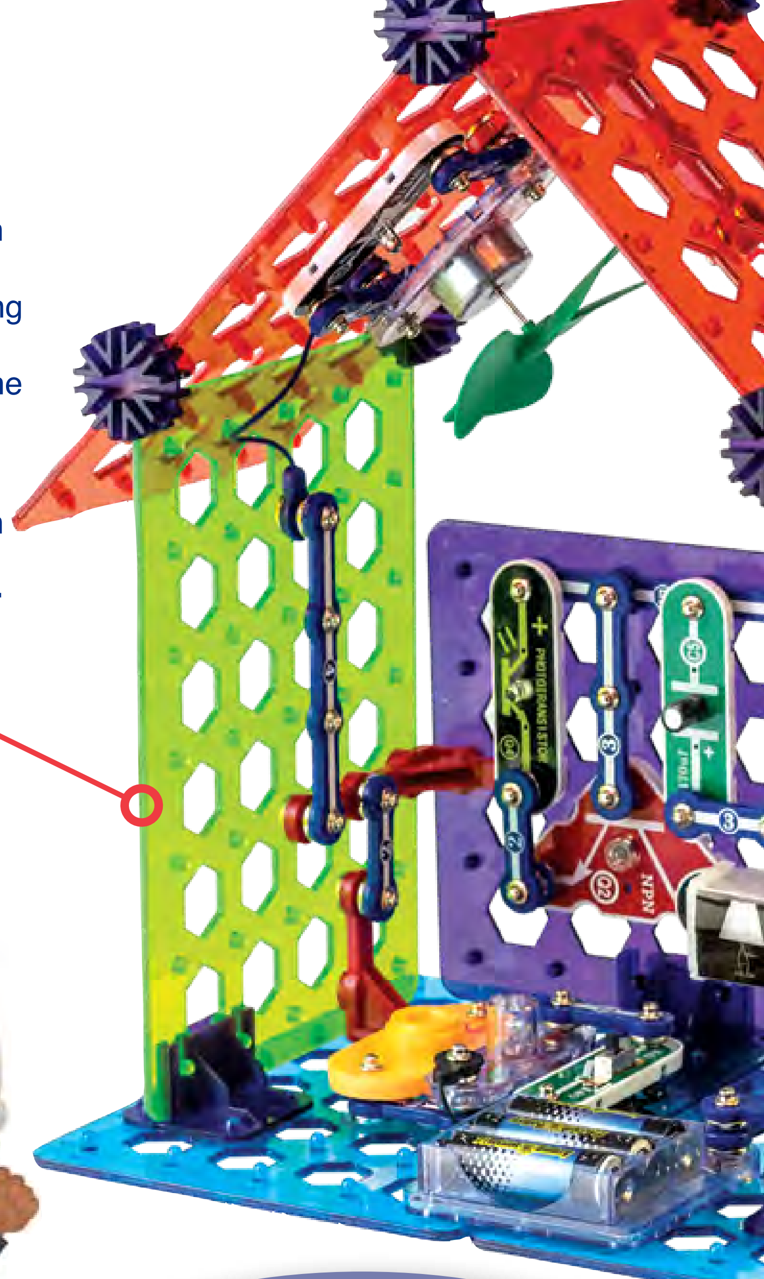
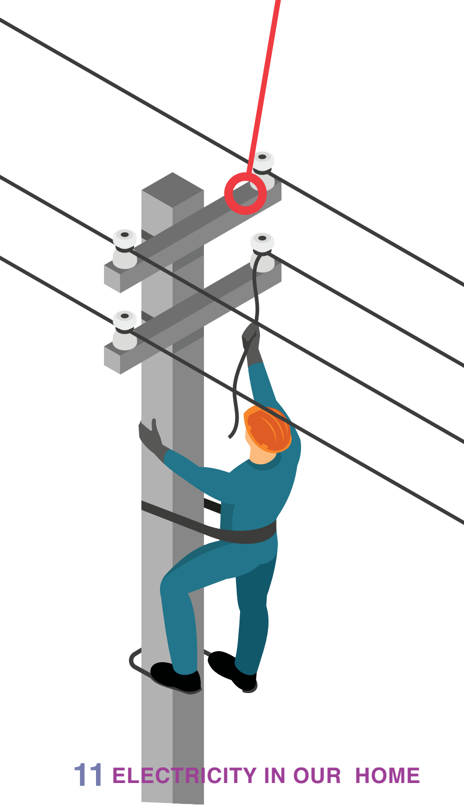
**When lightning (or ice or wind) causes a tree to fall and break a power line**, a gap is created in the line that cuts off electricity to every building along its route. If it is a main transmission line, entire towns and cities can lose power until the line is repaired. When this happens, it's no use plugging your appliances in and turning them on, the electricity is 'out'. This is when batteries come in handy; and your phone, your car, your video-game controller wouldn't be the same without them.

