resistor control can turn the LED (D1) on and off.
12. **$100\mu\text{F}$ (C4) and $470\mu\text{F}$ capacitor (C5):** Build project #49, then press and release the press switch (S2). The LED (D1) should go off slowly. Replace the $470\mu\text{F}$ with the $100\mu\text{F}$ and the LED is only lit for about 4 seconds now.
13. **$100\text{K}\Omega$ resistor (R5) and $0.02\mu\text{F}$ (C1), $0.1\mu\text{F}$ (C2), and $10\mu\text{F}$ (C3) capacitors:** Build project #163, but replace the $100\text{K}\Omega$ resistor with the photoresistor (RP) and cover it. You will hear a whining or clicking sound unless the $0.02\mu\text{F}$ capacitor is bad. Now place the $100\text{K}\Omega$ resistor back in the circuit, you hear a whining sound unless the $100\text{K}\Omega$ is bad. Replace the $0.02\mu\text{F}$ with the $0.1\mu\text{F}$, the sound should be different (lower frequency) or the $0.1\mu\text{F}$ is bad. Replace the $0.1\mu\text{F}$ with the $10\mu\text{F}$, the circuit will “click” about once a second unless the $10\mu\text{F}$ is bad.
14. **Variable Capacitor (CV):** Build project #169 and place it near an AM radio, tune the radio and the capacitor to verify you hear the music on your radio.
15. **High Frequency IC (U5):** Build project #224 and adjust the variable capacitor (CV) until you hear a radio station.
16. **Electromagnet (M3):** Build the mini-circuit shown here. Lamp (L2) must be dim, and must get brighter when you press the press switch (S2).



Note: If you have RS-303, there are additional tests in your other project manual.

For more information, contact:

Radio Shack Corporation

Fort Worth, TX 76102

Call us at

1-800-THE-SHACK

or visit us online at

www.radioshack.com

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 IC's using configurations given in the projects, incorrectly doing so may damage them. **Radio Shack is not responsible for parts damaged due to incorrect wiring.**

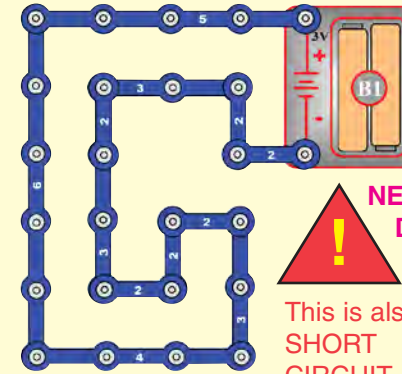
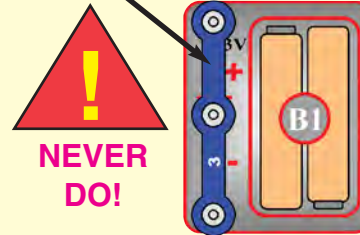
Here are some important guidelines:

- ALWAYS** use eye protection when experimenting on your own.
- ALWAYS** include at least one component that will limit the current through a circuit, such as the speaker, lamp, capacitors, IC's (which must be connected properly), motor, photoresistor, or resistors (the adjustable resistor doesn't count if it's set at/near minimum resistance).
- ALWAYS** use LED's, transistors, the high frequency IC, the antenna, and switches in conjunction with other components that will limit the current through them. Failure to do so will create a short circuit and/or damage those parts.
- ALWAYS** connect the adjustable resistor so that if set to its 0 setting, the current will be limited by other components in the circuit.
- ALWAYS** connect position capacitors so that the "+" side gets the higher voltage.
- ALWAYS** disconnect your batteries immediately and check your wiring if something appears to be getting hot.
- ALWAYS** check your wiring before turning on a circuit.
- ALWAYS** connect IC's 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** 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.

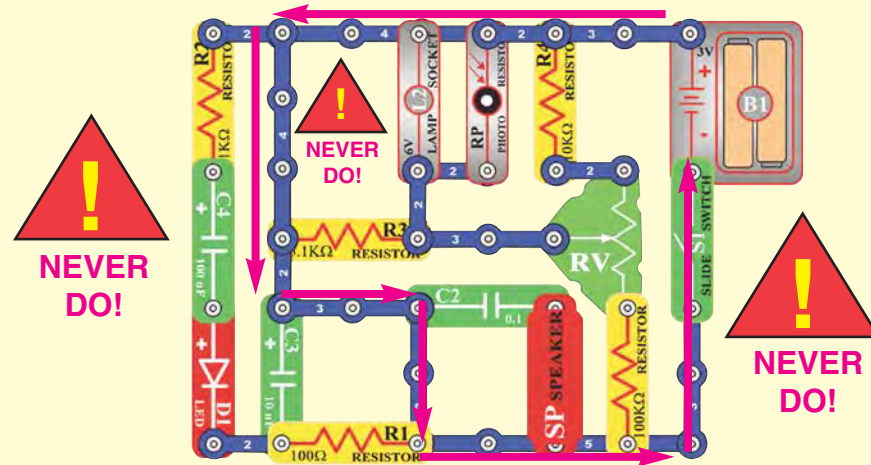
Examples of SHORT CIRCUITS - NEVER DO THESE!!!

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



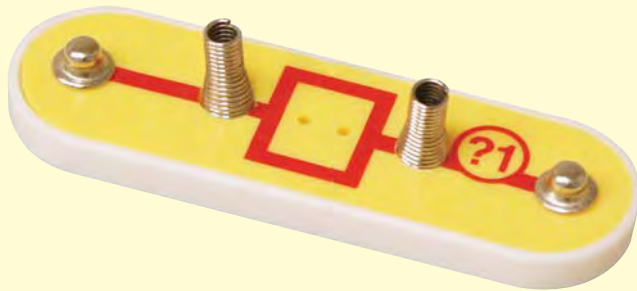
This is also a SHORT CIRCUIT.

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



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

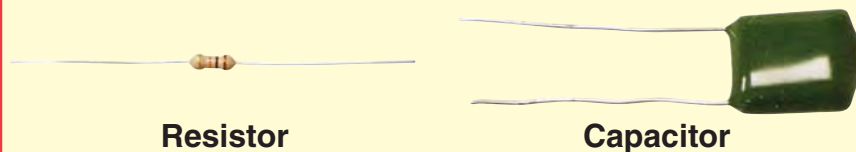
About the TWO-SPRING SOCKET (?1)



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 Kits™. 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, that have a wide range of available values. For example, your Snap Kits™ 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. Your Snap Kits™ also includes an adjustable 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, but this is also difficult with only five values to choose from.

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 LED's, diodes, or coils/inductors can also be used. You can usually find electronic components at any Radio Shack store.

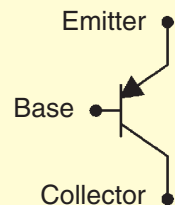
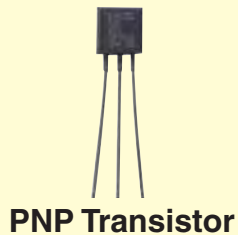
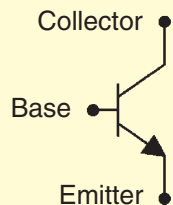
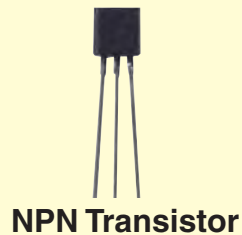
You can design your own circuits or substitute new parts into the projects in the manuals. For LED's, diodes, or electrolytic capacitors, be sure to connect your parts using the correct polarity or you may damage them. Never exceed the voltage ratings of any parts. **RADIO SHACK IS NOT RESPONSIBLE FOR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

About the THREE-SPRING SOCKET (?Q)



The three-spring socket (?Q) just has three 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 Kits™. It should only be used by advanced users who are creating their own circuits.

There are many different types of transistors such as switching, high gain, high frequency, high power, field-effect, and others. All of these come with different specifications. Other common components that have three connection points include adjustable resistors, voltage regulator IC's, SCR's, some amplifier IC's, some types of inductors and filters, bi-color LED's, and others.



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



Any component with three wires coming from it (called leads) can be connected with the three-spring socket (?Q), assuming the leads are long enough. Usually you will connect different types of transistors, but other components with 3 leads can also be used. You can find electronic components like this at Radio Shack.

You can design your own circuits or substitute new parts into the projects in the manuals. Be sure to connect your parts correctly or you may damage them. Never exceed the voltage ratings of any parts. **RADIO SHACK IS NOT RESPONSIBLE FOR ANY PARTS DAMAGED BY IMPROPER CIRCUIT DESIGN OR WIRING. Never connect to external voltages. The three-spring socket is intended for advanced users only.**

Project Listings

Project #	Description	Page #	Project #	Description	Page #	Project #	Description	Page #
1	Electric Light & Switch	15	35	Space Battle	28	69	Space War Siren	41
2	DC Motor & Switch	15	36	Silent Space Battle	28	70	Sunrise Light	41
3	Hear the Motor	16	37	Periodic Sounds	28	71	Light-controlled Lamp	42
4	Adjusting Sound Level	16	38	Blinking Double Flashlight	28	72	Motor-controlled Lamp	42
5	Lamp & Fan in Series	17	39	Motor-controlled Sounds	29	73	Light NOR Gate	42
6	Lamp & Fan in Parallel	17	40	More Motor Sounds	29	74	Light-controlled LED	43
7	Light Emitting Diode	18	41	More Motor Sounds (II)	29	75	Motor-controlled Time Delay LED	43
8	One Direction for LED	18	42	More Motor Sounds (III)	29	76	Capacitor Slow-down	43
9	Conduction Detector	19	43	More Motor Sounds (IV)	29	77	Space War Flicker LED	44
10	Space War Alarm Combo	19	44	Light-controlled Flicker	30	78	Human Space War	44
11	Flying Saucer	20	45	More Sound Effects	30	79	Flash & Tone	44
12	Decreasing Saucer Lift	20	46	Slow Off Switch	31	80	Fan Blade Storing Energy	45
13	Two-Speed Fan	21	47	Transistor Diodes	31	81	Speaker Storing Energy	45
14	The Fuse	21	48	Four Outputs	31	82	NPN Light Control	45
15	Musical Doorbell	22	49	Auto-off Night Light	32	83	Fun with the Alarm IC	46
16	Momentary Alarm	22	50	Auto-off Night Light (II)	32	84	Musical Motor	46
17	Alarm Circuit	23	51	Reflection Detector	33	85	Musical Light	46
18	Laser Gun	23	52	Quieter Reflection Detector	33	86	Music Alarm Combo	47
19	Space War	24	53	Flashing Laser Light with Sound	34	87	Bomb Sound	47
20	Light Switch	24	54	Space War Flicker	34	88	Bomb Sound (II)	47
21	Paper Space War	24	55	Spinning Rings	35	89	Motor Sounds Combo	48
22	Light Police Siren	25	56	Strobe the House Lights	35	90	Motor Sounds Combo (II)	48
23	More Loud Sounds	25	57	Race Game	36	91	Fan Detector	49
24	More Loud Sounds (II)	25	58	Using Parts as Conductors	36	92	Slow Siren Changer	49
25	More Loud Sounds (III)	25	59	Spin Draw	37	93	Capacitor Photo Control	50
26	More Loud Sounds (IV)	25	60	Space War Flicker Motor	37	94	Capacitor Control	50
27	The Transistor	26	61	Speaker Static	38	95	Photo Space War with LED	51
28	The Transistor (II)	26	62	Parallel Resistors	38	96	Alarm Rectifier	51
29	The Transistor (III)	26	63	Series Resistors	38	97	Light-controlled Alarm	52
30	The Transistor (IV)	26	64	The Transistor (V)	39	98	Fading Siren	52
31	Sound Mixer	27	65	The Transistor (VI)	39	99	Lamp & Fan Independent	53
32	Sound Mixer (II)	27	66	The Transistor (VII)	39	100	Motor Space Sounds	53
33	Sound Mixer (III)	27	67	Simple Rectifier	40	101	Motor Space Light	53
34	Sound Mixer (IV)	27	68	Space War Music Combo	40	102	Automatic Street Lamp	54

Project Listings

Project #	Description	Page #	Project #	Description	Page #	Project #	Description	Page #
103	Pitch	54	137	Ambulance Symphony	64	171	Standard Transistor Circuit	74
104	Pitch (II)	54	138	Static Symphony	65	172	Motor & Lamp by Sound	75
105	Pitch (III)	54	139	Static Symphony (II)	65	173	Fast Fade Siren	75
106	Space War Sounds	55	140	Capacitors in Series	65	174	Changing Siren	76
107	Space War Sounds Controlled by Light	55	141	Capacitors in Parallel	65	175	Symphony of Sounds	76
108	Adjustable Tone Generator	56	142	Current Controllers	66	176	Transistor Amplifiers	77
109	Photosensitive Electronic Organ	56	143	NPN Dark Control	66	177	Pressure Meter	77
110	Electronic Cicada	56	144	PNP Light Control	66	178	Resistance Meter	77
111	Space War Radio	57	145	PNP Dark Control	66	179	Auto-off Night Light (III)	78
112	The Lie Detector	57	146	Whining Fan	67	180	Discharging Caps	78
113	NPN Amplifier	58	147	Light Whining	67	181	Morse Code Generator	79
114	PNP Amplifier	58	148	More Light Whining	67	182	LED Code Teacher	79
115	Sucking Fan	59	149	Motor That Won't Start	67	183	Ghost Shriek Machine	79
116	Blowing Fan	59	150	Current Equalizing	68	184	LED & Speaker	79
117	PNP Collector	59	151	Lazy Fan	68	185	Dog Whistle	79
118	PNP Emitter	59	152	Laser Light	68	186	Mind Reading Game	80
119	NPN Collector	60	153	Whiner	69	187	Enhanced Quiet Zone Game	81
120	NPN Emitter	60	154	Hummer	69	188	Capacitor Charge & Discharge	81
121	NPN Collector - Motor	60	155	Adjustable Metronome	69	189	Two-Finger Touch Lamp	82
122	NPN Emitter - Motor	60	156	Quiet Flasher	69	190	One-Finger Touch Lamp	82
123	Buzzing in the Dark	61	157	Hissing Foghorn	70	191	Space Battle	83
124	Touch Buzzer	61	158	Hissing & Clicking	70	192	Space Battle (II)	83
125	High-Frequency Touch Buzzer	61	159	Video Game Engine Sound	70	193	Multi-speed Light Fan	83
126	Mosquito	61	160	Make Your Own Battery	71	194	Light & Finger Light	83
127	Loud Mosquito	61	161	Make Your Own Battery (II)	71	195	Storing Electricity	84
128	Radio Music Alarm	62	162	Make Your Own Battery (III)	71	196	Lamp Brightness Control	84
129	Daylight Music Radio	62	163	Tone Generator	72	197	Electric Fan	84
130	Night Music Radio	62	164	Tone Generator (II)	72	198	Fire Engine Symphony	85
131	Night Gun Radio	62	165	Tone Generator (III)	72	199	Light Dimmer	85
132	Radio Gun Alarm	62	166	More Tone Generator	73	200	Motion Detector	86
133	Daylight Gun Radio	62	167	More Tone Generator (II)	73	201	Fan Modulator	86
134	Fire Fan Symphony	63	168	Radio Announcer	73	202	Oscillator 0.5 - 30Hz	87
135	Fan Symphony	63	169	Music Radio Station	74	203	Sound-pulse Oscillator	87
136	Police Car Symphony	64	170	Alarm Radio Station	74	204	Motion Detector (II)	87

Project Listings

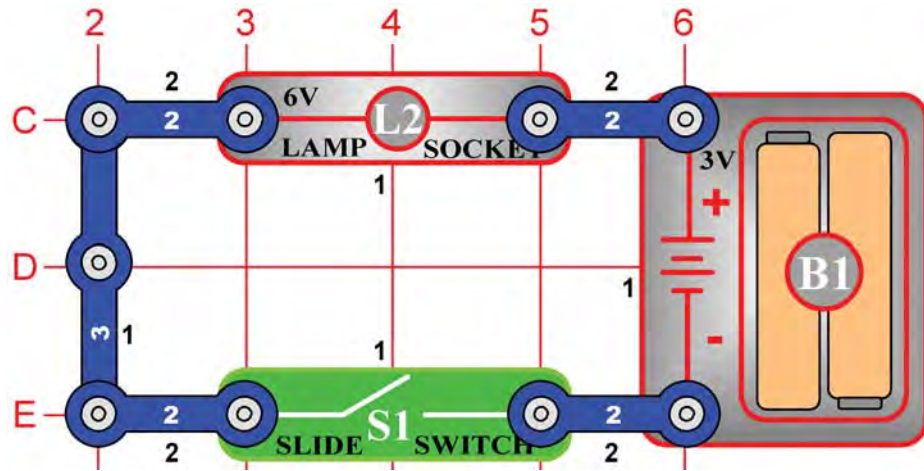
Project #	Description	Page #	Project #	Description	Page #	Project #	Description	Page #
205	Motor Rotation	88	239	Neither This NOR That	100	273	Fading Bomb Sound	116
206	Motor Delay Fan	88	240	NOT This AND That	100	274	Fading Music Sound	116
207	Motor Delay Fan (II)	88	241	Music AND Gate	101	275	Fading Music Sound (II)	116
208	High-pitch Bell	89	242	Lamp, Speaker & Fan in Parallel	101	276	Sound & Lights	117
209	Steamship	89	243	Light-controlled LED (II)	102	277	Music with Timer	117
210	Wet Finger Detector	89	244	AM Radio	102	278	Motor Tone Generator	118
211	Motor-activated Burglar Alarm	90	245	Transistor AM Radio	103	279	Motor Tone Generator (II)	118
212	Light-activated Burglar Alarm	90	246	Antenna Storing Energy	103	280	Motor Tone Generator (III)	118
213	Spacey Fan	90	247	Back EMF	104	281	Motor Tone Generator (IV)	118
214	LED Fan Rotation Indicator	91	248	Flashing Laser LED's with Sound	104	282	Turn Off Timer	119
215	Space War Sounds with LED	91	249	Electromagnet Delayer	105	283	Turn Off Timer (II)	119
216	Photoresistor Control	92	250	Photoresistor Paper Clip Suspension	105	284	LED & Bulb Timer	119
217	Sound Mixer Fan Driver	92	251	Electromagnetism	106	285	Alarm Timer	120
218	Electric Fan Stopped by Light	93	252	Electromagnetism & Compass	107	286	Alarm Timer (II)	120
219	Motor & Lamp	93	253	Electromagnet Storing Energy	107	287	Alarm Timer (III)	120
220	Start-stop Delay	94	254	Electromagnet Tower	108	288	Space War Timer	121
221	Mail Notifying System	94	255	Paper Clip Compass	108	289	Alarm Speed Adjuster	121
222	Mail Notifying Electronic Bell	95	256	Paper Clip Oscillator (II)	109	290	The SCR	122
223	Mail Notifying Electronic Lamp	95	257	Paper Clip Oscillator (III)	109	291	Light-controlled SCR	122
224	AM Radio with Transistors	95	258	Paper Clip Oscillator (IV)	110	292	Light-controlled SCR (II)	122
225	Lasting Doorbell	96	259	Paper Clip Oscillator (V)	110	293	Light-controlled SCR (III)	122
226	Lasting Clicking	96	260	Oscillating Compass	110	294	LED Control Motor	123
227	Delayed Action Lamp	96	261	Siren Paper Clip Vibrator	111	295	LED Control Motor (II)	123
228	Delayed Action Fan	96	262	Alarm Paper Clip Vibrator	111	296	Light Oscillator	124
229	Adjustable Time Delay Lamp	97	263	Machine Gun Paper Clip Vibrator	111	297	Sound, Light & Motor Stepper Circuit	124
230	Adjustable Time Delay Fan	97	264	Alarm Vibrator w/ LED	112	298	Blink & Beep	125
231	Transistor Fading Siren	97	265	Alarm Vibrator w/ LED (II)	112	299	Blink & Beep (II)	125
232	Fading Doorbell	97	266	Motor Oscillator	113	300	Simple Rectifier (II)	125
233	Adjustable Time Delay Lamp (II)	98	267	Motor Oscillator (II)	113	301	Alarm Motor	126
234	Adjustable Time Delay Fan (II)	98	268	Motor Oscillator (III)	113	302	Alarm Light	126
235	Watch Light	98	269	Two-speed Motor Lights	114	303	Mirror Circuit	126
236	Delayed Bedside Fan	98	270	Two-speed Motor Lights-Sound	114			
237	This OR That	99	271	Short-time Sound	115			
238	This AND That	99	272	Slow Light Dimmer	115			



Project #1

Electric Light & Switch

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



Build the circuit shown on the left by placing all the parts with a black 1 next to them on the base first. Then, assemble parts marked with a 2. Install two (2) "AA" batteries (not included) into the battery holder (B1) and screw the bulb into the lamp socket (L2) if you have not done so already.

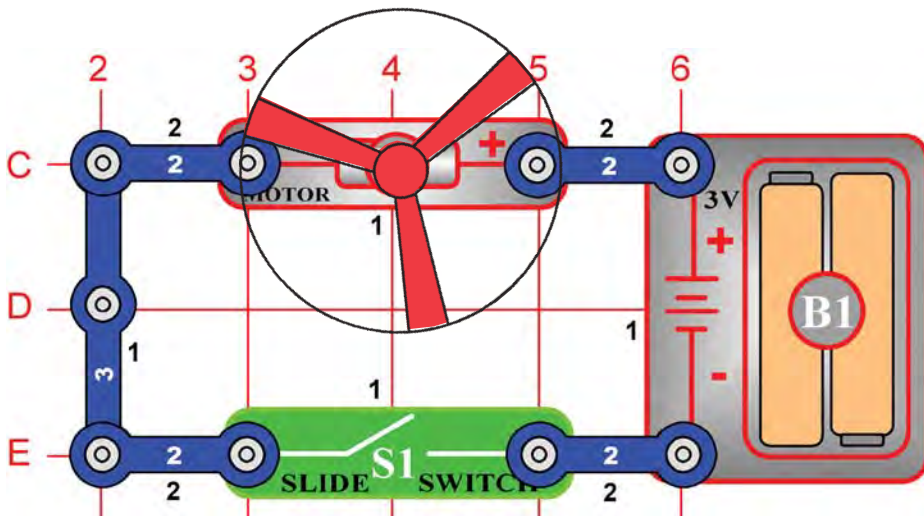
When you turn on the slide switch (S1), current flows from the batteries through the lamp and back to the battery through the switch. The closed switch completes the circuit. In electronics this is called a closed circuit. When the switch is opened, the current can no longer flow back to the battery,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



Project #2

DC Motor & Switch

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



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

When you turn on the slide switch (S1), current flows from the batteries through the motor making it rotate. Place the fan blade on the motor shaft and close the slide switch. The motor (M1) will rotate forcing the fan blade to move air past the motor.

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

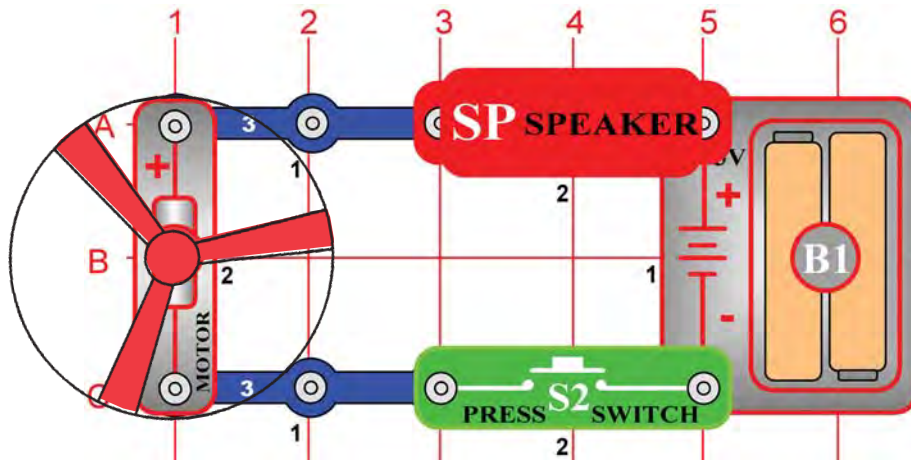
WARNING: Moving parts. Do not touch the fan or motor during operation.



Project #3

Hear the Motor

OBJECTIVE: To show how a motor works.



Place the fan on the motor (M1). Press the press 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 (SP) converts into sound.

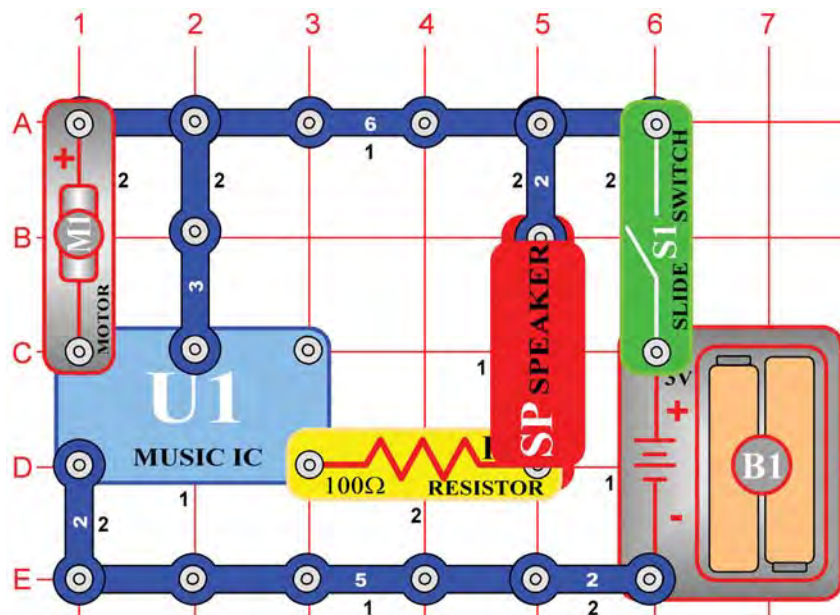
If you replace the motor with the 6V lamp (L2), then it will work the same, but only make noise when the lamp is turned ON or OFF.



Project #4

Adjusting Sound Level

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



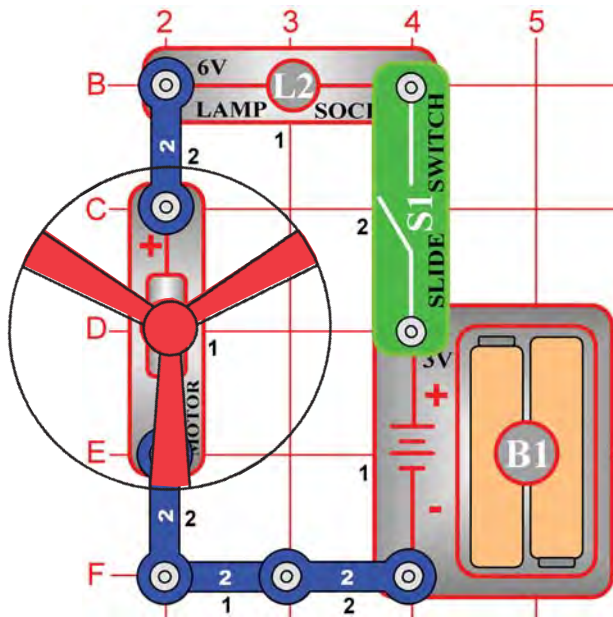
Build the circuit shown on the left, but leave the fan off the motor (M1). When you turn on the slide switch (S1), the music may play for a short time and then stop. After the music has stopped, spin the motor with your fingers. The music should play again for a short time, then stop.

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

In this project, you changed the amount of current that goes through the speaker (SP) and increased the sound output of the speaker. Resistors are used throughout electronics to limit the amount of current that flows.



Project #5



Lamp & Fan in Series

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

Build the circuit shown on the left by placing all the parts with a black 1 next to them on the base first. Then, assemble parts marked with a 2. Finally, place the fan blade on the motor (M1).

When you turn on the slide switch (S1), the fan will spin and the lamp (L2) should turn on. The fan will take a while to start turning due to inertia. Inertia is the property that tries to keep a body at rest from moving and tries to keep a moving object from stopping.

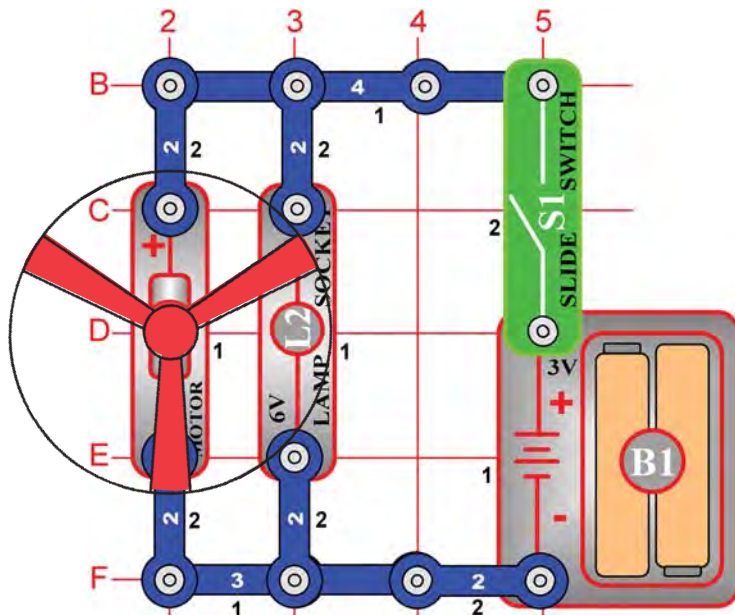
The lamp helps protect the motor from getting the full voltage when the switch is closed. Part of the voltage goes across the light and the rest goes across the motor. Remove the fan and notice how the lamp gets dimmer when the motor does not have to spin the fan blade.



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



Project #6



Lamp & Fan in Parallel

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

Build the circuit shown on the left.

When you turn on the slide switch (S1), both the fan and the lamp should turn on. The fan will take a while to start turning due to inertia. In this connection, the lamp does not change the current to the motor (M1). The motor should start a little faster than in project #5.

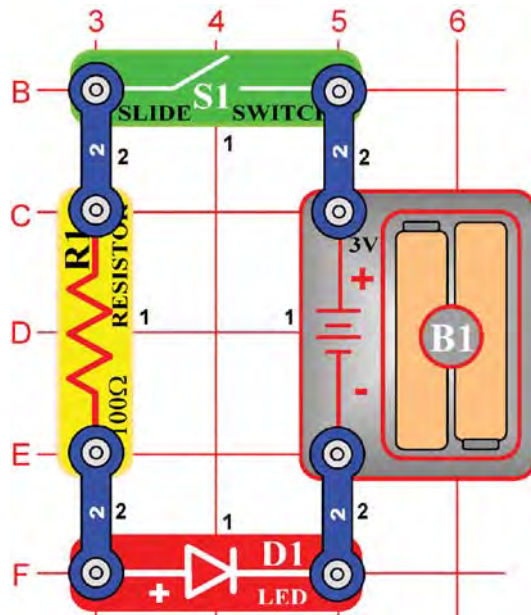
Remove the fan and notice how the lamp does not change in brightness as the motor picks up speed. It has its own path to the battery (B1).



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



Project #7



Light Emitting Diode

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

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

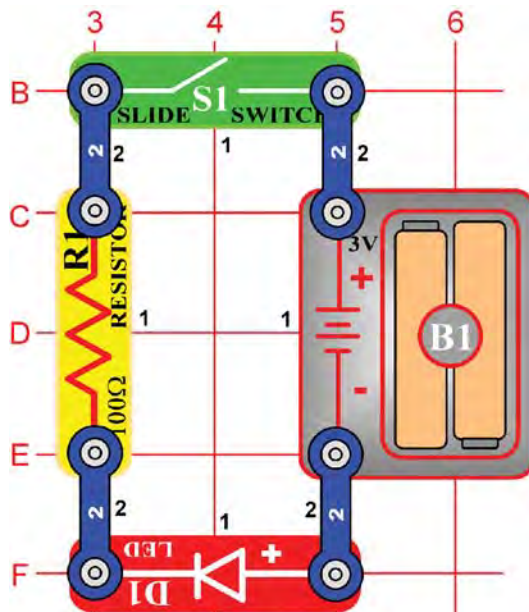
When you turn on the slide switch (S1), current flows from the batteries (B1) through the switch, through the resistor (R1), through the LED (light emitting diode) (D1) and back to the battery. The closed (turned on) switch completes the circuit. The resistor limits the current and prevents damage to the LED. NEVER PLACE AN LED DIRECTLY ACROSS THE BATTERY! If no resistor is in the circuit, the battery may push enough current through the LED to damage the semiconductor that is used to produce the light.

LED's are used in all types of electronic equipment to indicate conditions and pass information to the user of that equipment.

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



Project #8



One Direction for LED

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

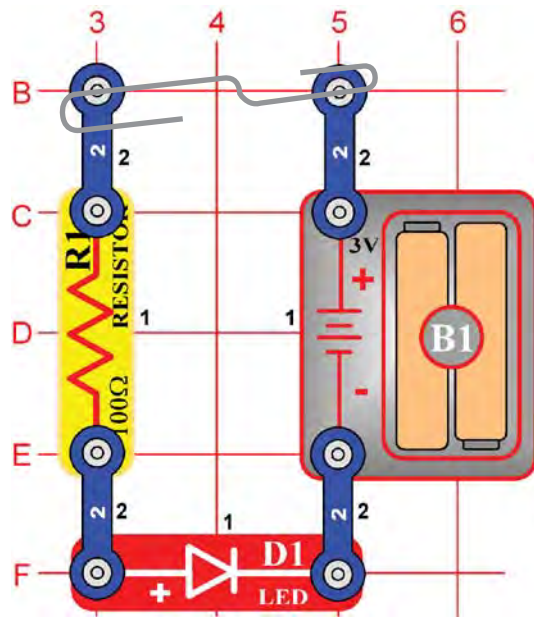
Rebuild the circuit used in project #7, but put the LED (D1) in as shown on the left.

When you turn on the slide switch (S1), current should flow from the batteries (B1) through the resistor (R1) and then through the LED. When current flows through an LED, it lights up. Since the LED is in backwards, current cannot flow. The LED is like a check valve that lets current flow in only one direction.

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



Project #9



Conduction Detector

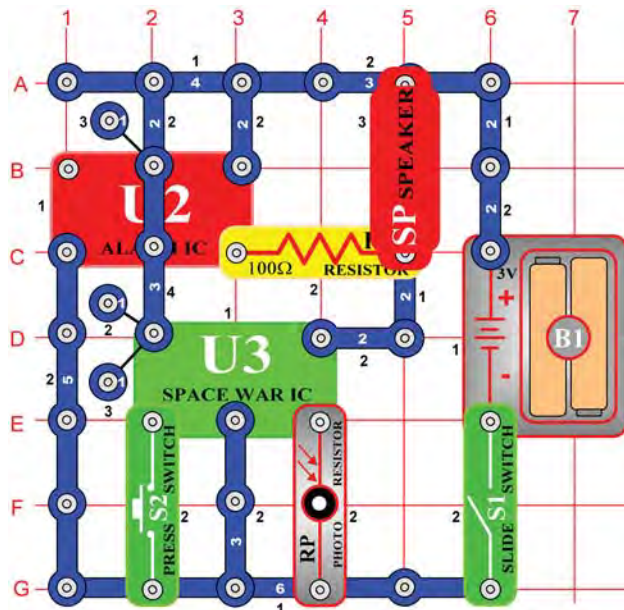
OBJECTIVE: To make a circuit that detects the conduction of electricity in different materials.

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

When you place a metal paper clip across the terminals as shown in the picture on the left, current flows from the batteries (B1) through the resistor (R1), through the LED (D1), and back to the battery. The paper clip completes the circuit and current flows through the LED. Place your fingers across the terminals and the LED does not light. Your body is too high of a resistance to allow enough current to flow to light the LED. If the voltage, which is electrical pressure, was higher, current could be pushed through your fingers and the LED would light. This detector can be used to see if a material like plastic is a good conductor or a poor conductor.



Project #10



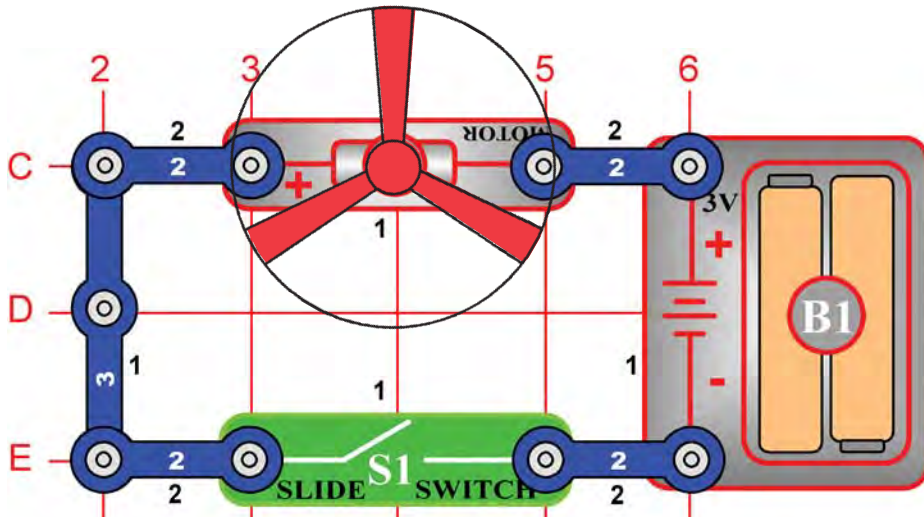
Space War Alarm Combo

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

Build the circuit shown. Turn it on, press the press switch (S2) several times, and wave your hand over the photoresistor (RP) to hear all the sound combinations. You can make the sound from the alarm IC (U2) louder by replacing the 100Ω resistor (R1) with the 6V lamp (L2).



Project #11



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

WARNING: Do not lean over the motor.

Flying Saucer

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

Rebuild the circuit from project #2, but reverse the polarity on the motor (M1) so the negative (-) on the motor goes to the positive (+) on the battery.

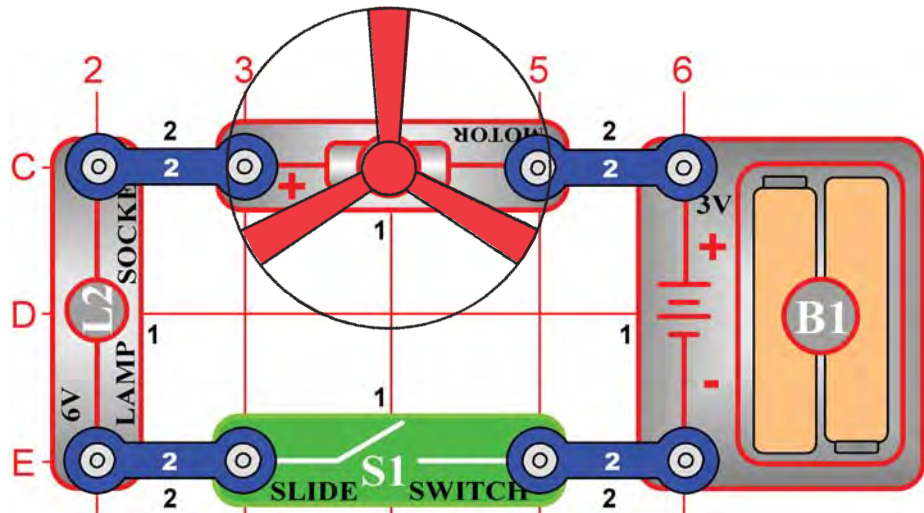
When you turn on the slide switch (S1), the motor will slowly increase in speed. When the motor has reached maximum rotation, turn the slide switch off. The fan blade should rise and float through the air like a flying saucer. Be careful not to look directly down on fan blade when it is spinning.

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

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



Project #12



Decreasing Saucer Lift

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

Change the circuit in project #11 by adding the lamp (L2) in series with the motor (M1) as shown in the diagram on the left.

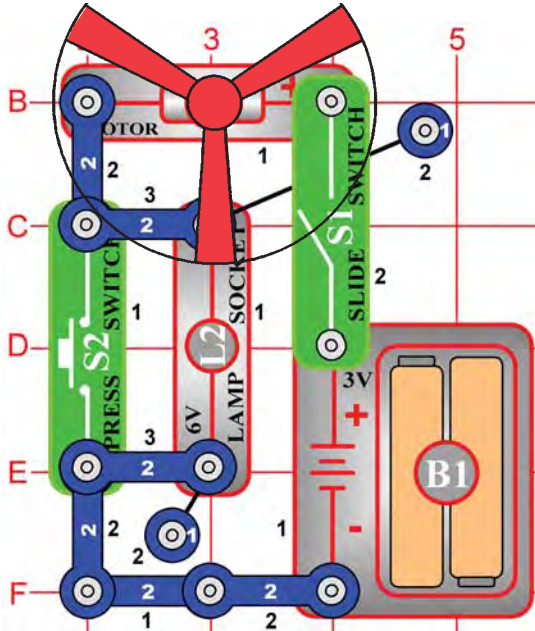
When you place the lamp in series with any electronic device, it will draw less current because it adds resistance. In this case, the lamp in series reduces the current through the motor, and that reduces the top speed of the motor. Turn on the slide switch (S1) and wait until the fan reaches maximum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

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

WARNING: Do not lean over the motor.



Project #13



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

Two-Speed Fan

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

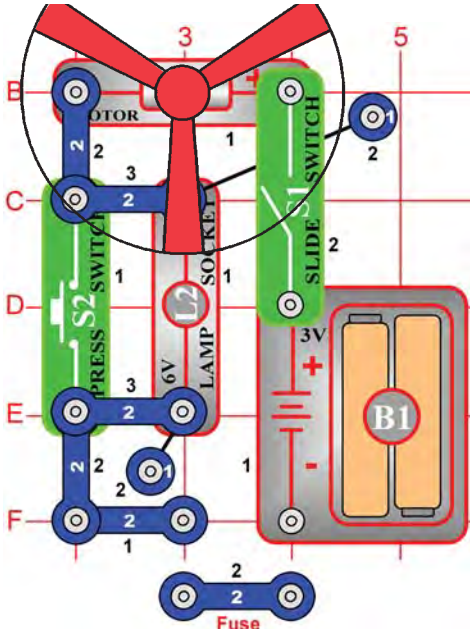
Build the circuit shown on the left by placing all the parts with a black 1 next to them on the board first. Then, assemble parts marked with a 2. Finally, add the 2-snap wires that are marked for level 3.

When you turn on the slide switch (S1), current flows from the batteries (B1) through the slide switch, motor (M1), the lamp (L2), and back to the battery. When the press switch (S2) is pressed, the lamp is shorted and motor speed increases.

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



Project #14



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

The Fuse

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

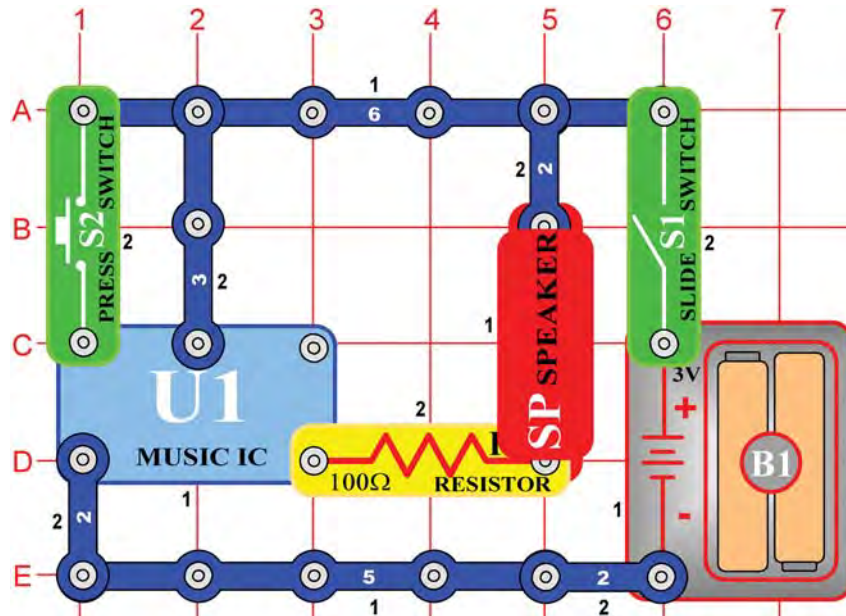
Use the circuit built in project #13.

When you turn on the slide switch (S1), current flows from the batteries (B1) through the slide switch, the lamp (L2), motor (M1), and back to the battery. Pretend the 2-snap wire marked fuse in the drawing on the left is a device that will open the circuit if too much current is taken from the battery. When press switch (S2) is pressed, the lamp is shorted and motor speed increases due to an increase in current to the motor. While still holding the press switch down, remove the 2-snap wire marked fuse and notice how everything stops. Until the fuse is replaced, the open circuit path protects the electronic parts. If fuses did not exist, many parts could get hot and even start fires. Replace the 2-snap wire and the circuit should return to normal.

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



Project #15



Musical Doorbell

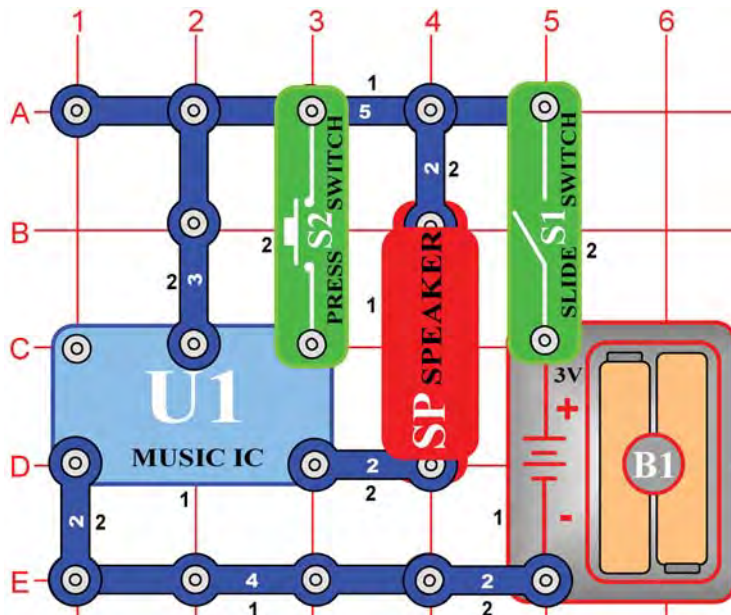
OBJECTIVE: To show how an integrated circuit can be used as a musical doorbell.

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

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



Project #16



Momentary Alarm

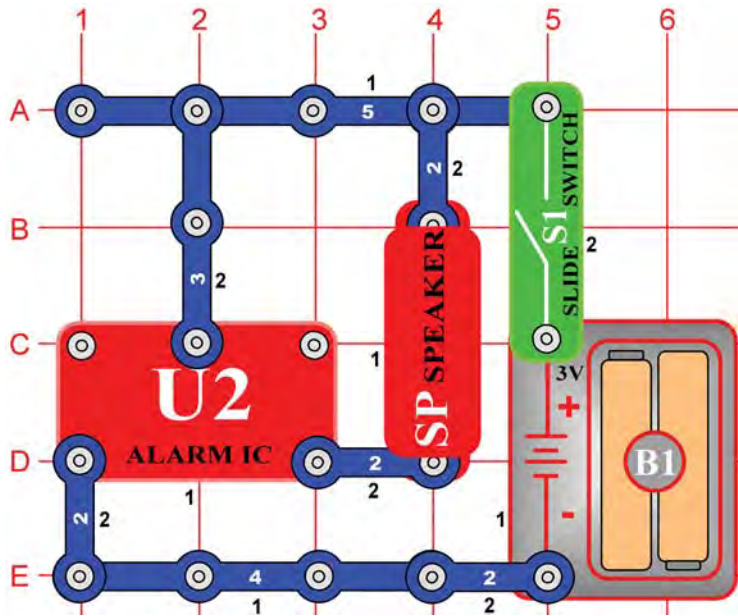
OBJECTIVE: To show how integrated circuits can also create loud alarm sounds in case of emergencies.

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

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



Project #17



Alarm Circuit

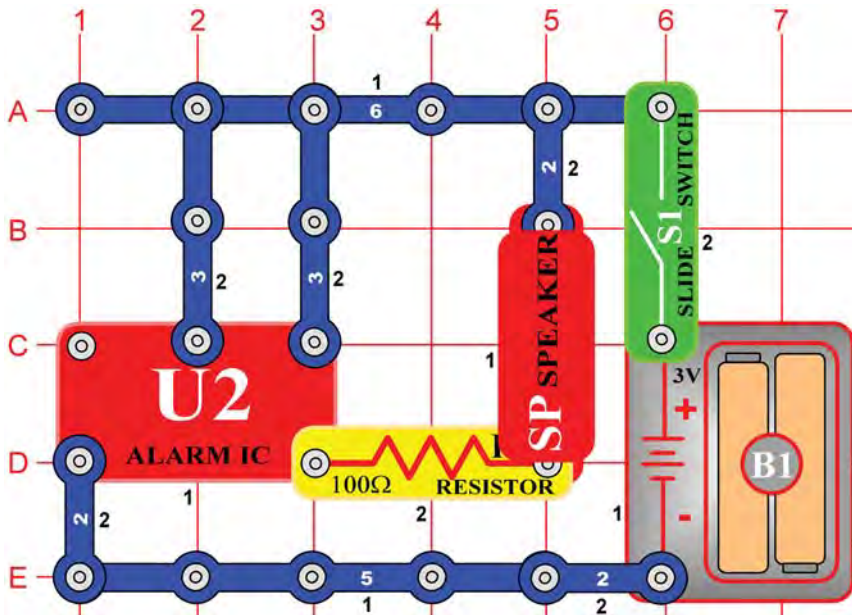
OBJECTIVE: To show how an integrated circuit can be used to make real alarm sounds.

