SNAP CIRCUITS®

ELENCO®

GREEN ENERGY

EXPLORATION IN ALTERNATIVE ENERGY

Simply Snap Together!

OVER 125 EXCITING PROJECTS

CONTAINS OVER 45+ PARTS

Project 38

STEM.ORG AUTHENTICATED™ EDUCATIONAL PRODUCT

Ages 8-108

Rechargable battery included

MADE WITH CIRCUITSAFE™ fuse technology

AWARD WINNING SNAP CIRCUITS GENUINE BRAND

PRINTED Projects 38

95 ONLINE Projects

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ELENCO® Learn by doing.®

Rev B 753170

Table of Contents

For the best learning experience, do the projects in order.

Visit **https://shop.elenco.com/consumers/snap-circuits-green-energy.html** to download projects 39-133

Warning to Snap Circuits® Owners: Do not connect additional voltage sources from other sets, or you may damage your parts. Also, do not connect the hand crank to parts from other sets or you may damage them. Contact ELENCO® if you have questions or need guidance.

Conforms to all applicable government Requirements. The toy is only to be connected to Class II equipment bearing the symbol ⧈

Basic Troubleshooting

1. **The battery (B4) will only work if it is charged. Project 3 shows how to recharge it.**
2. **Most circuit problems are due to incorrect assembly, always double-check that your circuit exactly matches the drawing for it.**
3. **Be sure that parts with positive/negative markings are positioned as per the drawing.**
4. **Be sure that all connections are securely snapped.**
5. **Sometimes the motor or solar cell is mounted on the pivot stand so its angle to the sun or wind can be adjusted. The pivot stand base, post, and top should be assembled together.**

Note: If you suspect you have damaged parts, you can follow the Advanced Troubleshooting procedure on page 9 to determine which ones need replacing.

ELENCO® is not responsible for parts damaged due to incorrect wiring.

WARNING: Moving parts. Do not touch the motor or fan during operation. If you have long hair, be careful that it does not get caught in the fan blade.

WARNING: CHOKING HAZARD - Small parts. Not for children under 3 years.

WARNING: SHOCK HAZARD - Never connect Snap Circuits® to electrical outlets in your home!

WARNING: Always check your wiring before turning on a circuit. Never leave a circuit unattended while the batteries are installed. Never connect additional batteries or any other power sources to your circuits. Discard any cracked or broken parts.

Adult Supervision: Because children's abilities vary so much, even with age groups, adults should exercise discretion as to which experiments are suitable and safe (the instructions should enable supervising adults to establish the experiment's suitability for the child). Make sure your child reads and follows all of the relevant instructions and safety procedures, and keeps them at hand for reference.

This product is intended for use by adults and children who have attained sufficient maturity to read and follow directions and warnings.

Never modify your parts, as doing so may disable important safety features in them, and could put your child at risk of injury.

Parts List (colors and styles may vary) Symbols and Numbers

Qty.	ID	Name	Symbol	Part #	Qty.	ID	Name	Symbol	Part #
❒ 1		Base Grid (11” x 7.7”) Green Color		6SCBGGR	❒ 1		Black Jumper Wire		6SCJ1
❒ 2	1	1-Snap Wire		6SC01	❒ 1		Red Jumper Wire		SCCJ2
❒ 3	2	2-Snap Wire		6SC02	❒ 1		Liquid Holder		6SCLH
❒ 3	3	3-Snap Wire		6SC03	❒ 1	M4	Motor	M4 MOTOR	6SCM4
❒ 1	4	4-Snap Wire		6SC04	❒ 1		Wind Fan		6SCM4B
❒ 1	5	5-Snap Wire		6SC05	❒ 1		Water Wheel		6SCM4C
❒ 1	B4	Rechargeable Battery	B4	6SCB4	❒ 1	M6	Meter	M6	6SCM6
❒ 1	B7	Solar Cell	B7	6SCB7	❒ 1		Mini Car		6SCMCAR
❒ 1	C5	470µF Capacitor	C 5 470µF	6SCC5	❒ 1		Pivot Stand Base	PIVOT STAND	6SCPSB
❒ 1	D8	Color LED	D8 COLOR	6SCD8	❒ 1		Pivot Post		6SCPSP
❒ 1	D10	Red/Yellow LED	D10 YELLOW RED	6SCD10	❒ 1		Pivot Top		6SCPST
❒ 3		Copper Electrode		6SCEC	❒ 2		Rubber Ring 0.375”		6SCRUBRG
❒ 3		Zinc Electrode		6SCEZ	❒ 1	S2	Press Switch	PRESS S2 SWITCH	6SCS2
❒ 1		Copper Electrode with Snap		6SCECS	❒ 1	S6	Switcher	S6	6SCS6
❒ 1		Zinc Electrode with Snap		6SCEZS	❒ 1	T2	Clock	T2	6SCT2
❒ 1		Gear 1.75”		6SCGEAR2	❒ 1	U32	Melody IC	U32 MELODY IC	6SCU32
❒ 1	GM	Geared Motor	GM	6SCGM	❒ 3		Nut 8-32		644800
❒ 1		Crank Arm	CRANK ARM	6SCGMC	❒ 3		Screw 8-32		641840

Important: If any parts are missing or damaged, **DO NOT RETURN TO RETAILER**. Go to ***www.elenco.com/replacement-parts*** or email us at support@elenco.com

How to Use It

Snap Circuits® uses building blocks with snaps to build the different electrical and electronic circuits in the projects. Each block has a function: there are switch blocks, light blocks, battery blocks, different length wire blocks, etc. These blocks are different colors and have numbers on them so that you can easily identify them. The circuit you will build is shown in color and numbers, identifying the blocks that you will use and snap together to form a circuit.