After successfully passing through the fuses or circuit breakers in your service panel, the electricity travels through wires inside your walls to outlets and switches all over your house. The electrical wiring in **your house** is hidden by plaster and wooden walls, ceilings, and floors and requires a lot of work to install and access when repairs are needed.

Use your electrical appliances according to their instructions in order to ensure the electricity in your house works the way it's intended.





**It's *your home and your power*, you should know how it works to keep your gadgets going and to stay safe!**

**Thank you**
to children's author Melissa Rooney, PhD, for her assistance in writing the Introduction and other sections of this manual.
You can find out more about Melissa at www.melissarooneywriting.com.

# PROJECT LISTINGS



**Projects 1-2 demonstrate your parts in simple circuits.**

**Projects 3-4 demonstrate simple circuit arrangements.**

**Projects 5-6 demonstrate using a motor as a generator.**

**Project 7 is a simple 3D circuit construction.**

**Project 8 demonstrates and explains what electricity does in a home.**

**Projects 9-29 are basic circuits and applications.**

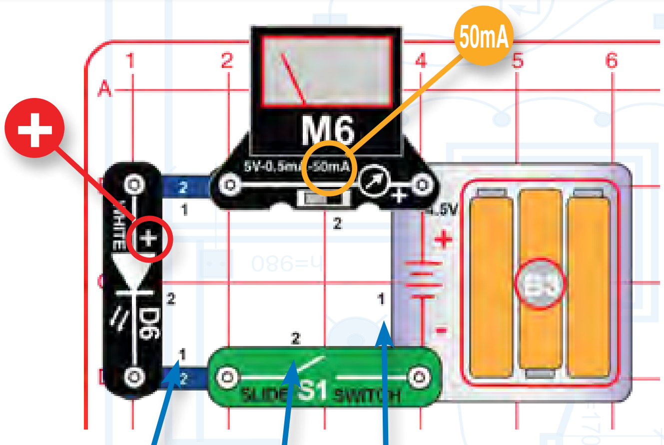
**Projects 30-33 are large 3D home circuits.**

**Project 34 demonstrates static electricity.**

**Projects 35-48 are basic circuits and applications.**

**Projects 49-53 are large 3D home circuits.**

# Project 1 | MEET YOUR PARTS




**Placement Level Numbers**

Build the circuit shown on the left by placing all the parts with a black **1** next to them on the base grid first. Then, assemble parts marked with a **2**. Install three (3) "AA" batteries (not included) into the battery holder (B3) if you have not done so already. Set the meter (M6) to the 50mA setting.

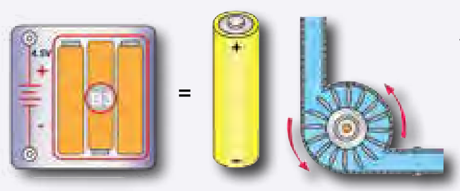
Turn on the slide switch (S1). The white LED (D6) lights and the meter measures the current.

**The circuits in this book often do not use a resistor or other component to slow down the electrical current passing through the LED. Normally this would damage an LED, because LEDs can only handle very low currents (much smaller than the current provided by your battery). But your Snap Circuits® LEDs have resistors built into them, and these internal resistors protect the LEDs by slowing down the current. Be careful if you use electrical sets with unprotected LEDs, as you will need to use external resistors to prevent them from burning out.**

**Snap Circuits® uses electronic blocks that snap onto a clear plastic base grid to build different circuits. These blocks have different colors and numbers so you can easily identify them. This set contains five different color base grids, you may use any one to build the circuit.**

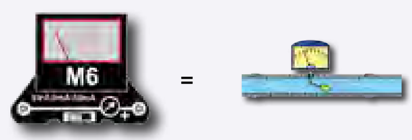
## WHAT IS REALLY HAPPENING HERE ?

1. The batteries (B3) convert chemical energy into electrical energy and "push" it through the circuit, just like the electricity from your power company. A battery pushes electricity through a circuit like a pump (or gravity in the case of a water tower) pushes water through pipes.