Build the circuit shown on the left by placing all the parts with a black 1 next to them on the board first. Then, assemble parts marked with a 2. When you turn on the slide switch (S1), the integrated circuit (U2) should start sounding a very loud alarm sound. This integrated circuit is designed to sweep through all the frequencies so even hard of hearing people can be warned by the alarm. If the alarm sound was passed through an amplifier and installed into a police car, it would also serve as a good police siren.



Project #18

Laser Gun

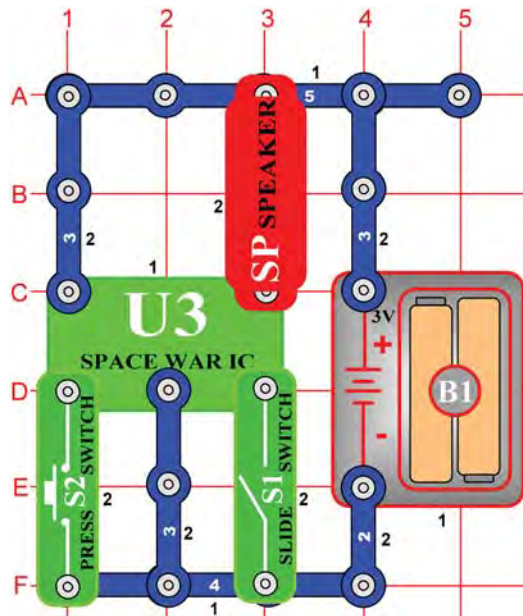


OBJECTIVE: To show how integrated circuits sound can easily be changed to exciting space war sounds.

Build the circuit shown on the left by placing all the parts with a black 1 next to them on the board first. Then, assemble parts marked with a 2. When you turn on the slide switch (S1), the integrated circuit (U2) should start sounding a laser gun sound. This integrated circuit is designed to produce different sounds that can easily be changed. You can even switch the sound on and off quickly to add sound effects to your games or recordings.



Project #19



Space War

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

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

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

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

Project #20 Light Switch

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



Use the circuit from project #19 above, but replace the slide switch (S1) with the photoresistor (RP). The circuit immediately makes noise. Try turning it off. If you experiment, then you can see that the only ways to turn it off are to cover the photoresistor, or to turn off the lights in the room (if the room is dark). Since light is used to turn on the circuit, you might say it is a "light switch".

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

Project #21 Paper Space War

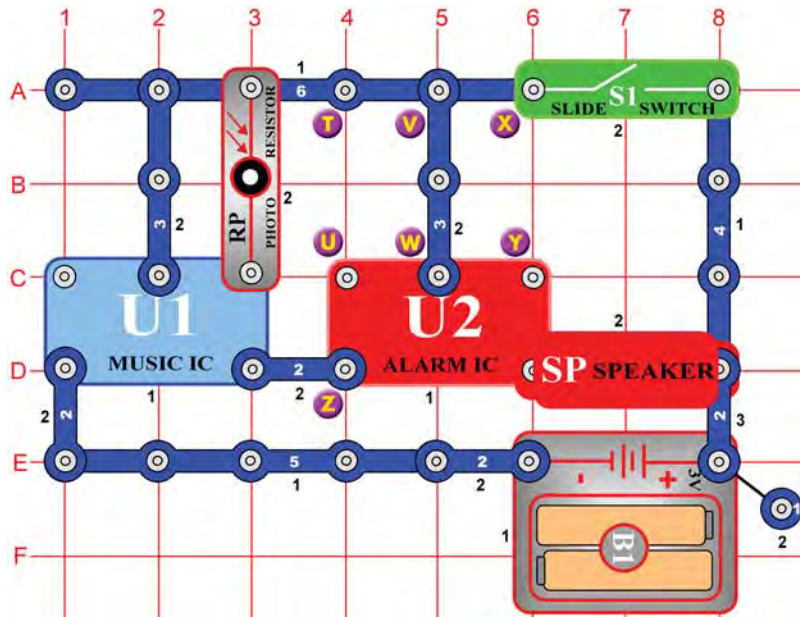
OBJECTIVE: To give a more dramatic demonstration of using the photoresistor.

Use the same circuit as for project #20. Find a piece of white paper that has a lot of large black or dark areas on it, and slowly slide it over the photosensitive resistor. You should hear the sound pattern constantly changing, as the white and dark areas of the paper control the light to the photosensitive resistance. You can also try the pattern below or something similar to it:





Project #22



Light Police Siren

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

Build the circuit shown on the left by placing all the parts with a black 1 next to them on the board first. Then, assemble parts marked with a 2. Finally, insert the parts with a 3 last on level 3.

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

Project #23 More Loud Sounds

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

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

Project #24 More Loud Sounds (II)

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

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

Project #25 More Loud Sounds (III)

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

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

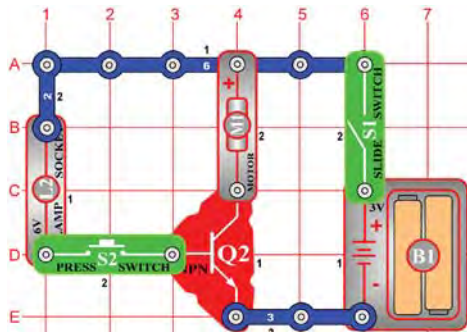
Project #26 More Loud Sounds (IV)

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

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

Project #27 The Transistor

OBJECTIVE: To compare transistor circuits.



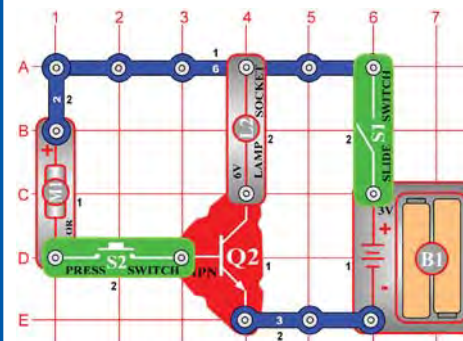
WARNING: Moving parts. Do not touch the fan or motor during operation.

Place the fan on the motor (M1) and turn on the slide switch (S1) - nothing happens. Press the press switch (S2), the lamp (L2) lights dimly and the motor spins. The lamp will be brighter if you remove the fan from the motor.

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

Project #28 The Transistor (II)

OBJECTIVE: To compare transistor circuits.



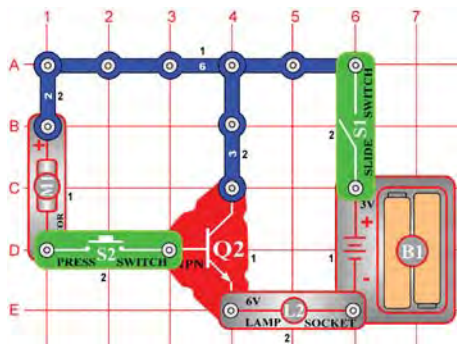
WARNING: Moving parts. Do not touch the fan or motor during operation.

Compare this circuit to project #27. It works the same way, but the lamp (L2) is brighter here and the motor (M1) is slower.

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

Project #29 The Transistor (III)

OBJECTIVE: To compare transistor circuits.

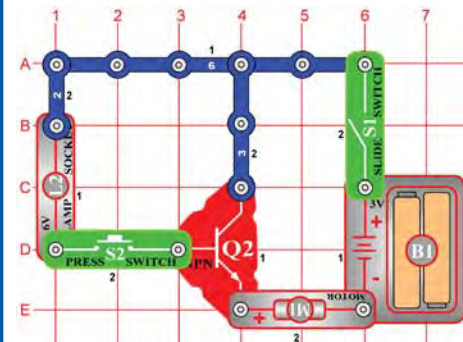


Compare this circuit to project #28. It works in a similar way, but the motor (M1) does not spin even though the lamp (L2) is bright. But the lamp is not as bright here as in project #28.

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

Project #30 The Transistor (IV)

OBJECTIVE: To compare transistor circuits.



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

Compare this circuit to project #29. It works in a similar way, the lamp (L2) is off but the motor (M1) spins. But the motor does not spin as fast as in project #27.

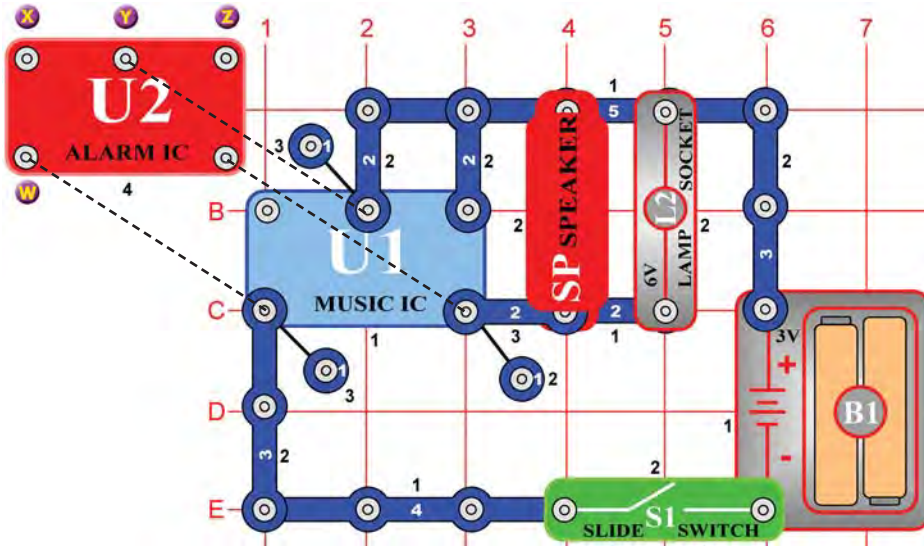
The currents in the lamp branch and 3-snap branch are combined into the motor branch. Since the 3-snap has no resistance, the current through its branch will be much larger than the lamp branch current.



Project #31

Sound Mixer

OBJECTIVE: To connect two sound IC's together.



In the circuit, the outputs from the alarm and music IC's are connected together. Build the circuit shown and then place the alarm IC (U2) directly over the music IC (U1), resting on two 1-snaps and a 2-snap. Turn on the slide switch (S1) and you will hear a siren and music together while the lamp (L2) varies in brightness.



Project #32 Sound Mixer (II)

OBJECTIVE: To connect two sound IC's together.

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



Project #33 Sound Mixer (III)

OBJECTIVE: To connect two sound IC's together.

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

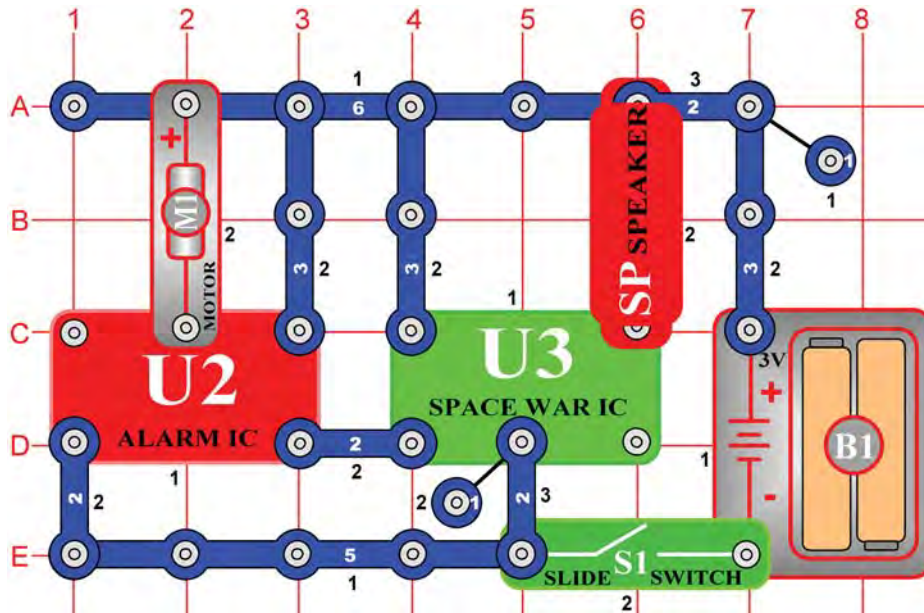


Project #34 Sound Mixer (IV)

OBJECTIVE: To connect two sound IC's together.

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

Project #35



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

Build the circuit shown on the left, which is based on the circuit in the Space War project #19. Turn on the slide switch (S1) and you will hear exciting sounds, as if a space battle is raging!

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

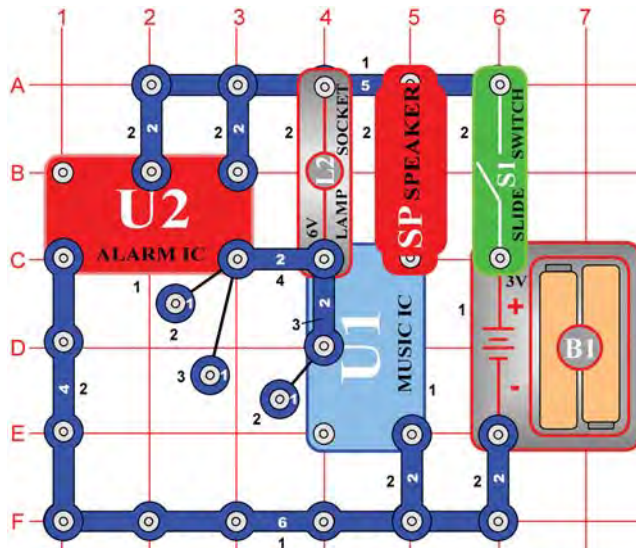
Project #36 Silent Space Battle

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

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

Project #37 Periodic Sounds

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



Build the circuit shown on the left and turn it on. The lamp (L2) alternates between being on and off while the speaker (SP) alternates between two musical tones . . . like someone is flipping a switch, but at a very consistent rate. Periodic signals like this are very important in electronics.

Project #38 Blinking Double Flashlight

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

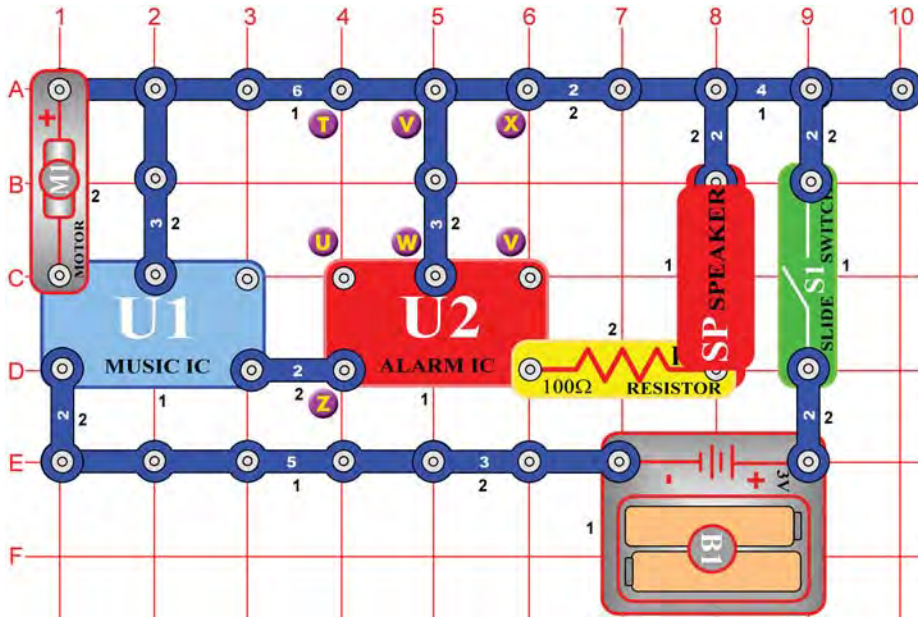
In the circuit at left, replace the speaker (SP) with the LED (D1). Make sure you connect the LED with the positive (+) side on A5, not U1. The lamp (L2) alternates between being on and off while the LED alternates between being dimmer and brighter.



Project #39

Motor-controlled Sounds

OBJECTIVE: To show how motion can trigger electronic circuits.



This circuit is controlled by spinning the motor (M1) with your hands. Turn on the slide switch (S1). A police siren is heard and then stops. Spin the motor and it will play again. Note, however, that music can be heard faintly in the background of the siren.

Project #40 More Motor Sounds

OBJECTIVE: To show how motion can trigger electronic circuits.

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

Project #41 More Motor Sounds (II)

OBJECTIVE: To show how motion can trigger electronic circuits.

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

Project #42 More Motor Sounds (III)

OBJECTIVE: To show how motion can trigger electronic circuits.

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

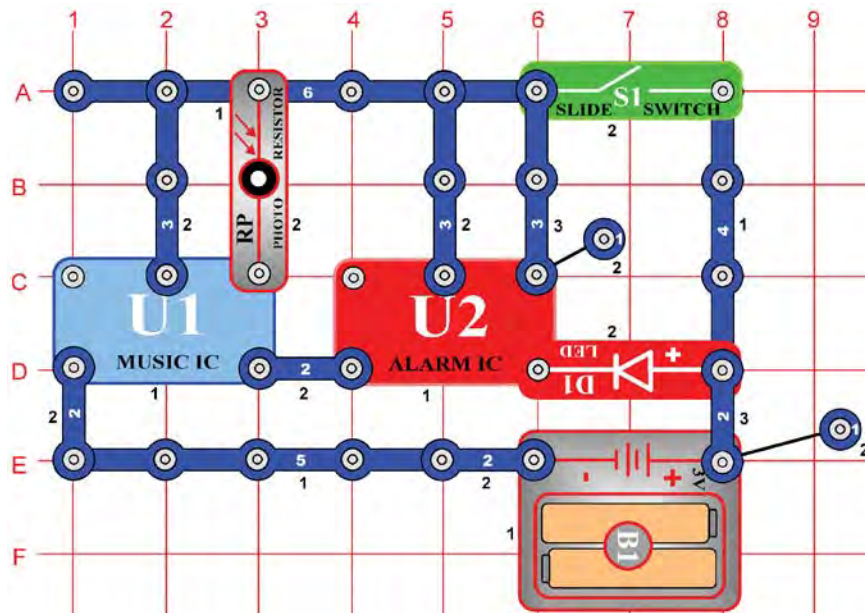
Project #43 More Motor Sounds (IV)

OBJECTIVE: To show how motion can trigger electronic circuits.

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



Project #44



Light-controlled Flicker

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

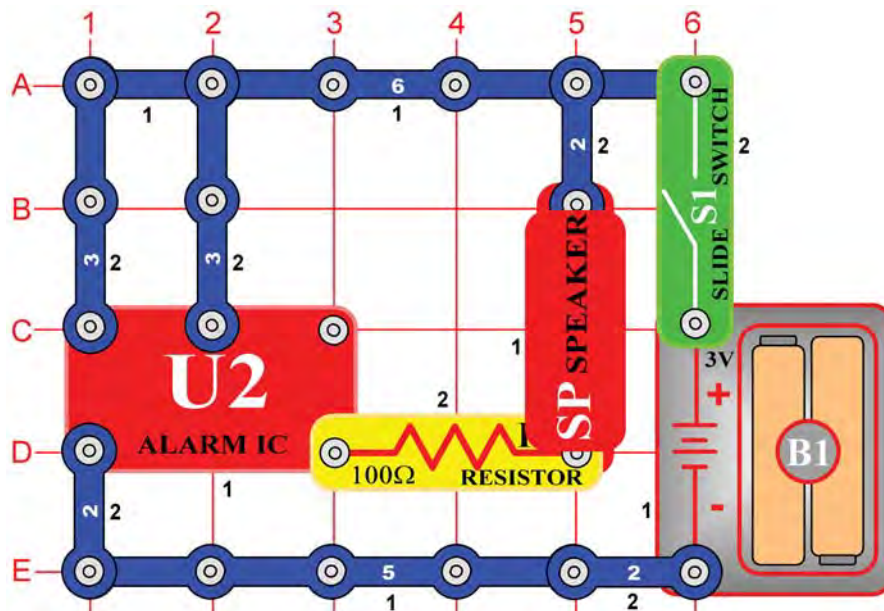
This circuit does not use the noisy speaker it uses a nice quiet LED (D1). Turn on the slide switch (S1), the LED flickers. Wait a few seconds, and then cover the photoresistor (RP), and the flicker stops. The flicker is controlled by the photoresistor; uncover it and the flicker resumes.

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

Can you think of other uses?



Project #45



More Sound Effects

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

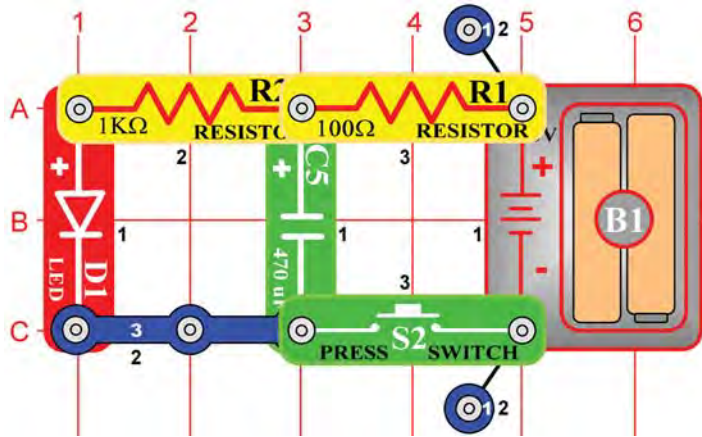
Build the circuit shown on the left. When you turn on the slide switch (S1), the integrated circuit (U2) should start sounding an up-down siren. This is just one more sound effect that this integrated circuit is designed to produce. Different sounds that can easily be changed are very important when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



Project #46

Slow Off Switch

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



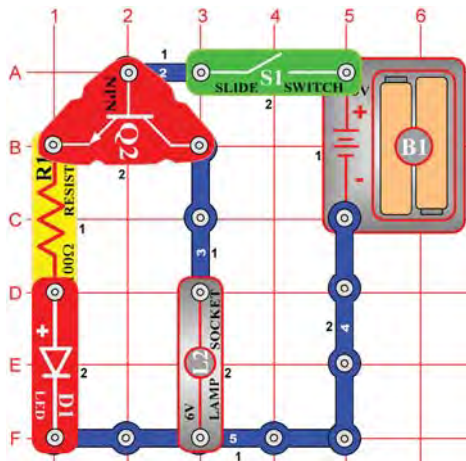
Build the circuit and press the press switch (S2). You see that the LED (D1) turns off slowly after you release the switch.

This delay in turning off the LED is caused by the 470µF capacitor (C5). Capacitors can store electricity and are used to delay changes in voltage. They can block unchanging voltages while passing fast-changing voltages.



Project #47 Transistor Diodes

OBJECTIVE: To learn about transistors.



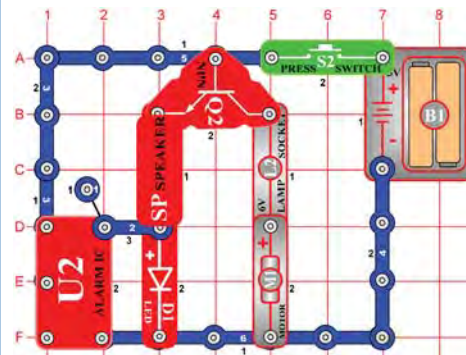
Turn on the slide switch (S1), the LED (D1) and lamp (L2) are bright. This is an unusual circuit which uses the NPN transistor (Q2) as two connected diodes to split the current from the batteries (B1) into the paths with the LED and lamp. If the LED does not light, you may have weak batteries in need of replacement.

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



Project #48 Four Outputs

OBJECTIVE: To learn about transistors.



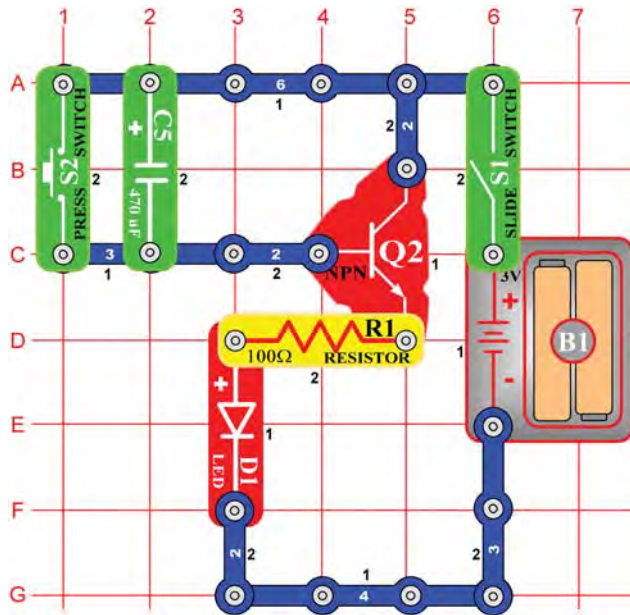
This circuit has four different types of output. Do not place the fan on the motor (M1). Press the press switch (S2) several times. The LED (D1) and lamp (L2) are bright, the motor spins, and the speaker (SP) makes a static sound. If the LED does not light, you may have weak batteries that need replacement.

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

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



Project #49



Auto-Off Night Light

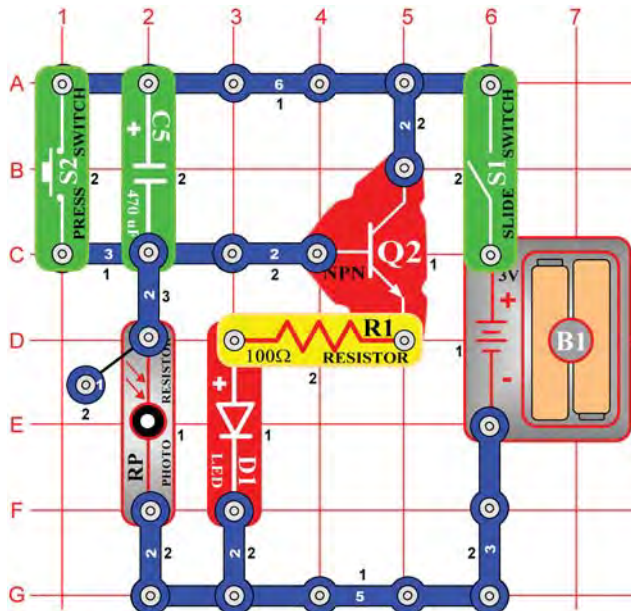
OBJECTIVE: *To learn about one device that is used to delay actions in electronics.*

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

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



Project #50



Auto-Off Night Light (II)

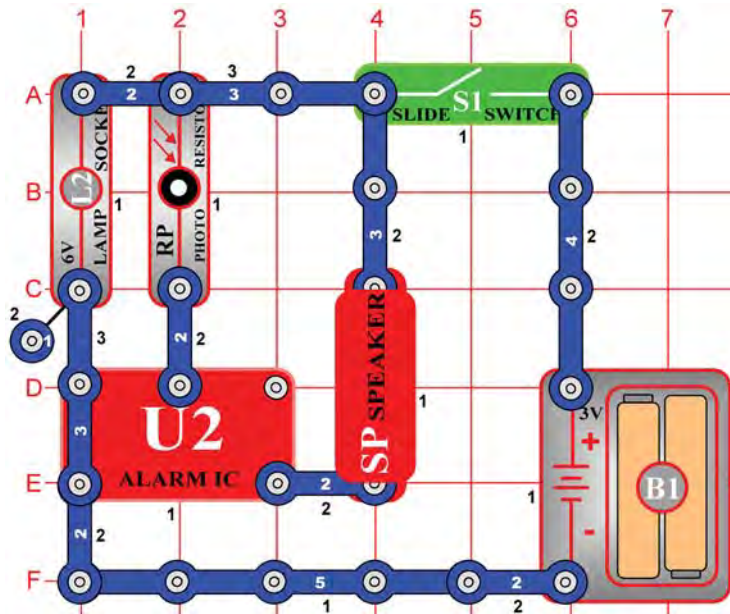
OBJECTIVE: *To learn about one device that is used to delay actions in electronics.*

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

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



Project #51



Reflection Detector

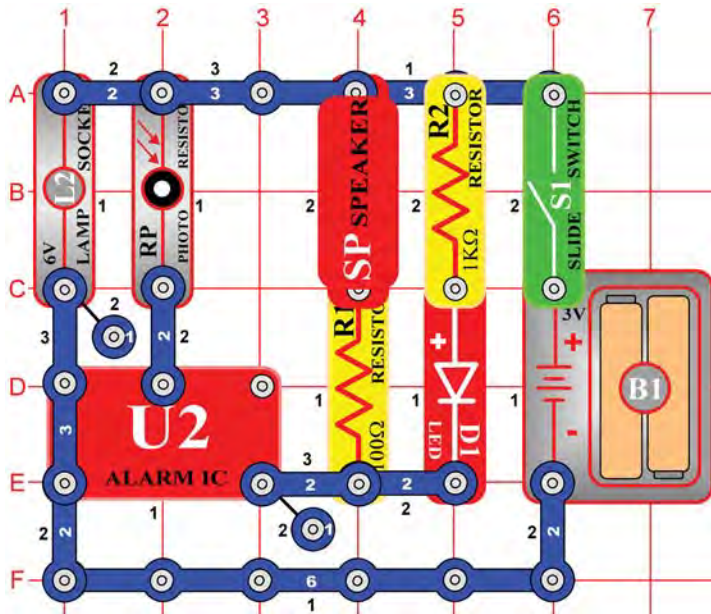
OBJECTIVE: To detect if a mirror is present.

Build the circuit on the left. Place it where there won't be any room light hitting the photoresistor (RP) (such as in a dark room or under a table), and then turn it on. The 6V lamp (L2) will be bright but there should be little or no sound.

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



Project #52



Quieter Reflection Detector

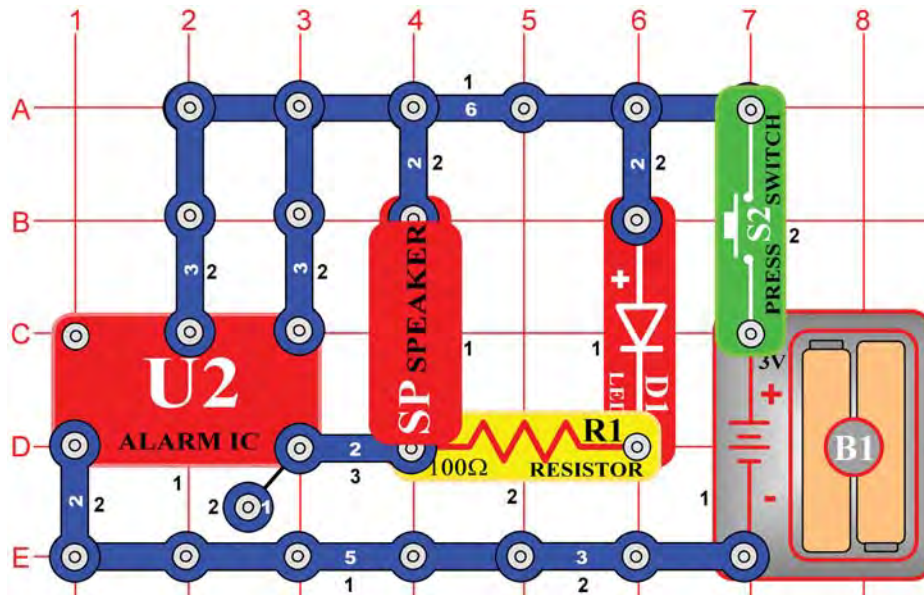
OBJECTIVE: To detect a mirror.

Let's modify the reflection detector circuit so that it is not so loud and annoying. We'll also put a lamp on it that can be seen in a noisy room. Build the circuit on the left. Place it somewhere where there won't be any room light hitting the photoresistor (RP) (such as in a dark room or under a table), and then turn it on. The 6V lamp (L2) will be bright but there should be little or no sound.

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



Project #53



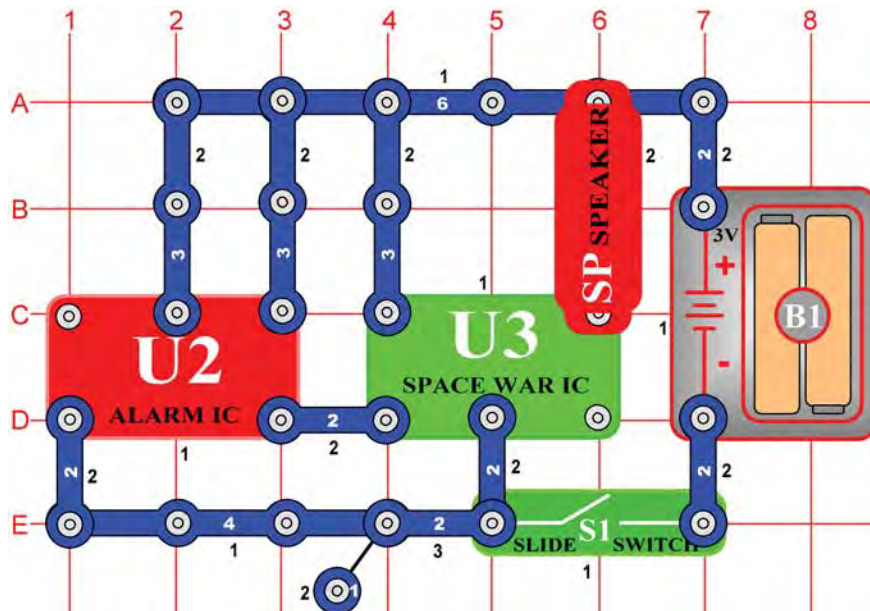
Flashing Laser Light with Sound

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

When you press the press switch (S2), the integrated circuit (U2) should start sounding a very loud laser gun sound. The red LED (D1) will flash simulating a burst of laser light. You can shoot long repeating laser burst, or short zaps by tapping the trigger switch.



Project #54



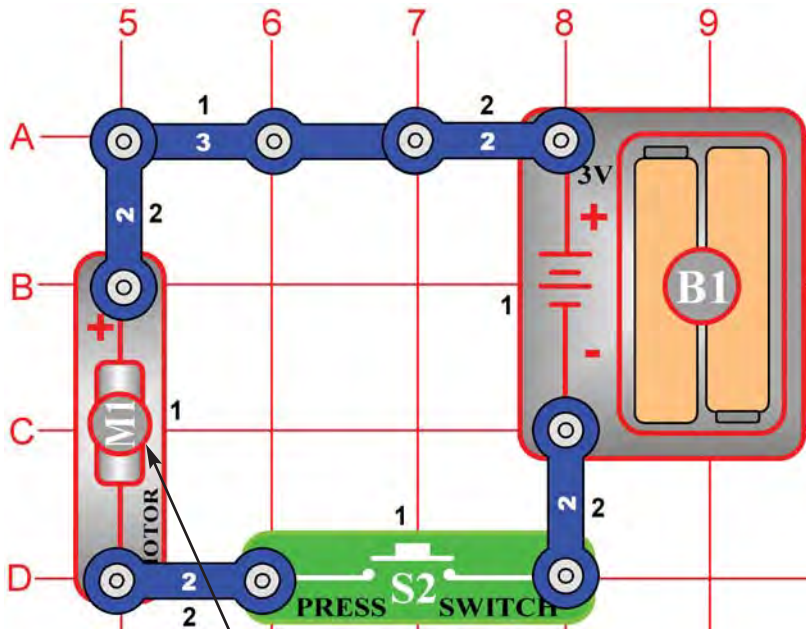
Space War Flicker

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

Build the circuit shown on the left, which uses the space war integrated circuit (U3).

Turn the slide switch (S1) on and the speaker (SP) makes exciting sounds. The output of the IC can control lights, speakers, and other low power devices.

You may replace the speaker with the 6V lamp (L2), and the bulb will flicker. You can also use the LED (D1) in place of the lamp (position it with the "+" side towards the 6-snap).



Project #55 Spinning Rings

OBJECTIVE: To build an electronic spinner.

Setup: Cut out the disc on page #49 that looks like the one shown here. Using Scotch tape, attach the disc with the printed side up on the top of the fan blade. Place the blade on the motor (M1) as shown on the left and below.

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

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

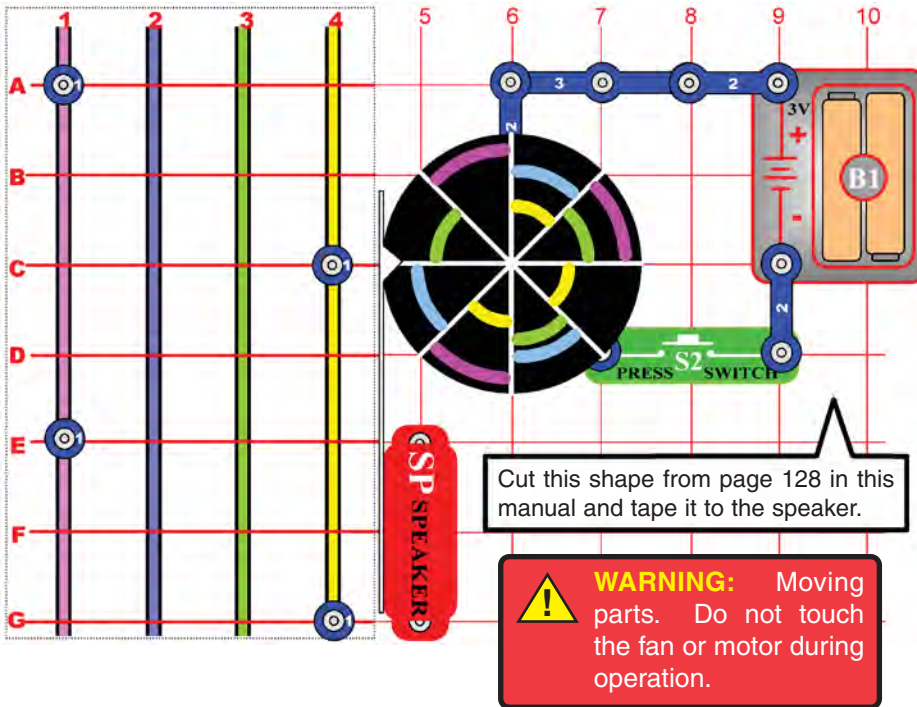
Project #56 Strobe the House Lights

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

Use the circuit from project #55.

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

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



Project #57 Race Game

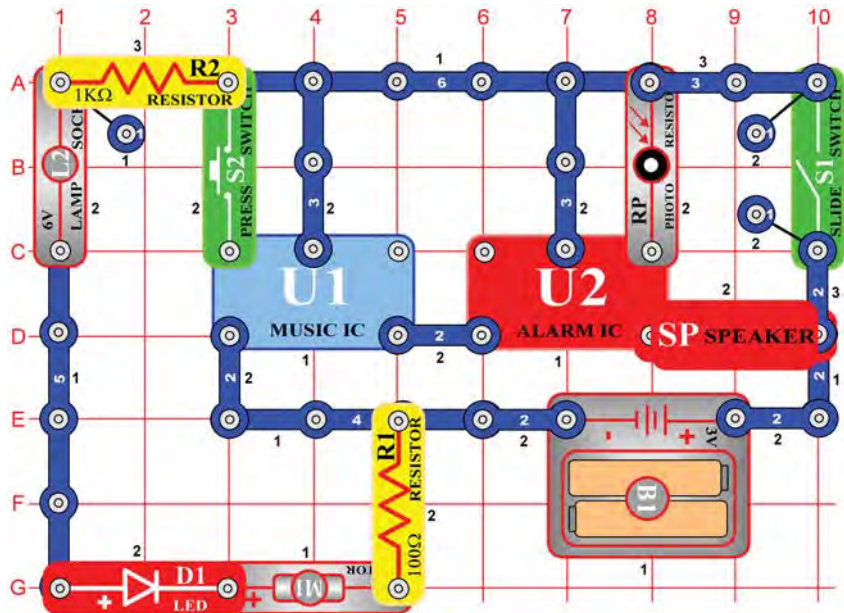
OBJECTIVE: Build an electronic game for racing.

Modify project #56 by adding the pointer as shown on the left. The paper should be cut from page 128 and taped high enough on the speaker (SP) so the pointer will stick over the fan with paper. Bend the pointer at a right angle as shown on the left.

Setup: Cut out the grid with four (4) colors from page 128 and place it under the base as shown on the left. Each player picks a color (or two colors if only 2 people are playing) and places a single snap on row G. The purple player in column 1, the blue player in column 2, the green player in column 3, and the yellow player in column 4. Spin the wheel by pressing the press switch (S2). The first single color wedge that the pointer points to is the first player to start.

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

Project #58

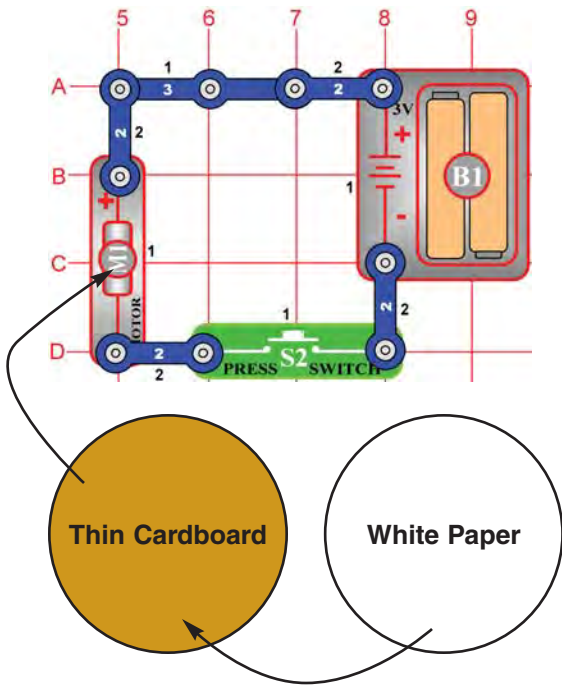


Using Parts as Conductors

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

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

Note that the LED (D1) lights, but the lamp (L2) does not light, and the motor (M1) does not spin. Electricity is flowing through the lamp and motor, but not enough to turn them on. So in this circuit they are acting like 3-snap wires.



Project #59

Spin Draw

OBJECTIVE: *To produce circular artistic drawings.*

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

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

Drawing: To make a ring drawing obtain some thin and thick marking pens as drawing tools. Spin the paper by pressing and holding the press switch (S2) down. Press the marker on the paper to form rings. To make spiral drawings, release the press switch, and as the motor (M1) approaches a slow speed, move the marker from the inside outward quickly.

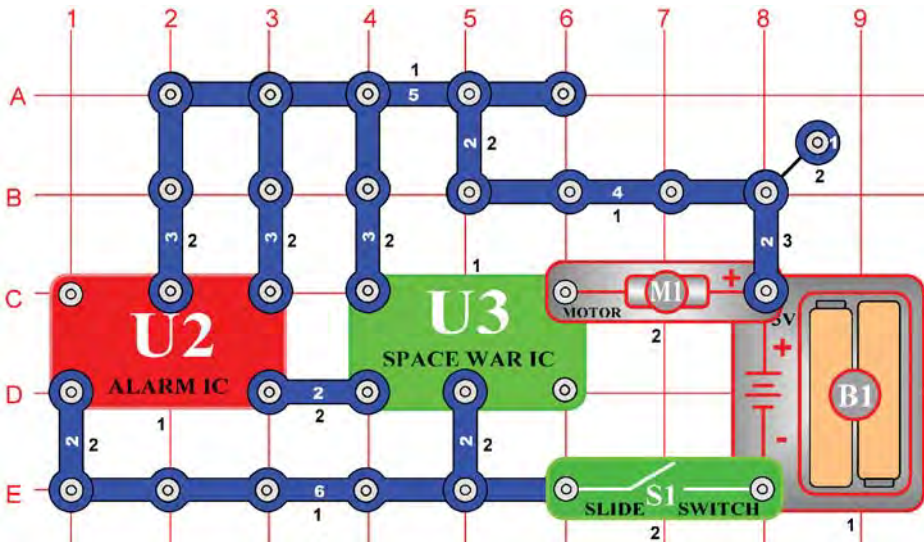
Change the colors often and avoid using too much black to get hypnotic effects. Another method is to make colorful shapes on the disc then spin the disc and watch them blend into each other. When certain speeds are reached under fluorescent lights without electronic ballasts, the strobe principle shown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



Project #60

Space War Flicker Motor

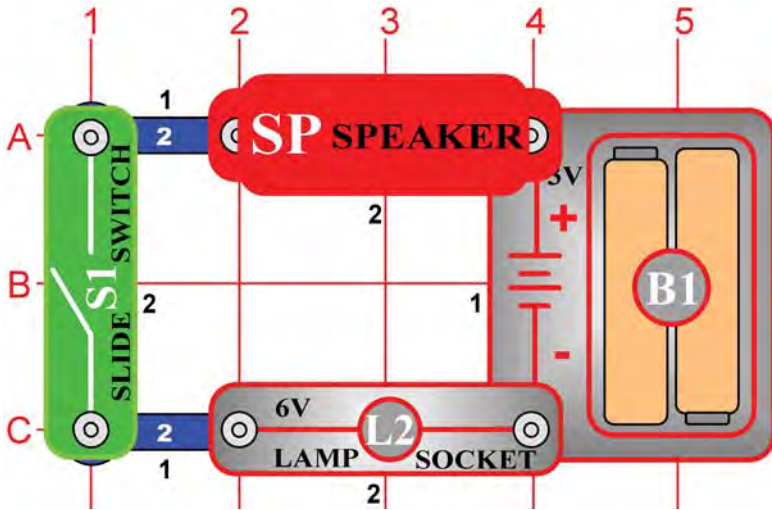
OBJECTIVE: *To run the motor using the space war IC.*



Turn on the slide switch (S1) and the motor (M1) spins (you may need to give it a push with your finger to get it started). The sounds from the space war IC (U3) are used to drive the motor. Because the motor uses magnets and a coil of wire similar to a speaker, you may even hear the space war sounds coming faintly from the motor.



Project #61



Speaker Static

OBJECTIVE: To learn about the speaker.

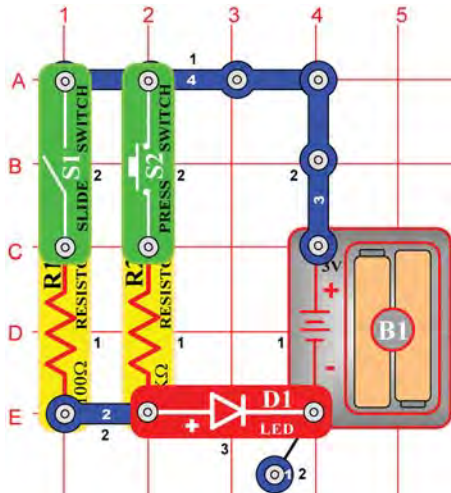
Turn the slide switch (S1) on and off several times. You hear static from the speaker (SP) when you first turn on the switch, but hear nothing after it is left on.

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



Project #62 Parallel Resistors

OBJECTIVE: To learn about resistors.



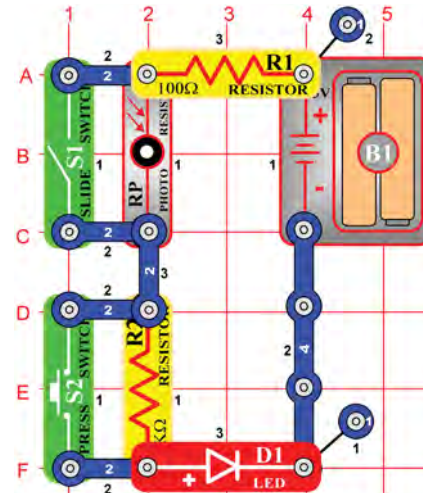
Turn on either or both switches (S1 & S2) and compare the LED (D1) brightness.

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



Project #63 Series Resistors

OBJECTIVE: To learn about resistors.

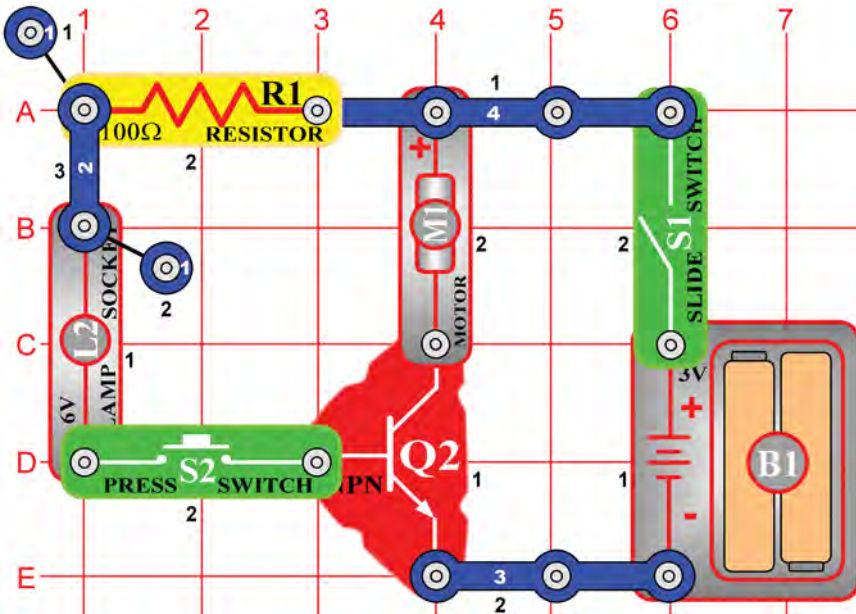


Turn on either or both switches (S1 & S2) and compare the LED (D1) brightness.

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



Project #64



The Transistor (V)

OBJECTIVE: To compare transistor circuits.

Place the fan on the motor (M1) and turn on the slide switch (S1), then compare this circuit to project #27. Press the press switch (S2), the lamp (L2) doesn't light now, but the motor still spins.

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

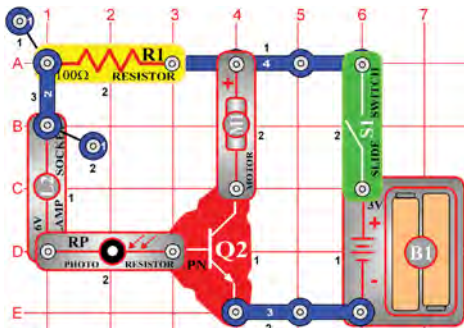
Now replace the 100Ω resistor (R1) with the larger 1KΩ resistor (R2). The motor spins more slowly now, because the transistor cannot create as large of a motor current from such a small controlling current.

