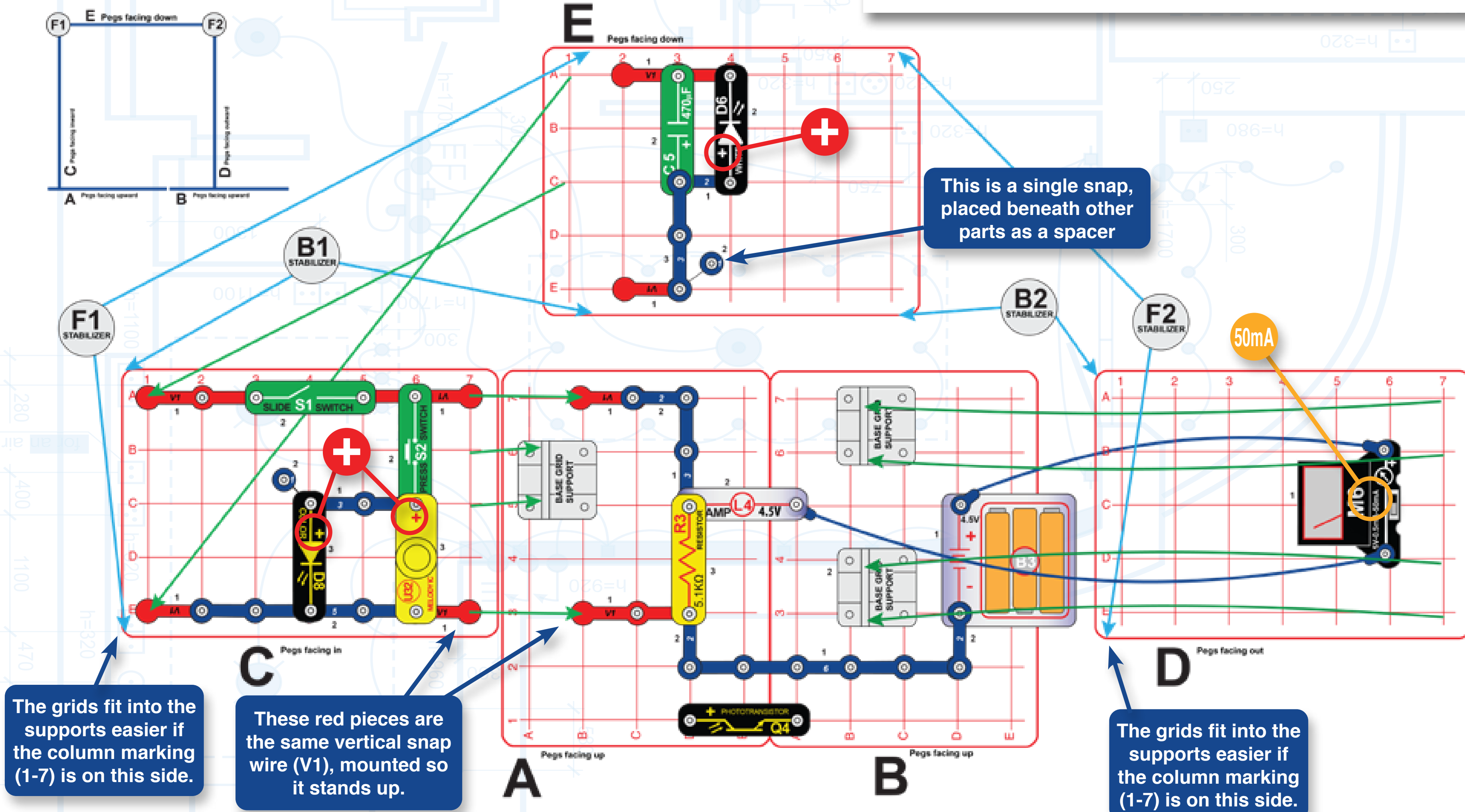
Project 8 | ELECTRIC HOME

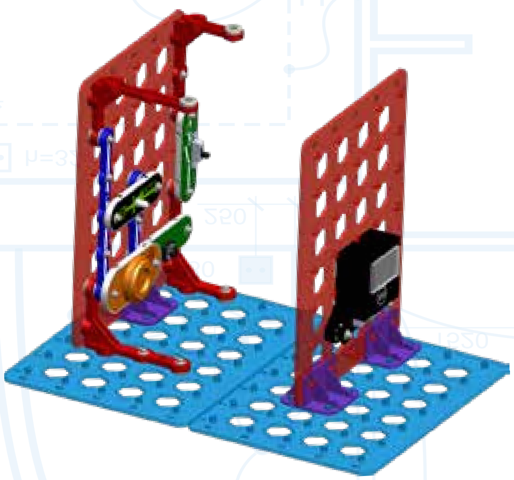
The light covers and slides may be placed on the LEDs (D6 and D8) or lamp (L4) as decoration. Fold the slides as indicated and slide them into the slots on the cover, as shown.



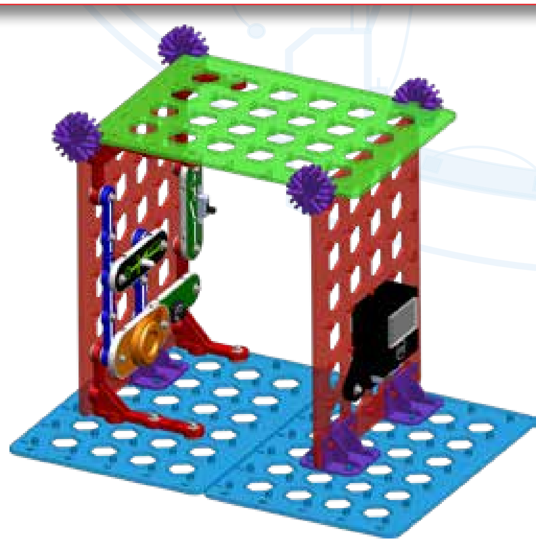
Assembly (adult supervision recommended):

1. Place base grid supports on base grids A & B.

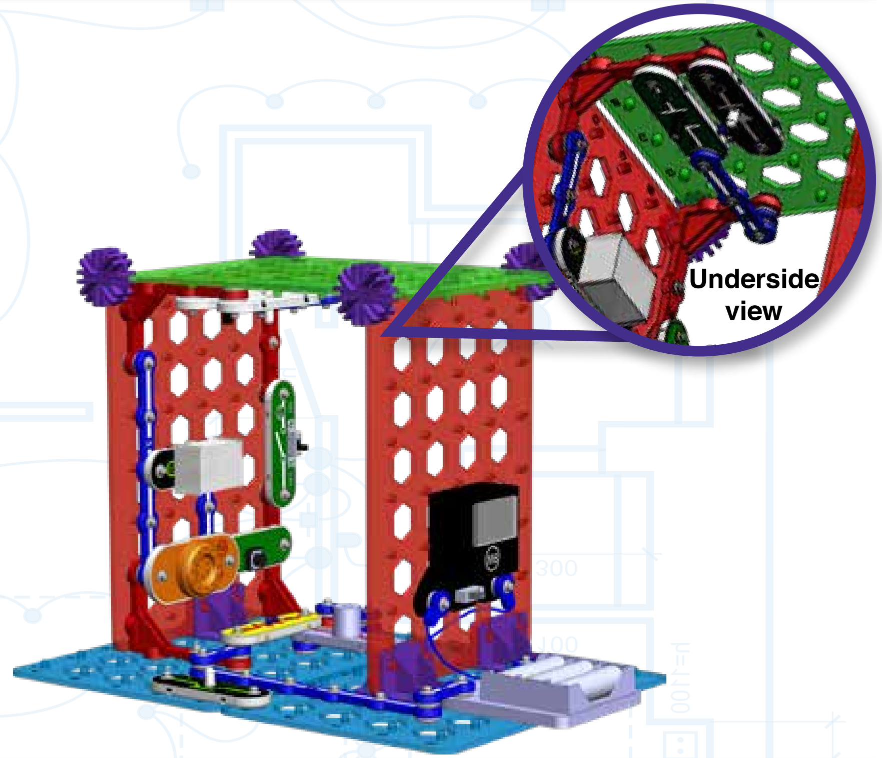
2. Place parts (except the blue jumper wires) on base grids C & D, and install into base grid supports on grids A & B. The pegs should be facing inward on grid C and outward on grid D. Base grid colors are interchangeable, so you can use any color you like at any location.



3. Mount grid E on top of grids C & D using 4 stabilizers, attaching the 2 vertical snap wires (V1) as you do it.



4. Place the remaining parts on grids A, B, & E, including the two blue jumper wires



This circuit does not have an on-off switch, so connect one of the blue jumper wires last, and disconnect it when you are done using this circuit. Set the meter (M6) to the 50mA setting. Turn on the slide switch (S1) or push the press switch (S2) to make things happen, and watch the current on the meter. The lamp (L4) will not light.

The light covers and slides may be placed on the LEDs (D6 and D8) or lamp (L4) as decoration. Fold the slides as indicated and slide them into the slots on the cover, as shown.

You can replace either LED (D6 or D8) or the melody IC (U32) with the motor (M4) and fan. The motor represents a ceiling fan, fan for a furnace or air conditioner, or other appliance.

Go to www.elenco.com/MyHome. for an interactive 3D picture to help with constructing this circuit.

This Circuit Demonstrates How Electricity Is Used In Your Home:

The **battery holder (B3)** represents the electricity supplied to your home. Usually the electricity is generated by a power station, but it could also come from a gasoline-powered backup generator, from solar panels on your roof, from wind turbines, or from larger batteries.

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The **meter (M6)** is the meter that measures how much electricity you're using and reports it to your local electric company. This meter is usually located on the outside of your house or somewhere nearby. Your electric company uses this measurement to determine how much electricity you have to pay for. Electricity is measured in kilowatt hours (kWh), which is the amount of electricity needed to power a 1000W light bulb for 1 hour. The present cost of 1 kWh of electricity in the United States is around ten cents ($0.10).

