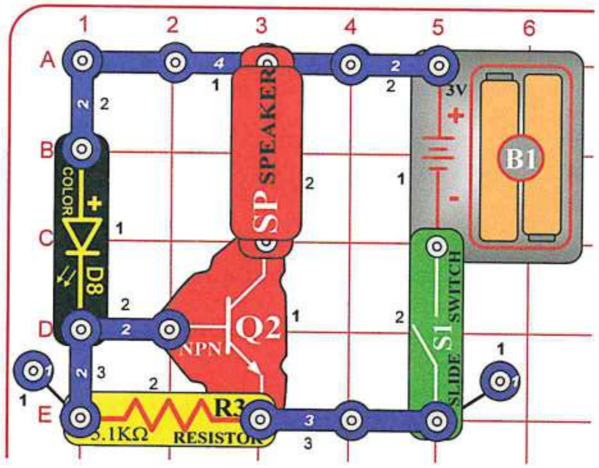
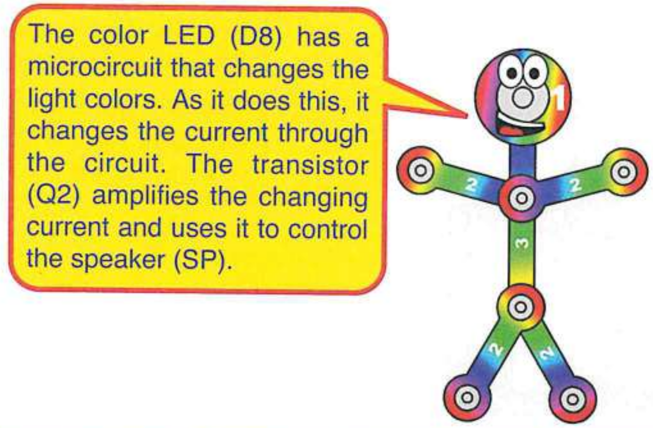
☐ Project 87 Blinking Beeping



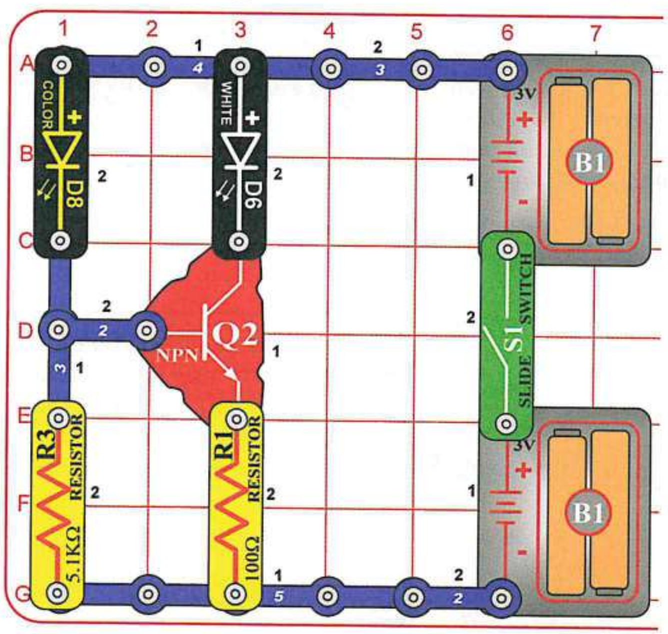
Build the circuit as shown and turn on the switch (S1). The color LED (D8) will be blinking and you hear beeping from the speaker. The sound will not be very loud.



☐ Project 88 Blinking Blinking

Use the preceding circuit, but replace the speaker with the red LED (D1). Now the red LED will also be blinking.

☐ Project 89 Blinking Control



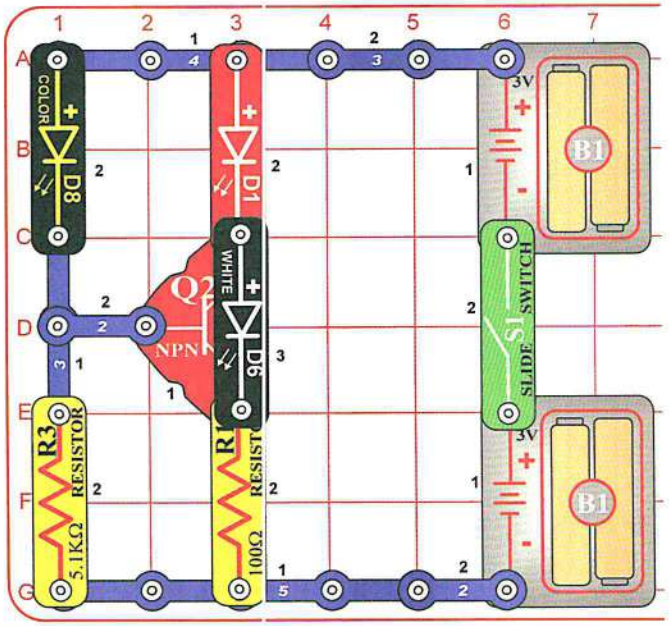
Build the circuit as shown and turn on the switch (S1). The color LED (D8) and white LED (D6) will both be blinking. The color LED will be brighter than in the preceding circuit.

The white LED is controlled by the color LED using the transistor (Q2). If you remove the color LED from the circuit then the white LED will not blink.

☐ Project 90 Blinking Control Beeping

Use the preceding circuit, but replace the white LED (D6) with the speaker (SP). Now the blinking LED controls a beeping sound, but the sound will not be very loud.

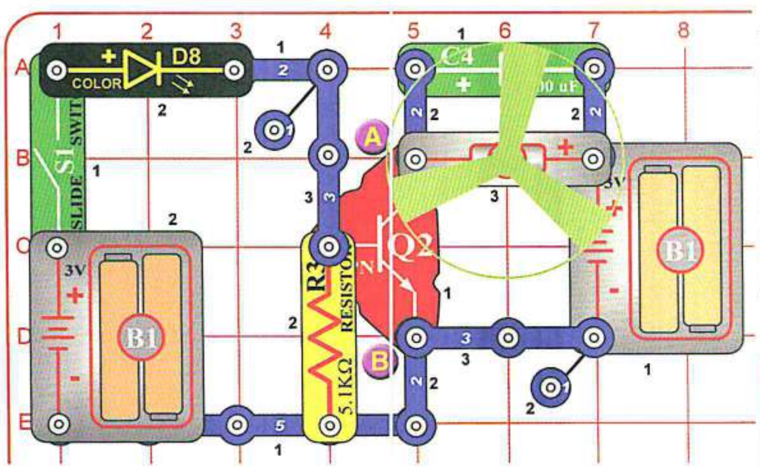
Project 91 Triple Blinker



Build the circuit as shown and turn on the switch (S1). Three LEDs (D1, D6, and D8) will be blinking.

The red and white LEDs are controlled by the color LED using the transistor (Q2). If you remove the color LED from the circuit then the other LEDs will not blink.

Project 92 Funny Speed Motor



Build the circuit as shown and turn on the switch (S1). The color LED (D8) is blinking and the motor (M1) spins at different speeds. Try this circuit with the glow fan on the motor, and without the fan.

The motor is controlled by the color LED using the transistor (Q2). If you remove the color LED from the circuit then the motor will not spin.

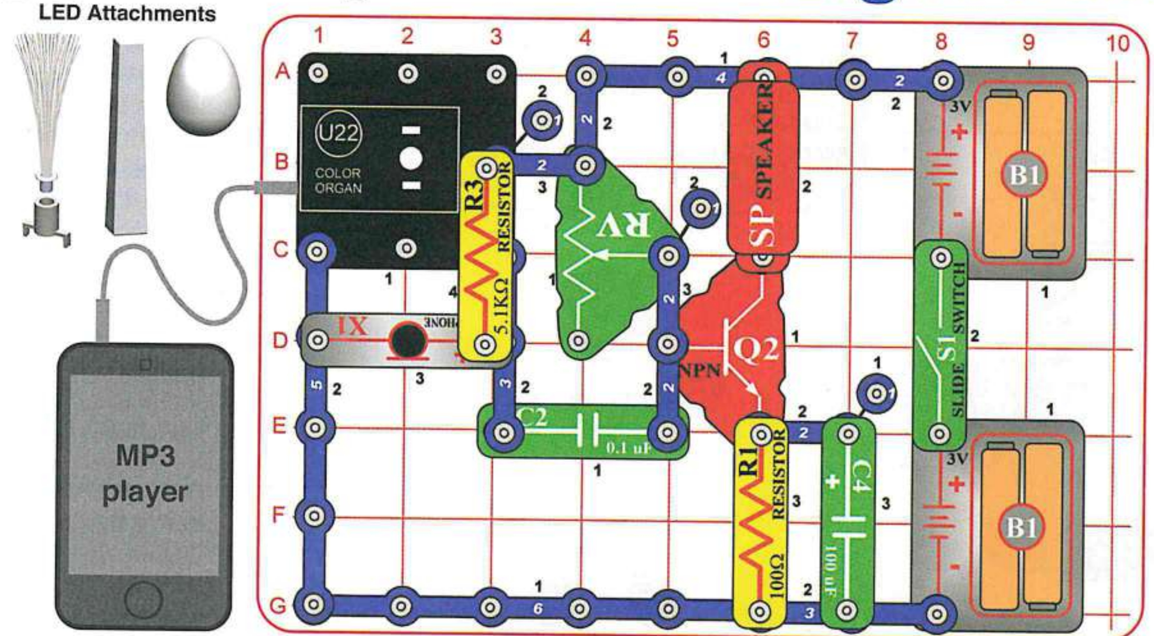
WARNING: Moving parts. Do not touch the fan or motor during operation.

In this circuit the color LED is powered by one set of batteries, and the motor is powered by different set. This was done because the motor produces electrical pulses as it spins, and these pulses can confuse the color LED.

Project 93 Funny Speed Motor with Light

Use the preceding circuit, but add the red LED (D1) across points A & B ("+" to A). This adds another blinking light.

Project 94 — Light Dance Audio Override

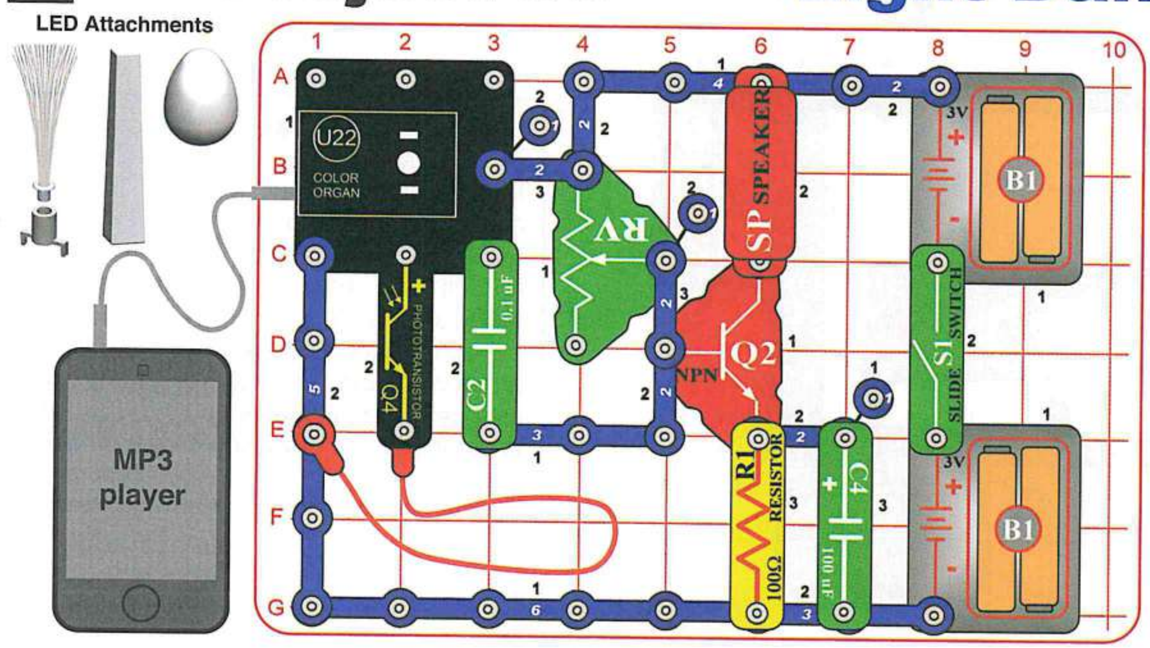


Build the circuit, which is similar to project 34 (Dance to the Music). Connect a music device (not included) to the color organ (U22) as shown, and start music on it. Place one of the LED attachments over the light on the color organ. Set the lever on the adjustable resistor (RV), and the volume control on your music device, for best sound quality and light effects. The color organ light will "dance" in synch with the music.

For the next part, you need the color organ light to be changing slowly. Set your music device to play a song with a slow beat, and set the volume control on it so the sound is not very loud.

Now blow on the microphone (X1) or talk loud directly into it. The dancing light pattern should be interrupted by your blowing/talking. If you don't notice any difference then lower the volume control on your music device. Songs with a slower beat work best for this.

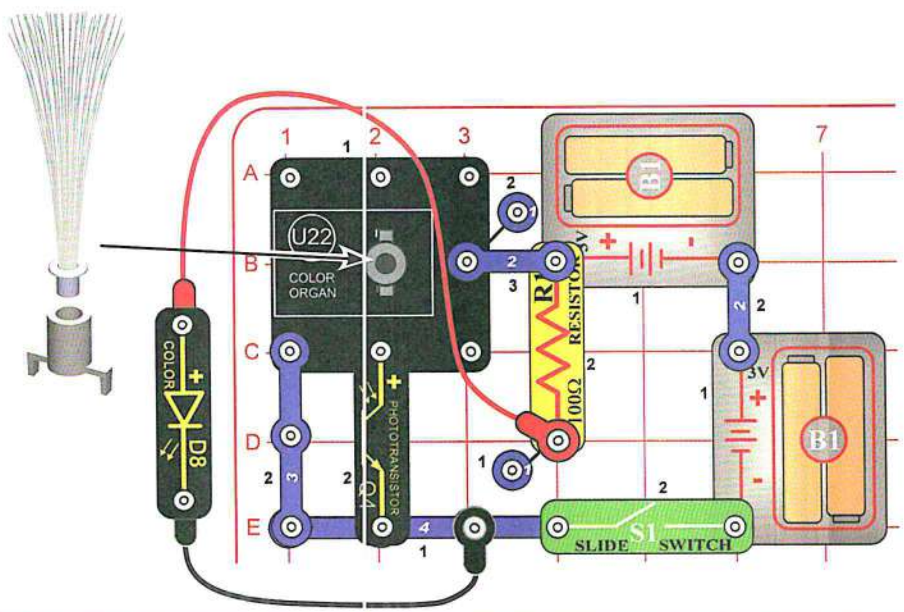
Project 95 — Light Dance Light Override

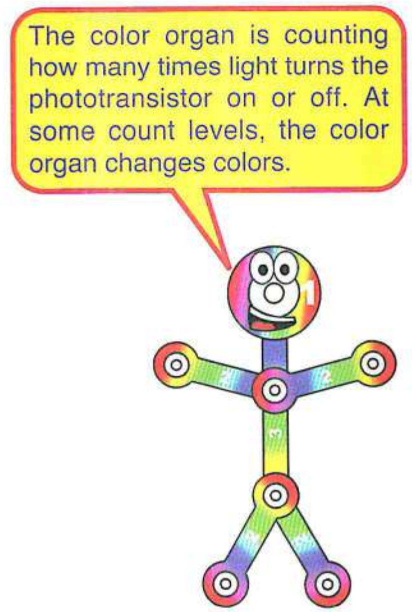


Build the circuit, which is similar to project 34 (Dance to the Music). Connect a music device (not included) to the color organ (U22) as shown, and start music on it. Place one of the LED attachments over the light on the color organ. Cover the phototransistor (Q4) with your hand and set the lever on the adjustable resistor (RV), and the volume control on your music device, for best sound quality and light effects. The color organ light will "dance" in synch with the music.

Uncover the phototransistor and shine a bright light on it. The color organ light will stop changing until you re-cover the phototransistor. The music will not be affected.

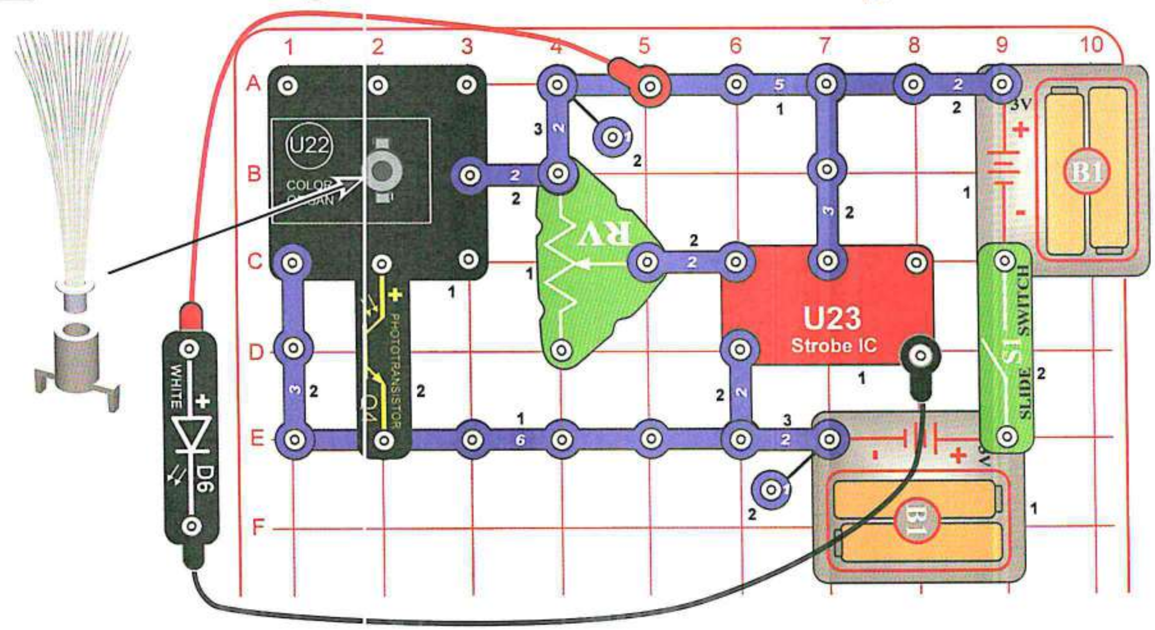
Project 96 — Counting Light





Build the circuit as shown and turn on the switch (S1). Place one of the LED attachments over the LED on the color organ (U22). Connect the color LED (D8) using the red & black jumper wires and hold it just above the phototransistor (Q4), so that it shines directly into the phototransistor. For best effects, do this in a dimly lit room. Every few seconds, the color organ light will change colors.