For Example:

This is the switch block which is green and has the marking S2 on it. The part symbols in this booklet may not exactly match the appearance of the actual parts, but will clearly identify them.

This is a wire block which is blue and comes in different wire lengths. This one has the number 2, 3, 4, or 5 on it depending on the length of the wire connection required.

There is also a 1-snap wire that is used as a spacer or for interconnection between different layers.

A large clear plastic base grid is included with this kit to help keep the circuit blocks properly spaced. You will see evenly spaced posts that the different blocks snap into. The base has rows labeled A-G and columns labeled 1-10.

Next to each part in every circuit drawing is a small number in black. This tells you which level the component is placed at. Place all parts on level 1 first, then all of the parts on level 2, then all of the parts on level 3, etc.

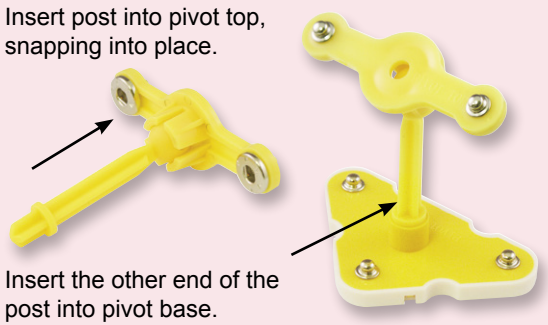
Some circuits use the jumper wires to make unusual connections. Just clip them to the metal snaps or as indicated.

Note: While building the projects, be careful not to accidentally make a direct connection across the battery holder (a “short circuit”), as this may damage and/or quickly drain the batteries.

Sometimes the crank arm will be mounted on the geared motor (GM) to produce a hand crank:

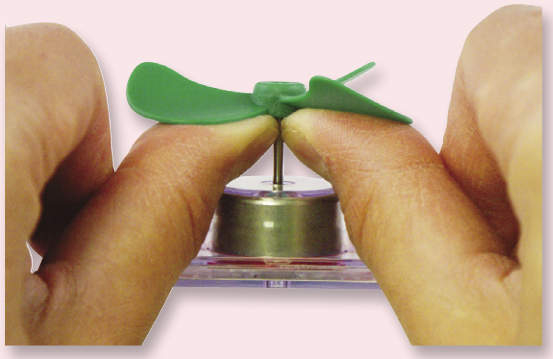
The 3.6V rechargeable battery (B4) may have discharged during shipping and distribution. Recharge it as shown in project 3.

Sometimes parts will be mounted on a pivot, so they can be adjusted for the best angle to the wind or sun. Assemble the pivot as shown here:

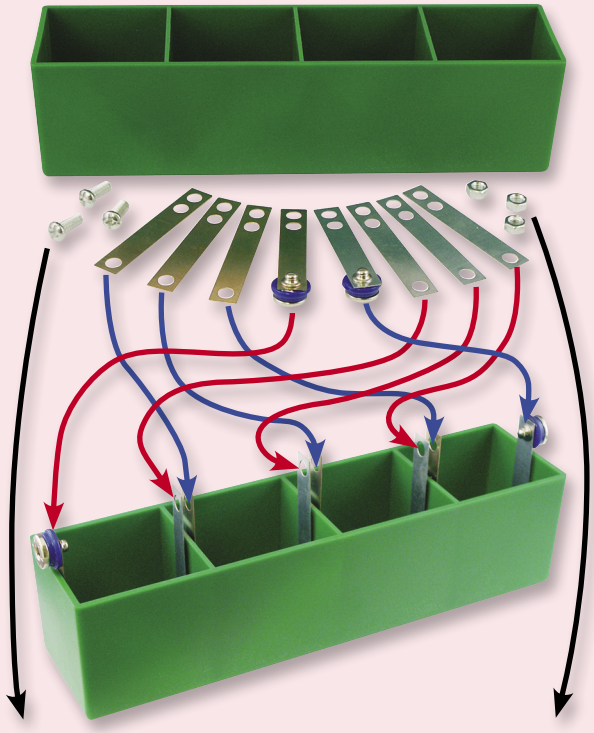


How to Use It

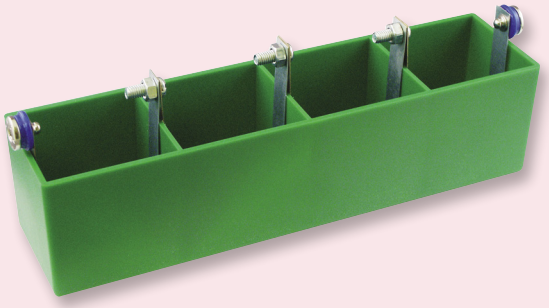
Whenever the motor (**M4**) is used, it will have the wind fan or the water wheel placed on top; simply push the fan onto the shaft. To remove it, push up on it with a screwdriver or your thumbs, being careful not to break it.