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



Project #65 The Transistor (VI)

OBJECTIVE: To compare transistor circuits.



Compare this circuit to project #64. It uses the photoresistor (RP) to control the current to the NPN transistor (Q2), instead of the press switch (S2). You can adjust the speed of the motor (M1) by changing how much light shines on the photoresistor.

The lamp (L2) is dark because the photoresistor limits the current through it. The NPN transistor uses the small lamp current to create a large current that spins the motor.

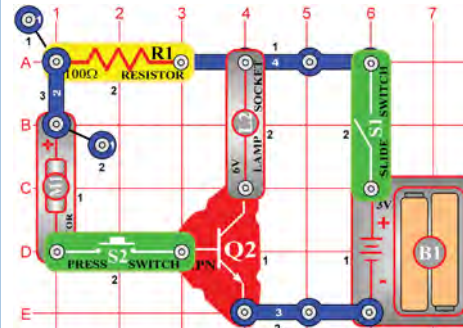
If you tried to control the motor speed by placing the photoresistor in series with the motor, the motor would not spin because the photoresistor would limit the current. But the photoresistor can control the motor speed with help from the transistor. You may need to shine a light on the photoresistor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

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



Project #66 The Transistor (VII)

OBJECTIVE: To compare transistor circuits.



Compare this circuit to project #28. Press the press switch (S2), the motor (M1) doesn't spin now, but the lamp (L2) still lights.

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

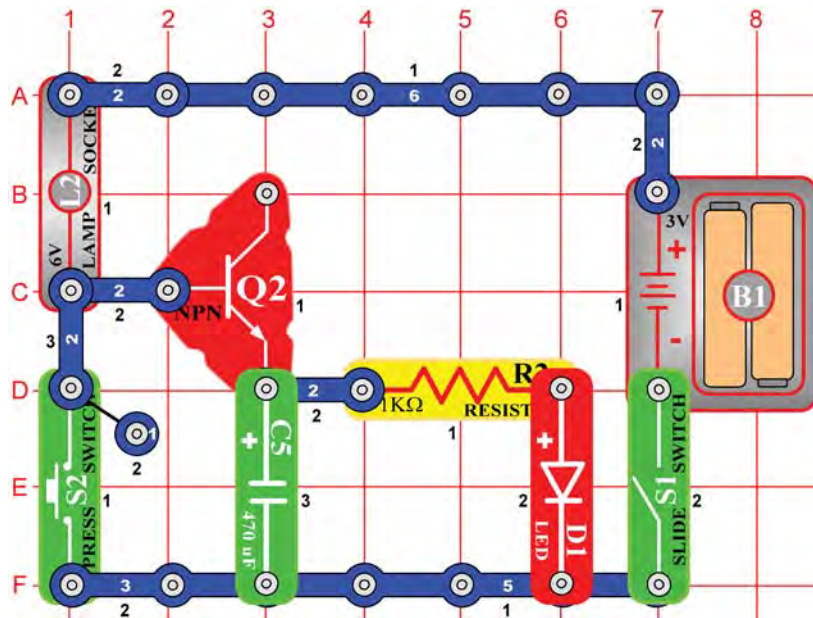
Now replace the 100Ω resistor (R1) with the larger 1KΩ resistor (R2). The lamp is only slightly less bright even though the motor current is much lower.

Now place the 100Ω resistor back in the circuit and replace the press switch (S2) with the photoresistor (RP). A bright light on the photoresistor will turn the lamp on. But if the light is dim then the photoresistor has high resistance, so little current flows through the transistor and the lamp is off.

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



Project #67



Simple Rectifier

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

Turn on the slide switch (S1) and the LED (D1) lights; it will not be very bright so turn off the room lights or hold your fingers around it to see it better. Press the press switch (S2) several times slowly; the LED and lamp (L2) go on and off.

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

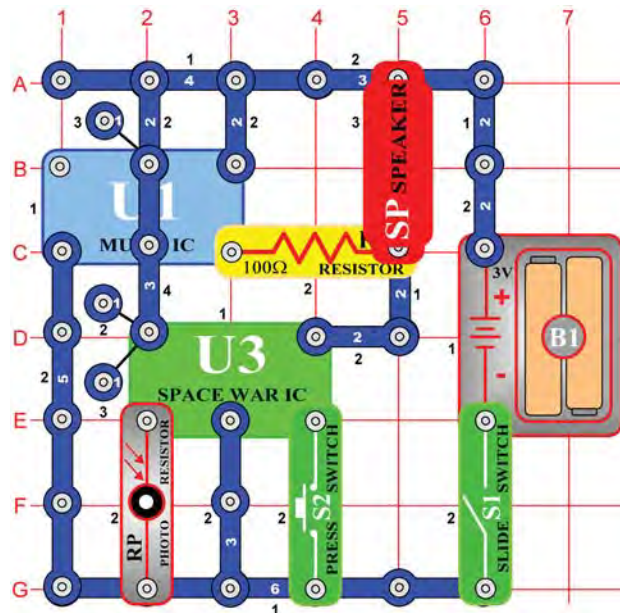
Pressing the switch quickly simulates a changing voltage, which turns the LED on and off. The 470µF capacitor can store electricity, and it combines with the NPN transistor (Q2) to simulate a rectifier. This rectifier converts the changing voltage at the press switch into a constant voltage, which keeps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

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

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



Project #68



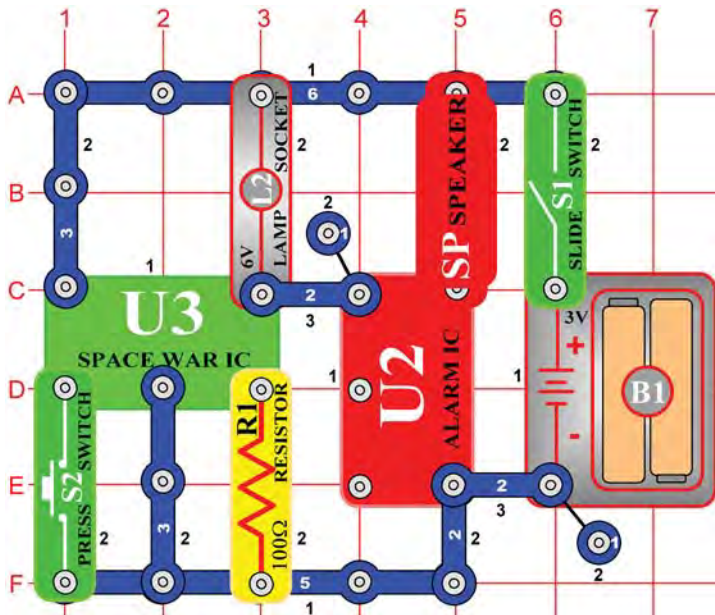
Space War Music Combo

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

Build the circuit shown. Turn it on, press the press switch (S2) several times, and wave your hand over the photoresistor (RP) to hear all the sound combinations. You can make the sound from the music IC (U1) louder by replacing the 100Ω resistor (R1) with the 6V lamp (L2).



Project #69

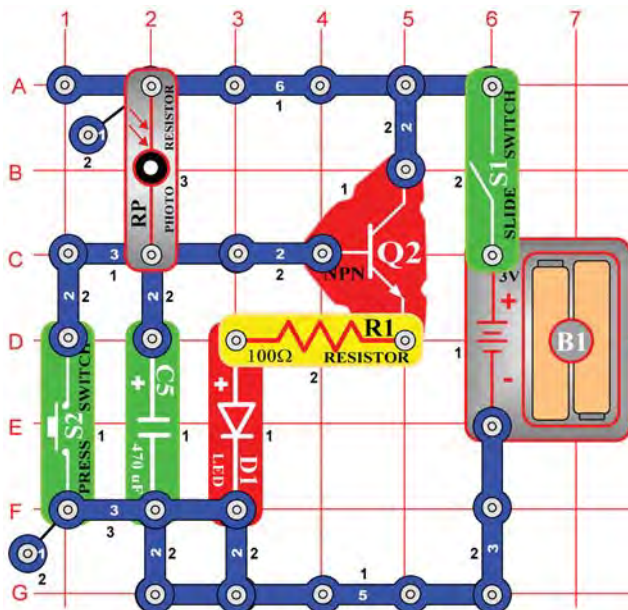


OBJECTIVE: To combine effects from the space war and alarm integrated circuits.

Build the circuit shown on the left and turn on the slide switch (S1). Press and hold the press switch (S2) to make the lamp (L2) brighter.



Project #70



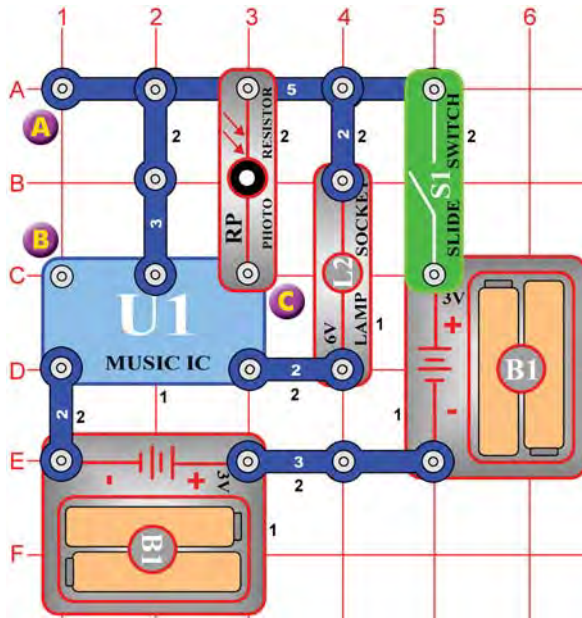
OBJECTIVE: To learn about one device that is used to delay actions in electronics.

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

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



Project #71



Light-controlled Lamp

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

Cover the unit, turn the slide switch (S1) on, and notice that the lamp (L2) is off after a few seconds. Place the unit near a light and the lamp turns on. Cover the photoresistor (RP) and place it near the light again. The lamp will not turn on. The resistance of the photoresistor decreases as the light increases. The low resistance acts like a wire connecting point C to the positive (+) side of the battery (B1).



Project #72

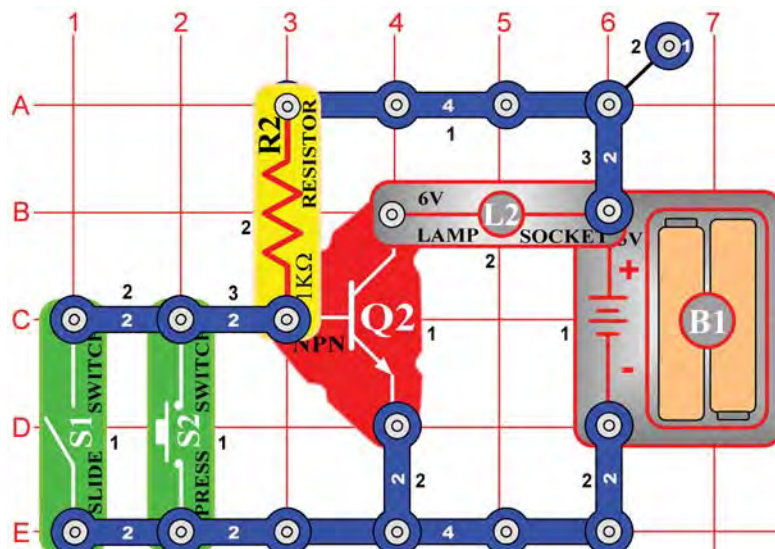
Motor-controlled Lamp

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

Use the circuit from project #71. Remove the photoresistor (RP) and connect the motor (M1) across points A & B. Turn the slide switch (S1) on and turn the shaft of the motor and the lamp (L2) will light. As the motor turns, it produces a voltage. This is because there is a magnet and a coil inside the motor. When the axis turns the magnetic field will change and generate a small current in the coil and a voltage across its terminals. The voltage then activates the music IC (U1).



Project #73



Light NOR Gate

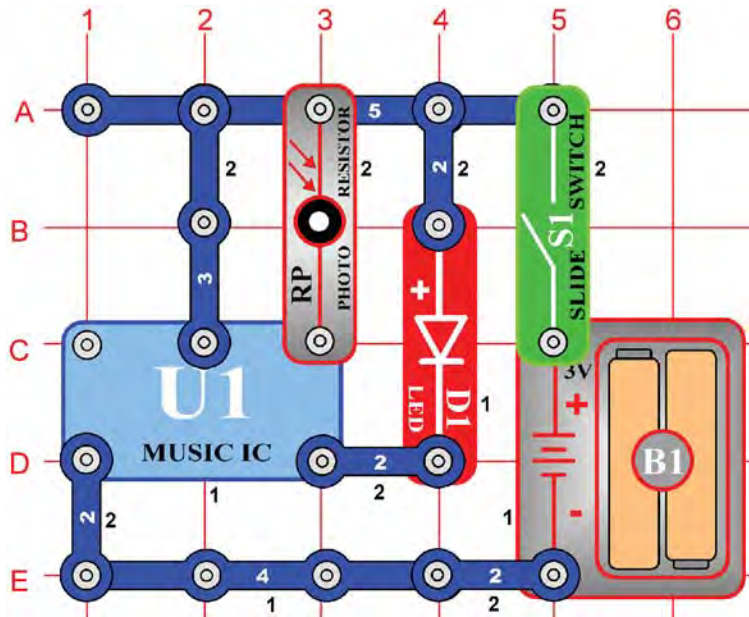
OBJECTIVE: To build a NOR gate.

Build the circuit on the left. You will find that the lamp (L2) is on when neither the slide switch (S1) NOR the press switch (S2) are on. This is referred to as an NOR gate in electronics and is important in computer logic.

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



Project #74



Light-controlled LED

OBJECTIVE: To control an LED using light.

Cover the unit, turn the slide switch (S1) on, and notice that the LED (D1) is on for a few seconds and then goes off. Place the unit near a light and the LED will light. Cover the photoresistor (RP) and place it near the light again. The LED will not turn on. The resistance of the photoresistor decreases as the light increases.



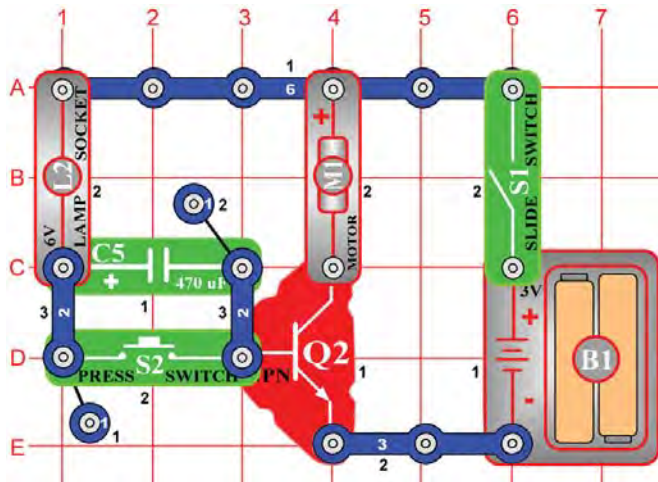
Project #75 Motor-controlled Time Delay LED

OBJECTIVE: To control an LED using a motor.

Use the circuit from project #74. Connect the motor (M1) across points A1 and C1 on the base grid, then remove the photoresistor (RP). Turn the slide switch (S1) on and turn the shaft of the motor and the LED (D1) will light. As the motor turns, it produce a voltage. There is a magnet and a coil inside the motor. When the axis turns the magnetic field will change and generate a small current across its terminals. The voltage then activates the music IC (U1).



Project #76



Capacitor Slow-down

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

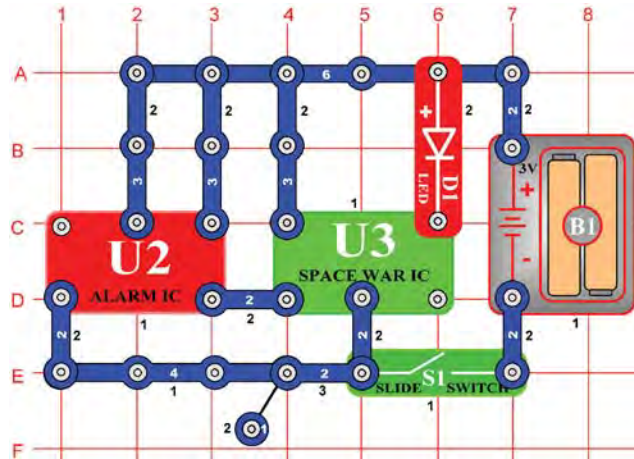
Place the fan on the motor (M1) and turn on the slide switch (S1). The motor spins briefly as the 470µF capacitor (C5) charges up. Turn off the slide switch and press the press switch (S2) to discharge the capacitor and reset the circuit.

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



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

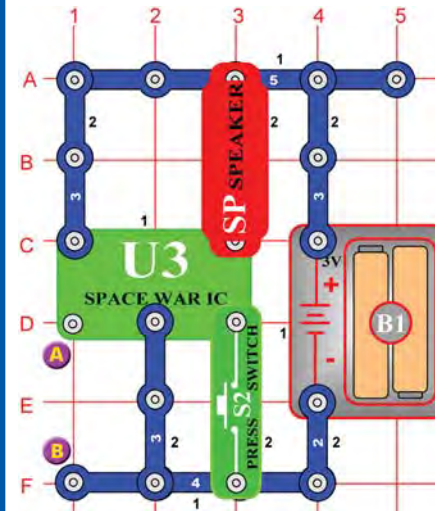
Project #77 Space War Flicker LED



OBJECTIVE: To flash an LED using the space war IC.

Build the circuit shown on the left. The circuit uses the alarm IC (U2) and space war IC (U3) to flash the LED (D1). Turn the slide switch (S1) on and the LED starts flashing.

Project #78 Human Space War

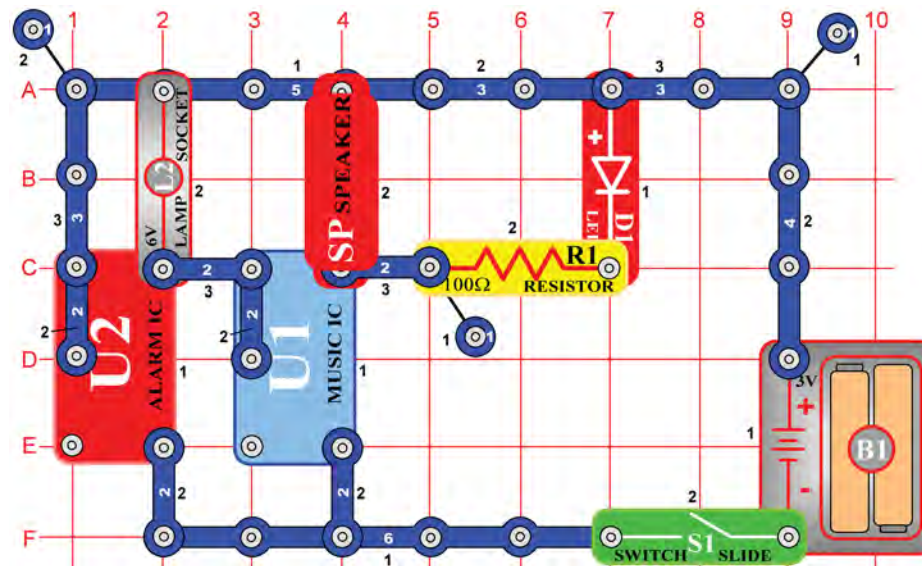


OBJECTIVE: To use your body to control the space war IC.

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

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

Project #79



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

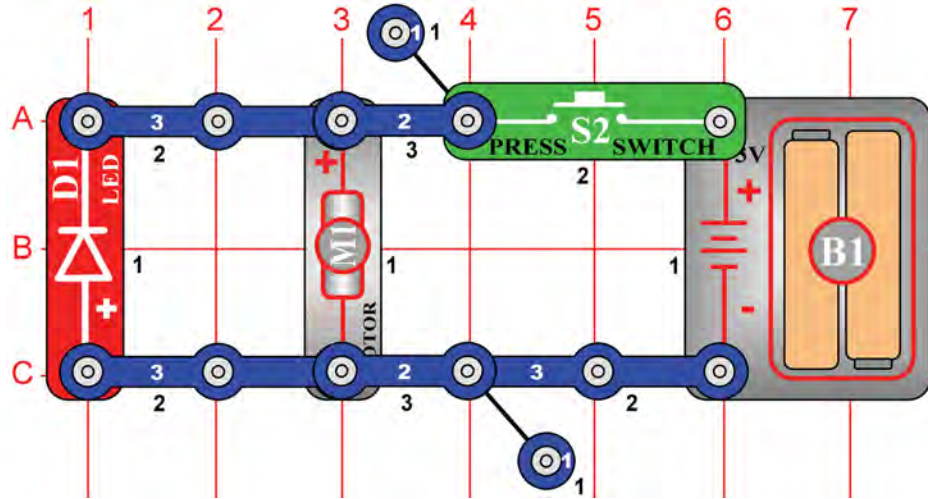
Turn the slide switch (S1) on and the lamp (L2) and LED (D1) starts flashing. You hear two different tones driving the LED and lamp. IC's can be connected to control many different devices at the same time.



Project #80

Fan Blade Storing Energy

OBJECTIVE: To show that the fan blade stores energy.



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

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

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

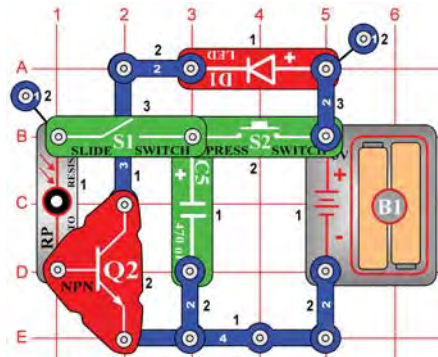
WARNING: Moving parts. Do not touch the fan or motor during operation.

WARNING: Do not lean over the motor.



Project #81 Photo Timer Light

OBJECTIVE: To show how capacitors store energy.



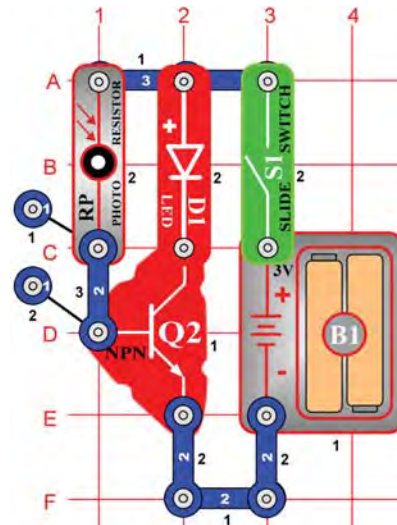
Press and release the press switch (S2), then turn on the slide switch (S1). The LED will light for a while when there is light on the photoresistor (RP).

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



Project #82 NPN Light Control

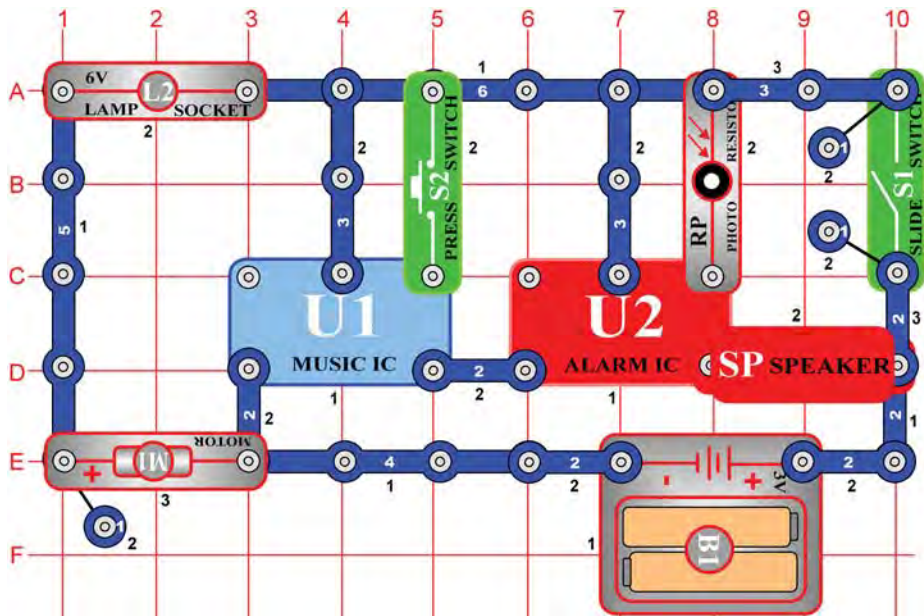
OBJECTIVE: To compare transistor circuits.



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



Project #83



Fun with the Alarm IC

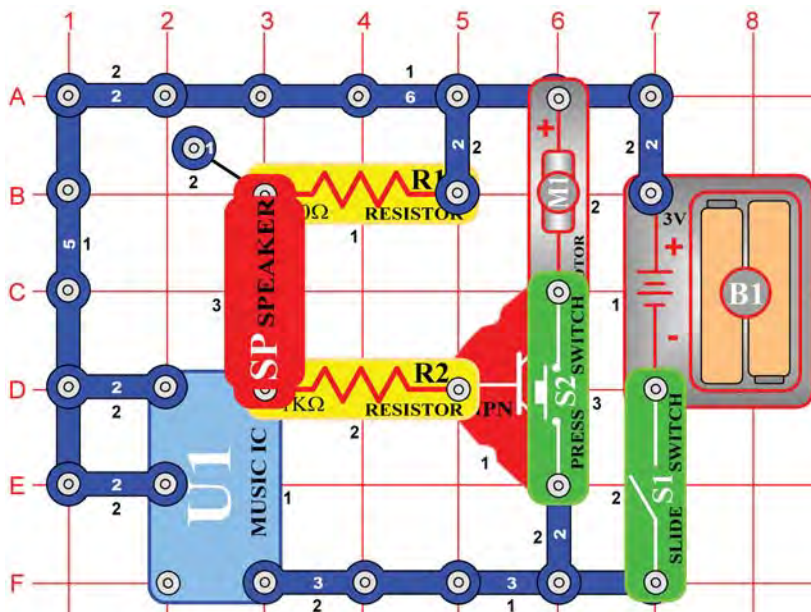
OBJECTIVE: To show some new ways of using the alarm IC.

Place the fan on the motor (M1) and turn on the slide switch (S1). The lamp (L2) lights, the motor spins, and you hear a machine gun sound (with music in background). Thoroughly cover the photoresistor (RP) with your hand and the sound becomes a siren. After a while the sound will stop, hold down the press switch (S2) and the sound resumes.

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



Project #84



Musical Motor

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

Place the fan on the motor (M1) and turn on the slide switch (S1). A song is heard and the fan spins unevenly. The fan speed is being controlled by the music IC (U1).
 Now press the press switch (S2) to control the motor directly, and the motor spins much faster.

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



Project #85 Musical Light

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

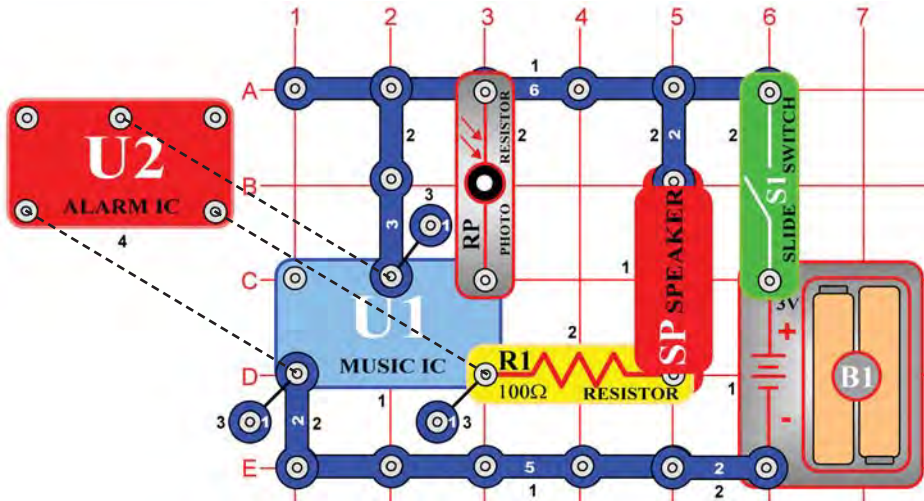
Use the circuit in project #84. Replace the motor (M1) with the 6V lamp (L2). Now the music IC (U1) and press switch (S2) control the lamp brightness.



Project #86

Music Alarm Combo

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



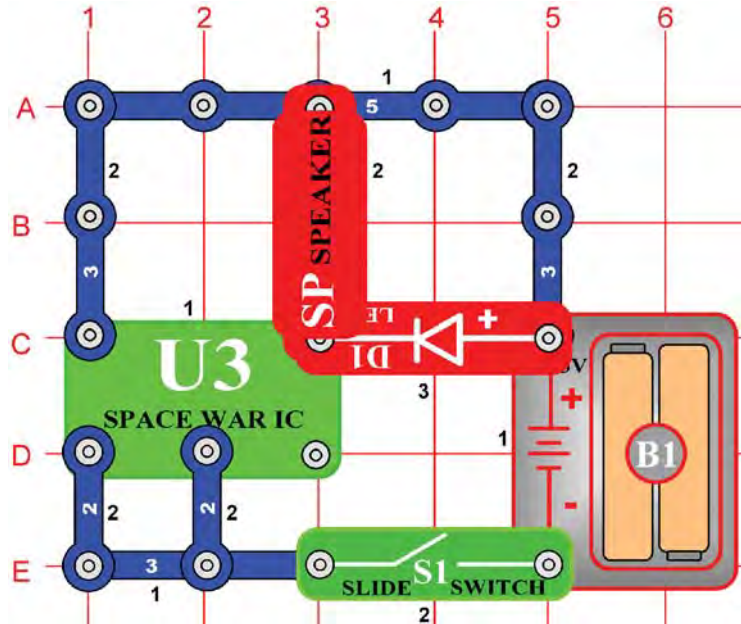
Build the circuit shown and then place the alarm IC (U2) directly over the music IC (U1), resting on the three 1-snaps. Turn on the slide switch (S1) and you will hear a siren and music together. After a few seconds, covering the photoresistor (RP) will stop the music (but the siren continues).



Project #87

Bomb Sound

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



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



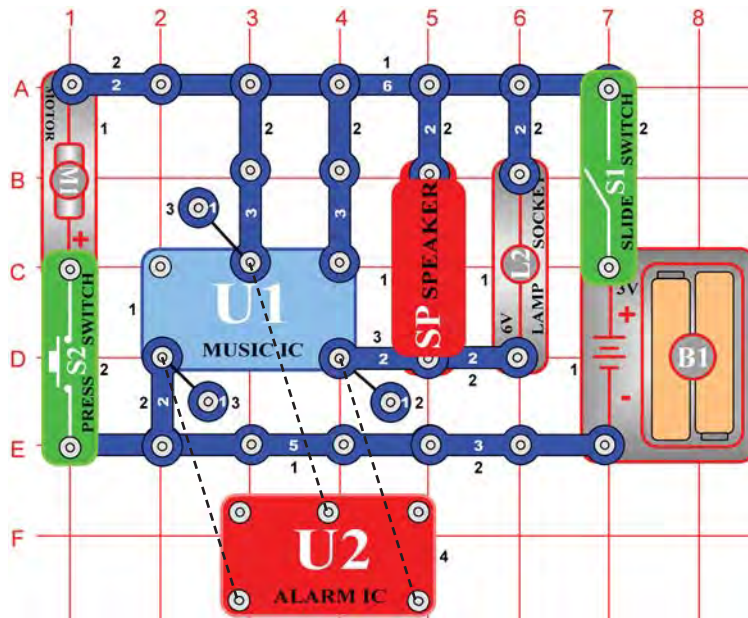
Project #88 Bomb Sound (II)

OBJECTIVE: Build a circuit that sounds like bombs dropping.

Use the circuit from project #87. Replace the slide switch (S1) with the motor (M1). Turn the shaft on the motor and now it sounds like a bunch of bombs dropping.



Project #89



Motor Sounds Combo

OBJECTIVE: To connect multiple devices together.

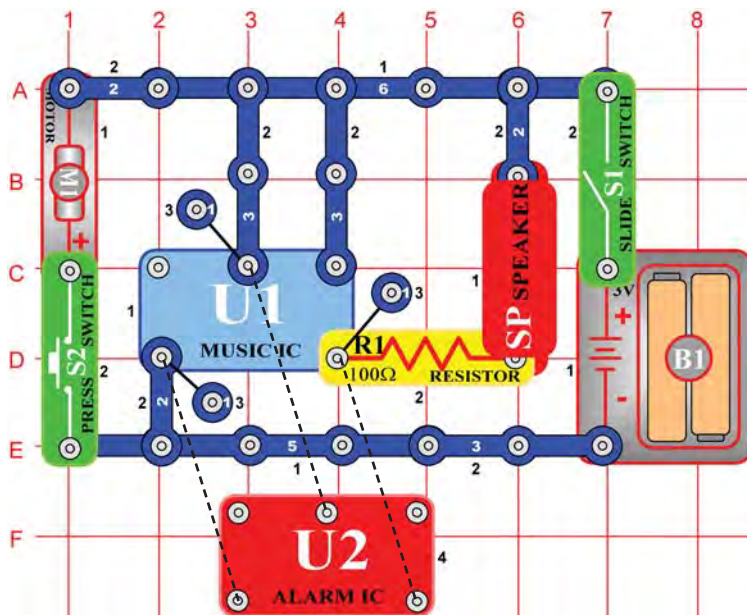
In the circuit, the outputs from the alarm IC (U2) and music IC (U1) are connected together. Build the circuit shown and then place the alarm IC directly over the music IC, resting on two 1-snaps and a 2-snap. Turn on the slide switch (S1) and you will hear a siren and music together while the lamp (L2) varies in brightness. Press the press switch (S2) and the fan spins, while the sound may not be as loud. The fan may rise into the air when you release the switch.

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

WARNING: Do not lean over the motor.



Project #90



Motor Sounds Combo (II)

OBJECTIVE: To connect multiple devices together.

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

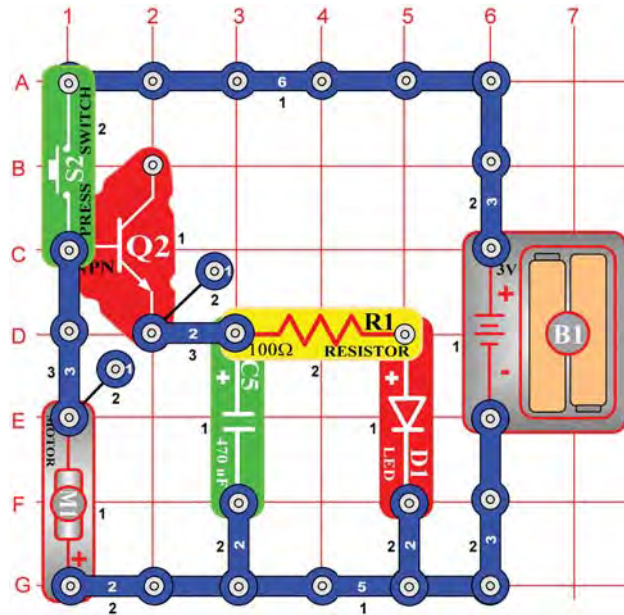
This circuit is similar to project #89, but the fan will fly a little higher since the sound circuit no longer drives the lamp (L2) and therefore uses less battery power.

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

WARNING: Do not lean over the motor.



Project #91



Fan Detector

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

Press the press switch (S2). If the fan is off the motor (M1) (or flies off) then the LED (L1) will light.

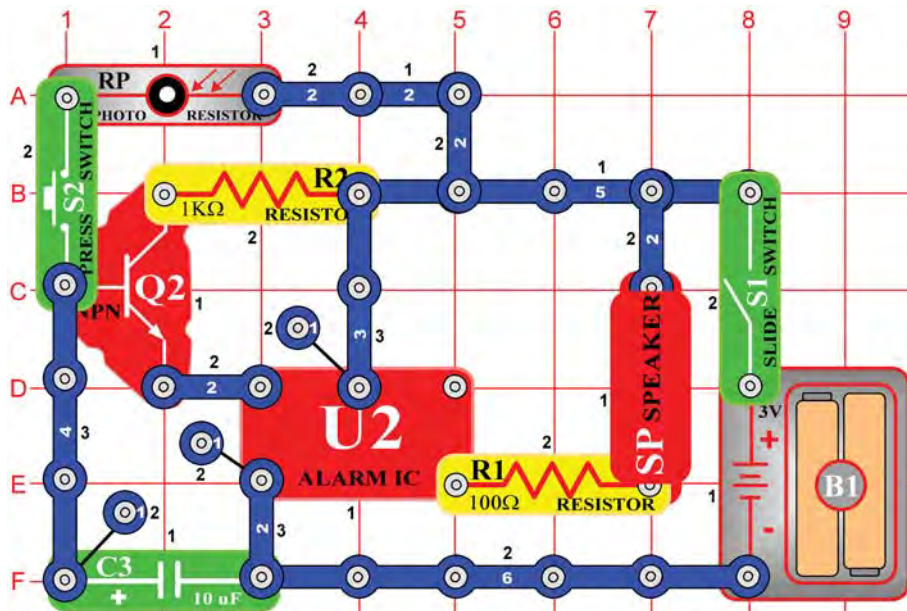
It takes a lot of current to spin the motor when the fan is on it, and the voltage drops because the batteries (B1) cannot supply enough. When the fan flies off, the current drops and the voltage rises. The NPN transistor (Q2, used here as a diode) and 470µF capacitor (C5) are a detector circuit, which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

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

WARNING: Do not lean over the motor.



Project #92



Slow Siren Changer

OBJECTIVE: To change siren sounds with a delay.

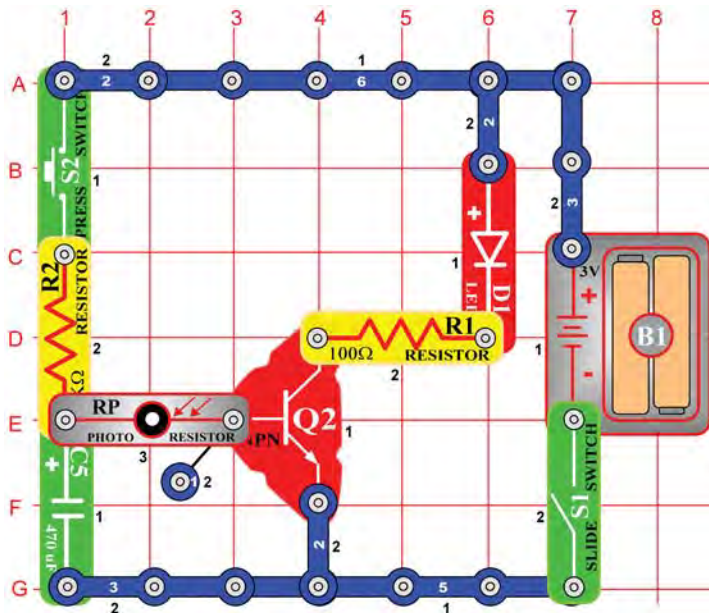
Turn on the slide switch (S1) and you hear a siren sound.

Now hold down the press switch (S2) until the sound becomes a fire engine sound. This delay is due to the 10µF capacitor (C3) charging up and is controlled by the photoresistor (RP). If there is bright light on the photoresistor, then the delay will be only a few seconds.

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



Project #93



Capacitor Photo Control

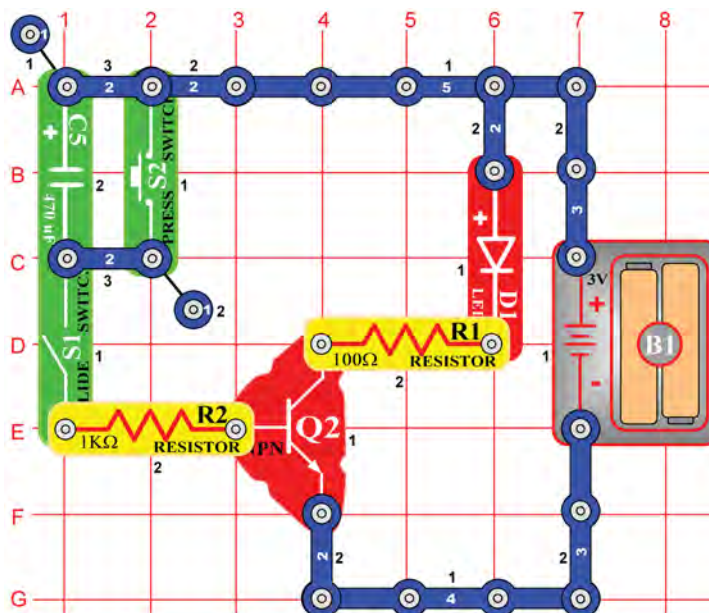
OBJECTIVE: To learn about a device that is used to delay actions in electronics.

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

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



Project #94



Capacitor Control

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

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

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



Project #95

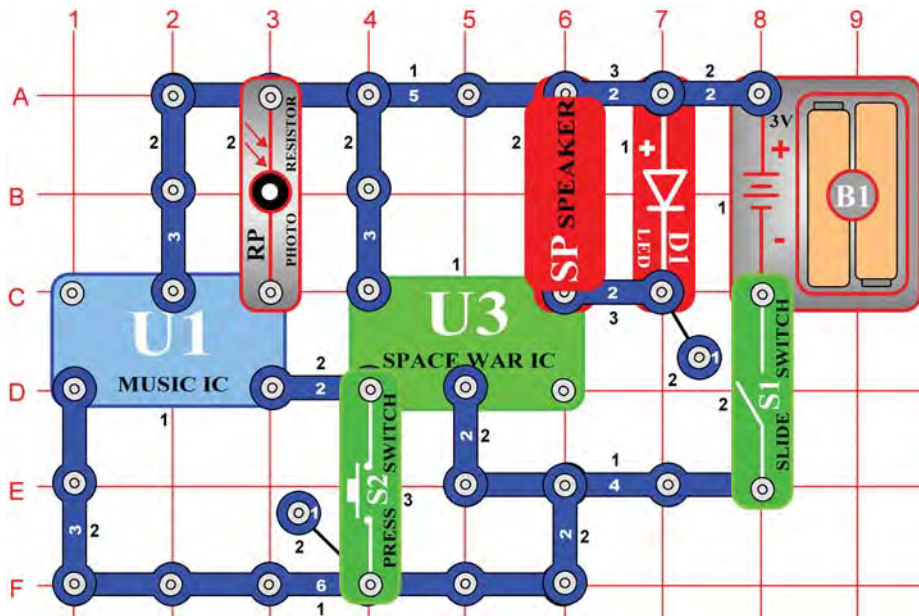


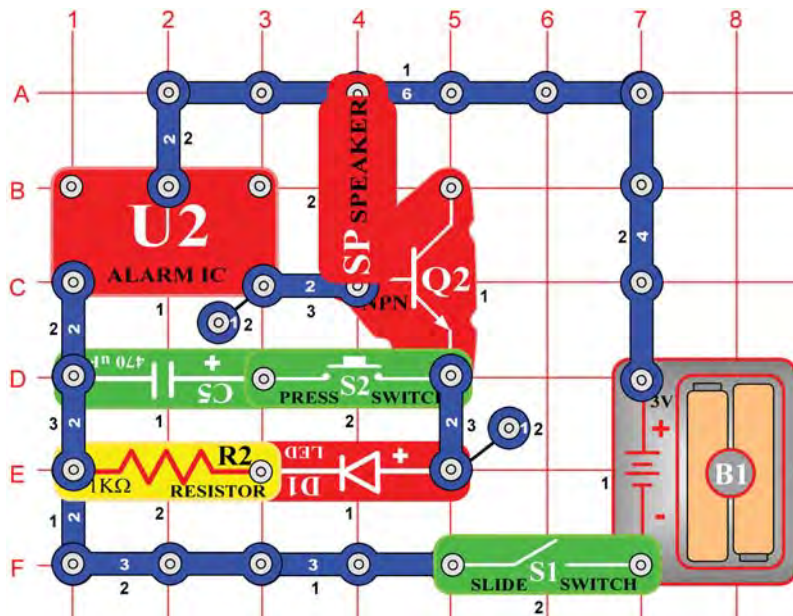
Photo Space War with LED

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

Turn the slide switch (S1) on, a space war sound plays and the LED (D1) flashes. Press the press switch (S2) to change the sound. If the photoresistor (RP) is covered, then the sound may stop. Shine light on it and action resumes. See how many sounds are programmed into the space war sound IC (U3).



Project #96



Alarm Rectifier

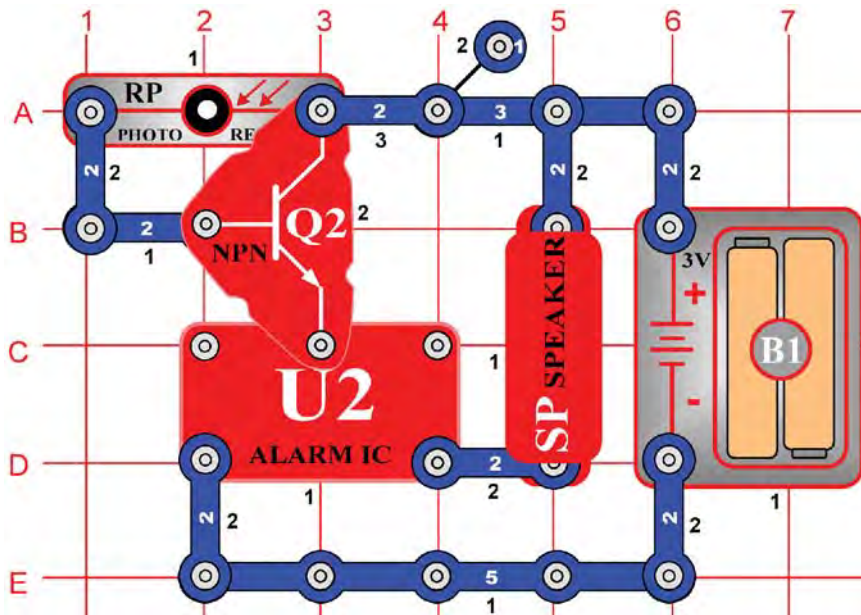
OBJECTIVE: To convert a changing voltage into a constant voltage.

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

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



Project #97



Light-controlled Alarm

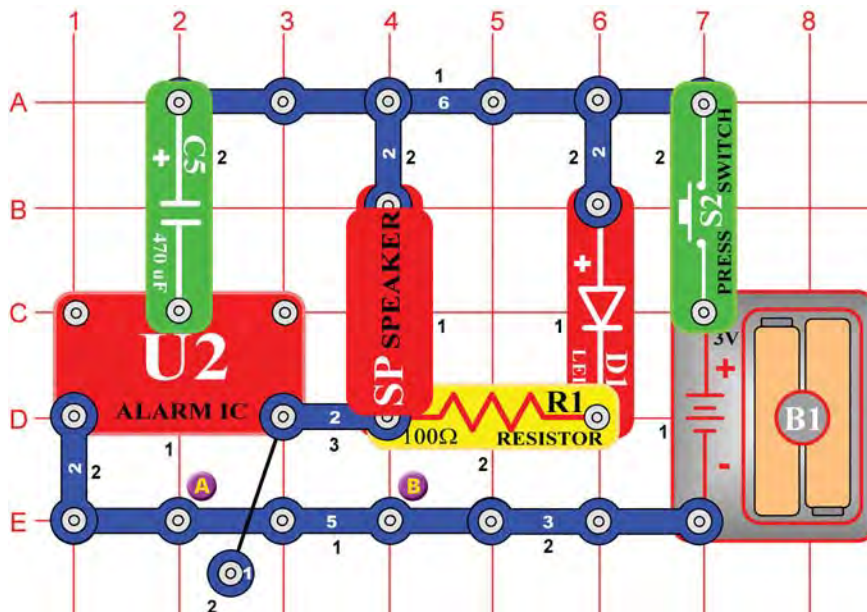
OBJECTIVE: To show how light is used to turn an alarm.

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

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



Project #98



Fading Siren

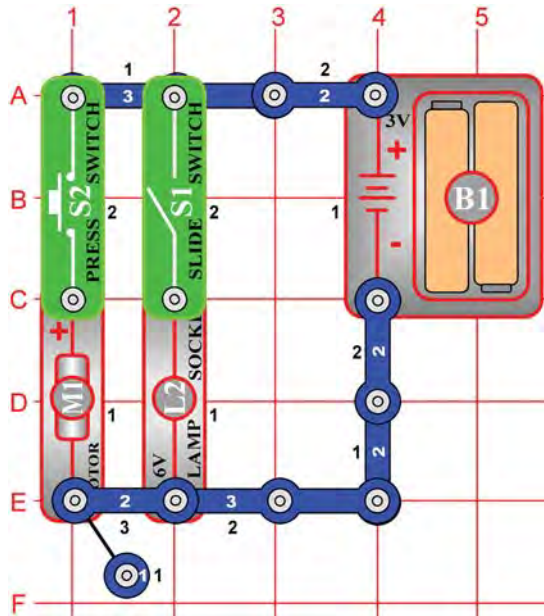
OBJECTIVE: To produce sound of a siren driving away into the distance.

Press the press switch (S2), the integrated circuit (U2) should make the sound of an up-down siren that gets weaker with time. The fading is produced by the charging of the 470µF capacitor (C5), After it is charged the current stops and the sound is very weak.