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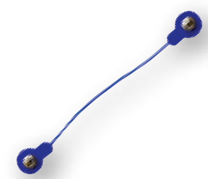
The **blue snap wires**, jumper wires, and vertical snap wires (V1) represent the wires in your walls, ceiling, and floor, by which electricity travels throughout your home to where it is needed.

 = 

The **press switch (S2)** turns on (or off) the color LED (D8, which represents your television or computer screen) and the melody IC (U32, which represents your stereo or sound device).

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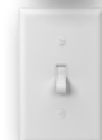
The **slide switch (S1)** controls the white LED (D6) the same way a switch on the wall controls a ceiling light.

 = 

The **470μF capacitor (C5)** keeps the white LED glowing for a moment after you turn off switch S1, giving you a little light to walk out of the room by. Try removing C5 and see how much faster the light turns off.

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The **5.1kΩ resistor (R3)** represents various devices that are always on and using small amounts of electricity, like your refrigerator, hot water heater, computer, television, and Wifi. Change your M6 meter to the 0.5-mA setting and see how much current flows to R3 when the S1 and S2 switches are off.

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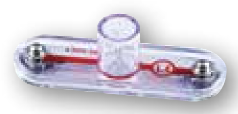
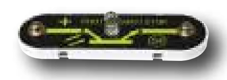
The **lamp (L4)** represents a fuse and will only light if there is a problem in your circuit. Normally L4 will be off.

 = 

What is a short circuit? You can connect an extra jumper wire across the 5.1kΩ resistor to simulate the short circuit problems that often happen in homes. **A short circuit occurs when the resistance in an electrical pathway is suddenly and drastically reduced, so that the electricity suddenly flows very quickly.** If you connect an extra jumper wire across the 5.1kΩ resistor you bypass the resistor, so the current doesn't have to go through it at all (it goes through the jumper wire instead). Because there is nothing blocking its way, the current flows much more quickly through the jumper wire, causing meter M6 to go off the scale and the lamp to light up. Although the meter continues to show a current overload (off the scale), the resistance of the bright lamp slows down the current enough to prevent damage to the wires and batteries down the line (representing the electric company's infrastructure). Note that when the lamp is on, turning the S1 and S2 switches on does not illuminate the LEDs or make the melody sound. This is because the fuse has shut down the electricity flowing through your home as a result of the short circuit you caused across the 5.1kΩ resistor. When you remove the jumper wire from across the resistor, the lamp turns off, the meter returns to normal, and the S1 and S2 switches work again. (A similar fuse is also built into your B3 battery holder; but it resets automatically, so you don't even notice it's working.)

The phototransistor (Q4) is used here to help hold grids A & B together. It is not electrically connected to the other components.



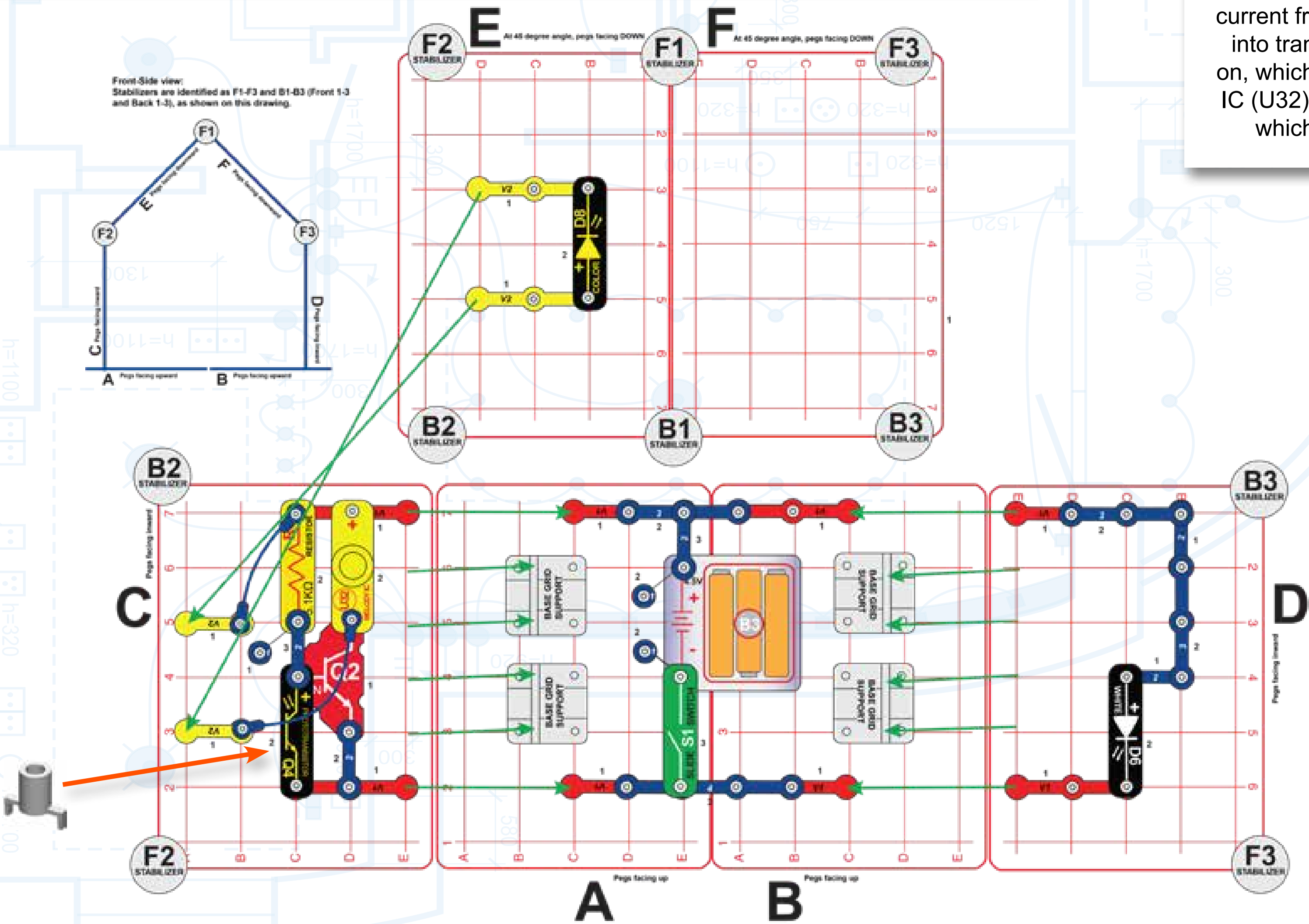
Replacing either LED (D6 or D8) or the melody IC (U32) with the motor (M4) and fan creates a ceiling fan or the fan in a furnace, air conditioner, or other appliance.

Project 9 | HOME SECURITY

You can place an object inside this house, If an intruder tries to reach in and grab it, then the alarm sounds and color LED flashes to scare the intruder away.

This circuit is similar to security systems that may be in your home, which can be activated when a beam of light is broken, when motion is detected, or by loud sounds (like when a window is broken into). Some home security systems are linked to a monitoring company, which can contact the police.

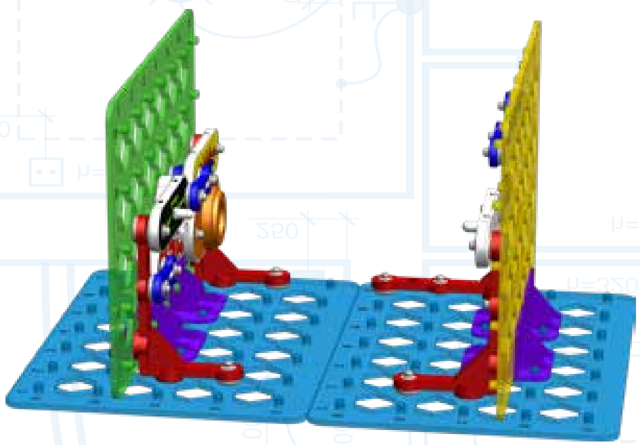
How it works: Light from the white LED (D6) shines on the phototransistor (Q4), keeping its resistance low, and all of the current flowing through resistor R3 flows through Q4. If a burglar blocks the light from the white LED, Q4's resistance increases and current from R3 begins to flow into transistor Q2, turning it on, which turns on the melody IC (U32) and color LED (D8), which act as an alarm.



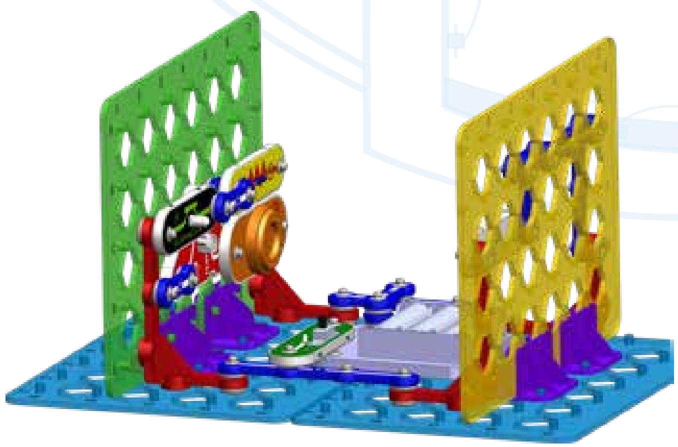
Assembly (adult supervision recommended):

1. Place base grid supports on base grid A & B.

2. Place parts on base grids C & D, and install into base grid supports on grids A & B. The pegs should be facing inward.