Assembling the Liquid Power Source:



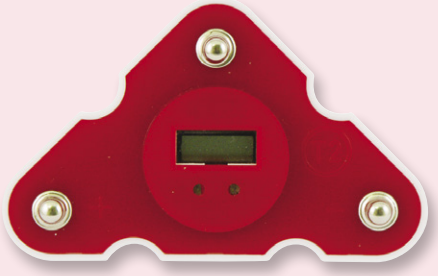
Connect the 3 electrode parts together with screws and nuts as shown. Tighten by hand, a screwdriver is not needed.



If the copper and zinc electrodes get corroded through use, use sandpaper, steel wool, or a scraper to remove the corrosion and improve performance.

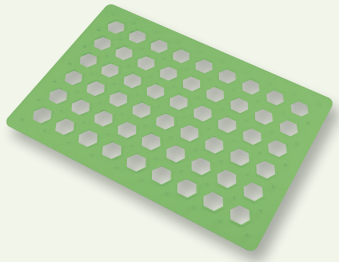
Setting the time on the clock (T2):

- Press the left button to select what to change (month, date, hour, or minutes).
- Press the right button until it is correct.
- Press the left button until the time is showing, then press the right button once to start.
- The colon (“:”) will be flashing when the clock is running.
- Press the right button to display the date.



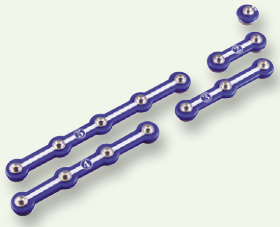
About Your Snap Circuits® Green Parts

BASE GRID



The **base grid** is a platform for mounting parts and wires. It functions like the printed circuit boards used in most electronic products, or like how the walls are used for mounting the electrical wiring in your home.

SNAP WIRES & JUMPER WIRES



The blue **snap wires** are wires used to connect components. They are used to transport electricity and do not affect circuit performance. They come in different lengths to allow orderly arrangement of connections on the base grid.

The red & black **jumper wires** make flexible connections for times when using the snap wires would be difficult. They're also used to make connections off the base grid (like the projects using water).

Wires transport electricity just like pipes are used to transport water. The colorful plastic coating protects them and prevents electricity from getting in or out.

BATTERY

Battery (B4)

The **battery (B4)** contains a rechargeable battery and some supporting parts. This battery produces an electrical **voltage** using a reversible chemical reaction. This "voltage" can be thought of as electrical pressure, pushing electricity through a circuit just like a pump pushes water through pipes. This voltage is much lower and much safer than that used in your house wiring. Using more batteries increases the "pressure" and so more electricity flows.

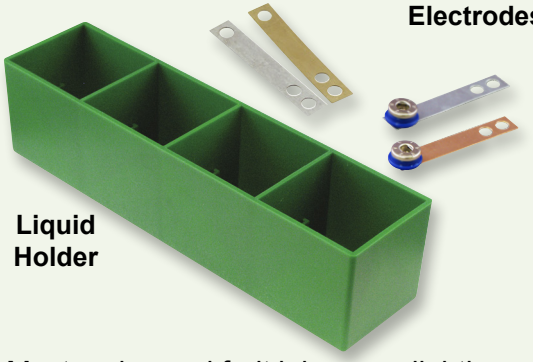
SOLAR CELL

Solar Cell (B7)

The **solar cell (B7)** contains positively and negatively charged silicon crystals, arranged in layers that cancel each other out. When sunlight shines on it, charged particles in the light unbalance the silicon layers and produce an electrical voltage of up to 7V. The maximum current depends on the type of light and its brightness, but will be much less than a battery can produce. Bright sunlight works best, but incandescent light bulbs also work.

LIQUID HOLDER & ELECTRODES

Electrodes



Liquid Holder

Most sodas and fruit juices are lightly acidic. The acid is similar to the material used in some types of batteries but not nearly as strong. The acid will react with the copper and zinc electrodes to make an electric current, like a battery. Each of the four compartments in the liquid holder produces about 0.7V, but the current is very low and may not last long.

(Part designs are subject to change without notice).