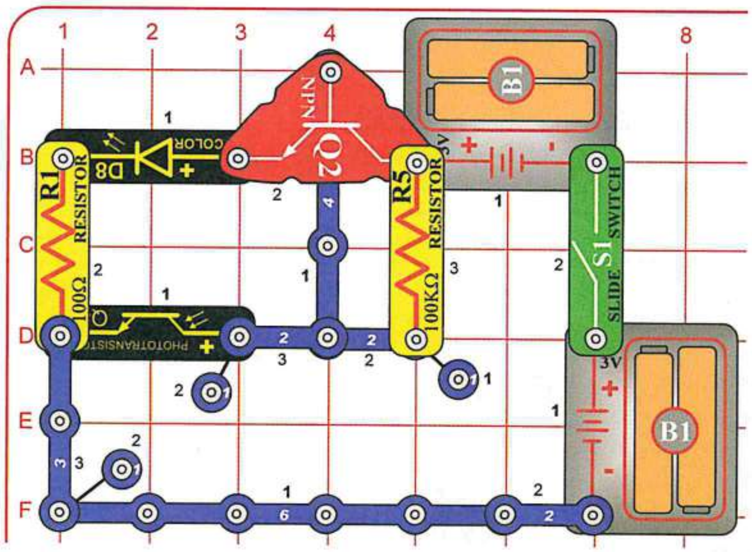
Project 97 — Adjustable Counting Light



Build the circuit as shown and turn on the switch (S1). Place one of the LED attachments over the LED on the color organ (U22). Connect the white LED (D6) using the red & black jumper wires and hold it just above the phototransistor (Q4), so that it shines directly into the phototransistor. For best effects, do this in a dimly lit room. The color organ light will change colors, the lever on the adjustable resistor (RV) controls how fast the colors change.

Project 98

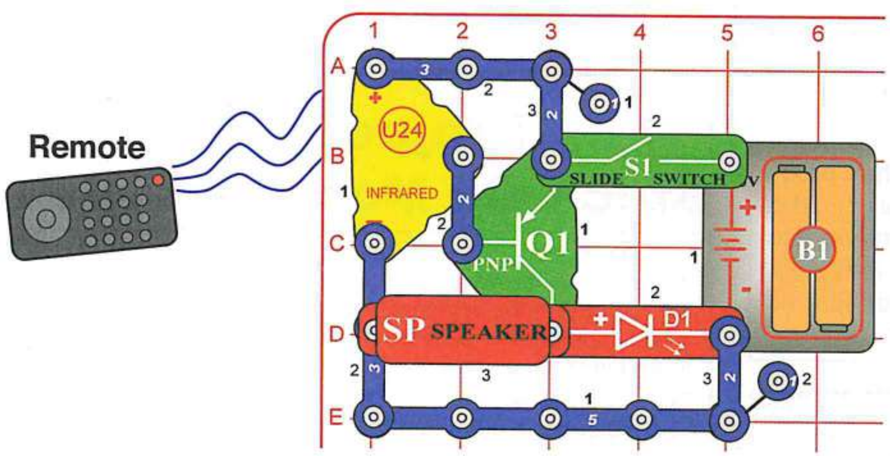
Bright Off Light



Build the circuit as shown and turn on the switch (S1). Place the circuit in a dark room or cover the phototransistor (Q4); the color LED (D8) should be on. Shine light on the phototransistor and the color LED turns off.

Project 99

R/C Blink & Beep

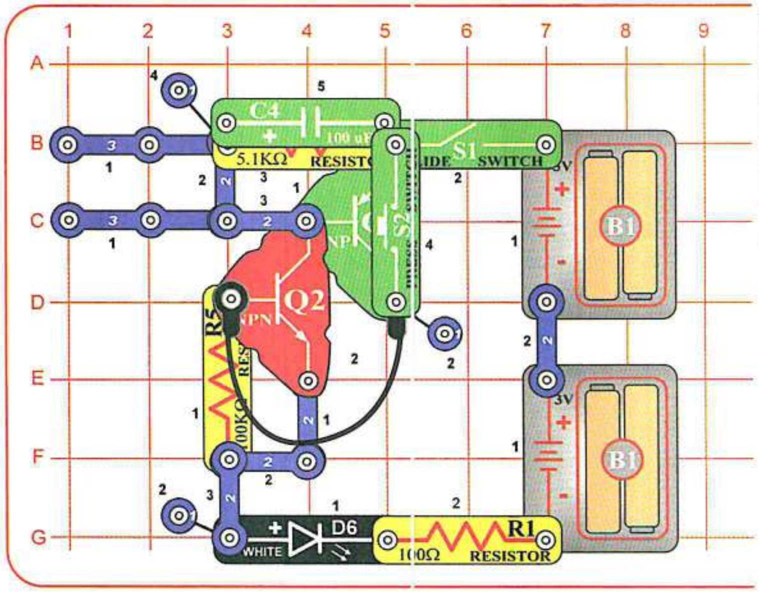


You need an infrared remote control for this project, such as any TV/ stereo/DVD remote control in your home.

Build the circuit and turn on the switch (S1). Point your remote control toward the infrared module (U24) and press any button to activate the red LED (D1) and speaker (SP).

Sometimes this circuit may activate without a remote control, due to infrared in sunlight or some room lights. If this happens, try moving to a dark room.

☐ Project 100 Stuck On Light



Build the circuit as shown, and note that several parts are stacked over others. Turn on the slide switch (S1); nothing happens.

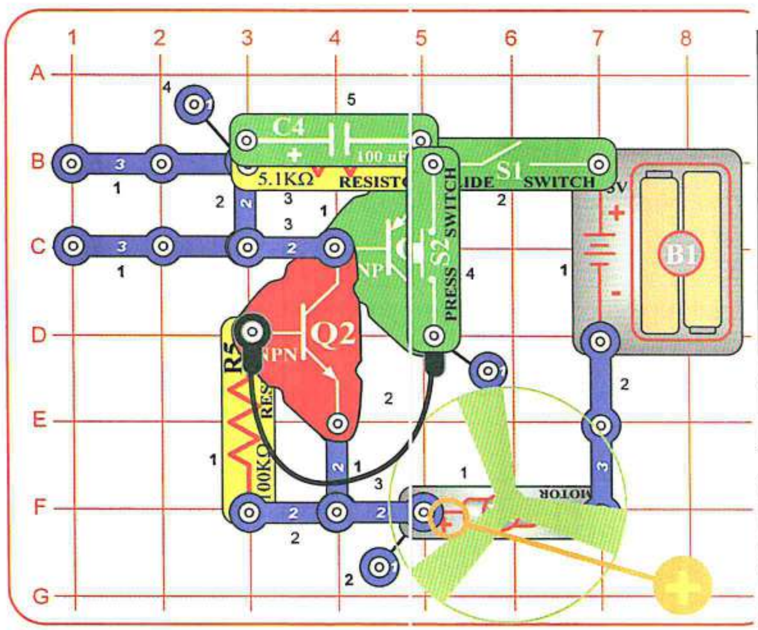
Now push the press switch (S2); the white LED (D6) turns on and stays on. The white LED will stay on until you turn off the slide switch.

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

☐ Project 101 Stuck On Lights

Use the preceding circuit, but replace the 100Ω resistor (R1) with the color LED (D8) or the red LED (D1).

☐ Project 102 Stuck on Motor



Build the circuit as shown, and note that several parts are stacked over others. Turn on the slide switch (S1); nothing happens.

Now push the press switch (S2); the motor (M1) turns on and stays on. The motor will stay on until you turn off the slide switch.

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

☐ Project 103 Low Voltage Stuck On Lights

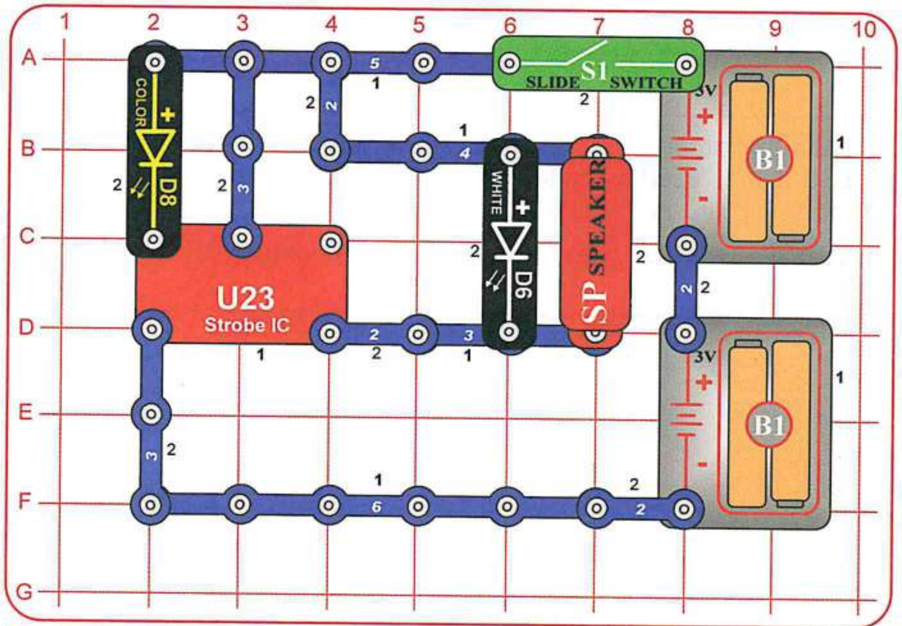
Use the preceding circuit, but replace the motor with the red LED (D1).

☐ Project 104 Stuck On Motor & Lights

Use the project 102 circuit but place the red LED (D1) next to the motor at base grid locations G5-G7 ("+" to G5). Connect the red LED to the adjacent points on the motor using the red & black jumper wires, making sure the jumper wires do not touch the motor or fan.

Turn on the slide switch (S1), then push the press switch (S2). The motor spins and the red LED is dim. Turn off the circuit, remove the fan from the motor, and turn the circuit back on. Now the red LED is bright because it takes less electricity to spin the motor without the fan, leaving more electricity for the red LED.

Project 105 Funky Light & Sound



Build the circuit as shown and turn on the switch (S1). The color LED (D8) is used to control the strobe IC (U23), producing unusual effects.

Project 106 Light & Sound

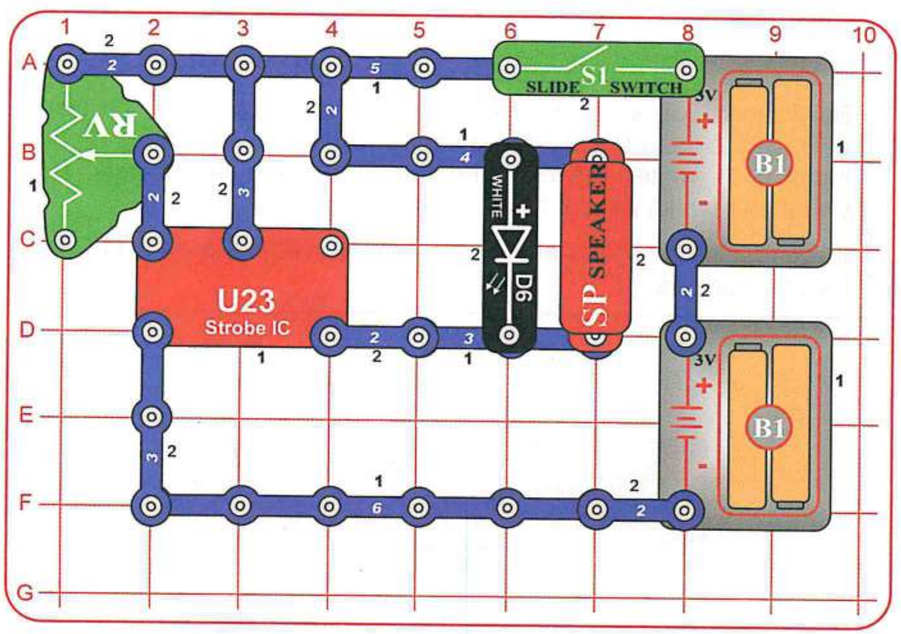
Use the preceding circuit, but replace the color LED (D8) with the 100kΩ resistor (R5) or the 5.1kΩ resistor (R3).

Project 107 Light & Motion

Repeat projects 105 & 106 but replace the speaker with the motor (M1) and glow fan (motor "+" toward S1).

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

Project 108 Adjustable Light & Sound



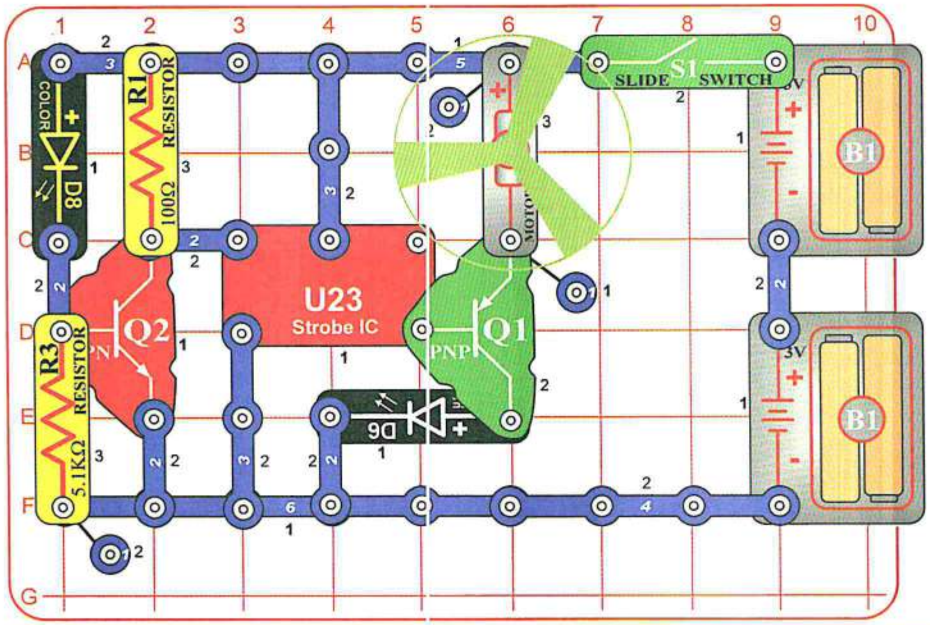
Modify the preceding circuit to match the one shown here. Use the lever on the adjustable resistor (RV) to control the light & sound. At some settings the white LED (D6) will not light, or will appear to be on continuously.

Project 109 Adjustable Light & Motion

Use the preceding circuit, but replace the speaker with the motor (M1) and glow fan (motor "+" toward S1).

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

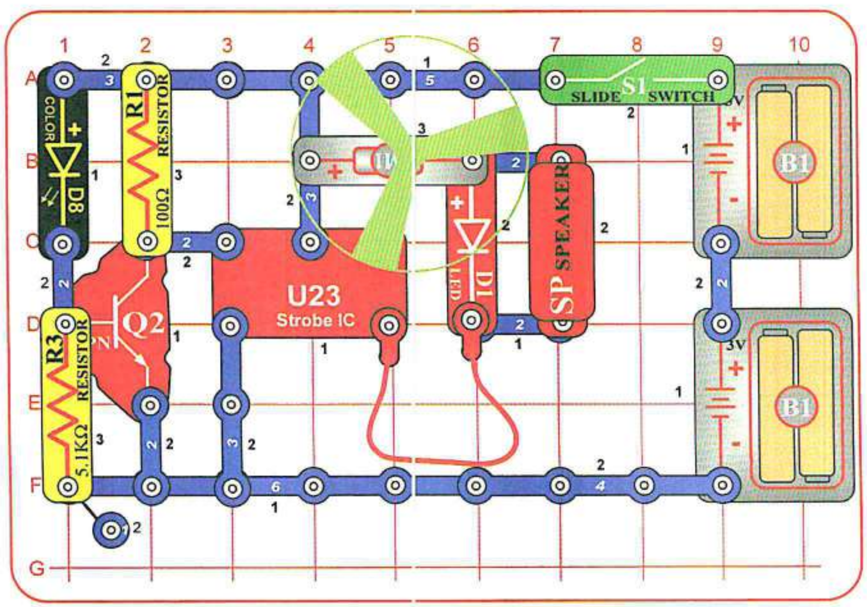
Project 110 — Blinking Step Motor



Build the circuit as shown and turn on the switch (S1). The color LED (D8) is used to control the strobe IC (U23), which turns on the motor (M1) in short bursts.

To have 3 LEDs, place the red LED (D1) directly over the white LED (D6).

Project 111 — Blink Step Beep

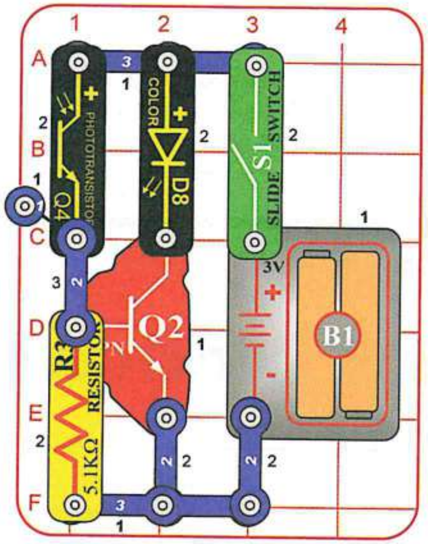


Build the circuit as shown and turn on the switch (S1). The color LED (D8) is used to control the strobe IC (U23), which turns on the motor (M1), white LED (D6), and speaker (SP) in short bursts. The circuit also works without the fan on the motor.

If you replace the motor with the black jumper wire, the white LED will be a little brighter.

