

SNAP CIRCUITS

ELENCO

Elements

140

Make Electronics a SNAP!

Over
140
Projects



Learn the
fundamentals
of electricity



Projects
with light



Projects
with aerial
stunts



Create fun
Sounds



PRINTED
Projects 71

70+ ONLINE
Projects



Ages 8-108

Requires Two (2) "AA" Batteries



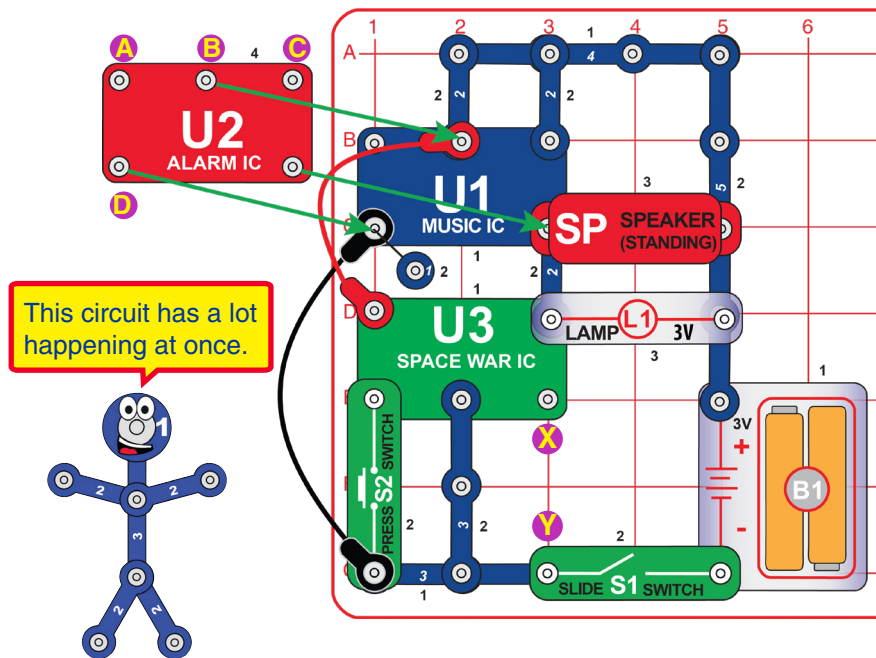
Build Over
140 Projects!

Projects 72-140 See your printed manual for projects 1-71



ELENCO®
Learn by doing.™

□ Project 72



Symphony of Sounds

Turn on the slide switch (S1); you hear sounds from the music & alarm ICs (U1 & U2), and the lamp (L1) lights. Push the press switch (S2) several times to add sounds from the space war IC (U3).

□ Project 73 Photo Symphony of Sounds

Use the preceding circuit, but add the photoresistor (RP) across points X & Y using a 1-snap wire. Cover and uncover the photoresistor to change some of the sounds.

□ Project 74 LED Symphony of Sounds

Use the preceding circuit, but replace the lamp (L1) with the color LED (D8, "+" on right).

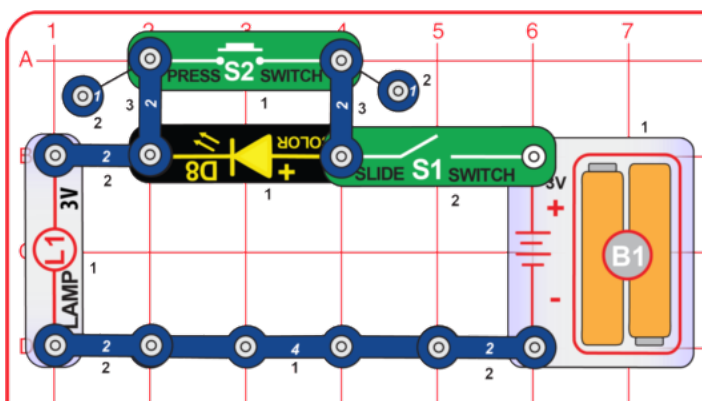
□ Project 75 Whistle Symphony of Sounds

Use any of the preceding circuits, but replace the speaker (SP) with the whistle chip (WC).

□ Project 76 Sirens Symphony of Sounds

Use any of the preceding circuits, but add a 2-snap wire across points A & B, B & C, or A & D.

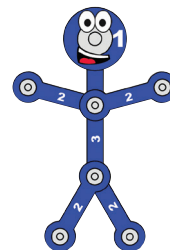
□ Project 77



Power Shifter

When you turn on the slide switch (S1), the color LED (D8) is on and the lamp (L1) is off.

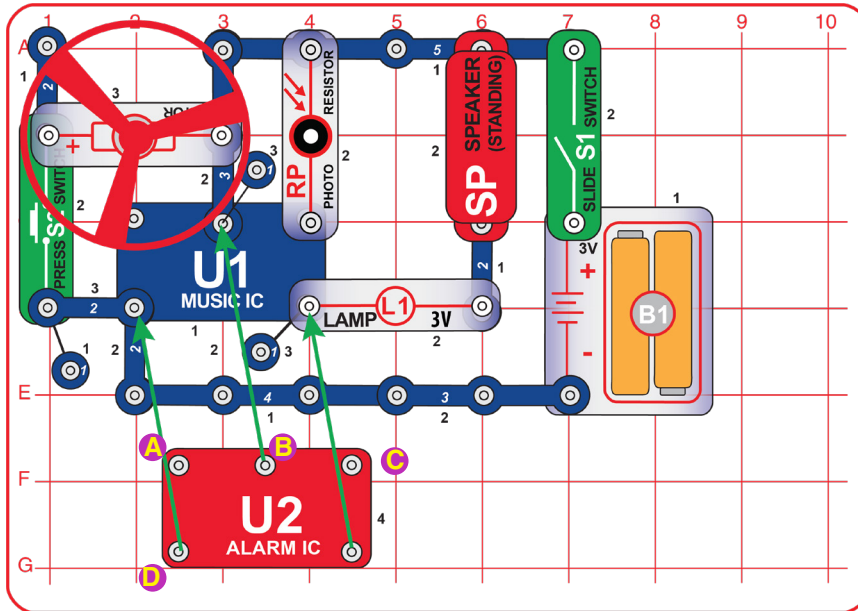
Push the press switch (S2) to bypass the LED. The lamp turns on and the LED turns off. This shows how switches can be used to shift power between different devices.



The color LED has an internal resistor to protect it from overload. This resistor does not prevent the LED from lighting, but it limits the circuit current too much to allow the lamp to light.

If you swap the locations of the lamp and color LED (put LED "+" on top), then the LED will always be on, the lamp will always be off, and the press switch will have no effect.

Project 78



Sing & Fling

In the circuit, the outputs from the alarm (U2) and music ICs are connected together. Build the circuit shown and then place the alarm IC (U2) directly over the music IC (U1), resting on two 1-snaps and a 2-snap. Turn on the slide switch (S1) and you will hear a siren and music together. Push the press switch (S2) and the fan spins, while the sound may not be as loud. The fan may rise into the air when you release the switch. Some of the sounds may stop after a while unless there is light on the photoresistor (RP).

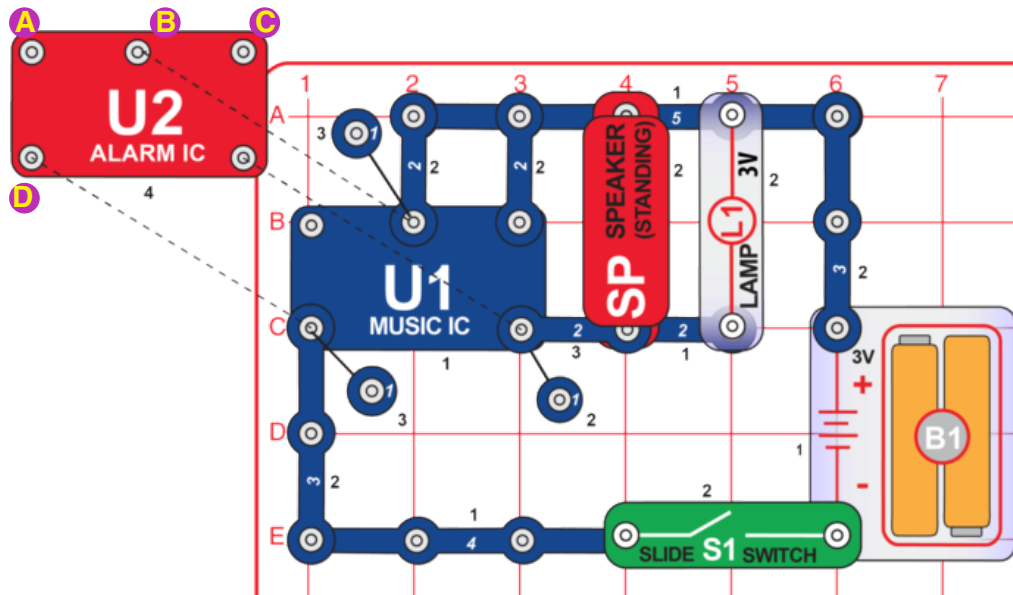
Project 79 Sing & Fling (II)

Use the preceding circuit, but add a 2-snap wire across points A & B, B & C, or A & D.



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

Project 80



Mixed Up Music

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

Project 81 Whistle Mixed Up Music

Use the preceding circuit, but replace the speaker (SP) with the whistle chip (WC).

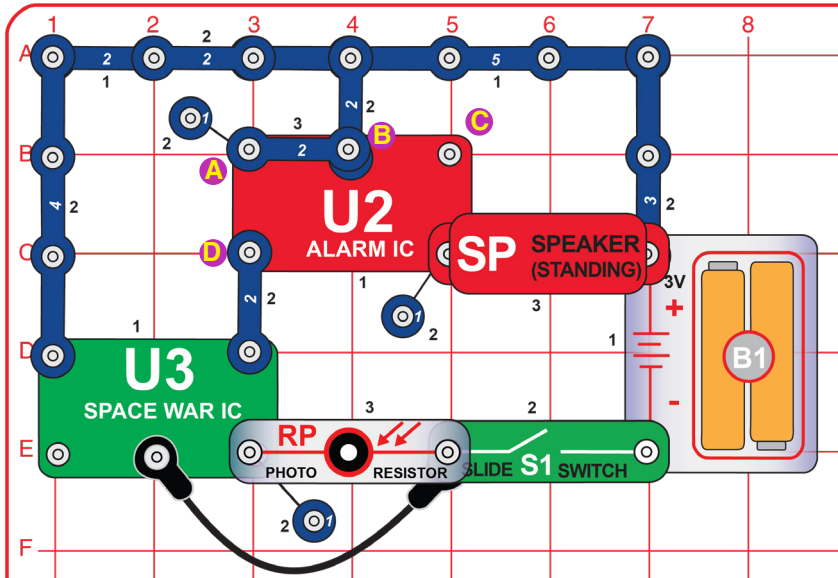
Project 82 Color Mixed Up Music

Use the preceding circuit, but replace the lamp (L1) with the color LED (D8).