About Your Snap Circuits® Green Parts

METER

Meter (M6)

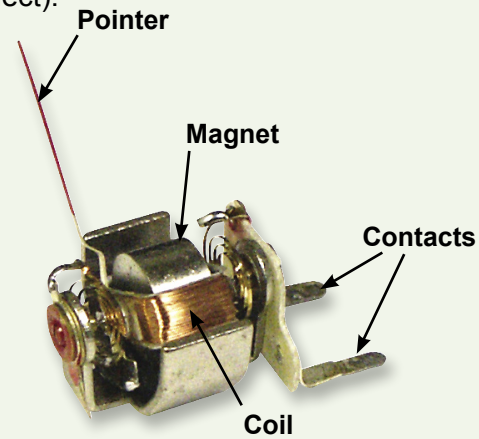
The **meter (M6)** is an important measuring device. You will use it to measure the voltage (electrical pressure) and **current** (how fast electricity is flowing) in a circuit.

The meter measures voltage when connected in parallel to a circuit and measures the current when connected in series in a circuit.

This meter has one voltage scale (**5V**) and two current scales (**0.5mA** and **50mA**). These use the same meter but with internal components that scale the measurement into the desired range. Sometimes resistors in the pivot stand will be used to change the **5V** scale to 10V, or the **0.5mA** scale to 5mA.

Meter Symbol

Inside the meter there is a fixed magnet and a movable coil around it. As current flows through the coil, it creates a magnetic field. The interaction of the two magnetic fields causes the coil (connected to the pointer) to move (deflect).

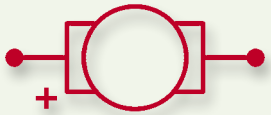


MOTOR

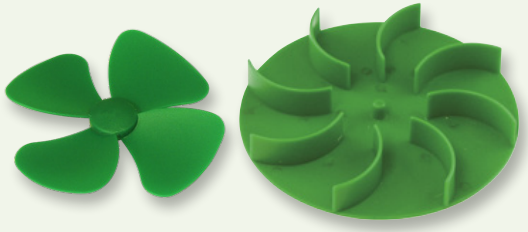
Motor (M4)

The **motor (M4)** converts electricity into mechanical motion. An electric current through the motor will turn the shaft.

It can also be used as a generator, since it produces an electric current when the shaft is turned.



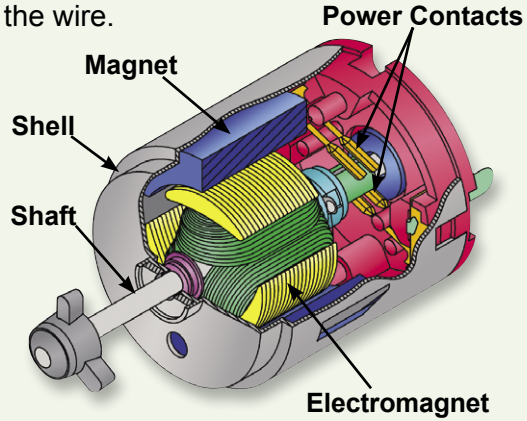
Motor Symbol



Wind Fan Water Wheel

How does electricity turn the shaft in the motor? The answer is magnetism. Electricity is closely related to magnetism & an electric current flowing in a wire has a magnetic field similar to that of a very, very tiny magnet. Inside the motor is a coil of wire with many loops. If a large electric current flows through the loops, the magnetic effects become concentrated enough to move the coil. The motor has a magnet inside, so as the electricity moves the coil to align it with the permanent magnet, the shaft spins.

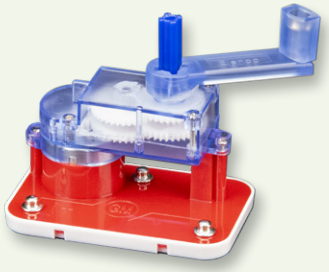
When used as a generator, wind or water turns the shaft. A coil of wire is on the shaft, and as it spins past the permanent magnet an electric current is created in the wire.



About Your Snap Circuits® Green Parts

GEARED MOTOR

Geared Motor & Crank Arm



The **geared motor (GM)** is a motor with a gearbox attached. The crank arm may be attached to it so it can be turned by hand. The gearbox spins the motor shaft faster but with less force than when turning the crank arm.

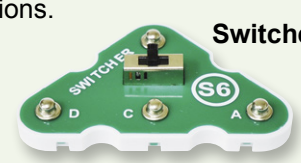
SWITCHES

Press Switch (S2)

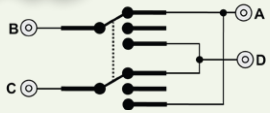
The **press switch (S2)** connects (pressed, "ON") or disconnects (not pressed, "OFF") the wires in a circuit. When ON it has no effect on circuit performance. It turns on electricity just like a faucet turns on water from a pipe.

The **switcher (S6)** is a more complex switch used to reverse the wires to a component or circuit. See project 18 for an example of connections.