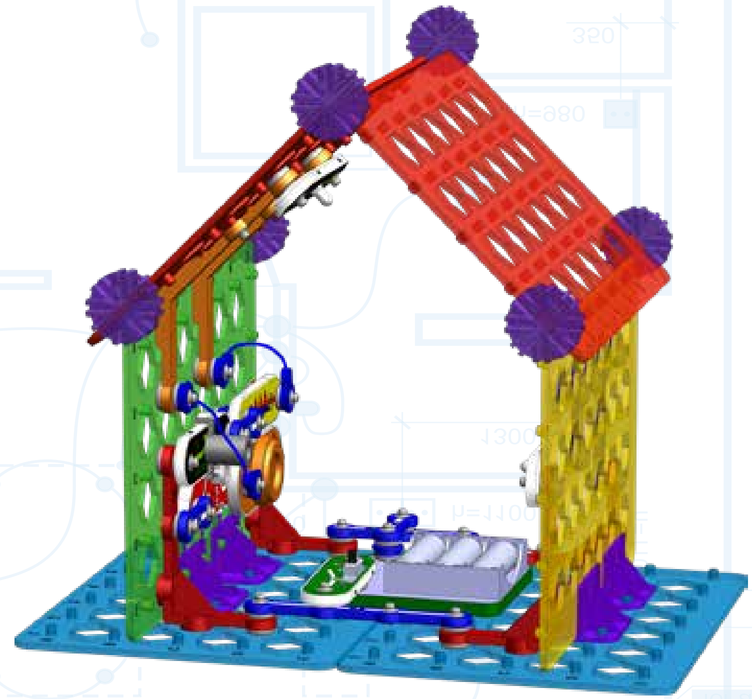
3. Place remaining parts on grids A & B.



4. Mount grids E & F, at 45 degree angles and with pegs oriented down, on top of grids C & D using 6 stabilizers, attaching the two angled snap wires (V2) as you do it. Adjust the positions of the stabilizers as needed.

5. Place the color LED (D8) on the angled snap wires (V2) on grid E.

6. Add the mounting base on the phototransistor (Q4).



Turn on the slide switch (S1); the white LED (D6) should be on, but there should not be any sound. Now place your hand between the white LED and the phototransistor (Q4); an alarm sounds and the color LED (D8) turns on.

Easier Roofless Version: skip assembly steps 4 and 5, and omit the angled jumper wires (V2) from step 2. Grids E and F, and all parts on them are not used. The circuit works the same way except that the color LED (D8) is not included.

Project 10 l BLOCK THE SOUND

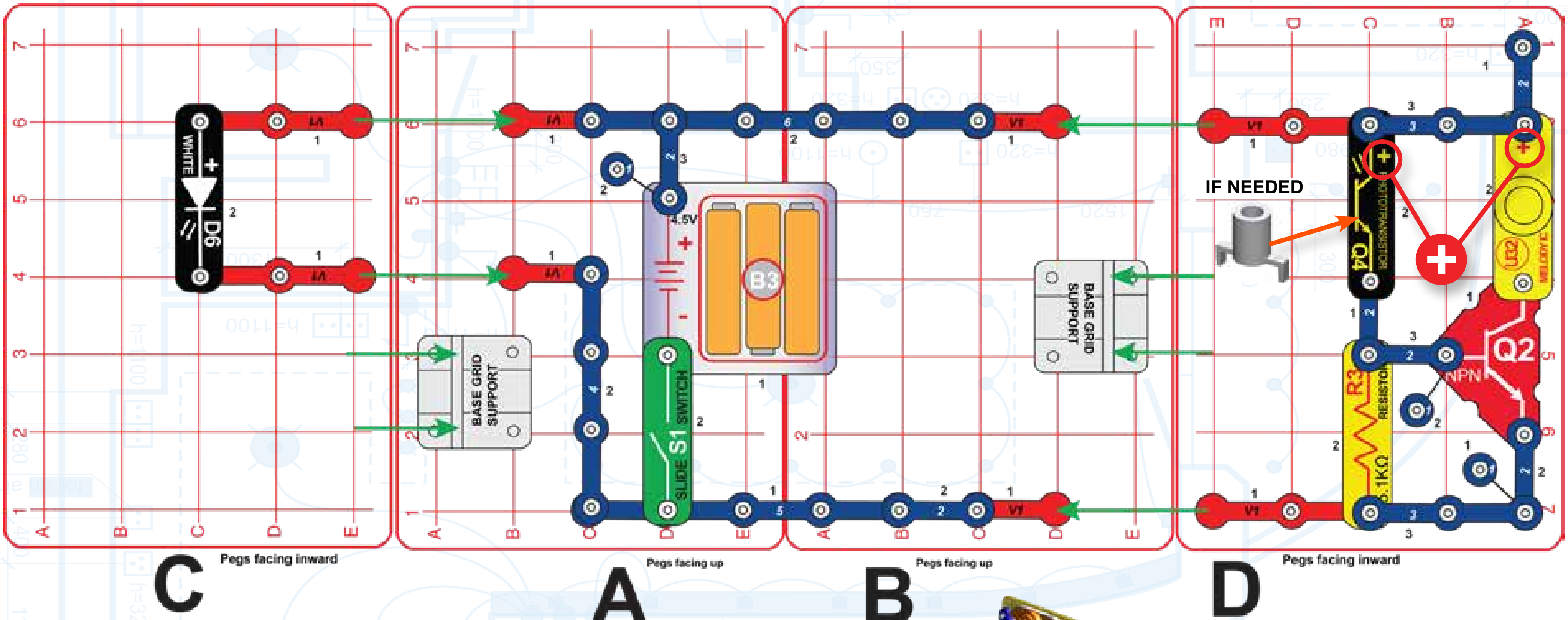
Assembly (adult supervision recommended):

1. Place base grid supports on base grids A&B.

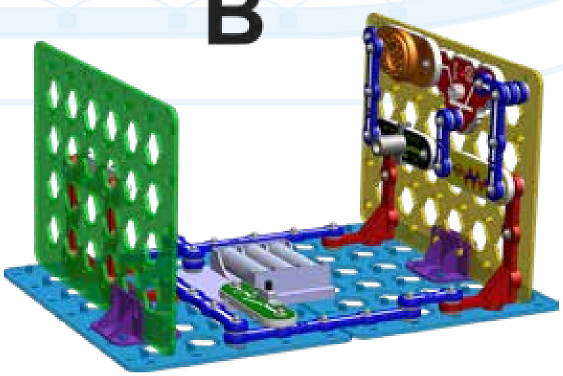
2. Place parts on grids C&D and install into base grid supports on grids A&B.

3. Install remaining parts on grids A&B.

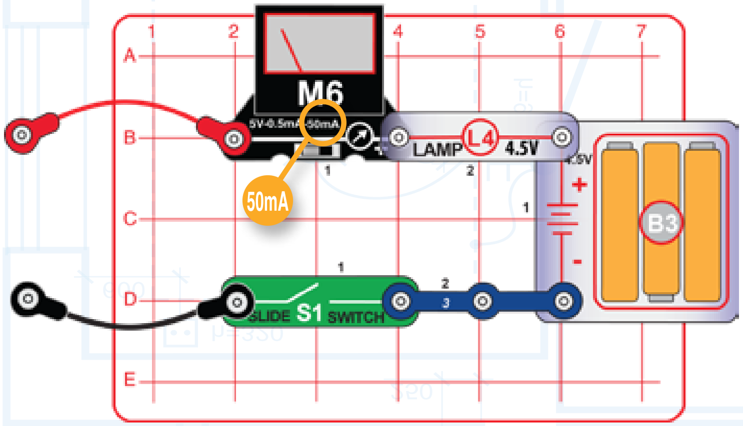
Turn on the slide switch (S1); the white LED (D6) and melody IC (U32) are on. Place your hand to block the light between the white LED and phototransistor (Q4); the sound stops. **Hint:** The light in your room may be keeping the sound on, to check for this, try pointing the phototransistor away from your room light.



This circuit is the opposite of the Security House project (roofless version). The positions of resistor (R3) and phototransistor (Q4) have been switched, reversing how the melody IC (U32) is activated. Now the “alarm” is always on unless you block the light to turn it off.



Project 11 I MATERIALS TESTER



You can calculate the resistance of the materials you tested using Ohm's law: Resistance = Voltage / Current. From the information on your batteries, you know that the Voltage is around 4.5V, and you can measure the Current using the meter.

WHAT IS RESISTANCE: If you rub your palms together very quickly, they will begin to feel warm. The **friction** between your hands converts the physical motion of your body into heat. Resistance is the friction between an electric current and the material it flows through; and, like friction, resistance creates heat as well. We use electrical components called **resistors** to increase this electrical friction (resistance) to control how electricity flows through circuits. In this circuit, the resistor (R3) decreases the brightness of the LED, makes it dimmer but which also makes the batteries last longer.

Build the circuit and set the meter (M6) to the 50mA setting. Turn on the slide switch (S1) and touch (or connect) various materials between the loose ends of the red & black jumper wires. See which materials are good at transporting electricity by watching the meter current and lamp (L4) brightness. Try string, the electrodes, a shirt, plastic, paper, two of your fingers, wood, or anything in your home.

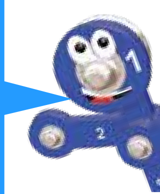
If the meter reads zero, switch it to the 0.5mA setting to see if there is just a very small current. To help protect the meter, always switch back to the 50mA scale before testing a new circuit.

Which materials gave the highest reading on the meter, and which gave the lowest?

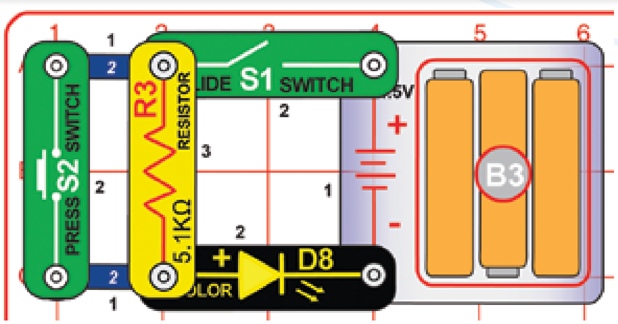
Some materials, like copper, gold, and platinum metals, have very low resistance to electricity, meaning electrons travel through them very easily. This is why the lamp glows brightly and the meter measures a large current. Because we can conduct electricity (or make it flow) through these materials, we call them conductors.

Other materials, like paper, air, and plastic, have very high resistances to electricity, meaning they nearly block the flow of electrons completely. We call these kinds of materials insulators. If you incorporate these insulating materials into the circuitry, they cause the lamp to turn off and the meter to read a current of 0 even at its lowest setting (0.5 mA).