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



Project #99



Lamp & Fan Independent

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

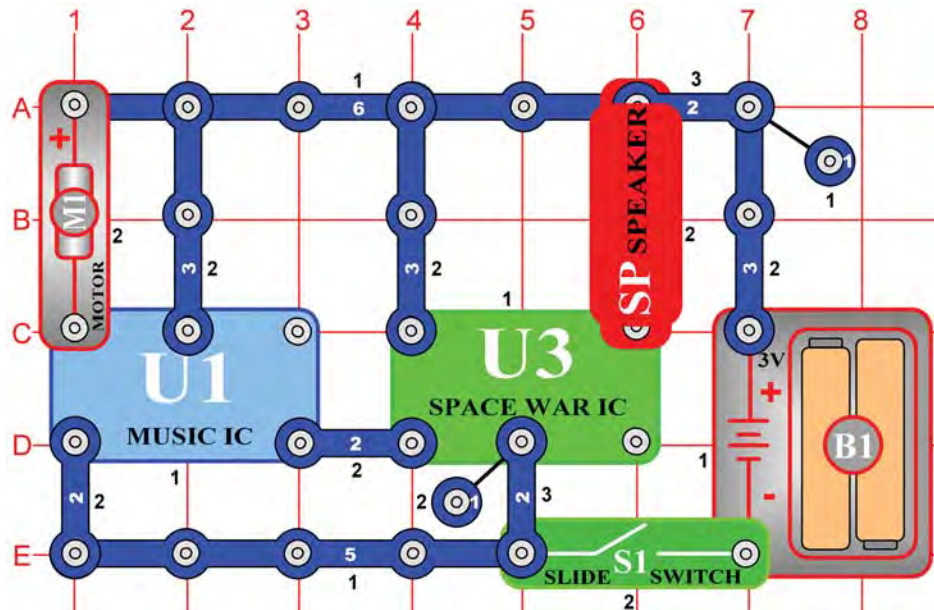
This circuit combines projects #1, #2, and #6 into one circuit.

Build the circuit and place the fan on the motor (M1). Depending on which of the switches (S1 or S2) are on, you can turn on either the lamp (L2) (project #1), the motor (M1) (project #2), or both together (project #6).

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



Project #100 Motor Space Sounds



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

Turn on the slide switch (S1) and wait for any sounds to stop then spin the motor (M1) and the sounds play again.

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



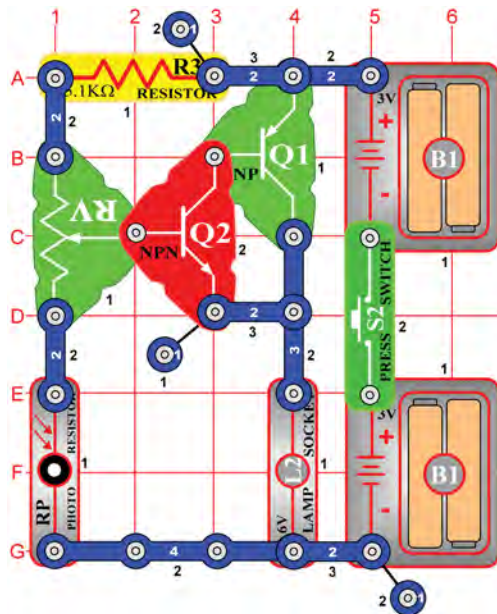
Project #101 Motor Space Light

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

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



Project #102



Automatic Street Lamp

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

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

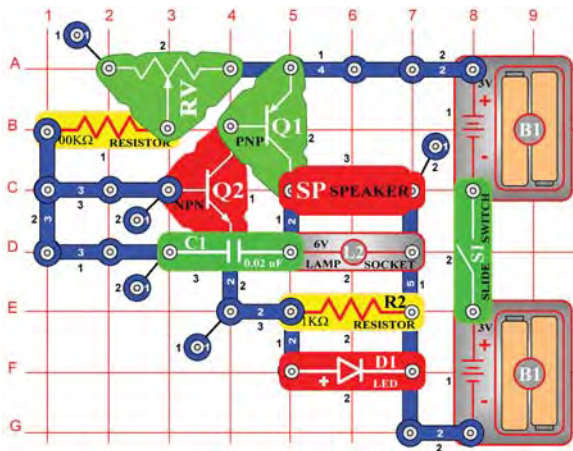
This is an automatic street lamp that you can turn on by a certain darkness and turn off by a certain brightness. This type of circuit is installed on many outside lights and forces them to turn off and save electricity. They also come on when needed for safety.



Project #103

Pitch

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



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



Project 104 Pitch (II)

OBJECTIVE:
See project #103.

Since we've seen we can adjust the frequency by varying the resistance in the adjustable resistor (RV), are there other ways to change frequency? You can also change frequency by changing the capacitance of the circuit. Replace the 0.02µF capacitor (C1) with the 0.1µF capacitor (C2); notice how the sound has changed.



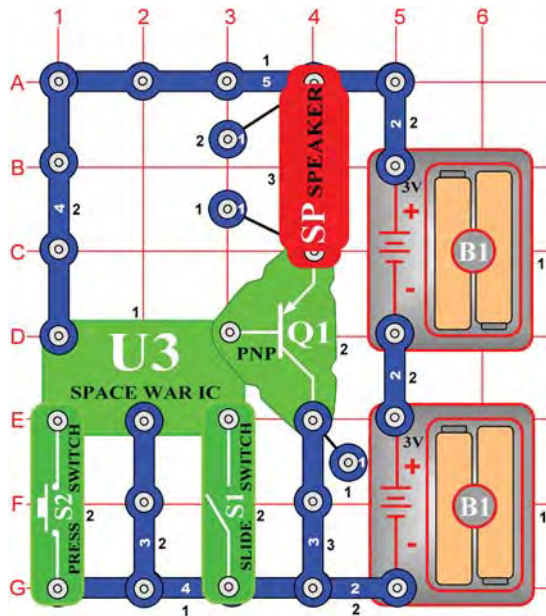
Project 105 Pitch (III)

OBJECTIVE:
See project #103.

Replace the 0.1µF capacitor (C2) with the 0.02µF capacitor (C1) and replace the 100kΩ resistor (R5) with the photoresistor (RP). Wave your hand up and down over the photoresistor to change the sound. Changing the light on the photoresistor changes the circuit resistance just like varying the adjustable resistance does. **Note:** If you have the adjustable resistor (RV) set to the right and light shining on the photoresistor, then you may not get any sound because the total resistance is too low for the circuit to operate.



Project #106



Space War Sounds

OBJECTIVE: To build a circuit that produces multiple space war sounds.

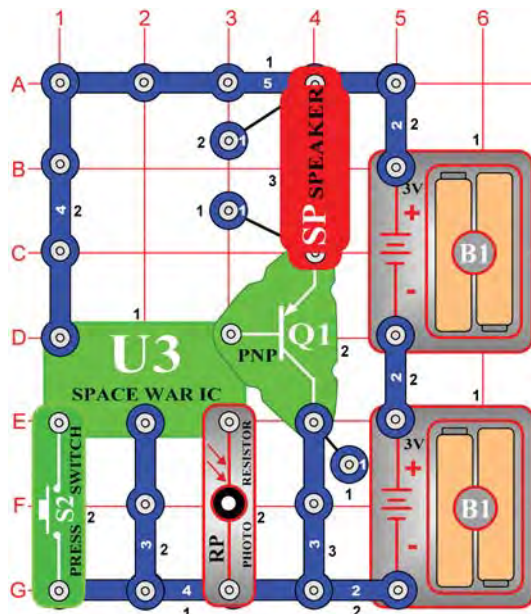
Turn the slide switch (S1) to the OFF position. Press the press switch (S2) down and a space sound will be played. If you hold the press switch down the sound repeats. Press the press switch again and a different sound is played. Keep pressing the press switch to hear all the different sounds.

Next, turn the slide switch to ON position. One of the sounds will be played continuously. Turn the switch off and then back on. A different sound is played. Keep pressing the press switch to hear all the different combinations of sounds.

The space war integrated circuit has "logic" built into its circuitry that allows it to switch between many different sounds.



Project #107



Space War Sounds Controlled By Light

OBJECTIVE: To change the sounds of a multiple space war with light.

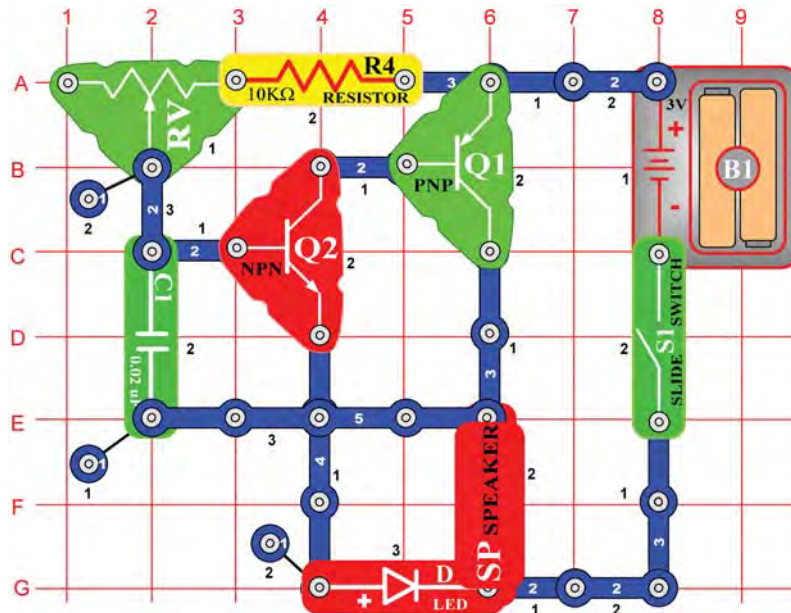
Modify the preceding circuit to look like the one shown on the left.

The space war IC (U3) will play a sound continuously. Block the light to the photoresistor (RP) with your hand. The sound will stop. Remove your hand and a different sound is played. Wave your hand over the photoresistor to hear all the different sounds.

Press the press switch (S2) down and now two space war sounds are played. If you hold the press switch down the sound repeats. Press the press switch again and a different sound is played. Keep pressing the press switch to hear all the different combinations of sounds.



Project #108



Adjustable Tone Generator

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

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



Project #109 Photosensitive Electronic Organ

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

Use the circuit from project #108 shown above. Replace the 10kΩ (R4) with the photoresistor (RP). Turn on the slide switch (S1). The speaker (SP) will sound and the LED (D1) will light. Move your hand up and down over the photoresistor (RP) and the frequency changes. Decreasing the light on the photoresistor increases the resistance and causes the circuit to oscillate at a lower frequency. Notice that the LED flashes also at the same frequency as the sound.

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



Project #110 Electronic Cicada

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

Use the circuit from project #108 shown above, replace the photoresistor (RP) back to the 10kΩ resistor (R4). Place the 0.1μF capacitor (C2) on top of the 0.02μF capacitor (C1). Turn the slide switch (S1) on and adjust the adjustable resistor (RV). The circuit produces the sound of the cicada insect. By placing the 0.1μF capacitor on top of the 0.02μF capacitor, the circuit oscillates at a lower frequency. Notice that the LED (D1) flashes also at the same frequency.

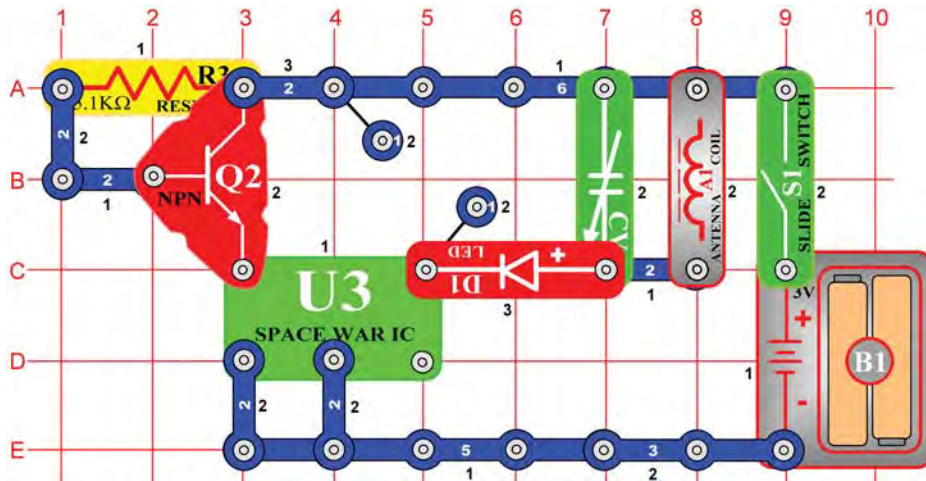
It is possible to pick resistors and capacitors that will make the pitch higher than humans can hear. Many animals, however, can hear these tones. For example, a parakeet can hear tones up to 50,000 cycles per second, but a human can only hear to 20,000.



Project #111

Space War Radio

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



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

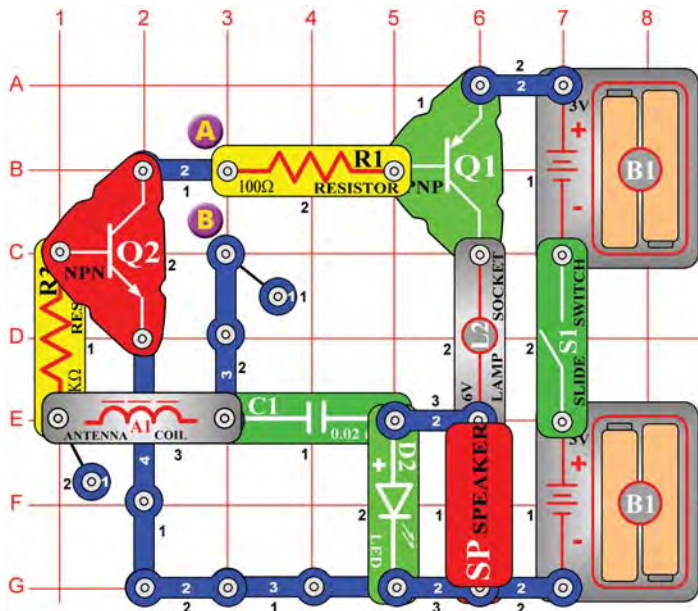
You have just performed the experiment that took Guglielmo Marconi (who invented the radio) a lifetime to invent. The technology of radio transmission has expanded to the point that we take it for granted. There was a time, however, when news was only spread by word of mouth.



Project #112

The Lie Detector

OBJECTIVE: To show how sweat makes a better conductor.

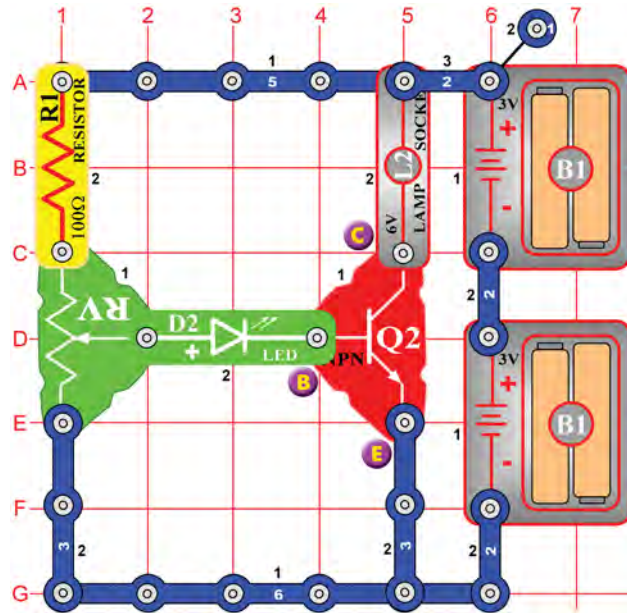


Turn on the slide switch (S1) and place your finger across points A & B. The speaker (SP) will output a tone and the LED (D2) will flash at the same frequency. Your finger acts as a conductor connecting points A & B. When a person is lying, one thing the body starts to do is sweat. The sweat makes the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

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



Project #113



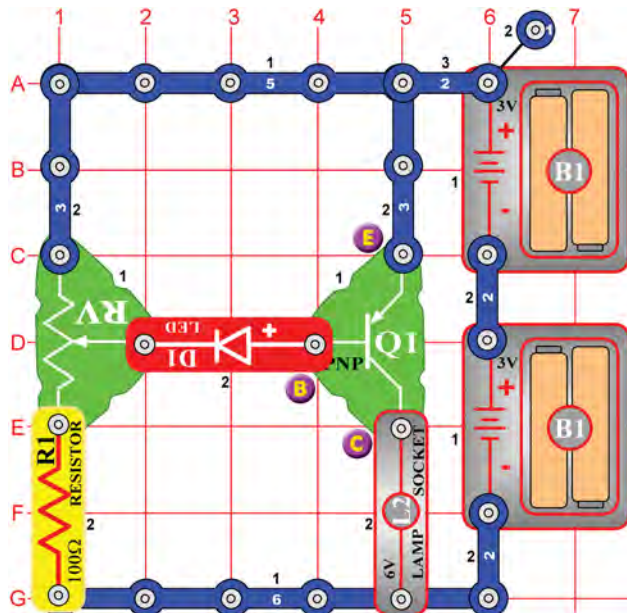
NPN Amplifier

OBJECTIVE: To compare transistor circuits.

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



Project #114



PNP Amplifier

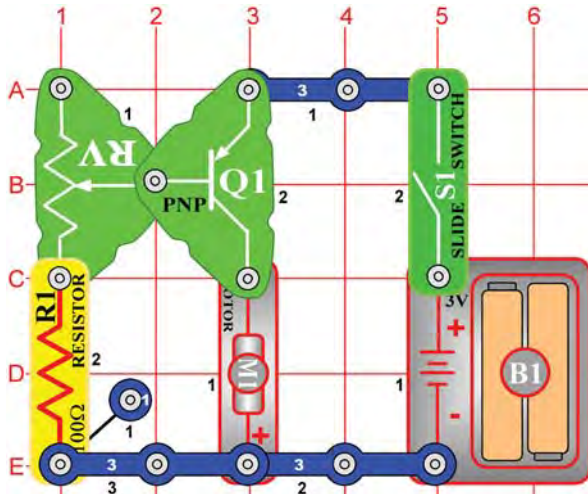
OBJECTIVE: To compare transistor circuits.

The PNP transistor (Q1) is similar to the NPN transistor (Q2) in project #113 except that the electric currents flow in the opposite directions. When a small electric current flows from the emitter to the base, a larger (*amplified*) current will flow from the emitter to the collector. Build the circuit and slowly move down the adjustable resistor (RV) control. When the LED (D1) becomes bright, the lamp (L2) will also turn on and will be much brighter.

Project #115

Sucking Fan

Project #116 Blowing Fan



OBJECTIVE: To adjust the speed of a fan.

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

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

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

WARNING: Do not lean over the motor.

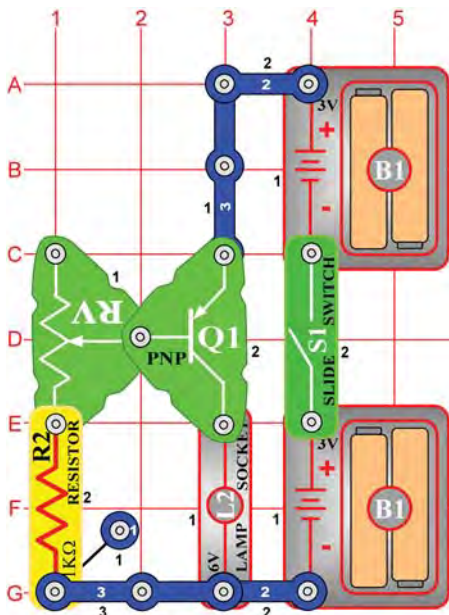
OBJECTIVE: To build a fan that won't come off.

Modify the circuit from project #115 by reversing the position of the motor (M1) so the positive (+) side is towards the PNP transistor (Q1). Turn it on, and set the adjustable resistor (RV) for the fan speed you like best. Set it for full speed and see if the fan flies off - it won't! The fan is blowing air upward now! Try holding a piece of paper just above the fan to prove this.

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

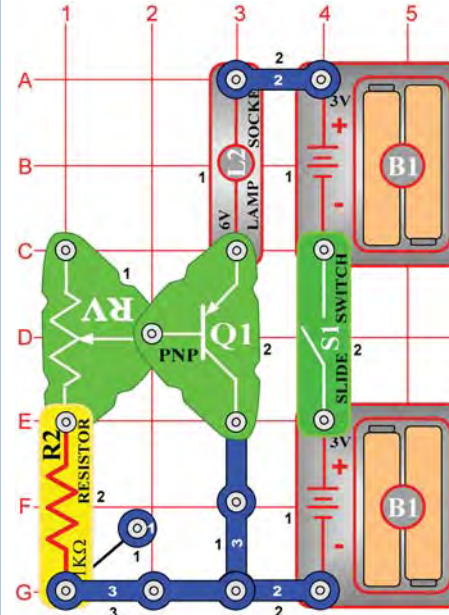
Project #117 PNP Collector

Project #118 PNP Emitter



OBJECTIVE: To demonstrate adjusting the gain of a transistor circuit.

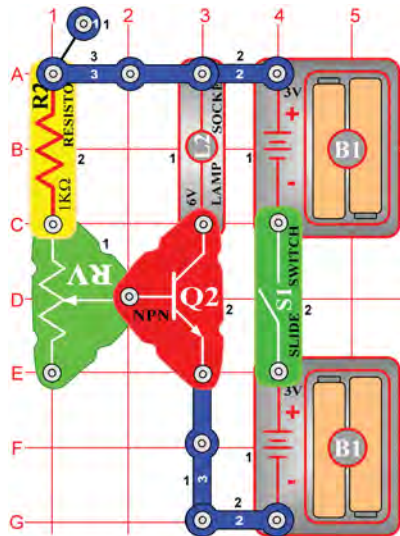
Build the circuit and vary the lamp (L2) brightness with the adjustable resistor (RV), it will be off for most of the resistor's range. The point on the PNP transistor (Q1) that the lamp is connected to (point E3 on the base grid) is called the collector, hence the name for this project.



OBJECTIVE: To compare transistor circuits.

Compare this circuit to that in project #117. The maximum lamp (L2) brightness is less here because the lamp resistance reduces the emitter-base current, which contacts the emitter-collector current (as per project #117). The point on the PNP transistor (Q1) that the lamp is now connected to (grid point C3) is called the emitter.

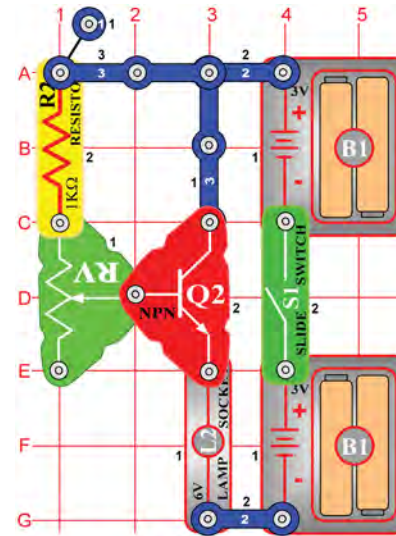
Project #119 NPN Collector



OBJECTIVE: To compare transistor circuits.

Compare this circuit to that in project #117, it is the NPN transistor (Q2) version and works the same way. Which circuit makes the lamp (L2) brighter? (They are about the same because both transistors are made from the same materials).

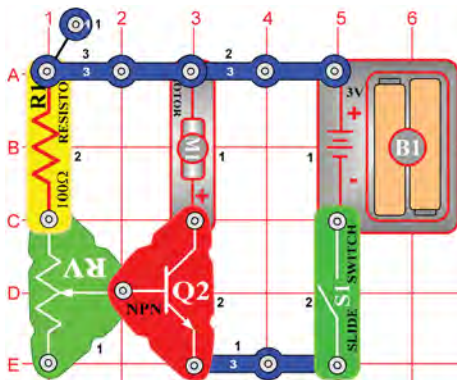
Project #120 NPN Emitter



OBJECTIVE: To compare transistor circuits.

Compare this circuit to that in project #118. It is the NPN transistor (Q2) version and works the same way. The same principles apply here as in projects #117-#119, so you should expect it to be less bright than #119 but as bright as #118.

Project #121 NPN Collector - Motor



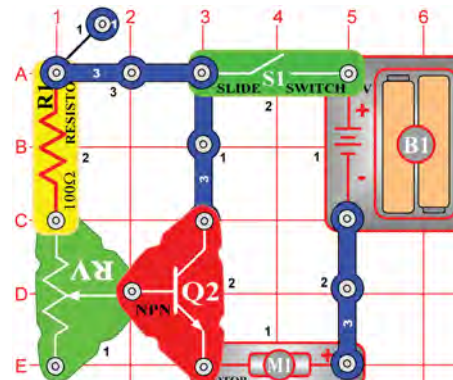
OBJECTIVE: To compare transistor circuits.

This is the same circuit as in project #119, except that it has the motor (M1) instead of the lamp (L2). Place the motor with the positive (+) side touching the NPN transistor (Q2) and put the fan on it.

The fan will not move on most settings of the resistor (R1), because the resistance is too high to overcome friction in the motor. If the fan does not move at any resistor setting, then replace your batteries.

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

Project #122 NPN Emitter - Motor

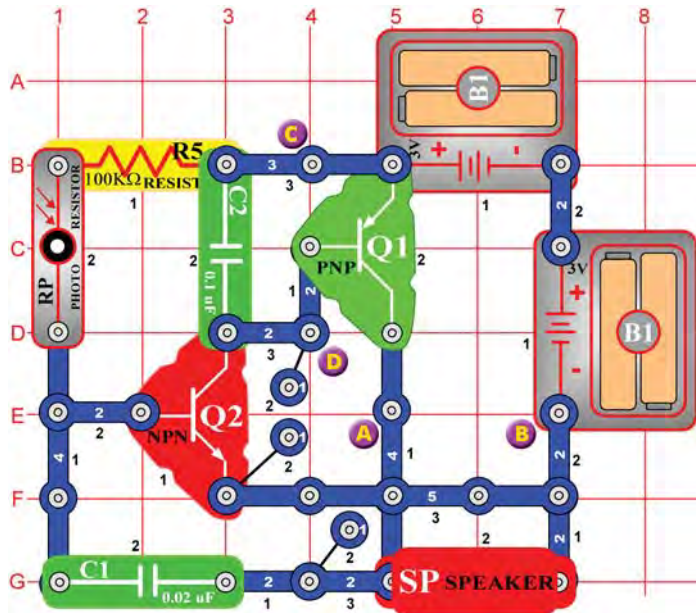


OBJECTIVE: To compare transistor circuits.

This is the same circuit as in project #120, except that it has the motor (M1) instead of the lamp (L2). Place the motor with the positive (+) side to the right and put the fan on it. Compare the fan speed to that in project #121. Just as the lamp was dimmer in the emitter configuration, the motor is not as fast now.

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

Project #123



Buzzing in the Dark

OBJECTIVE: To make a circuit that buzzes when the lights are off.

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

Project #124

Touch Buzzer

OBJECTIVE: To build a human buzzer oscillator.

Remove the photoresistor (RP) from the circuit in project #123 and instead touch your fingers across where it used to be (points B1 & D1 on the grid) to hear a cute buzzing sound.

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

Project #125

High-Frequency Touch Buzzer

OBJECTIVE: To build a high frequency human buzzer oscillator.

Now place the 6V lamp (L2) across the points marked A & B (in parallel with the speaker, SP). Now touching your fingers between B1 & D1 creates a higher frequency sound.

Project #126

Mosquito

OBJECTIVE: To build an oscillator circuit.

Place the photoresistor (RP) into the circuit in project #126 across where you were connecting the jumpers (points B1 & D1 on the grid, and as shown in project #123). Now the buzz sounds like a mosquito.

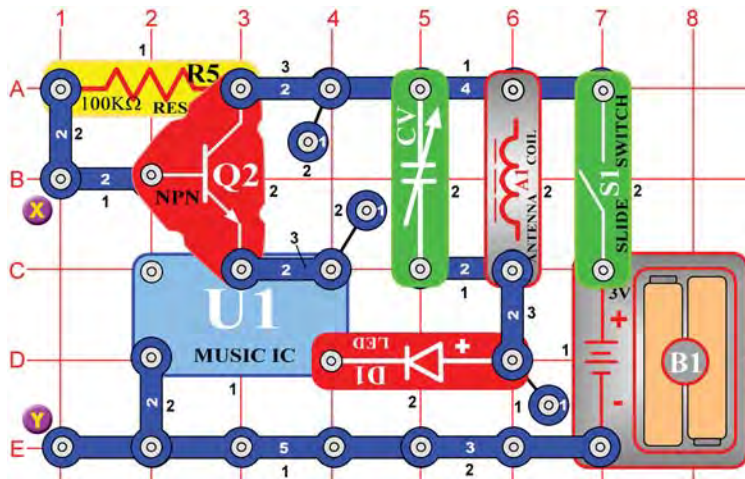
Project #127

Loud Mosquito

OBJECTIVE: To build an oscillator circuit.

Now place the 10μF capacitor (C3) across the points marked C & D (in parallel with the 0.1μF capacitor, C2) and remove the 6V lamp (L2). Now the sound is much louder.

Project #128



OBJECTIVE: To build a radio music alarm.

You need an AM radio for this project. Build the circuit on the left and turn on the slide switch (S1). Place it next to your AM radio and tune the radio frequency to where no other station is transmitting. Then, tune the variable capacitor (CV) until your music sounds best on the radio. Now connect a 4-snap wire between X & Y on the drawing, the music stops.

If you remove the 4-snap wire now, the music will play indicating your alarm wire has been triggered. You could use a long wire instead of the 4-snap and wrap it around a bike, and use it as a burglar alarm!

Radio Music Alarm

Project #129 Daylight Music Radio

OBJECTIVE: To build a light-controlled radio transmitter.

Remove the 4-snap wire. Replace the 100kΩ resistor (R5) with the photoresistor (RP). Now your AM radio will play music as long as there is light in the room.

Project #130 Night Music Radio

OBJECTIVE: To build a dark-controlled radio transmitter.

Put the 100kΩ resistor (R5) back in as before and instead connect the photoresistor (RP) between X & Y (you also need a 1-snap and a 2-snap wire to do this). Now your radio plays music when it is dark.

Project #131 Night Gun Radio

OBJECTIVE: To build a dark-controlled radio transmitter.

Replace the music IC (U1) with the alarm IC (U2). Now your radio plays the sound of a machine gun when it is dark.

Project #132 Radio Gun Alarm

OBJECTIVE: To build a radio alarm.

Remove the photoresistor (RP). Now connect a 4-snap wire between X & Y on the drawing.

If you remove the 4-snap wire now, the machine gun sound will play on the radio indicating your alarm wire has been triggered.

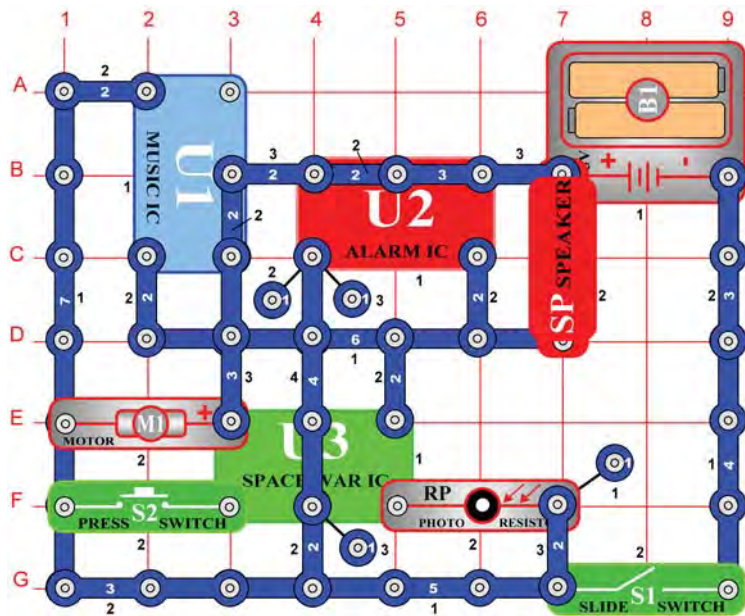
Project #133 Daylight Gun Radio

OBJECTIVE: To build a light-controlled radio transmitter.

Remove the 4-snap wire. Replace the 100kΩ resistor (R5) with the photoresistor (RP). Now your AM radio will play the machine gun sound as long as there is light in the room.



Project #134



Fire Fan Symphony

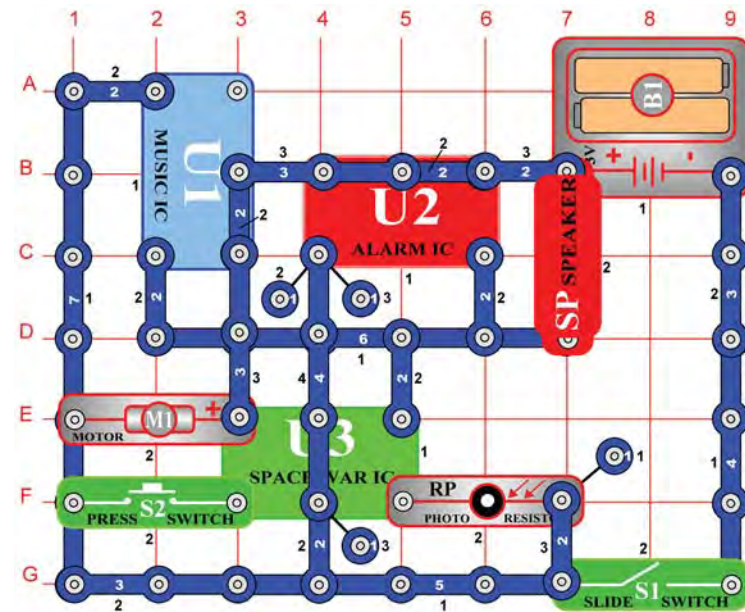
OBJECTIVE: To combine sounds from the music, alarm, and space war integrated circuits.

Build the circuit shown, note that in some places parts are stacked on top of each other. Turn it on and press the press switch (S2) several times and wave your hand over the photoresistor (RP) to hear the full spectrum of sounds that this circuit can create. Have fun!

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



Project #135



Fan Symphony

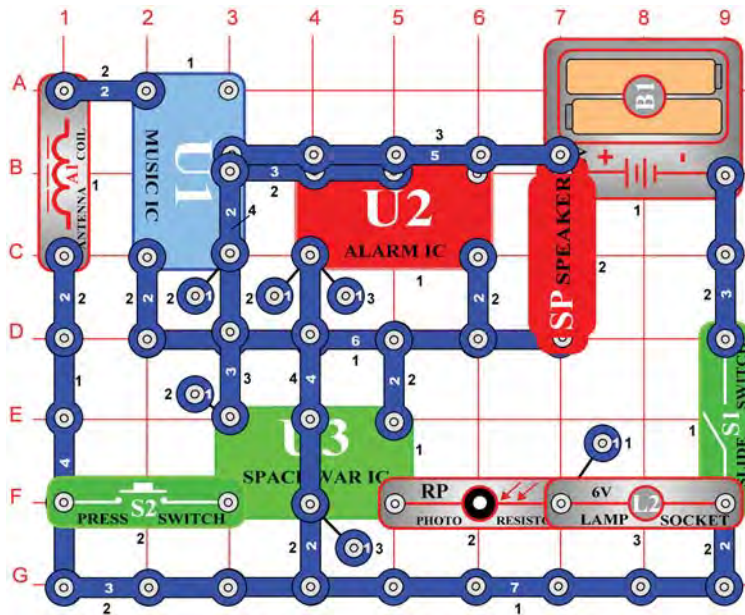
OBJECTIVE: To combine sounds from the music, alarm, and space war integrated circuits.

Modify the circuit from project #134 to match the circuit shown on the left. The only differences are the connections around the alarm IC (U2). It works the same way.

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



Project #136



Police Car Symphony

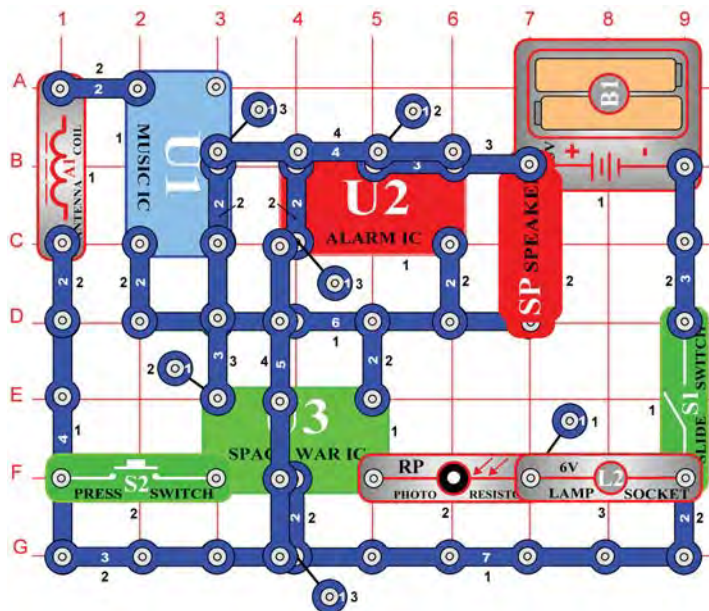
OBJECTIVE: To combine sounds from the integrated circuits.

Build the circuit shown and note that in some places parts are stacked on top of each other. Turn it on and press the press switch (S2) several times and wave your hand over the photoresistor (RP) to hear the full spectrum of sounds that this circuit can create. Have fun!

Do you know why the antenna (A1) is used in this circuit? It is being used as just a 3-snap wire, because it acts like an ordinary wire in low frequency circuits such as this. Without it, you don't have enough parts to build this complex circuit.



Project #137



Ambulance Symphony

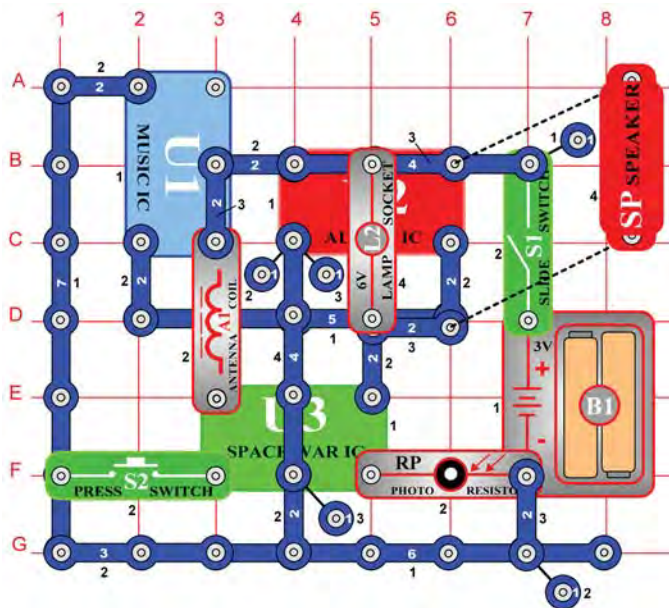
OBJECTIVE: To combine sounds from the music, alarm, and space war integrated circuits.

Modify the circuit from project #136 to match the circuit shown on the left. The only differences are the connections around the alarm IC (U2). It works the same way.

Project #138

Static Symphony

OBJECTIVE: To combine sounds from the integrated circuits.



Build the circuit shown. Note that in some places parts are stacked on top of each other. Turn it on and press the press switch (S2) several times and wave your hand over the photoresistor (RP) to hear the full spectrum of sounds that this circuit can create. Have fun!

Project #139 Static Symphony (II)

OBJECTIVE:
See project #138.

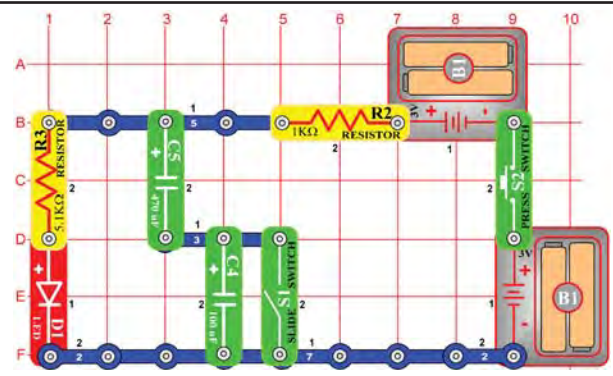
For a variation on the preceding circuit, you can replace the 6V lamp (L2) with the LED (D1), with the positive (+) side up, or the motor (M1) (do not place the fan on it).

Project #140 Capacitors in Series

OBJECTIVE: To compare types of circuits.

Turn on the slide switch (S1), then press and release the press switch (S2). The LED (D1) becomes bright when the 470 μ F capacitor (C5) charges up with the press switch on, then the LED slowly gets dim after you release the press switch.

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

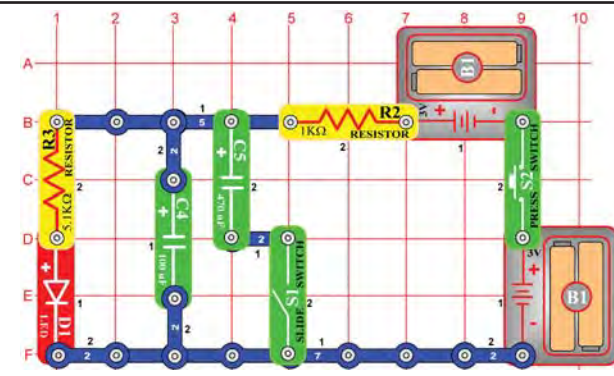


Project #141 Capacitors in Parallel

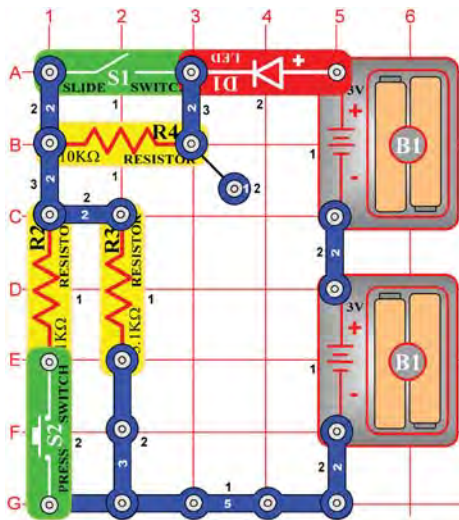
OBJECTIVE: To compare types of circuits.

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

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



Project #142 Current Controllers

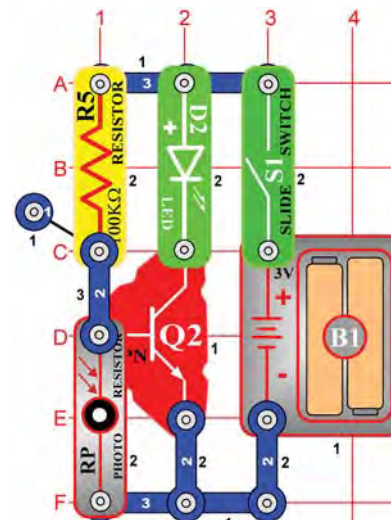


OBJECTIVE: To compare types of circuits.

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

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

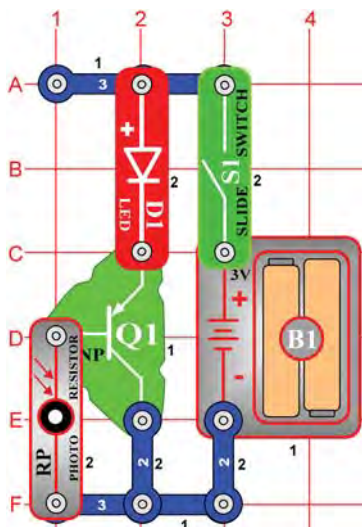
Project #143 NPN Dark Control



OBJECTIVE: To compare transistor circuits.

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

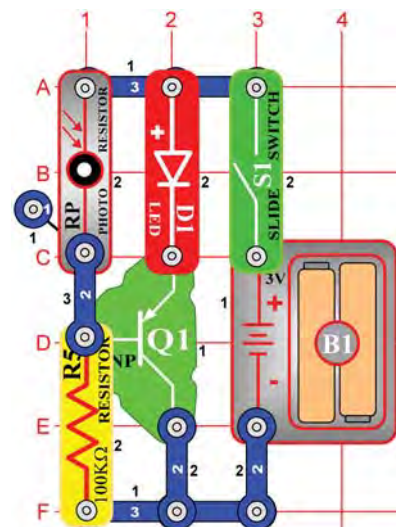
Project #144 PNP Light Control



OBJECTIVE: To compare transistor circuits.

Turn on the slide switch (S1), the brightness of the LED (D1) depends on how much light shines on the photoresistor (RP). The resistance drops as more light shines, allowing more current through the PNP transistor (Q1). This is similar to the NPN circuit above.

Project #145 PNP Dark Control



OBJECTIVE: To compare transistor circuits.

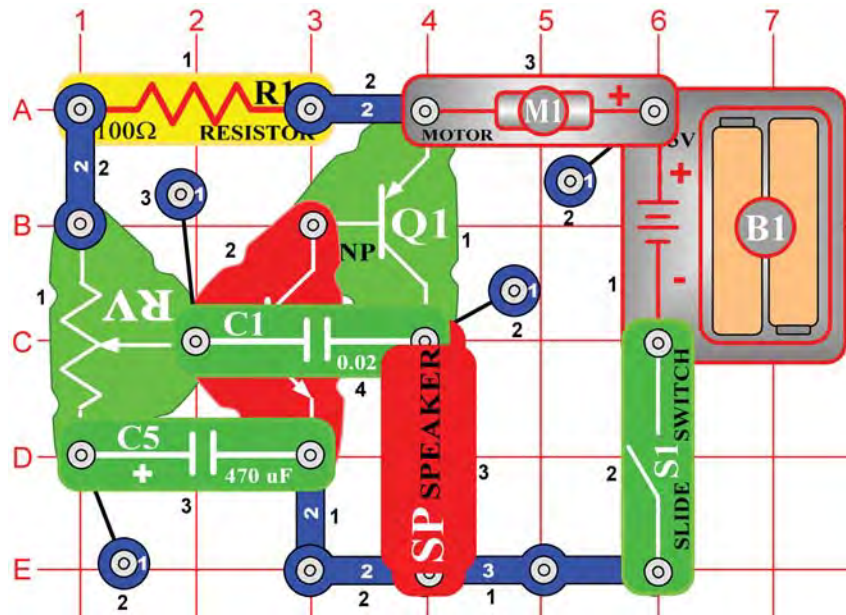
Turn on the slide switch (S1), the brightness of the LED (D1) depends on how LITTLE light shines on the photoresistor (RP). The resistance drops as more light shines, so more current gets to the 100kΩ resistor (R5) from the photoresistor path and less from the PNP-diode path. This is similar to the NPN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



Project #146

Whining Fan

OBJECTIVE: To make different sounds.



Build the circuit on the left. Turn on the slide switch (S1) and move the setting on the adjustable resistor (RV) across its range. You hear a high-pitch whine and the fan spins.

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

Project #147

Light Whining

OBJECTIVE: To make different sounds.

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

Project #148

More Light Whining

OBJECTIVE: To make different sounds.

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

Project #149

Motor That Won't Start

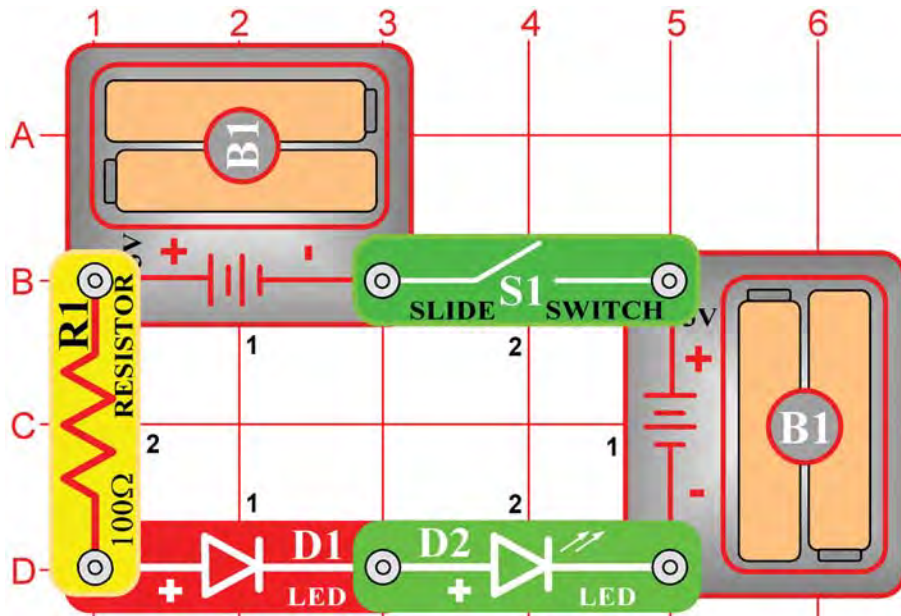
OBJECTIVE: To make different sounds.

Replace the 0.1μF capacitor (C2) with the 10μF capacitor (C3), put the positive (+) side towards the left. It now makes clicking sounds and the fan moves only in small bursts, like a motor (M1) that won't start.

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



Project #150



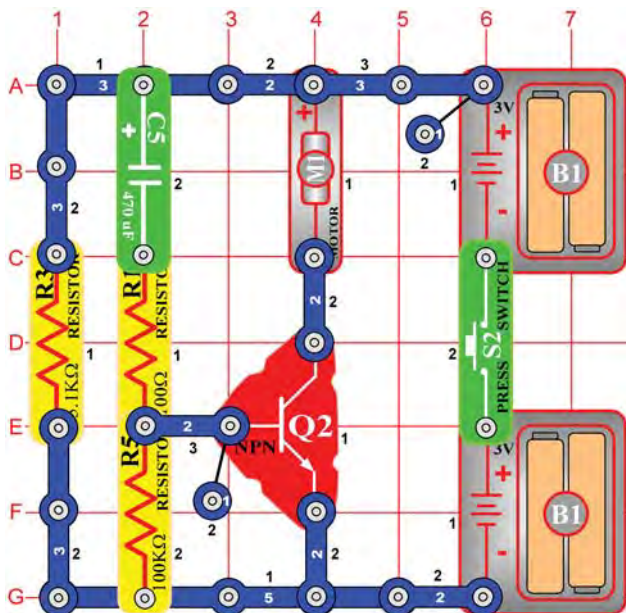
Current Equalizing

OBJECTIVE: To compare types of circuits.