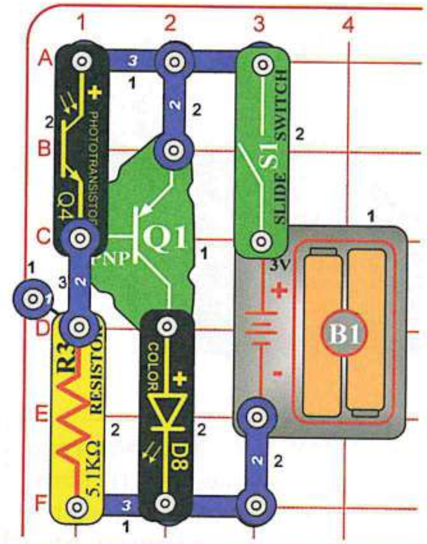
WARNING: Moving parts. Do not touch the fan or motor during operation.

Project 112
Day Blinker



Build the circuit as shown and turn on the switch (S1). The color LED (D8) is on when there is light on the phototransistor (Q4). Shine light on or cover the phototransistor to turn the color LED on or off.

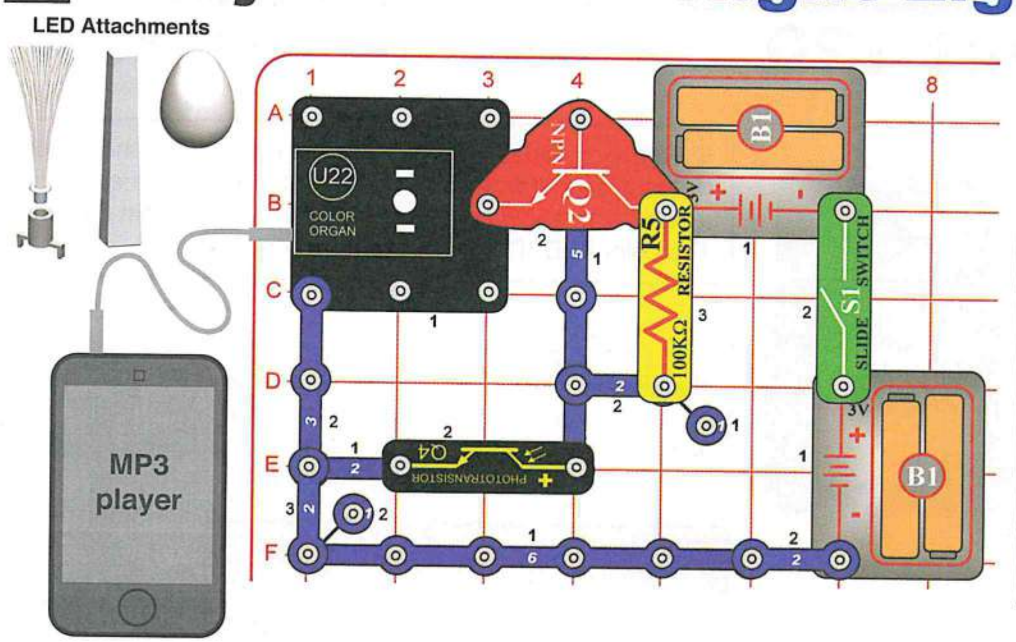
Project 113
Night Blinker



Build the circuit as shown and turn on the switch (S1). The color LED (D8) is off when there is light on the phototransistor (Q4). Cover or shine light on the phototransistor to turn the color LED on or off.

If the color LED comes on too easily, reduce the sensitivity by replacing the 5.1kΩ resistor (R3) with the 100kΩ resistor (R5).

Project 114 Night Light Show



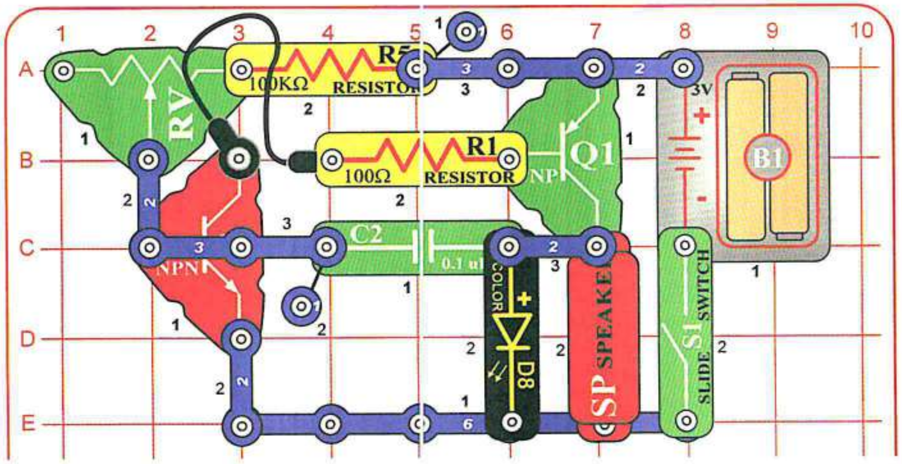
Build the circuit as shown. Connect a music device (not included) to the color organ (U22) as shown, and start music on it. Place one of the LED attachments over the light on the color organ. Turn on the switch (S1), then cover the phototransistor (Q4) to see a light show. Adjust the volume on your music device for best light effects.

Replace the 100kΩ resistor (R5) with the 5.1kΩ resistor (R3) to make the light brighter.

Project 115
Daylight Light Show

Use the preceding circuit, but swap the locations of the phototransistor (Q4) and the 100kΩ resistor (R5), put the "+" side of Q4 towards the NPN transistor (Q2). Now covering the phototransistor turns off the light show.

☐ Project 116 Buzzer



This circuit is an oscillator, which uses feedback to control the pitch of the sound.

Build the circuit as shown and turn on the switch (S1). Move the lever on the adjustable resistor (RV) to vary the pitch of the buzzing sound.

☐ Project 117 Higher Pitch Buzzer

Use the preceding circuit, but place the 5.1kΩ resistor directly over the 100kΩ resistor using a 1-snap. The pitch of the tone is higher now, but the circuit may not make noise on all settings for the adjustable resistor.

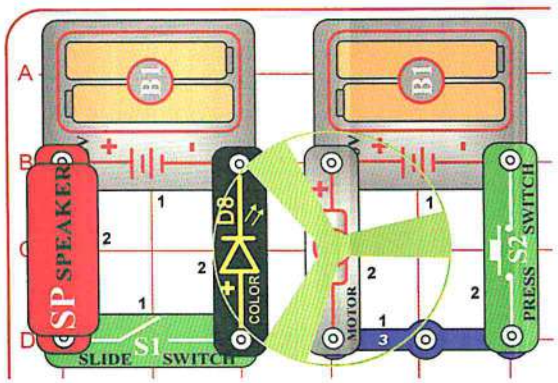
☐ Project 118 Photo Light & Motion

Use the circuits from projects 116-117, but add the phototransistor (Q4) across base grid locations B2-B4 (between RV and R1, "+" on the left), on level 3. Vary the amount of light on the phototransistor to change the sound, while also varying RV.

☐ Project 119 Slow Light & Motion

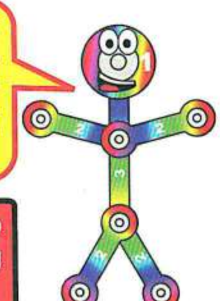
Use the circuits from projects 116-117, but replace the 0.1μF capacitor (C2) with the 100μF capacitor (C4), "+" to the right. Turn the switch on and patiently wait. The speaker will beep and the color LED (D8) will flash every 5-20 seconds, depending on the resistors.

☐ Project 120 Light Up the Fan



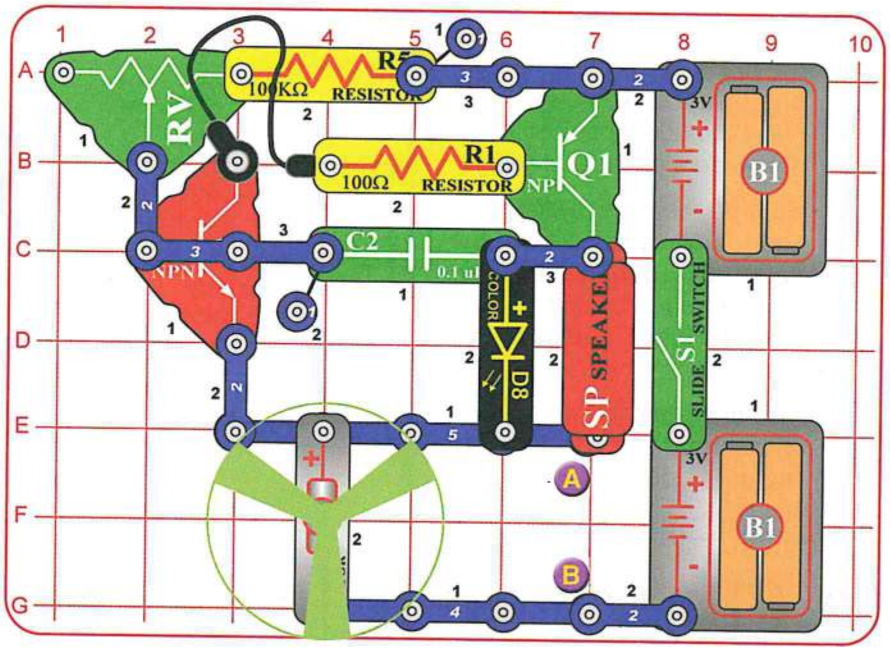
Build the circuit as shown, place the glow fan on the motor (M1), and turn on the slide switch (S1). Place the circuit in a dark room and push the press switch (S2) to spin the fan. The color LED (D8) lights up the spinning fan.

The circuit with the color LED is not electrically connected to the circuit with the motor. This was done because the motor produces electrical pulses as it spins, and these pulses can confuse the color LED.



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

Project 121
High Power Buzzer



Build the circuit as shown and turn on the switch (S1). Move the lever on the adjustable resistor (RV) to vary the pitch of the buzzing sound. The motor (M1) may not spin.

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

Project 122
Buzz Fan

Use the preceding circuit, but place the 5.1kΩ resistor (R3) directly over the 100kΩ resistor (R5) using a 1-snap. The pitch of the tone is higher now, and the fan spins. The circuit may not make noise on all settings for the adjustable resistor. The motor may not spin.

Project 123
Photo Buzzer

Use the circuits from projects 121-122, but add the phototransistor (Q4) across base grid locations B2-B4 (between RV and R1, "+" on the left), on level 3. Shine a bright light on the phototransistor to change the sound, while also moving the lever on RV.

You can also place the phototransistor directly over the 100kΩ resistor, as done for the 5.1kΩ resistor in project 122. For this arrangement, "+" on Q4 should be on the right.

Project 124
Step Beeper

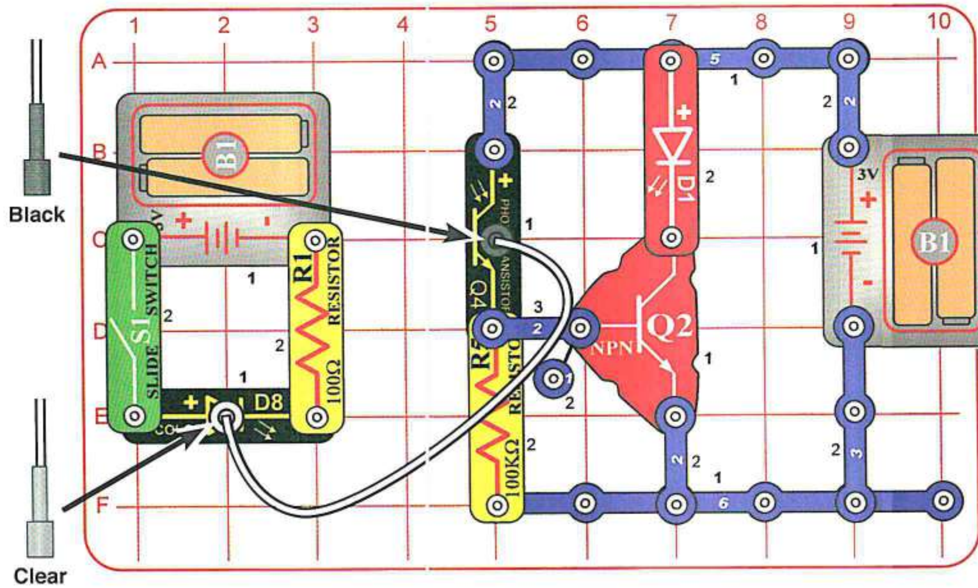
Use the circuits from projects 121-123, but replace the 0.1μF capacitor (C2) with the 100μF capacitor (C4), "+" to the right. The motor will move in small bursts, with long intervals or almost continuously, depending on the resistors and phototransistor.

Next, replace the color LED (D8) with the white LED (D6). See how the circuit works now.

Project 125
Wacky Buzzer

Repeat projects 121-123, but add the 100μF capacitor (C4) across the points marked A & B in the drawing ("+" to A). The motor may not spin but the sound is different. The sound may not be very loud.

Project 126 Fiber Fun



Build the circuit as shown. Place the clear cable holder on the color LED (D8) and the black cable holder on the phototransistor (Q4), then place the fiber optic cable into the holders as far as it will go.

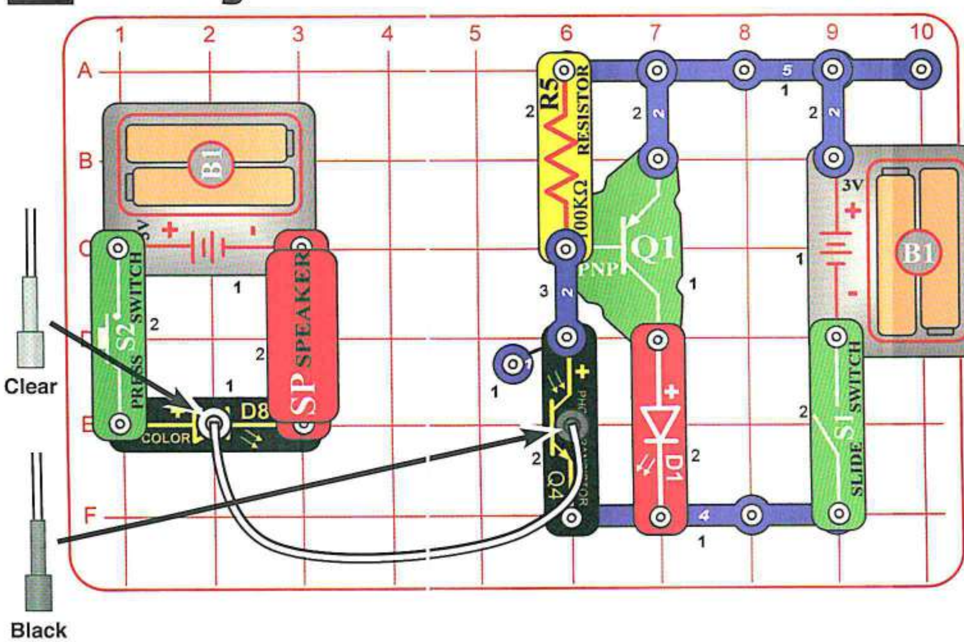
Turn on the slide switch (S1). Light is transmitted from the color LED, through the fiber optic cable, to control the NPN transistor (Q2) and red LED (D1).

You can replace the red LED with the white LED (D6), but the white LED may be dim or not light.

Project 127 Fiber Fun Backwards

Use the preceding circuit but swap the locations of the phototransistor (Q4) and the 100kΩ resistor (R5), keep the "+" side of Q4 in the same direction. Now the red LED will be on whenever the color LED is off.

Project 128 More Fiber Fun



Build the circuit as shown. Place the clear cable holder on the color LED (D8) and the black cable holder on the phototransistor (Q4), then place the fiber optic cable into the holders as far as it will go. For best performance the fiber optic cable should stand straight up in the holders, without bending them.

Turn on the slide switch (S1). Light is transmitted from the color LED, through the fiber optic cable, to control the PNP transistor (Q1) and red LED (D1). The speaker is used to help limit the current through the color LED, and will not make noise.

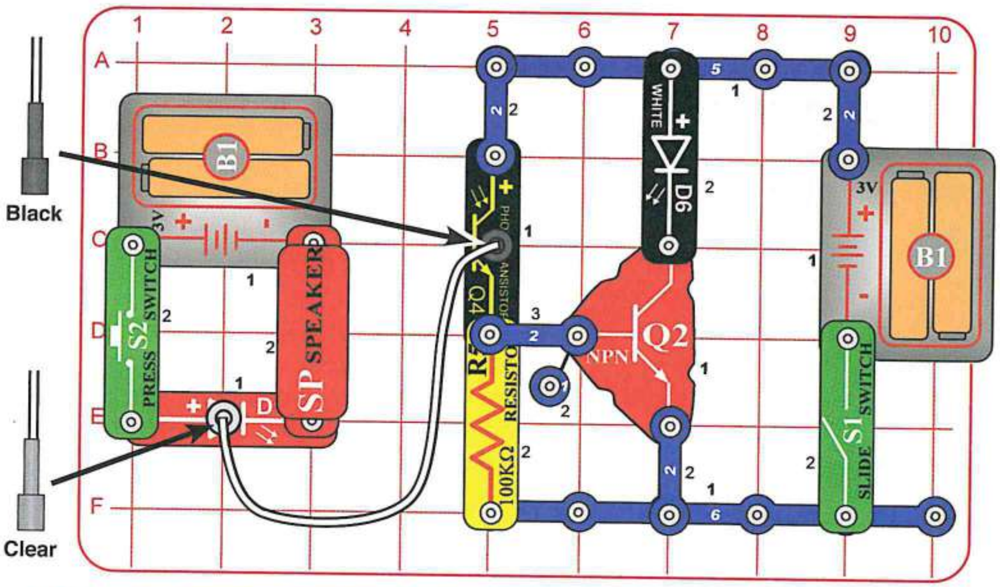
For more fun, swap the locations of the color LED (D8) and red LED (D1). You may also replace either LED with the white LED (D6), but the white LED may be dim or not light.

Project 129 Other Fiber Fun

Use the preceding circuit but swap the locations of the phototransistor (Q4) and the 100kΩ resistor (R5), keep the "+" side of Q4 in the same direction. Now the red LED will be on whenever the color LED is on.