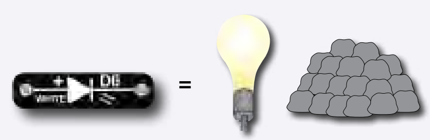


2. The snap wires (the blue pieces) carry the electricity around the circuit, just like wires carry electricity around your home. Wires carry electricity like pipes carry water.

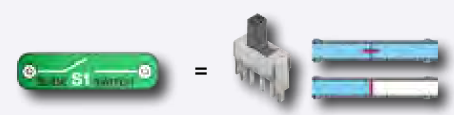
3. The meter (M6) measures how much electricity flows in a circuit, like a water meter measures how fast water flows in a pipe.



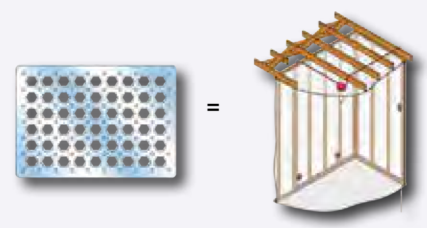

4. The white LED (D6) converts electrical energy into light, it is similar to a lamp in your home except smaller. LEDs are increasingly being used for home lighting because they are more efficient than other types of bulbs. An LED uses the energy carried by electricity, resisting its flow like a pile of rocks resists the flow of water in a pipe.



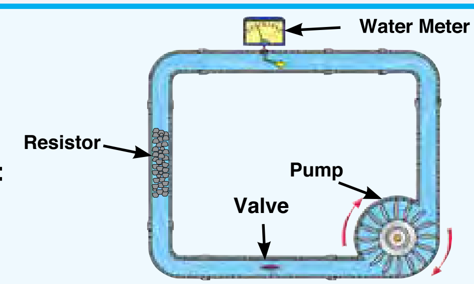
5. The slide switch (S1) controls the electricity by turning it on or off, just like a light switch on the wall of your home. A switch controls electricity like a faucet controls water.



6. The base grid is a platform for mounting the circuit, just like how wires are mounted in the walls of your home to control the lights.



**Comparing Electric Flow to Water Flow:**



**Part B:** Replace the white LED with the color LED (D8, "+" on top) and enjoy the light show as the meter measures the current. For best effects, dim the room lights.

**Part C:** Replace the color LED with the lamp (L4). The current measured on the meter will be very high and off the scale (you are measuring a 200mA lamp with a 50mA meter). Incandescent light bulbs are much less energy efficient than LEDs. *Do not leave the circuit for two minutes because the lamp will be hot.*

**Part D:** Replace the lamp with the melody IC (U32, "+" on top) and listen to the sound as the meter measures the current.

**Part E:** Replace the melody IC with the motor (M4) and green fan and see the fan spin as the meter measures the current. Reverse the orientation of the motor to make the fan spin in the opposite direction (this changes whether the fan blows air up or down).

**Part F:** Replace the motor with the phototransistor (Q4, "+" on top) and vary the amount of light shining on it. The current measured on the meter varies from near zero when you cover the phototransistor to high when you shine a flashlight directly on it.

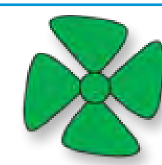
**Part G:** Replace the phototransistor with the 5.1kΩ resistor (R3) and see the current on the meter. The current will be very low, but you can change the meter to the 0.5mA setting to confirm that some current is flowing.

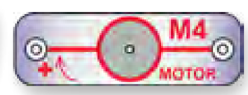
LEDs are light emitting diodes, which convert electrical energy into light. The color of light from an LED depends on the characteristics of the material used in it. The color LED actually contains separate red, green, and blue lights, with a micro-circuit controlling them.


The lamp (L4) converts electricity into light. It is an incandescent light bulb, just like other incandescent bulbs in homes except smaller. In an incandescent bulb electricity heats up a high-resistance wire until it glows, producing light. Incandescent light bulbs are very inefficient, converting less than 5% of the electricity used into light, with the rest becoming heat. LEDs are much more efficient than incandescent light bulbs, and are increasingly being used for home lighting and flashlights.


The melody IC makes an electrical pattern from tunes recorded in its memory. A speaker inside it then converts the electrical pattern into sound by making mechanical vibrations. These vibrations create variations in air pressure which travel across the room. You "hear" when your ears feel these air pressure variations.


The motor uses magnetism to convert electricity into mechanical motion (see page 57 [About Your Parts] for more explanation).