Turn on the slide switch (S1) and the two LED's (D1 & D2) will have the same current. When connected in *series*, all components will have equal electric current through them.



Project #151



Lazy Fan

OBJECTIVE: To build a fan that doesn't work well.

Press the press switch (S2) and the fan will be on for a few turns. Wait a few moments and press again, and the fan will make a few more turns.

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



Project #152 Laser Light

OBJECTIVE: To build a simple laser.

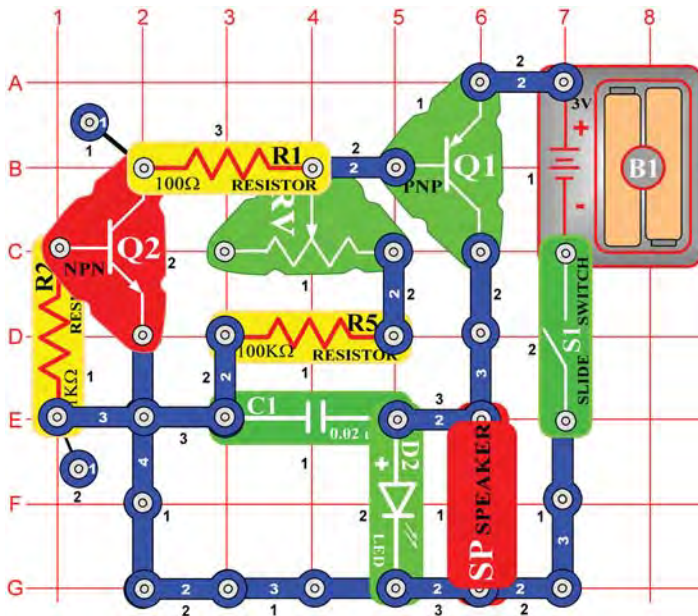
Replace the motor (M1) with the 6V lamp (L2). Now pressing the press switch (S2) creates a blast of light like a laser.



Project #153

Whiner

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



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

Project #154 Hummer

OBJECTIVE: To show how adding capacitance reduces frequency.

Now place the 0.1μF capacitor (C2) above the 0.02μF capacitor (C1) and vary the adjustable resistor (RV) again. The frequency (or pitch) of the whine has been reduced by the greater added capacitance and it sounds more like a hum now.

Project #155 Adjustable Metronome

OBJECTIVE: To build an adjustable electronic metronome.

Now place the 10μF capacitor (C3, positive “+” side on right) above the 0.02μF capacitor (C1) and vary the adjustable resistor (RV) again. There is no hum now but instead there is a click and a flash of light repeating about once a second, like the “beat” of a sound. It is like a metronome, which is used to keep time for the rhythm of a song.

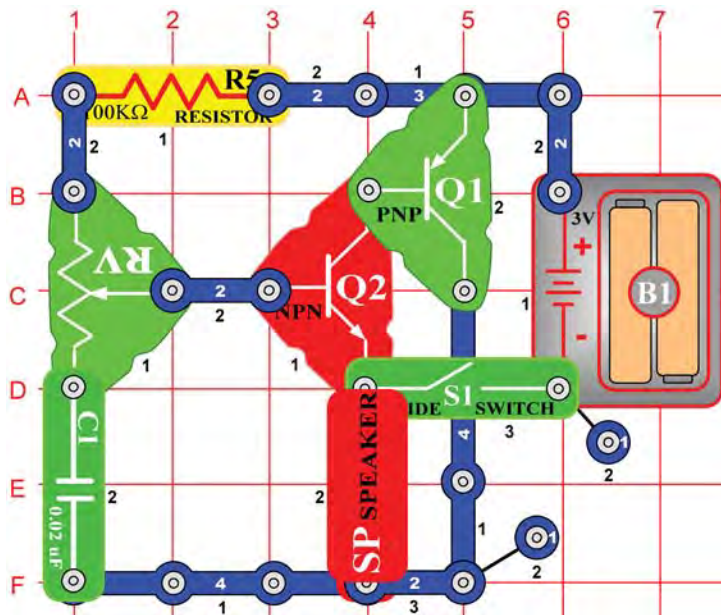
Project #156 Quiet Flasher

OBJECTIVE: To make a blinking flashlight.

Leave the 10μF capacitor (C3) connected but replace the speaker (SP) with the 6V lamp (L2).



Project #157



Hissing Foghorn

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

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



Project #158 Hissing & Clicking

OBJECTIVE: To build an adjustable clicking oscillator.

Modify the circuit in project #157 by replacing the 100kΩ resistor (R5) with the photoresistor (RP). Move the adjustable resistor (RV) setting until you hear hissing sounds, and then completely cover the photoresistor with your hand and you hear clicking sounds.



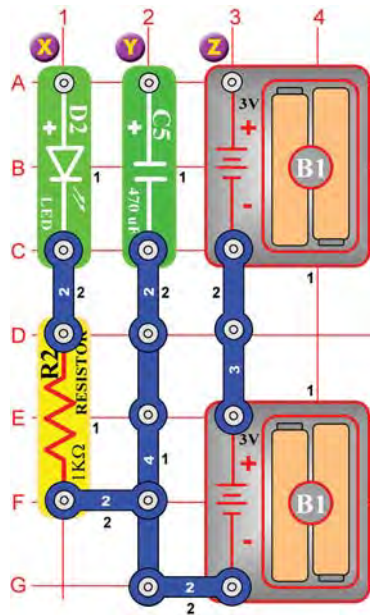
Project #159 Video Game Engine Sound

OBJECTIVE: To build a human oscillator.

Remove the photoresistor (RP) from the circuit in project #158 and instead touch your fingers between the contacts at points A4 and B1 on the base grid while moving the adjustable resistor (RV). You hear a clicking that sounds like the engine sound in auto-racing video games.



Project #160



Make Your Own Battery

OBJECTIVE: To demonstrate how batteries can store electricity.

Build the circuit, then connect points Y & Z (use a 2-snap wire) for a moment. Nothing appears to happen, but you just filled up the 470µF capacitor (C5) with electricity. Now disconnect Y & Z and instead touch a connection between X & Y. The green light emitting diode (D2) will be lit and then go out after a few seconds as the electricity you stored in it is discharged through the diode and resistor (R2).

Notice that a capacitor is not very efficient at storing electricity - compare how long the 470µF kept the LED lit for with how your batteries run all of your projects! That is because a capacitor stores electrical energy while a battery stores chemical energy.



Project #161 Make Your Own Battery (II)

OBJECTIVE: To demonstrate how batteries can store electricity.

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



Project #162 Make Your Own Battery (III)

OBJECTIVE: To demonstrate how batteries can store electricity.

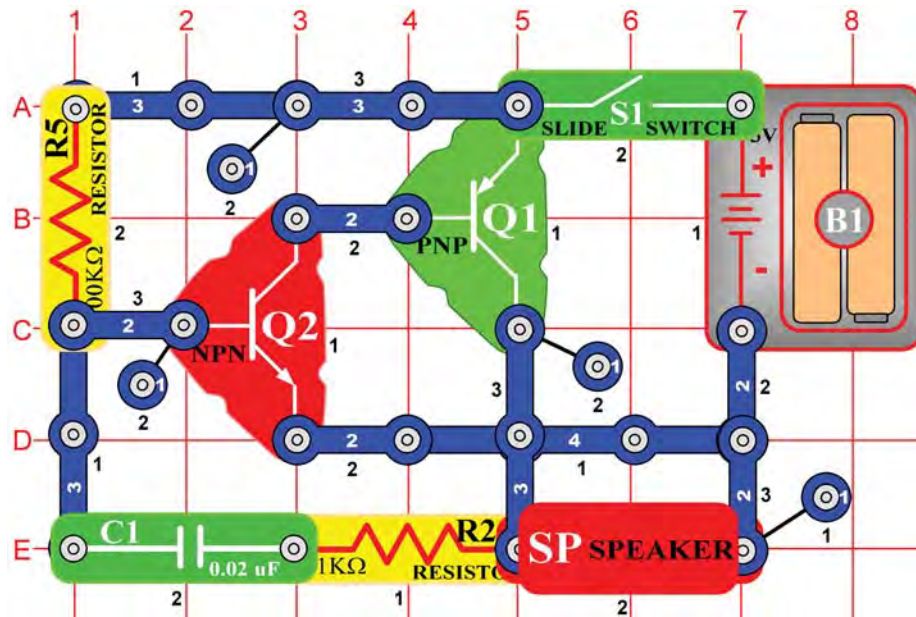
Now replace the 1kΩ resistor (R2) with the 100Ω resistor (R1) and try it. The LED (D2) gets brighter but goes out faster because less resistance allows the stored electricity to dissipate faster.



Project #163

Tone Generator

OBJECTIVE: To build a high-frequency oscillator.



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



Project #164 Tone Generator (II)

OBJECTIVE: To lower the frequency of a tone by increasing circuit capacitance.

Replace the 0.02μF capacitor (C1) with the larger 0.1μF capacitor (C2). You now hear a low frequency sound, due to more capacitance.



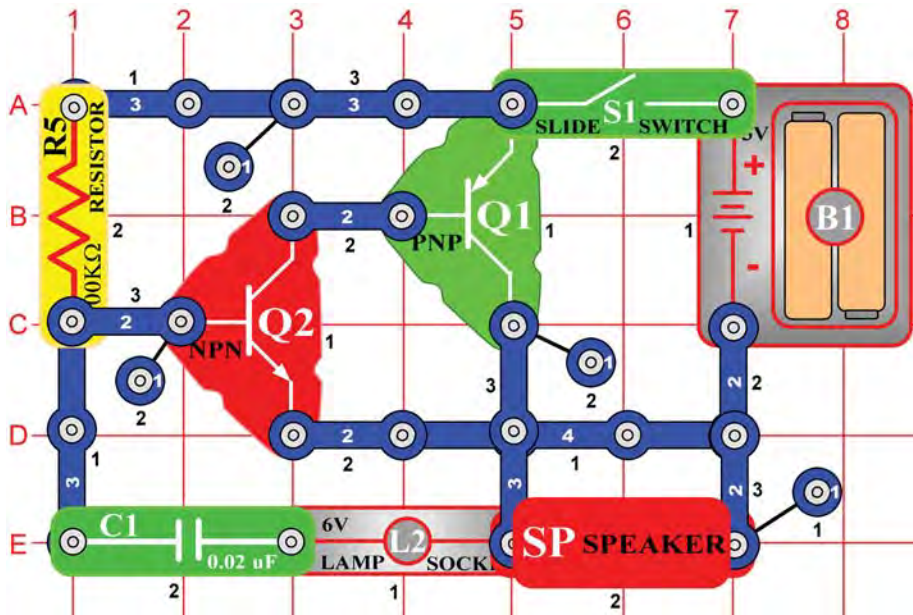
Project #165 Tone Generator (III)

OBJECTIVE: To raise the frequency of a tone by decreasing circuit resistance.

Next, replace the 1kΩ resistor (R2) with the smaller 100Ω resistor (R1). The tone has a higher pitch now, since less resistance increases the frequency.



Project #166



More Tone Generator

OBJECTIVE: *To build a middle-frequency oscillator.*

Build the circuit, as the name suggests this circuit is similar to that in project #163. Turn it on, you hear a middle-frequency sound.



Project #167

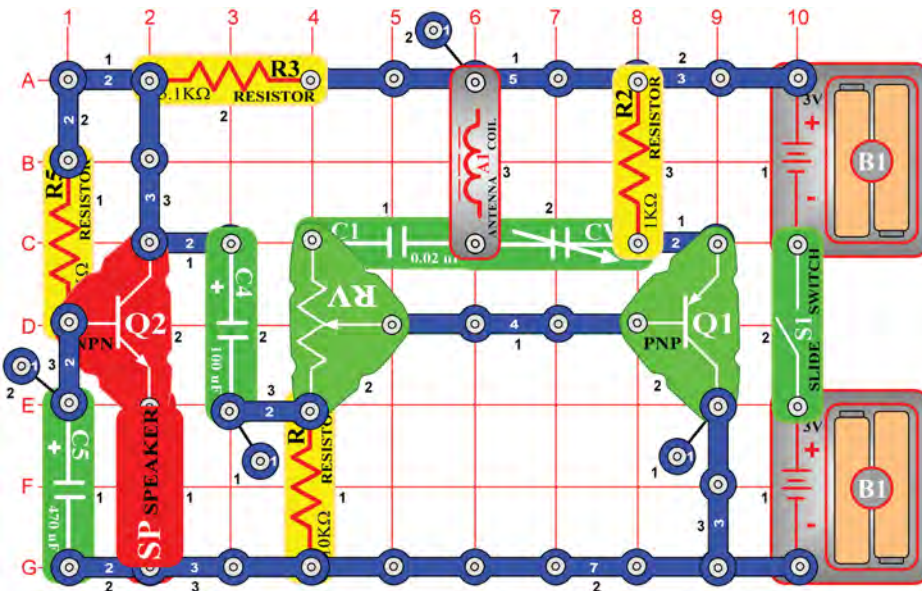
More Tone Generator (II)

OBJECTIVE: *To raise the frequency of a tone by decreasing circuit resistance.*

Replace the 0.02μF capacitor (C1) with the larger 10μF capacitor (C3). You hear a low frequency clicking sound, due to more capacitance. You can decrease the frequency of an oscillator circuit by increasing either the resistance or the capacitance.



Project #168



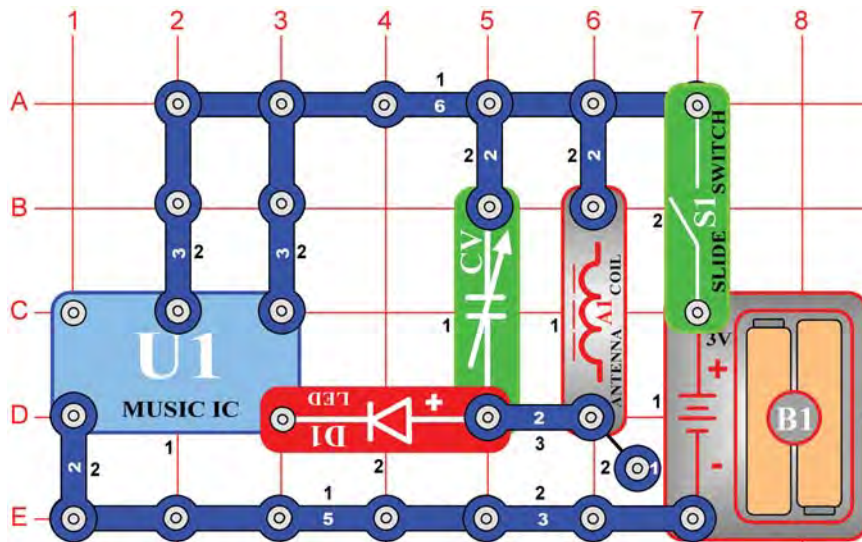
Radio Announcer

OBJECTIVE: *To hear your voice on the radio.*

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

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

Project #169 Music Radio Station



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

You need an AM radio for this project. Build the circuit shown on the left and turn on the slide switch (S1). Place it next to your AM radio and tune the radio frequency to where no other station is transmitting. Then, tune the adjustable capacitor (CV) until your music sounds best on the radio.

Project #170 Alarm Radio Station

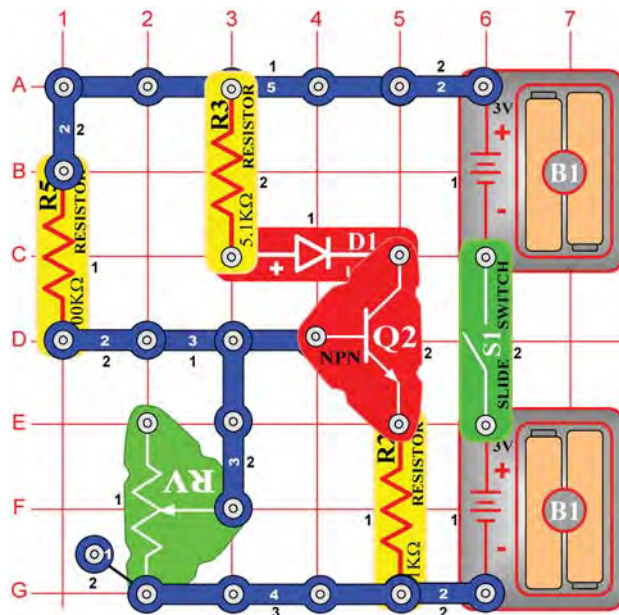
OBJECTIVE: To create music and transmit it to a radio.

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

Project #171

Standard Transistor Circuit

OBJECTIVE: To save some electricity for later use.

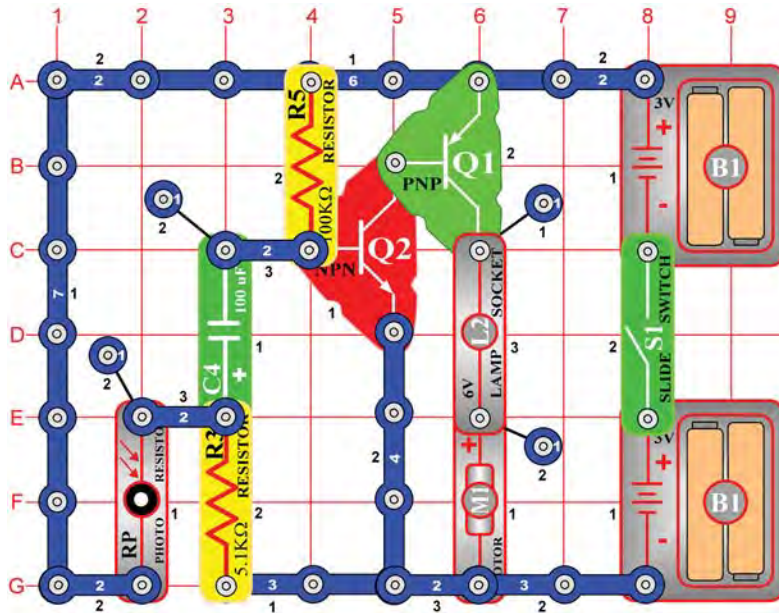


Turn on the slide switch (S1) and move the adjustable resistor (RV) control lever across its range. When the lever is all the way down the LED (D1) will be off, as you move the lever up it will come on and reach full brightness. This circuit is considered the standard transistor configuration for amplifiers. The adjustable resistor control will normally be set so that the LED is at half brightness, since this minimizes distortion of the signal being amplified.



Project #172

Motor & Lamp by Sound



OBJECTIVE: To control a motor using light.

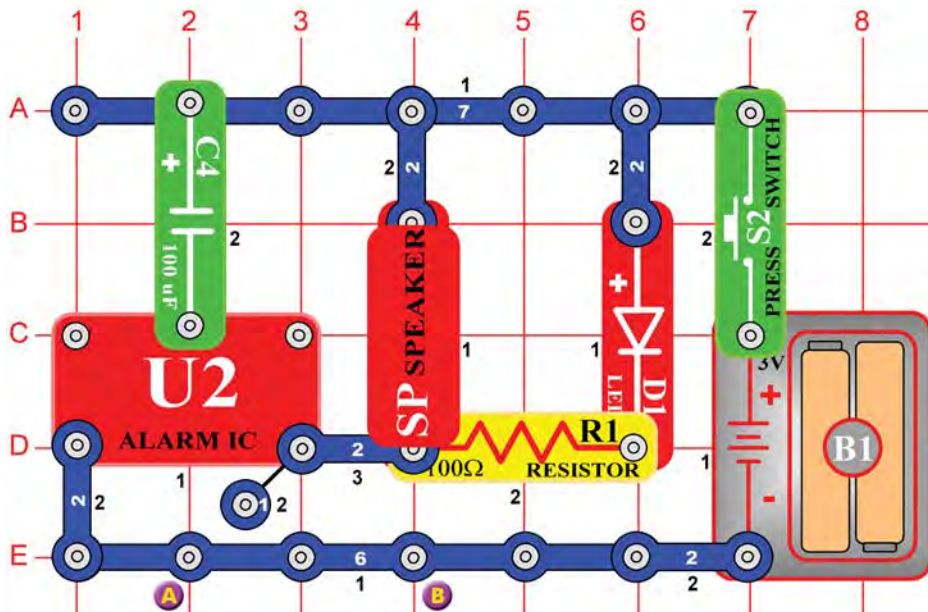
Turn the slide switch (S1) on, the motor (M1) spins and the lamp (L2) lights. As you move your hand over the photoresistor (RP), the motor slows. Now place your finger onto the photoresistor to block the light. The motor slows down. In a few seconds, the motor speeds up again.

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



Project #173

Fast Fade Siren



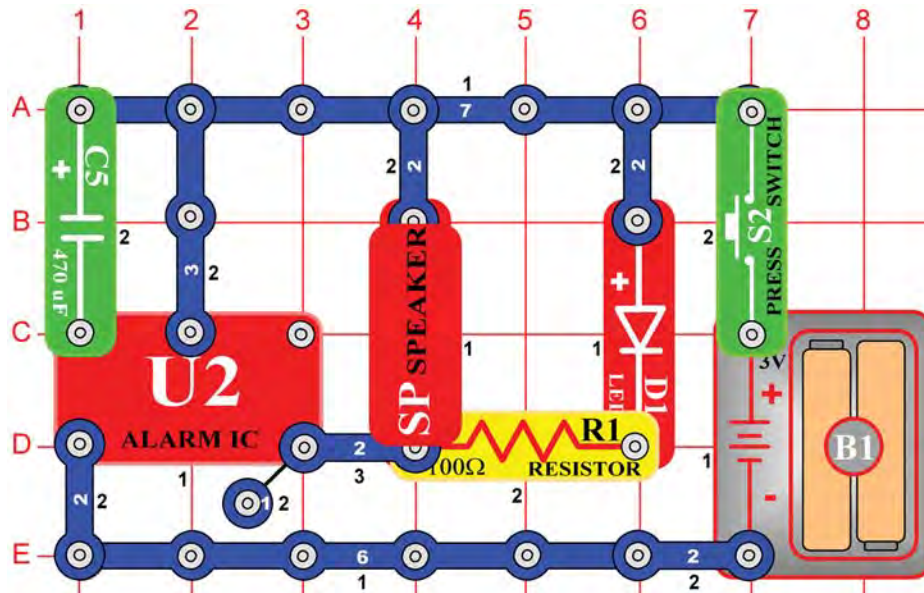
OBJECTIVE: To produce sound of a siren driving away into the distance.

Press the press switch (S2), the integrated circuit (U2) should make the sound of an up-down siren that gets weaker with time. The fading is produced by the charging of the 100μF capacitor (C4). After it is charged the current stops and the sound is very weak.

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



Project #174



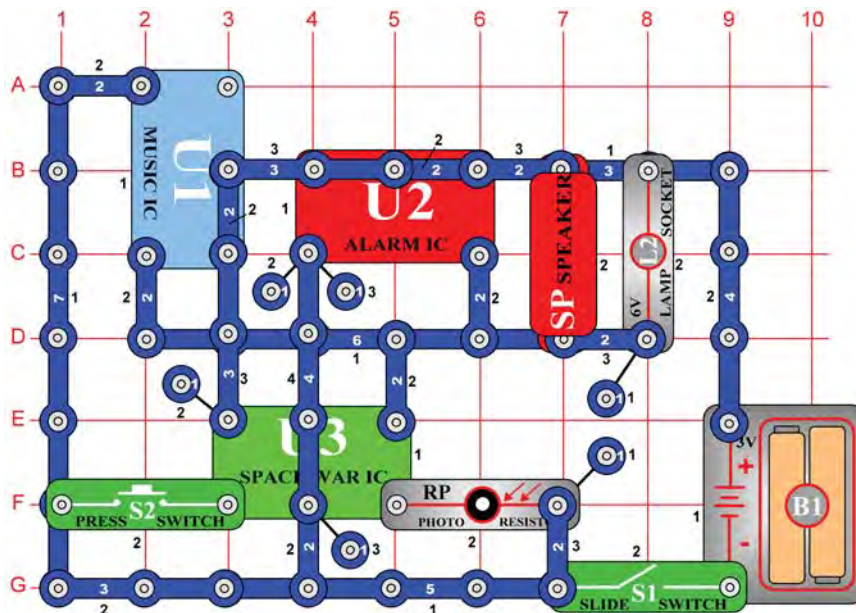
Changing Siren

OBJECTIVE: To build a siren that changes after a few seconds.

When you turn on the press switch (S2), the integrated circuit (U2) will make a loud siren sound and the LED (D1) will light. After a few seconds the sound will change to a different siren. Leave the circuit off for a while to recharge the first siren.



Project #175



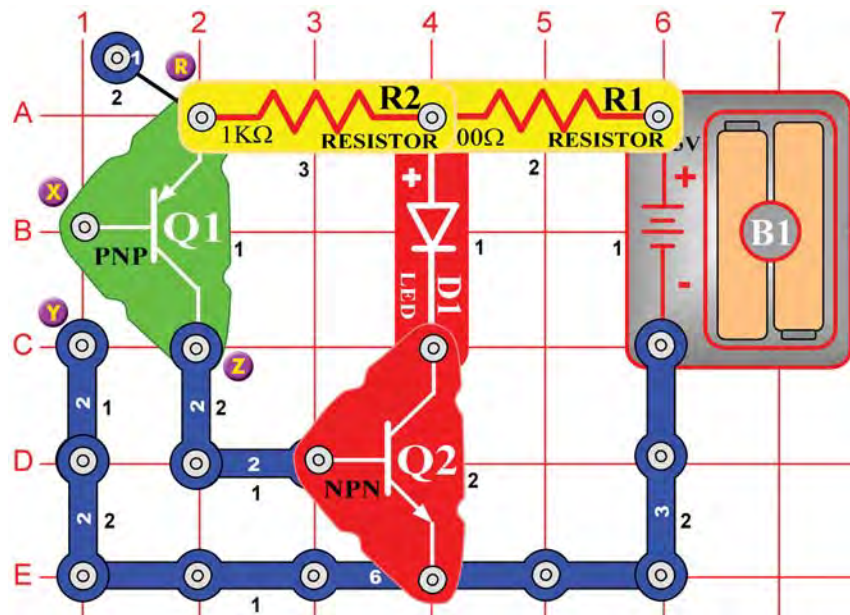
Symphony of Sounds

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

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



Project #176



Transistor Amplifiers

OBJECTIVE: To learn about the most important component in electronics.

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



Project #177 Pressure Meter

OBJECTIVE: To show how electronic amplifiers can detect skin pressure on two contacts.

Use the circuit from project #176 shown above.

When you placed your fingers across the two snaps marked X & Y you noticed the LED (D1) came on in project #176. Repeat this process, but this time press very lightly on the two snaps marked X & Y. Notice how the brightness of the LED is dependent on the amount of pressure you use. Pressing hard makes the LED bright while pressing very gently makes it dim or even flash. This is due to what technicians call contact resistance. Even switches made to turn your lights on and off have some resistance in them. When large currents flow this resistance, will drop the voltage and produce the undesirable side effect of heat.



Project #178 Resistance Meter

OBJECTIVE: To show how electronic amplifiers can detect different values of resistance.

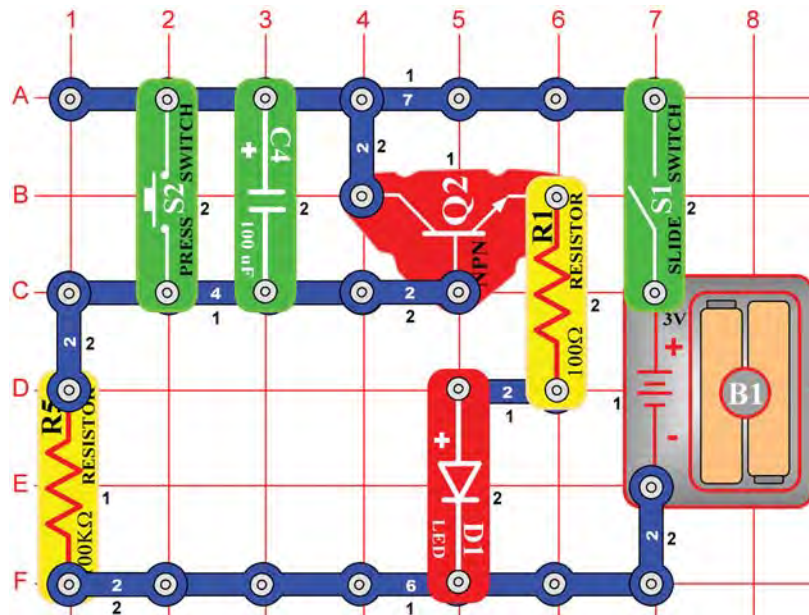
Use the circuit from project #176 shown above

When you placed your fingers across the two snaps marked X & Y you noticed the LED (D1) came on in project #176. In this project, you will place different resistors across R & Z and see how bright the LED glows. Do not snap them in; just press them up against the snaps labeled R & Z in the diagram above.

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



Project #179



Auto-off Night Light (III)

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

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

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

This circuit is just like project #50, which stayed on longer because of higher capacitance. In electronics, capacitors are used in every piece of equipment to delay signal or tune circuits to a desired frequency.



Project #180

Discharging Caps

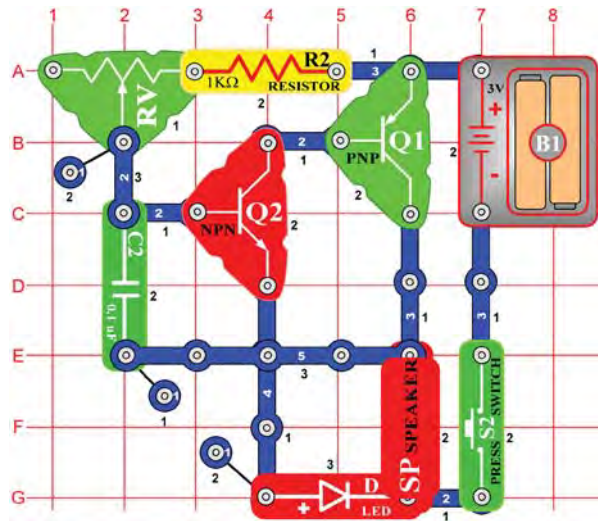
OBJECTIVE: *To show how capacitor delays can be repeated by discharging the capacitor.*

Use the circuit from project #179 shown above.

When you first turned on the slide switch (S1) in project #179, the LED (D1) came on and very slowly got dimmer and dimmer. When you turned the slide switch off and back on after the light went out, it did NOT come on again. The 100 μ F capacitor (C4) was charged and everything stopped. This time turn the slide switch off. Then press the press switch (S2) for a moment to discharge the 100 μ F capacitor. Now when you turn the slide switch back on the delay repeats. Shorting a capacitor with a low resistance will allow the charges on the capacitor to leave through the resistance. In this case, the low resistance was the press switch.



Project #181



Morse Code Generator

OBJECTIVE: To make a Morse code generator and learn to generate code.

When you press the press switch (S2) you will hear a tone. By pressing and releasing the press switch you can generate long and short tones called Morse code. For International code, a short tone is represented by a “+”, and a long tone by a “-”. See the chart below for letter or number followed by code.

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

Project #182 LED Code Teacher

OBJECTIVE: A method of learning the Morse code without all the noise.

Use the circuit from project #181 shown above. Replace the speaker (SP) with a 100Ω resistor (R1) so you can practice generating the Morse code without the loud speaker. Have someone transmit code and watch the LED (D1). Tell them the letter or number after each is generated. When you have learned code, replace the speaker.

Project #183 Ghost Shriek Machine

OBJECTIVE: To make a ghost like special effect from the Morse code generator.

Use the circuit from project #181 shown above, but change the 1kΩ resistor (R2) to a 10kΩ resistor (R4), and 0.1µF capacitor (C2) to the variable capacitor (CV). While holding the press switch (S2) down adjust both the adjustable resistor (RV) and the variable capacitor for a ghost like sound. At certain settings, sound may stop or get very faint.

Project #184 LED & Speaker

OBJECTIVE: To improve Morse code skills and visual recognition.

Use the circuit from project #181 shown above. Try and find a person that already knows the Morse code to send you a message with both sound and LED (D1) flashing. Try in a dark room first so LED is easier to see. Morse code is still used by many amateur radio operators to send messages around the world.

Project #185 Dog Whistle

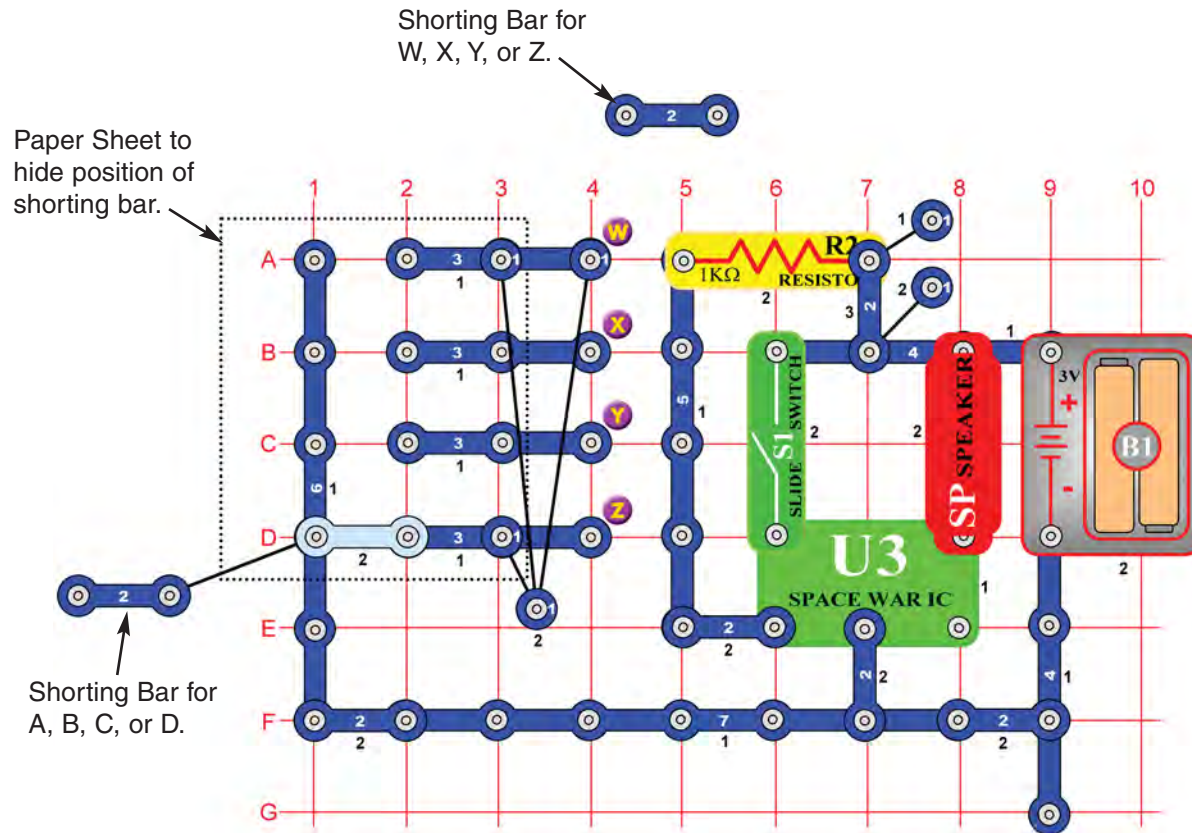
OBJECTIVE: To make an oscillator that only a dog can hear.

Use the circuit from project #181 shown above, but change the 1kΩ resistor (R2) to the 100Ω resistor (R1). While holding down the press switch (S2), move the slider on the adjustable resistor (RV) around. When the slider is near the 100Ω resistor you won't hear any sound, but the circuit is still working. This oscillator circuit is making sound waves at a frequency too high for your ears to hear. But your dog may hear it, because dogs can hear higher frequencies than people can.

Project #186

Mind Reading Game

OBJECTIVE: To make an electronic game of mind reading.



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

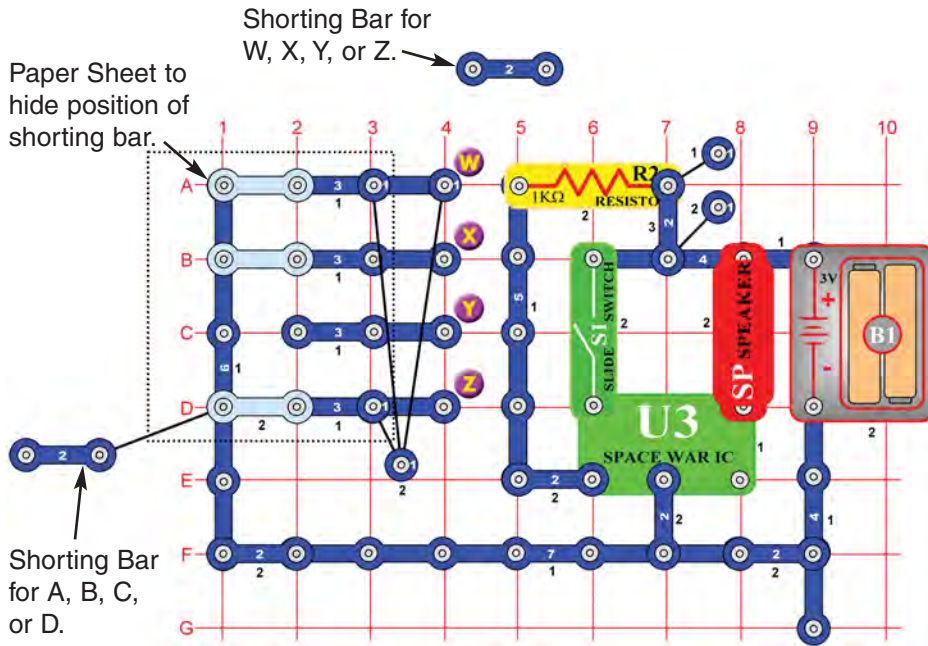
Setup: Player 1 sets up by placing one shorting bar under the paper on row A, B, C, or D. Player 2 must **NOT** know where the shorting bar is located under the paper.

The object is for Player 2 to guess the location by placing his shorting bar at positions W, X, Y, or Z. In the drawing on the left, Player 1 set up at position "D". If Player 2 places his shorting bar across "Z" on the first try, then he guessed correctly and marks a 1 on the score card sheet under that round number. If it takes three tries, then he gets a three. Player 2 then sets the A, B, C, D side and Player 1 tries his luck. Each player records his score for each round. When all 18 rounds have been played, the player with the lowest score wins. Additional players can play. Use the score card below to determine the winner.

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



Project #187



Enhanced Quiet Zone Game

OBJECTIVE: Make and play the electronic game of “Quiet Zone”.

Use the circuit from project #186, but place three (3) 2-snap wires (“shorting bars”) under paper as shown on left.

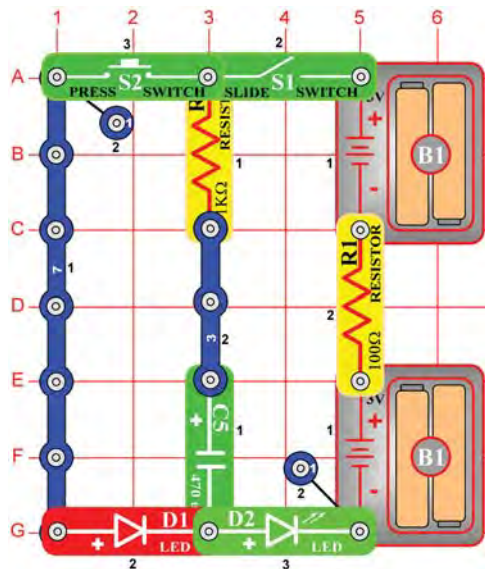
Setup: Player 1 sets the “Quiet Zone” by placing three (3) shorting bars under the paper on row A, B, C, or D, leaving only one open. Player 2 must **NOT** know where the shorting bars are located under the paper.

Both Player 1 and Player 2 are given 10 points. The object is for Player 2 to guess the location of the “Quiet Zone” by placing his shorting bar at positions W, X, Y, or Z. In the drawing on the left Player 1 set up the “Quiet Zone” at position “C”. If Player 2 places his shorting bar across “Z” on the first try, the sounds played mean he has not found the “Quiet Zone” and he loses 1 point. He has 3 tries to find the zone on each turn. Each time sounds are made he loses a point.

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



Project #188



Capacitor Charge & Discharge

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

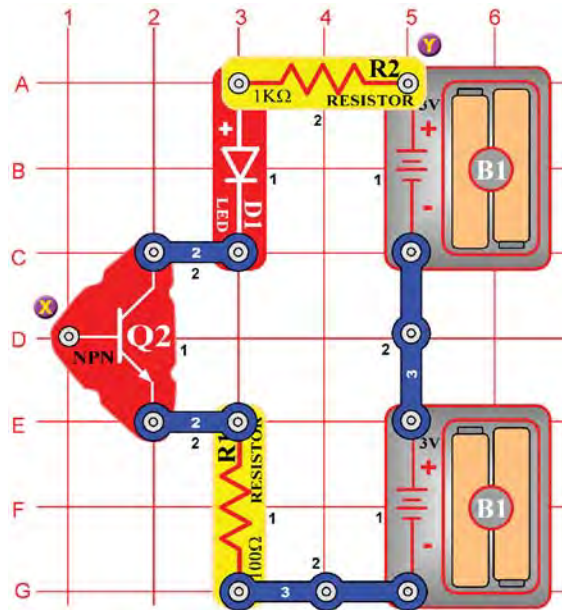
Turn on the slide switch (S1) for a few seconds, then turn it off. The green LED (D2) is initially bright but goes dim as the batteries (B1) charge up the 470µF capacitor (C5). The capacitor is storing electrical charge.

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

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



Project #189



Two-Finger Touch Lamp

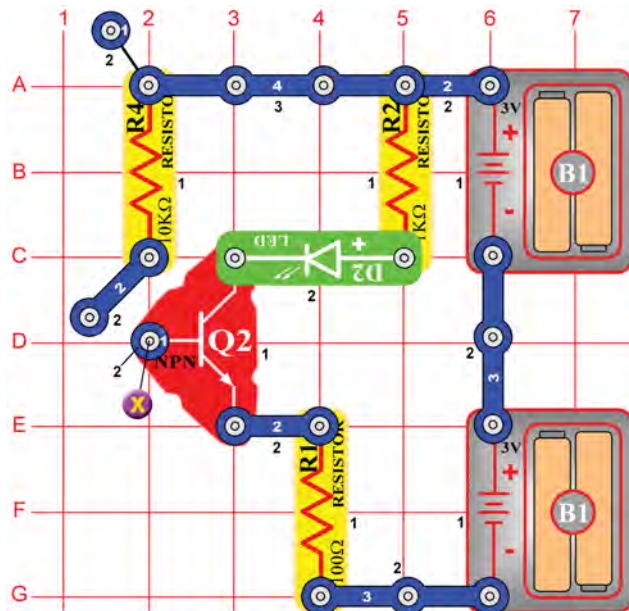
OBJECTIVE: To show that your body can be used as an electronic component.

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

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



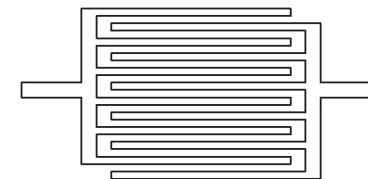
Project #190



One-Finger Touch Lamp

OBJECTIVE: To show you how finger touch lamps work.

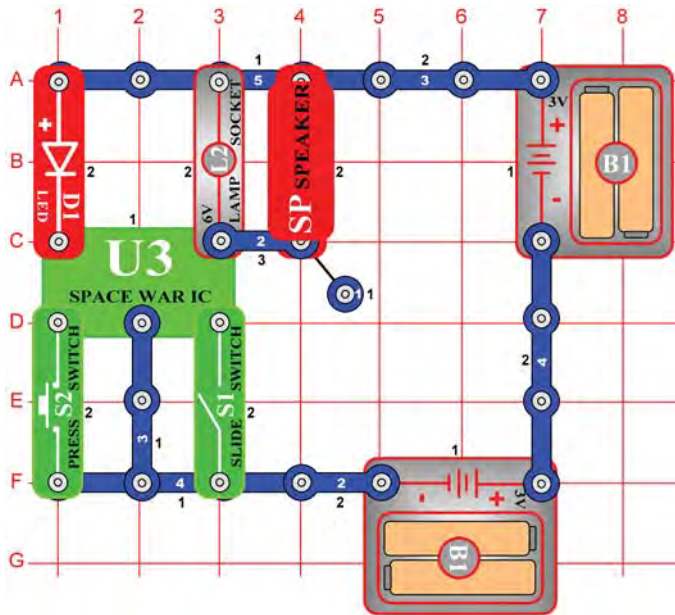
The touch lamps you see in stores only need to be touched by one finger to light, not two. So let's see if we can improve the last circuit to only need one finger. Build the new circuit, note that near point X there is a 2-snap wire that is only mounted on one side, swing it so the plastic touches point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



Project #191

Space Battle

Project #192 Space Battle (II)



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

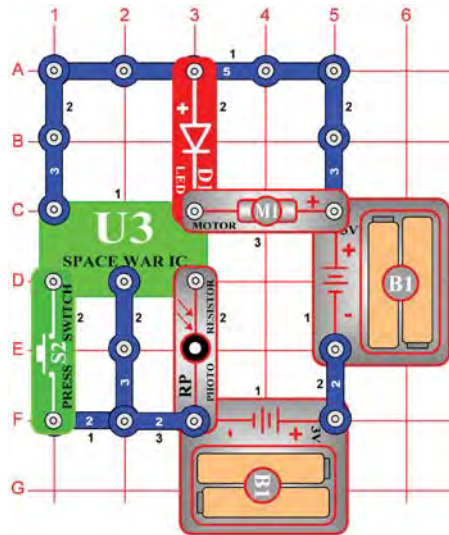
Build the circuit shown on the left. Activate the circuit by turning on the slide switch (S1) or pressing the press switch (S2), do both several times and in combination. You will hear exciting sounds and see flashing lights, as if a space battle is raging!

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

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

Project #193 Multi-speed Light Fan

Project #194 Light & Finger Light



OBJECTIVE: To vary the speed of a fan activated by light.

Build the circuit shown on the left, with the fan on the motor (M1).

This circuit is activated by light on the photoresistor (RP), though the fan will barely turn at all. Press the press switch (S2) and the fan will spin. If you hold the press switch down, the fan will spin faster. If you cover the photoresistor, the fan will stop unless the press switch is pressed.

OBJECTIVE: To show another way the space war IC may be used.

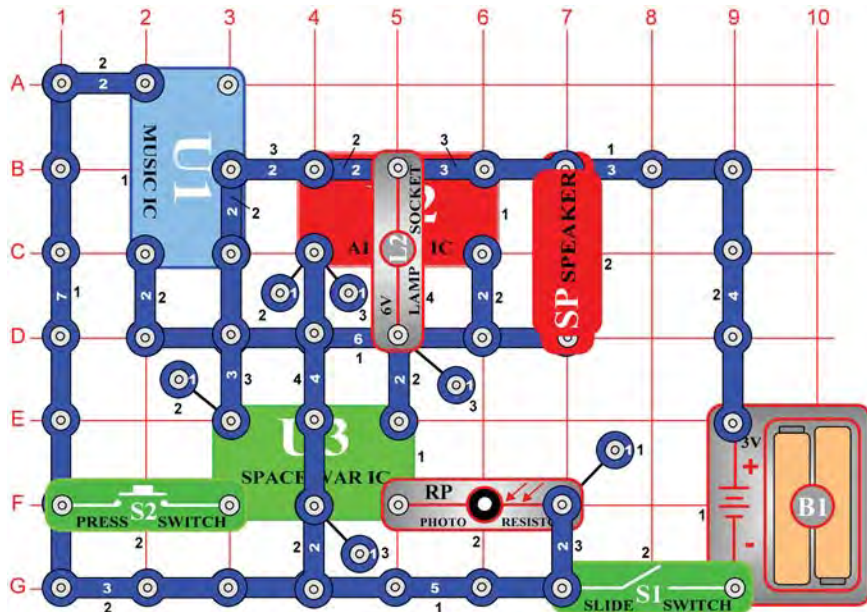
In the circuit at left, replace the motor (M1) with a 6V lamp (L2) shown below. Vary the brightness of the lamp by covering the photoresistor and holding down the press switch (S2) in various combinations. Notice that pressing the press switch when the photoresistor is covered still turns on the lamp, while in project #193, doing this would turn off the motor.



