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OFF
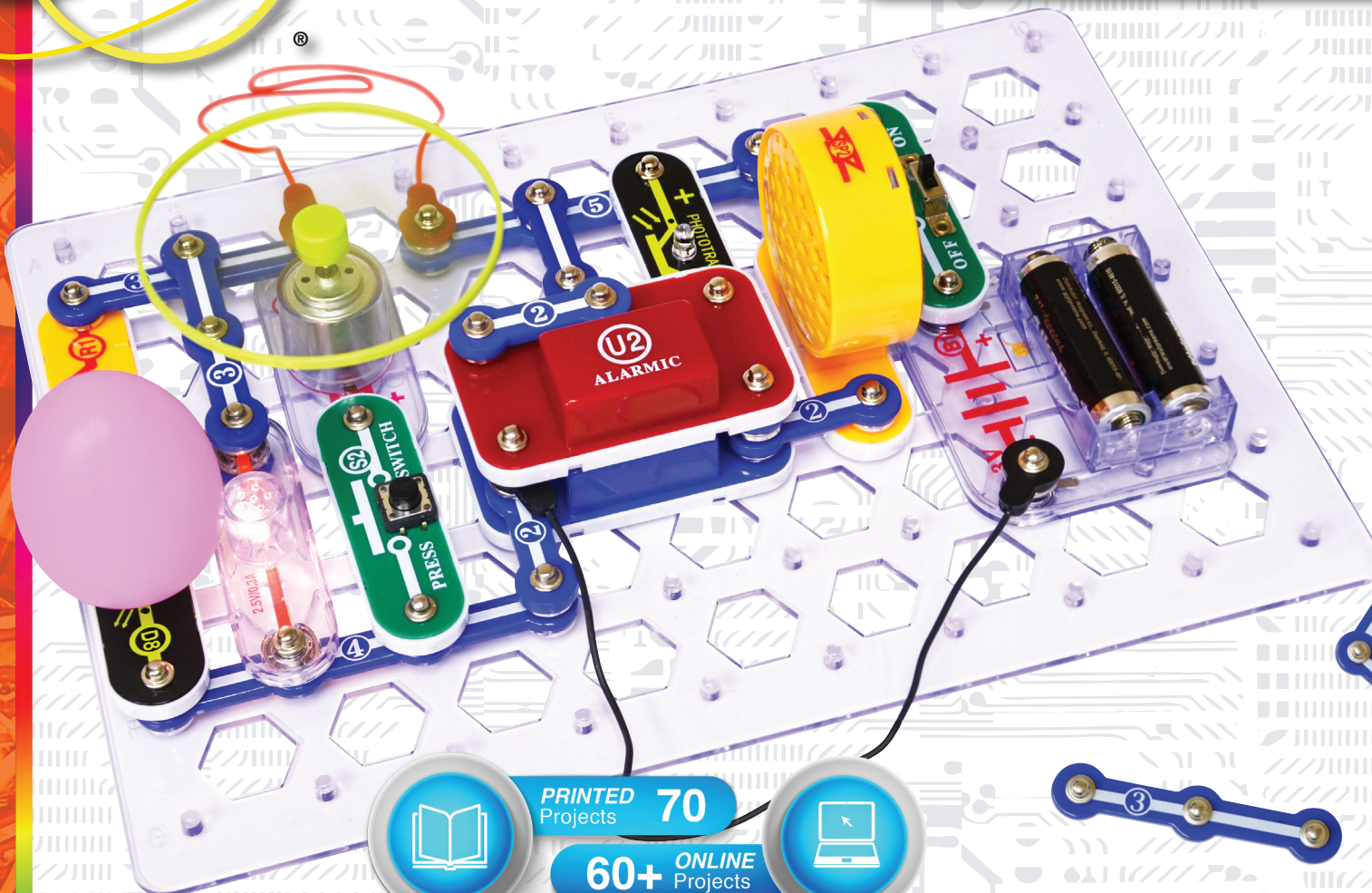
LEARN THE FUNDAMENTALS OF ELECTRICITY

ACTIVATE AERIAL STUNTS

FUN SOUNDS

BUILD OVER

130

ELECTRONIC PROJECTS

AGES 8 to 108

Two (2) "AA" batteries required

Project 20

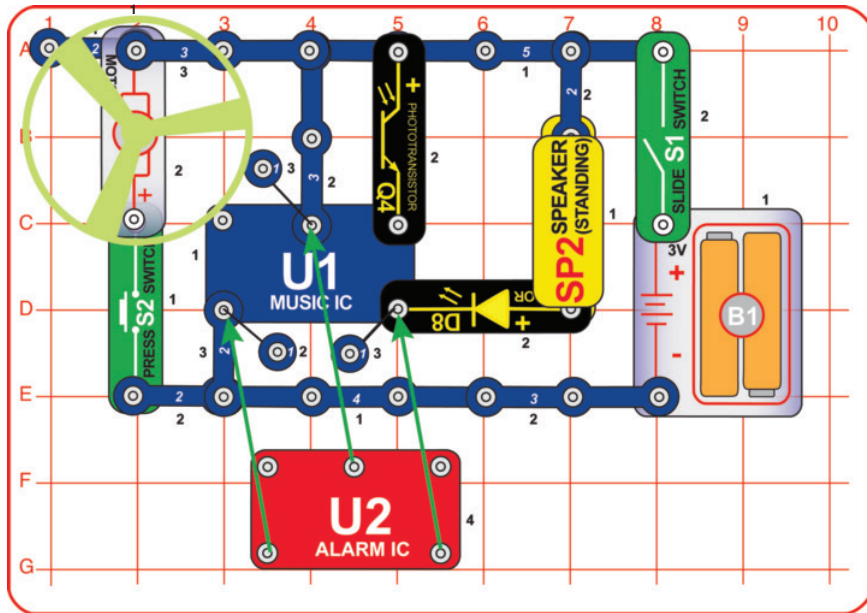PRINTED Projects **70**

60+ ONLINE Projects

Projects 71-134. See your printed manual for projects 1-70
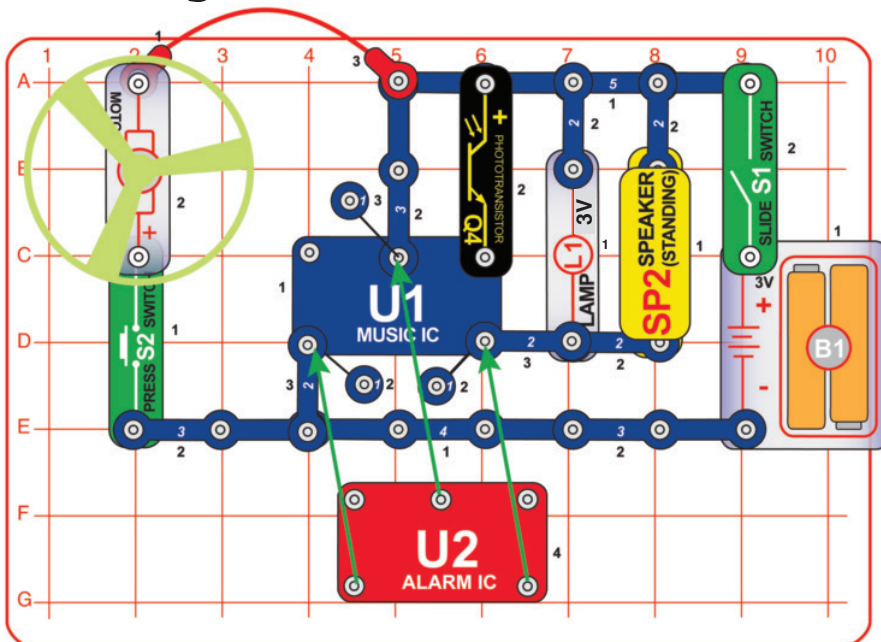
ELENCO
Learn by doing.®

Project 71

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. If the sound stops, shine light on the phototransistor (Q4).

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

Project 72

Power Pitch

In the circuit, the outputs from the alarm and music ICs are connected together. Build the circuit shown and then place the alarm IC (U2) directly over the music IC (U1), resting on two 1-snaps and a 2-snap. Turn on the slide switch (S1) and you will hear a siren and music together while the lamp (L1) varies in brightness. Push the press switch (S2) and the fan spins, while the sound may not be as loud. The fan may rise into the air when you release the switch.

You can replace the lamp with the color LED (D8, "+" on top). The sound will be louder than in the preceding circuit.