Project 83 Sirens Mixed Up Music

Use any of the preceding circuits, but add a 2-snap wire across points A & B, B & C, or A & D.

□ Project 84



Space War Controlled Siren

Turn on the slide switch (S1), then cover and uncover the photoresistor (RP) several times to change the sound. If there is no sound then shine more light on the photoresistor.

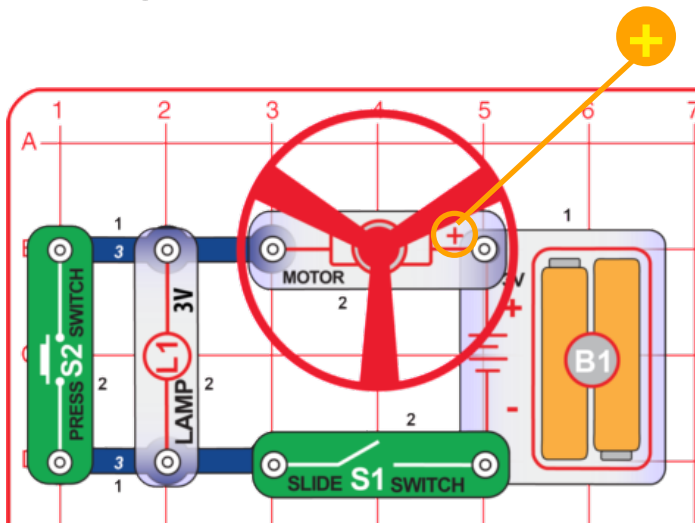
□ Project 85 Space War Controlled Sirens

Use the preceding circuit, but move the 2-snap wire and 1-snap wire connecting points A & B and instead connect them across points B & C or A & D, or omit them. Cover and uncover the photoresistor several times. The sounds are different now.

□ Project 86 Space War Controlled Sirens

Use any of the preceding circuits, but replace the speaker (SP) with the whistle chip (WC) and color LED (D8, "+" on right), stacked together.

□ Project 87



Two-Speed Fan

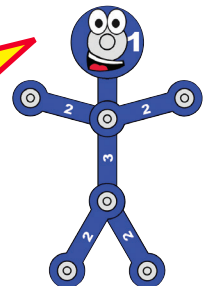
Turn on the slide switch (S1); the motor (M1) spins the fan and the lamp (L1) lights. Push the press switch (S2) to bypass the lamp and increase the fan speed.

Swap the locations of the lamp and motor (motor "+" on top). Now pushing the press switch bypasses the motor and makes the lamp brighter.

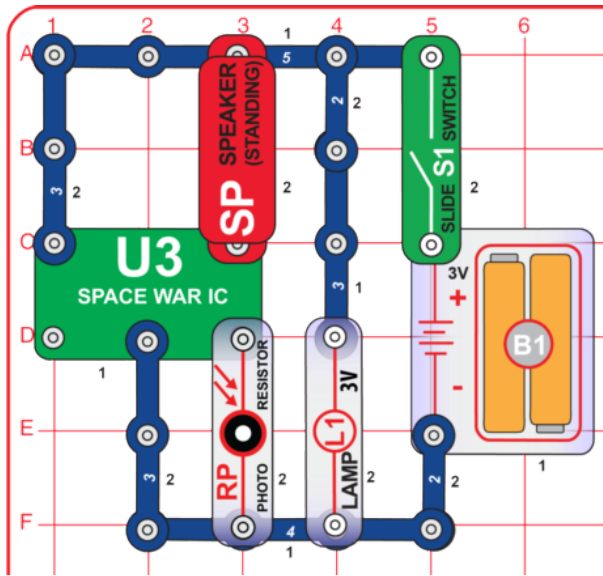
When the lamp is on, the fan spins slower because the battery power is divided between the motor and lamp. Pushing S2 allows electricity to bypass the lamp, so all the battery power is available to the motor, so the fan spins faster.



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



Project #88



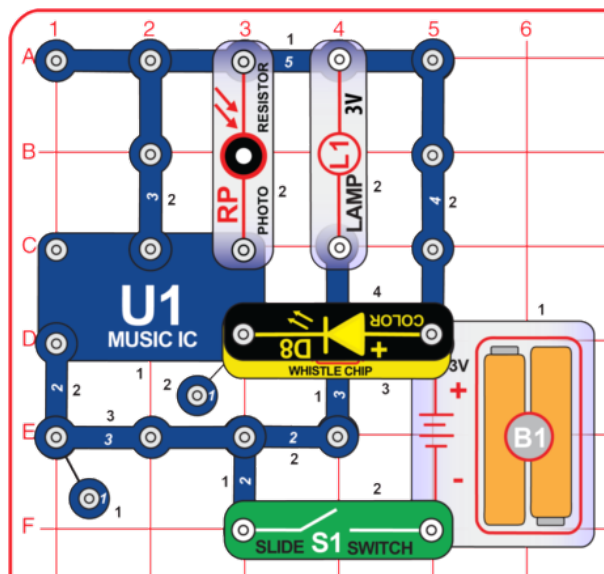
Reflection Detector

Build the circuit and 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 lamp (L1) will be bright, but there should be no sound.

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

For more fun, remove the lamp, replace the photoresistor with the whistle chip (WC), and tap on the whistle chip to hear sound. You can also replace the speaker (SP) with the color LED (D8, “+” on top); tapping on the whistle chip makes the LED flicker.

Project 89



Whistle Reflection Detector

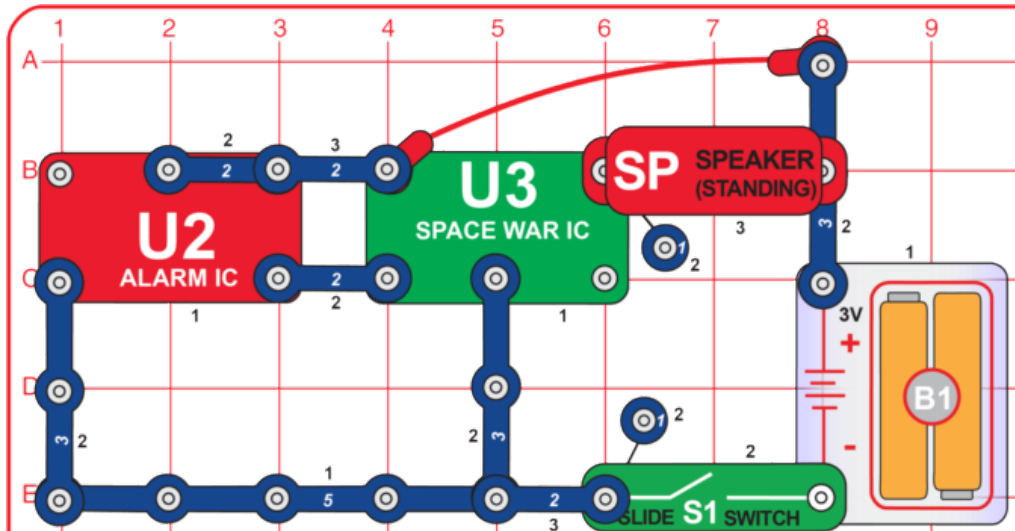
Build the circuit and place it where there won't be any room light hitting the photoresistor (RP) (such as in a dark room or under a table), and then turn it on. The lamp (L1) will be bright and one song may play, but then there should be no sound.

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

Project 90 Music Reflection Detector

Use the preceding circuit, but replace the whistle chip (WC) and color LED (D8) with the speaker (SP).

Project 91



Space Battle

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

Project 92 Space Battle (II)

Use the preceding circuit, but replace the speaker (SP) with the whistle chip (WC) and color LED (D8, "+" on right), stacked together.

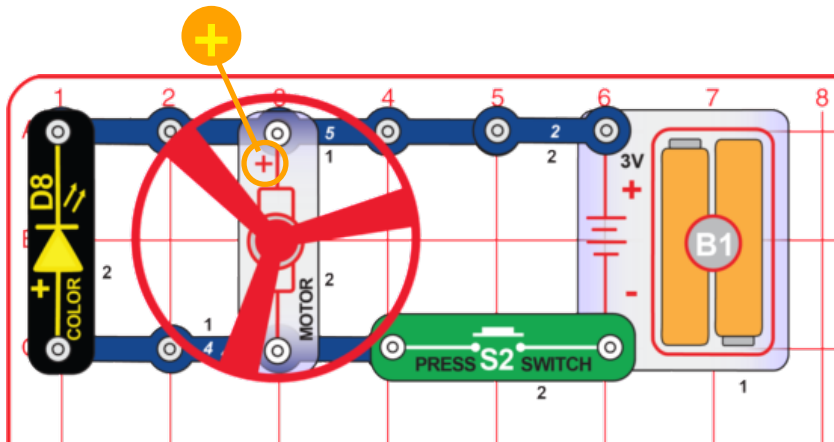
Project 93 Space Battle (III)

Use the preceding circuit but replace the color LED with the lamp (L1).

Project 94 Space Battle (IV)

Use the preceding circuits but replace the lamp with the motor (M1, "+" on right) and fan.

Project 95



Fan Flash Energy

Place the fan on the motor (M1). Hold down the press switch (S2) for a few seconds and then watch the color LED (D8) as you release the switch. The LED flashes briefly but only after the batteries (B1) are disconnected from the circuit.

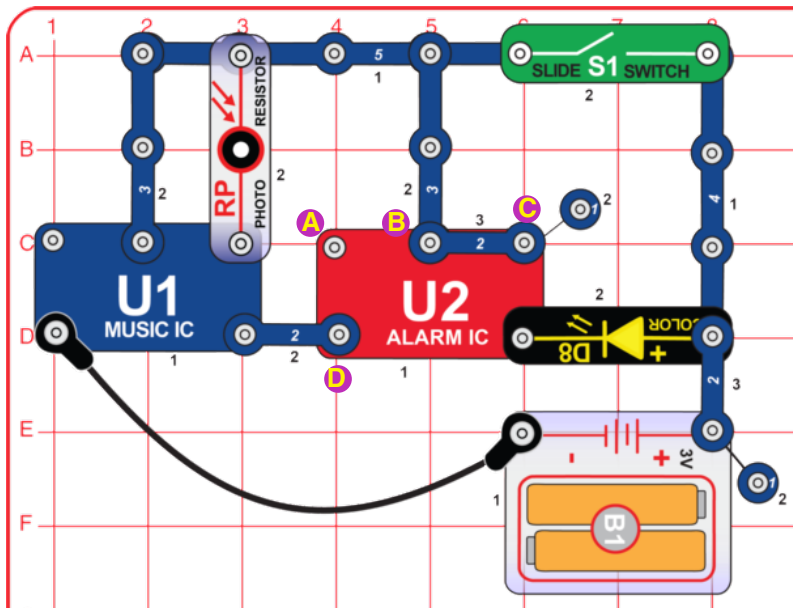
Do you know why the LED flashes? It flashes because the motor uses a magnetic field to spin the shaft. When the switch is released energy creates a brief current through the LED.