Switcher (S6)



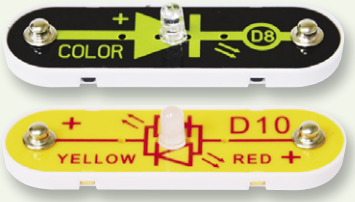
Its symbol & connections look like this:



RED & YELLOW LEDs

The **color LED (D8) and red/yellow bicolor LED (D10)** are light emitting diodes, and may be thought of as a special one-way light bulbs. In the "forward" direction, (indicated by the "arrow" in the symbol) electricity flows if the voltage exceeds a turn-on threshold (about 1.5V for red, slightly higher for yellow, about 2.0V for green, and about 3.0V for blue); brightness then increases. The color LED contains red, green, and blue LEDs, with a micro-circuit controlling then. The red/yellow bicolor LED contains red & yellow LEDs in connected in opposite directions. A high current will burn out an LED, so the current must be limited by other components in the circuit (though your Snap Circuits® LEDs have internal resistors to protect against incorrect wiring). LEDs block electricity in the "reverse" direction.

LEDs (D8 & D10)



CAPACITOR

Capacitor (C5)

The **470μF capacitor (C5)** can store electrical pressure (voltage) for periods of time. This storage ability allows it to block stable voltage signals and pass changing ones. Capacitors are used for filtering and delay circuits.

OTHER PARTS

Melody IC (U32)

The **melody IC (U32)** contains a specialized sound-generation integrated circuit (IC), a small speaker, and a few supporting components. The IC has a recording of the melody, which it makes into an electrical signal for the speaker. The speaker converts the signal into mechanical vibrations. The vibrations create variations in air pressure, which travel across the room. You "hear" sound when your ears feel these air pressure variations.

Clock (T2)

The **clock (T2)** contains a small crystal. When a crystal is struck by an electronic pulse, it vibrates. A microelectronic circuit makes the pulse and measures the vibration rate. The vibration rate is used as a time standard, from which minutes, hours, and the date are calculated.

Pivot Stand

The pivot stand contains two resistors, 47Ω and 10KΩ. **Resistors** "resist" the flow of electricity and are used to control or limit the electricity in a circuit. Materials like metal have very low resistance (<1Ω), while materials like paper, plastic, and air have near-infinite resistance. Increasing circuit resistance reduces the flow of electricity.

Introduction to Electricity

What is electricity? Nobody really knows. We only know how to produce it, understand its properties, and how to control it. Electricity is the movement of sub-atomic charged particles (called **electrons**) through a material due to electrical pressure across the material, such as from a battery.

Power sources, such as batteries, push electricity through a circuit, like a pump pushes water through pipes. Wires carry electricity, like pipes carry water. Devices like LEDs, motors, and speakers use the energy in electricity to do things. Switches and transistors control the flow of electricity like valves and faucets control water. Resistors limit the flow of electricity.

The electrical pressure exerted by a battery or other power source is called **voltage** and is measured in **volts** (V). Notice the "**+**" and "–" signs on the battery; these indicate which direction the battery will "pump" the electricity.

The **electric current** is a measure of how fast electricity is flowing in a wire, just as the water current describes how fast water is flowing in a pipe. It is expressed in **amperes** (A) or **milliamps** (mA, 1/1000 of an ampere).

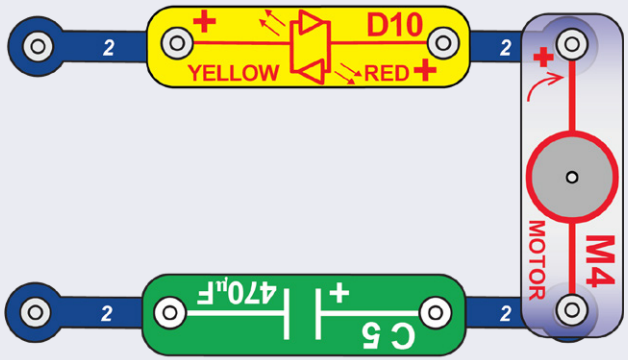
The "**power**" of electricity is a measure of how fast energy is moving through a wire. It is a combination of the voltage and current (Power = Voltage x Current). It is expressed in **watts** (W).

The **resistance** of a component or circuit represents how much it resists the electrical pressure (voltage) and limits the flow of electric current. The relationship is Voltage = Current x Resistance. When the resistance increases, less current flows. Resistance is measured in **ohms** (Ω), or **kilo ohms** (kΩ, 1000 ohms).

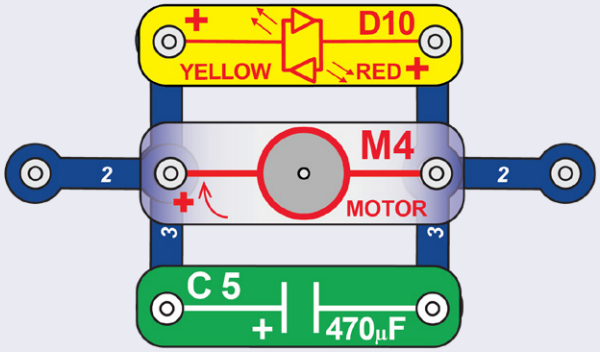
Nearly all of the electricity used in our world is produced at enormous generators driven by steam or water pressure. Wires are used to efficiently transport this energy to homes and businesses where it is used. Motors convert the electricity back into mechanical form to drive machinery and appliances. The most important aspect of electricity in our society is that it allows energy to be easily transported over distances.