> **WARNING:** Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.
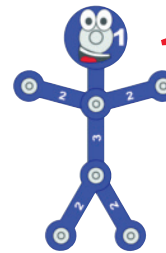
☐ Project 73
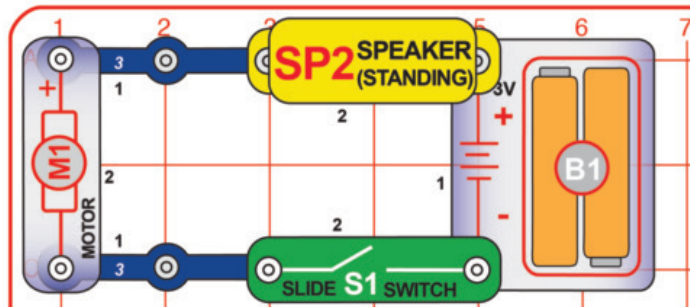
Hear the Motor

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 glow 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 74
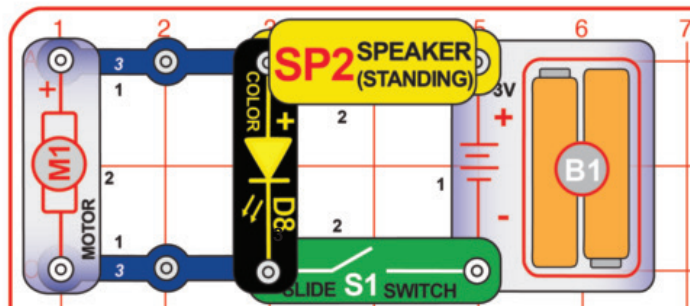
Hear the Motor with Light

Turn on the slide switch (S1), and look at the brightness of the color LED (D8). If the shaft on the motor (M1) isn't spinning, then give it a push to get started. Try it three ways: with no fan on the motor, with the glow 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).
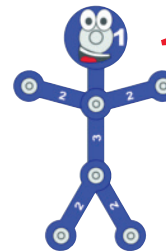
> The motor needs a lot of electricity to start spinning, but needs less the faster it is spinning. When kept from spinning by your fingers, the motor sucks up all the electricity, leaving none to light the color LED. With the fan on the motor, the LED gets enough electricity to light. When the motor is spinning without the fan, the LED gets more electricity and is brighter.
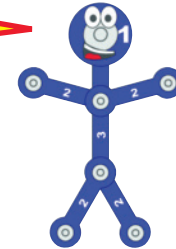
Project 75
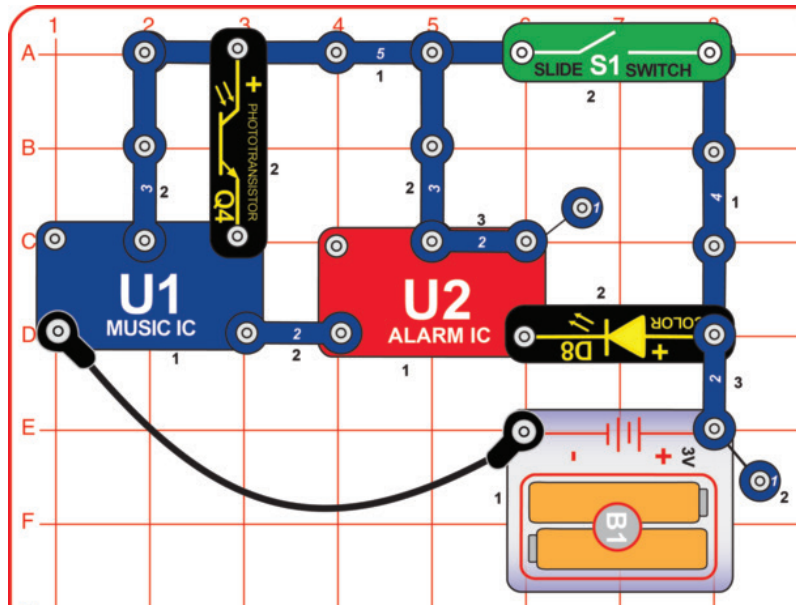
Wave & Watch

This circuit does not use the noisy speaker (SP2) but instead uses a nice quiet color LED (D8). Turn on the slide switch (S1), the LED flickers. Wait a few seconds, and then cover the phototransistor (Q4), 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.
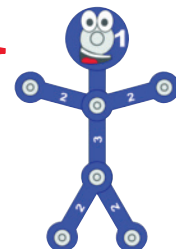
Can you think of other uses?

Project 76
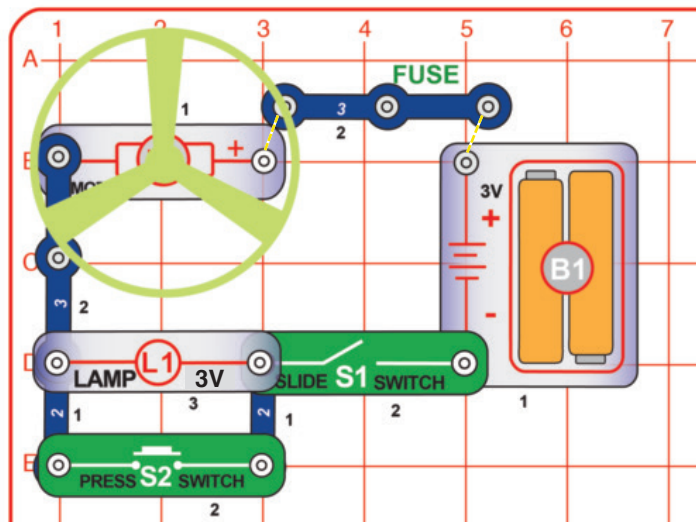
Fuse

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.

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

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

3

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,
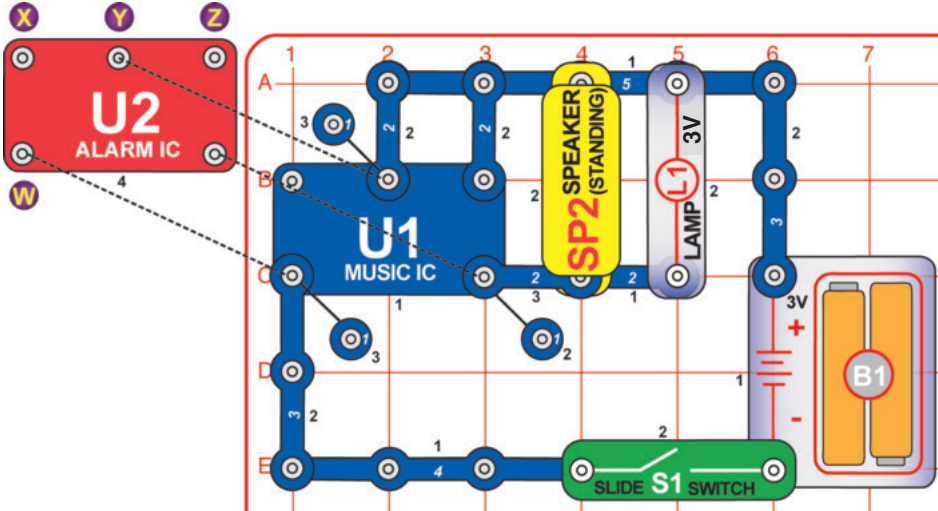
remove the 3-snap shorting bar and slide the switch off and on to reset the sound.

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.