The best conductor known to humans is silver, but it would be very expensive to build circuits out of silver. Copper is the second-best conductor and, because it is much cheaper, it is used in almost all electrical wiring.



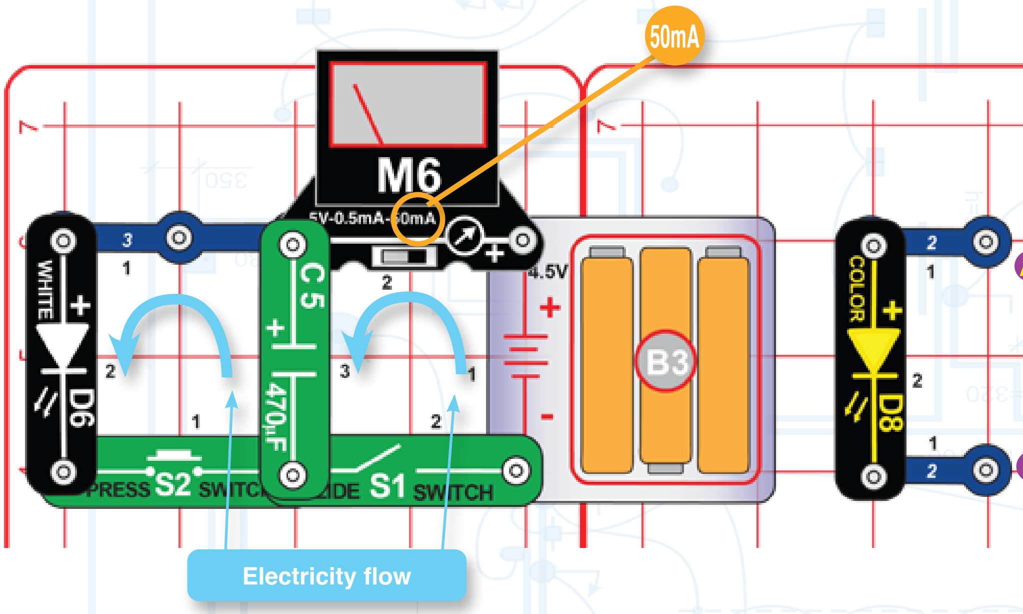
Project 12 I DIM COLOR LIGHT



Build the circuit as shown and turn on the slide switch (S1); the color LED (D8) will be dim. Push the press switch (S2) to make the LED much brighter.

Next, replace the color LED (D8) with the white LED (D6) and compare the results.

Project 13 | MINI BATTERY



Watch the current measured by the meter. Turning on S1 allows electricity to flow from the batteries into capacitor C5, causing the current to increase; but the flow of electricity stops when C5 is fully charged (that is, when all the electrons that can crowd into the capacitor do so). In this way, charging a capacitor is a lot like filling a water tank – you can only push as many electrons/ water droplets into them as they can hold.

When S1 is off and you press S2, the electricity that is stored in C5 flows through S2 and lights the white LED. The LED stays lit until C5 is discharged, meaning all the electrons that crowded into the capacitor have dissipated or moved away. Dissipating a fully charged capacitor is like opening the valve at the bottom of a full water tank – once the path is cleared, both water and electrons will flow freely.

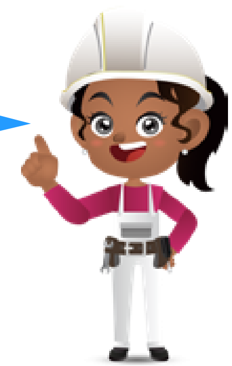
Build the circuit as shown and set the meter to the 50mA setting. Turn on the slide switch (S1) until the meter current drops to zero (indicating the 470μF capacitor (C5) is fully charged), then turn the switch off. Push the press switch (S2) to discharge the capacitor through the white LED (D6), lighting it. Turn S1 on and off and then push S2, several times.

Now turn S1 on and off, but then remove C5 from the circuit and place it across points A & B ("+" to A) and the color LED (D8) lights. Return C5 to the original circuit and repeat.

Pushing S2 while S1 is on connects the batteries directly to the white LED, and makes the effects of the capacitor difficult to see.

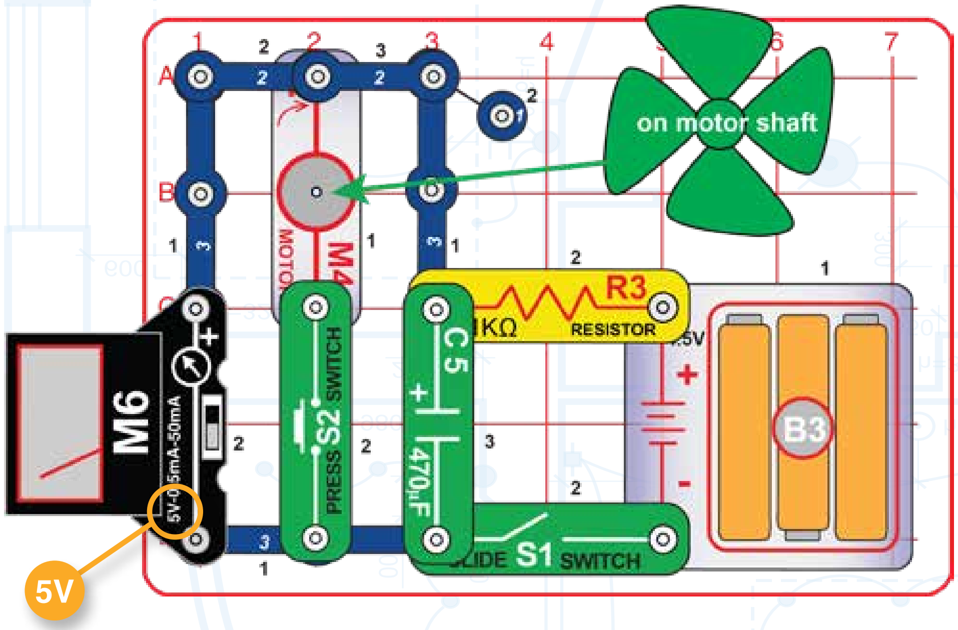
Capacitors like C5 store electricity like tiny rechargeable batteries. Although they can't store as much electricity as batteries, capacitors can store and release electricity much faster than batteries. And, like a battery, a capacitor can store electricity for a long time. To demonstrate this, once C5 is charged, remove it from the main circuit and place it across the mini circuit containing D8.

Capacitors and rechargeable batteries are used in many devices in your home to store information, like the date or time, when the devices are turned off or when the power goes out in your home.



Part B: Replace the slide switch (S1) with the 5.1kΩ resistor (R3) and set the meter to the 0.5mA setting. Now the capacitor charges up very slowly, because the resistor limits its charging current.

Project 14 I STORING ELECTRICITY

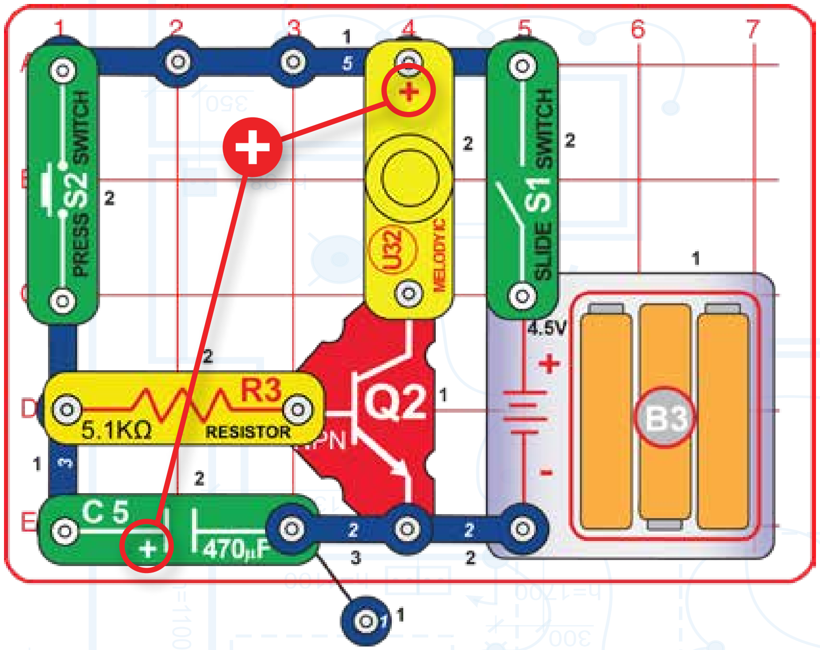


Build the circuit as shown and set the meter (M6) to the 5V setting. Turn on the slide switch (S1) and watch as the voltage slowly rises to 3V or more. Next push the press switch (S2) for a moment; the fan wiggles and the voltage drops to 0. Repeat this several times.

How it works: the 5.1kΩ resistor (R3) slows the flow of electricity from the batteries, causing the capacitor (C5) to charge up slowly and the voltage reading on the meter to increase. Pushing S2 discharges the capacitor, so that electricity flows through the motor. But the capacitor can only store enough energy to make the fan wiggle for a moment. Once the capacitor's charge has dissipated (meaning all the water has drained out of the tank), no more current will flow, so the fan does not move.

For outdoor lighting, you can use a photocell or timer, so the lights are off when there is daylight, or use "motion sensitive" lights instead of continuous lighting.

Project 15 | FADER



Build the circuit as shown, turn on the slide switch (S1), and then push the press switch (S2) to hear a melody. After you release the press switch the sound slowly fades out. Push the press switch to resume the sound.

Part B: Replace the melody IC (U32) with the motor (M4) and fan. The fan spins for a time after the press switch is released.

Part C: Replace the motor and fan with the white LED (D6). The LED slowly dims after you release the press switch.

Pressing S2 instantly charges up the 470μF capacitor (C5) and makes a control current flow into the NPN transistor (Q2), which turns on the melody IC. When S2 is released, the electricity stored in C5 slowly drains into Q2 through the 5.1kΩ resistor (R3), keeping the transistor and melody IC on for a short time until the capacitor has discharged. The white LED stays on longer than the melody IC or motor, because the white LED can operate at a lower current than the others.