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



Project #198



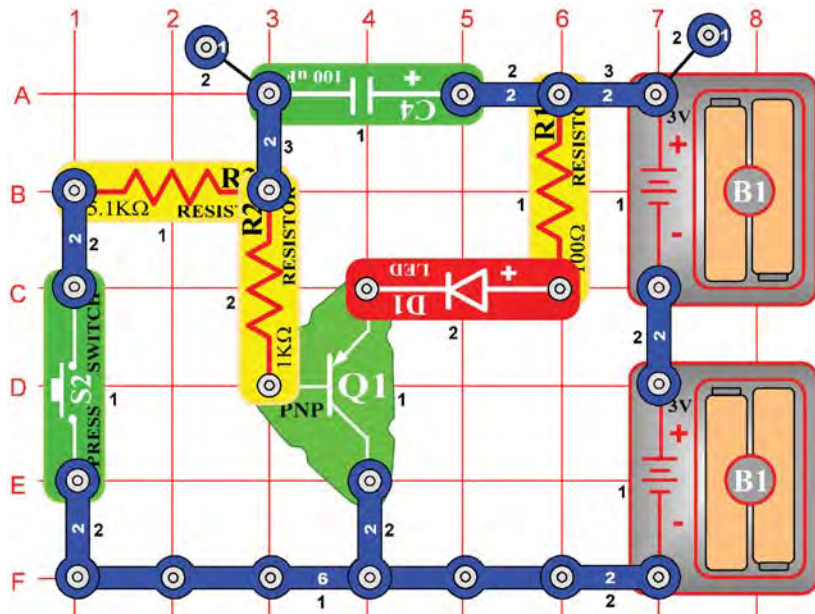
Fire Engine Symphony

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

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



Project #199



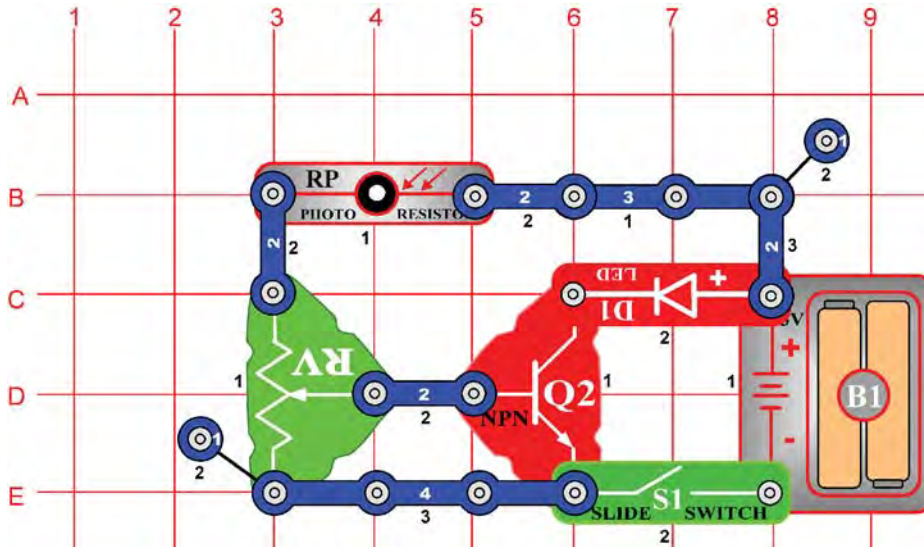
Light Dimmer

OBJECTIVE: To build a light dimmer.

Press the press switch (S2) to complete the current's path flow. You might expect the LED (D1) to light instantly but it takes about a second. The charging current flows into the 100µF capacitor (C4) first. As the capacitor charges, the charging current decreases, input current to the PNP transistor (Q1) increases. So current begins to flow to the LED and the LED gradually brightens. Now release the press switch. The capacitor begins to discharge, sending input current to the transistor. As the capacitor discharges, the input current reduces to zero and gradually turns off the LED and the transistor.



Project #200



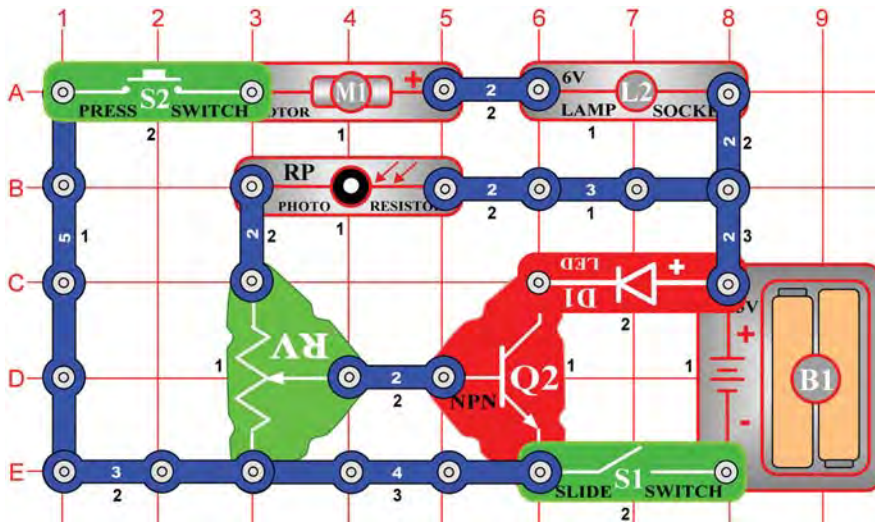
Motion Detector

OBJECTIVE: Build a circuit that detects motion.

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



Project #201

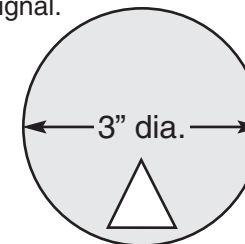


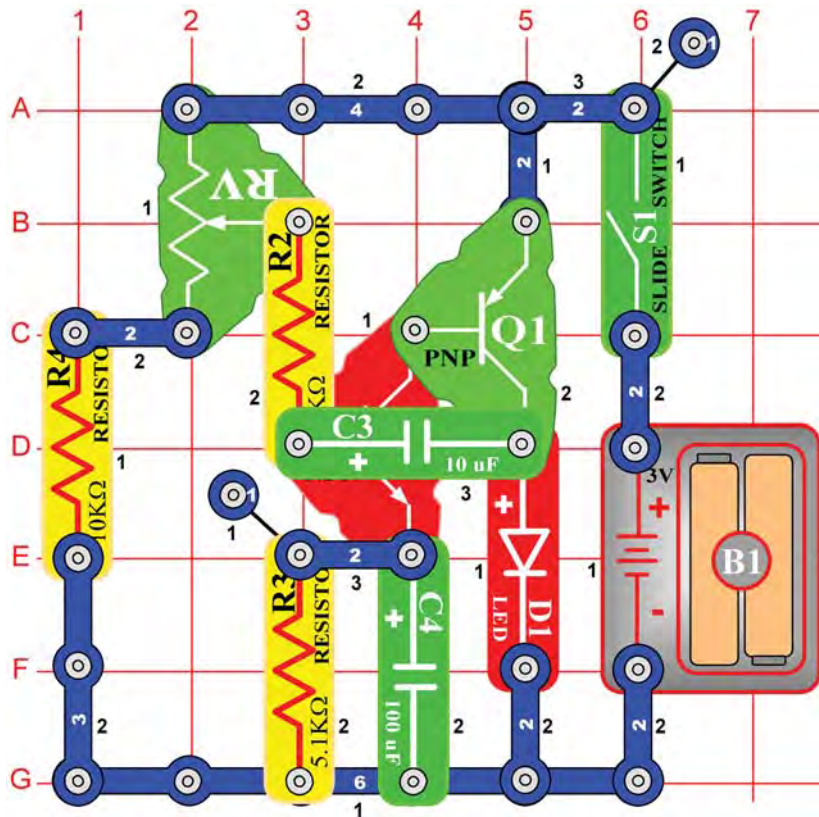
WARNING: Moving parts. Do not touch the fan or motor during operation.

Fan Modulator

OBJECTIVE: To modulate the brightness of an LED.

Using the fan outline as a guide, cut a 3" circle out of a piece of paper. Then, cut a small triangle in it as shown. Tape the circle onto the fan and then place it onto the motor (M1). Set the adjustable resistor (RV) to the center position and turn the slide switch (S1) on. Press the press switch (S2), the fan spins and the lamp (L2) lights. As the triangle opening moves over the photoresistor (RP), more light strikes it. The brightness of the LED (D1) changes, or is *modulated*. As in AM or FM radio, modulation uses one signal to modify the amplitude or frequency of another signal.





Project #202 Oscillator 0.5 - 30Hz

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

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



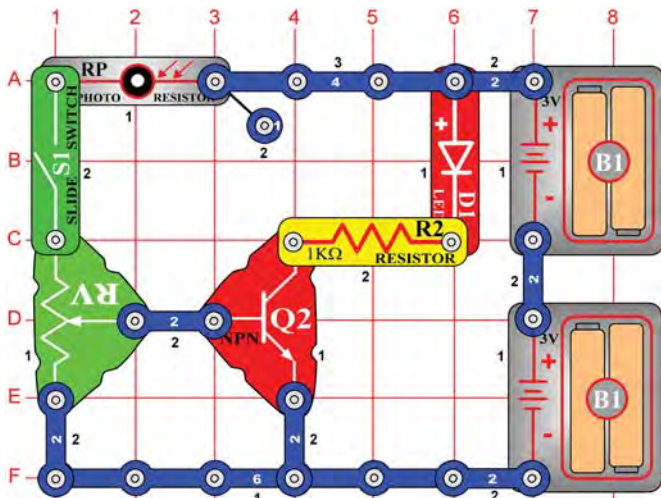
Project #203 Sound-pulse Oscillator

OBJECTIVE: To build a 0.5Hz - 30Hz oscillator and hear it on a speaker.

Use the circuit from project #202. Connect a single snap under the speaker (SP) and then connect it across the LED (D1) (on level 4). Turn the slide switch (S1) on and now you can hear the oscillator. Adjust the adjustable resistor (RV) to hear the different frequencies. Now you can hear and see the frequencies. Note: You may not hear sounds at all settings of the adjustable resistor.



Project #204



Motion Detector (II)

OBJECTIVE: To build a motion detector that senses an objects movement.

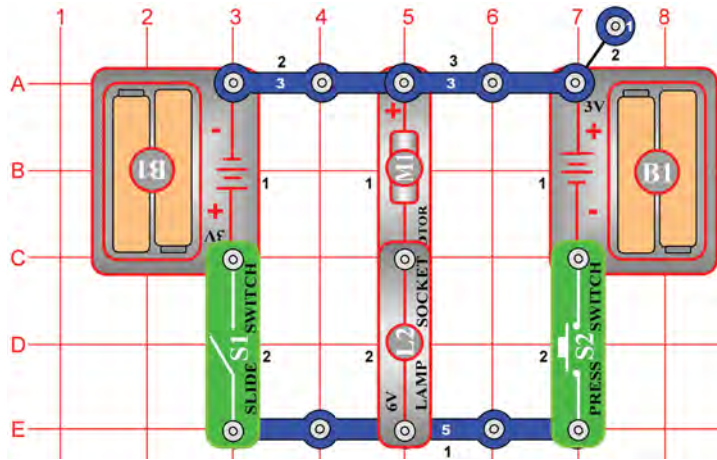
Turn the slide switch (S1) on and move the adjustable resistor (RV) control all the way up. The brightness of the LED (D1) is at maximum. Now, move the adjustable resistor control down until the LED goes out. Set the control up a little and the LED lights dimly.

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

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



Project #205



Motor Rotation

OBJECTIVE: To show how voltage polarity affects a DC motor.

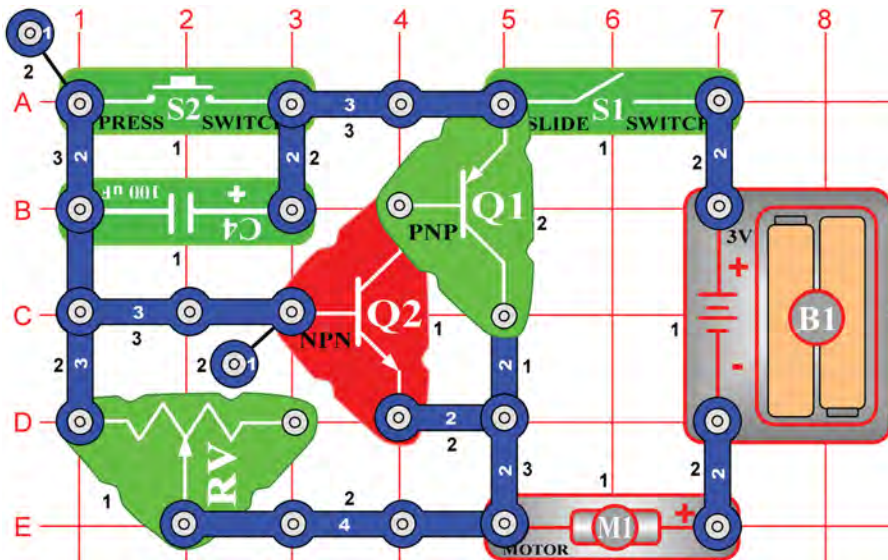
Place the fan onto the motor (M1). Press the press switch (S2), the fan rotates clockwise. When you connect the positive (+) side of the battery (B1) to the positive (+) side of the motor, it spins clockwise. Release the press switch and turn on the slide switch (S1). Now the fan spins the other way. The positive (+) side of the battery is connected to the negative (-) side of the motor. The polarity on the motor determines which way it rotates. Notice that the lamp (L2) lights in both polarities. It is not effected by the polarity changes.



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



Project #206



Motor Delay Fan

OBJECTIVE: To build a circuit that controls how long the fan is on.

Place the fan onto the motor (M1) and set the adjustable resistor (RV) control to the far right. Turn the slide switch (S1) on and then press the press switch (S2) once. The motor will spin and then stop. Now set the resistor control to the far left and press the press switch again. The time the fan spins is much less now.

When the press switch is pressed, the current flows through the circuit and the fan spins. The 100µF capacitor (C4) charges up also. When the switch is released, the capacitor discharges and supplies the current to keep the transistors (Q1 & Q2) on. The transistor acts like a switch connecting the fan to the battery (B1). When the capacitor fully discharges, the transistors turn off and the motor stops. The adjustable resistor controls how fast the capacitor discharges. The more resistance, the longer the discharge time.



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



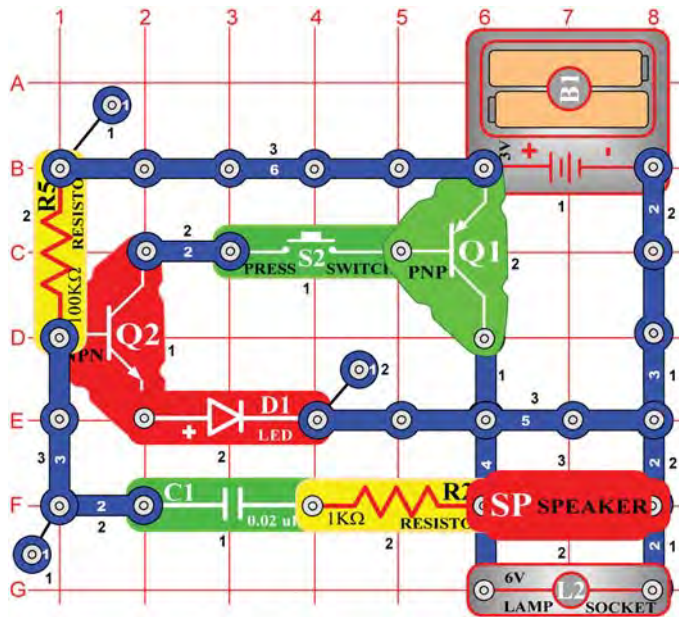
Project #207 Motor Delay Fan (II)

OBJECTIVE: To change capacitance to affect time.

Use the circuit from project #206. Connect a single snap under the positive (+) side of the 470µF capacitor (C5) and then connect it over the top of the 100µF capacitor (C4). Turn the switch (S1) on and press the press switch (S2). Notice that the fan spins longer now. When capacitors are in parallel, the values are added, so now you have 570µF. The time it takes to discharge the capacitors is longer now, so the fan keeps spinning.



Project #208



OBJECTIVE: To build a high pitch bell.

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



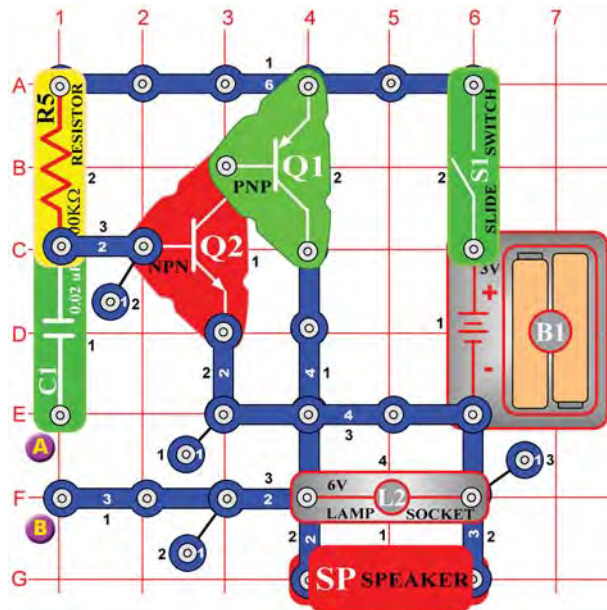
Project #209 Steamship

OBJECTIVE: To generate the sound of a steamship.

Using the circuit in project #208, connect the 0.1μF capacitor (C2) across the 0.02μF capacitor (C1). Press the press switch (S2). The circuit now generates the sound of a steamship.



Project #210



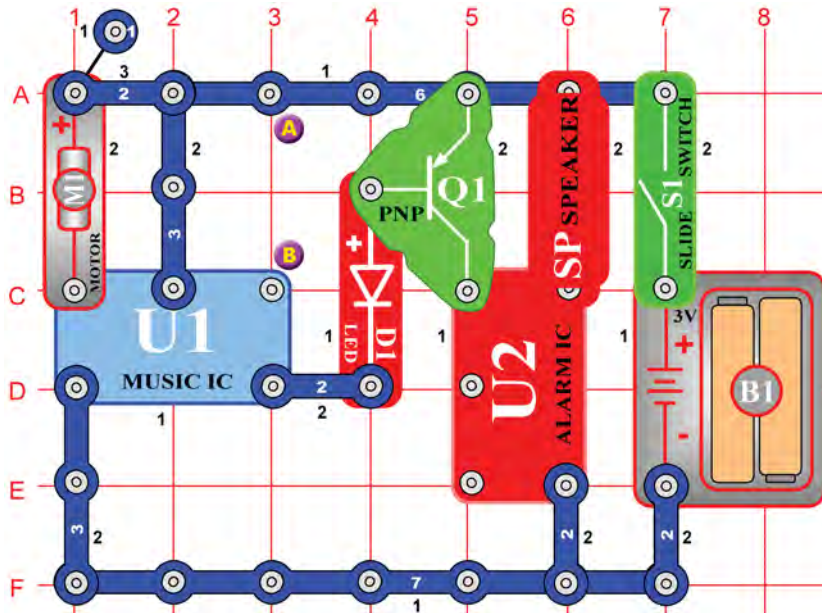
OBJECTIVE: To use your body as an electronic component.

Turn the circuit on, nothing happens. Touch points A & B with your fingers, nothing happens. Wet your fingers with water or saliva and touch points A & B, you hear a loud tone.

Wetting your fingers makes better electrical contact with the metal, effectively lowering your body's resistance.



Project #211



Motor-activated Burglar Alarm

OBJECTIVE: To build a motor-activated alarm.

Place the circuit into a room you want guarded. Wind a piece of string around the axis of the motor (M1) so when you pull it the axes spins. Connect the other end of the string to a door or window. Turn the slide switch (S1) on and wait for the sound to stop. If a thief comes in through the door or window the string pulls and the axis spins. This will activate the sound.



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



Project #212

Light-activated Burglar Alarm

OBJECTIVE: To build a light-activated burglar alarm.

Use the circuit from project #211 shown above. Connect a photoresistor (RP) across points A & B and cover it or turn off the lights. Turn the slide switch (S1) on and wait for the sound to stop. At night, when the thief comes in and turns on the light, the speaker (SP) makes the sound of a machine gun.



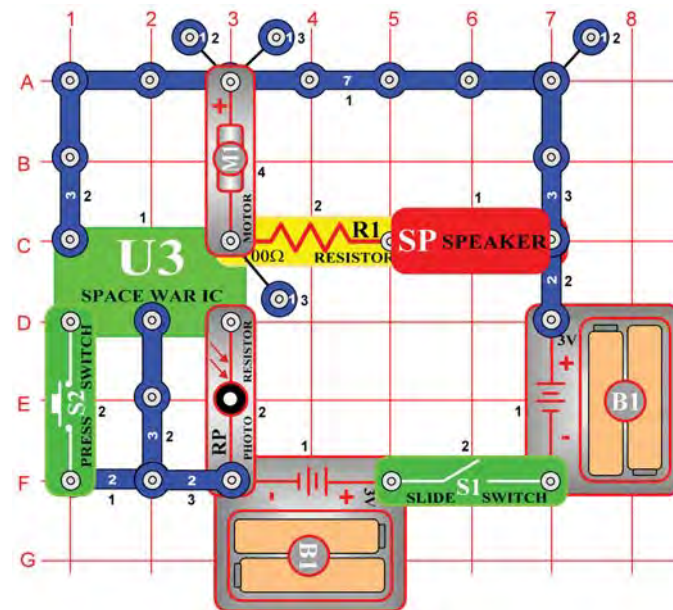
WARNING: Moving parts. Do not touch the fan or motor during operation.



Project #213

Spacey Fan

OBJECTIVE: To build a fan with space war sounds that is activated by light.



Place the fan onto the motor (M1). Space war sounds are heard if light shines on the photoresistor (RP) OR if you press the press switch (S2), the fan may start to spin, but will only get to high speed if you do BOTH. Try various combinations of shining light and holding down the press switch.

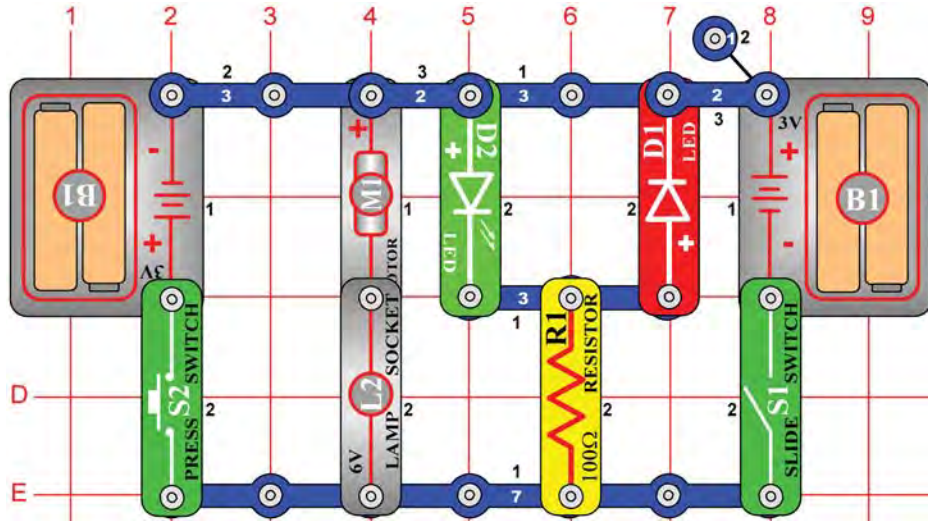


WARNING: Moving parts. Do not touch the fan or motor during operation.



Project #214

LED Fan Rotation Indicator



OBJECTIVE: To build an LED fan rotation indicator.

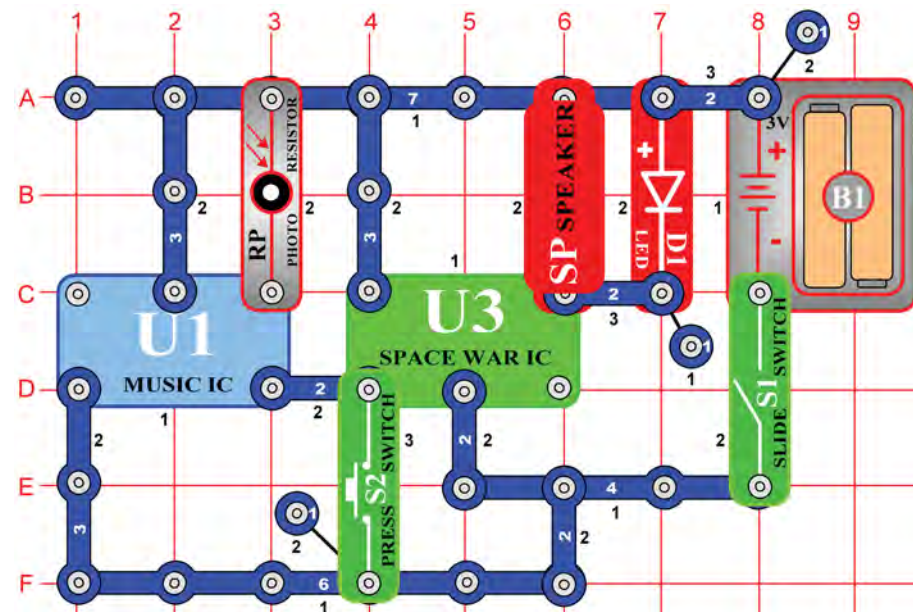
Place the fan onto the motor (M1). Turn the slide switch (S1) on. The fan rotates clockwise, the green LED (D2) and the lamp light (L2). When you connect the positive (+) side of the battery (B1) to the positive (+) side of the motor, it spins clockwise. Turn the switch off and press the press switch (S2). Now the fan spins the other way and the red LED (D1) and lamp light. The positive (+) side of the battery is connected to the negative (-) side of the motor. The polarity on the motor determines which way it rotates. Notice that the lamp lights in both polarities.

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



Project #215

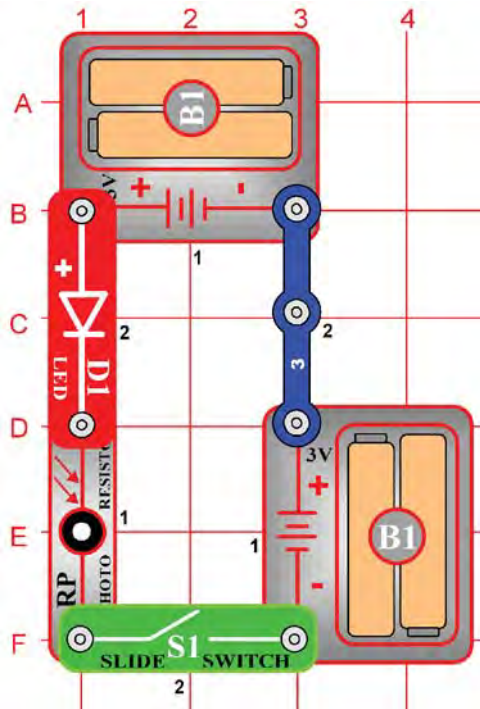
Space War Sounds with LED



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

Build the circuit shown on the left, which uses the space war integrated circuit (U3). Turn the slide switch (S1) on. A space war sound plays, and the LED (D1) flashes. If there is no light on the photoresistor (RP) then the sound will stop after a while.

You also make sounds by pressing the press switch (S2). See how many sounds are programmed into the space war sound IC.



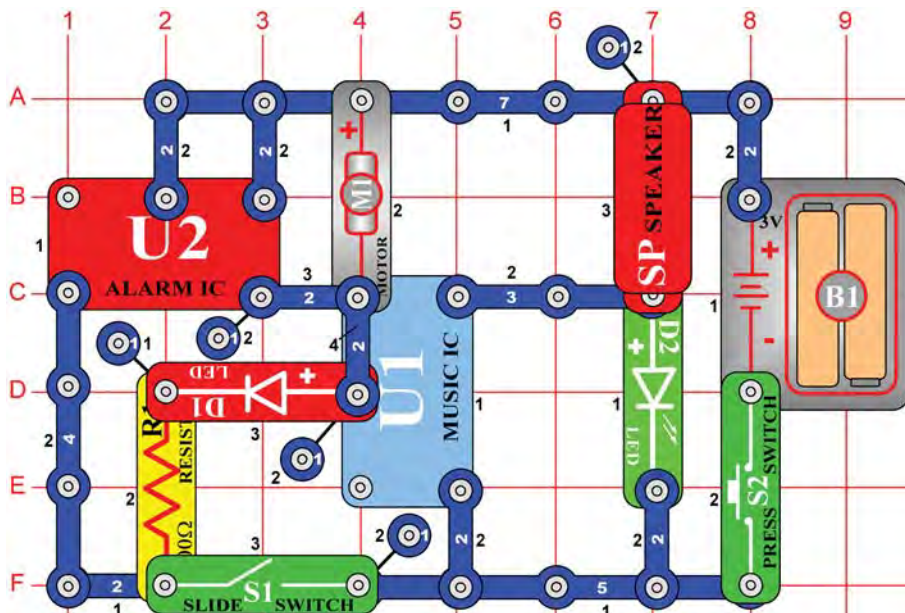
Project #216 Photoresistor Control

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

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

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

Project #217



Sound Mixer Fan Driver

OBJECTIVE: To connect two sound IC's together to drive two LED's and a motor.

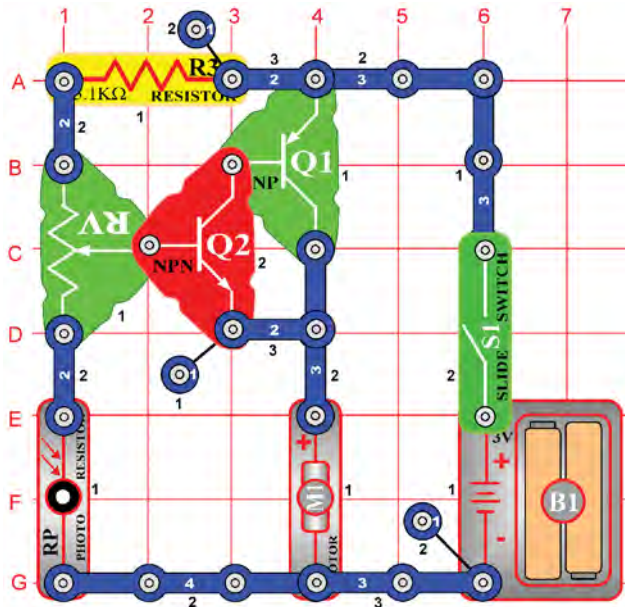
Build the circuit shown on the left. Place the fan onto the motor (M1).

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

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



Project #218



Electric Fan Stopped by Light

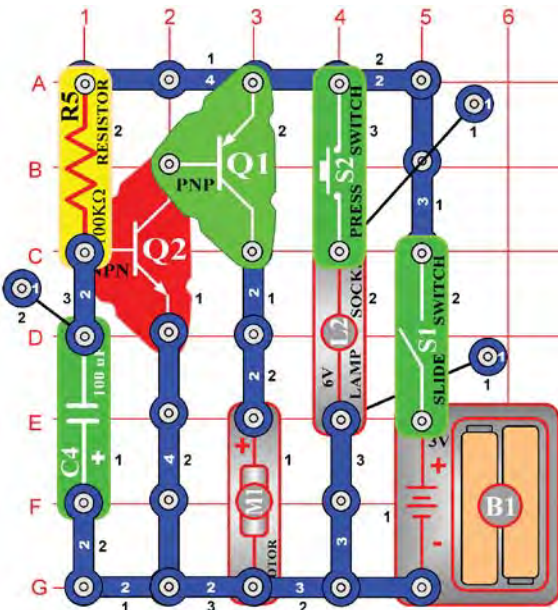
OBJECTIVE: To show how light can control a motor.

Turn on the slide switch (S1) and set the adjustable resistor (RV) control so the motor (M1) just starts spinning. Slowly cover the photoresistor (RP) and the motor spins faster. By placing more light over the photoresistor, the motor slows down.

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



Project #219



Motor & Lamp

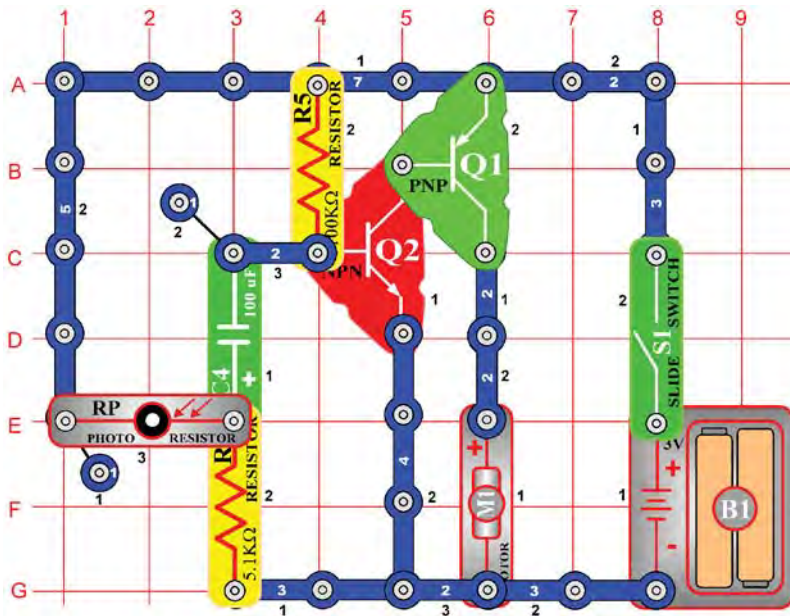
OBJECTIVE: To control large currents with a small one.

Place the fan on the motor (M1). Turn the slide switch (S1) on and the motor spins. The transistors (Q1 & Q2) are like two switches connected in series. A small current turns on the NPN transistor (Q2), which turns on the PNP transistor (Q1). The large current used to spin the motor now flows through the PNP. The combination allows a small current to control a much larger one.

Press the press switch (S2) and the lamp (L2) lights and slows the motor. When the lamp lights, the voltage across the motor decreases and slows it down.



Project #220



Start-stop Delay

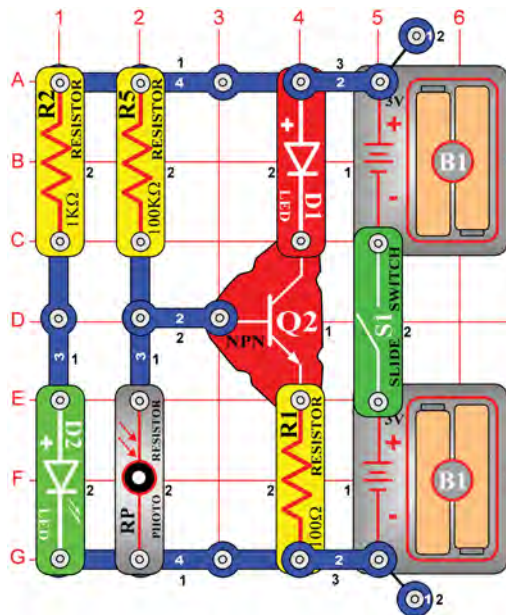
OBJECTIVE: To start and stop a motor with light.

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

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



Project #221

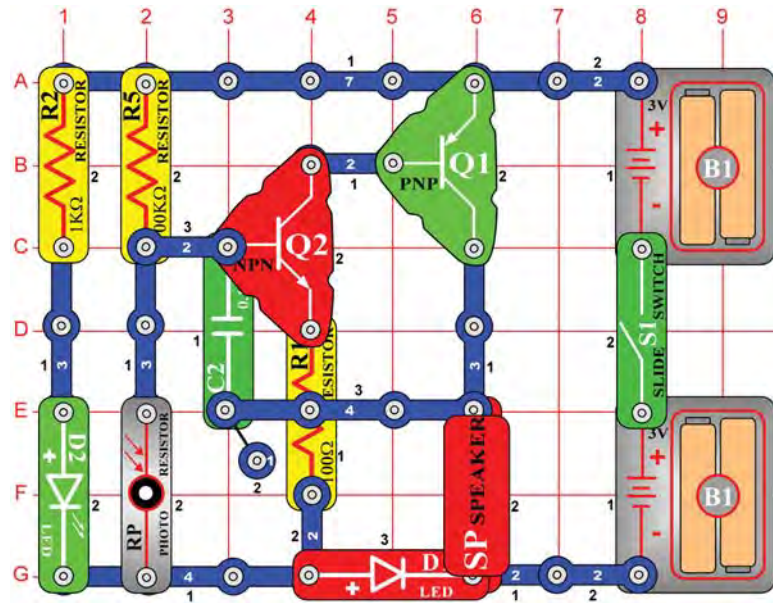


Mail Notifying System

OBJECTIVE: To build a circuit to indicate if you have mail.

Turn on the slide switch (S1). If there is light on the photoresistor (RP) the red LED (D1) will not light. Place your finger over the photoresistor and now the red LED lights. A simple mail notifying system can be made using this circuit. Install the photoresistor and the green LED (D2) inside the mailbox facing each other. Place the red LED outside the mailbox. When there is mail, the light is blocked from the photoresistor and the red LED turns on.

Project #222 Mail Notifying Electronic Bell



OBJECTIVE: To build a circuit to indicate if you have mail by sounding a tone.

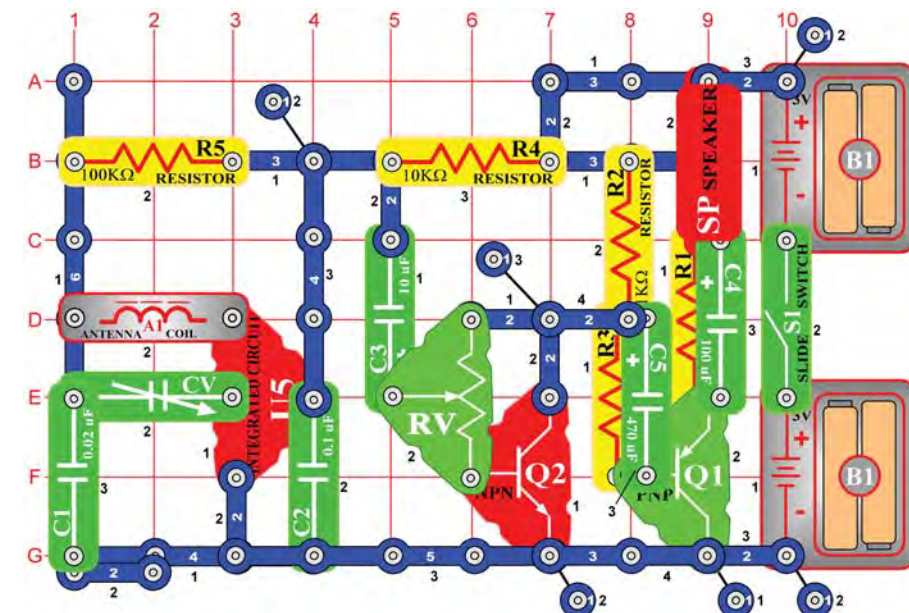
Turn on the slide switch (S1). If there is enough light on the photoresistor (RP), the speaker (SP) will not make any sound. Place your finger over the photoresistor and now the speaker sounds. The sound will stay on until you turn off the switch. A simple mail notifying system can be made using this circuit. Install the photoresistor and the green LED (D2) inside the mailbox facing each other. When there is mail, the light is blocked from the photoresistor and the speaker turns on.

Project #223 Mail Notifying Electronic Lamp

OBJECTIVE: To build a circuit to indicate if you have mail by activating the lamp.

Replace the speaker (SP) with the 6V lamp (L2). When there is mail, the light is blocked from the photoresistor (RP) and the lamp lights up.

Project #224



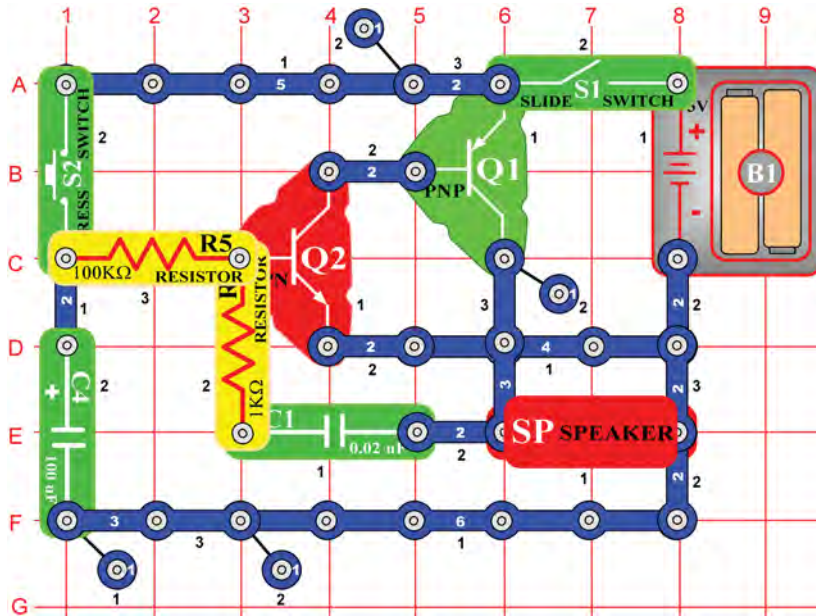
AM Radio with Transistors

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

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

Project #225

Lasting Doorbell



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

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

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

Project #226

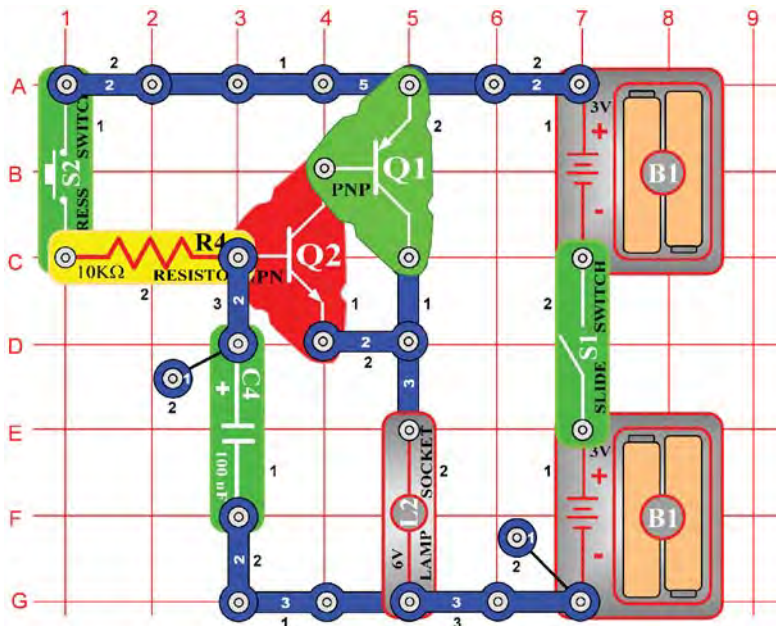
Lasting Clicking

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

Place the 10µF capacitor (C3) on top of the 0.02µF capacitor (C1). Press and release the press switch (S2). It makes a clicking sound that repeats for a while.

Project #227

Delayed Action Lamp



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

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

Project #228

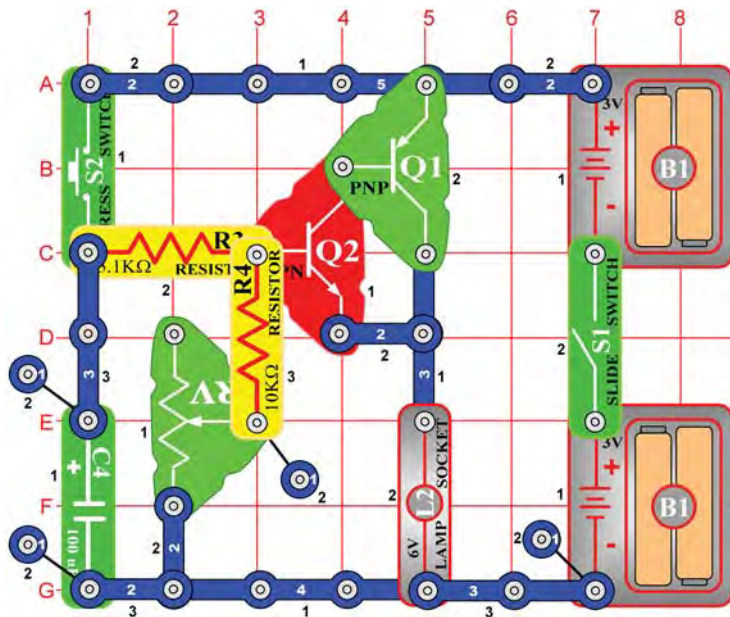
Delayed Action Fan

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

Replace one battery holder (B1) with a 3-snap and replace the lamp (L2) with the motor (M1), positive (+) side up. Be sure to put on the fan. Turn on the slide switch (S1) and press the press switch (S2). The fan turns on slowly but stays on for a while after you release the press switch.

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

Project #229 Adjustable Time Delay Lamp



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

Turn on the slide switch (S1) and press the press switch (S2). The lamp (L2) stays on for a while after you release the press switch. You can change the delay time with the adjustable resistor (RV).

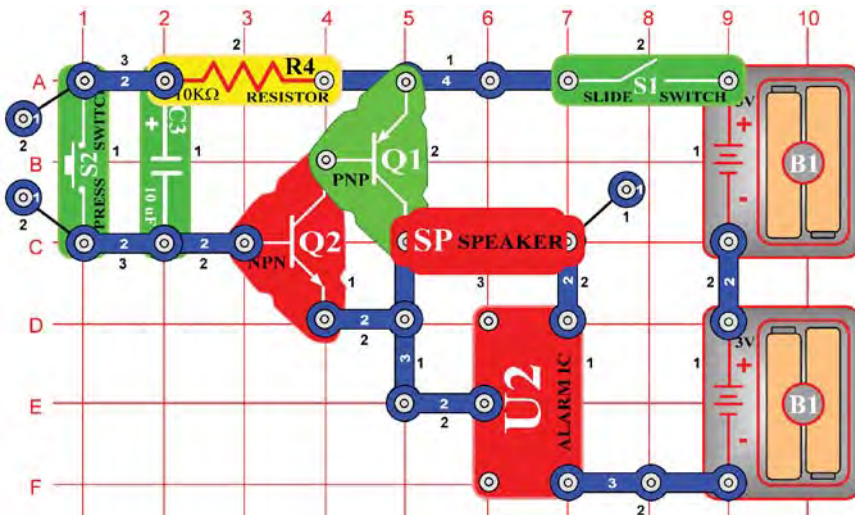
Project #230 Adjustable Time Delay Fan

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

Replace on battery holder (B1) with a 3-snap and replace the lamp (L2) with the motor (M1), be sure to put on the fan. Turn on the slide switch (S1) and press the press switch (S2). The fan stays on for a while after you release the press switch. You can change the delay time with the adjustable resistor (RV).

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

Project #231 Transistor Fading Siren



OBJECTIVE: To build a siren that slowly fades away.

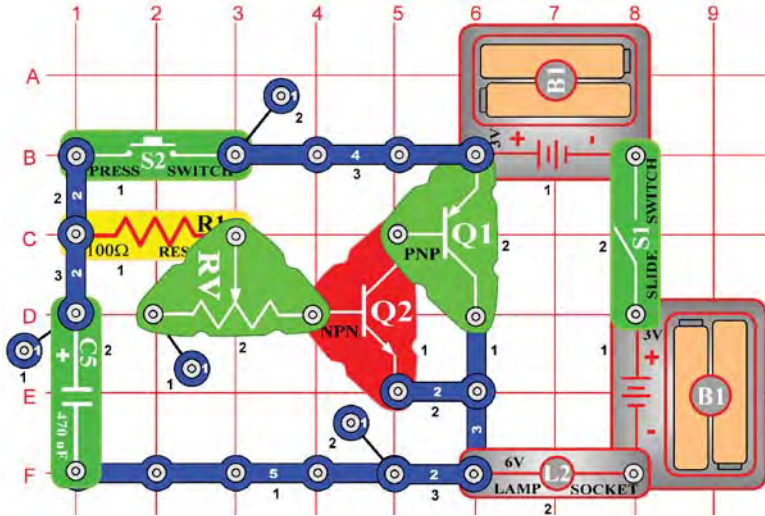
Turn on the slide switch (S1), then press and release the press switch (S2). You hear a siren that slowly fades away and eventually goes off. You can modify this circuit to make machine gun or ambulance sound instead like in the other projects. You can also replace the 10μF capacitor (C3) with the 100μF (C4) or 0.1μF (C2) to greatly slow down or speed up the fading.

Project #232 Fading Doorbell

OBJECTIVE: To build a doorbell that slowly fades away.

Replace the alarm IC (U2) with the music IC (U1). The circuit has a doorbell sound that plays and stops.

Project #233



Adjustable Time Delay Lamp (II)

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

Turn on the slide switch (S1) and press the press switch (S2). The lamp (L2) stays on for a few seconds after you release the press switch. You can change the delay time with the adjustable resistor (RV).

Project #234

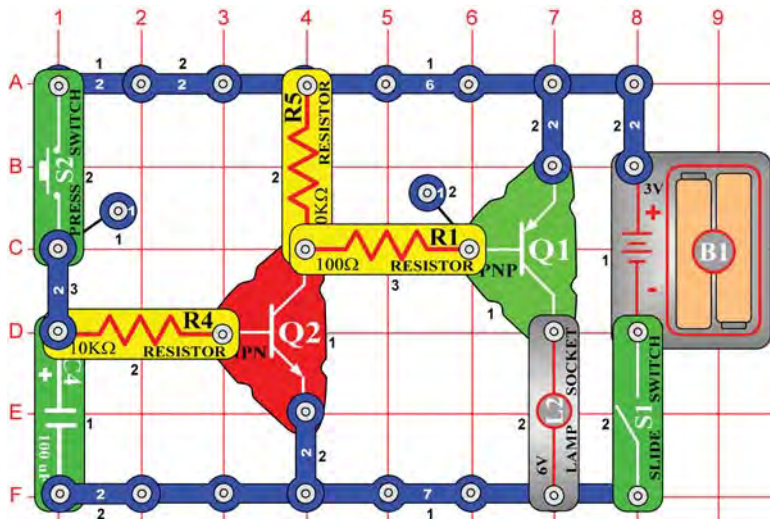
Adjustable Time Delay Fan (II)

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

Replace one battery holder (B1) with a 3-snap and replace the lamp (L2) with the motor (M1), be sure to put on the fan. Turn on the slide switch (S1) and press the press switch (S2). The fan stays on for a while after you release the press switch. You can change the delay time with the adjustable resistor (RV).

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

Project #235



Watch Light

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

Turn on the slide switch (S1) and press the press switch (S2). The lamp (L2) stays on for a few seconds after you release the press switch.

A miniature version of a circuit like this might be in your wristwatch - when you press a light button on the watch to read the time in the dark, a light comes on but automatically turns off after a few seconds to avoid draining the battery (B1).