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



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

Project 96



Wave & Watch

Turn on the slide switch (S1), the color LED (D8) 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.

Project 97 Wave & Watch (II)

Use the preceding circuit, but move the 2-snap wire and 1-snap wire connecting points B & C and instead connect them across points A & B or A & D, or omit them. Cover and uncover the photoresistor several times. The color LED light patter is different.

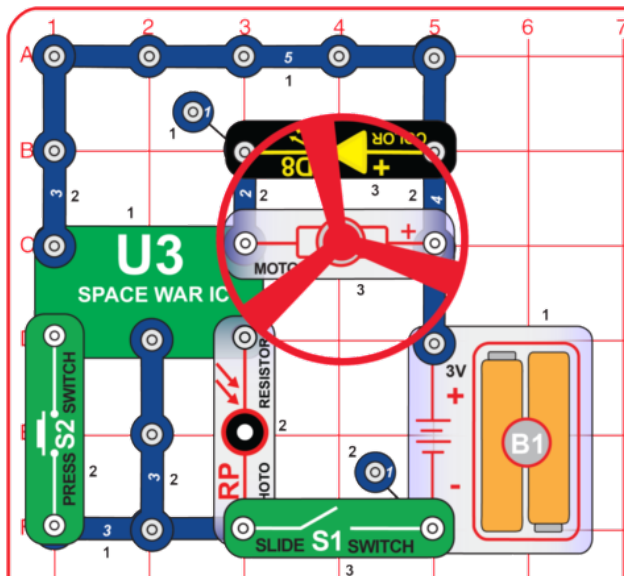
Project 98 Wave & Watch (III)

Use any of the preceding circuits, but replace the color LED with the lamp (L1).



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 99



Singing Spinner

Turn on the slide switch (S1). Push the press switch and cover/uncover the photoresistor (RP) to light the color LED (D8) and make the motor (M1) spin the fan at different speeds. The motor also produces sound.

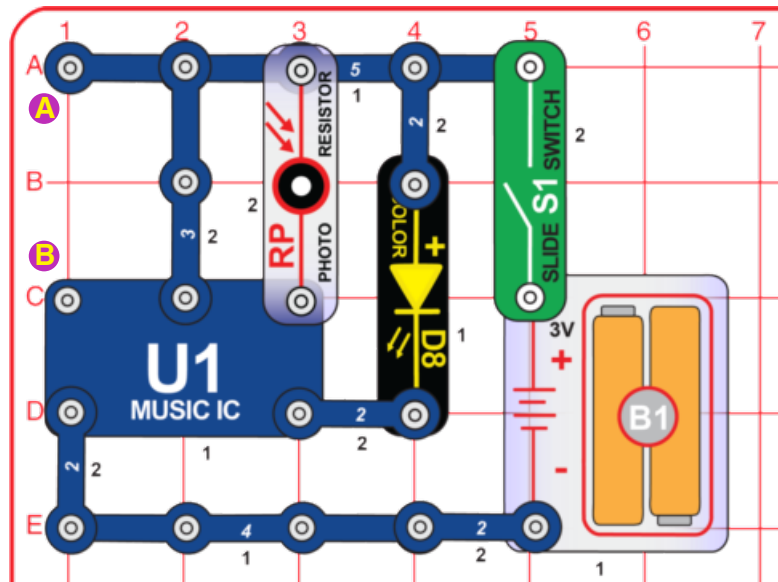
Project 100 Whistling Spinner

Use the preceding circuit but add the whistle chip (WC) directly under the motor. The sound is louder now. S2 may only work when RP is covered.



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

Project 101

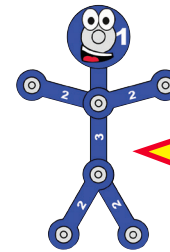


Light Makes Light

Build the circuit as shown. Cover the photoresistor (RP), turn the switch on, and notice that the color LED (D8) is on for several seconds and then goes off. Uncover the photoresistor and place the unit near a light and the LED will light. Cover the photoresistor again and the LED will turn off.

Project 102 Go & Glow

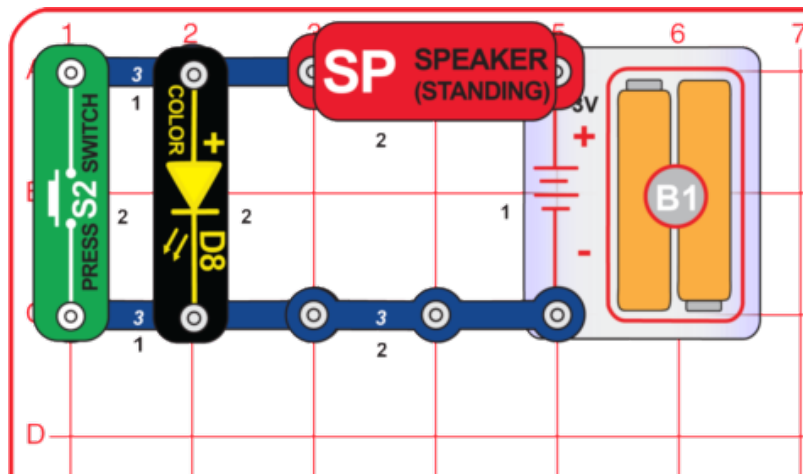
Use the preceding circuit, but connect the motor (M1, without the fan) across points A and B on the base grid, and remove the photoresistor (RP). Turn the switch on and the color LED (D8) lights for several seconds then goes out. Now spin the shaft of the motor and the LED will light again.



The resistance of the photoresistor decreases as the light increases. If the photoresistor's resistance is low enough it activates the music IC (U1), which controls the voltage to the color LED, making it light.

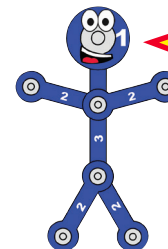
Inside the motor is a magnet and a coil. When the motor shaft turns the magnetic field will change and generate a small voltage across the coil. This voltage then activates the music IC.

Project 103



NOT Circuit

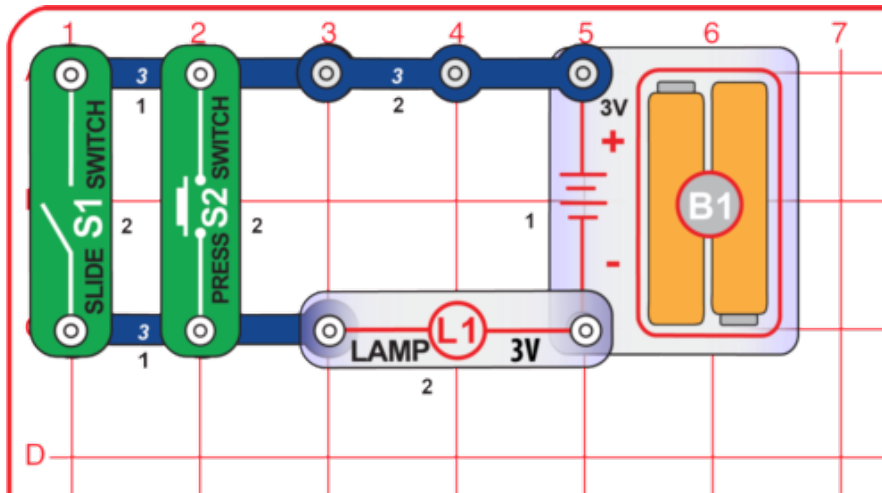
Build the circuit shown. Notice that when the press switch (S2) is pressed, the color LED (D8) goes off. This is an example of an inverter circuit, or NOT gate. Whenever the input is high (switch is on), the output is low (LED is off) and whenever the input is low (switch is off) the output is high (LED is on). Ignore any sound coming from the speaker (SP). Disassemble the circuit when finished to avoid draining your batteries.



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

The speaker is used here to load the batteries, so there will not be a short circuit when S2 is pressed. The speaker will make a little noise as the color LED changes the circuit current as it changes colors.

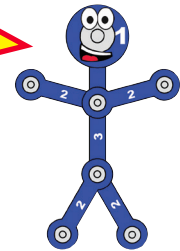
Project 104



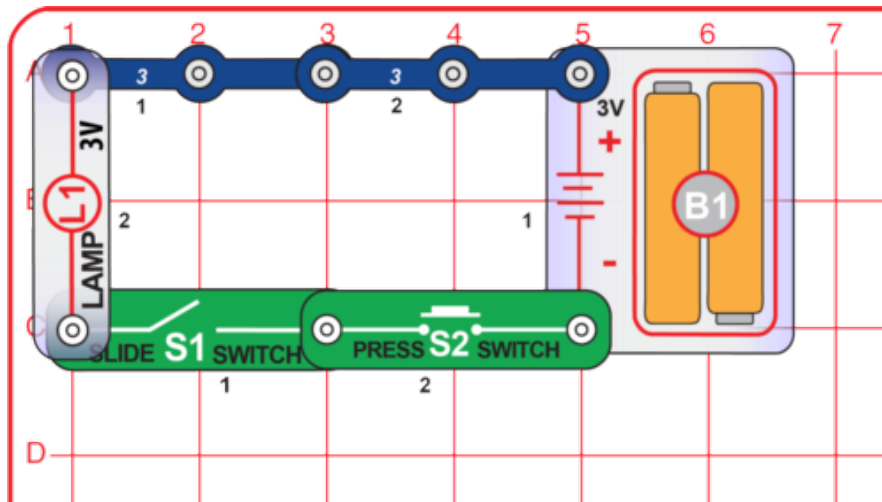
This OR That

Build the circuit shown. Notice that if you turn on the slide switch (S1) OR press the press switch (S2) the lamp (L1) lights up. There is no partially lit state here, the lamp is either totally on or totally off. While this may seem very simple and boring, it represents an important concept in electronics. Two switches like this may be used to turn on a light in your house, or they might be two sensors at a railroad crossing used to start the ding-ding sound and lower the gate. You could also have more than two switches and the circuit would function the same way.