Capacitors are used in fading circuits like this in your home, like when the light slowly fades as you leave the room or you hear a short stretch of music after you have turned off the radio.

Project 16 I TIMED WALL OF FUN

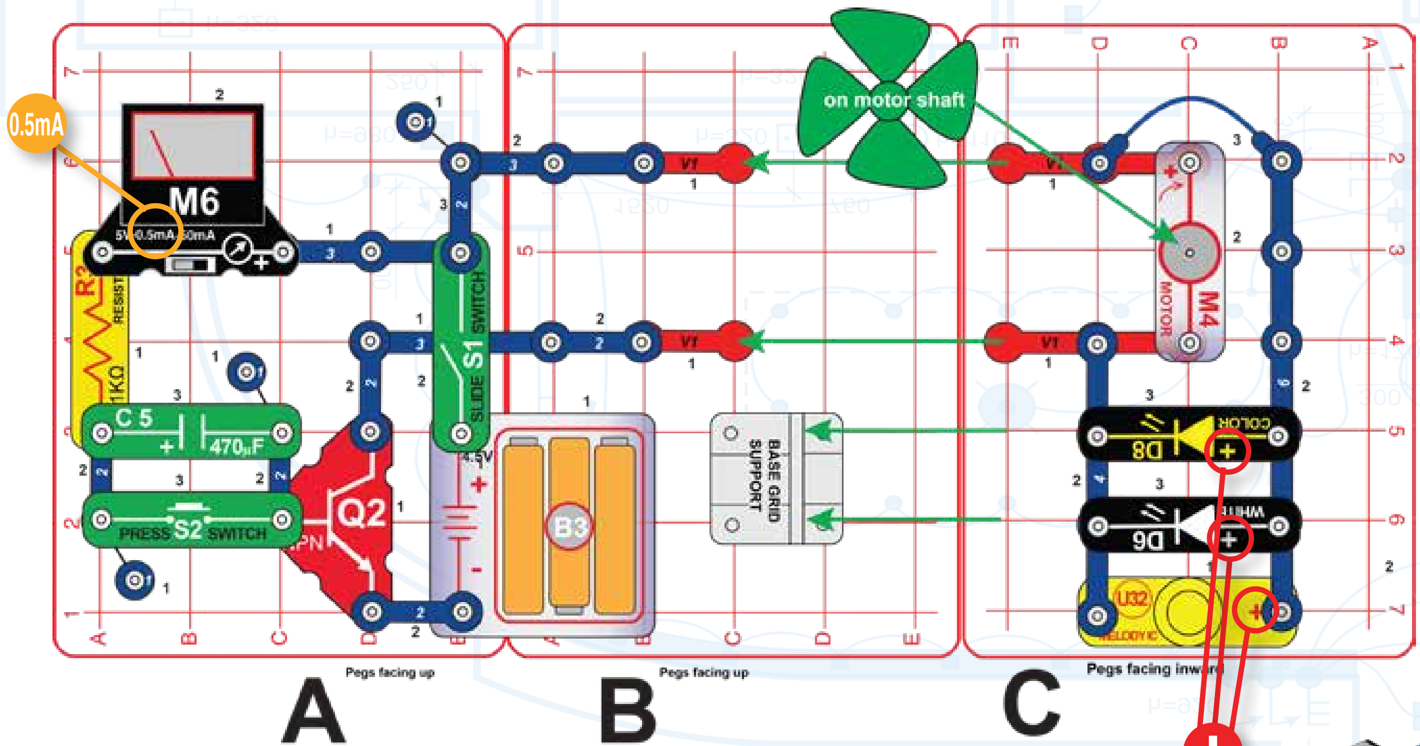
Assembly:

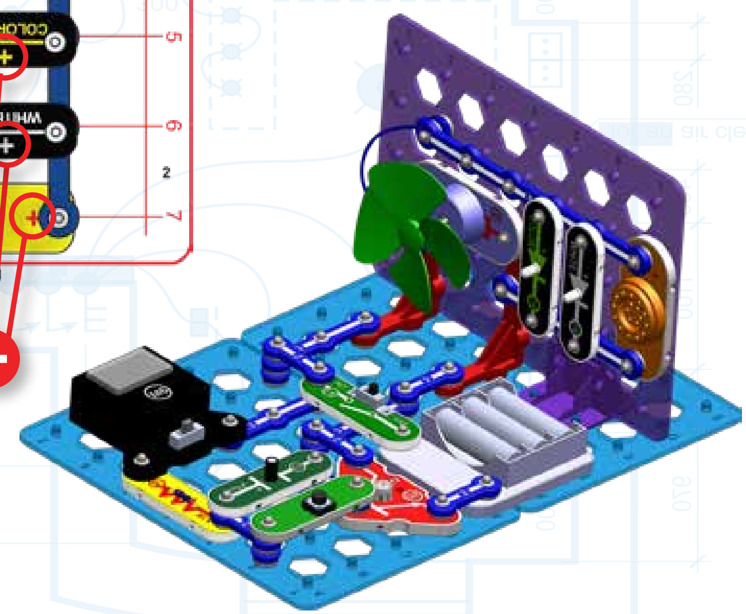
1. Place the base grid support on base grid B.

2. Place parts on grids C and install into base grid supports on grid B.

3. Install remaining parts on grids A&B.

Set the meter (M6) to the 0.5mA scale, push the press switch (S2), and then turn on the slide switch (S1). The motor (M4) spins the fan, the LEDs (D6 & D8) light, the melody IC (U32) plays a tune, and the meter measures the current charging the 470μF capacitor through the 5.1kΩ resistor. The meter shows the current decreasing and soon everything stops. Push the press switch to re-start the circuit.

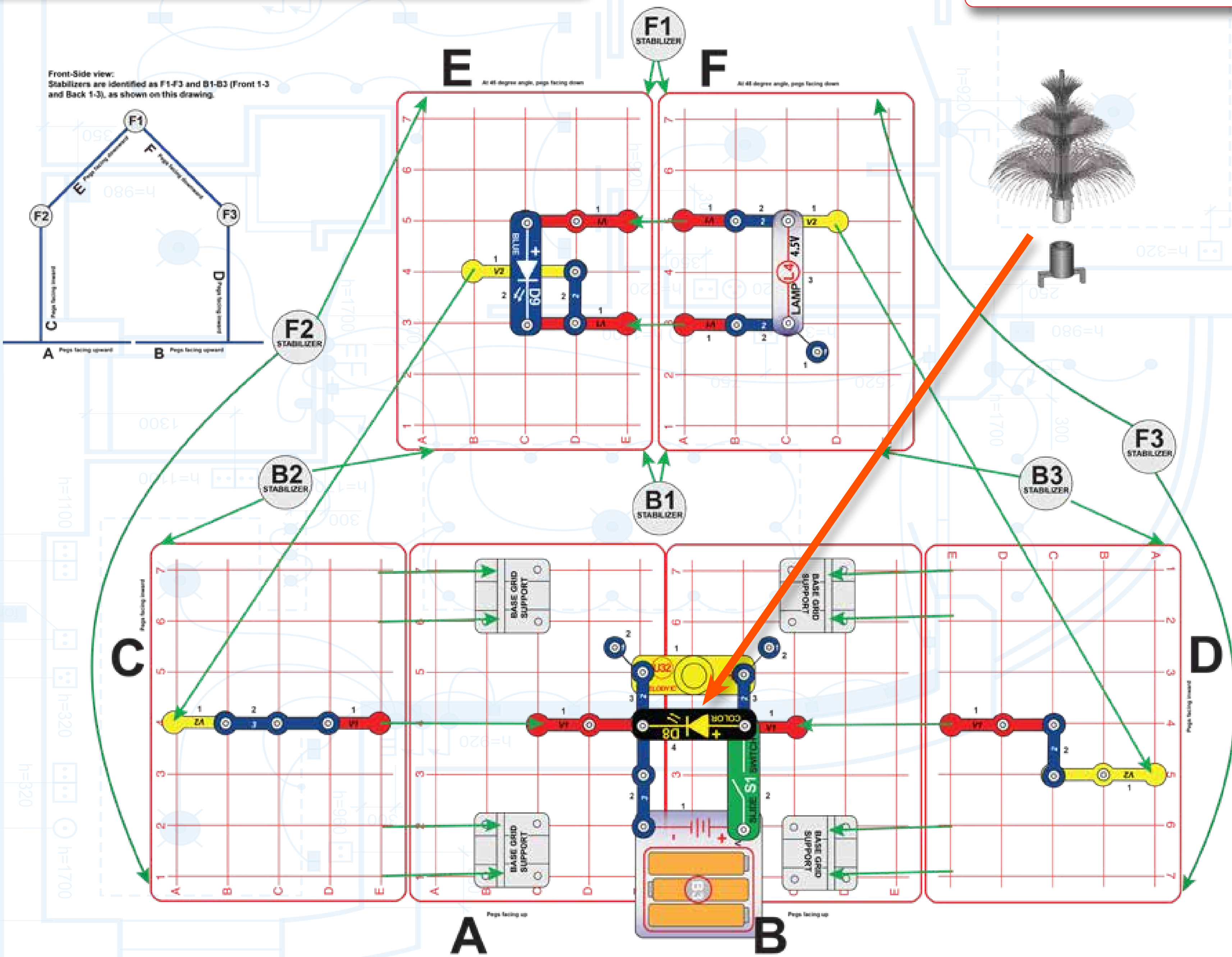




The lights, fan, and sound are on while capacitor C5 is charging, then stop as the capacitor gets fully charged. Pressing S2 instantly discharges the capacitor and resumes the fun. The circuit would run longer if you used a higher value resistor or capacitor, because then the charging would take longer.