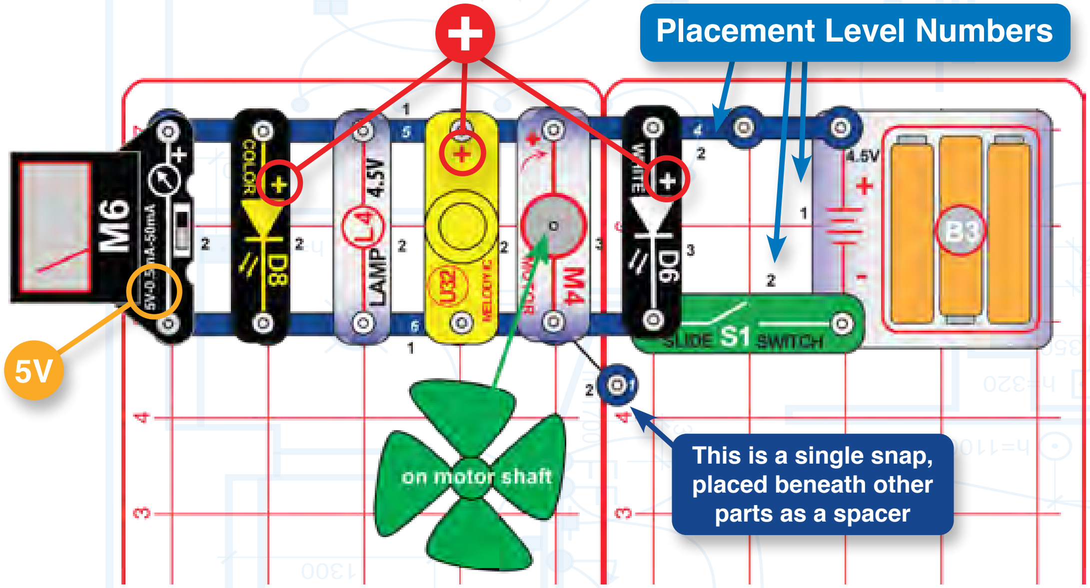


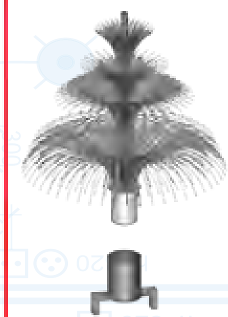

The phototransistor is a material whose electrical resistance varies depending on the amount of light shining on it.


A resistor "resists" or slows down the flow of electricity. Resistors are used to limit or control electricity in a circuit.


To learn more go to pages 77-80.

# Project 2 I WIRE UP! LIGHTS CAN SHARE THE SAME CIRCUIT



Build the circuit shown. Set the meter (M6) to the 5V setting. If desired, place the fiber optic festive tree in its mounting base and on the color LED (D8). Turn on the slide switch (S1) and enjoy the show.

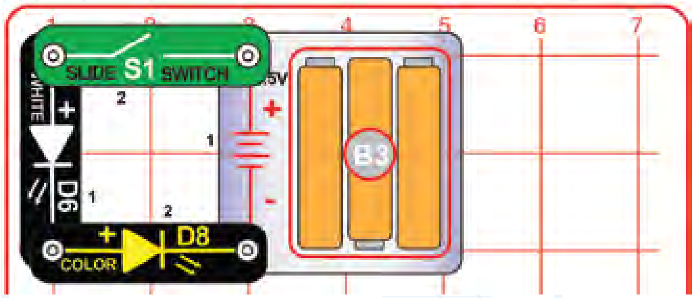
The meter measures the voltage from the batteries - this may be 4.5V if your batteries are new, but will likely be less because the circuit components are a heavy load on the batteries. Try removing the lamp, motor, melody IC, and LEDs, one at a time and see how the measured voltage changes. *Do not leave the circuit for two minutes because the lamp will be hot.*

The battery voltage (electrical pressure) may drop as the current increases, because the batteries may not be able to supply all the current the circuit needs. This effect is more noticeable when the batteries are weaker. The lamp needs much more current than the other components, so it has the greatest effect on the battery voltage.

**Note:** base grid colors are interchangeable, so use any color you like.

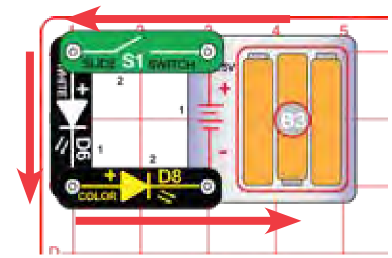
A “brownout” occurs when power plants cannot supply enough current to a city during high demand, and must reduce the voltage they supply. This sometimes occurs on hot days in summer when everyone is using their air conditioners.