Project #236

Delayed Bedside Fan

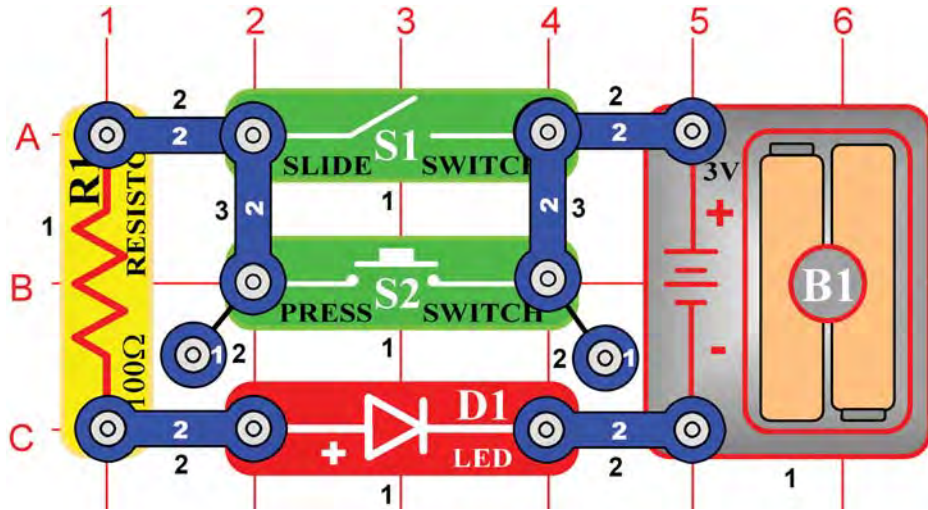
OBJECTIVE: To build a fan that stays on for a while.

Replace the lamp (L2) with the motor (M1, positive "+" side up), be sure to put on the fan. Turn on the slide switch (S1) and press the press switch (S2). The fan stays on for a while after you release the press switch. This could have a longer delay and be near your bed, to turn off after you fall asleep.

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



Project #237



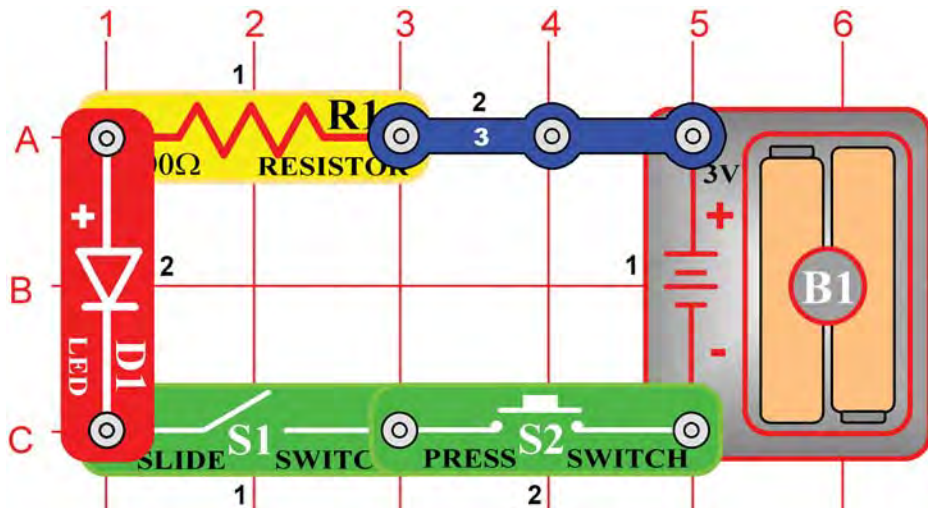
This OR That

OBJECTIVE: To introduce you to the OR concept of electronic wiring.

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



Project #238



This AND That

OBJECTIVE: To introduce you to digital circuits.

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

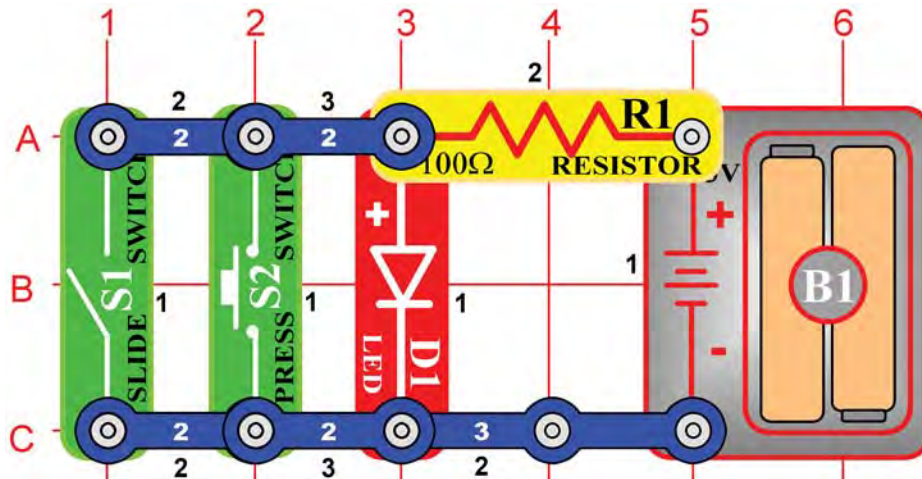
Combinations of AND and OR circuits are used to add and multiply numbers together in modern computers. These circuits are made of tiny transistors in massive integrated circuits.



Project #239

Neither This NOR That

OBJECTIVE: To demonstrate the concept of a NOR circuit.



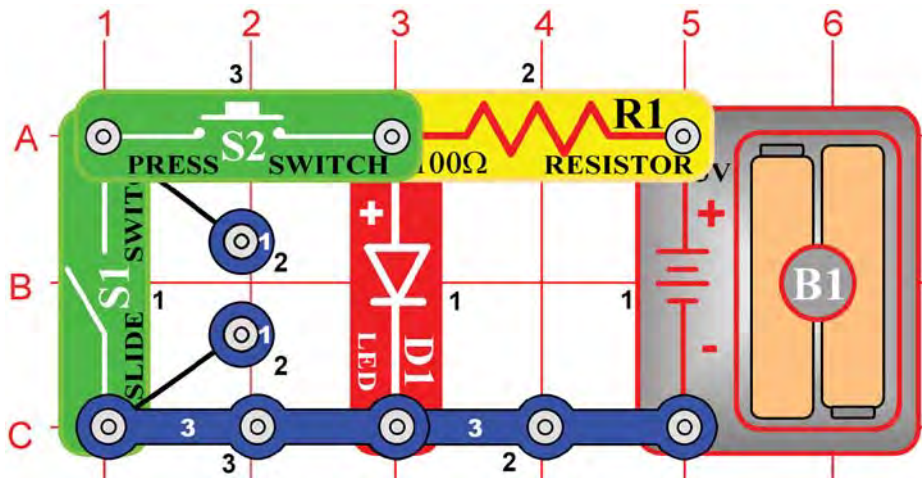
Build the circuit on the left and test the combinations of the slide switch (S1) and press switch (S2). If you compare it to the OR circuit in project #237, you can see the LED (D1) lights in the opposite combinations of that circuit. Hence, we refer to it as a **NOR** circuit (short for “NOT this OR that”). Like the OR and AND, it is an important building block in computers.



Project #240

NOT This AND That

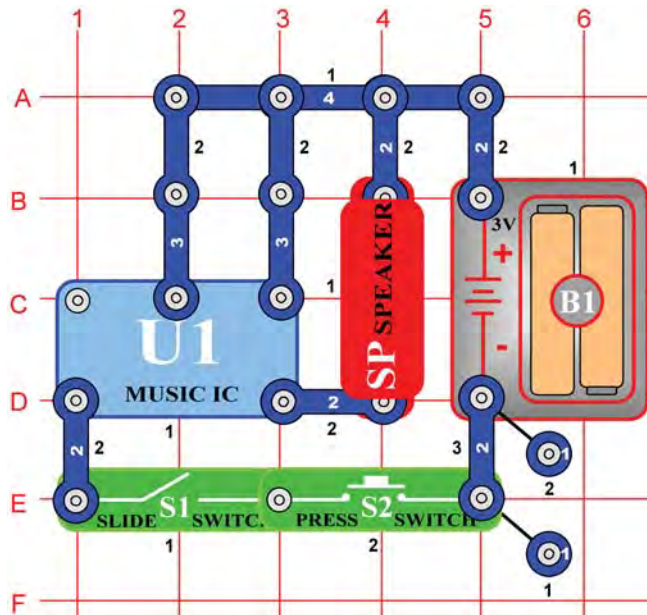
OBJECTIVE: To demonstrate the concept of a NAND circuit.



Build the circuit at left and test the combinations of the slide switch (S1) and press switch (S2). If you compare it to the AND circuit in project #238, you can see the LED (D1) lights in the opposite combinations of that circuit. Hence, we refer to it as a **NAND** circuit (short for “NOT this AND that”). This circuit can also have more or less than two inputs, though when it only has one input it is referred to as a **NOT** circuit. Like the OR, AND, and NOR, NAND and NOT are important building blocks in computers.



Project #241



Music AND Gate

OBJECTIVE: To build an AND gate.

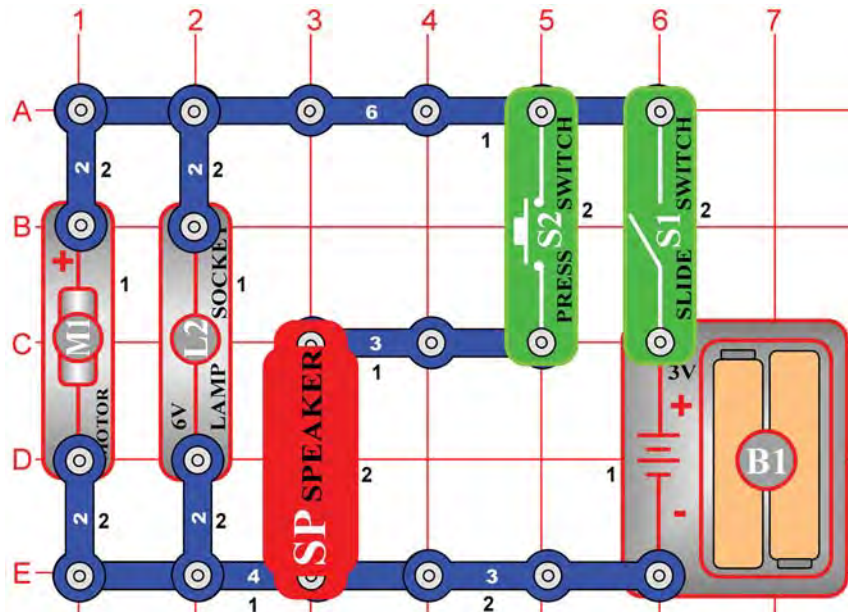
You will only hear music if you turn on the slide switch (S1) AND press the press switch (S2). This is referred to as an AND gate in electronics.

This concept is important in computer logic.

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



Project #242



Lamp, Speaker & Fan in Parallel

OBJECTIVE: To show the power drop of components connected in parallel.

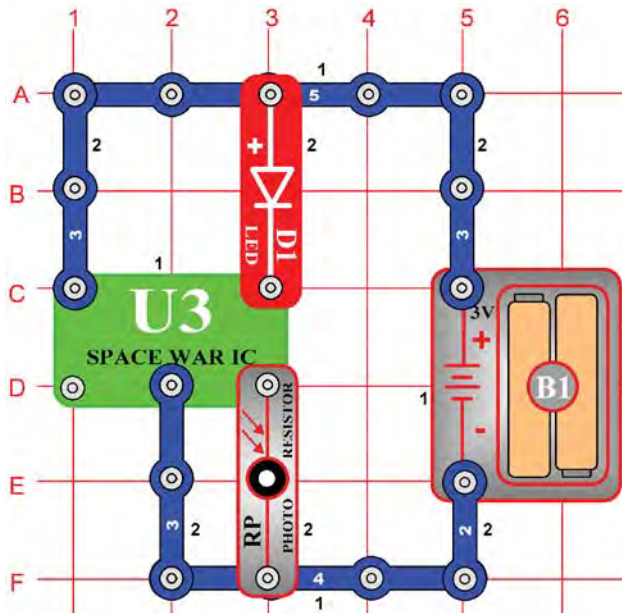
Leave the fan off the motor (M1). Turn on the slide switch (S1), the motor spins and the lamp (L2) turns on. Place the fan on the motor and press the press switch. The lamp is not as bright now, because it takes more power from the batteries (B1) to spin the motor with the fan on it, which leaves less battery power available to light the lamp. If you have weak batteries, the difference in lamp brightness will be more obvious because weaker batteries don't have as much power to supply.

The speaker (SP) is being used as a low-value resistance here to make the above effects more apparent.

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



Project #243



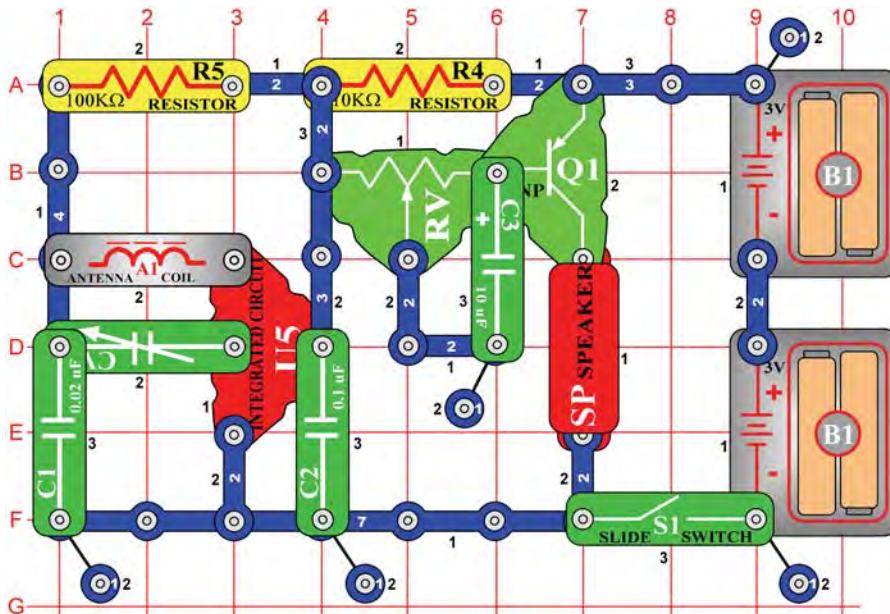
Light-controlled LED (II)

OBJECTIVE: Build a circuit that turns an LED on and off if there is light present.

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



Project #244



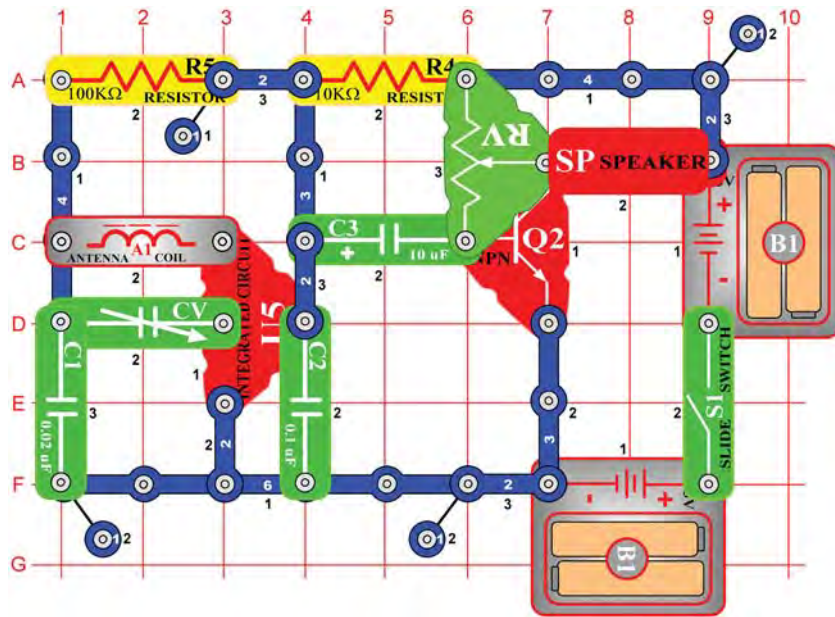
AM Radio

OBJECTIVE: To build a one IC AM radio.

Turn on the slide switch (S1) and adjust the variable capacitor (CV) for a radio station.



Project #245



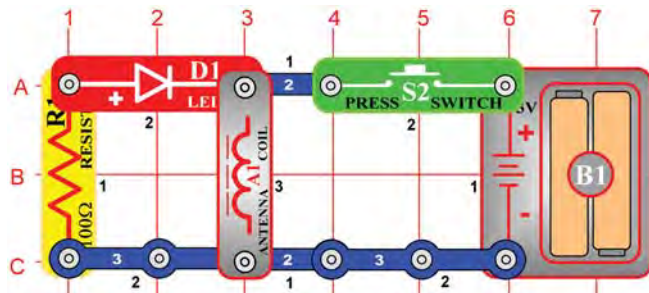
Transistor AM Radio

OBJECTIVE: To show the output of an AM radio.

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



Project #246



Antenna Storing Energy

OBJECTIVE: To show that the antenna stores energy.

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 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.

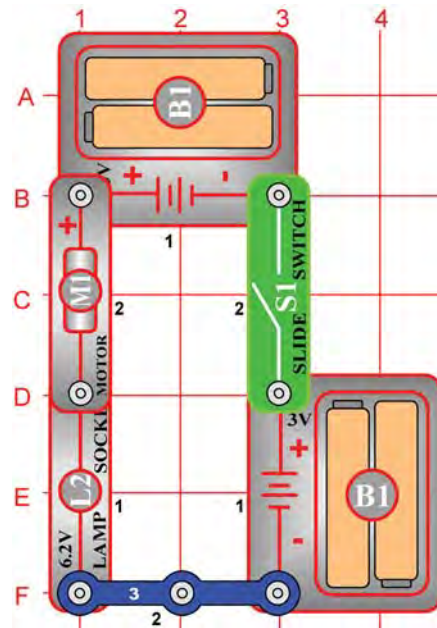


Project #247

Back EMF

OBJECTIVE: To demonstrate how the motor works.

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



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 slide switch (S1). The 6V lamp (L2) will be bright, indicating that the Back EMF is low and the current is high.

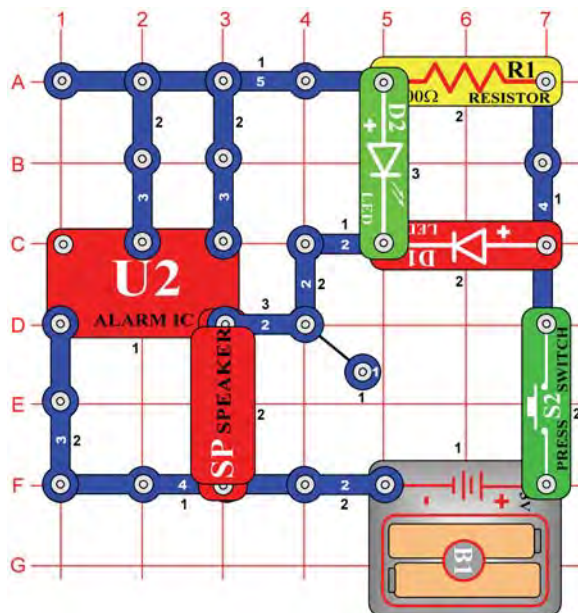
Turn off the switch, remove the fan, and turn the switch back on. The lamp is bright when the motor (M1) starts and the lamp dims as the motor speeds up. Now the Back EMF is high and the current is low. BE CAREFUL NOT TO TOUCH THE MOTOR WHILE IT SPINS.



Project #248

Flashing Laser LED's with Sound

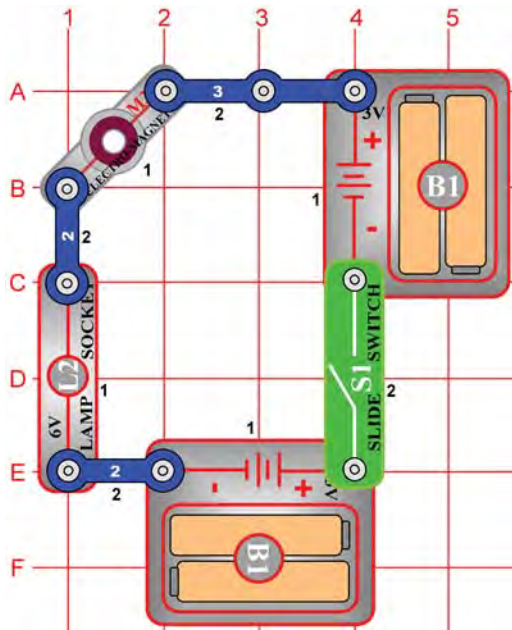
OBJECTIVE: To build a laser sounding circuit.



When you press the press switch (S2) the integrated circuit (U2) should sound like a laser gun. The red (D1) and green (D2) LED's will flash simulating a burst of light. You can shoot long repeating laser burst, or short zaps by tapping the switch.



Project #249



Electromagnet Delayer

OBJECTIVE: *To learn about the electromagnet.*

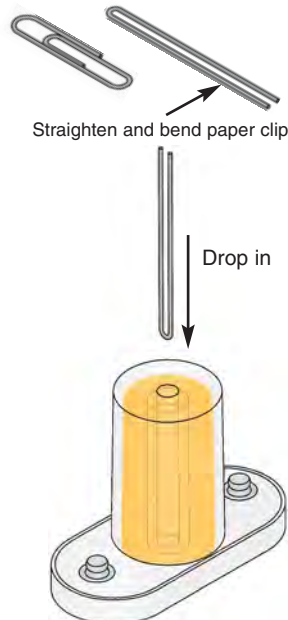
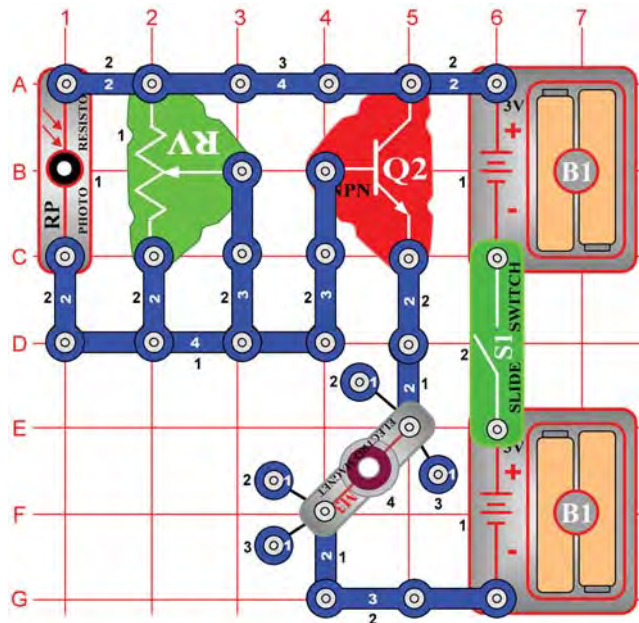
Build the circuit and turn it on. After a delay of about 2 seconds, the lamp (L2) will light but be dim. Replace your batteries if it does not light at all.

Why does the electromagnet (M3) delay the lamp turn-on? The electromagnet contains a large coil of wire, and the batteries (B1) 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.



Project #250



Photoresistor Paper Clip Suspension

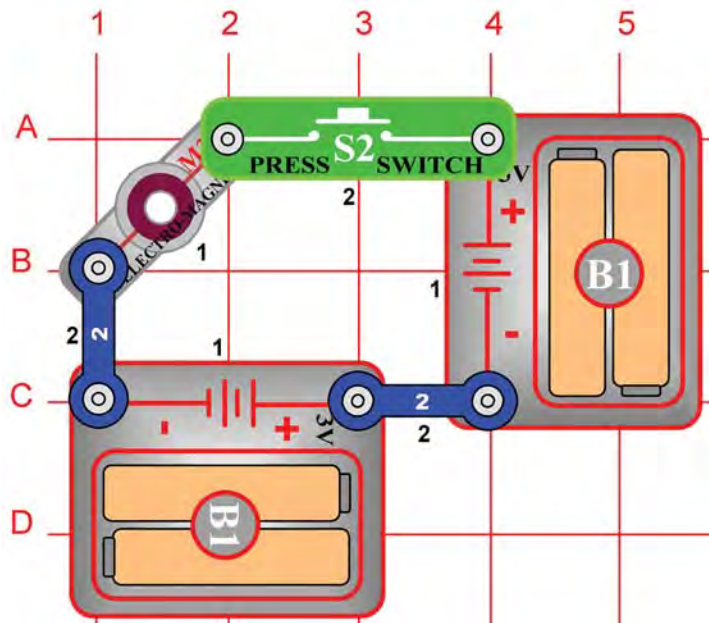
OBJECTIVE: *To show how electricity can lift things using magnetism.*

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

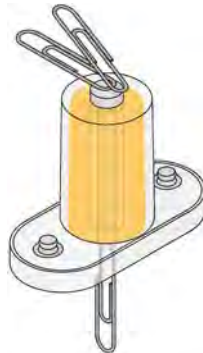
Now move the adjustable resistor (RV) control lever around while waving your hand over the photoresistor (RP). Depending on the adjustable resistor setting, sometimes covering the photoresistor causes the paper clip to fall and sometimes it doesn't. You can also adjust the light to set the paper clip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



Project #251



Use the electromagnet to pick up some paper clips, they will be attracted to both ends of the iron core rod. See how many paper clips you can lift at once.



Electromagnetism

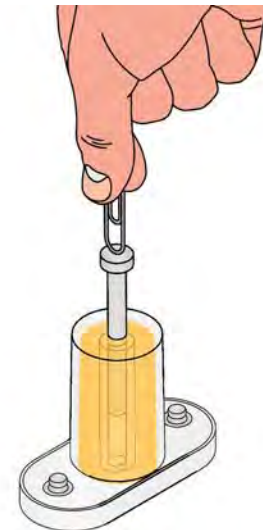
OBJECTIVE: To learn how electricity and magnetism are related.

Put the iron core rod into the electromagnet (M3). Press the press switch (S2) and hold some iron objects near the electromagnet (M3), they will be attracted to it. By carrying the base grid around, you can use the electromagnet 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.

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.

You can also use a paper clip to lift the iron core rod up from the electromagnet.

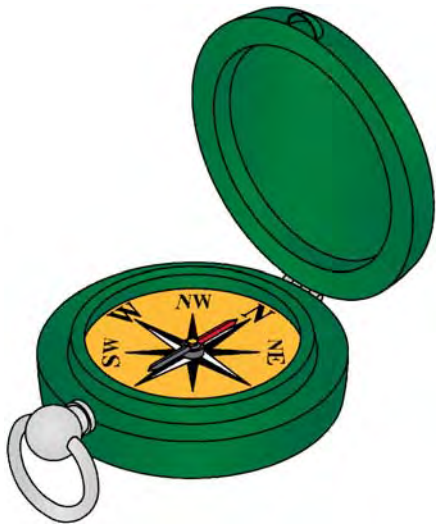


See what other small objects you can pick up. You can only pick up things made of iron, not just any metal.

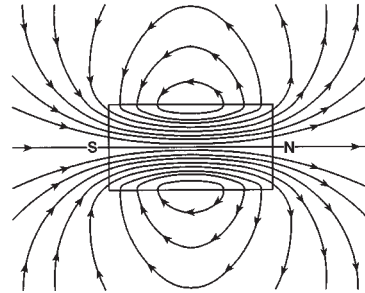


Project #252

Electromagnetism & Compass



Compass



Magnetic Field

OBJECTIVE: To learn how electricity and magnetism are related.

You need a compass for this project (not included). Use the circuit from project #251, 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.

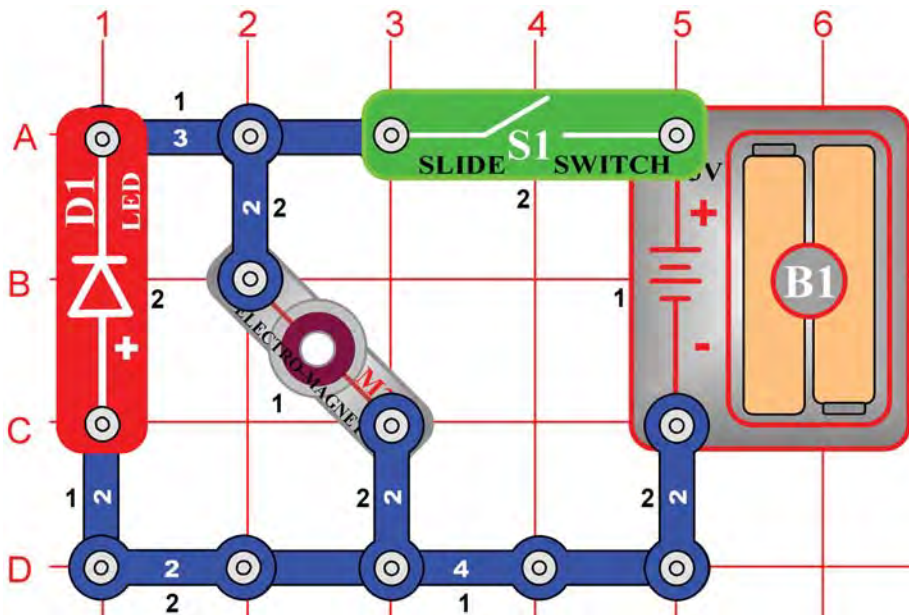
The earth has a similar magnetic field, due to its iron core. A compass points north because it is attracted to this magnetic field. The electromagnet creates its own magnetic field, and attracts the compass in a similar way.



Project #253

Electromagnet Storing Energy

OBJECTIVE: To learn about the electromagnet.

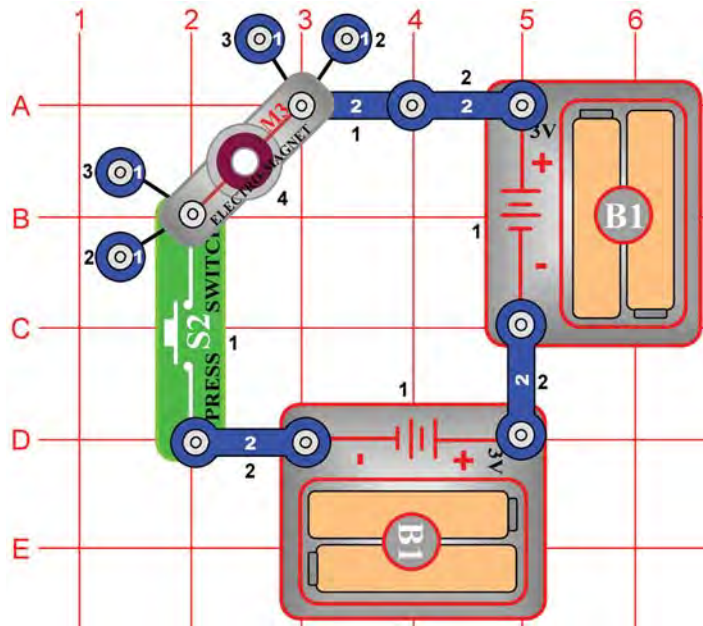


Turn on the slide switch (S1) - nothing happens. Turn the switch off - the LED (D1) flashes.

When you turn on the switch, the electromagnet (M3) stores energy from the batteries (B1) into a magnetic field. When you turn off the switch, the magnetic field collapses and the energy from it discharges through the LED.



Project #254



Electromagnet Tower

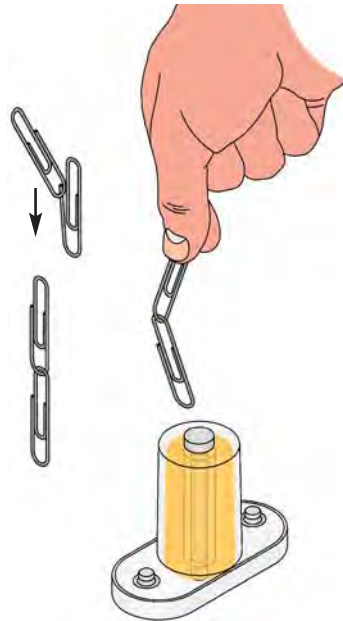
OBJECTIVE: To show how electricity can lift things using magnetism.

This circuit gives a dramatic demonstration of how the electromagnet can suck up a paper clip. Take a paper clip and straighten it out, then bend it in half. Drop it into the electromagnet (M3) center, and then press the press switch (S2) several times. The paper clip 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 #255



Paper Clip Compass

OBJECTIVE: To learn how electricity and magnetism are related.

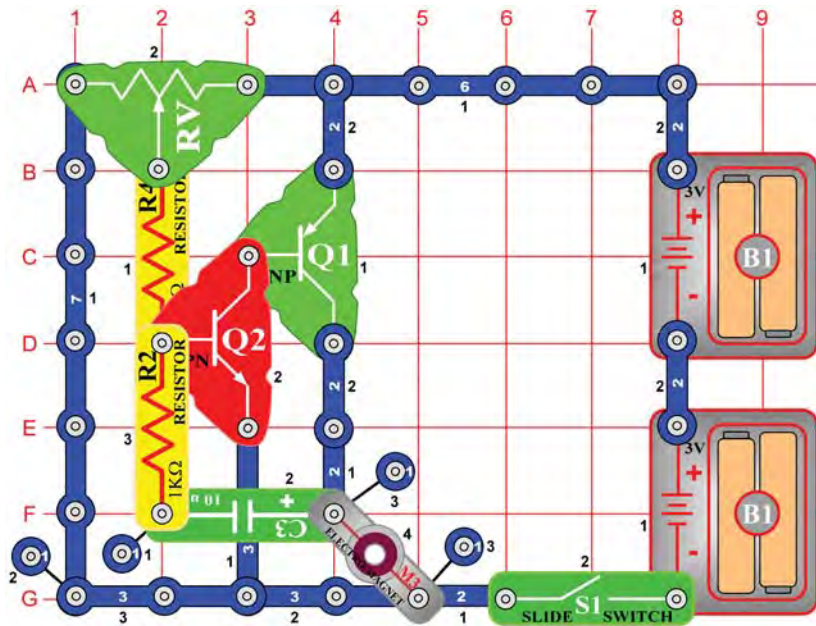
Use the circuit from project #254, but place the iron core rod in the electromagnet (M3). You may want to use the slide switch (S1) in place of the press switch (S2), but only turn it on as needed or you will quickly drain your batteries.

Slide two paper clips together, using their loops.

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



Project #256

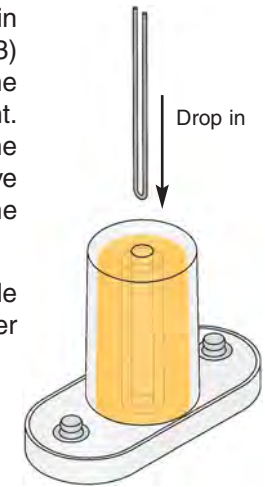
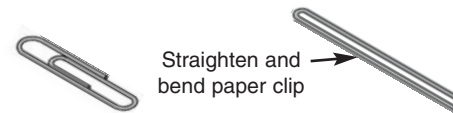


Paper Clip Oscillator (II)

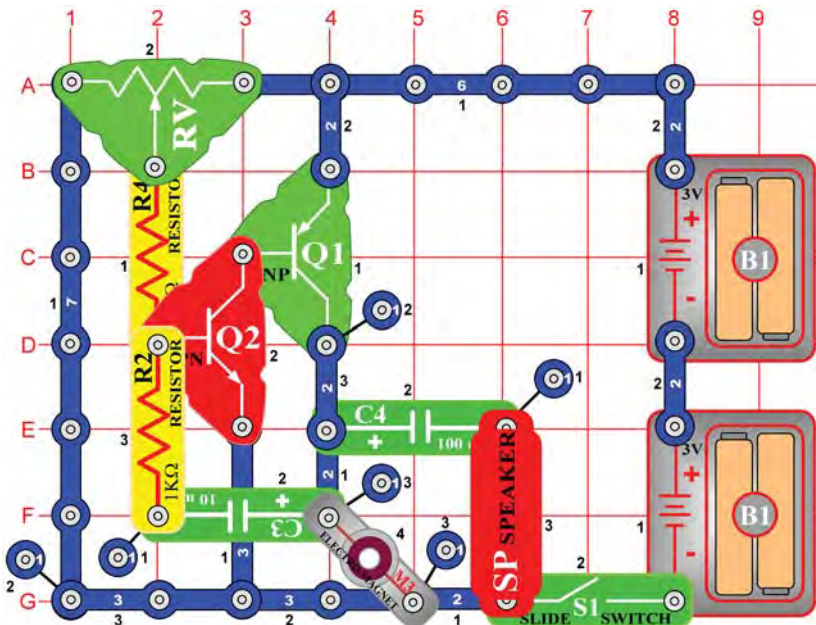
OBJECTIVE: To show how electricity can lift things using magnetism.

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

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



Project #257

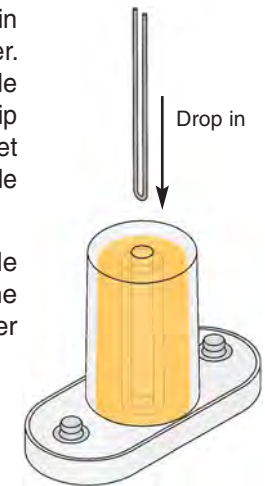
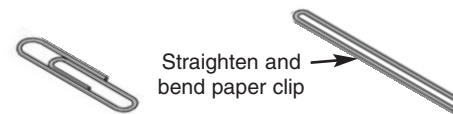


Paper Clip Oscillator (III)

OBJECTIVE: To show how electricity can lift things using magnetism.

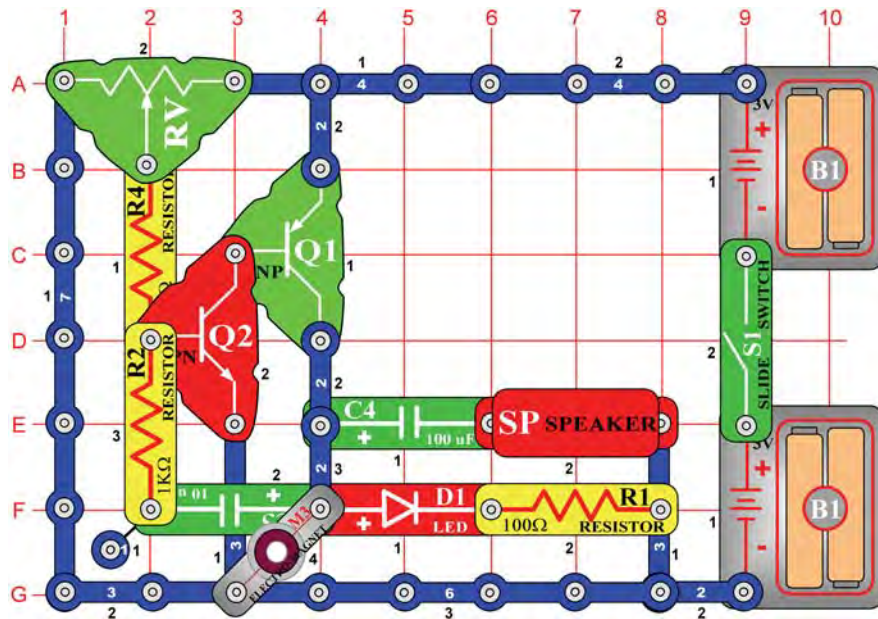
Take a paper clip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the slide switch (S1), and set the adjustable resistor control lever to the right. The paper clip gets sucked into the center of the electromagnet and stays suspended there. Move the adjustable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

Now for the fun part: Slowly slide the adjustable resistor lever until you find a spot where the paper clip is bouncing up and down. The speaker (SP) makes a clicking sound.





Project #258



Paper Clip Oscillator (IV)

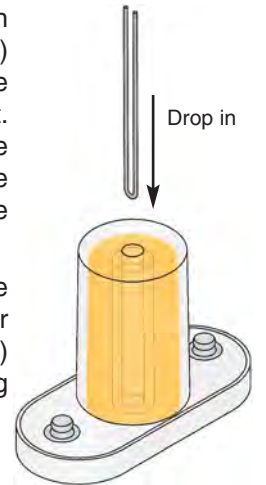
OBJECTIVE: To show how electricity can lift things using magnetism.

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

Now for the fun part: slowly slide the adjustable resistor lever until you find a spot where the paper clip is bouncing up and down. The LED (D1) flashes and the speaker (SP) makes a clicking sound.



Straighten and bend paper clip



Project #259

Paper Clip Oscillator (V)

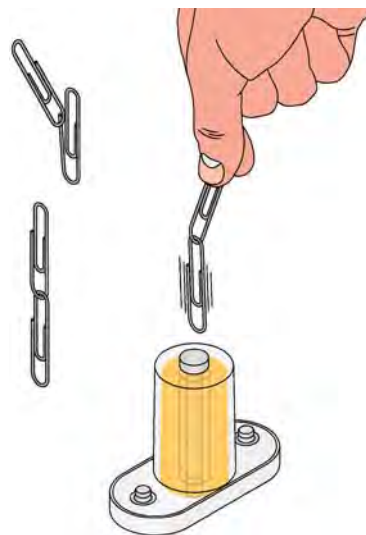
OBJECTIVE: To show how electricity can lift things using magnetism.

Use the circuit from project #258, but replace the 100µF capacitor (C4) with a 3-snap wire and replace the speaker (SP) with the 6V lamp (L2). The circuit works the same way, but the lamp flashes like a strobe light.



Project #260

OBJECTIVE: To learn how electricity and magnetism are related.



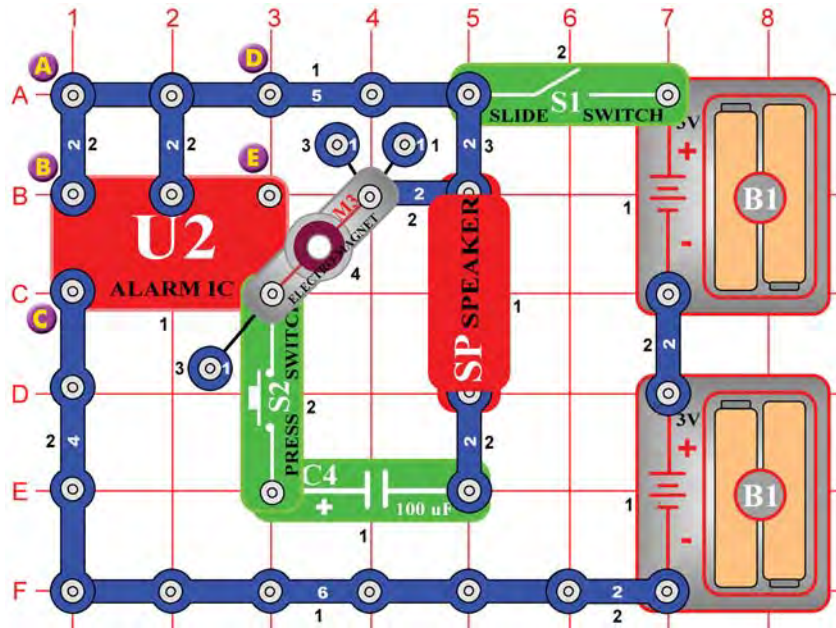
Oscillating Compass

Use the circuit from project #258, but replace the 100µF capacitor (C4) with a 3-snap wire and replace the speaker (SP) with the 6V lamp (L2). Place the iron core rod in the electromagnet (M3) and don't use the bent paper clip. Slide two paper clips together, using their loops.

Turn on the slide switch (S1) and hold the paper clips just above the electromagnet, without them touching the iron core rod. Watch how the lower paper clip is drawn toward the iron core rod. Notice that the lower paper clip is vibrating, due to the changing magnetic field from this oscillator circuit. Compare this circuit to project #255 (Paper Clip Compass).



Project #261

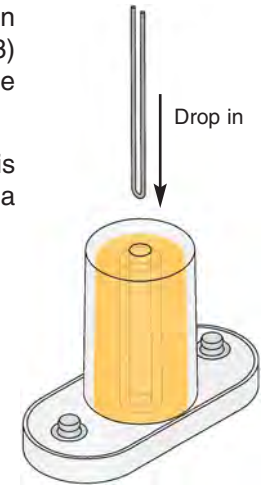
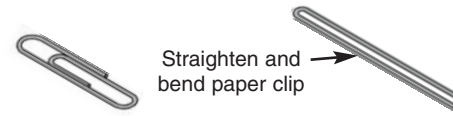


Siren Paper Clip Vibrator

OBJECTIVE: To show how electricity can move things using magnetism.

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

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



Project #262

Alarm

Paper Clip Vibrator

OBJECTIVE: To show how electricity can move things using magnetism.

Use the circuit from project #261, remove the connection between points A & B and make a connection between points B & C (using a spacer on point B). The sound and vibration are different now. Compare the vibration height and frequency to project #261.



Project #263

Machine Gun

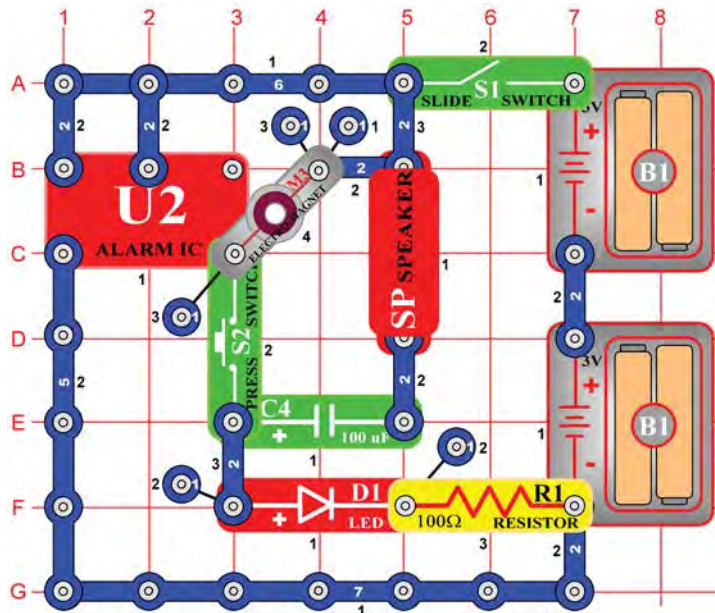
Paper Clip Vibrator

OBJECTIVE: To show how electricity can move things using magnetism.

Now remove the connection between points B & C and make a connection between points D & E. The sound and vibration are different now. Compare the vibration height and frequency to projects #261 and #262.



Project #264

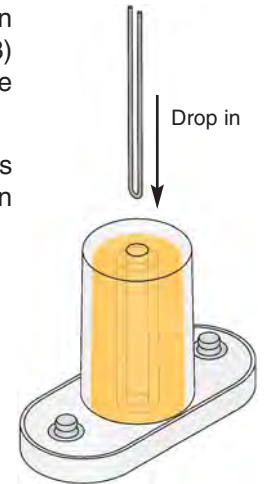
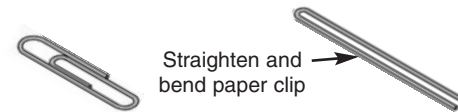


Alarm Vibrator w/ LED

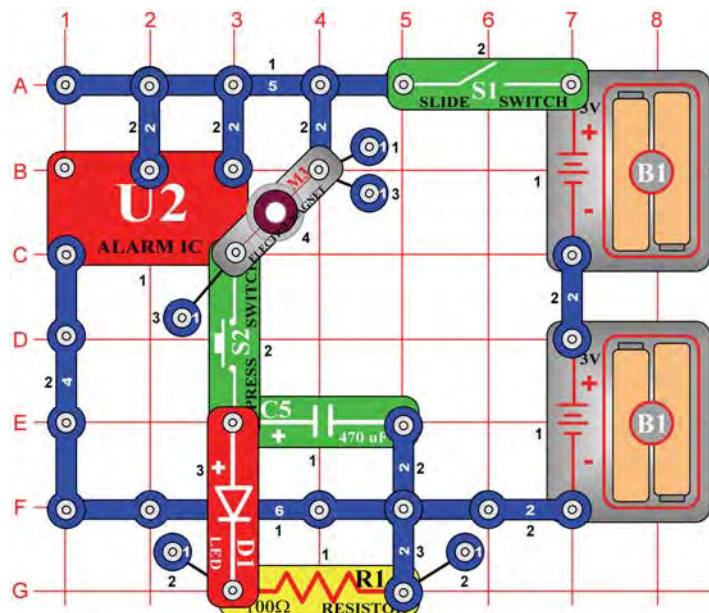
OBJECTIVE: To show how electricity can move things using magnetism.

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

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



Project #265

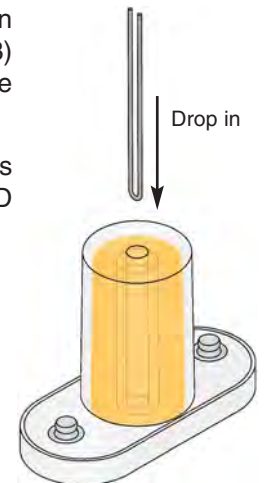
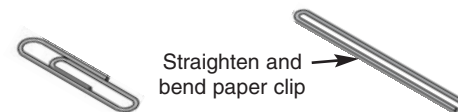


Alarm Vibrator w/ LED (II)

OBJECTIVE: To show how electricity can move things using magnetism.

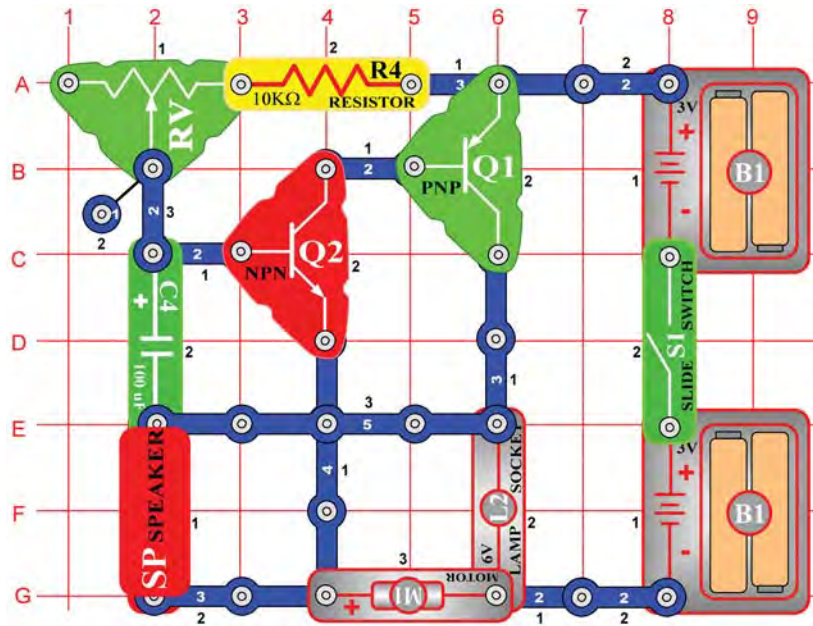
Take a paper clip and straighten it out, bend it in half, and place it into the electromagnet (M3) center. Turn on the slide switch (S1), and the paper clip should vibrate.