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



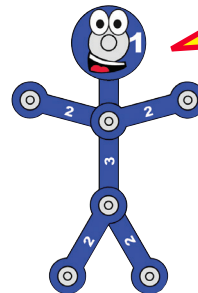
Project 105



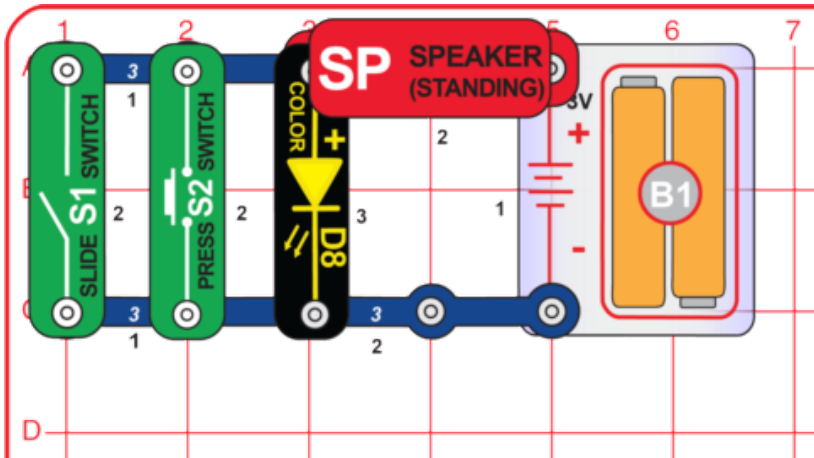
This AND That

Build the circuit shown. Notice that if you turn on the slide switch (S1) AND press the press switch (S2) the lamp (L1) lights up. Once again, there is no partially lit state here, the lamp is either totally on or totally off. Two switches like this may be used to turn on the same light in your house, the room switch and the master switch in the electrical box. You could also have more than two switches and the circuit would function the same way.

This circuit is commonly called an AND gate. AND gates are used in digital logic circuits to perform logical multiplies. When one of the inputs is low (one of the switches is off) the output is low (lamp off). The output will only be high (lamp on) if both inputs are high (both switches are on). Combinations of AND and OR circuits are used to add and multiply numbers together in modern computers. These circuits are made of tiny transistors in massive integrated circuits.

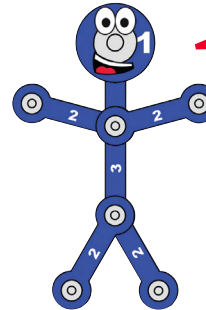


Project 106



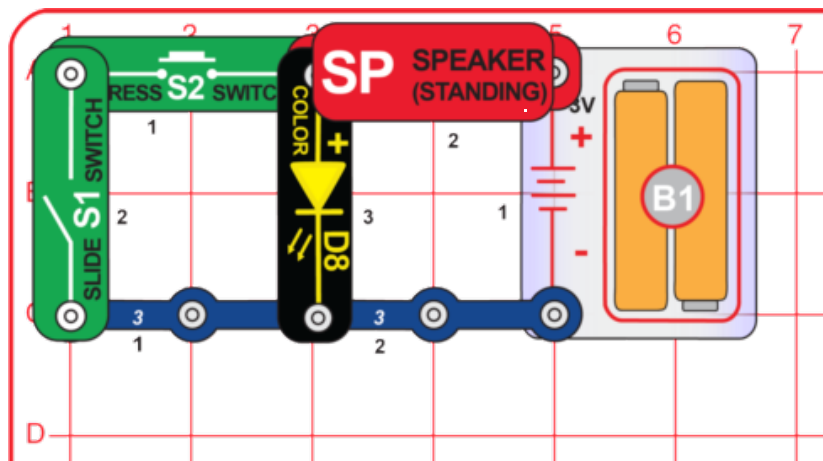
Neither This NOR That

Build the circuit at left and test the combinations of the slide switch (S1) and press switch (S2). If you compare it to the OR circuit in Project 104, you can see the color LED (D8) lights in the opposite combinations of when the lamp lit in 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. Disassemble the circuit when finished to avoid draining your batteries.



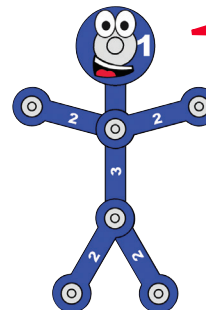
This circuit is commonly called a NOR gate. NOR gates are used in digital logic circuits to perform an inverted logical add. When one of the inputs is high (one of the switches is on) the output is low (LED off). The output will only be high (LED on) if both inputs are low (both switches are off).

Project 107



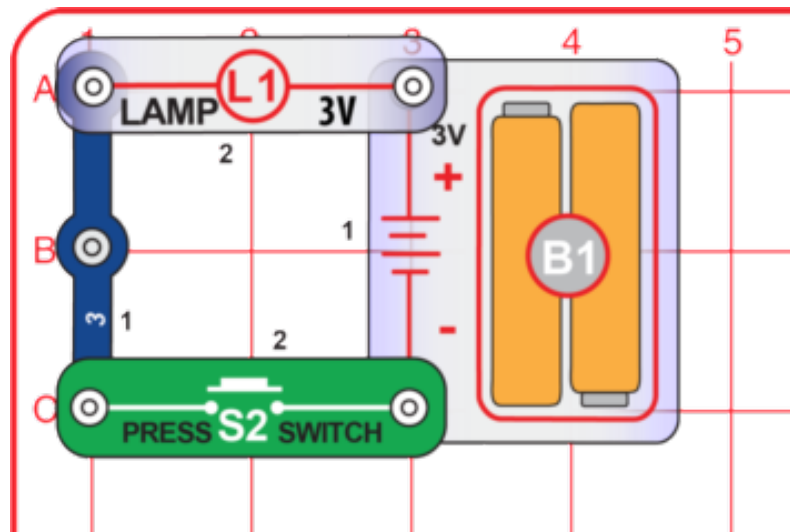
NOT This AND That

Build the circuit at left and test the combinations of the slide switch (S1) and press switch (S2). If you compare it to the AND circuit in Project 105, you can see the color LED (D8) lights in the opposite combinations of when the lamp lit in 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. Disassemble the circuit when finished to avoid draining your batteries.



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

Project 108



Morse Code

This simple circuit can be used for communication. Press the press switch (S2) in long and short bursts to make a pattern of light flashes representing the dots and dashes shown in the Morse Code table below. You can use Morse Code and this circuit to send secret messages to some friends in the room without others knowing what you're saying.

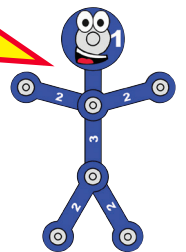
If you have a strong flashlight or searchlight then you can send messages to friends far away at night. During World War II Navy ships sometimes communicated by flashing Morse Code messages between ships using searchlights (because radio transmissions might reveal their presence to the enemy).

Years ago Native Americans would send messages to other tribes using smoke signals and a special code.

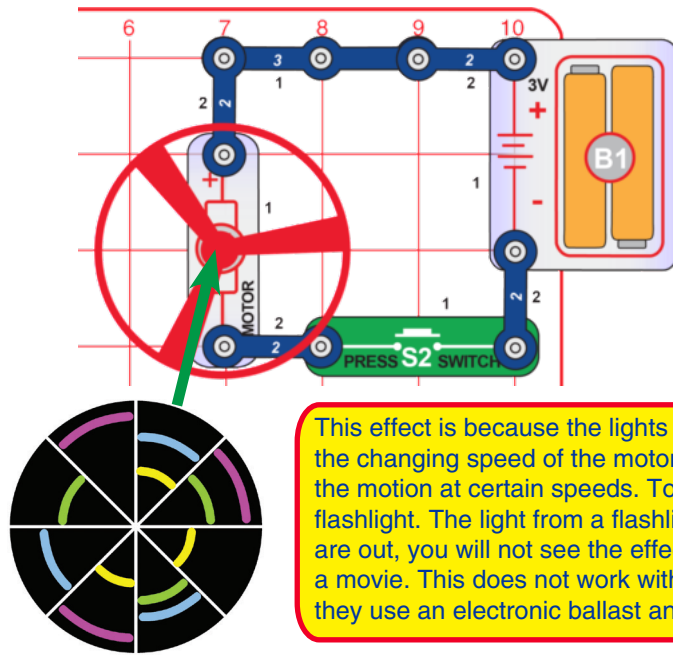
Morse Code: The forerunner of today's telephone system was the telegraph, which was widely used in the latter half of the 19th century. It only had two states - on or off (that is, transmitting or not transmitting), and could not send the range of frequencies contained in human voices or music. A code was developed to send information over long distances using this system and a sequence of dots and dashes (short or long transmit bursts). It was named Morse Code after its inventor. It was also used extensively in the early days of radio communications, though it isn't in wide use today. It is sometimes referred to in Hollywood movies, especially Westerns. Modern fiber optics communications systems send data across the country using similar coding systems, but at much higher speeds.

MORSE CODE

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



Project 109



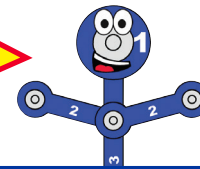
Spinning Rings

Setup: Cut out the disc on the last page that looks like the one shown here. Using tape, attach the disc with the printed side up on the top of the fan blade. Place the blade on the motor as shown.

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.

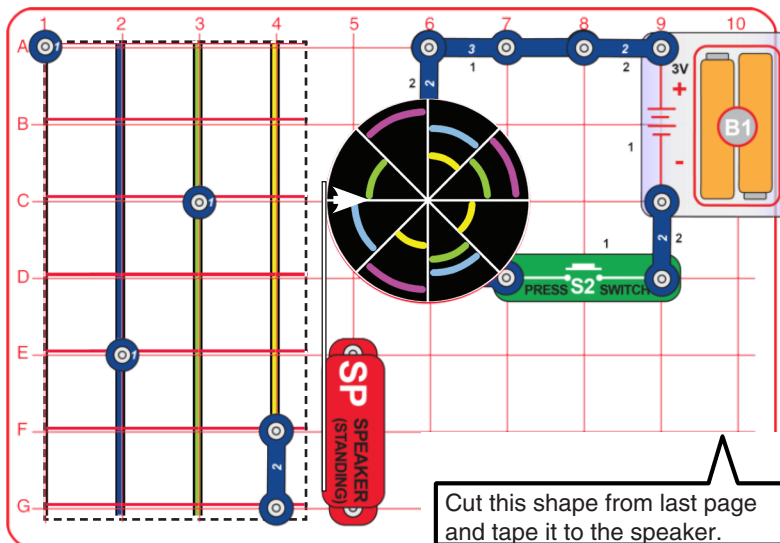
Project 110 Strobe the House Lights

This requires a fluorescent light with a T12 bulb (1.5" diameter) that runs on normal house current. Place the Spinning Rings circuit under the fluorescent light. 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.



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

Project 111



Cut this shape from last page and tape it to the speaker.