Paper Sheet to hide position of shorting bar
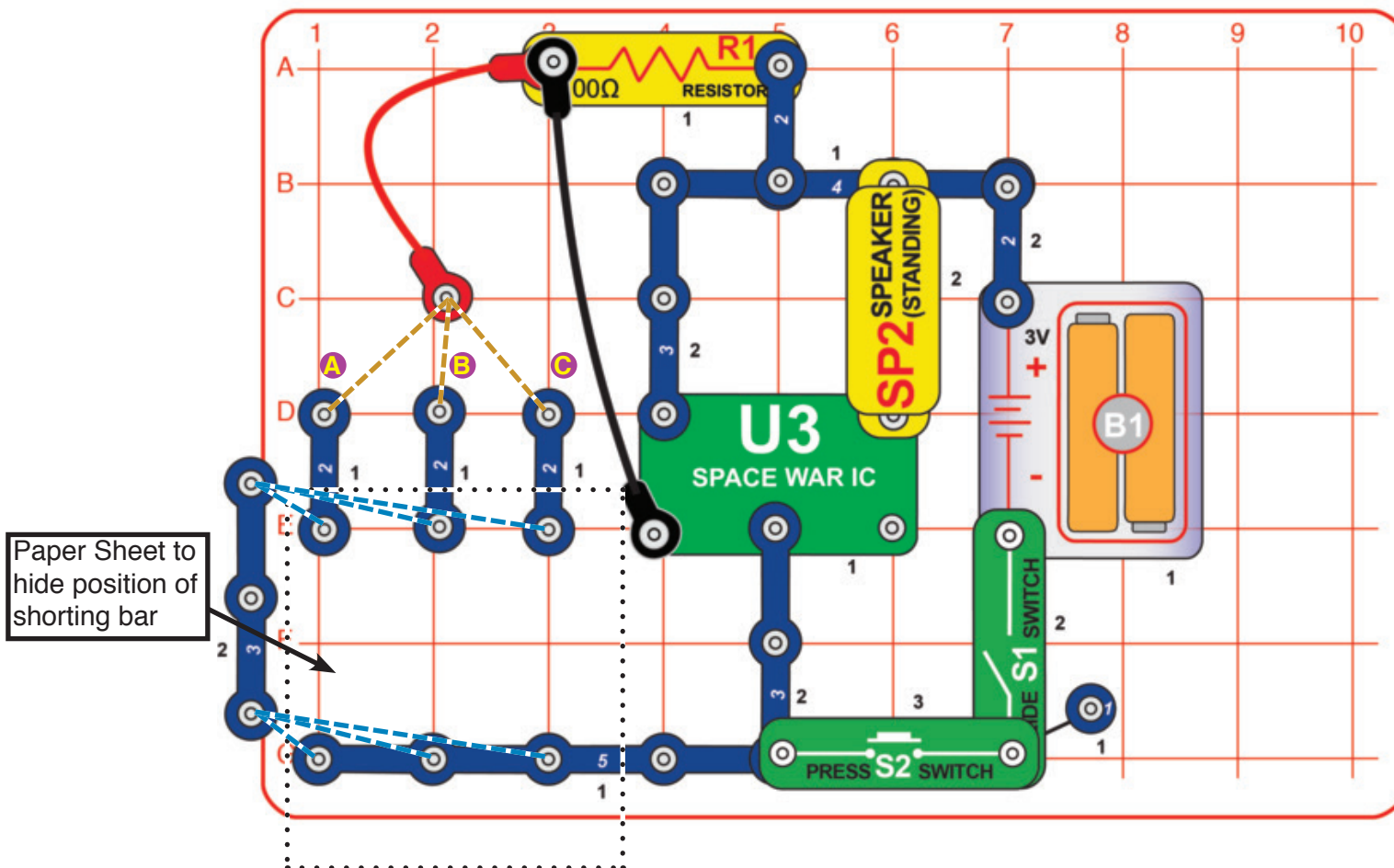
Project 78

Mixed Up Music

There are a lot of different sounds that can be made with the music and alarm ICs.

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 79 Disaster Blaster
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 80 Siren & Song
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 81 Ambulance Song
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.
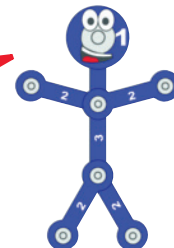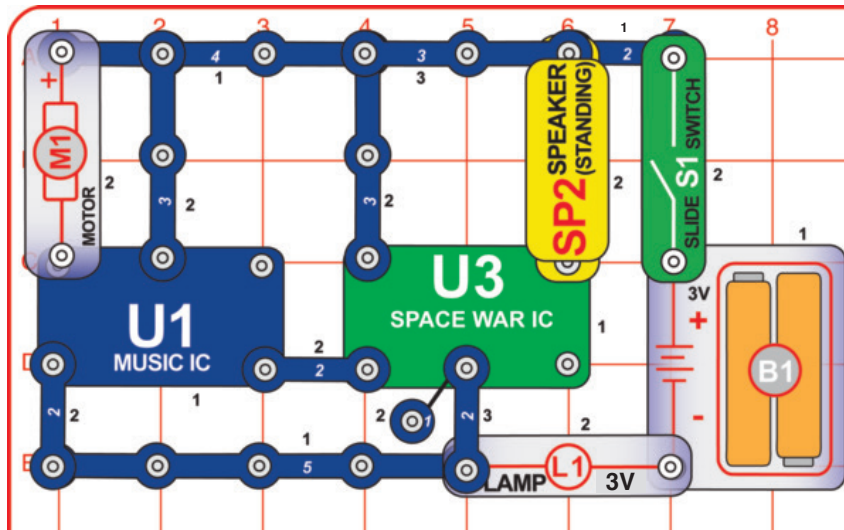
Project 82
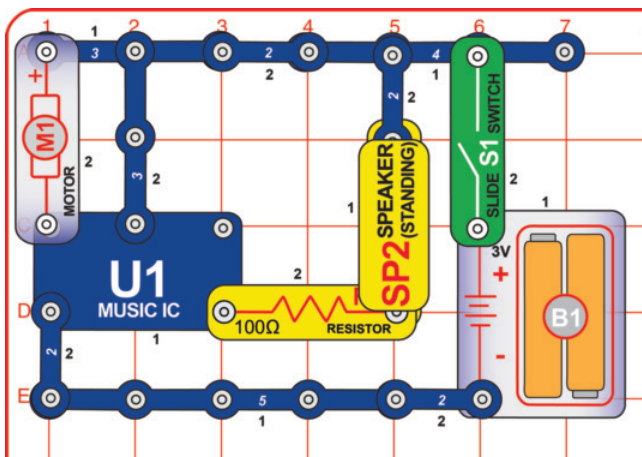
Spin Sound

Build the circuit shown on the right, 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.

Project 83 Loud Spin Sound
Use the preceding circuit but replace the 100Ω resistor with a 3-snap wire. Now the sound is louder. In this project, you changed the amount of current that goes through the speaker (SP2) and increased the sound output of the speaker.

Resistors are used throughout electronics to limit the amount of current that flows.
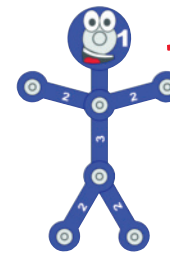
Project 84

Motor Space Sounds

Turn it on and wait for any sounds to stop. Then, spin the motor (M1) and the sounds play again.

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

Project 85 Twist & Blink

This circuit is loud and may bother other people around you so replace the speaker (SP2) with the color LED (D8), ("+" side on top); the circuit operates in the same manner but now the color LED flashes instead of the speaker making sounds.

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 86
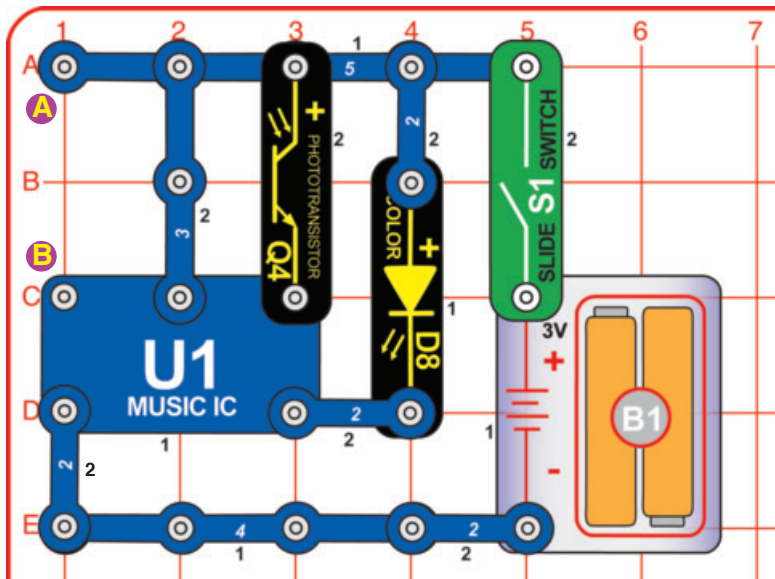
Light Makes Light

Build the circuit to the left. Cover the phototransistor (Q4), 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 phototransistor again and the LED will turn off. The resistance of the photoresistor decreases as the light increases activating the U1 IC that varies the voltage to the LED making it light.

Project 87 Light-Controlled Lamp

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

Project 88 Go & Glow

Use either of the preceding circuits, but connect the motor (M1) across points A and B on the base grid, and remove the phototransistor (Q4). Turn the switch on and the color LED (D8) lights for several seconds then goes out. Turn the shaft of the motor and the LED will light again. 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 through its terminals. This voltage then activates the music IC.

Project 89
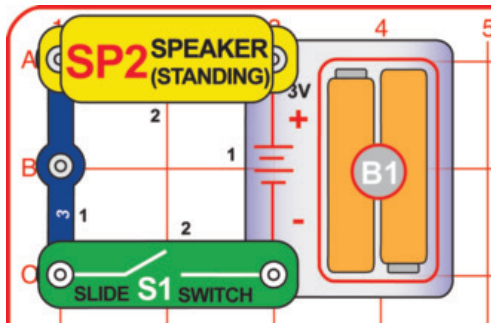
Pop On, Pop Off

Turn the slide switch (S1) on and off several times. You hear static from the speaker (SP2) when you turn the switch on or off.