# Project 3 | DEPENDENT LIGHTS




Build the circuit and turn on the slide switch (S1). The white and color LEDs (D6 & D8) should be blinking but may be dim. If neither lights at all then replace your batteries.

The two LEDs are connected in a series, and all the electric current from the batteries flows through each component in the circuit. The LEDs are dim because the voltage from the batteries (B3) is divided between them.

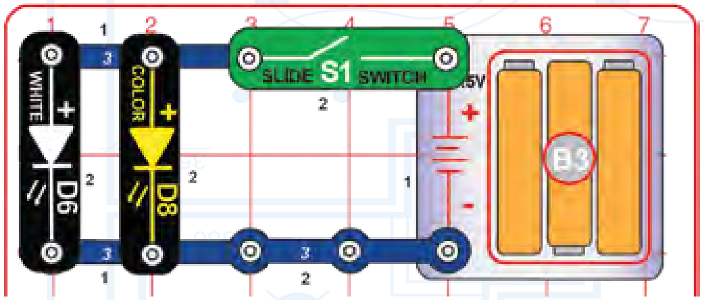



Connecting parts in series is one way of arranging them in a circuit. The advantage of it is that wiring them together is simple. The disadvantage is that if one LED breaks, all will be off.

**This circuit has both LEDs connected in SERIES. Series circuits are simple to connect, and allow one component to easily control another (here the white LED blinking is controlled by the color LED's blinking). The LEDs may be dim because the battery voltage may not be high enough to make both bright. If one LED breaks, then the circuit is broken and neither will work.**

**The slide switch (S1) is also connected in series with the LEDs, so it can turn them on and off.**

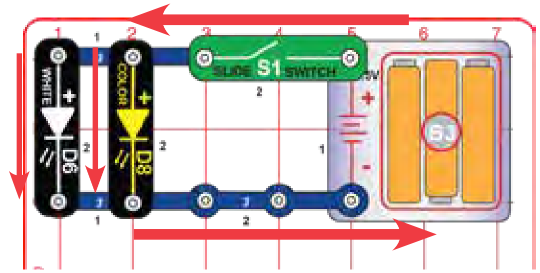
# Project 4 I INDEPENDENT LIGHTS




Build the circuit and turn on the slide switch (S1). The white and color LEDs (D6 & D8) are bright now and only the color LED is blinking.

Compare this circuit to the preceding circuit. This circuit has both LEDs connected in PARALLEL. Parallel circuits make components independent of each other but require more complex wiring (notice how this circuit requires more parts than the preceding circuit). Both LEDs are bright because each gets the full battery voltage, but they will drain the batteries faster. If one LED breaks then the other will still work.

In this circuit the batteries produce an electric current, which flows through the switch, then divides between the 2 LEDs, then re-combines and flows back into the batteries.




The two LEDs are connected in parallel with one another. They are bright because each LED gets the full battery voltage. Most of the lights in your house are connected in parallel; so if one bulb burns out then the others are not affected.

# Project 5 I WINDMILL

**Assembly:**

**1.** Place base grid supports on base grid B.

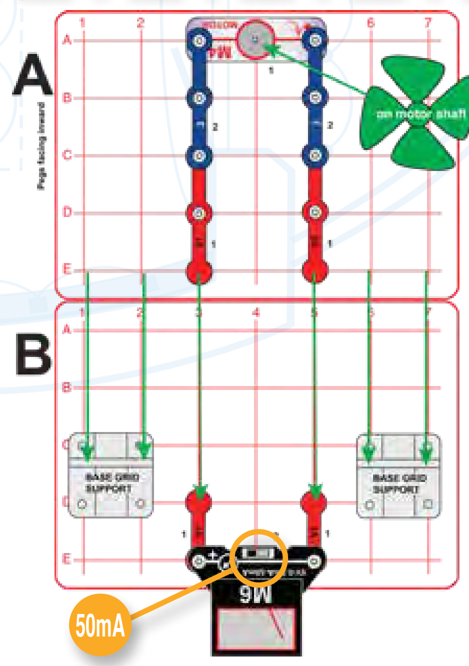
**2.** Place parts on grid A, and install into base grid supports on grid B.

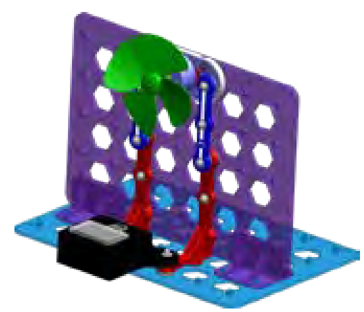
**3.** Install remaining parts on grid B.