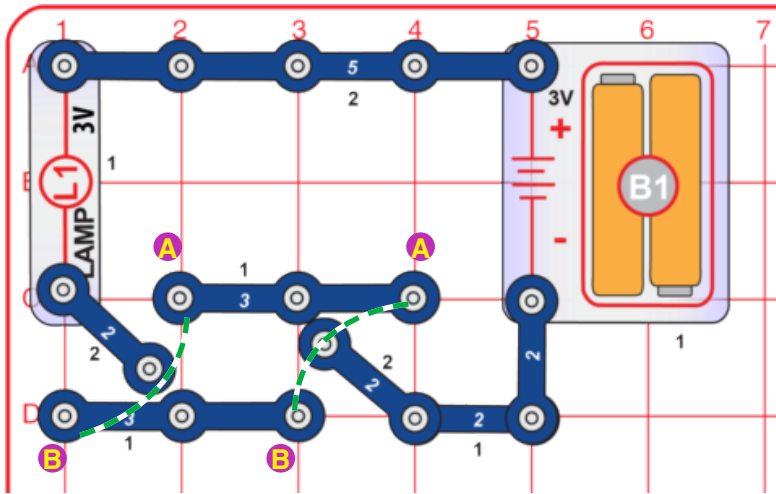
Race Game

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

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

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

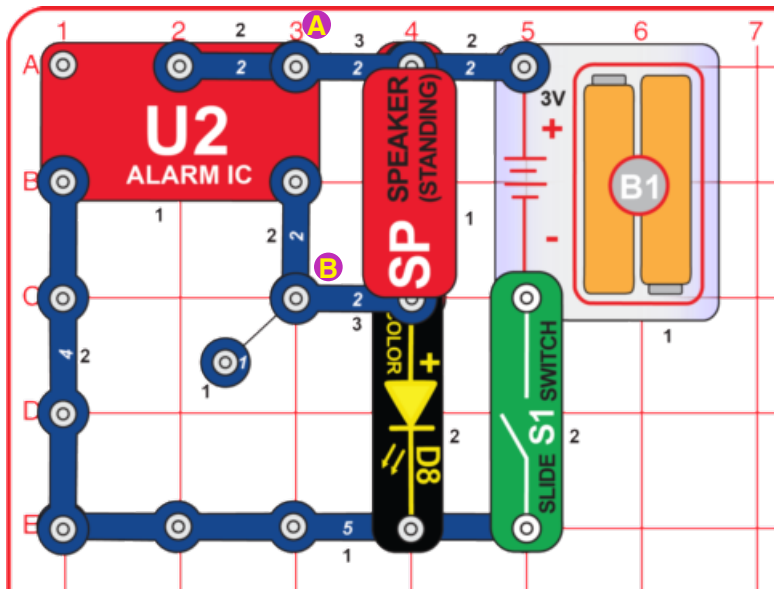
☐ Project 112



Two-way Light Switch

Build the circuit on the left. Note that two of the 2-snaps are left unconnected on one end because they will be used as switches in this project. If you connect the free ends of each of these 2-snaps both to the “high bar” or positions B in the figure or both to the “low bar” or positions A in the figure, the lamp (L1) lights. But if you connect the free end of one of the 2-snaps to the “high bar” and the free end of the other 2-snap to the “low bar”, then the lamp does not light.

☐ Project 113



Machine Gun Buzz

Build the circuit shown on the left. Turn on the switch (S1) and you hear a machine gun and a buzzing sound, while the color LED (D8) is changing colors.

Project 114 Double Flash Machine Gun

Use the preceding circuit, but add the lamp (L1) across the points marked A & B, on level 4.

Project 115

Mind Reader Game

Build the circuit below. It uses the red jumper wire and a 3-Snap Wire as “shorting bars”.

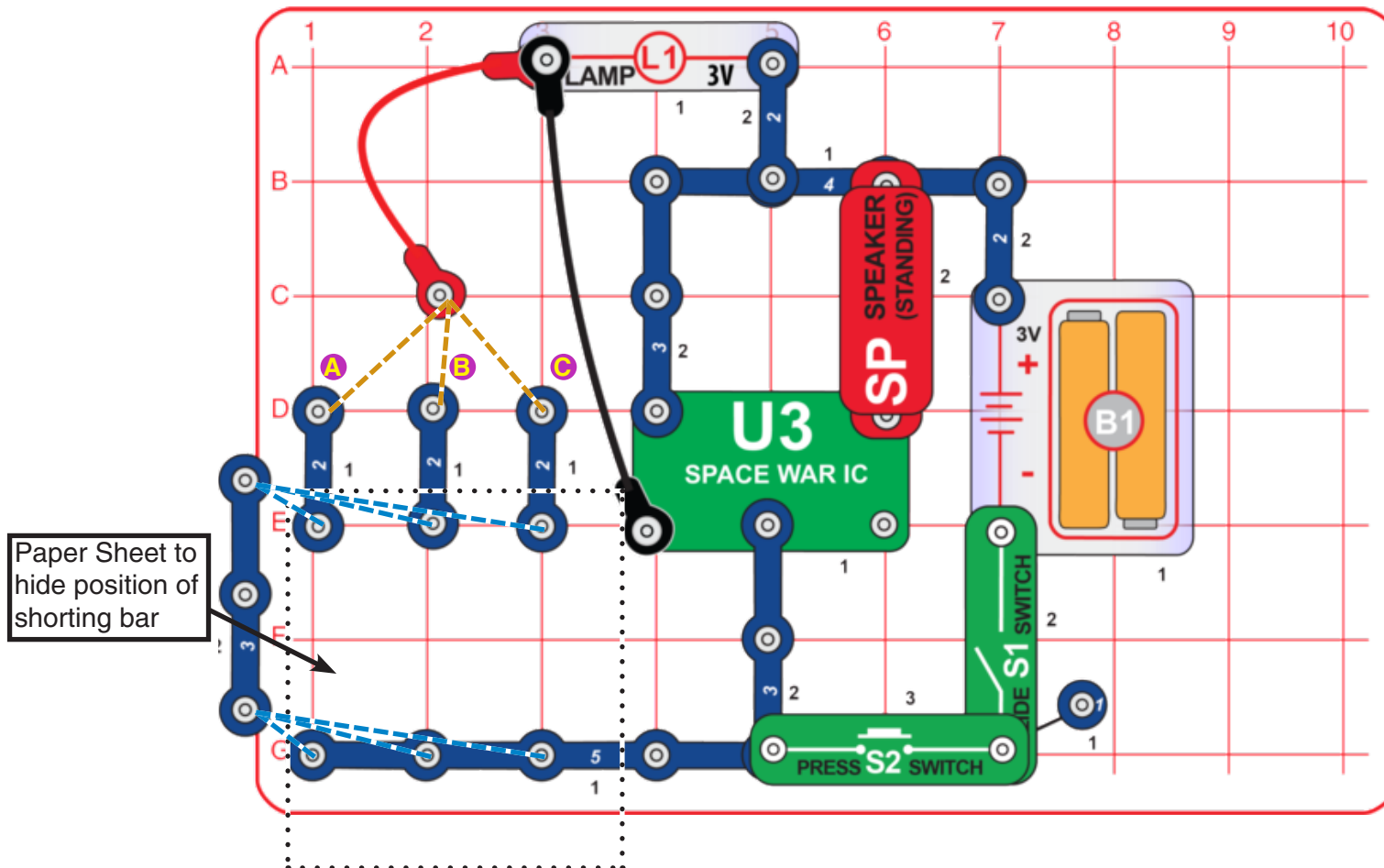
Setup: Player 1 sets the target by placing the 3-snap shorting bar under the paper on column 2, 3 or 4. Player 2 must NOT know where the shorting bar is located under the paper.

The object is for Player 2 to guess the location by placing the loose end of the red jumper wire on the 5-snap wire at positions A, B, or C and then pressing the press switch (S2). If Player 2 places the red jumper wire at the correct position, the sounds played indicates a “hit”. They keep guessing until they get a hit. After each hit, remove the 3-snap

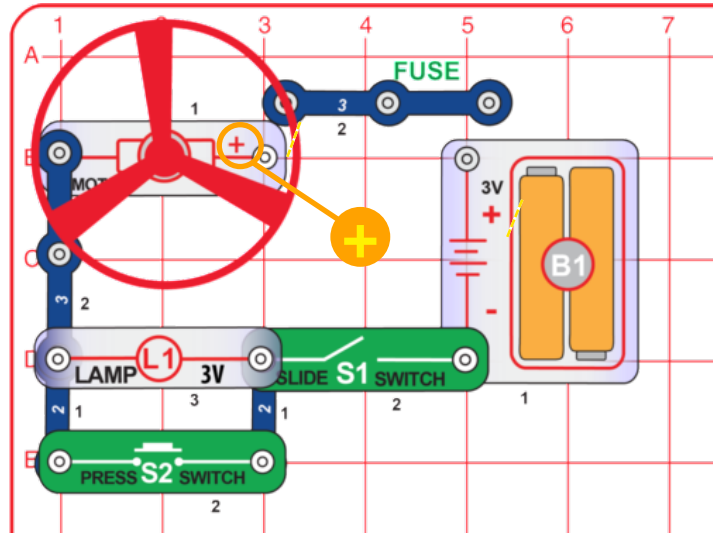
shorting bar and slide the switch off and on to reset the sound.

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

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



Project 116



Fuse

Pretend the 3-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 you close the slide switch (S1), current flows from the batteries through the slide switch (S1), the lamp (L1), motor (M1), and back to the battery (B1). When press switch (S2) is closed, the light is shorted and motor speed increases due to an increase in current to the motor. While still holding press switch (S2) down, remove the 3-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 3-snap wire and the circuit should return to normal.

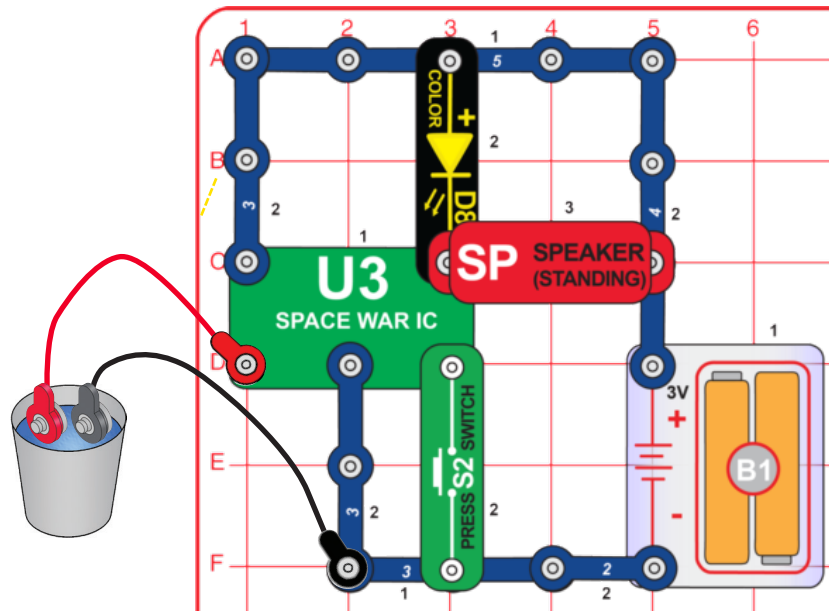


WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.

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



Project 117



Water Activated Space War

Build the circuit shown, including the jumper wires going between it and the cup of water shown. There will be sound when you push the press switch (S2) or when the jumper wires are in the water. Pushing the press switch or placing the jumper wires out and then back into the water will change the sound played.