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.
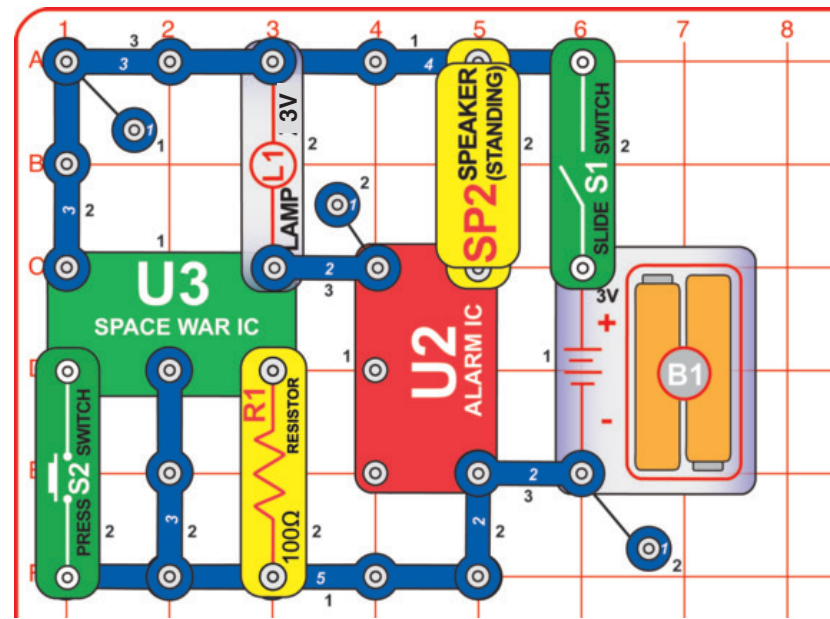
Project 90
Photo LED Control
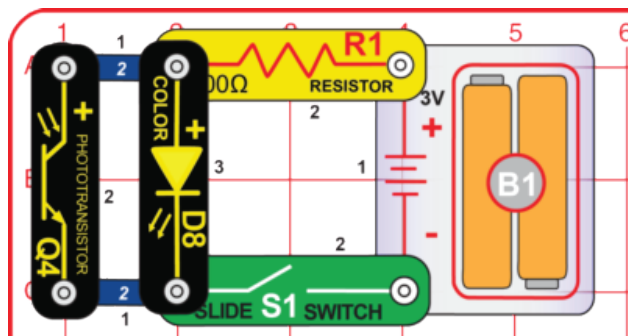
Build the circuit shown on the left. Cover the phototransistor (Q4) and turn on the switch (S1); the color LED (D8) should be changing colors.

Now shine a bright light on the phototransistor and the color LED should get dim or turn off. Vary the amount of light on the phototransistor and see how bright the color LED is. Try using a flashlight in a dimly lit room.

Project 91
Alien Alarm

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 (L1) brighter.
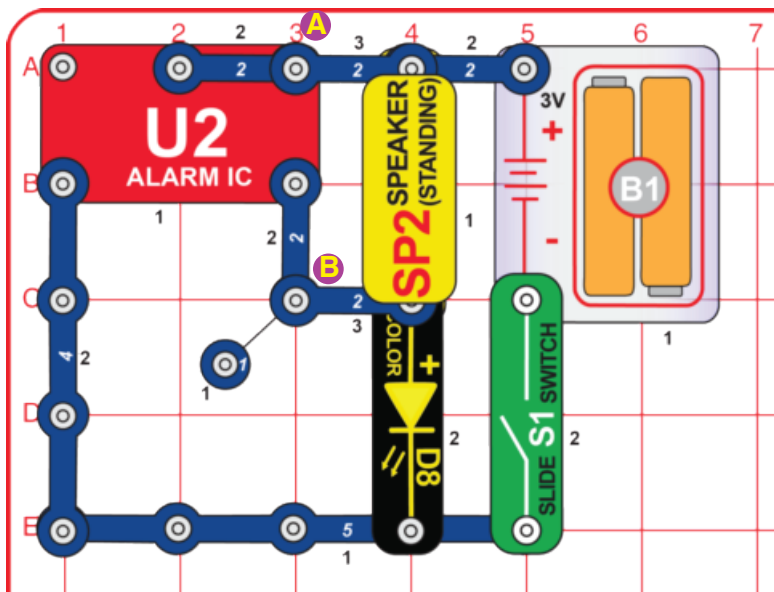
Project 92
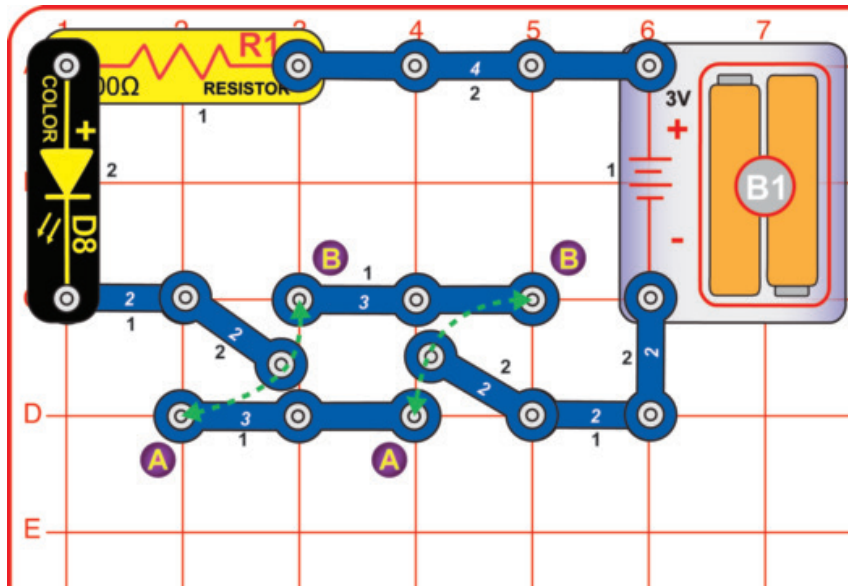
Two-way Light Switch

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 color LED (D8) lights up. 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 color LED does not light up.

Project 93

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 94 Double Flash Machine Gun

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

Project 95

Motor-Controlled Sounds

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

Project 96 Machine Gun
Use the preceding circuit, but add a connection between the points marked B & C using a 1-snap wire and a 2-snap wire. Now it sounds like a machine gun.

Project 97 Fire Engine
Use the preceding circuit, but remove the connection between B & C, and add a connection between A & B. Now it sounds like a fire engine

Project 98 European Siren
Use the preceding circuit, but remove the connection between A & B, and add a connection between A & D. Now it sounds like a European siren.
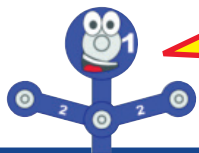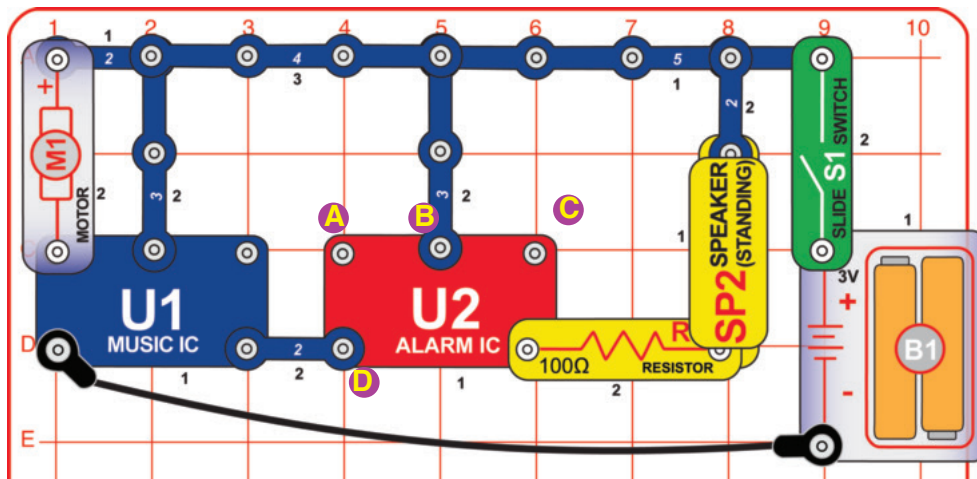
When you spin the motor shaft the energy of the spinning shaft produces a small electrical voltage. This voltage is used to activate the music IC (U1), which controls the alarm IC (U2).