Project 17 | FESTIVE HOUSE

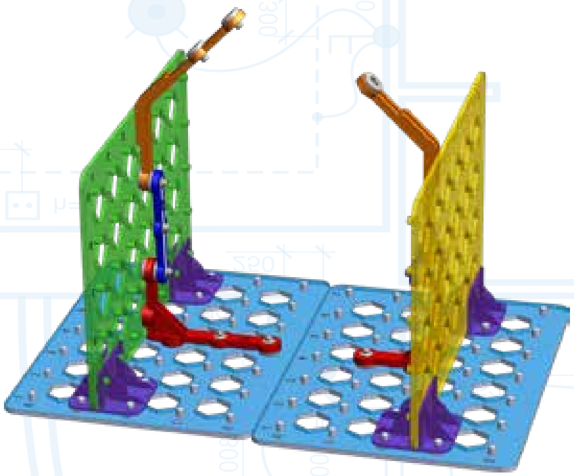
Do not leave the circuit for two minutes because the lamp will be hot.



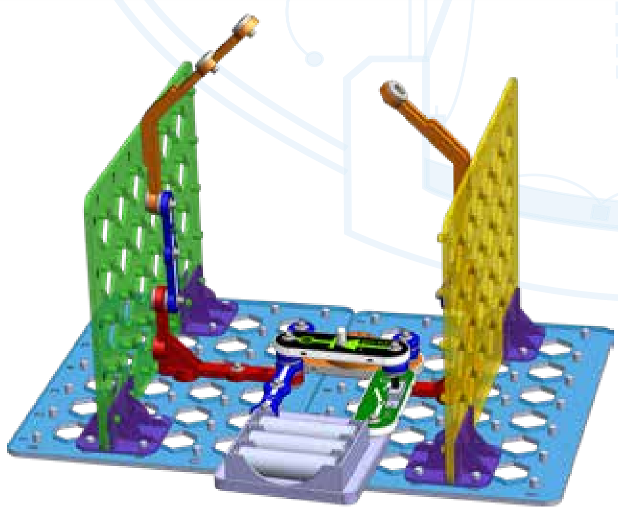
Assembly (adult supervision recommended):

1. Place base grid supports on base grids A & B.

2. Place parts on base grids C & D, and install into base grid supports on grids A & B. The pegs should be facing inward.

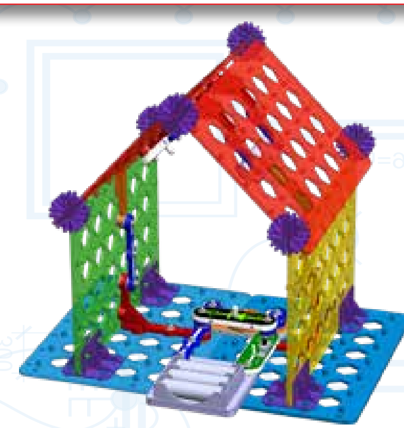


3. Place remaining parts on grid A & B.

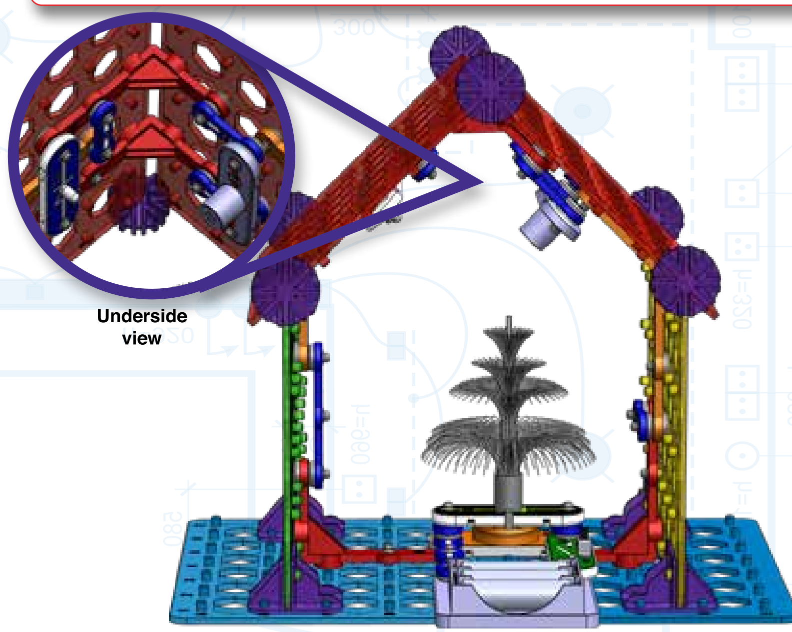


4. Mount grids E & F, at the angles shown and with pegs facing down, on top of grids C & D using 6 stabilizers. attaching 2 vertical snap wires (V1) and 2 angled snap wires (V2) as you do it. Adjust the positions of the stabilizers as needed.

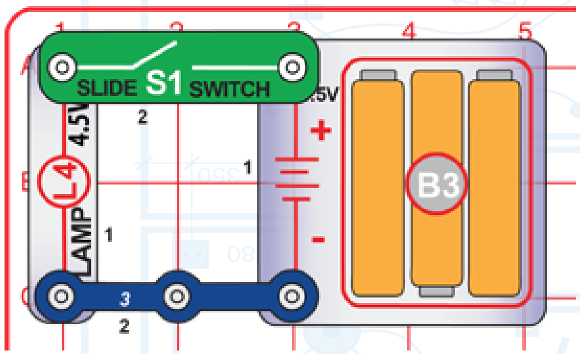
5. Add the remaining parts on grids E & F.



6. Place the fiber optic festive tree in its holder and on the color LED (D8). Turn on the slide switch (S1) to light the LEDs (D8 & D9) and lamp (L4).



Project 18 | ELECTRIC HEATER

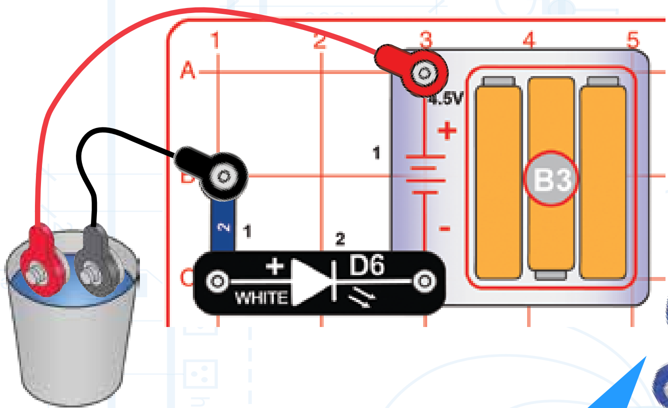


Turn on the slide switch (S1), cover the holes in the top of the lamp (L4) with your finger, and wait. After a minute or so you should feel the lamp heating up. *Do not leave the circuit for two minutes because the lamp will be hot.*

⚠ **CAUTION:** very warm lamp enclosure.

Incandescent light bulbs like L4 contain a special thin wire that gets so hot when electricity flows through it that it glows. Only about 5% of the electricity used in incandescent light bulbs is used to make light; the rest becomes heat, which is why you can feel the L4 lamp heat up when you cover its venting holes. Electric space heaters convert electricity to heat in a similar way to warm up a room.

Project 19 | WATER COMPLETES CIRCUIT



Distilled (or filtered) water has almost no impurities (or things other than water molecules) in it. Because of this, distilled water has a very high electrical resistance, meaning that current doesn't flow through it easily.

The water that comes out of your tap has chlorine, fluoride and other chemicals to make it safe for you to drink. Because of these impurities, tap water has a low electrical resistance, meaning that current flows through it rather easily.

Adding salt (sodium chloride) to the water decreases its resistance even more, because this adds sodium and chloride ions (or movable charges) to the mix. This is why it is incredibly important that you don't enter a swimming pool when there's a chance of lightning. If lightning occurs anywhere near the pool, the high-energy electrons will follow the path of least resistance straight into the water and, because your body is mostly water, into you.

Build the circuit as shown, leaving the ends of the red & black jumper wires unconnected for now. Turn on the slide switch (S1); the white LED (D6) should be off.

Place the loose ends of the red & black jumper wires into a cup of water (but not distilled water), without them touching each other. The white LED should be on now, because water conducts electricity, completing this circuit.

Try dissolving some salt in the water or using different liquids, and see how the LED brightness changes. You can also replace the white LED with the color LED (D8).

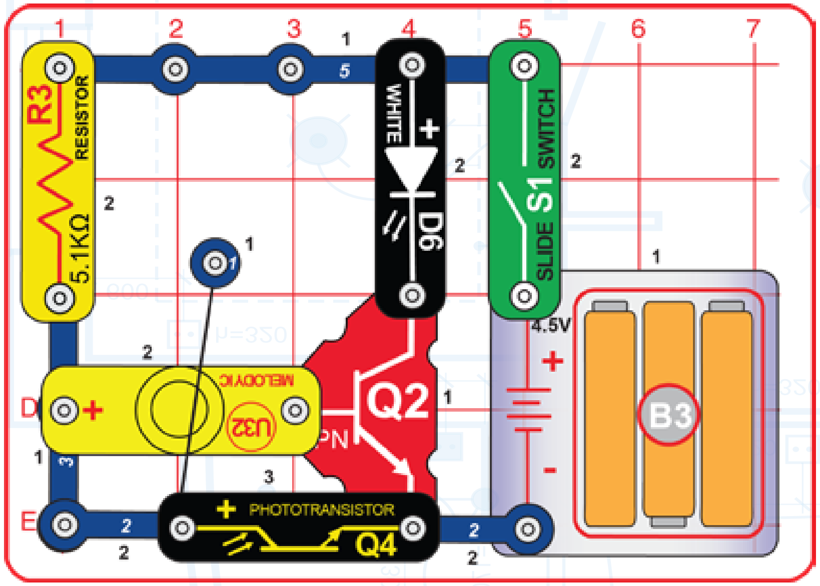
Don't drink any liquids used here.

There is no danger in touching the circuits you build with Snap Circuits because of the low-voltage batteries they use (4.5V). But the electricity from your electric company is a much higher voltage (120V), and it can seriously injure and even kill you if it enters your body. This is why it is important that you never touch a wire without disconnecting it from the electricity (by turning it off and unplugging it) or without placing proper insulation (materials that electrons cannot travel through) between you and the wire (which is why most of the wiring inside appliances has a colorful plastic coating).