Project 130

Morse Code



Build the circuit as shown. Place the clear cable holder on the red LED (D1) and the black cable holder on the phototransistor (Q4), then place the fiber optic cable into the holders as far as it will go. For best performance the fiber optic cable should stand straight up in the holders, without bending them.Turn on the slide switch (S1), then push the press switch (S2) several times to send secret messages between the circuits using Morse Code. If your fiber optic cable was a lot longer, you could use this circuit to send messages to your friends in different cities. The speaker is used to help limit the current through the red LED, and will not make noise.

If desired, you can swap the locations of the red and white LEDs (D1 & D6).

Note: If the white LED (D6) does not light or is dim, replace it with the color LED (D8). The white LED can be brighter and won't change colors, but requires higher voltage to activate.

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

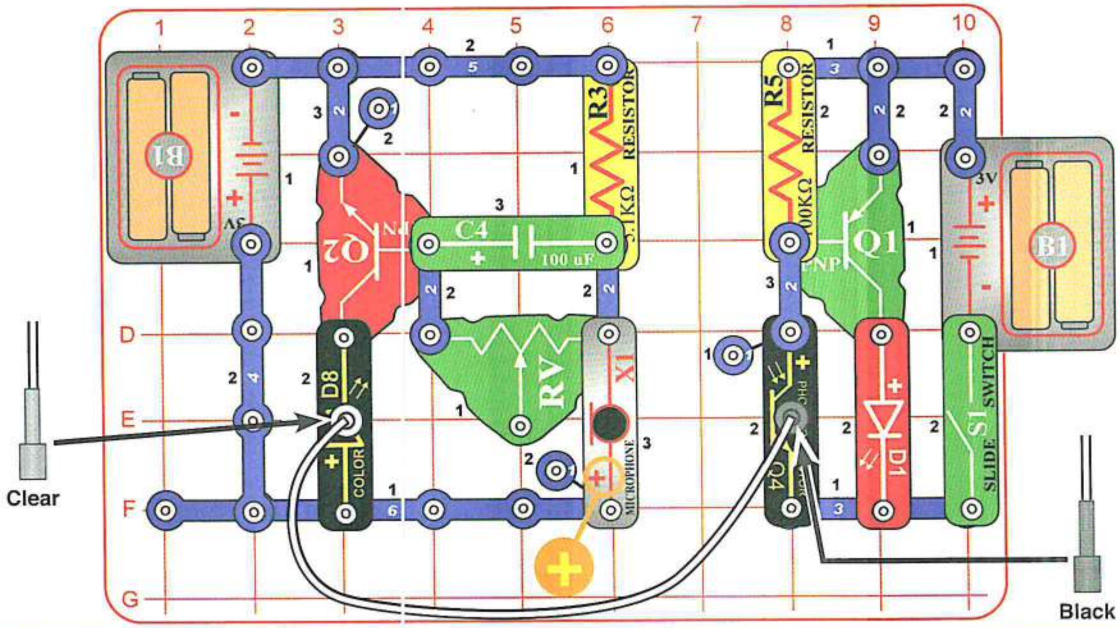
A	.-	N	-.	Period	.-.-.-
B	-...	O	---	Comma	--..--
C	-.-.	P	.--.	Question	..--..
D	-..	Q	--.-	1	.----
E	.	R	.-.	2	..---
F	..-.	S	...	3	...--
G	--.	T	-	4	....-
H	....	U	..-	5	.....
I	..	V	...-	6	-....
J	.---	W	.--	7	--...
K	-.-	X	-..-	8	---..
L	.-..	Y	-.--	9	----.
M	--	Z	--..	0	-----

Project 131

Fiber Shut-Off

Use the preceding circuit but swap the locations of the phototransistor (Q4) and the 100kΩ resistor (R5), keep the "+" side of Q4 in the same direction. Now pushing the press switch will turn off the LED in the right half of the circuit.

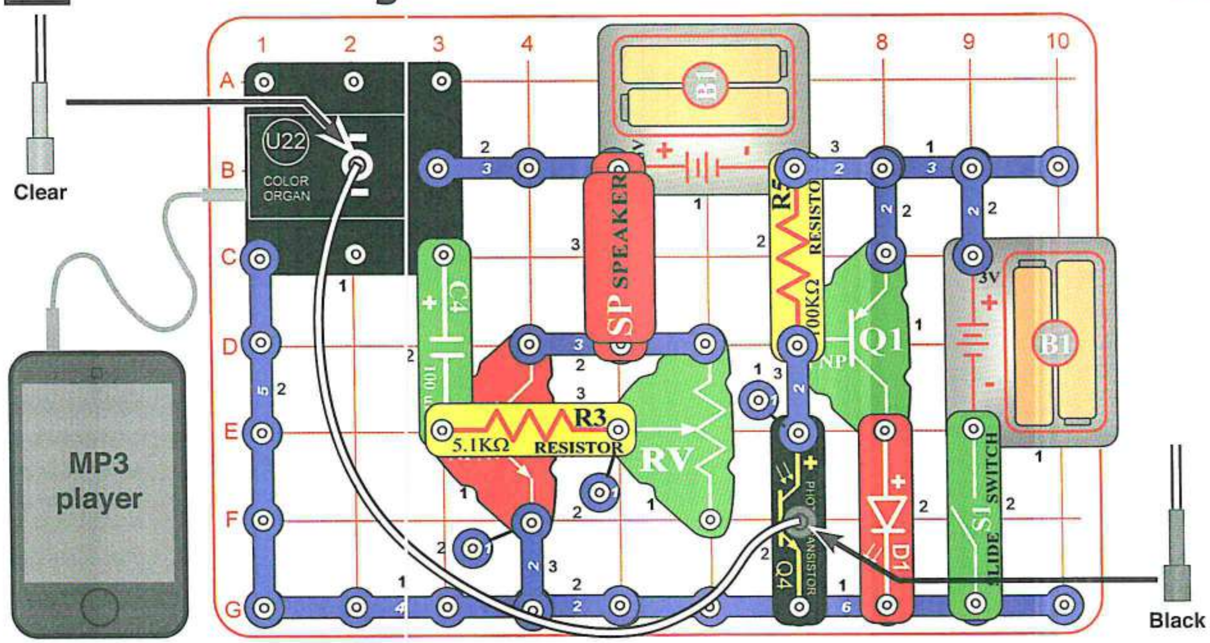
Project 132 — Blow On Fiber



Build the circuit as shown. Place the clear cable holder on the color LED (D8) and the black cable holder on the phototransistor (Q4), then place the fiber optic cable into the holders as far as it will go. For best performance the fiber optic cable should stand straight up in the holders, without bending them.

Turn on the slide switch (S1), and blow on the microphone or talk loudly into it. The signal from the microphone will be sent through the fiber optic cable to the right half of the circuit, to activate the red LED (D1).

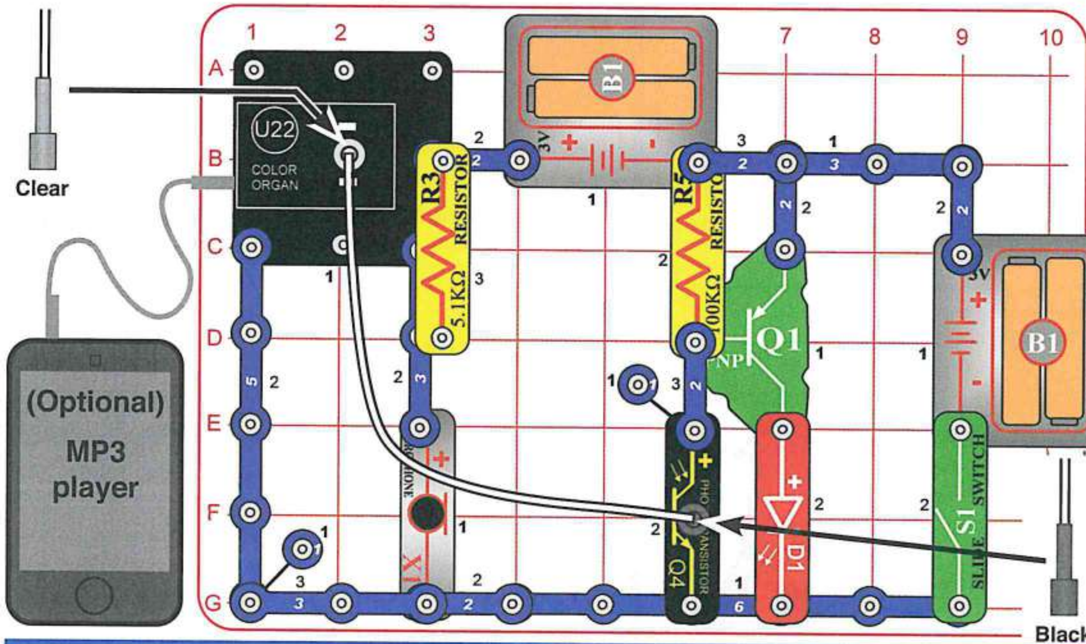
Project 133 — Fiber Music



Build the circuit as shown. Place the clear cable holder on the color organ (U22) and the black cable holder on the phototransistor (Q4), then place the fiber optic cable into the holders as far as it will go. For best performance the fiber optic cable should stand straight up in the holders, without bending them. The clear holder will be a loose fit.

Connect a music device (not included) to the color organ as shown, and start the music on it. The music plays on the speaker (SP) while the LED on the color organ controls the red LED (D1) through the fiber optic cable. Set the volume control on your music device for best light & sound effects.

Project 134 — Fiber Color Organ

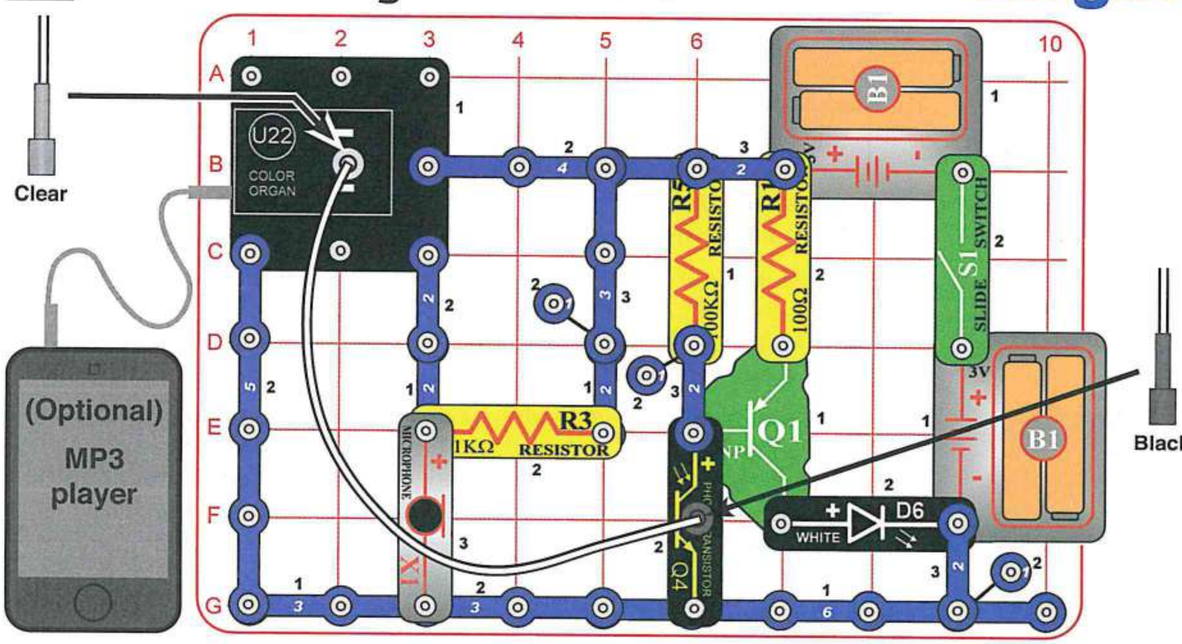


Build the circuit as shown. Place the clear cable holder on the color organ (U22) and the black cable holder on the phototransistor (Q4), then place the fiber optic cable into the holders as far as it will go. For best performance the fiber optic cable should stand straight up in the holders, without bending them.The clear holder will be a loose fit.

Turn on the slide switch (S1), and blow on the microphone or talk loudly into it. The signal from the microphone will change the LED on the color organ, then send the light through the fiber optic cable to the phototransistor, which controls the red LED (D1).

Optional: Connect a music device (not included) to the color organ as shown, and start the music on it. The music device will control the red LED. Set the volume control on your music device for best light effects. If you replace the red LED with the speaker (SP), then you get sound effects (beeping, not music).

Project 135 — Bright Fiber Color Organ

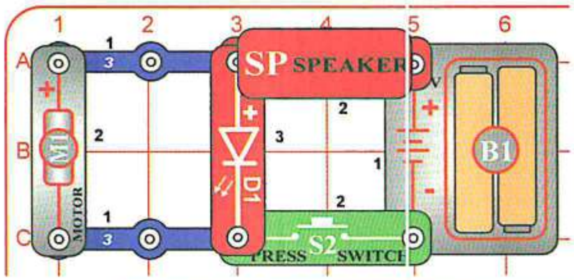


Build the circuit as shown. Place the clear cable holder on the color organ (U22) and the black cable holder on the phototransistor (Q4), then place the fiber optic cable into the holders as far as it will go. For best performance the fiber optic cable should stand straight up in the holders, without bending them. The clear holder will be a loose fit.

Turn on the slide switch (S1), and blow on the microphone or talk loudly into it. The signal from the microphone will change the LED on the color organ, then send the light through the fiber optic cable to the phototransistor, which controls the white LED (D6).

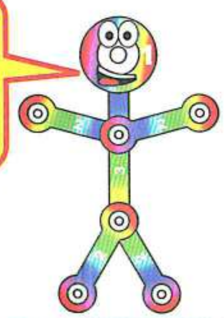
Optional: Connect a music device (not included) to the color organ as shown, and start the music on it. The music device will control the white LED. Set the volume control on your music device for best light effects.

☐ Project 136 Motor Power



Build the circuit as shown, push the press switch (S2), and look at the brightness of the red LED (D1). 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 red 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.

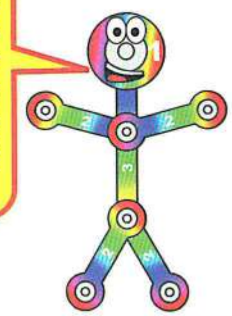


WARNING: Moving parts. Do not touch the fan or motor during operation.

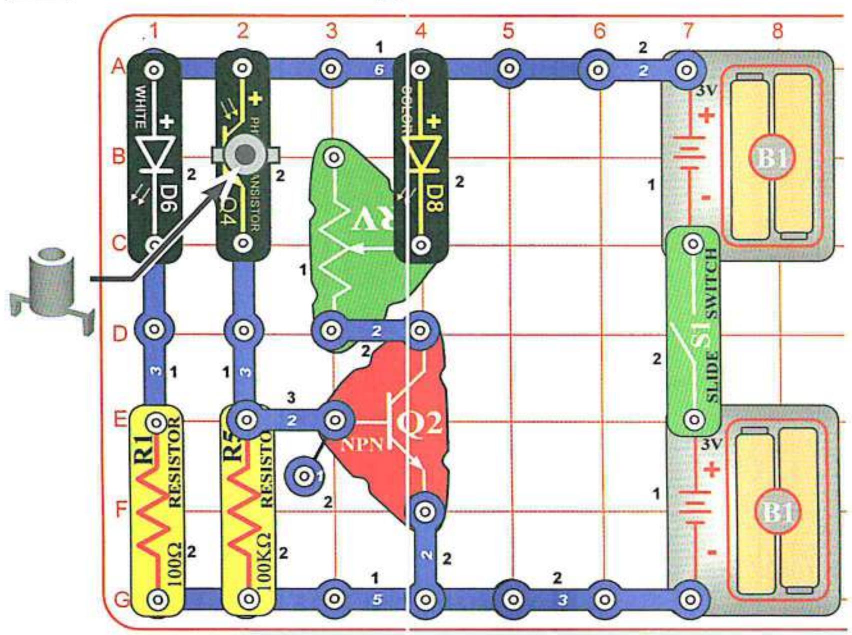
☐ Project 137 More Motor Power

Use the preceding circuit but replace the red LED (D1) with the color LED (D8) or the white LED (D6), see how they compare to the red LED.

The color and white LEDs need more electricity to light than the red LED. The motor "noise" that you hear on the speaker can also confuse the color LED and disrupt its color pattern.



☐ Project 138 Reflection Detector



Build the circuit as shown and turn on the switch (S1). Place the mounting base over the phototransistor (Q4). Set the lever on the adjustable resistor (RV) all the way toward the NPN transistor (Q2). Move the circuit into a dimly lit room, so that the color LED (D8) is off.

Place a mirror directly over the white LED (D6) and photo-transistor (Q4), or hold it facing a wall mirror. When enough light from the white LED reaches the phototransistor, the color LED will turn on, indicating that a reflection has been detected.

The mounting base is used to block direct light from the white LED to the phototransistor, and to shield the phototransistor from room light. If your room is very dark, you may get better results by placing the mounting base over the white LED instead of the phototransistor.