Project 99

Same or "NOT"

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). Disassemble the circuit when finished to avoid draining your batteries.
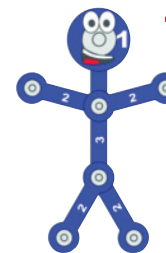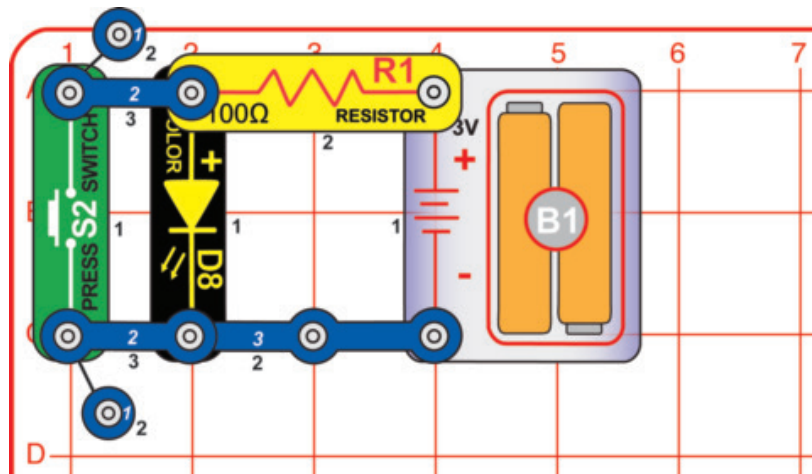
Although this circuit seems simple, inverters or NOT gates are very important in digital logic circuits.

☐ Project 100
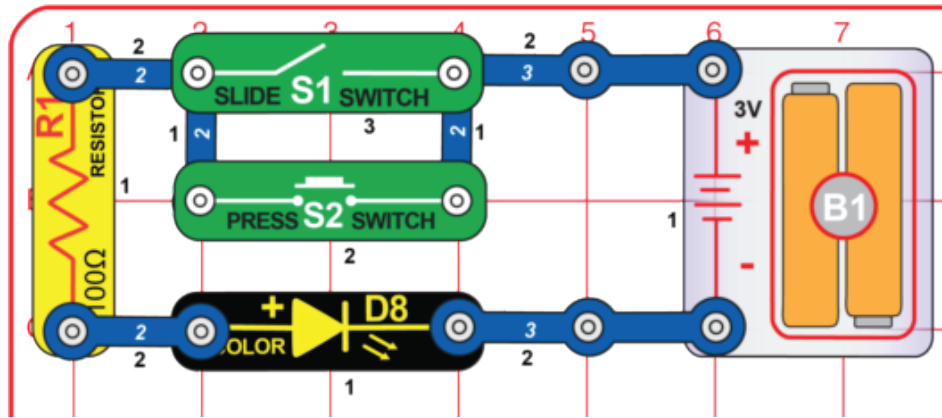
This OR That

Build the circuit shown. Notice that if you turn on the slide switch (S1) <u>OR</u> press the press switch (S2) the color LED (D8) 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 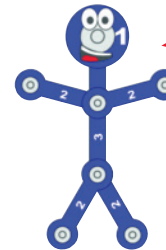used to turn on a light in your house, or they might be two sensors at a railroad crossing used to start the ding-ding sound and lower the gate. You could also have more than two switches and the circuit would function the same way.
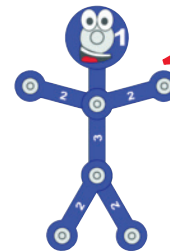
> This circuit is commonly called an OR gate. OR gates are used in digital logic circuits to perform logical additions. When one of the inputs is high (one of the switches is on) the output is high (LED on). The output will only be low (LED off) if both inputs are low (both switches are off).

☐ Project 101
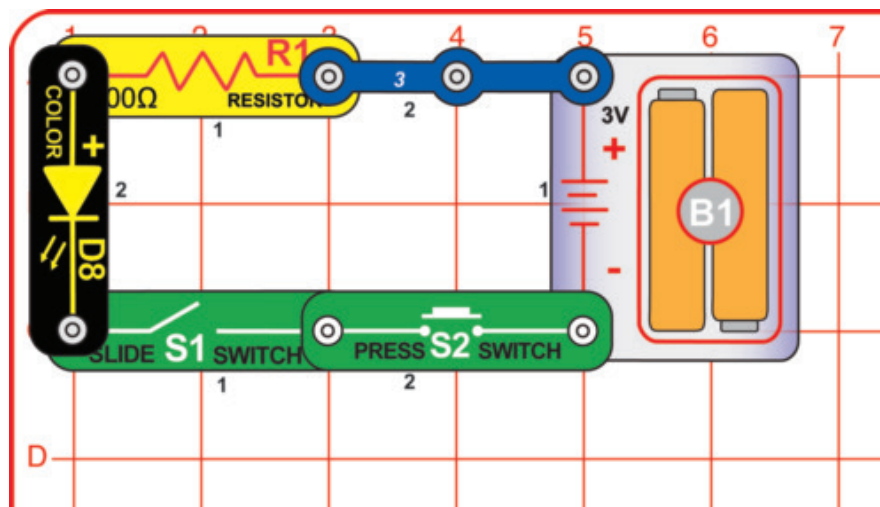
This AND That

Build the circuit shown. Notice that if you turn on the slide switch (S1) <u>AND</u> press the press switch (S2) the color LED (D8) 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.

> 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 (LED off). The output will only be high (LED 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 102

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 100, you can see the color LED (D8) 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.

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).
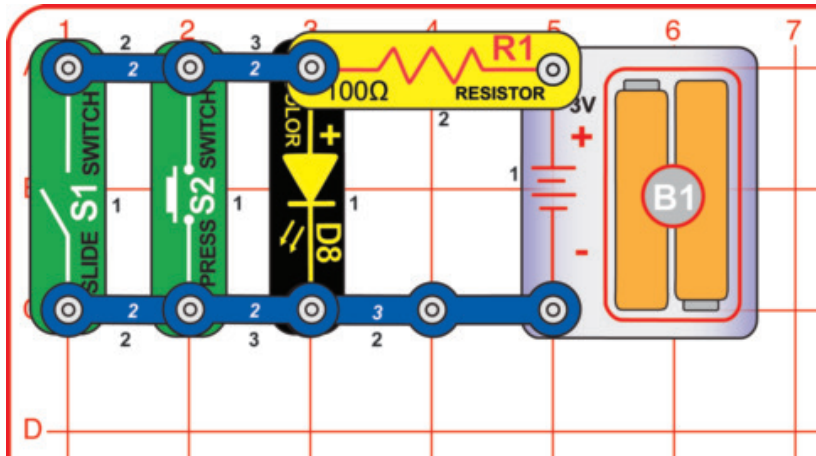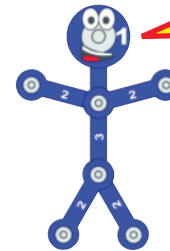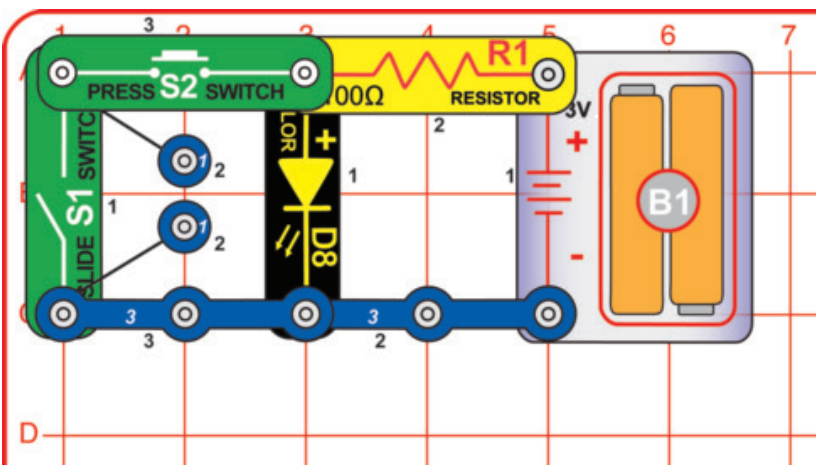
☐ Project 103

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 #101, you can see the color LED (D8) 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.
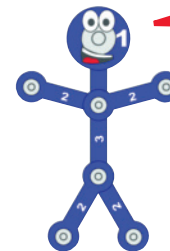
This circuit is commonly called a NAND gate. NAND gates are used in digital logic circuits to perform an inverted logical multiply. When one of the inputs is low (one of the switches is off) the output is high (LED on). The output will only be low (LED off) if both inputs are high (both switches are on).
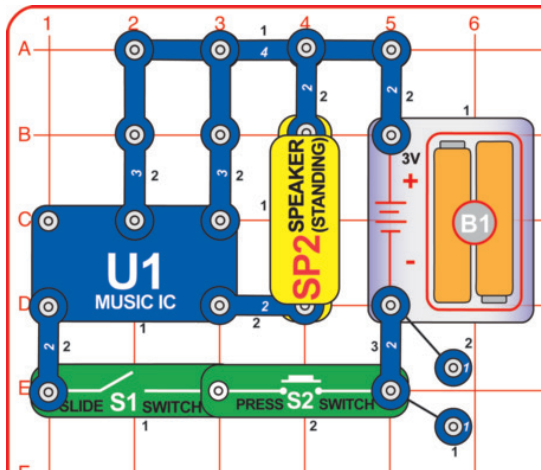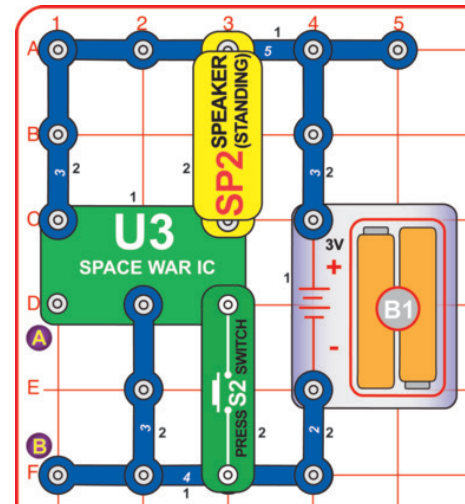
☐ Project 104
Music AND Gate