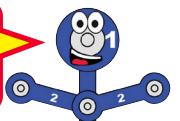
Next, wet your fingers and touch them to the metal snaps on the ends of the jumper wires to activate the sound.

Don't drink any water used here.

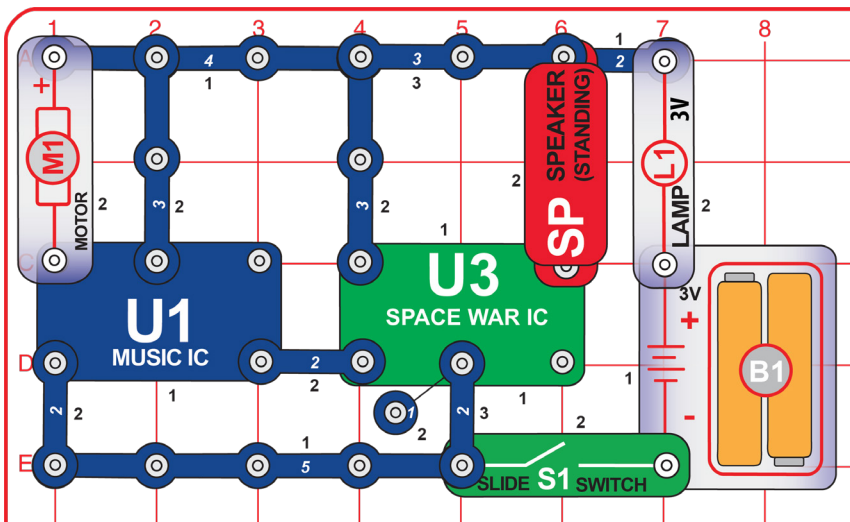
Project 118 Water Activated Whistle War

Use the preceding circuit but replace the speaker (SP) with the whistle chip (WC). If desired, place the lamp (L1) or the motor (M1), "+" on right, with the fan) on top of the whistle chip for more effects.

Normal tap water can conduct electricity due to the impurities in it. Your body can also conduct electricity because your body is mostly water.



Project 119



Space War Sensor

Turn on the slide switch (S1). Sound plays for a while and stops. Spin the motor (M1) top with your fingers to re-start the sound.

The lamp (L1) is used here as a 3-snap wire, and will not light.

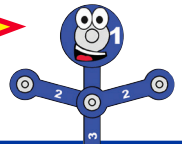
Project 120 Space War Sensor (II)

Use the preceding circuit but replace the motor with the whistle chip (WC). When the sound stops, re-start the sound by clapping loudly next to the whistle chip, or blowing on it, or tapping on it.

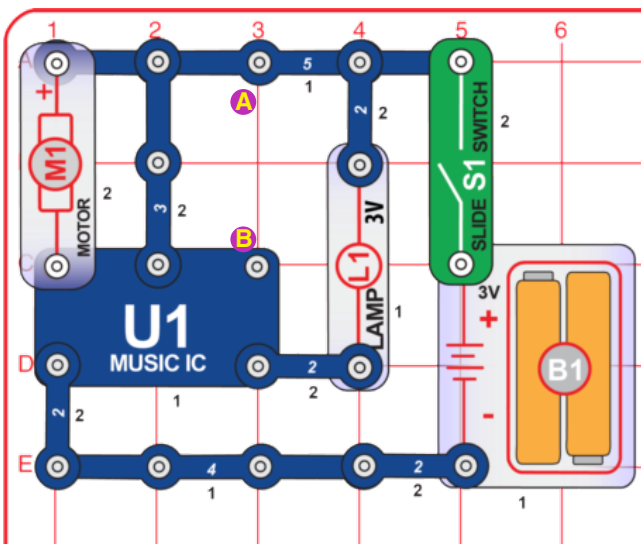
Project 121 Space War Sensor (III)

Use either of the preceding circuits but replace the speaker (SP) with the color LED (D8, "+" on top).

Think of this as having motion or sound sensors that activate space defense weapons.



Project 122



Motion Activated Light

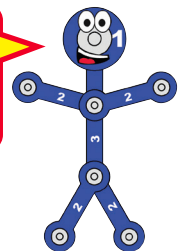
Turn on the slide switch (S1). The lamp (L1) flickers for a while and then stops. Spin the motor (M1) with your fingers to resume the flickering.

You can replace the lamp with the color LED (D8).

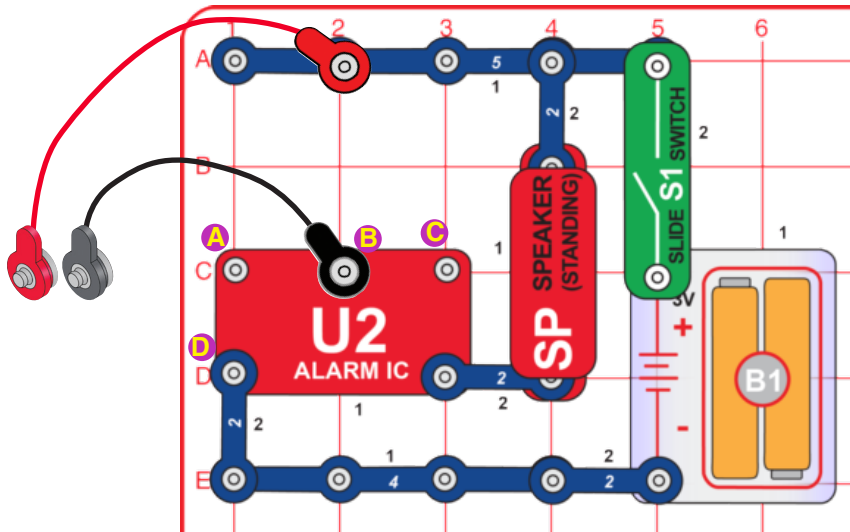
Project 123 Lighty Light

Use the preceding circuit but remove the motor and add the photoresistor (RP) across points A & B. If there is light on the photoresistor then the lamp flickers. Cover the photoresistor with your finger to turn off the light.

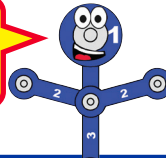
The upper-left snap on the music IC (U1) is triggered by an electrical pulse. The upper-right snap is controlled by a continuous voltage.



Project 124



The black core of pencils is graphite, the same material used in resistors (components that resist and control the flow of current).



Pencil Alarm

Build the circuit shown and connect the two jumpers to it, leave the loose ends of the jumpers unconnected for now. There is one more part you need and you are going to draw it. Take a pencil (No. 2 is best but other types will also work). **SHARPEN IT**, and fill in the shape below. You will get better results if you place a **hard**, flat surface directly beneath this page while you are drawing. Press **hard** (but don't rip the paper), and fill in the shape **several times** to be sure you have a **thick, even layer** of pencil lead.



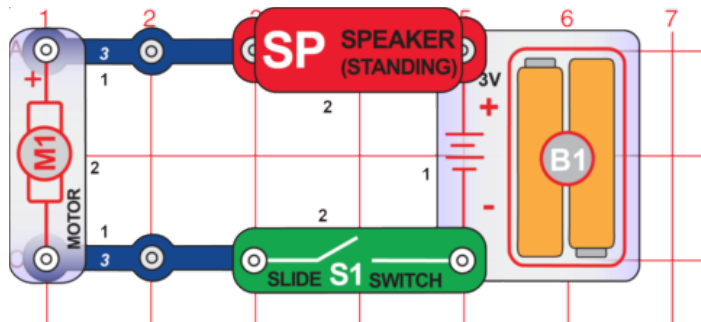
Turn on the slide switch (S1) and take the loose ends of the jumpers, press them to the shape and move them around over the drawing. If you don't hear any sound then move the ends closer together and move over the drawing, add another layer of pencil lead, or put a drop of water on the jumper ends to get better contact.

Now you can draw your own shapes and see what kinds of sounds you can make.

Project 125 Pencil Sirens

Use the preceding circuit, but connect points A & B, B & C, or A & D using a 2-snap wire and a 1-snap wire.

Project 126

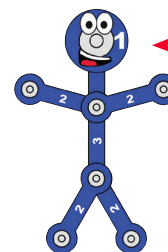


Hear the Motor

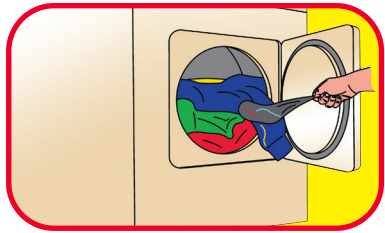
Turn on the slide switch (S1). If the shaft on the motor (M1) isn't spinning, then give it a push to get started. Listen to the motor.

You can also try this circuit with the fan on the motor.

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



□ Project 127



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



The crackling noise you hear when taking off a sweater is static electricity. You may see sparks when taking one off in a dark room.



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

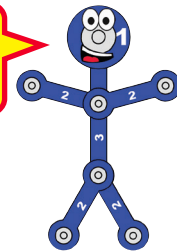
Note: This project works best on a cold dry day. If the weather is humid, the water vapor in the air allows the static electric charge to dissipate, and this project may not work.

Electricity You Can Wear

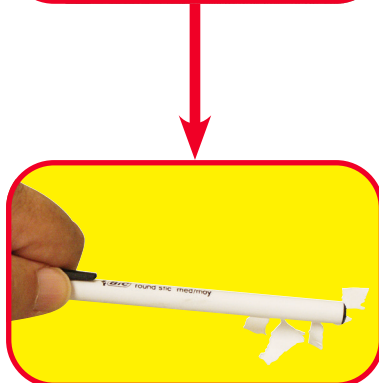
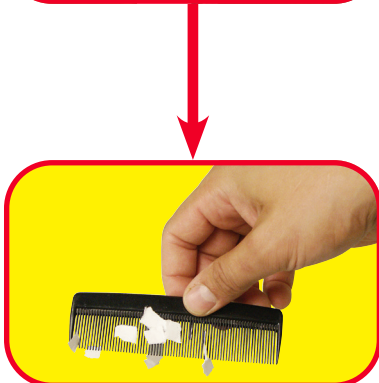
Did you ever wonder why clothes cling together when they come out of the dryer? Did you ever hear a crackling sound when you take off a sweater? (If the room is dark you might even see sparks.) Did you ever feel a “zap” when you touch someone wearing a sweater on a dry day?

These effects are caused by electricity. We call this static electricity because the electrical charges are not moving, although pulling clothes apart sounds like static on a radio. When electricity is moving (usually through wires) to do something in another place, we call it an electric current.

Clothes can cling together because electricity is all around us.