Note that "distances" includes not just large distances but also tiny distances. Try to imagine a plumbing structure of the same complexity as the circuitry inside a portable radio - it would have to be large because we can't make water pipes so small. Electricity allows complex designs to be made very small.

There are two ways of arranging parts in a circuit, in series or in parallel. Here are examples:



Series Circuit



Parallel Circuit

Placing components in series increases the resistance; highest value dominates. Placing components in parallel decreases the resistance; lowest value dominates.

The parts within these series and parallel sub-circuits may be arranged in different ways without changing what the circuit does. Large circuits are made of combinations of smaller series and parallel circuits.

DO's and DON'Ts of Building Circuits

After building the circuits given in this booklet, you may wish to experiment on your own. Use the projects in this booklet as a guide, as many important design concepts are introduced throughout them. Every circuit will include a power source (like a battery), a resistance (which might be a light, motor, sound module, etc.), and wiring paths between them and back. You must be careful not to create "short circuits" (very low-resistance paths across a power source, see examples below) as this will damage components and/or quickly drain your battery. **ELENCO® Electronics is not responsible for parts damaged due to incorrect wiring.**

Here are some important guidelines:

ALWAYS use eye protection when experimenting on your own.

ALWAYS include at least one component that will limit the current through a circuit, such as an LED, clock, or melody IC.

ALWAYS use the switches in conjunction with other components that will limit the current through them. Failure to do so will create a short circuit and/or damage those parts.

ALWAYS disconnect your batteries immediately and check your wiring if something appears to be getting hot.

ALWAYS check your wiring before turning on a circuit.

NEVER connect to an electrical outlet in your home in any way.

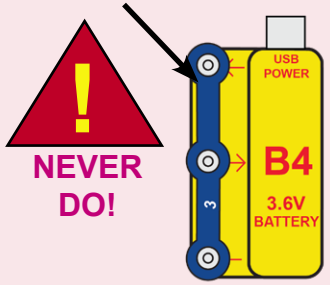
NEVER touch the motor when it is spinning at high speed.

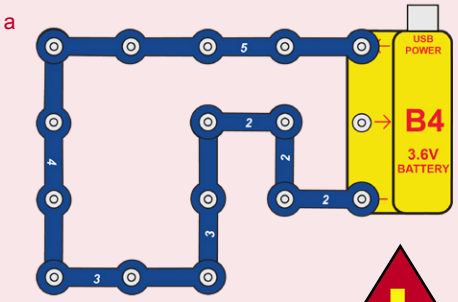
For all of the projects given in this book, the parts may be arranged in different ways without changing the circuit. For example, the order of parts connected in series or in parallel does not matter — what matters is how combinations of these sub-circuits are arranged together.

Warning to Snap Circuits® owners: Do not connect additional voltage sources from other sets, or you may damage your parts. Also, do not connect the hand crank to parts from other sets or you may damage them. Contact ELENCO® if you have questions or need guidance.

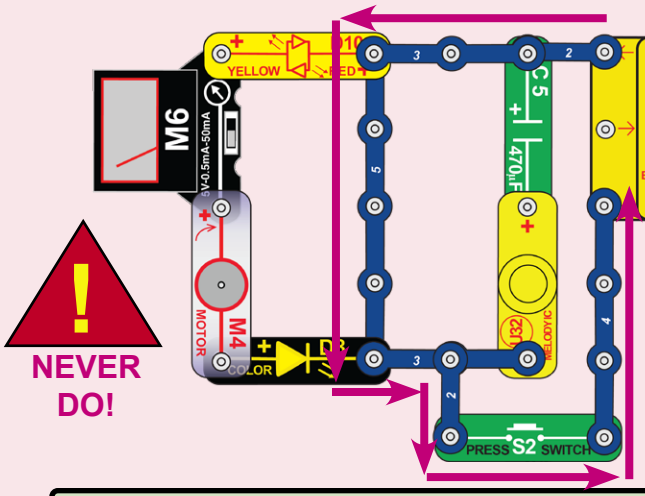
Examples of SHORT CIRCUITS - NEVER DO THESE!!!

Placing a 3-snap wire directly across a power source is a SHORT CIRCUIT.





This is also a SHORT CIRCUIT.



When the switch (**S2**) is turned on, this large circuit has a SHORT CIRCUIT path (as shown by the arrows). The short circuit prevents any other portions of the circuit from ever working.

You are encouraged to tell us about new circuits you create. If they are unique, we will post them with your name and state on our website at **www.elenco.com/for-makers**. Send your suggestions to Elenco Electronics: elenco@elenco.com.

Elenco® provides a circuit designer so that you can make your own Snap Circuits® drawings. This Microsoft® Word document can be downloaded from **www.elenco.com/for-makers.**

WARNING: SHOCK HAZARD - Never connect your Snap Circuits® set to the electrical outlets in your home in any way!