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 105
Touch & Go

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

This circuit uses your body to conduct electricity, and turn on the circuit. Wetting your fingers improves the connection between the metal and your finger.
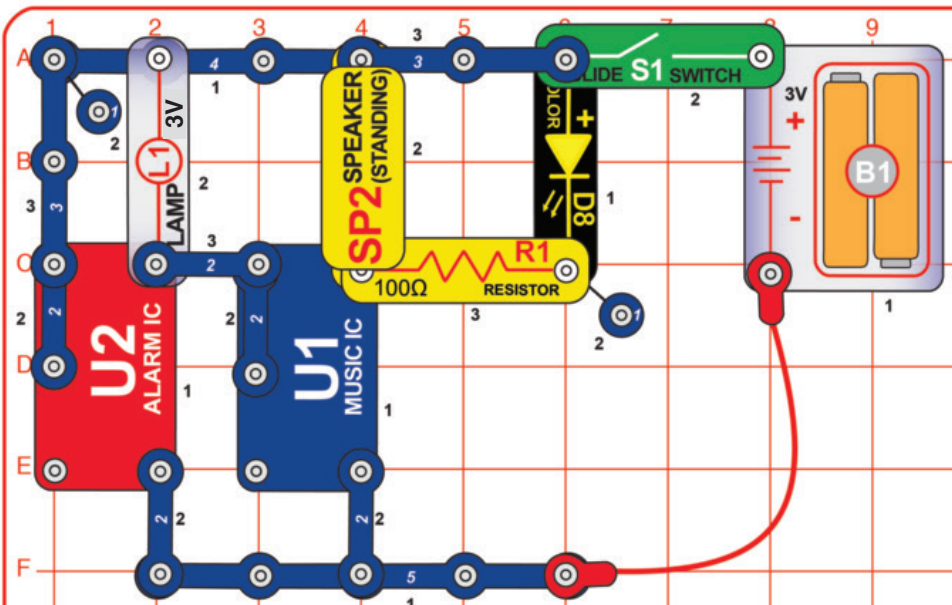
☐ Project 106
Flash & Tone

Turn the switch (S1) on and the lamp (L1) and color LED (D8) start flashing. You hear two different tones driving the LED and lamp. ICs can be connected to control many different devices at the same time.
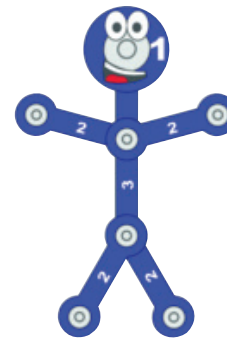
Connecting the output of the Alarm or Music ICs to multiple devices (such as the LED, speaker and lamp) enables these devices operations to be synchronized.

Project 107
Music Alarm Combo
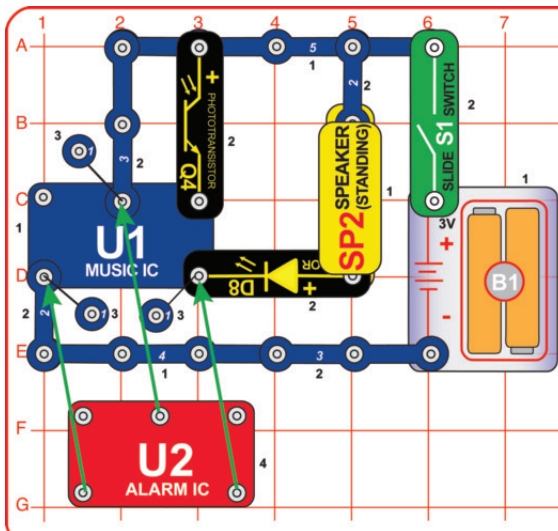
Build the circuit shown and then place the alarm IC (U2) directly over the music IC (U1), resting on the three 1-snaps. Turn on the slide switch (S1) and you will hear a siren and music together. After a few seconds, covering the phototransistor (Q4) will stop the music (but the siren continues).

Project 108
Hit the Target

Turn the slide switch (S1) on and you hear the sound of a bomb dropping and then exploding. The color LED (D8) lights and then flashes as the bomb explodes. This is one sound generated from the space war IC (U3).

Project 109
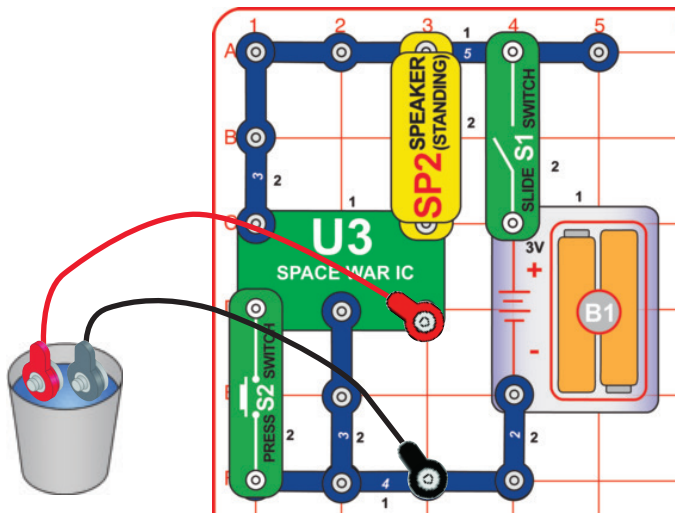
Water Space War

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 w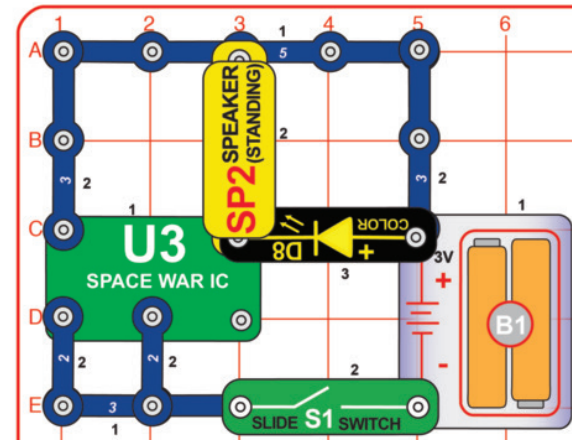ater. Pushing the press switch or placing the jumper wires out and then back in into the water will change the sound played.

Project 110 Light/Water Space War
Use the preceding circuit. Replace the speaker (SP2) with the color LED (D8, "+" to top). Putting the jumper wires in the water OR pressing the press switch (S2) will cause the LED to be bright.

Project 111 OR/AND Space War Light
Use the preceding circuit. Replace the color LED (D8) with the lamp (L1). Putting the jumper wires in the water OR pressing the press switch (S2) will cause the lamp to be dimly lit. Putting the jumper wires in the water AND pressing the press switch at the same time will cause the lamp to be much brighter.

☐ Project 112
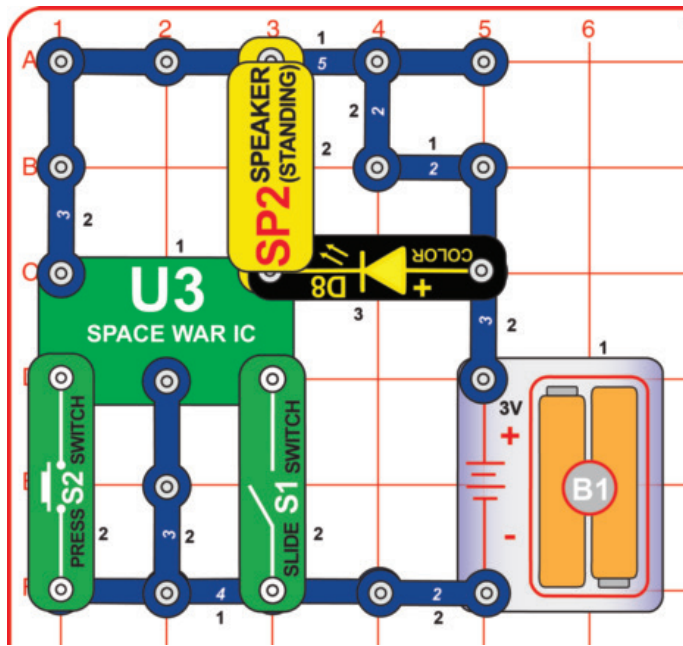
Super Space War

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

☐ Project 113 Super Photo Space War

Use the preceding circuit, but replace the slide switch (S1) with the phototransistor (Q4), with "+" toward U3. The circuit immediately makes noise (unless the room is vary dark), and the color LED (D8) lights. Cover and uncover the phototransistor to change the sound, or push the press switch (S2). Do both several times and in combination.