Set the meter to the 50mA scale and blow on the fan to simulate a strong wind. You can also set the meter to the 5V scale to measure the voltage produced.

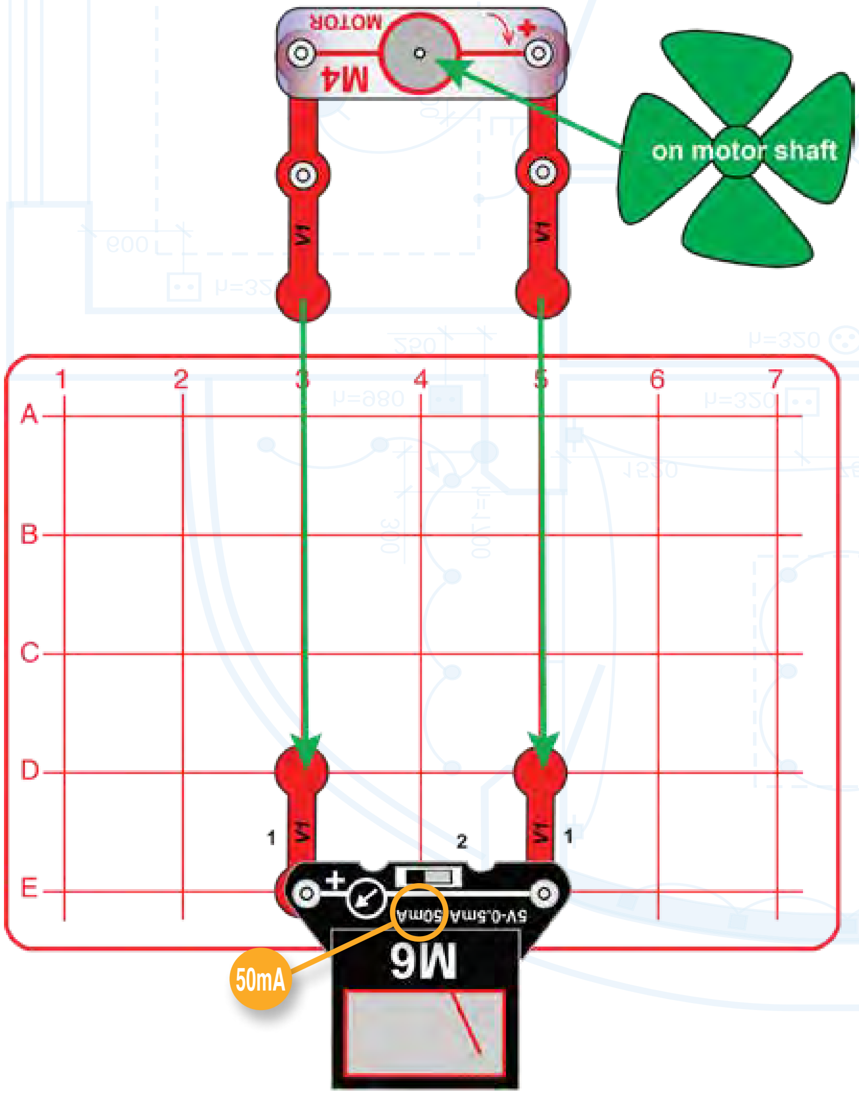
Replace the meter with the color LED ("+" on left). If you blow hard enough then the color LED (D8) will light.

Here the clear motor (M4) is a generator that uses the physical motion of the windmill to pump electricity through the circuit. The motors in commercial windmills are much more efficient, meaning they generate less heat and waste less electricity. Windmills also use fan blade shapes and materials that lower friction (friction is how hard the wind has to push on the blades to make them move), so they can produce electricity even in light winds.