Because tap water is **conductive** (low resistance), dropping a **live** wire (a wire that is plugged into your house's electricity) into your bath connects every wet part of your body to the 120V electricity flowing through the wiring in your house.

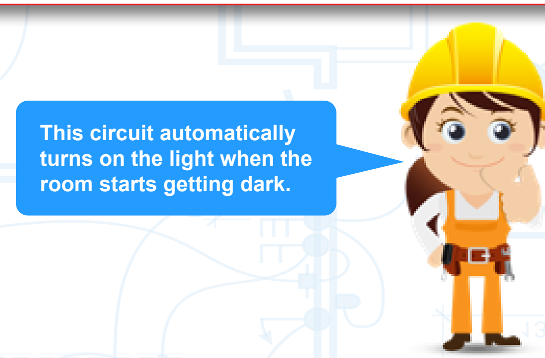
Part B: Instead of placing the red & black jumper wires in water, touch the metal part of each with your fingers, using your body to complete the circuit. Wet your fingers to get better electrical contact. The white LED (D6) should be on, but brightness may vary.

Project 20 | AUTOMATIC LIGHT

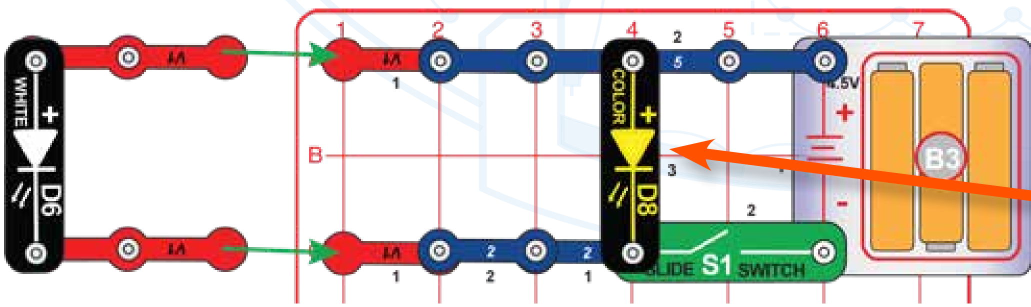


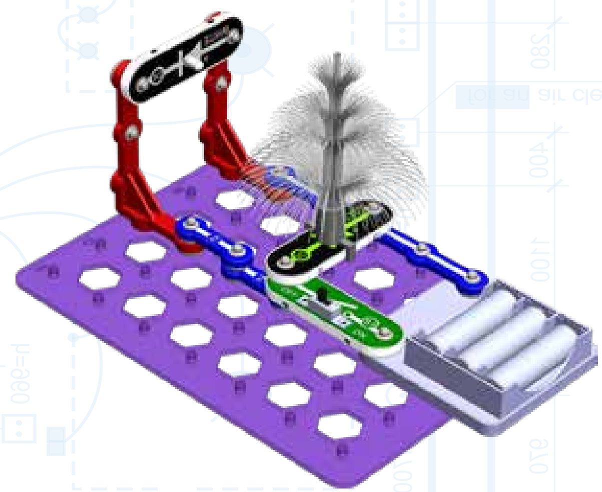
Build the circuit and turn on the slide switch (S1). The white LED (D6) will be on unless there is bright light on the phototransistor (Q4), so vary the amount of light shining on the phototransistor.

The melody IC (U32) will make little or no sound (it is used here to help control the phototransistor current).



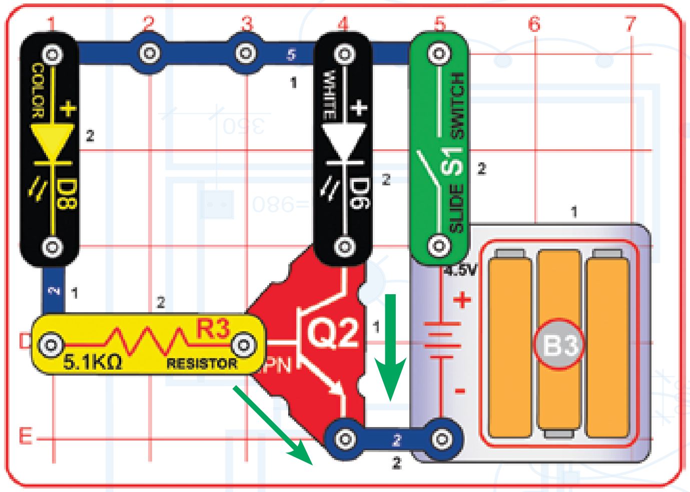
Project 21 | TREE LIGHTING





Use two vertical snap wires (V1) and mount the white LED (D6) on them so it will shine towards the festive fiber tree, mounted on the color LED (D8). Turn on the slide switch (S1) and place the circuit in a dimly lit room. Replace the white LED (D6) with the blue LED (D9) to change the look.

Project 22 | TRANSISTOR AMPLIFIER



Turn on the slide switch (S1). The color LED (D8) is dim but the white LED (D6) is bright.

Part B: Remove either LED (D6 or D8) and see what happens to the other one.

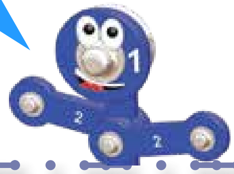
Part C: Swap the locations of the white LED (D6) and the color LED (D8).

Part D: In the original circuit, replace the color LED with the press switch (S2). Notice that the white LED is only on when S2 is pressed.

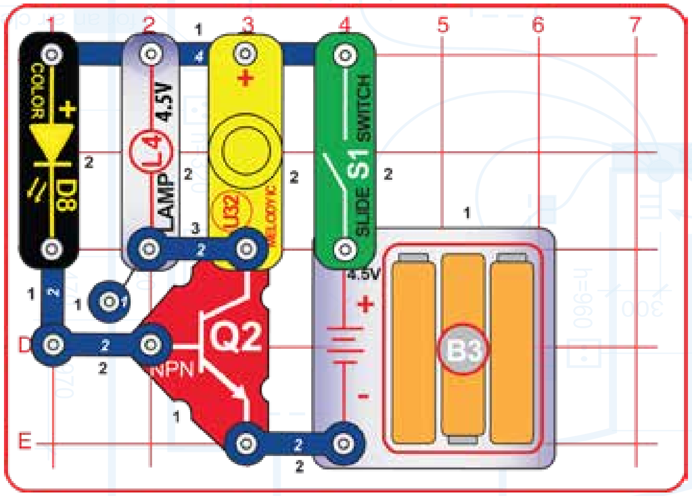
The NPN transistor (Q2) is a current amplifier, meaning it takes a small current and makes it larger. When a small current flows into Q2 through the left branch (through D8), a larger current will flow into Q2 through the right branch (with D6). Green arrows show the current flow. This is why the LED on the right side will be brighter than the LED on the left side. In fact, the current in the right branch can be as much as100 times larger than the current in the left branch.

The left branch controls the right branch, so removing D8 turns off D6, but removing D6 does not affect D8.

A small electric current may be flowing through the color LED even when it appears to be off. This small current, when it pass through the NPN transistor (Q2) and gets amplified, can be enough to keep the white LED on.



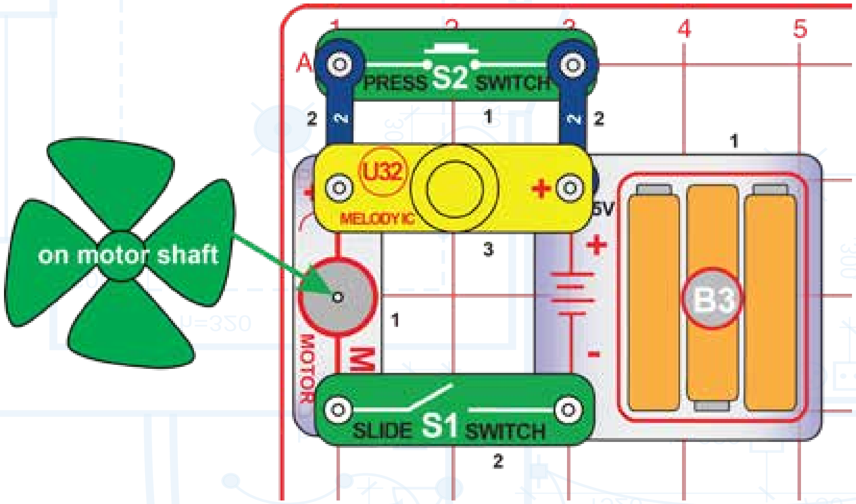
Project 23 | LIGHT & SOUND



Turn on the slide switch (S1) to get a blinking light with funky sounds. You can change the sound by removing the lamp (L4).

This circuit uses the blinking pattern of the color LED (D8) to control the current flowing through the lamp (L4) and melody IC (U32), making them go on and off. The NPN transistor (Q2) allows D8 to control the other electrical components. The melody IC does not start up instantly, so the blinking pattern of the color LED produces unusual sound effects in the melody IC.

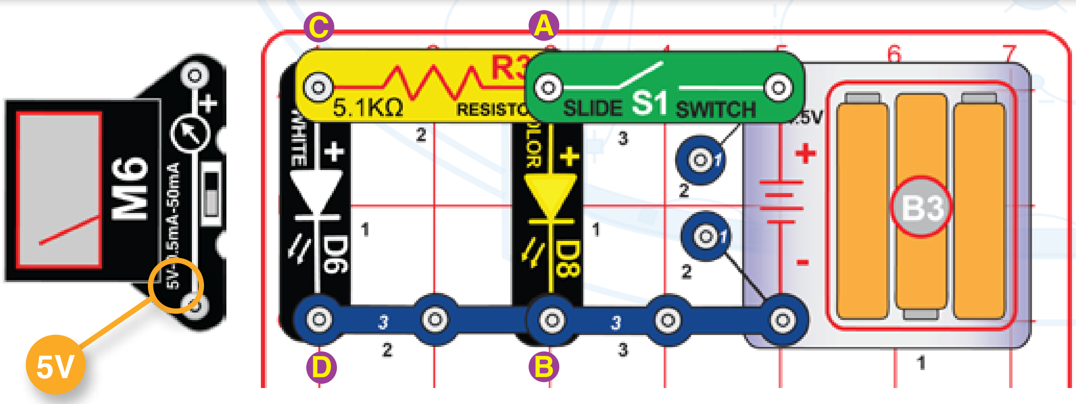
Project 24 | AUDIO FAN SPEED ADJUSTER



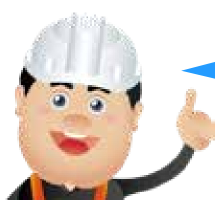
Turn on the slide switch (S1). The fan should spin and there should be sound from the melody IC (U32). If the fan does not spin then push the press switch (S2) to get the fan started.