☐ Project 114
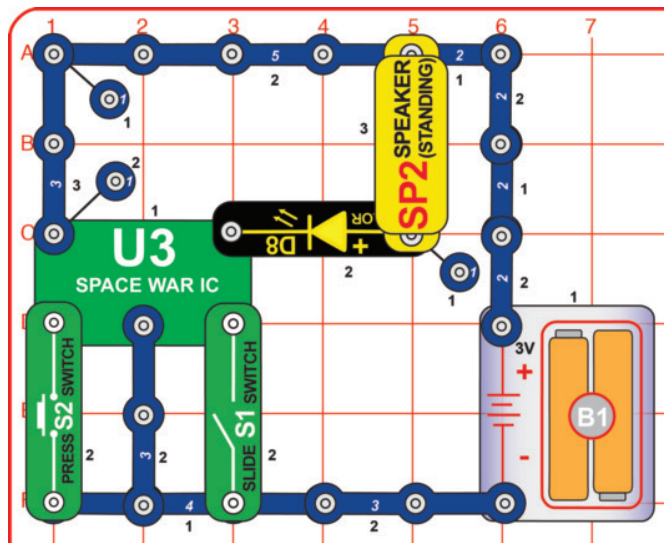
Quieter Super Space War

This circuit is just like project 23, but not as loud. Activate it by flipping the slide switch (S1) or pressing the press switch (S2); do both several times and in combination.

☐ Project 115 Quieter Super Photo Space War

Use the preceding circuit, but replace the slide switch (S1) with the phototransistor (Q4), with "+" toward U3. The circuit immediately makes noise (unless the room is vary dark), and the color LED (D8) lights. Cover and uncover the phototransistor to change the sound, or push the press switch (S2). Do both several times and in combination.

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).
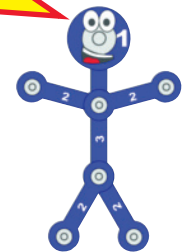
Years ago Indians would send messages to other tribes using smoke signals and a special code.
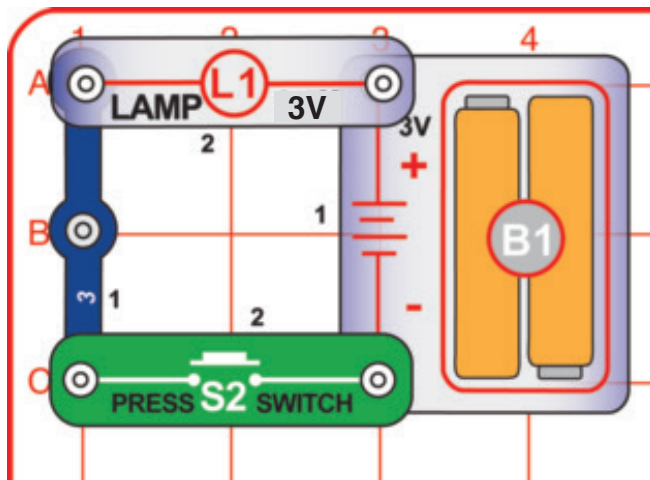
Morse Code: The forerunner of today's telephone system was the telegraph, which was widely used in the latter half of the 19th century. It only had two states - on or off (that is, transmitting or not transmitting), and could not send the range of frequencies contained in human voices or music. A code 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 117
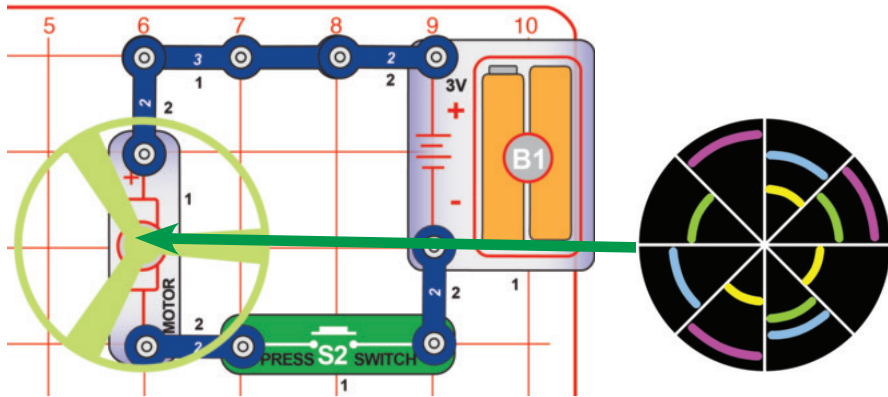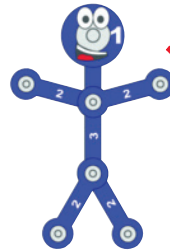
Spinning Rings

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 118 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.

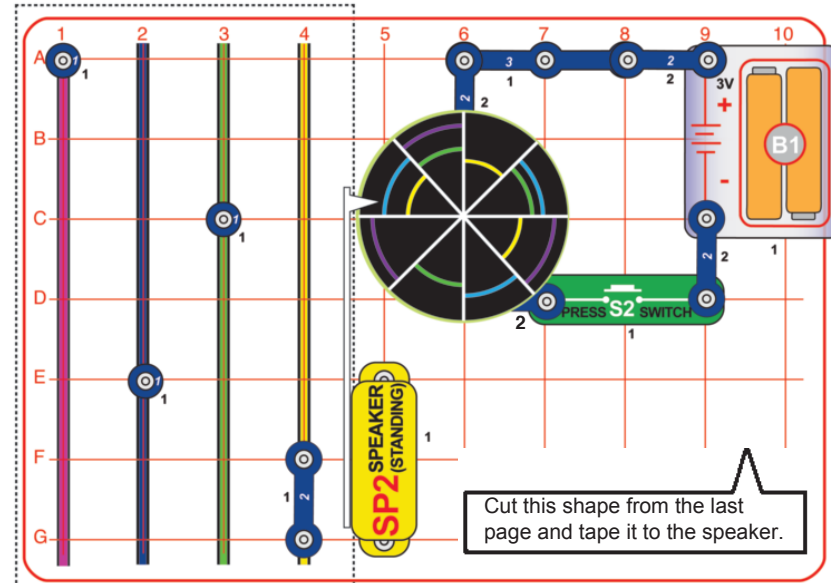This effect is because the lights are blinking 120 times a second and the changing speed of the motor is acting like a strobe light to catch the motion at certain speeds. To prove this, try the same test with a flashlight. The light from a flashlight is constant and if all other lights are out, you will not see the effect that looks like a helicopter blade in a movie. This does not work with newer fluorescent lights, because they use an electronic ballast and produce a constant light.

WARNING: Moving parts. Do not touch the fan or motor during operation. Do not lean over the motor.
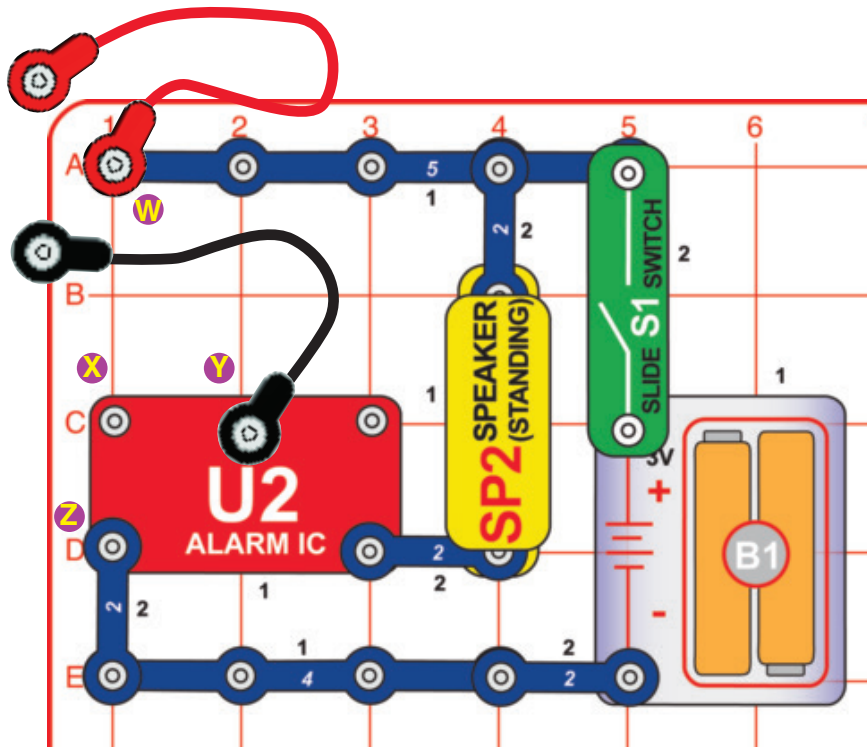
Project 119

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.