□ Project 128



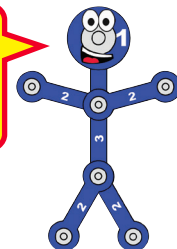
Electricity In Your Hair

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

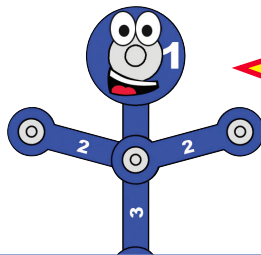
Rubbing the comb through your hair pulls extremely tiny charged particles from your hair onto the comb. These give the comb a static electrical charge, which attracts the paper pieces.

Note: This project works best on a cold dry day. If the weather is humid, the water vapor in the air allows the static electric charge to dissipate, and this project may not work.

Notice how your hair can “stand up” or be attracted to the comb when the air is dry. Wetting your hair dissipates the static charge.



Project 129



Bending Water

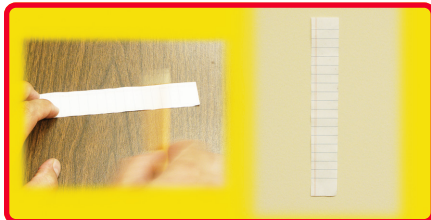
You need a comb (or plastic ruler) and a water faucet for this project. Run the comb through your hair several times then hold it next to a slow, thin stream of water from a faucet. The water will bend towards it. You can also use a plastic ruler. Rub it on your clothes (wool works best).

Rubbing the comb through your hair builds up a static electrical charge on it, which attracts the water.

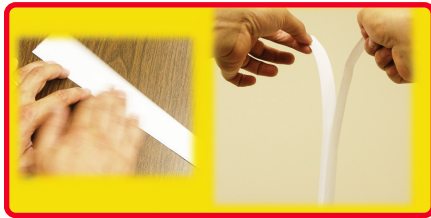
Note: This project works best on a cold dry day. If the weather is humid, the water vapor in the air allows the static electric charge to dissipate, and this project may not work.

Static electricity was discovered more than 2,500 years ago when the Greek philosopher Thales noticed that when amber (a hard, clear, yellow-tinted material) is rubbed, light materials like feathers stick to it. Electricity is named after the Greek word for amber, which is electron.

Project 130



Take a piece of newspaper or other thin paper and rub it vigorously with a sweater or pencil. It will stick to a wall.



Cut the paper into two long strips, rub them, then hang them next to each other. See if they attract or repel each other.



If you have two balloons, rub them to a sweater and then hang the rubbed sides next to each other. They repel away. You could also use the balloons to pick up tiny pieces of paper.

Note: This project works best on a cold dry day. If the weather is humid, the water vapor in the air allows the static electric charge to dissipate, and this project may not work.

Static Tricks

Electricity vs. Gravity:

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

Gravity is actually the attraction between objects due to their weight (or technically, their mass). This effect is extremely small and can be ignored unless one of the objects is as big as a planet (like the earth). Gravity attraction never goes away and is seen every time you drop something. Electrical charge, though usually balanced out perfectly, can move around and change quickly.

For example, you have seen how clothes can cling together in the dryer due to static electricity. There is also a gravity attraction between the sweaters, but it is always extremely small.

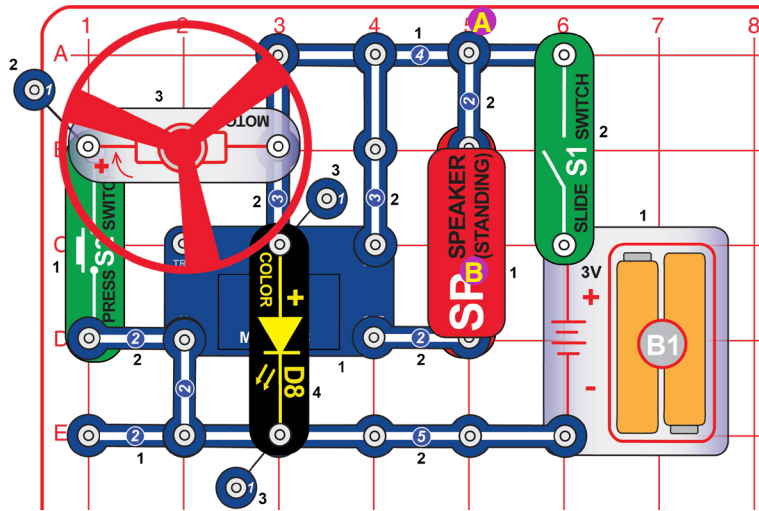


Electricity



Gravity

Project 131



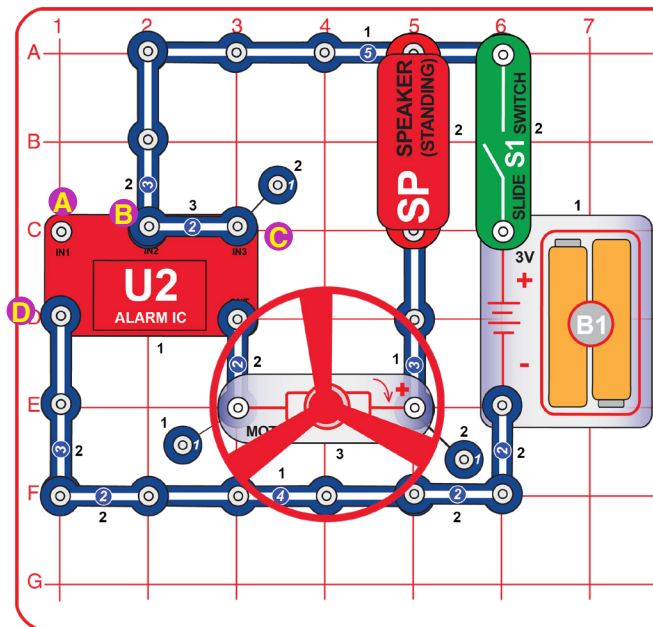
Happy Birthday

Turn on the slide switch (S1). When the Happy Birthday tune finishes for the first time, push the press switch (S2) until the fan reaches full speed, then release to make the fan fly into the air.

If you want the sound to stop after the first tune, remove the 3-snap wire that is across points labeled A & B.

If the sound is too loud then replace the speaker (SP) with the lamp (L1), and connect the whistle chip (WC) across the lamp using the red and black jumper wires.

Project 132



Machine Gun Fan

Turn on the slide switch (S1). A machine gun sounds and the motor (M1) spins the fan in bursts. You may need to give the fan a push to get it started.

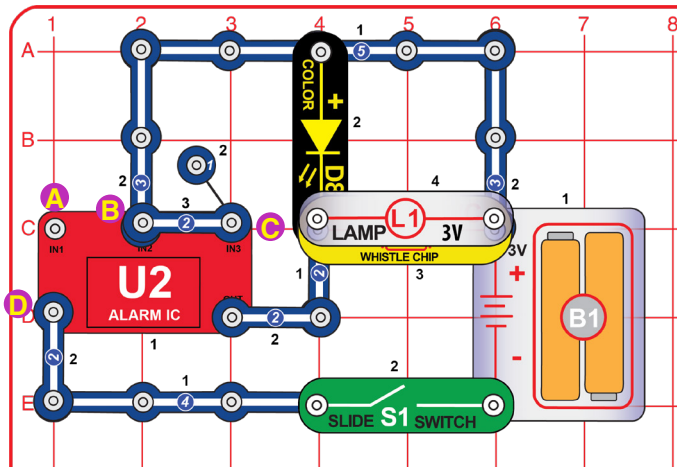
Project 133 Siren Fan

Use the preceding circuit but remove the 2-snap wire and 1-snap wire that are across points C & D. Leave them off, or add them across points A & B or A & D.

Project 134 Light Control Volume

Use any of the preceding circuits but replace the motor (M1) with the photoresistor (RP). Shine a bright light (like a flashlight) directly on the photoresistor to hear a machine gun sound, the sound will not be very loud.

Project 135

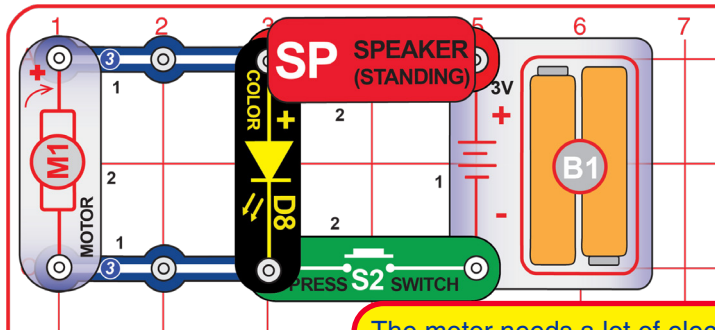


Flashing Lights & Sound

Turn on the slide switch (S1). A siren sounds and lights flash.

- ☐ **Project 136 Flashing Lights & Sound (II)**
Remove the 2-snap wire and 1-snap wire that are across points B & C. Leave them off, or add them across points A & B or C & D.
- ☐ **Project 137 Flashing Lights & Sound (III)**
Replace the whistle chip (WC) and 3V lamp (L1) with the speaker (SP).
- ☐ **Project 138 Flashing Lights & Sound (IV)**
In the original circuit, replace the alarm IC (U2) with the music IC (U1).

Project 139



The motor needs a lot of electricity to start spinning, but needs less the faster it is spinning. When kept from spinning by your fingers, the motor sucks up all the electricity, leaving none to light the LED. With the fan on the motor, the LED gets enough electricity to light. When the motor is spinning without the fan, the LED gets lots of electricity and is bright.



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

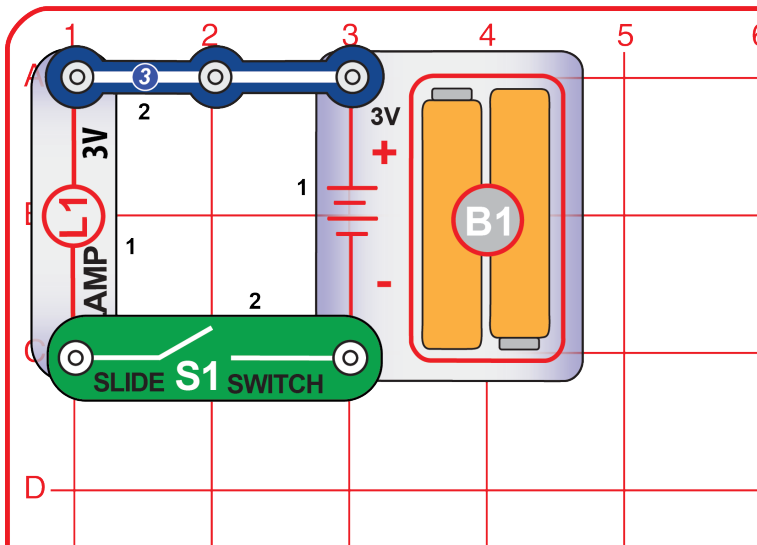
Motor Power

Build the circuit as shown, push the press switch (S2), and look at the brightness of the color LED (D8). Try it three ways: with no fan on the motor, with the fan on the motor, and keeping the motor from spinning with your fingers. When the motor is spinning, you will hear noise from the speaker (SP).