The speed of the fan varies depending on the current flowing into the melody IC, and the melody IC current depends on the sound it is making.

Project 25 | DISTANCE LOSS SIMULATOR

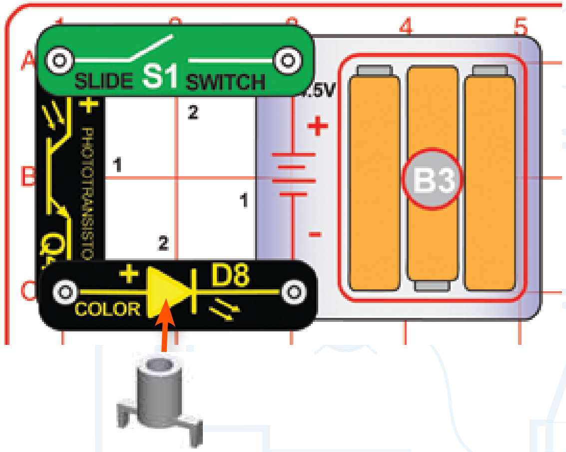


This circuit is intended to simulate electrical transmission loss over long distances. Turn on the slide switch (S1). The color LED (D8) is bright but the white LED (D6) is not at full brightness. Set the meter (M6) to the 5V setting and place it across points A & B to measure the voltage across the color LED, and then across points C & D to measure the voltage across the white LED.



The color LED is only separated from the batteries by the slide switch (S1), so it gets the full battery voltage (pressure) when the switch is on. The white LED is separated from the batteries by the 5.1kΩ resistor R3 (which represents the loss of electrical energy when it is transmitted over long distances); this slows down the current so that the white LED has a noticeably lower voltage across it.

Project 26 I LIGHT-CONTROLLED LIGHT



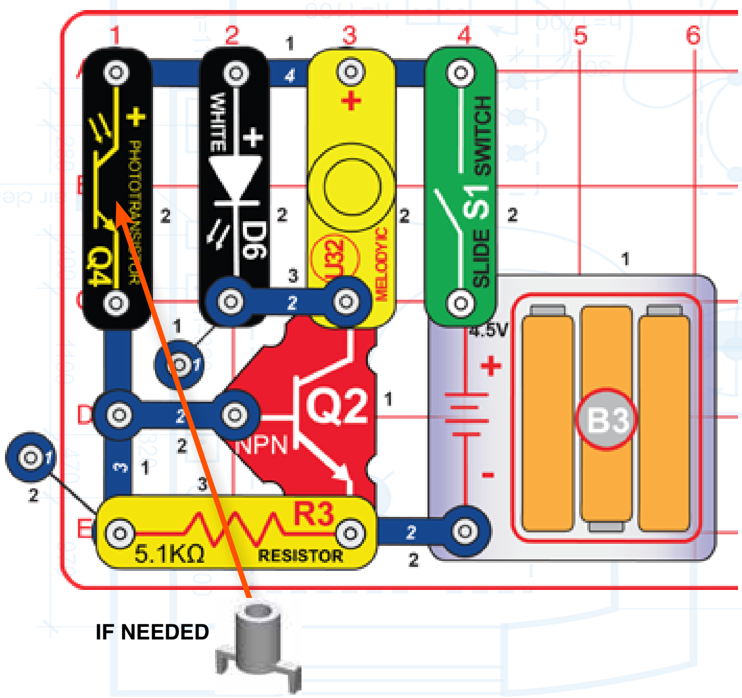
Turn on the slide switch (S1) and vary the amount of light shining on the phototransistor (Q4). The brighter the light on the phototransistor, the brighter the color LED (D8) should be. The Q4 attachment is placed on D8, to make it easier to see if it is dim.

Next, replace the color LED (D8) with the white LED (D6). Compared to the color LED, the white LED requires more light on Q4 to turn on, but gets brighter when there is a lot of light on Q4.

The phototransistor uses light to control electric current. When more light shines on the phototransistor, the current flowing through it increases, making the LED glow more brightly.

Project 27 I PHOTO CONTROL

In this project, the phototransistor is able to control other devices (like the LEDs) much more easily than in the preceding project. This is because the NPN transistor (Q2) is used to amplify (or increase) the current, enabling the small current that passes through the phototransistor to control the much larger electric current that passes through the LEDs.



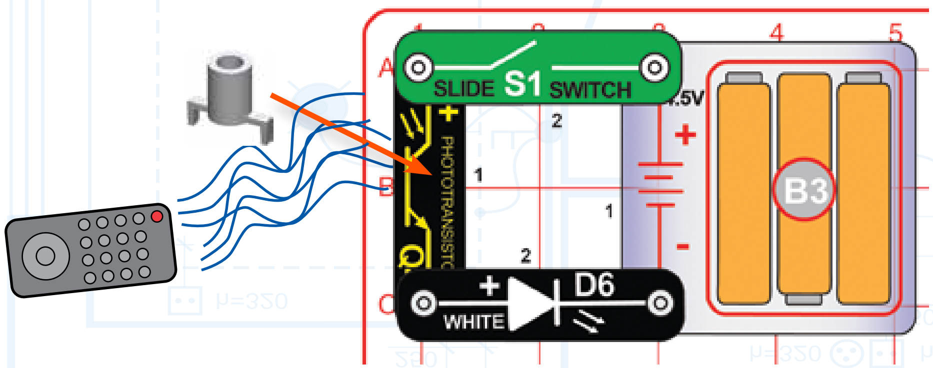
Build the circuit and turn on the switch (S1). The white LED (D6) and melody IC (U32) will be on if there is light on the phototransistor (Q4); cover the phototransistor to turn them off. If the LED and melody IC turn on too easily then place the Q4 attachment on Q4 to restrict the light to it. You can also replace D6 or U32 with the color LED (D8) or the lamp (L4).

Part B: Remove the resistor (R3), and see how its sensitivity to light changes. (The resistor (R3) diverts some current from the phototransistor to keep the circuit from being too sensitive to light.)

Part C, Adjustable Speed Fan: In the original circuit, replace the melody IC (U32) with the motor (M4) and fan. Vary the amount of light shining on the phototransistor to adjust the fan speed.

Part D: In the original circuit, swap the locations of Q4 and R3 (for Q4, put “+” on left). Now the light control is opposite.

Project 28 | INFRARED-CONTROLLED LIGHT

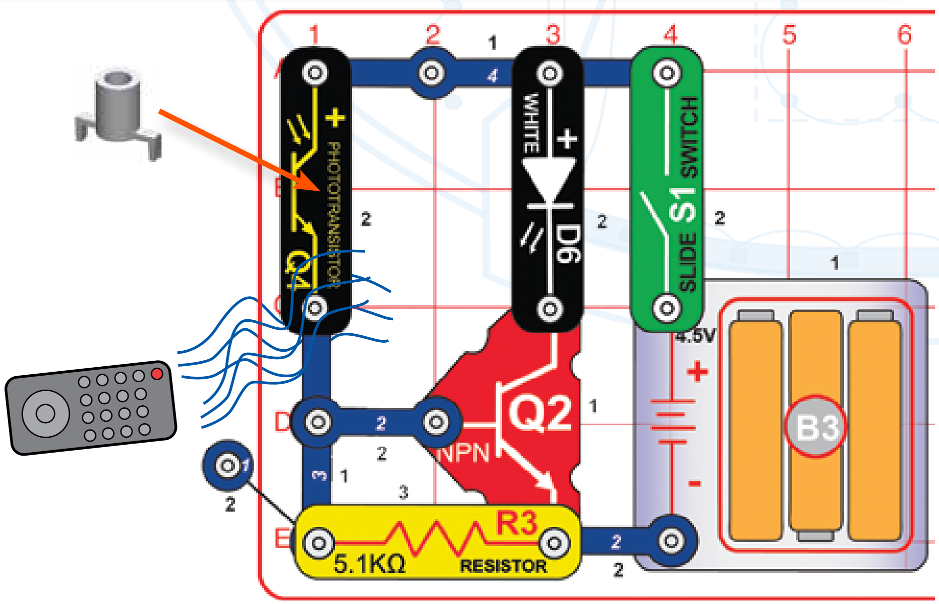


You need an infrared remote control for this project, such as any TV/ stereo/DVD remote control in your home.

Build the circuit and turn on the switch (S1). Place the Q4 attachment on the phototransistor (Q4). Position the circuit away from lights in the room so that the white LED (D6) is off. Point your remote control directly into the Q4 attachment, and press any button to turn on the white LED. The LED may not get very bright.

The phototransistor detects light, including infrared light that is invisible to the human eye.

Project 29 | IR CONTROL



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

Turn on the slide switch (S1) and place the Q4 attachment on the phototransistor (Q4). Position the circuit away from lights in the room so that the white LED (D6) is off. Point your remote control directly into the Q4 attachment, and press any button to turn on the white LED.

Note that when the phototransistor (Q4) is activated by room lights the white LED is on continuously, and when the phototransistor is activated by your infrared remote control LED will be blinking.

The phototransistor detects light, including infrared light that is invisible to the human eye. The white LED blinks even if you press the remote control continuously, because the signal that is coming from your remote control is a stream of infrared light bursts. Each burst of infrared light causes a burst of current to flow through the LED, making it blink.