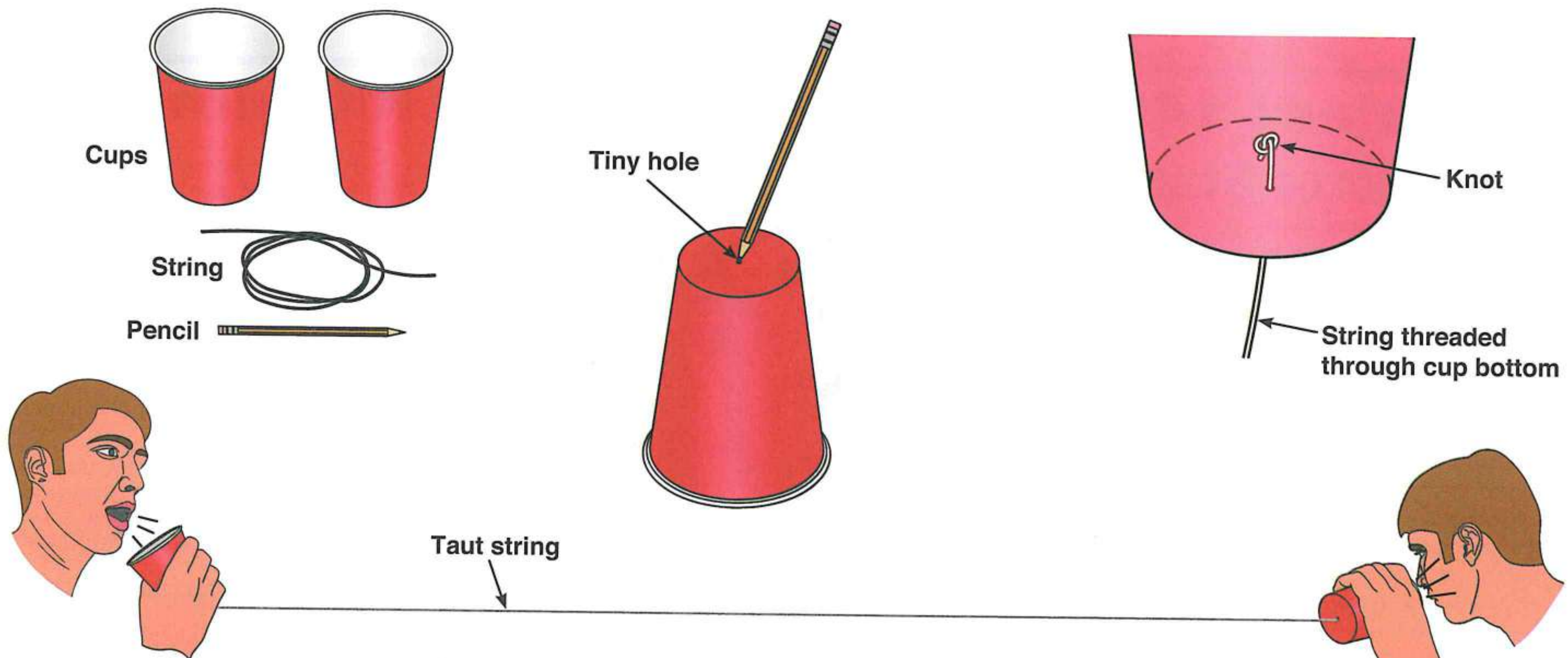
☐ Project 139 Cup & String Communication

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.

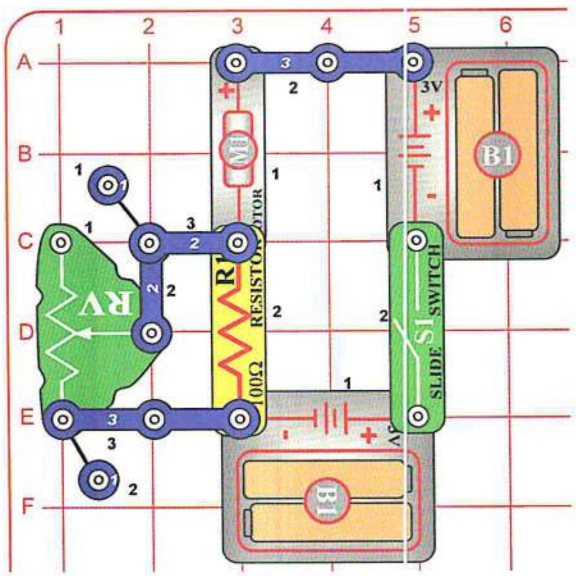
Take the cups and punch a tiny hole in the center of the bottom of each with a sharp pencil (or something similar). Take a piece of string (use between 25 and 100 feet) and thread each end through each hole. Either knot or tape the string so it cannot go back through the hole when the string is stretched. 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.

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.



Project 140 Slow Motor Speed Control



The motor needs a lot of electricity to start spinning, but needs less the faster it is spinning. The resistors (R1 & RV) are limiting how much electricity flows, so the motor can barely spin.

Build the circuit as shown; do not place the fan on the motor. Set the lever on the adjustable resistor (RV) toward the 3-snap. Turn on the switch (S1) to start the motor (M1). If the motor does not spin, then give it a push to get it started. Use the lever on the adjustable resistor to control the motor speed. If the motor does not spin even after giving it a push then replace your batteries.

Turn off the switch and turn the motor shaft counter-clockwise with your fingers. Now turn the switch on try turning the motor counterclockwise; now it is harder because the circuit is trying to turn the motor clockwise at the same time.

Project 141

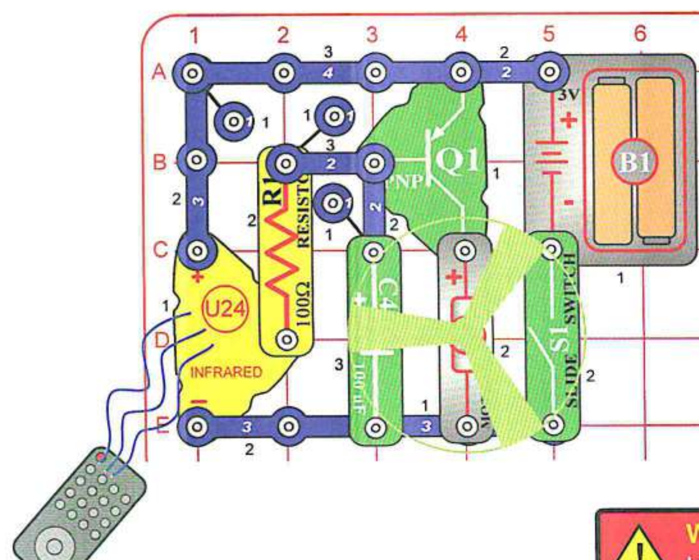
Slow Motor Start Aid

Use the preceding circuit but add the 100μF capacitor (C4) directly over the 100Ω resistor (R1), "+" side towards the motor. The circuit works the same, but starts more easily.

If you have a larger 470μF capacitor (C5), which is included with some other Snap Circuits® sets, then you can use it in place of the 100μF capacitor. It will make the motor start even more easily.

The capacitor allows a short surge of electricity to flow through it until it charges up. This short surge bypasses the higher resistance of the resistors, and helps the motor get going.

Project 142 R/C Motor



Remote

You need an infrared remote control for this project, such as any TV/stereo/DVD remote control in your home.

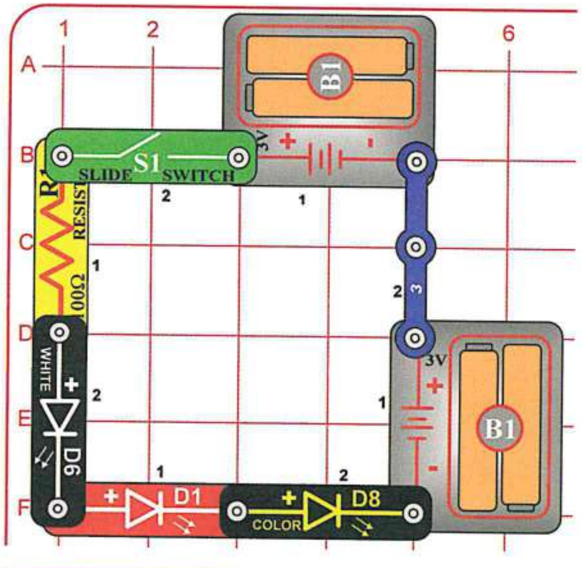
Build the circuit and turn on the switch (S1). Point your remote control toward the infrared module (U24) and press any button to spin the motor (M1).

Next, remove the 100μF capacitor (C4). The circuit woks the same, except now the motor moves in small steps.

Sometimes this circuit may activate without a remote control, due to infrared in sunlight or some room lights. If this happens, try moving to a darker room.

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

Project 143 — Series Lights



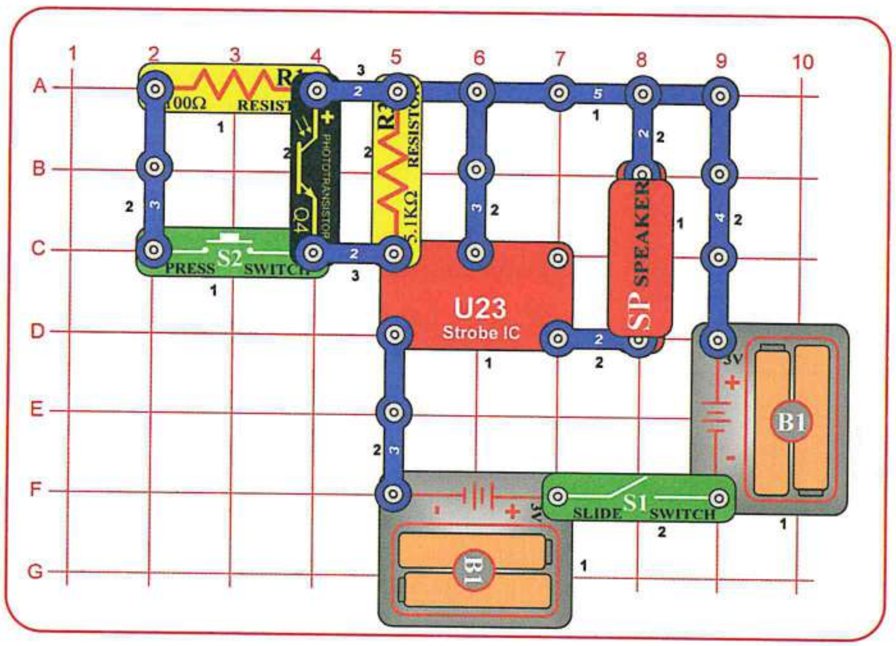
This circuit has all the parts connected in a series. Swapping the locations of any parts in the circuit (without changing the direction of their "+" side) will not change how the circuit works. Try it.

The LEDs are dim because the batteries need to overcome the activation voltage level for every LED in the series before any can light. That doesn't leave much voltage to overcome the resistance in the circuit. If you replace one of the LEDs with a 3-snap, the others will be much brighter. Try it.

Build the circuit and turn on the switch (S1). Place the circuit in a dimly lit room. Some of the LEDs (D1, D6, & D8) will be blinking, but none will be very bright. If nothing lights then replace your batteries.

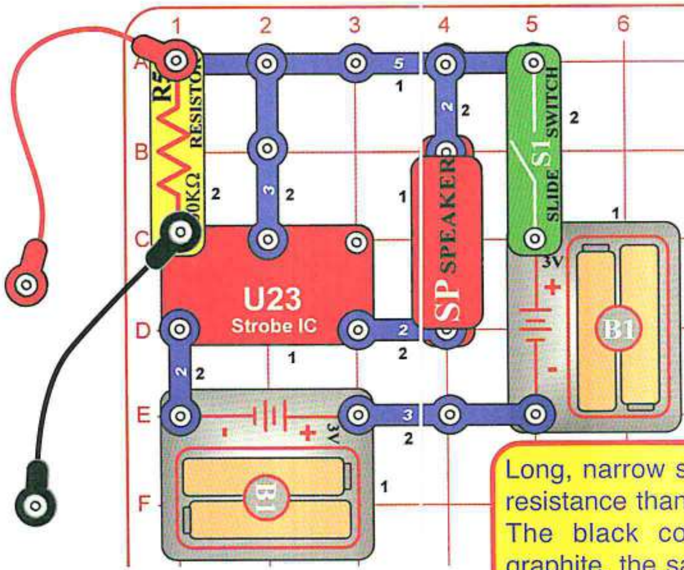
The LEDs are blinking because a color-changing circuit in the color LED is turning that LED on and off, which also affects the other LEDs.

Project 144 — Wacky Sound Control



Build the circuit and turn on the slide switch (S1). Vary the amount of light on the phototransistor (Q4) and push the press switch (S2) to change the sound.

Project 145 Musical Shapes



Build the circuit and turn on the switch (S1). Make your parts using either the water puddles method (A), the drawn parts method (B), or the pencil parts method (C). Touch the metal in the jumper wires to your parts and listen to the sound.

Long, narrow shapes have more resistance than short, wide ones. The black core of pencils is graphite, the same material used in resistors.

Method A (easy): Spread some water on the table into puddles of different shapes, perhaps like the ones shown here. Touch the jumper wires to points at the ends of the puddles.

Method B (challenging): Use a SHARP pencil (No. 2 lead is best) and draw shapes, such as the ones here. Draw them on a hard, flat surface. Press hard and fill in several times until you have a thick, even layer of pencil lead. Touch the jumper wires to points at the ends of the drawings. You may get better electrical contact if you wet the metal with a few drops of water. Wash your hands when finished.

Method C (adult supervision and permission required): Use some double-sided pencils if available, or VERY CAREFULLY break a pencil in half. Touch the jumper wires to the black core of the pencil at both ends.

Project 146 Human & Liquid Sounds

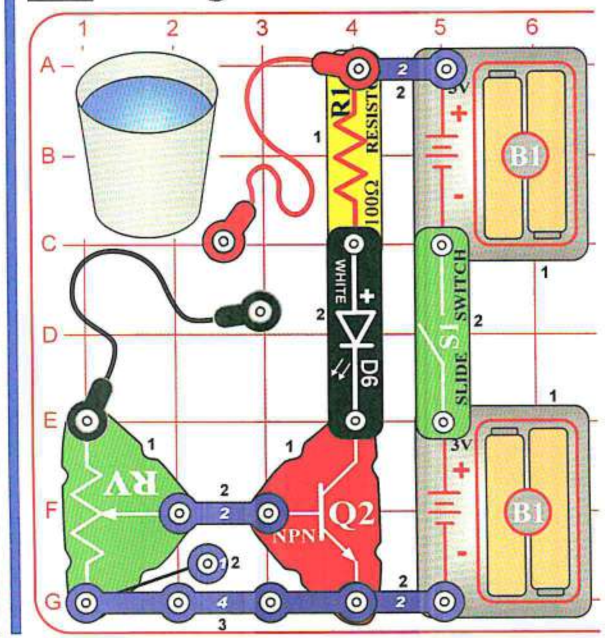
Use the preceding circuit but touch the metal in the jumper wires snaps with your fingers. Wet your fingers for best results. Your fingers will change the sound, because your body resistance is less than the 100kΩ resistor (F5) in the circuit.

Next, place the loose ends of the jumper wires in a cup of water, make sure the metal parts aren't touching each other. The water should change the sound.

Now add salt to the water and stir to dissolve it. The sound should have higher pitch now, since salt water has less resistance than plain water.

Don't drink any water used here.

Project 147 Human & Liquid Light



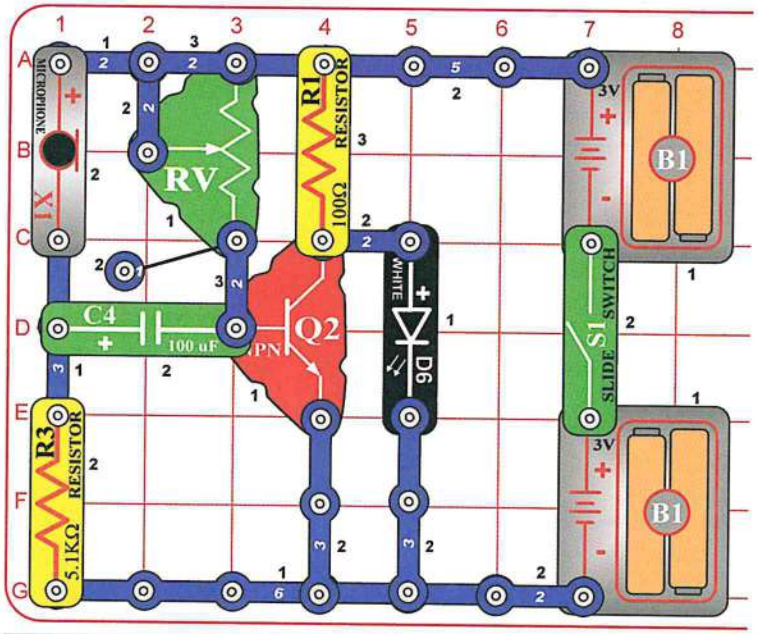
Build the circuit and turn on the switch (S1). Touch the metal in the jumper wire snaps with your fingers. Use the lever on the adjustable resistor (RV) to adjust the sensitivity of the circuit. You may see a difference in the light brightness just by pressing the contacts harder with your fingers.

Next, place the loose ends of the jumper wires in a cup of water, make sure the metal parts aren't touching each other. The water should change the light brightness. Readjust sensitivity using RV.

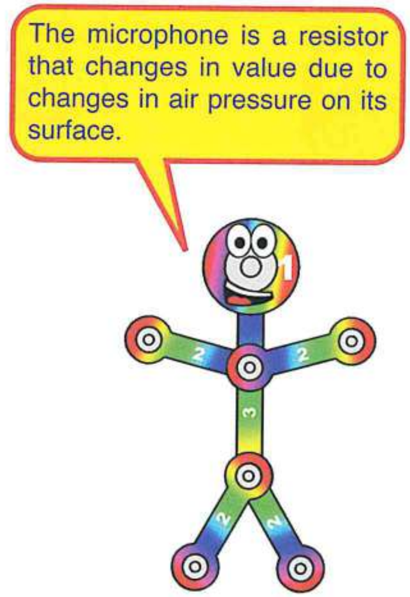
Now add salt to the water and stir to dissolve it. The light should be brighter, since salt water has less resistance than plain water. Readjust sensitivity using RV.

WARNING: Don't drink any water used here.

Project 148

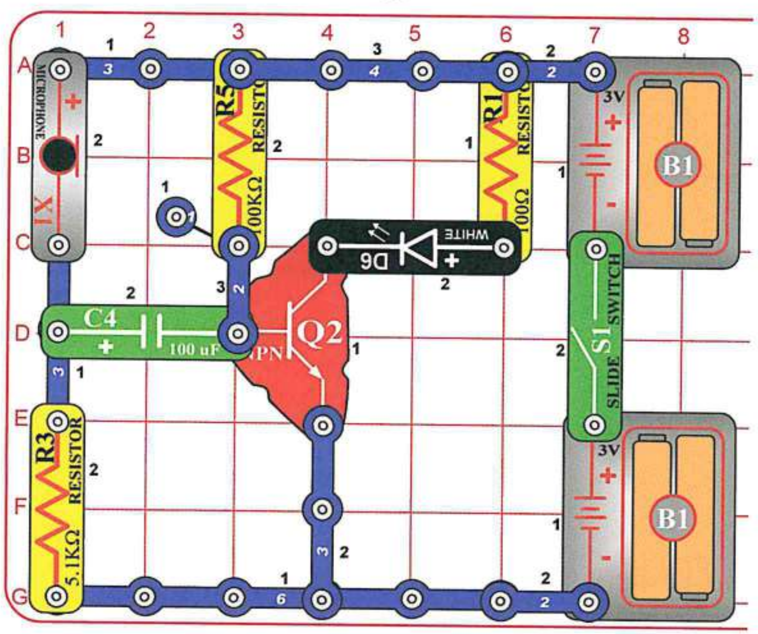


Blow On the Light



Build the circuit and turn on the slide switch (S1). Set the lever on the adjustable resistor (RV) to the top. If the white LED (D6) is on, move the lever on RV until the LED just shuts off. Now blow on the microphone (X1) to turn the white LED on.