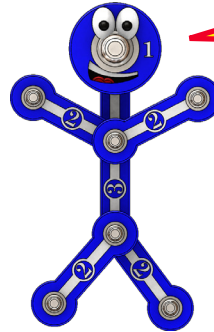
The motor "noise" that you hear on the speaker can also confuse the color LED and disrupt its color pattern.

Project 140



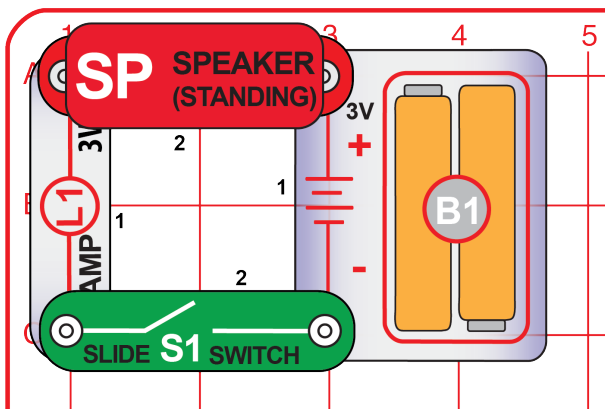
Electric Heater

Turn on the slide switch (S1), cover the holes in the top of the 3V lamp (L1) with your finger, and wait. After a short time you should feel the lamp heating up. *Do not leave the circuit on for more than two minutes.*



Incandescent light bulbs like L1 contain a special thin wire that gets so hot when electricity flows through it that it glows. Only about 5% of the electricity used in incandescent light bulbs is used to make light; the rest becomes heat, which is why you can feel the L1 lamp heat up when you cover its venting holes. Electric space heaters convert electricity to heat in a similar way to warm up a room.

Project 141

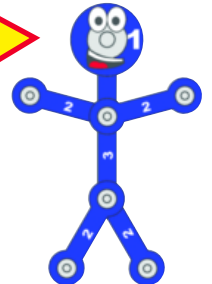


Speaker and Lamp

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

The speaker sound may be hard to hear over the switch contacts noise. To make the sound easier to hear, replace the swlide switch with a 3-snap wire, and gently touch one side onto the snap below it several times.

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.

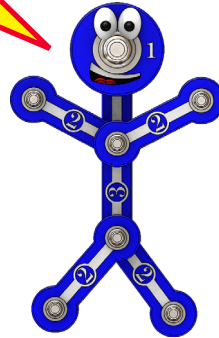


Project 142

Cup & String Communication

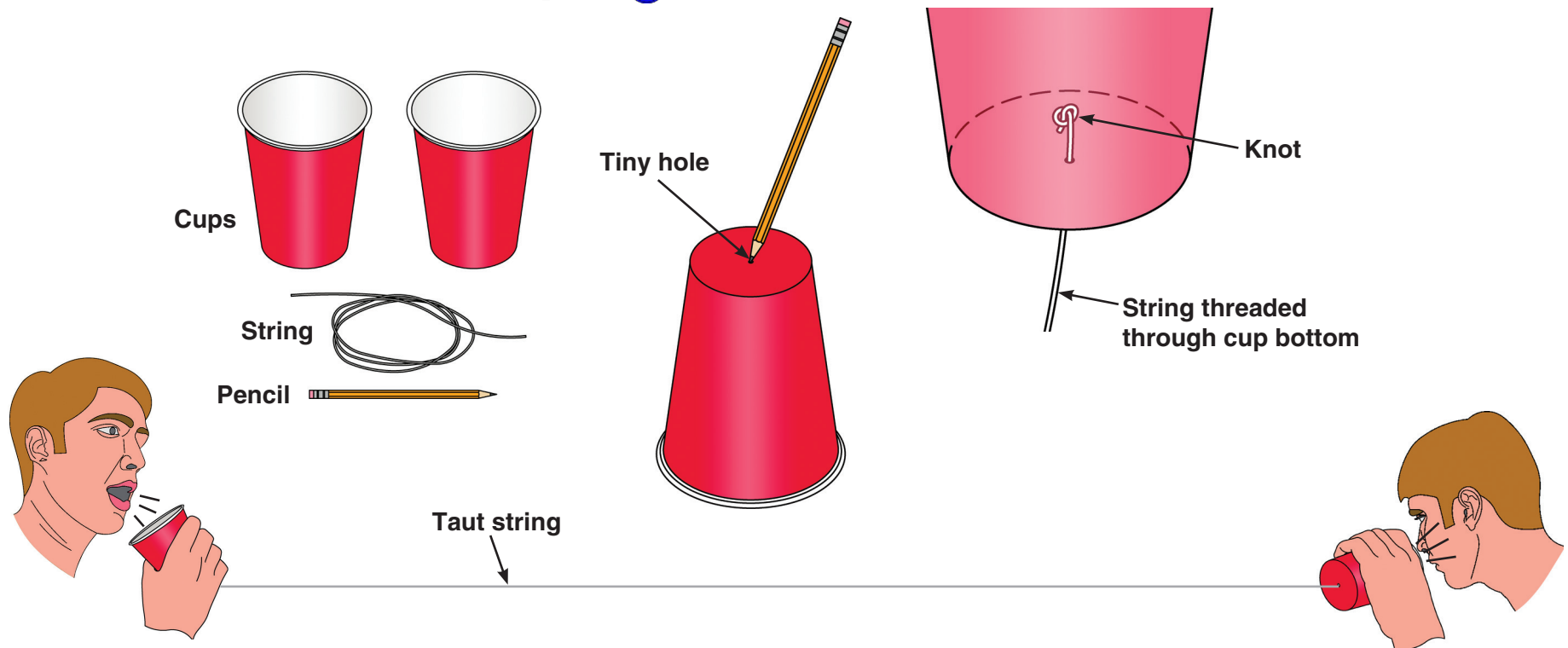
How it works: When you talk into the cup, the cup bottom vibrates back and forth from your sound waves. The vibrations travel through the string by pulling the string back and forth, and then make the bottom of the second cup vibrate just like the first cup did, producing sound waves that the listener can hear. If the string is tight, the received sound waves will be just like the ones sent, and the listener hears what the talker said.

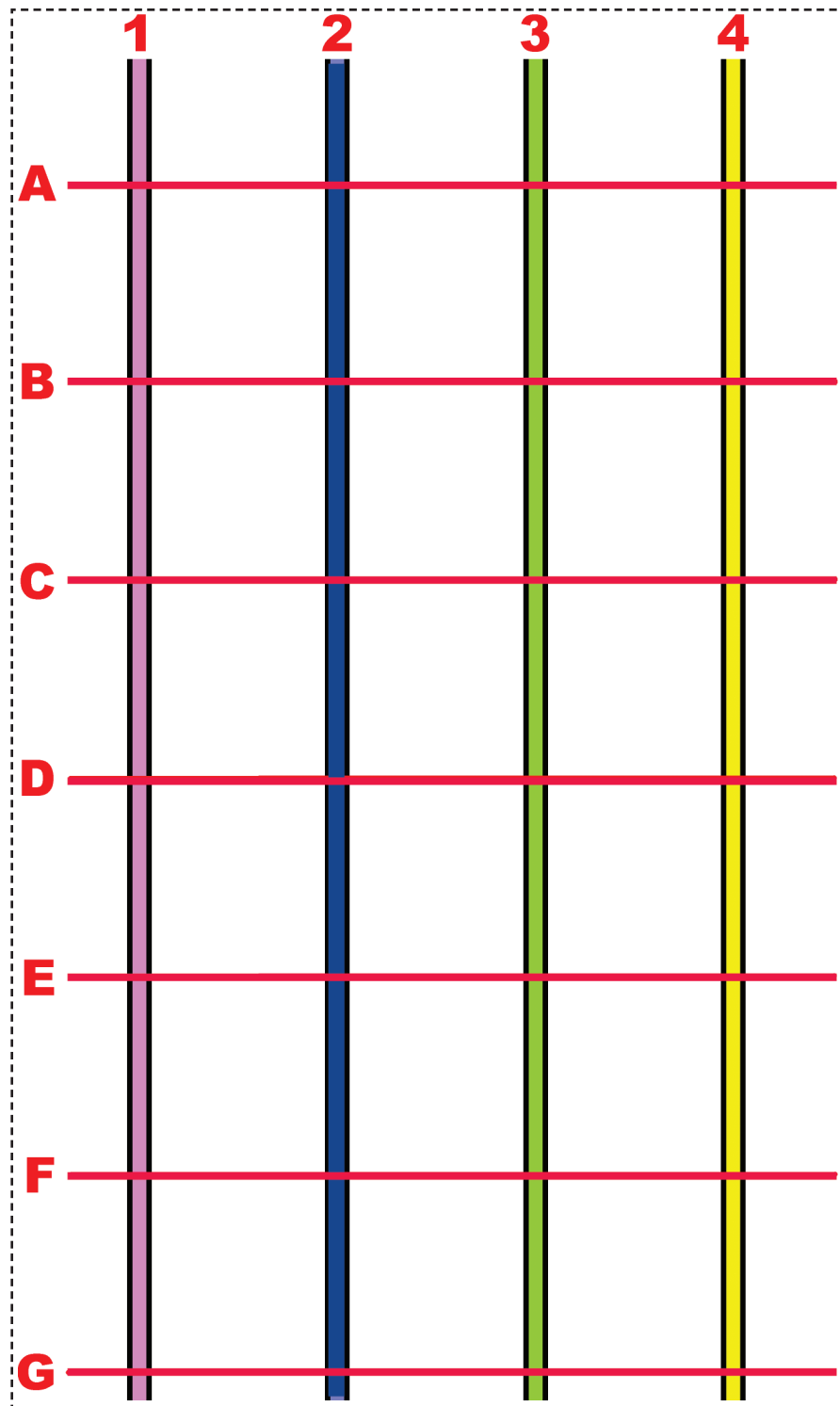
Telephones work the same way, except that electric current replaces the string. In radio, the changing current from a microphone is used to encode electromagnetic waves sent through the air, then decoded in a listening receiver.



Light, radio signals, and sound all travel through air like waves travel through water. To help you understand how they are like waves, you can make a cup & string telephone. This common trick requires some household materials (not included with this kit): two large plastic or paper cups, some non-stretchable thread or kite string, and a sharp pencil. Adult supervision is recommended.

Take the cups and punch a tiny hole in the center of the bottom of each with a sharp pencil (or something similar). Take a piece of string (use between 25 and 100 feet) and thread each end through each hole. Either knot or tape the string so it cannot go back through the hole when the string is stretched. Now with two people, have each one take one of the cups and spread apart until the string is tight. The key is to make the string tight, so its best to keep the string in a straight line. Now if one of you talks into one of the cups while the other listens, the second person should be able to hear what the first person says.





for Project 109

← for Project 111