# Project 6 I MINI-WINDMILL



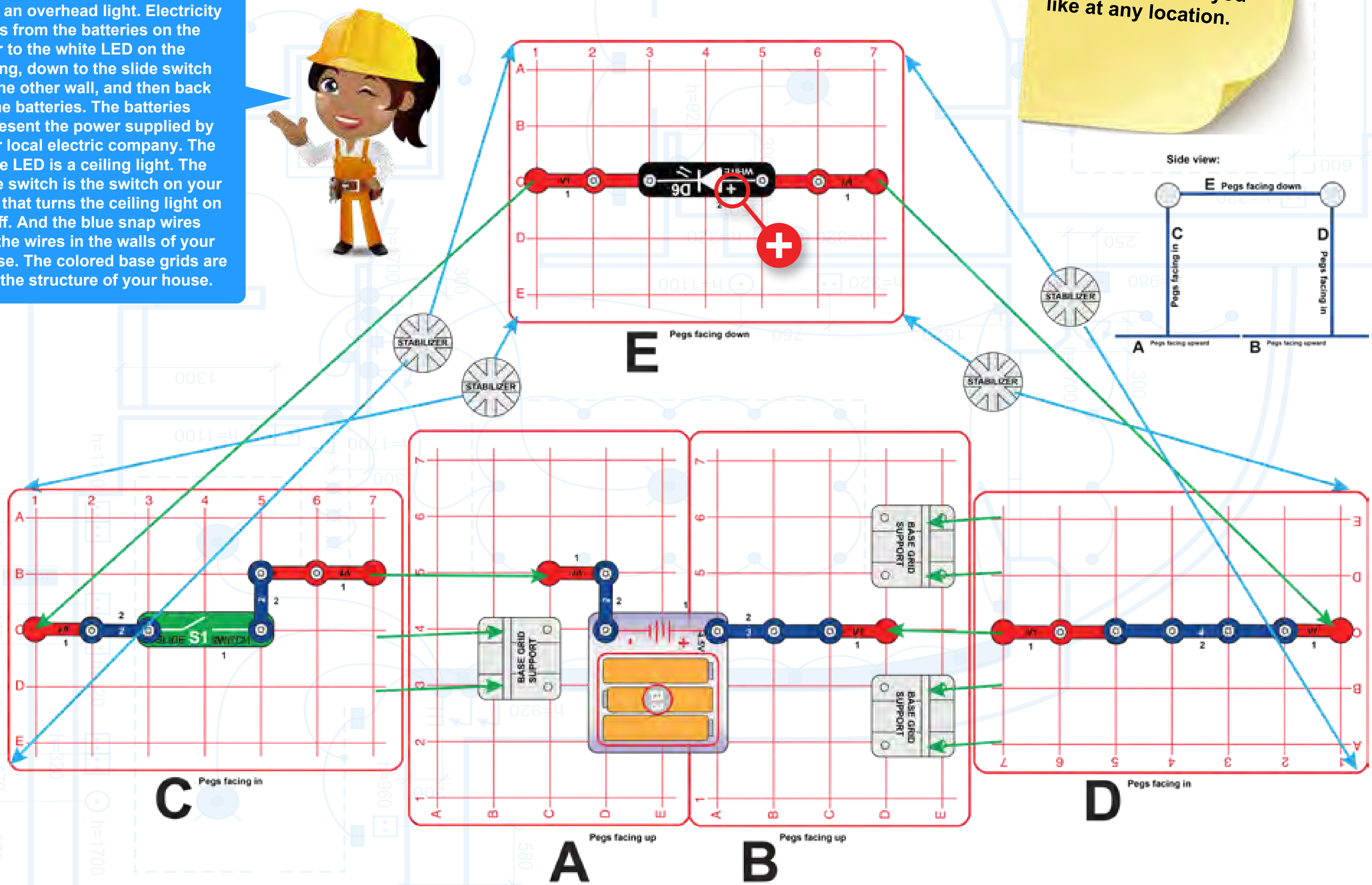

Change the preceding circuit into this one. Now blow on the fan to simulate wind. If you blow hard enough, the color LED (D8) lights up. Is it easier to light the LED in this circuit or the previous circuit?

This circuit improves the air flow by removing the base grid from behind the fan, but it is not as physically stable and comes apart more easily.

# Project 7 | OVERHEAD LIGHTS

Think of this circuit as a room with an overhead light. Electricity flows from the batteries on the floor to the white LED on the ceiling, down to the slide switch on the other wall, and then back to the batteries. The batteries represent the power supplied by your local electric company. The white LED is a ceiling light. The slide switch is the switch on your wall that turns the ceiling light on or off. And the blue snap wires are the wires in the walls of your house. The colored base grids are just the structure of your house.