Advanced Troubleshooting (Adult supervision recommended)

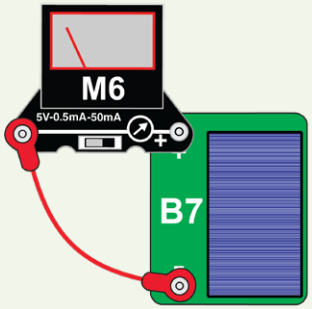
Elenco® Electronics is not responsible for parts damaged due to incorrect wiring.

If you suspect you have damaged parts, you can follow this procedure to systematically determine which ones need replacing:

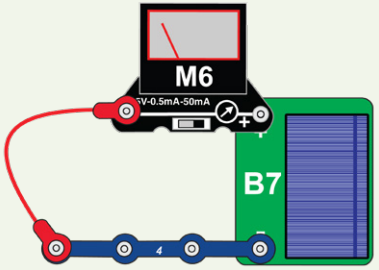
1. **Geared motor (GM), solar cell (B7), and meter (M6):** Place the meter directly across the solar cell and set it to the **5V** setting. Place the solar cell in sunlight or near a bright light source (incandescent light bulbs are best); the meter pointer should move. Then place the meter directly across the geared motor, attach the crank arm to it, and turn the crank arm clockwise; the meter pointer should move for all the meter switch settings (**5V**, **0.5mA**, and **50mA**).

- If the **5V** meter setting works with the hand crank but not the solar cell, then the solar cell is damaged. Be sure you used a bright light source and removed any protective plastic wrap covering the solar cell.
- If the **5V** meter setting works with the solar cell but not the hand crank, then the hand crank is damaged.
- If the **5V** meter setting does not work with either the solar cell or the hand crank, then the meter is damaged.
- If the **5V** meter setting works with the hand crank but the **0.5mA** or **50mA** meter settings do not, then the meter is damaged.

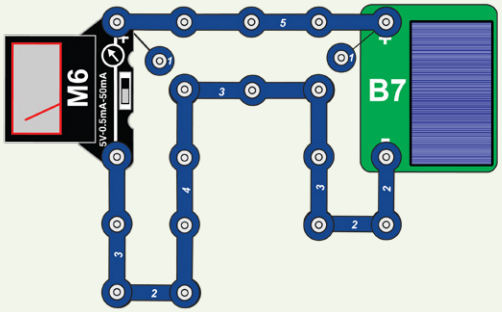
2. **Red & black jumper wires:** Set the meter to the **5V** setting and use this circuit to test each jumper wire. Place the solar cell (**B7**) near the same light source you used in step 1. The jumper wire is damaged if the meter pointer does not move.



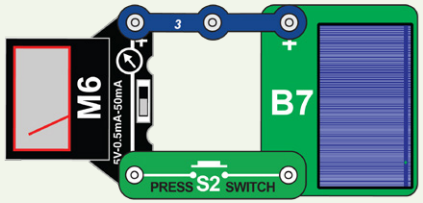
3. **Snap wires:** Set the meter to the **5V** setting and use this circuit to test each snap wire, one at a time. Place the solar cell (**B7**) near the same light source you used in step 1. The snap wire is damaged if the meter pointer does not move.



If you prefer, you can test all the snap wires at once using this circuit. If the meter pointer does not move, then test the snap wires one at a time to find the damaged one.



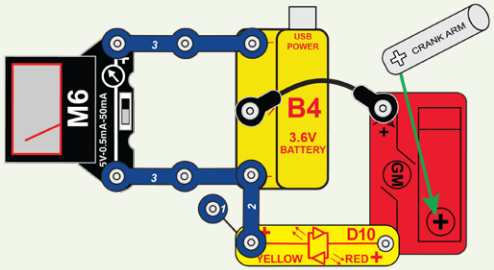
4. **Press switch (S2):** Set the meter to the **5V** setting and build this circuit. Place the solar cell (**B7**) near the same light source you used in step 1. If the meter pointer does not move when you press the switch, the switch is damaged.



5. **Color and red/yellow bi-color LEDs (D8 & D10):** Place the crank arm on the geared motor (GM) and place each LED directly across the geared motor without snapping it on. Make sure the "**+**" side of the LED matches the "**+**" side of the hand crank. Turn the crank handle clockwise; the LED will light unless it is damaged. **D10** will be either red or yellow, depending on how you oriented it.

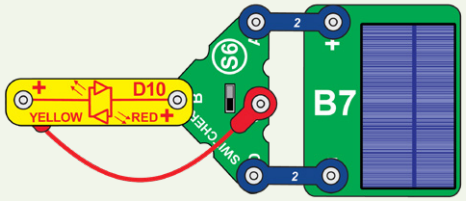
Advanced Troubleshooting (continued)

6. **Battery (B4):** Plug **B4** into a powered USB port; the "USB POWER" light on **B4** should come on, indicating that it is being charged by the USB. Next, build the circuit shown here and set the meter (**M6**) to the **5V** setting.