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

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 lead 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 121 Pencil Sound**
Remove the jumper connected to point Y (as shown in the drawing) and connect it to point X instead. Touch the loose ends to the pencil drawing again, the sound is different now.

□ **Project 122 Pencil Alarm (II)**
Next connect a 2-snap wire between points X & Y connect the jumper to either point. Touch the loose ends to the pencil drawing again, you hear a different sound.

□ **Project 123 Pencil Alarm (III)**
Now remove the 2-snap wire between X & Y and connect it between X & Z, connect the jumpers to W & Y. Touch the loose ends to the pencil drawing again, you hear yet another sound. Now you can draw your own shapes and see what kinds of sounds you can make.

The black core of pencils is graphite, the same material used in resistors.

Project 124

2-Light Symphony of Sounds

Note that the lamp does not snap on the battery holder (B1), but is secured by the 2-snap wire on level 3. Turn on the slide switch (S1); you hear sounds from the music & alarm ICs (U1 & U2), and the color LED (D8) and lamp light. Push the press switch (S2) several times to add sounds from the space war IC (U3).

Project 125 2-Light Symphony of Sounds (II)
Use the preceding circuit, but add the phototransistor (Q4) across points X & Y using a 1-snap wire; the "+" side of Q4 should be towards U3.

Project 126 2-Light Symphony of Sounds (III)
Use the preceding circuit, but replace the color LED (D8) with the lamp (L1).

Project 127 2-Light Symphony of Sounds (IV)
Use any of the preceding circuits, but remove the 2-snap wire that is on top of U2.
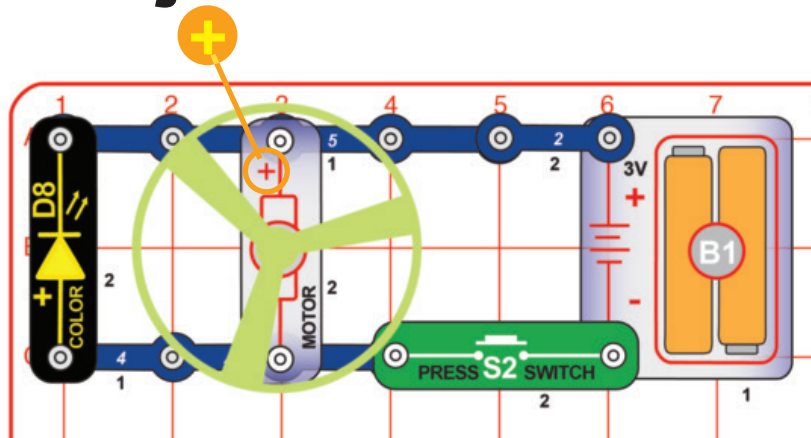
Project 128 2-Light Symphony of Sounds (V)
Use the original circuit or variants A or B, but move the 2-snap wire of top of U2 one space to the right (so it is across points B & C).

Project 129 2-Light Symphony of Sounds (VI)
Use the original circuit or variants A or B, but move the 2-snap wire of top of U2 to be across points A & D.

# Project 130

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 131

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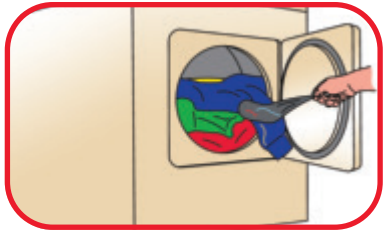
Find some clothes that cling together in the dryer, and try to uncling them.

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.

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.

Snappy says: clothes can cling together because electricity is all around us.

☐ Project 132
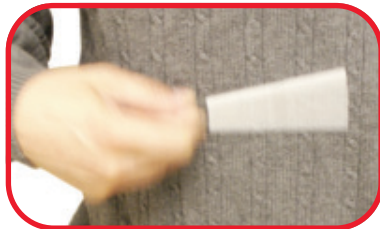
Electricity In Your Hair

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.

Snappy says: 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.
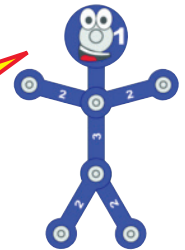
☐ Project 133

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 134

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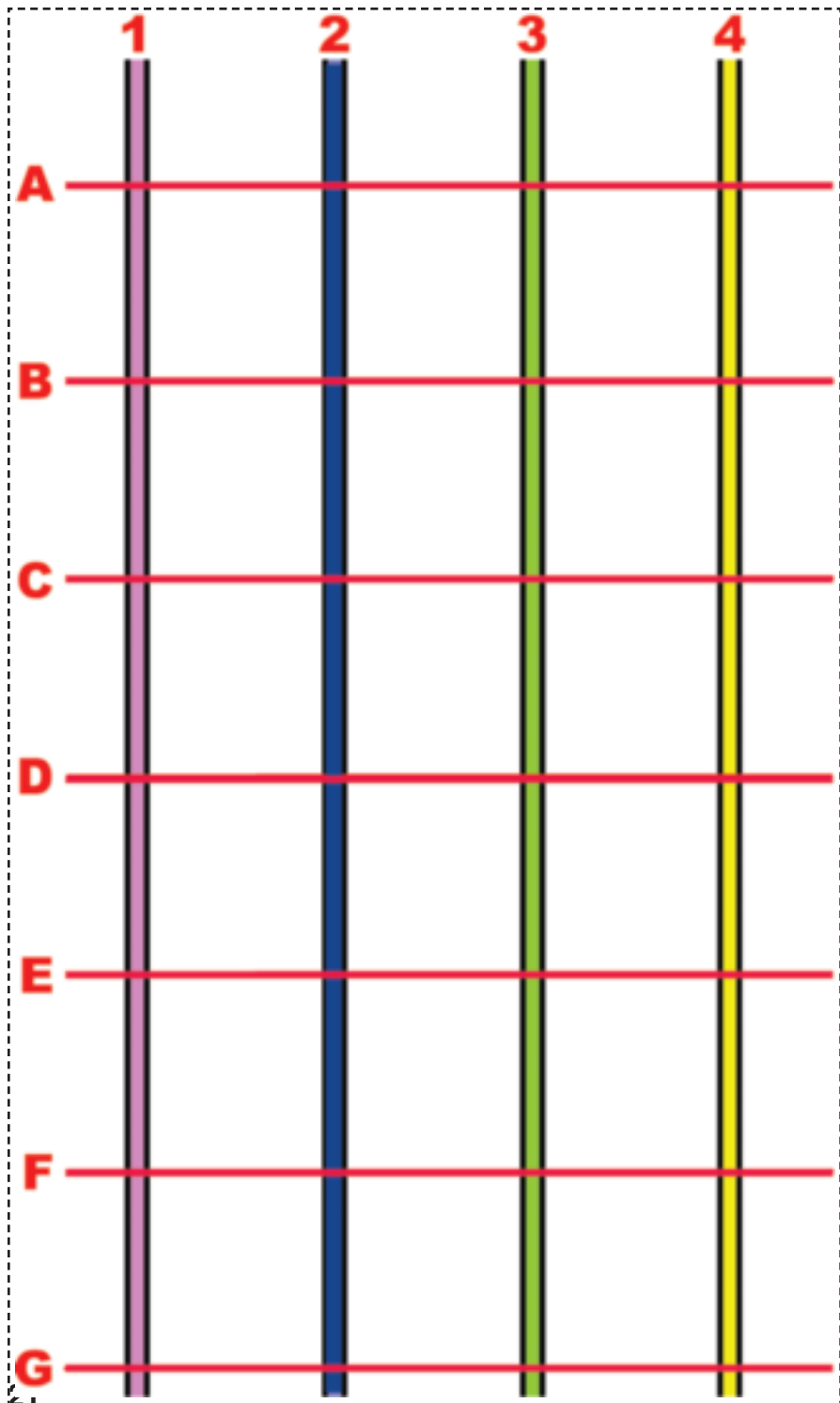
Gravity is actually the attraction between objects due to their weight (or technically, their mass). This effect is extremely small and can be ignored unless one of the objects is as big as a planet (like the earth). Gravity attraction never goes away and is seen every time you drop something. Electrical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

for Project 117

for Project 119