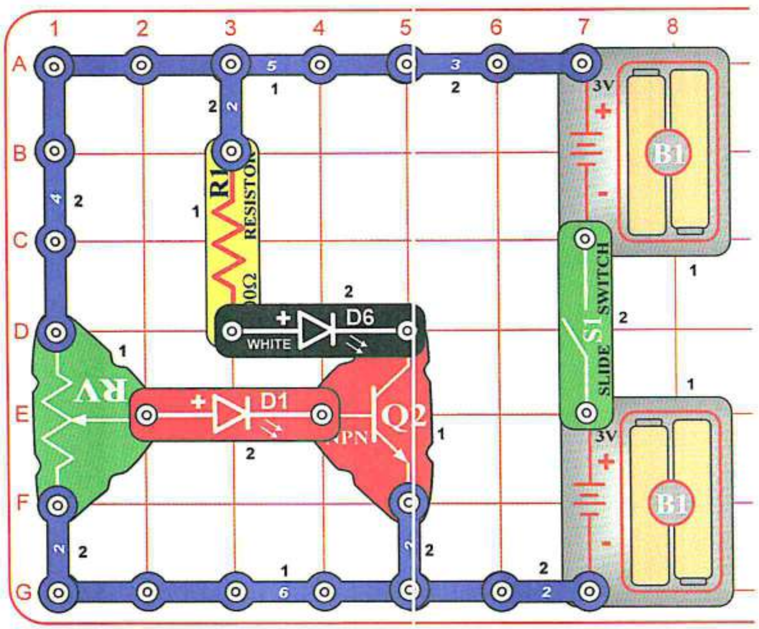
Project 149



Blow Off the Light

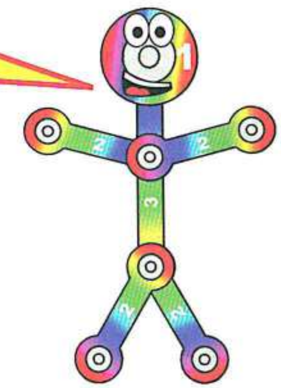
Build the circuit and turn on the slide switch (S1). Wait for the white LED (D6) to come on. Blow into the microphone (X1) to make the white LED flicker. If you blow hard enough, the LED will turn off for a moment.

Project 150 Transistor

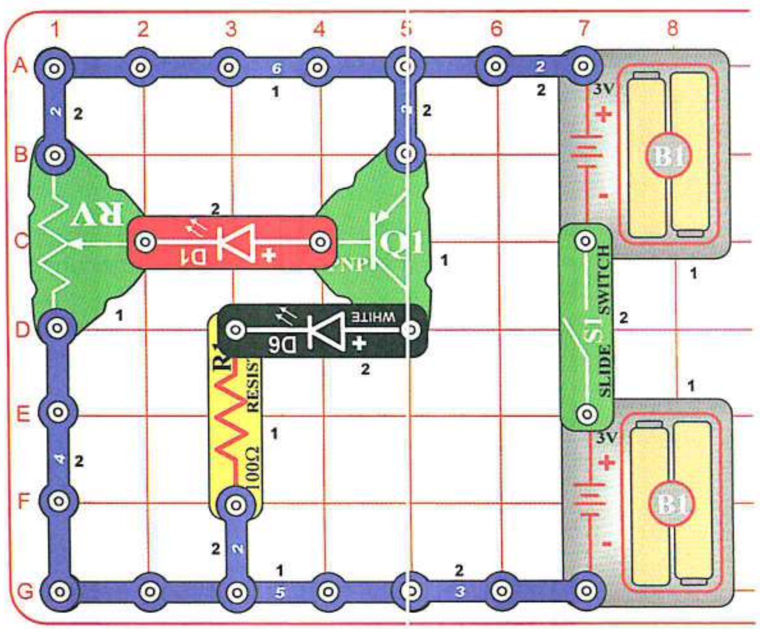


Build the circuit and turn on the slide switch (S1). Slowly move the lever on the adjustable resistor (RV) across its range while watching the brightness of the red & white LEDs (D1 & D6).

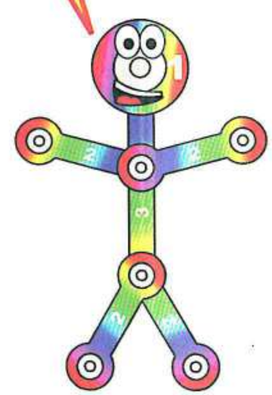
Transistors, such as the NPN transistor (Q2), can amplify electric currents. In this circuit, the adjustable resistor controls a small current going to the transistor through the red LED. The transistor uses this small current to control a larger current through the white LED. At some RV settings, the control current is too small to light the red LED, but the transistor-amplified is large enough to light the white LED.



Project 151 Another Transistor

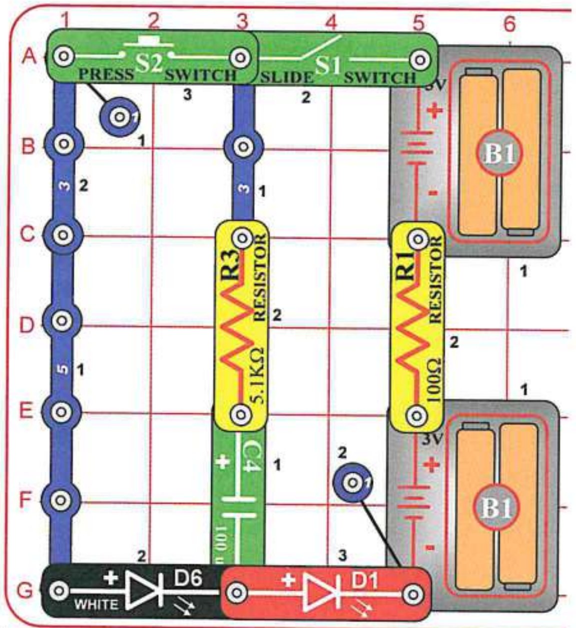


The PNP transistor (Q1) is just like the NPN transistor (Q2), except that the currents flow in opposite directions.



This circuit is just like the preceding one, except uses a different type of transistor. Build the circuit and turn on the slide switch (S1). Slowly move the lever on the adjustable resistor (RV) across its range while watching the brightness of the red & white LEDs (D1 & D6).

☐ Project 152 Charging & Discharging



Turn on the slide switch (S1) for a few seconds, then turn it off. The red LED (D1) is dimly lit for a few moments but goes completely dark as the batteries (B1) charge up the 100μF capacitor (C4). The capacitor is storing electrical charge.

Now press the press switch (S2) for a few seconds. The white LED (D6) is initially bright but goes dim as the capacitor discharges itself through it.

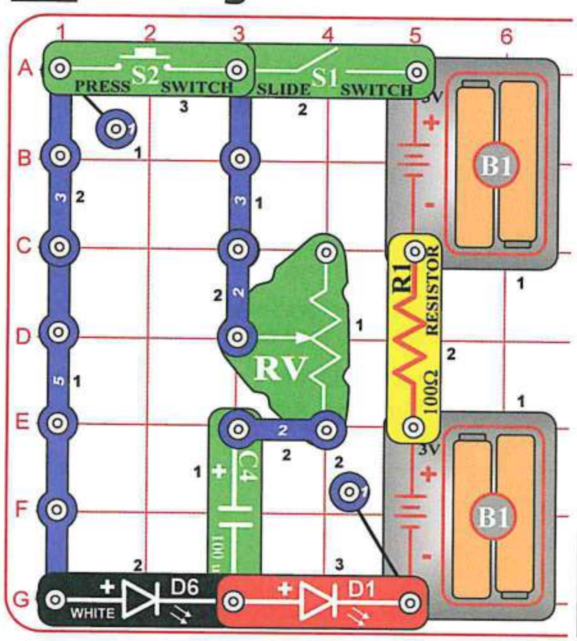
The C4 capacitor value (100μF) sets how much charge can be stored in it, and the R3 resistor value (5.1kΩ) sets how quickly that charge can be stored or released.

Now swap the locations of the white & red LEDs, and try the circuit again. Both LEDs have the same electrical current flowing through them, but white LED is much brighter than the red LED because it is a super-bright LED while the red one isn't.

☐ Project 153 Mini Capacitor

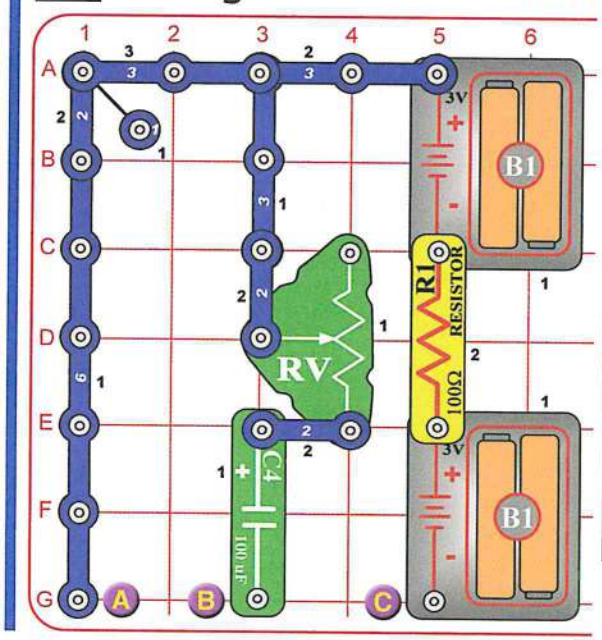
Use the project 152 circuit but replace the 100μF capacitor (C4) with the 0.1μF capacitor (C2). The circuit works the same, but the LEDs will only light very briefly, because the smaller 0.1μF capacitor stores much less electricity than the larger 100μF capacitor.

☐ Project 154 Adjustable Charging & Discharging



Modify the project 152 circuit to be this one, which has the adjustable resistor (RV) instead of the 5.1kΩ resistor (R3). Use the lever on RV to adjust the capacitor charge & discharge rate, setting it towards the red LED (D1) will make the LEDs flash brighter but get dim faster.

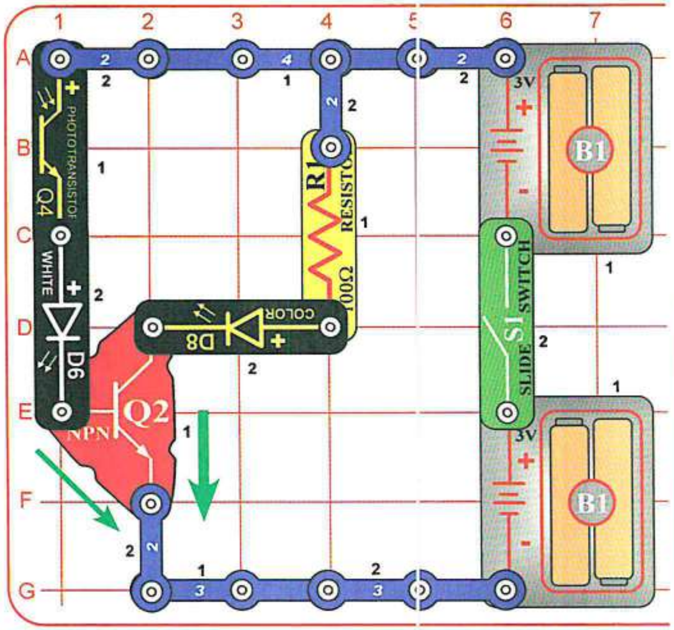
☐ Project 155 Mini Battery



This circuit is similar to the preceding one, but may be easier to understand. Set the lever on the adjustable resistor (RV) towards the 100μF capacitor (C4). Place the white LED (D6) across the points marked B & C; the LED lights as the capacitor charges. Next, place the white LED across points A & B instead; now the LED lights as the capacitor discharges. Move the white LED back to B & C and repeat. Use the lever on RV to vary the charge / discharge rate.

The capacitor is storing energy like a mini battery.

Project 156 Photo Current Amplifier



Build the circuit, turn on the switch (S1), and vary the amount of light on the phototransistor (Q4) using your hand. Compare the brightness of the white LED (D6) and color LED (D8).

Swap the locations of the white and color LEDs, and compare the brightness now.

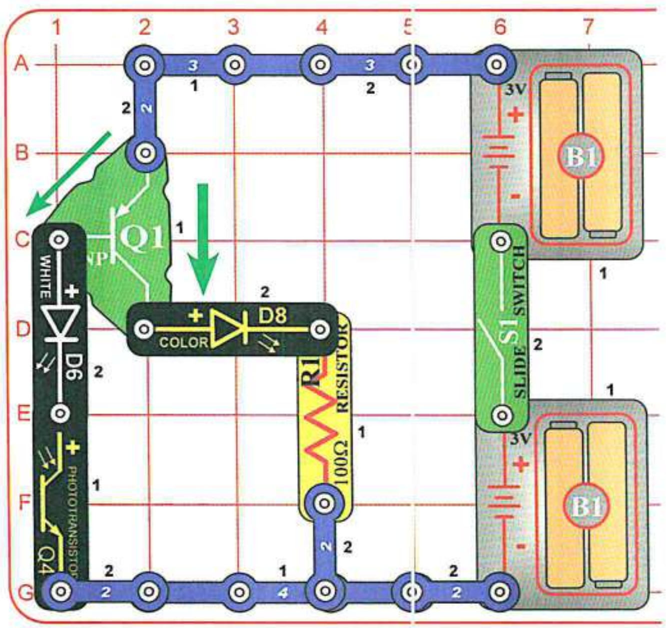
The NPN transistor (Q2) is a current amplifier. When a small current flows into Q2 through the left branch (through Q4), a larger current will flow into Q2 through the right branch (with R1). **Green arrows shown the current flow.** So the LED on the right side will be brighter than the LED on the left side. The current in the right branch might be 100 times larger than in the left branch.

Project 157 LEDs & Transistors

Use the preceding circuit but replace either LED (D6 or D8) with the red LED (D1). Compare all three LEDs, in both locations.

LED brightness depends on the materials used, construction quality, and the current through it. The white LED is super-bright, the red LED is low-brightness, and the color LED is between the others.

Project 158 PNP Amplifier

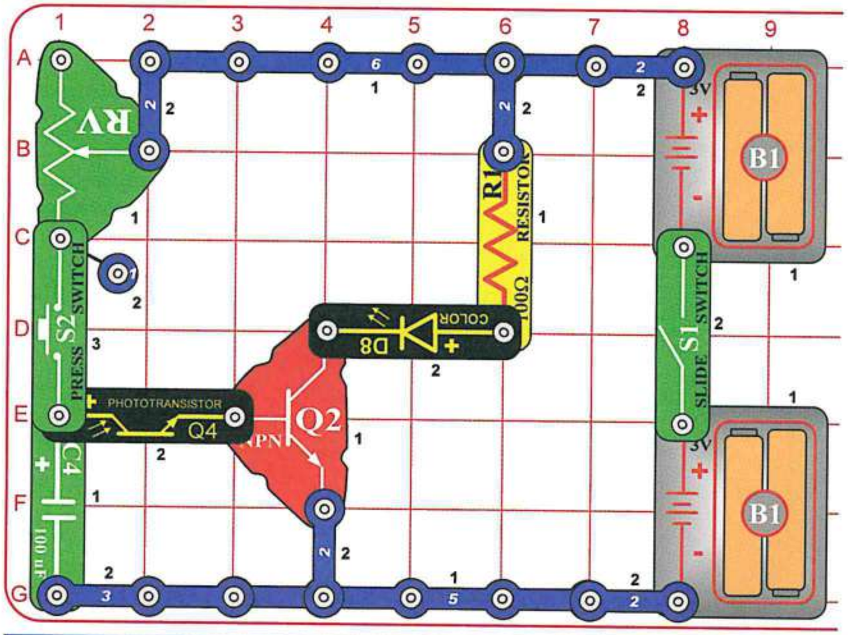


The PNP transistor (Q1) is just like the NPN transistor (Q2), except that the currents flow in opposite directions. **Green arrows shown the current flow.**

This circuit is just like the preceding one except it uses a different type of transistor. Build the circuit, turn on the switch (S1), and vary the amount of light on the phototransistor (Q4) using your hand. Compare the brightness of the white LED (D6) and color LED (D8).

Replace either LED (D6 or D8) with the red LED (D1). Compare all three LEDs, in both locations.

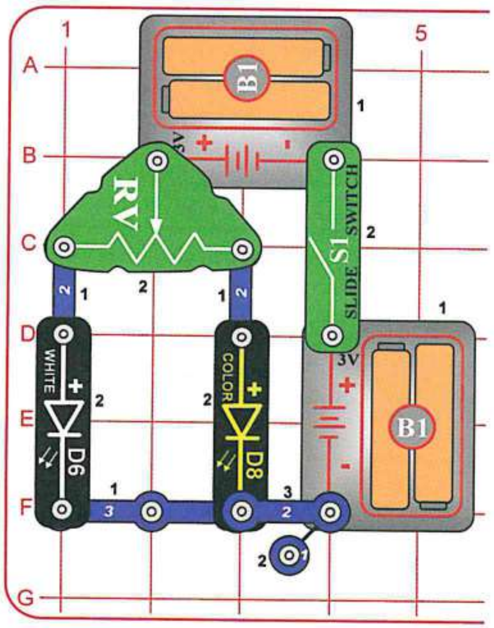
Project 159 — Photo Control



Set the lever on the adjustable resistor (RV) all the way towards the press switch (S2). Turn on the slide switch (S1), and push the press switch. The color LED (D8) will light for a while and then slowly turn off. The brighter the light on the phototransistor (Q4), the shorter the color LED stays on.