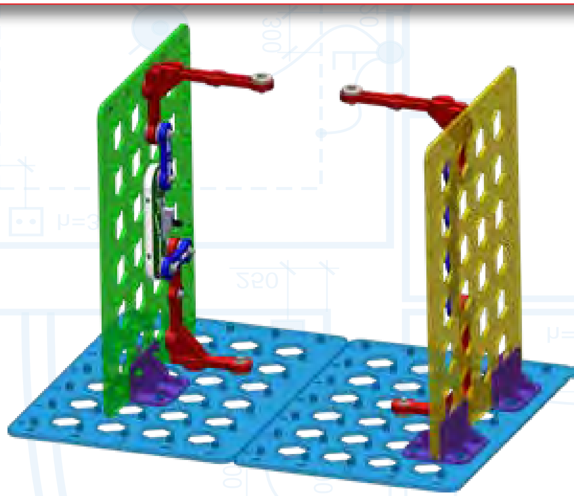
**Note:** Base grid colors are interchangeable, so use any color you like at any location.



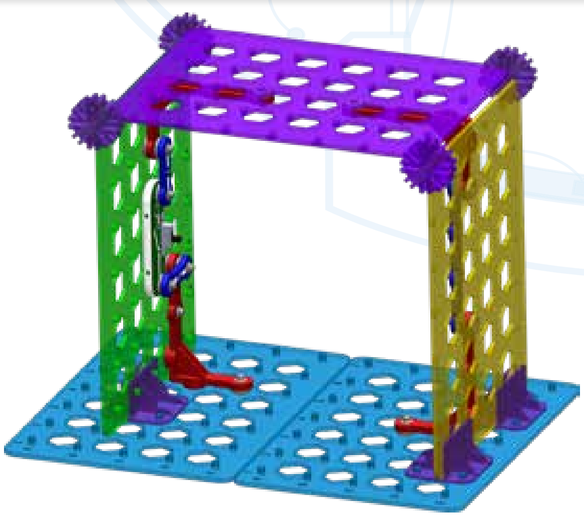
**Assembly (adult supervision recommended):**

**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. Base grid colors are interchangeable, so you any color you like at any location.



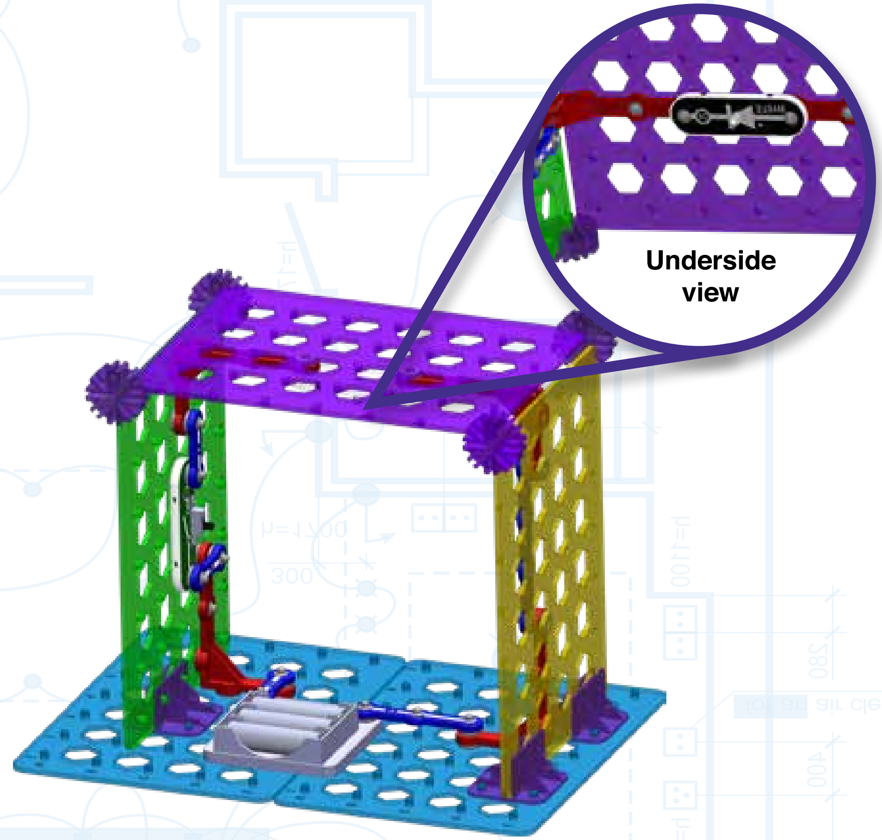
**3.** Mount grid E on top of grids C & D using 4 stabilizers, attaching the 2 vertical snap wires (V1) as you do it.



**4.** Place the remaining parts on grids A, B, & E.

Turn on the slide switch (S1) to light the white LED (D6).

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




**Part B:** Carefully replace the white LED (D6) with the color LED (D8), or carefully add the color LED next to the white LED as shown here.