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





Project #266



Motor Oscillator

OBJECTIVE: To experiment with oscillator circuits.

This circuit flashes the lamp (L2) and turns the motor (M1) about once a second. Moving the control lever on the adjustable resistor (RV) makes these occur more or less often. This works with the fan on or off the motor.

Nothing happens while the capacitor (C4) charges up through resistors RV and R4. Then the capacitor discharges in a burst that lights the lamp and turns the motor.

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



Project #267 Motor Oscillator (II)

OBJECTIVE: To experiment with oscillator circuits.

Replace the 100µF capacitor (C4) with the larger 470µF capacitor (C5). Now the circuit activates less often, but the lamp (L2) flash is brighter and the motor (M1) turns farther. This is due to more capacitance. The adjustable resistor (RV) control works the same way, and the fan can be on or off the motor.

You can decrease the frequency of an oscillator circuit by increasing either the resistance or the capacitance.

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



Project #268 Motor Oscillator (III)

OBJECTIVE: To experiment with oscillator circuits.

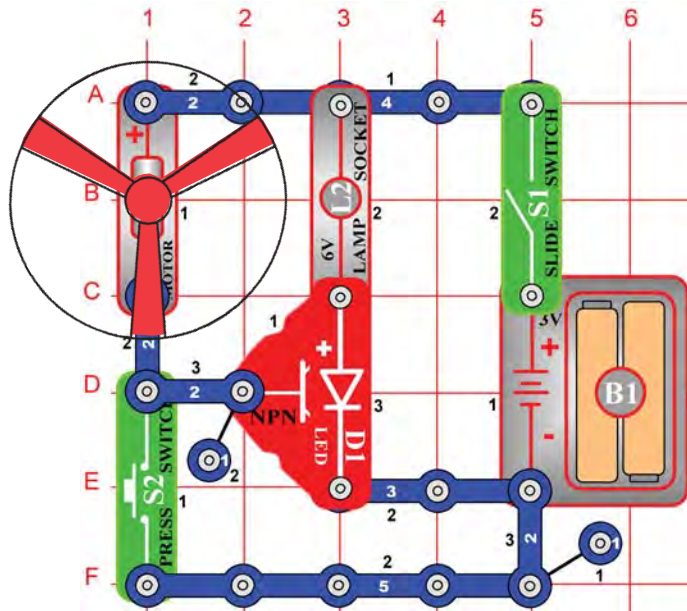
Now replace the 470µF capacitor (C5) with the smaller 10µF capacitor (C3). Now the circuit activates more frequently, but the lamp (L2) is dim and the motor (M1) jerks.

The adjustable resistor (RV) control works the same way, and the fan can be on or off the motor.

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



Project #269



Two-speed Motor Lights

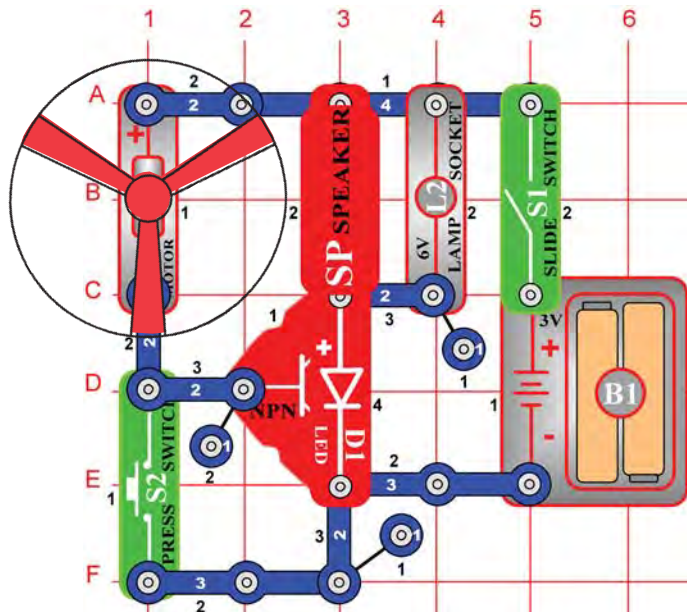
OBJECTIVE: To control the motor speed.

Turn on the slide switch (S1), the motor (M1) spins and the lamp (L2) lights. Press the press switch (S2), the motor spins faster and the LED (D1) lights but the lamp is off.

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



Project #270



Two-speed Motor Lights-Sound

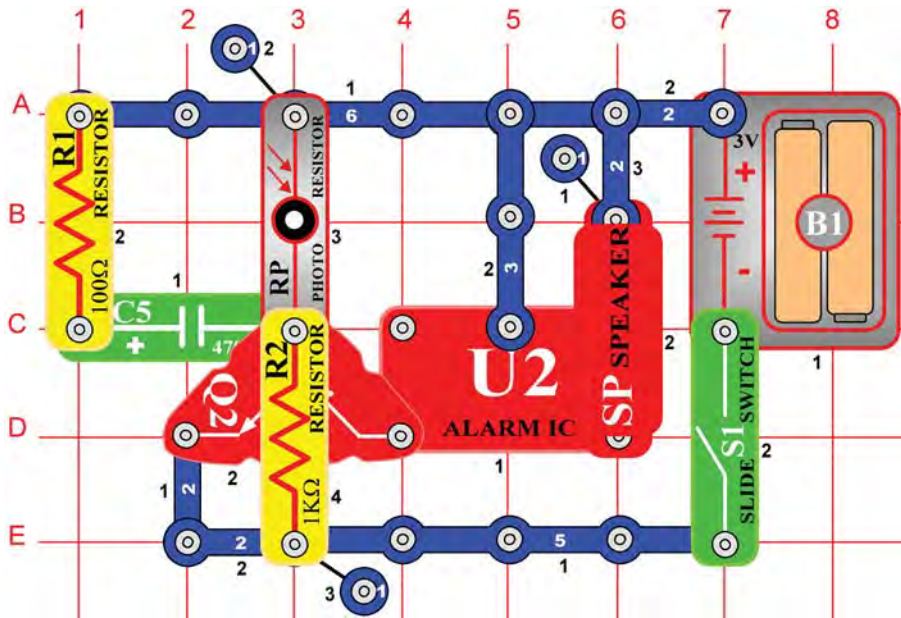
OBJECTIVE: To control the motor speed.

Turn on the slide switch (S1): the motor (M1) spins, the lamp (L2) lights, and you hear the sound of the motor in the speaker (SP). Push the press switch (S2): the motor spins faster and the LED (D1) lights but the lamp is off and the speaker is silent.

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



Project #271



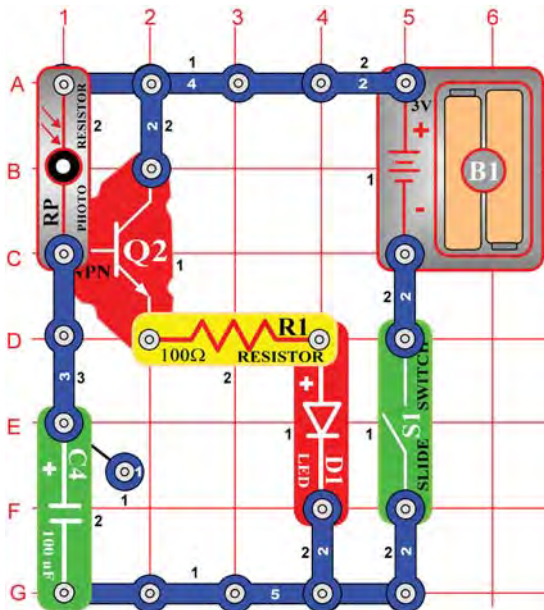
Short-time Sound

OBJECTIVE: To make a brief sound.

Turn on the slide switch (S1) and you a siren sound for only a second or two, increase the light on the photoresistor (RP) to make it last longer.



Project #272



Slow Light Dimmer

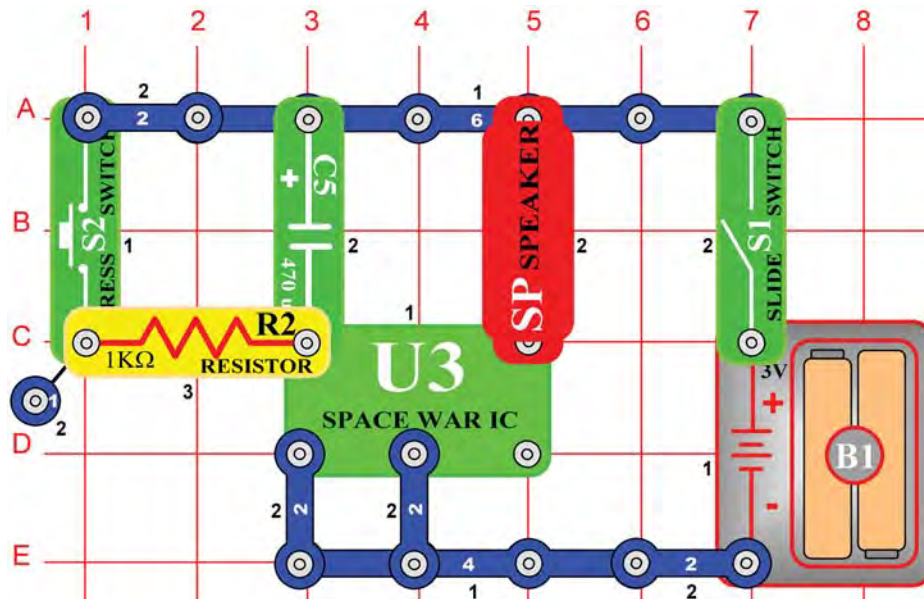
OBJECTIVE: To show how capacitors delay circuit changes.

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

You can replace the 100μF capacitor with the other values to change how long the LED stays on for when the photoresistor is covered.



Project #273



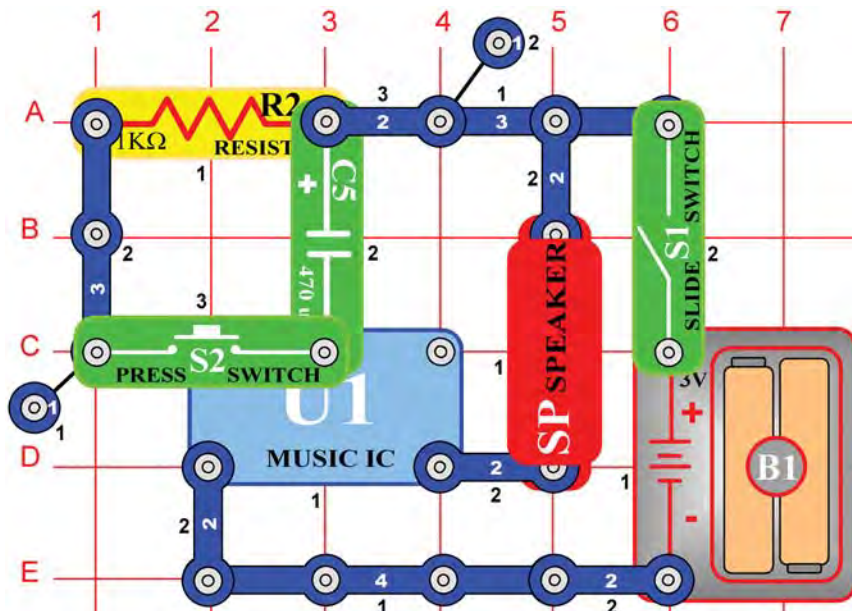
Fading Bomb Sound

OBJECTIVE: To make a fading sound.

Turn on the slide switch (S1), you hear a bomb sound that fades away as the 470µF capacitor (C5) charges up. Push the press switch (S2) to discharge the capacitor and make the sound loud again.



Project #274



Fading Music Sound

OBJECTIVE: To make a fading sound.

Turn on the slide switch (S1), you hear music that fades away as the 470µF capacitor (C5) charges up. Push the press switch (S2) to discharge the capacitor and make the sound loud again.



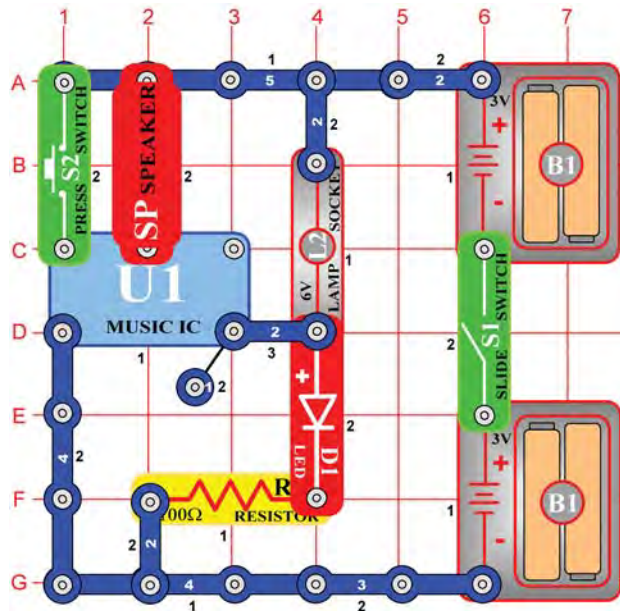
Project #275 Fading Music Sound (II)

OBJECTIVE: To make a fading sound.

Use the circuit from project #274 but replace the speaker (SP) with the red LED (D1), positive (+) side up. Turn on the slide switch (S1), the LED flashes for a few seconds and goes dim. Push the press switch (S2) to discharge the capacitor and make the LED flash again.



Project #276

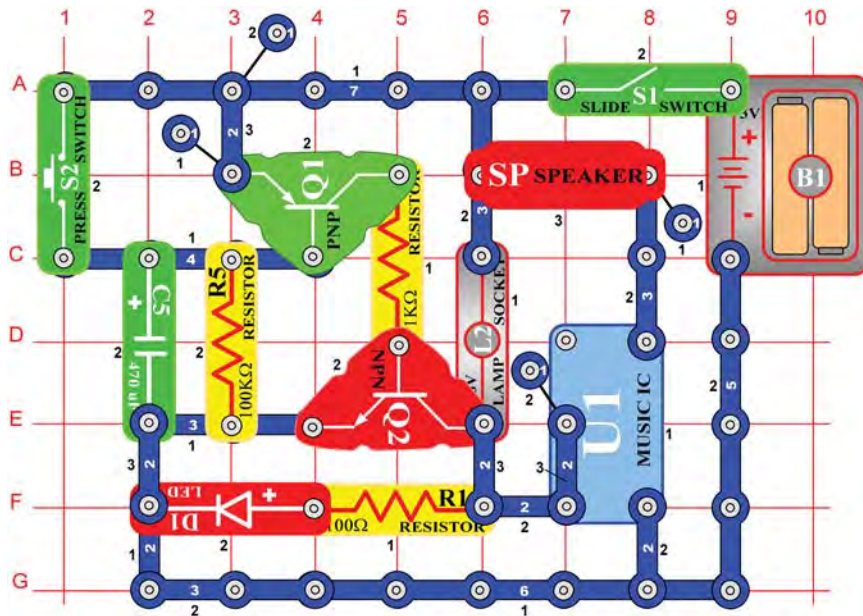


OBJECTIVE: To show how the music IC can be used.

Turn on the slide switch (S1), you hear sound from the speaker (SP) while the lamp (L2) and LED (D1) are bright. After the sound stops, only the LED will remain on. Press the press switch (S2) to restart the sound.



Project #277



OBJECTIVE: To connect the music IC to a timer circuit.

Turn on the slide switch (S1) and bulb (L2) lights. Press the press switch (S2) and the music IC (U1) plays and stops. The music will not play as long as Q2 is on. Press the press switch; transistors Q1, Q2 and the bulb turn off as the LED (D1) lights. As the song plays once at full volume, the LED slowly turns off.

Replace capacitor C5 with different values and see how it affects the circuit.

Sound & Lights

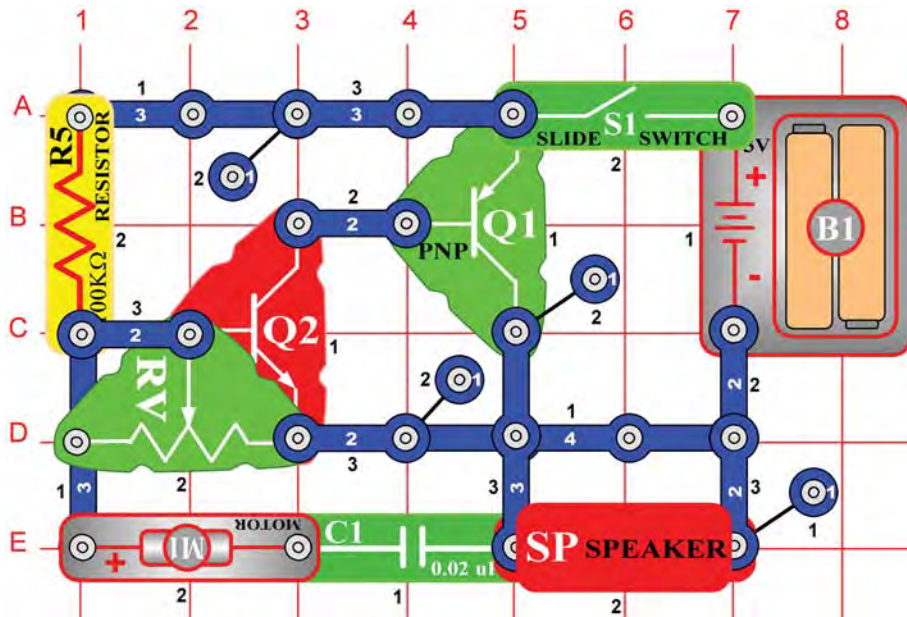
Music with Timer



Project #278

Motor Tone Generator

OBJECTIVE: To build a high-frequency oscillator.



Build the circuit and set the adjustable resistor (RV) to the middle position. Turn on the slide switch (S1) and you hear a high-frequency sound from the speaker (SP). Move the adjustable resistor slightly to the left or right and the frequency changes. Quickly rotate the motor's (M1) shaft back and forth and the frequency changes.



Project #279 Motor Tone Generator (II)

OBJECTIVE: To lower the frequency of tone by changing the capacitor.

Replace the 0.02μF (C1) with a 0.1μF (C2). Now the circuit generates a lower tone.



Project #280 Motor Tone Generator (III)

OBJECTIVE: To change the tone and loudness of the generator.

Now replace the motor (M1) with the 1kΩ resistor (R2). Set the adjustable resistor (RV) to the middle position and turn the slide switch (S1) on. The circuit generates a lower and louder tone than project #279.



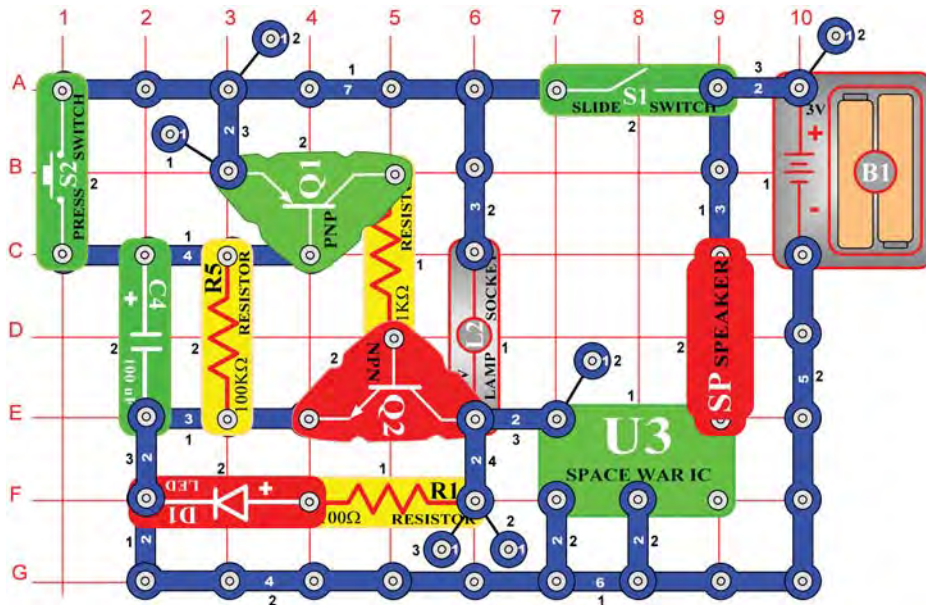
Project #281 Motor Tone Generator (IV)

OBJECTIVE: To use light to change the tone.

Next replace the 1kΩ resistor (R2) with the photoresistor (RP). Set the adjustable resistor (RV) to the middle position and turn the slide switch (S1) on. Change the tone by waving your hand over the photoresistor. Adjust the adjustable resistor to for different tones.



Project #288



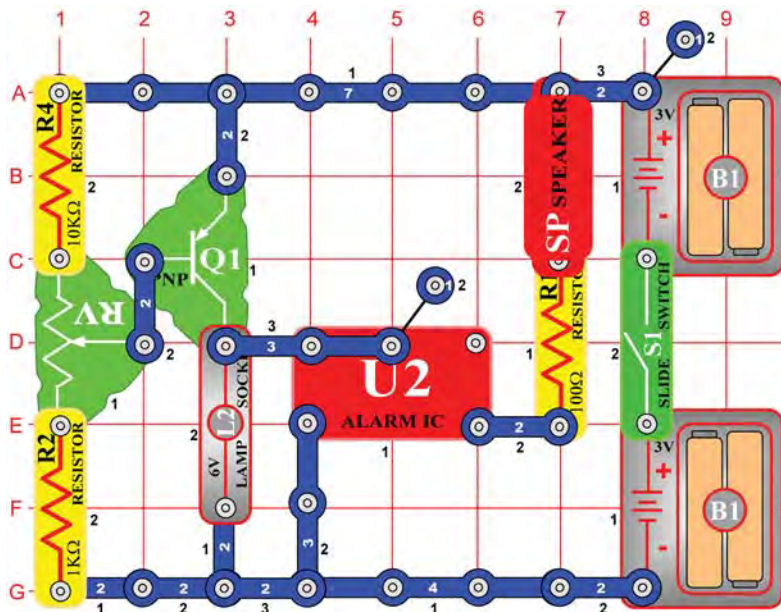
Space War Timer

OBJECTIVE: To build a space war timer.

Turn on the switch (S1) and the lamp (L2) lights and you hear the speaker (SP) sound. Now press the press switch (S2); the LED (D1) lights and the lamp turns off as the speaker sounds. You can change the length of time the speaker sounds by changing the values of C4 and R5.



Project #289



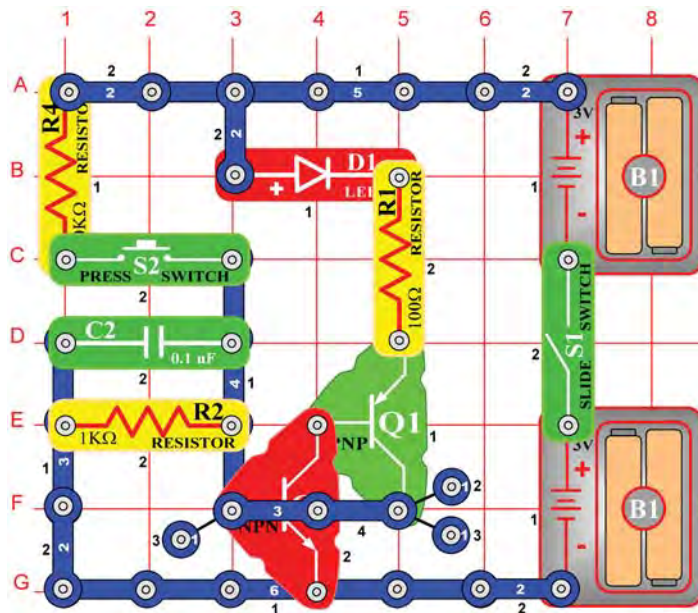
Alarm Speed Adjuster

OBJECTIVE: To change the speed of the alarm IC sound.

Set the adjustable resistor (RV) at the bottom position and turn on the slide switch (S1). The lamp (L2) lights and the speaker (SP) sounds. Now slowly adjust RV up. The lamp dims and the sound slows down. As you move RV up, the voltage at the base of Q1 increases as the collector and input of U2 decrease. This lowers the output frequency and brightness the bulb. You can only adjust RV about a quarter of the way up before the sound stops.



Project #290



The SCR

OBJECTIVE: To use two transistors to make an SCR.

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

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



Project #291

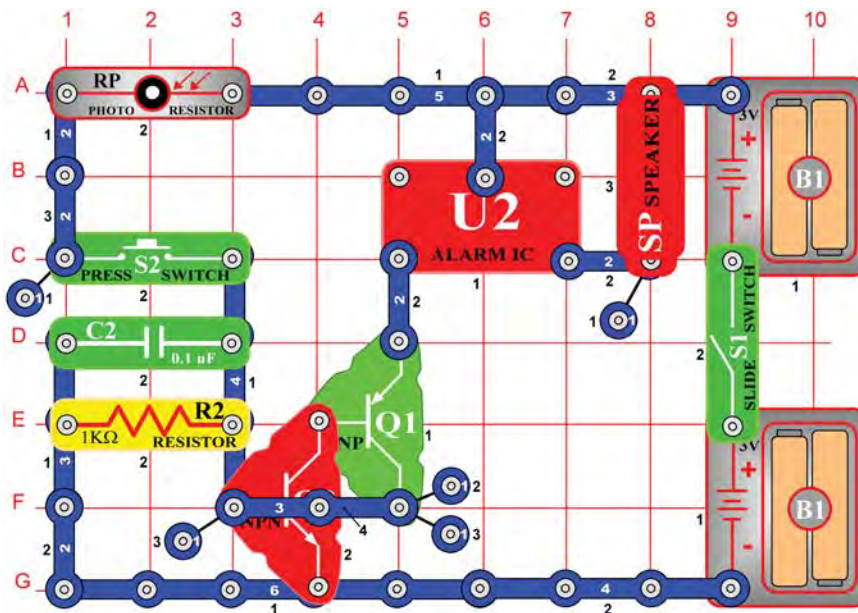
Light-controlled SCR

OBJECTIVE: To modify project #290 to use the photoresistor (RP).

Replace resistor R4 with the photoresistor (RP). The LED (D1) will only light when the press switch (S2) is pressed and there is enough light on the photoresistor. Turn on the slide switch (S1) on and place your finger over the photoresistor. Press the press switch and the LED should not light. Remove your finger and press the press switch again, the LED should light now.



Project #292



Light-controlled SCR (II)

OBJECTIVE: To build a circuit that sounds only when there is light in the room.

This circuit operates the same way as project #291, only now the alarm IC (U2) will sound when the press switch (S2) is pressed and the room is lit.



Project #293

Light-controlled SCR (III)

OBJECTIVE: To modify project #292 to use the music IC U1.

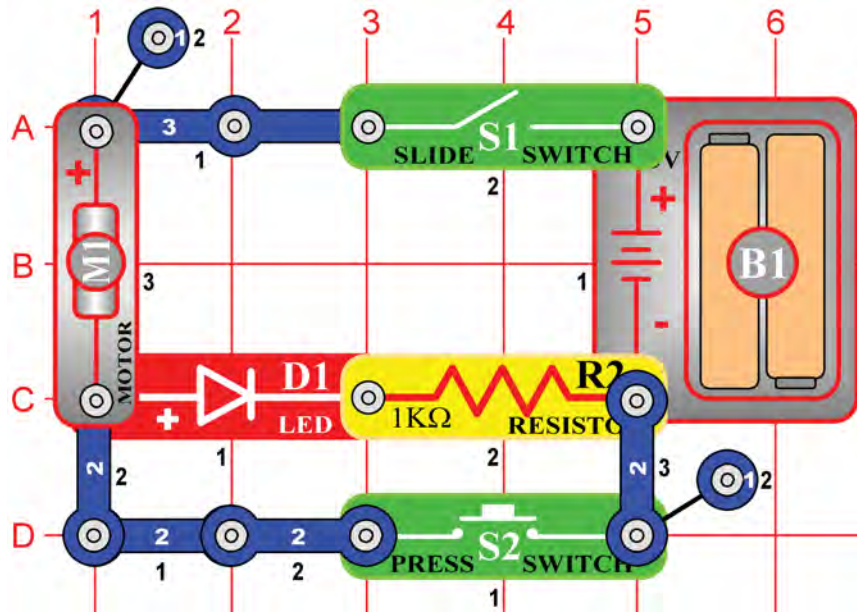
Replace the alarm IC (U2) with the music IC (U1). Turn on the slide switch (S1) and the music IC will sound when the press switch (S2) is pressed and the room is lit.



Project #294

LED Control Motor

OBJECTIVE: To indicate when a motor is spinning using an LED.



Place the fan on the motor (M1), turn on the slide switch (S1), and the LED (D1) lights but the motor does not spin. Pressing the press switch (S2) connects the motor to the battery (B1). The voltage across the LED drops, and the LED goes out. You can make a remote motor spinning indicator if the LED was wired to a different location.

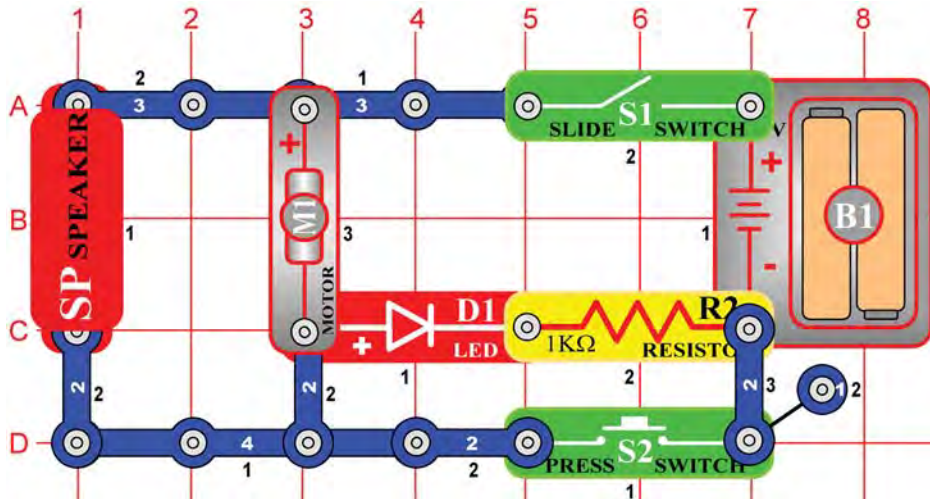
WARNING: Moving parts. Do not touch the fan or motor during operation.



Project #295

LED Control Motor (II)

OBJECTIVE: To indicate when a motor is spinning using an LED.

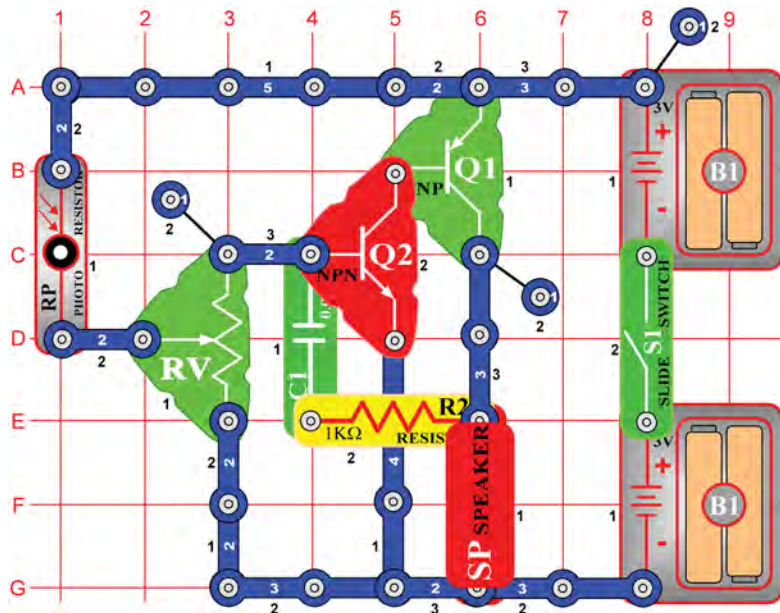


This project works the same way as project #294, only now the speaker (SP) sounds as the motor (M1) spins.

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



Project #296



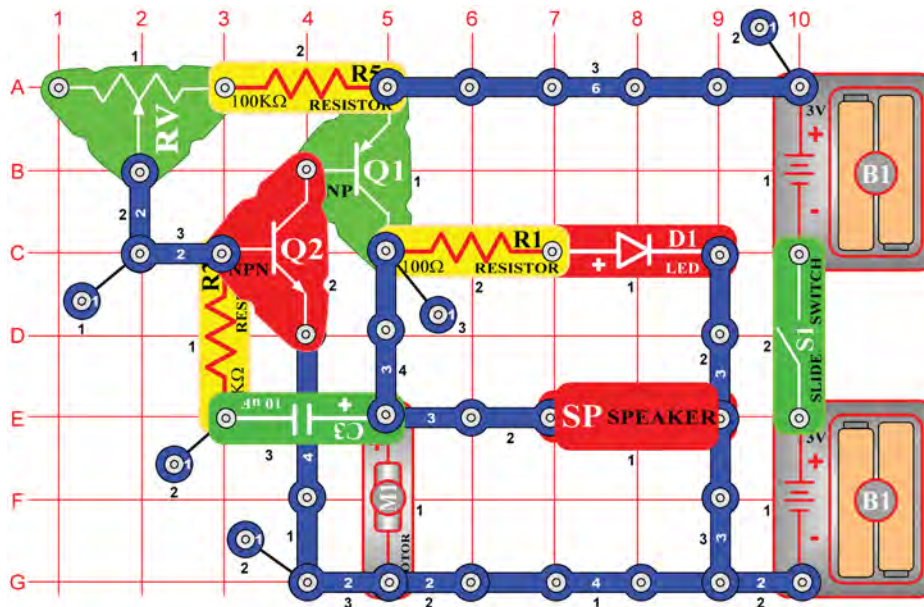
Light Oscillator

OBJECTIVE: To control an oscillator circuit using light.

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



Project #297



Sound, Light & Motor Stepper Circuit

OBJECTIVE: To build a stepper circuit that powers a motor, speaker and LED.

Set the adjustable resistor (RV) to the far left and turn on the slide switch (S1). The circuit produces around two pulses per second, which power the motor (M1), speaker (SP) and LED (D1). Increase the rate by moving the adjustable resistor to the left.

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

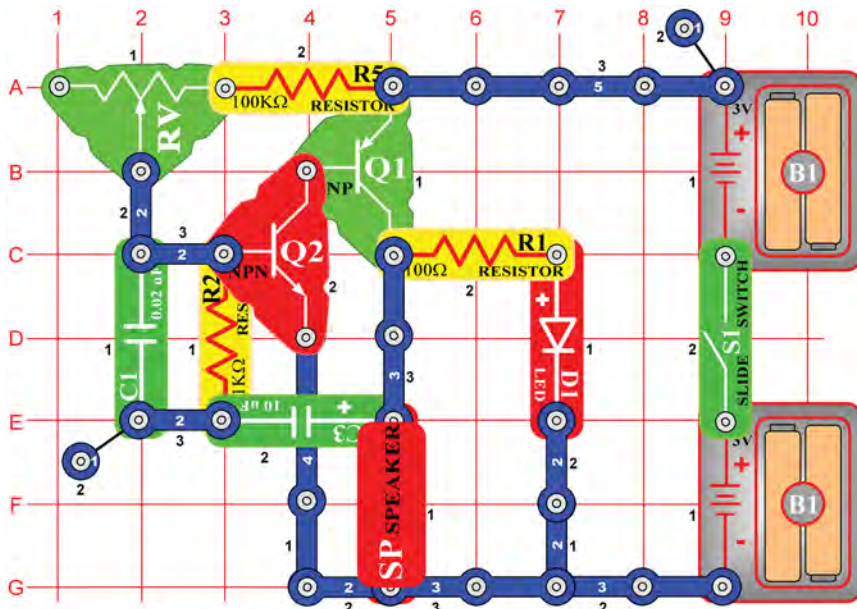


WARNING: Moving parts. Do not touch the fan or motor during operation.



Project #298

Blink & Beep



OBJECTIVE: To build a circuit that blinks an LED and drives a speaker.

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



Project #299 Blink & Beep (II)

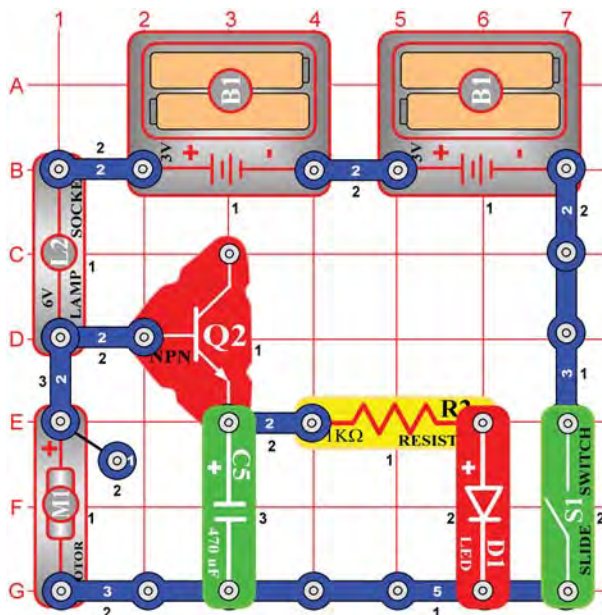
OBJECTIVE: To modify project #298 for a seven second delay and then a continuous sound.

Replace the 10μF capacitor (C3) with the 100μF capacitor (C5) and the 0.02μF capacitor (C1) with the 0.1μF capacitor (C2). When you turn on the slide switch (S1), LED (D1) will light every 10 seconds. The speaker (SP) clicks as the light blinks.



Project #300

Simple Rectifier (II)



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

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

Build the circuit shown but leave the fan off the motor (M1). Turn on the slide switch (S1); the motor spins and the 6V lamp (L2) and the LED (D1) light. The LED will not be very bright so turn off the room lights, or hold your fingers around it to see it better.

Now remove the 470μF capacitor (C5) from the circuit. The motor spins just as fast and the lamp is still bright, but the LED is very dim. Why?

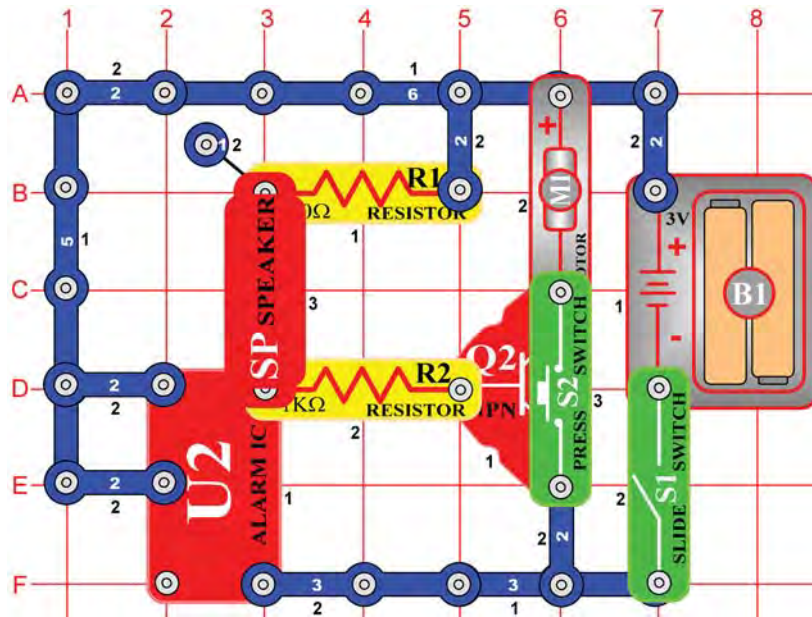
The spinning shaft in the motor creates a changing voltage, which can barely light the LED. The 470μF capacitor can store electricity, and it combines with the NPN transistor (Q2) to make a rectifier. This rectifier converts the changing voltage from the motor into a constant voltage, which makes the LED bright.

Place the capacitor back into the circuit and place the fan on the motor. Now the motor spins more slowly and the LED is off again, but the 6V lamp is slightly brighter. The motor has less voltage when it spins slower, so the LED stays off. But there is more voltage across the lamp now, making it brighter.

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



Project #301



Alarm Motor

OBJECTIVE: To build a circuit where the alarm IC controls the fan speed.

Place the fan on the motor and turn on the slide switch (S1). A machine gun sound is heard and the fan spins unevenly. The fan speed is being controlled by the alarm IC (U2).

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



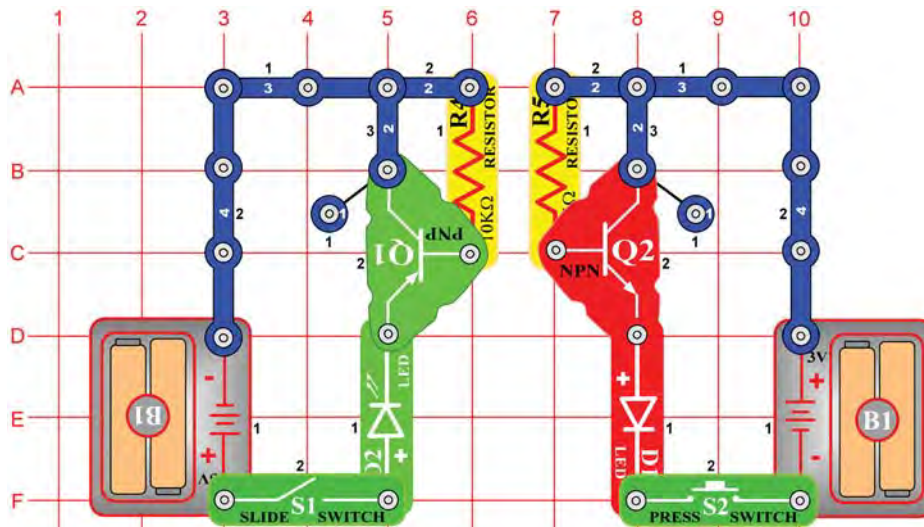
Project #302 Alarm Light

OBJECTIVE: To modify project #301.

Replace the motor (M1) with the 6V lamp (L2). Now the alarm IC (U2) and press switch (S2) control the lamp brightness.



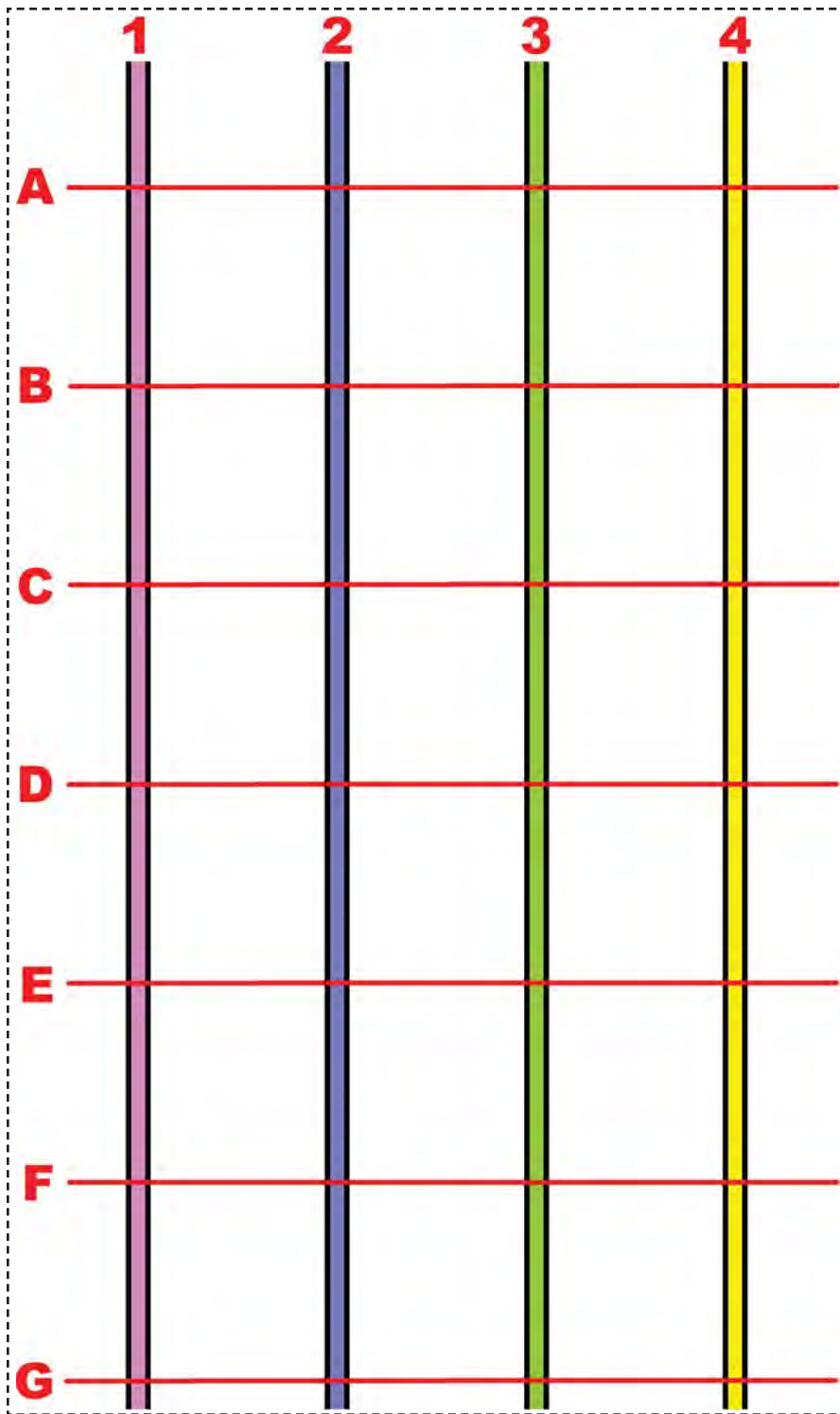
Project #303



Mirror Circuit

OBJECTIVE: To build a mirror view of a circuit.

Using PNP (Q1) and NPN (Q2) transistors, you can make two circuits that look the same, but are electrically opposite. When you turn on the slide switch (S1), the base of Q1 connects to the negative (-) side of the battery (B1), turning on Q1 and the green LED (D2) lights. When you press the press switch (S2), the base of Q2 connects to the positive (+) side of the battery, turning on Q2 and the red LED (D1) lights.



Page 35 for project #55

← Page 36 for project #57



OTHER RADIO SHACK PRODUCTS!

For more information, visit www.radioshack.com or call toll-free at 1-800-THE-SHACK.

Electronic Snap Kits™

Catalog # 28-288



Electronics 303

Build Over 700 Projects

Including:

- Electronic Cat
- Music Meter
- Adjustable Light Control
- Digitally Tuned FM Radio
- Digital Voice Recorder
- Light Controlled Music
- AC Generator
- Flashing Numbers
- Paperclip Oscillator
- All experiments in Electronics 101 & 202

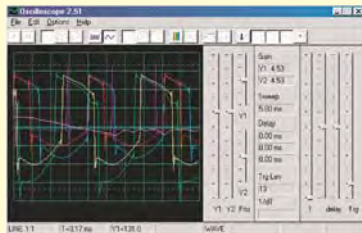
Contains Over 85 Parts

Including:

- CI-73 Computer Interface
- FM Radio Module
- Analog Meter
- Recording IC Module
- 7-Segment LED Display
- Relay
- Microphone
- Transformer
- 7 Sockets for Adding Your Own Parts

Also Includes:

Sample Screen of Computer Experiment



* Requires Microphone Input

Computer Interface Software with 73 Experiments

For Your Windows Based PC*

With this module you will also learn about and use an oscilloscope and spectrum analyzer, as you build over **70 BONUS EXPERIMENTS** using your Windows-based PC. Comes with all of the interface parts you need and the software. Great for introducing electronics through a computer. Works with all versions of our Snap Kits™.

Acts as a Scope and Allows You to See the Signals in the Circuit.

Electronics Learning Lab

Catalog # 28-280



This new lab is a complete introduction to analog and digital electronics, suitable for age 10 to adult.

PRODUCT FEATURES:

- Topics are presented in an increasing order of complexity, beginning with basic circuits using switches, a relay and a buzzer.
- Builders then advance to circuits using transistors, diodes and 15 integrated circuits.
- This lab has serious educational value but provides hours of fun and entertainment.
- Students will build projects that reward with warbles, sirens, flashing lights, even circuits that make decisions.
- Includes spring-coil connectors and breadboard for quick no-solder hookups.
- Documentation was written by best-selling author and science writer Forrest M. Mims III.
- Requires "9V" and 6 "AA" batteries, not included.

This new lab is a complete introduction to analog and digital electronics, suitable for ages 10 to adult, offered at a super-value price. Topics are presented in an increasing order of complexity, beginning with basic circuits using switches, a relay and a buzzer. Builders then advance to circuits using transistors, diodes and 15 integrated circuits. While the lab has serious educational value, it also provides many hours of fun and entertainment. Students of all ages will enjoy building projects that reward with warbles, sirens, flashing lights, even circuits that make decisions. Includes spring-coil connectors and breadboard for quick no-solder hookups. Documentation was written by best-selling author and science writer Forrest M. Mims III.

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



Radio Shack Corporation

Fort Worth, TX 76102

Call us at

1-800-THE-SHACK

or visit us online at

www.radioshack.com