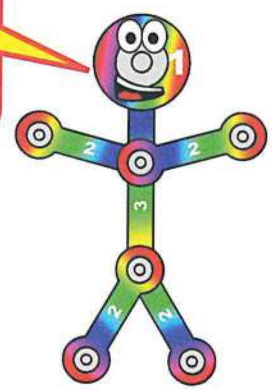
You can replace the color LED with the red LED (D1) or the white LED (D6).

Project 160 — Resistance Director



The adjustable resistor can be adjusted from about 200 ohms to about 50,000 ohms.

The white LED is a super-bright LED, so will be brighter than the others at comparable resistance.



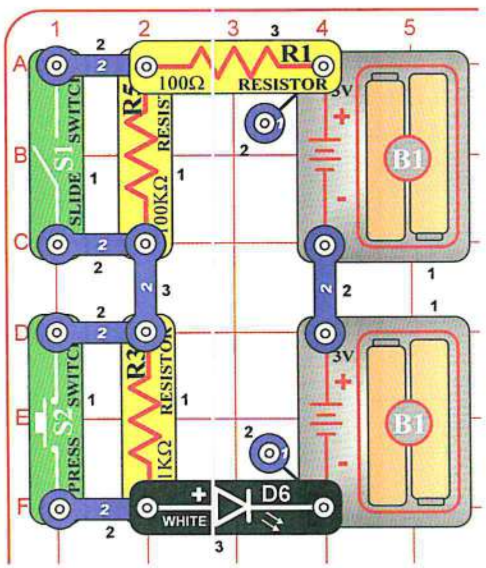
Move the lever on the adjustable resistor (RV) across its range and watch the brightness of the white and color LEDs (D6 & D8).

Replace either LED with the red LED (D1) and compare it too.

You can also replace one of the battery holders (B1) with a 3-snap wire, and compare the LED brightnesses at lower voltage.

Project 161

Current Controllers - Series



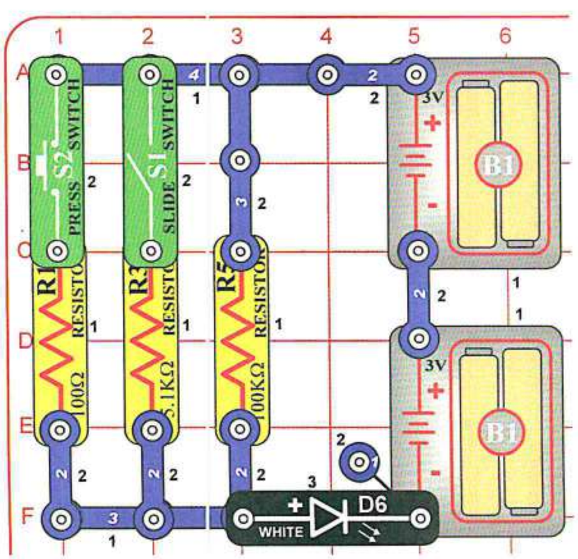
Resistors are used to control the amount of current through a circuit. Increasing the resistance decreases the current.

Turn on either or both switches (S1 & S2) and compare the white LED (D6) brightness.

This circuit has the 100Ω resistor (R1), the 5.1kΩ resistor (R3), and the 100kΩ resistor (R5) arranged in series. The switches are used to bypass the larger resistors. The largest resistor controls the brightness in this arrangement.

Project 162

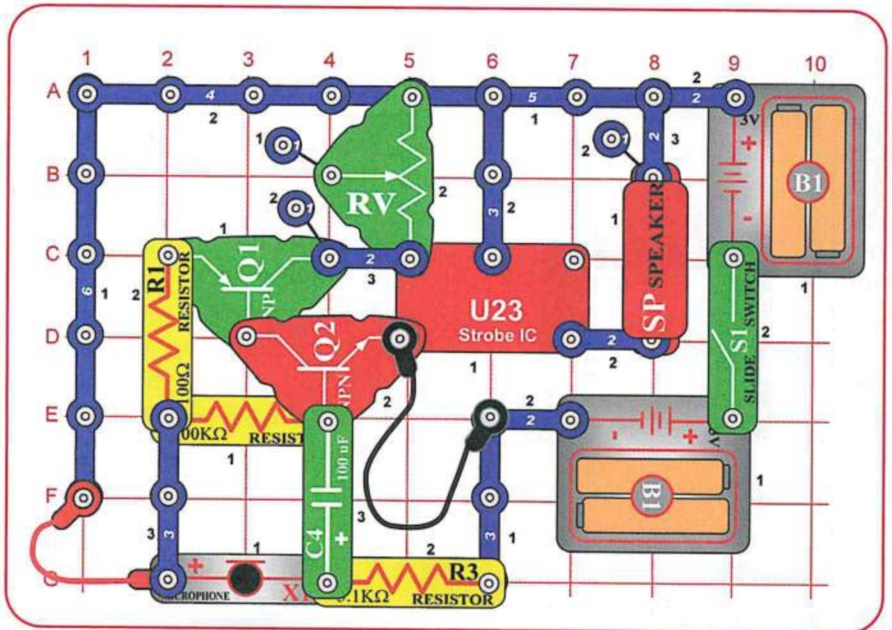
Current Controllers - Parallel



Turn on either or both switches (S1 & S2) and compare the white LED (D6) brightness.

This circuit has the 100Ω resistor (R1), the 5.1kΩ resistor (R3), and the 100kΩ resistor (R5) arranged in parallel. The switches are used to disconnect the smaller resistors. The smallest resistor controls the brightness in this arrangement.

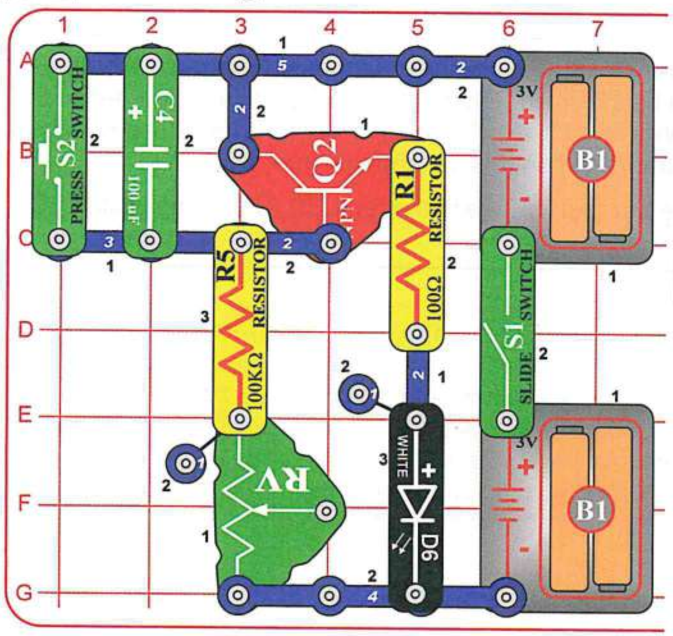
☐ Project 163 Blow Sound Changer

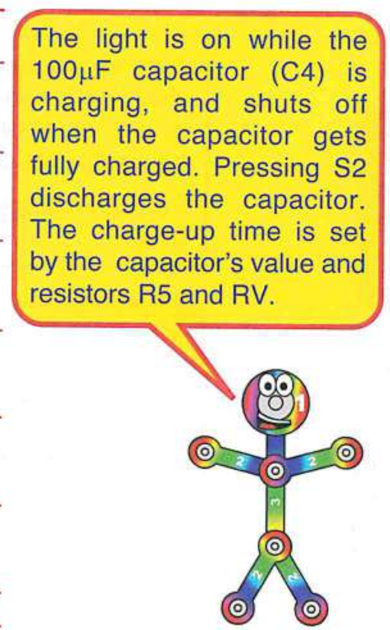


When you turn on the switch (S1), you hear a siren sound. Blow into the microphone (X1) to change the sound.

RV is used as a fixed resistor (50kΩ); so moving its control lever will have no effect.

☐ Project 164 Short Light





Build the circuit, turn on the slide switch (S1), and push the press switch (S2). The white LED (D6) is on for a while and then shuts off. Turning S1 off and back on will not get the light back on. Push S2 to get the light back on.

Replace the white LED with the color LED (D8) to change the light style.

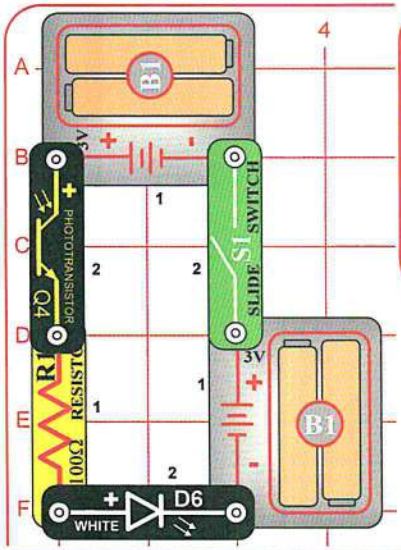
RV is used as a fixed resistor (50kΩ); so moving its control lever will have no effect.

☐ Project 165 Shorter Light

Use the preceding circuit but replace the 100kΩ resistor (R5) with the smaller 5.1kΩ resistor (R3). Now the light doesn't stay on as long.

Project 166

Photo Light Control



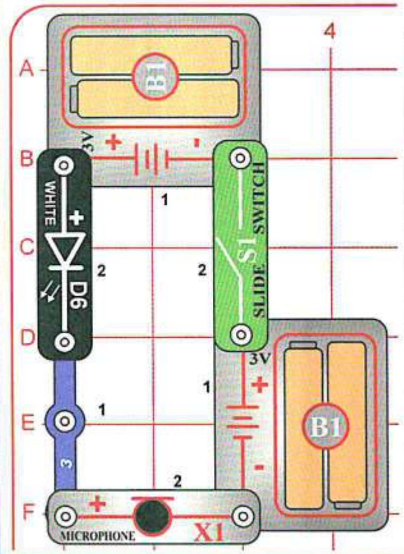
The phototransistor uses light to control electric current. As more light shines on the phototransistor, the current through it increases, making the LED brighter.

Turn on the switch (S1). Control the white LED (D6) brightness by varying the amount of light on the photo-transistor (Q4). Try holding the red, green, and blue filters over the phototransistor and see how they affect it.

Replace the white LED with the red LED (D1) or the color LED (D8) and compare them.

Project 167

Air Pressure Light Control



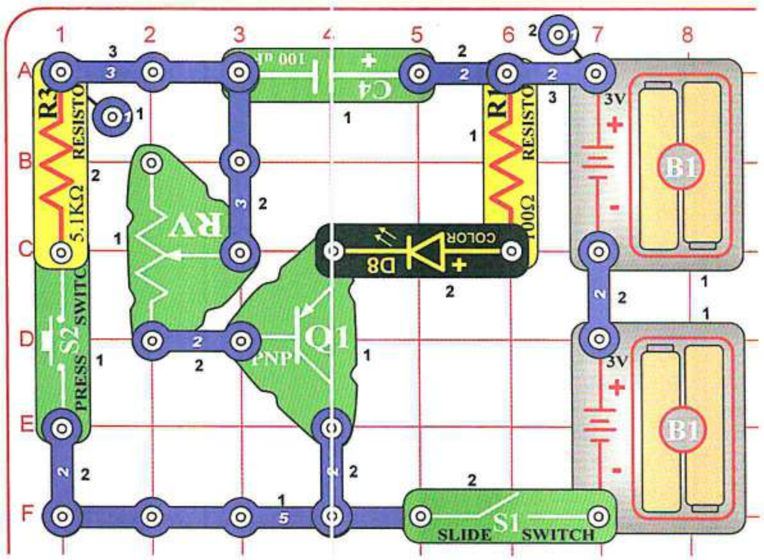
Blow on the microphone (X1). The white LED (D6) will flicker, because the resistance of the microphone changes when you blow on it.

Talking into the microphone also changes its resistance, but you will not be able to notice the difference here.

You can replace the white LED with the red LED (D1) or the color LED (D8), but they will not be very bright.

Project 168

Slow On, Slower Off



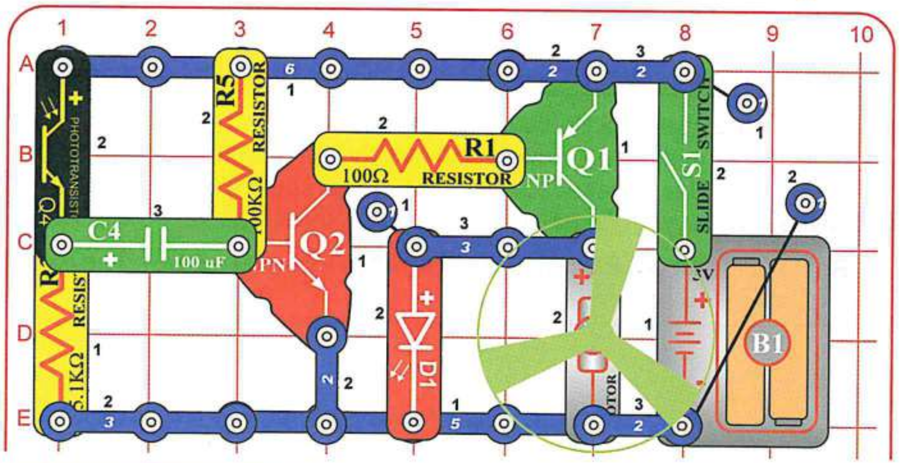
Turn on the slide switch (S1), nothing happens. Now push the press switch (S2) and hold it down. The color LED (D8) takes a few seconds to turn on, then will very slowly get dim after S2 is released. The adjustable resistor (RV) controls the shut-off time.

You can replace the color LED with the red LED (D1) or the white LED (D6).

The 100μF capacitor (C4) controls the color LED through the PNP transistor (Q1). Pressing S2 quickly charges up the capacitor, and releasing S2 allows the capacitor to slowly discharge. Capacitors can store electric charge and release it when needed, so they are often used in timing circuits like this.

Project 169

Delayed Photo Speed Control



Turn on the switch (S1), the motor (M1) spins. As you move your hand over the phototransistor (Q4), the motor slows. Cover the phototransistor with your hand. The motor slows down and may stop, but will speed up in a few seconds. Also try shining a flashlight into the phototransistor.

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

Project 170

Delayed Speed Control

Use the preceding circuit, but replace the 100μF capacitor (C4) with the much smaller 0.1μF capacitor (C2). Now varying the light to the phototransistor has only a small effect on the motor speed.

Project 171

Delayed Speed Control (II)

Use the circuit from project 169, but swap the locations of the phototransistor (Q4) and 5.1kΩ resistor (R3); put "+" on Q4 towards C4. Now increasing the light to the phototransistor slows down the motor, instead of speeding it up.

Project 172

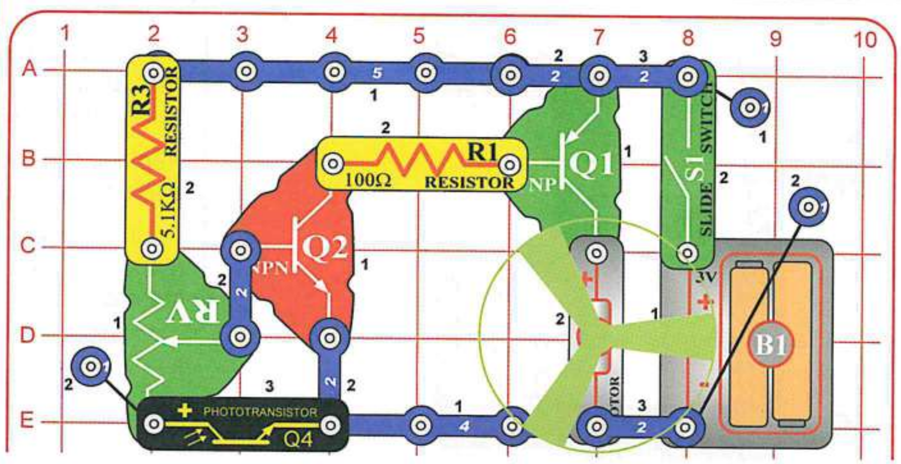
Audio Delayed Speed Control

Use the circuit from project 169, but replace the phototransistor (Q4) with the microphone (X1, "+" on top). Clap, talk loudly, or blow into the microphone to change the motor speed.

Project 173

Photo Speed Control

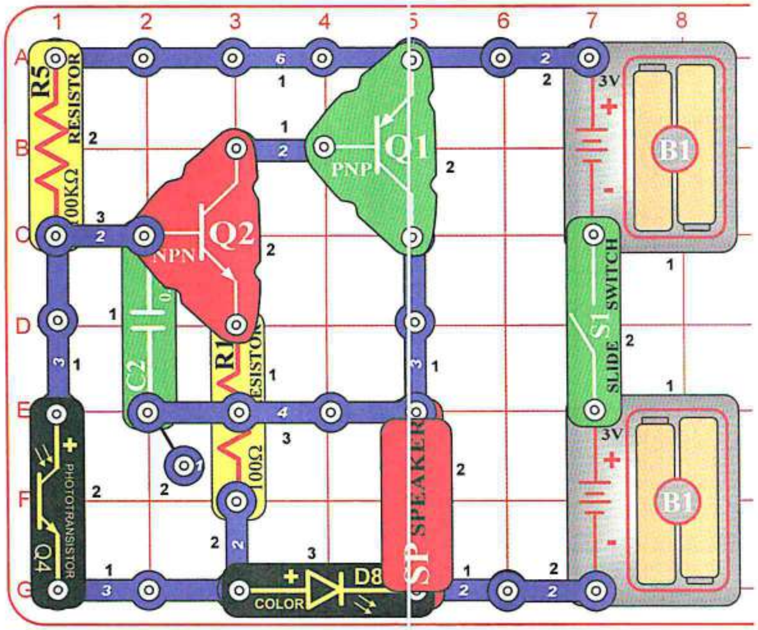
Turn on the switch (S1), and set the adjustable resistor (RV) so the motor (M1) just spins. Slowly cover the phototransistor (Q4) and the motor spins faster. Place more light on the phototransistor and the motor slows down.



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

Project 174

Light Buzz

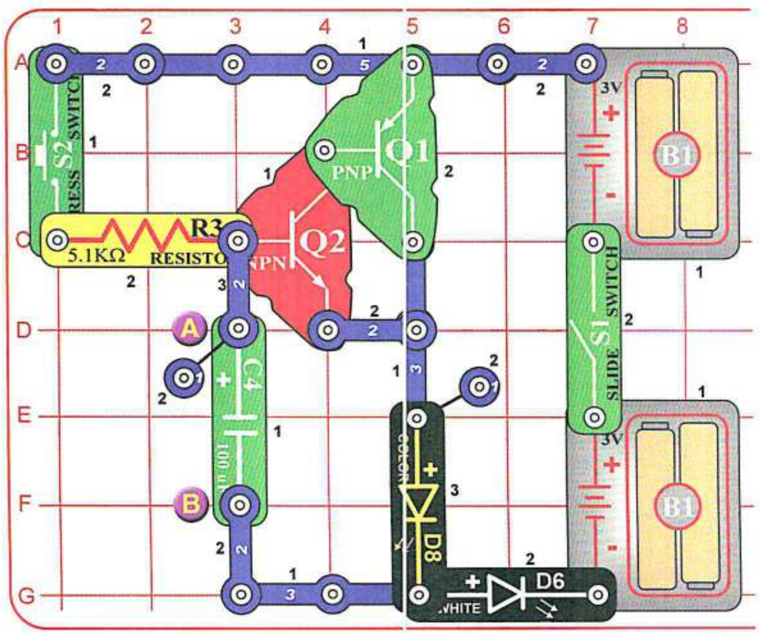


Turn on the switch (S1). If there is enough light on the phototransistor (Q4), then nothing will happen. Cover the phototransistor with your finger, now the speaker (SP) makes noise and the color LED (D8) flashes. Wave your fingers over the phototransistor to vary the sound.

Replace the color LED with the red or white LEDs (D1 & D6). The light and sound will be a little different.

Project 175

Delay Lights

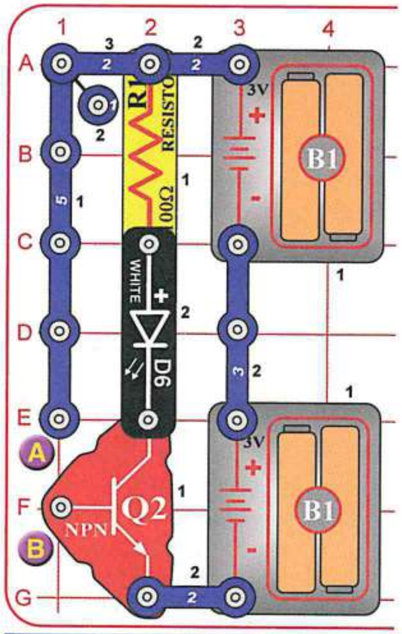


Turn on the slide switch (S1), and push the press switch (S2). The color and white LEDs (D6 & D8) come on slowly but will stay bright for a long time after you release the press switch. Connect the red jumper wire across points A & B if you get tired of waiting for the LEDs to turn off.

Replace the 5.1kΩ resistor with the 100kΩ resistor. Now you have to push the press switch for much longer to make the LEDs bright.

Replace the 100μF capacitor (C4) with the smaller 0.1μF capacitor (C2). Now the LEDs turn on and off much faster, because C2 does not store as much electricity as C4.

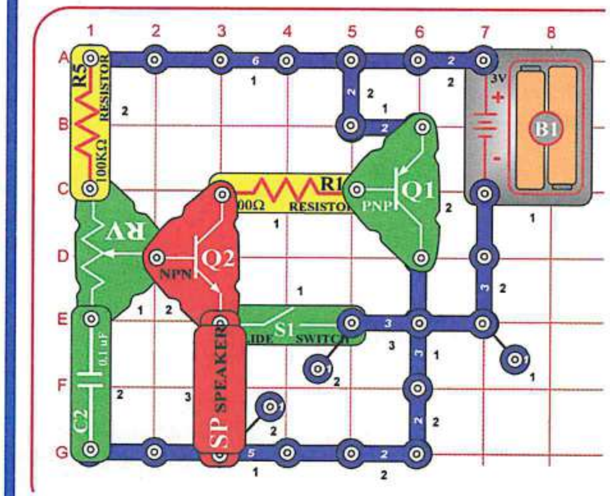
☐ Project 176 Touch Light



Build the circuit. It doesn't do anything, and may appear to be missing something. It is missing something, and that something is you.

Touch points A & B with your fingers. The white LED (D6) may be lit. If isn't bright, then you are not making a good enough electrical connection with the metal. Try pressing harder on the snaps, or wet your fingers with water or saliva. The LED should be bright now. You can replace the white LED with the red or color LEDs (D1 & D8).

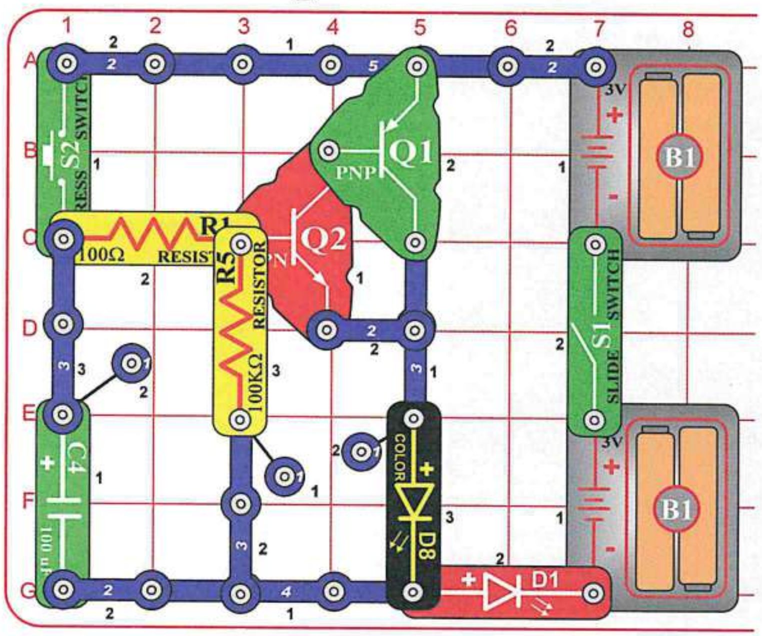
☐ Project 177 Narrow Range Tone



Turn on the switch (S1) and move the lever on the adjustable resistor (RV) around. The circuit makes a tone sound, but only over a small range of settings on RV.

Replace the 100kΩ resistor (R5) with the 5.1kΩ resistor (R3). The tone is a little different now.

☐ Project 178 Slow Off Lights



Turn on the slide switch (S1), and push the press switch (S2). The red and color LEDs (D1 & D8) stay on for a few seconds after you release the press switch.

You can change how long the LEDs stay on for by replacing the 100μF capacitor with the 0.1μF capacitor, by replacing the 100kΩ resistor (R5) with the 5.1kΩ resistor (R3), or by removing the 100kΩ resistor.

For more fun, try swapping the locations of the LEDs, or replacing either with the white LED (D6).

Project 179 — 3D Pictures

Look at the pictures here; they probably look blurry. Now place the red filter in front of your left eye and the blue filter in front of your right eye, and look at the pictures again. Now the pictures look clearer, and you can see them in three dimensions (3D).

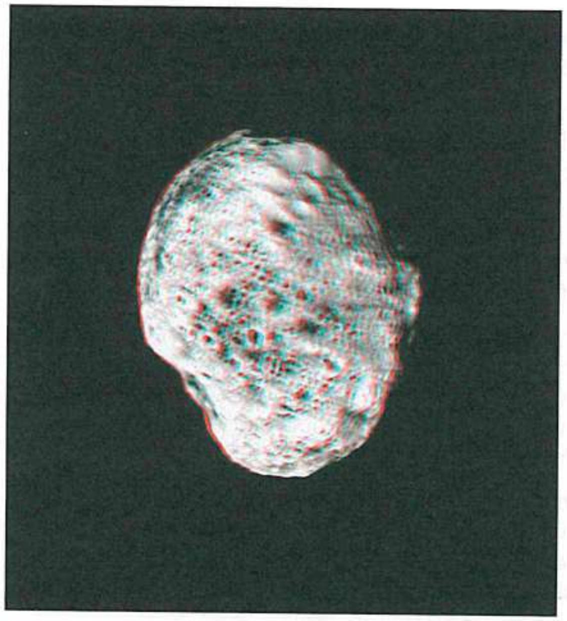
These pictures contain separate red & blue images, taken from slightly different viewpoints, combined together. When you view them through the red & blue filters, each eye sees only one image. Your brain combines the two images into the single picture that you "see", but the differences between the two images make the combined picture seem three-dimensional.

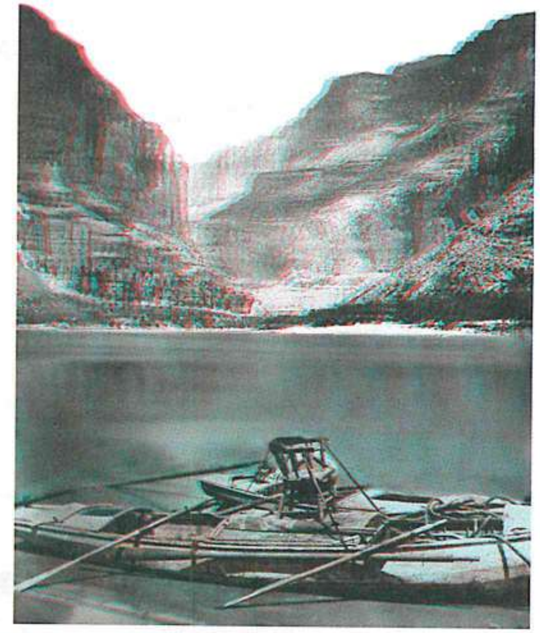
How 3D works:
Most people have two eyes, spaced about 2 inches apart. So each eye sees the world a little differently, and your brain uses the difference in views to calculate distance. For each object in view, the greater the difference between the two scenes, the closer it must be. If you close one eye, you will have a harder time judging distance – try catching a ball with just one eye! (Be sure to use a soft ball if you try playing catch with one eye.)

When you watch a 3D movie in a theater, you wear 3D glasses so that each eye will see a different image. The movie screen actually shows two images, and the glasses filter them so that only one image enters each eye. Most movie theaters use polarized images and glasses with polarized lenses, so that each eye sees a different image.

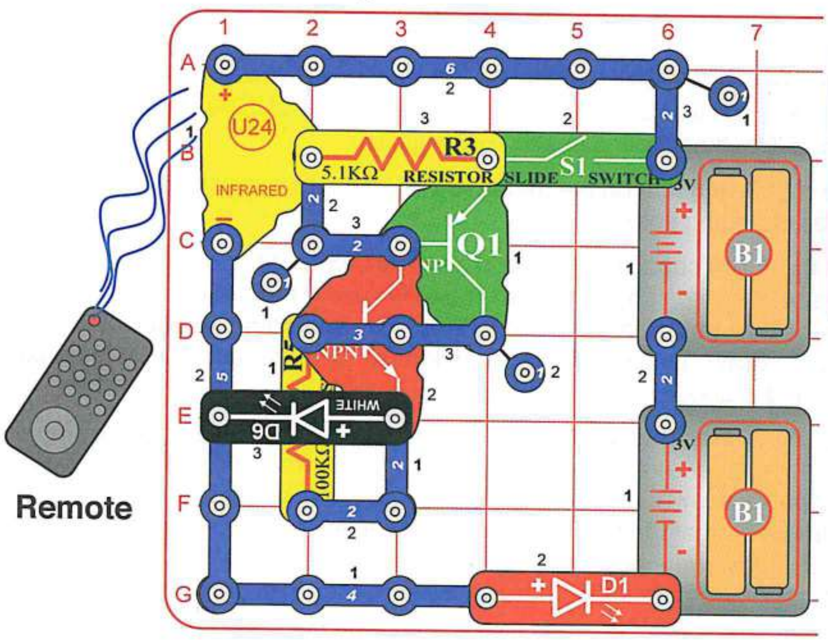
Another way to make 3D is using red & blue images, then view using glasses with red & blue filters, as you are doing in this project. Unfortunately this method does not give you the color quality that the polarization method has.

3D Pictures





☐ Project 180 Super Infrared Detector



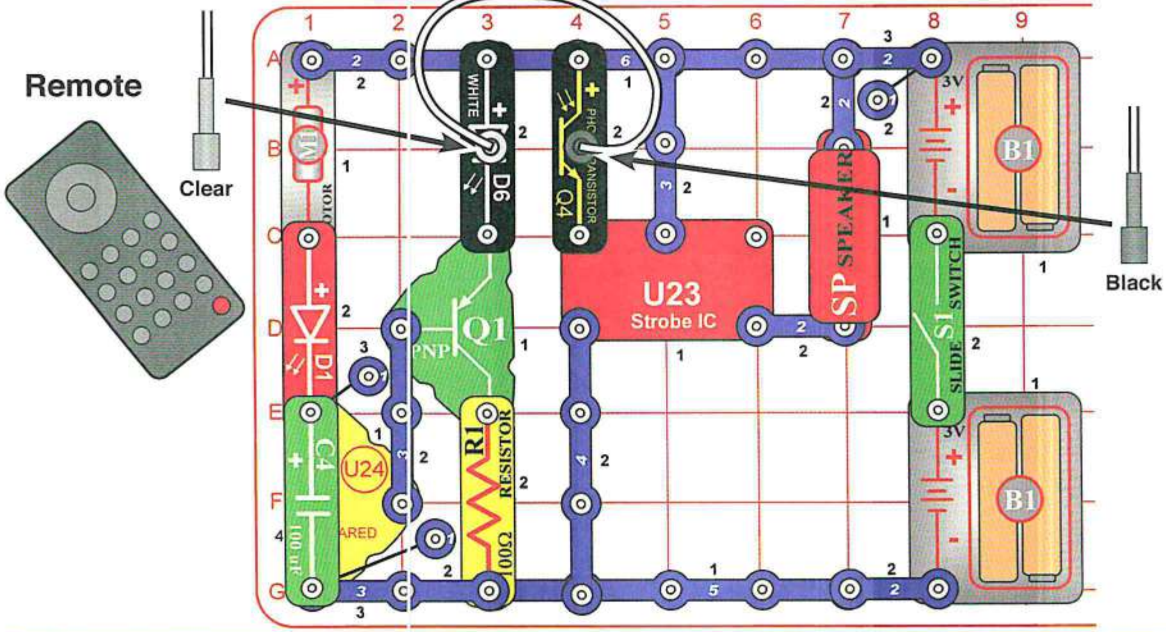
Infrared light can be given off by anything warm. Sunlight and room lights emit some infrared light, in addition to visible light. This circuit is very sensitive, and may often be activated without a remote control. TV remote control receivers look for a sequence of pulses that identify an infrared message directed to their TV set model, so will not be activated by sunlight or room lights.

You need an infrared remote control for this project, such as any TV/stereo/DVD remote control in your home.

Build the circuit. The red LED (D1) will be dim. Turn on the switch (S1). Point your remote control toward the infrared module (U24) and press any button to activate the white LED (D6). Once activated, the white LED stays on until the switch is turned off.

Note: This circuit can activate without a remote control, due to infrared in sunlight or some room lights. If this happens, try moving to a dark room.

Project 181 Infrared Optical Audio



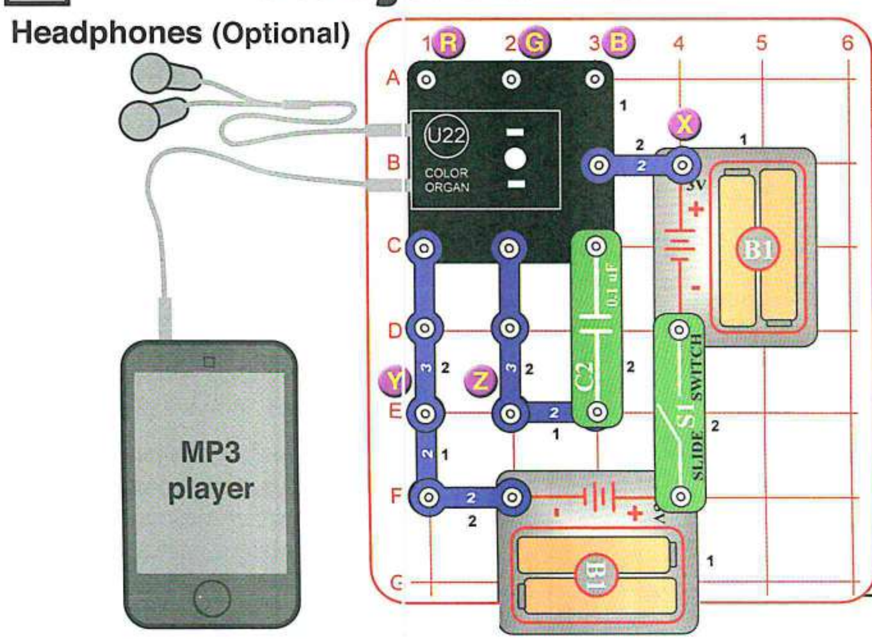
You need an infrared remote control for this project, such as any TV/stereo/DVD remote control in your home.

Build the circuit as shown. Place the clear cable holder on the white LED (D6) and the black cable holder on the phototransistor (Q4), then place the fiber optic cable into the holders as far as it will go. For best performance the fiber optic cable should stand straight up in the holders, without bending them.

Turn on the switch (S1). Point your remote control toward the infrared module (U24) and press any button to activate the white LED (D6). Light is transmitted from the white LED, through the fiber optic cable, to control the strobe IC (U23) and speaker (SP).

The motor (M1) is used as a 3-snap here, and will not spin. Sometimes this circuit may activate without a remote control, due to infrared in sunlight or some room lights. You may get better results in a dark room.

Project 182 Test the Color Organ



This project tests the features of the color organ (U22), and will be referenced by the Advanced Troubleshooting section on page 15.

A. Build the circuit, and turn on the switch (S1). The light on top of the color organ should be changing colors.

B. Remove the 0.1μF capacitor (C2), add a 2-snap across the points marked Y & Z, and reset the circuit by turning it off and on using the switch. Connect the red jumper wire between the point marked "X", and points marked "R", "G", or "B" in the drawing. Touching R should make the light red, G should make it green, and B should make it blue.

C. Remove the 2-snap that was added across points Y & Z. Connect a music device (not included) and headphones (optional, and not included) to the color organ as shown, and start music on it. Set the volume control on your music device so that the light on the color organ is changing (the light will not change if your volume is set too high or too low).