- The meter will measure more than 3V if the battery is charged up.
- If the meter pointer does not move from zero then either the battery is completely discharged or it is damaged.
- Turn the crank arm clockwise and check that the yellow LED (**D10**) comes on when you crank fast (indicating that the crank is charging the battery).
- If the meter was measuring zero then turn the crank for at least 20 seconds with the yellow LED on to see if it can be recharged.
- If the battery cannot be recharged, then it is damaged.
- If the battery needs to be recharged, you can use this circuit or see project 3 for other charging circuits.

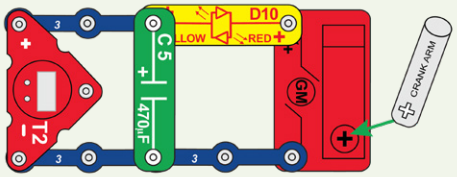
7. **Switcher (S6):** Build this circuit and place the solar cell (**B7**) near the same light source you used in step 1. The LED (**D10**) should be red, when the switcher is in the top position, off when the switcher is in the middle position, and yellow when the switcher is in the bottom position; otherwise the switcher is damaged.



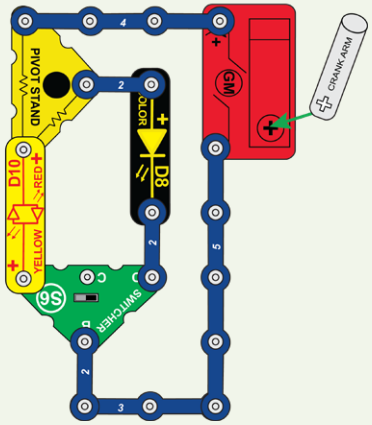
8. **Clock (T2), 470µF capacitor (C5), melody IC (U32), and motor (M4):** Build the circuit shown below, but remove the 470µF capacitor. Turn the crank arm clockwise and the clock display should turn on.

   Add the 470µF capacitor back in; the clock display should stay on for a while after you stop turning the crank; arm otherwise the capacitor is damaged.

- Replace the clock with the melody IC. Turning the crank arm should make sound.
- Replace the melody IC with the motor ("**+**" on top, the fan doesn't matter). Turning the crank arm clockwise should spin the motor shaft clockwise.



9. **Pivot stand resistors:** The pivot stand base has resistors mounted inside; they can be tested using this circuit. Set the switcher (**S6**) to the left position and turn the crank arm clockwise; the red/yellow LED (**D10**) should be bright red. Next, set the switcher to the right position and turn the crank arm clockwise; the color LED (**D8**) should be on but dim.



10. Check the remaining parts by inspecting them for damage.

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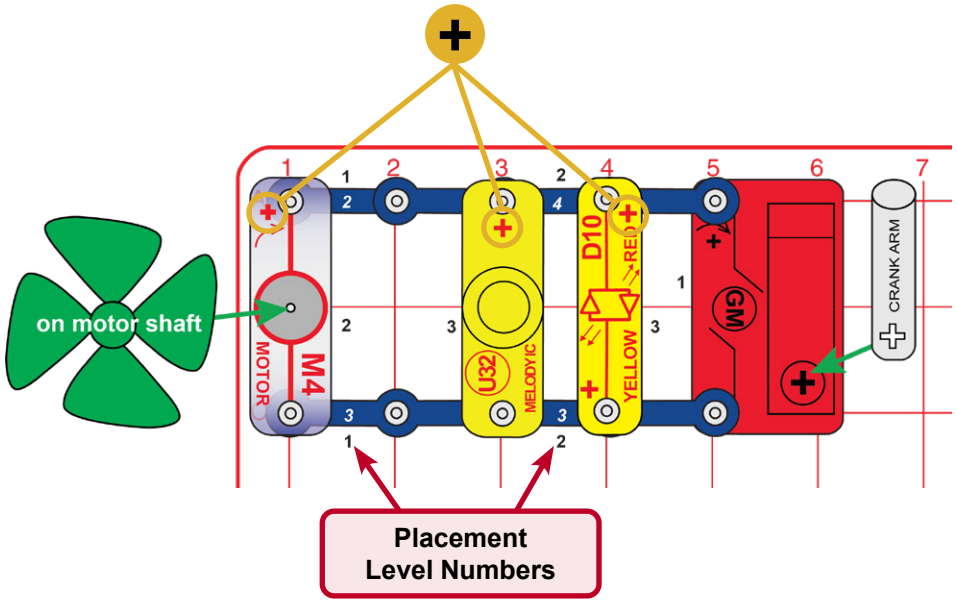
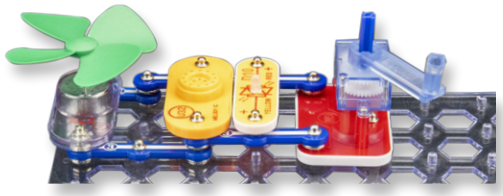
PROJECT 1 • Hand Cranking



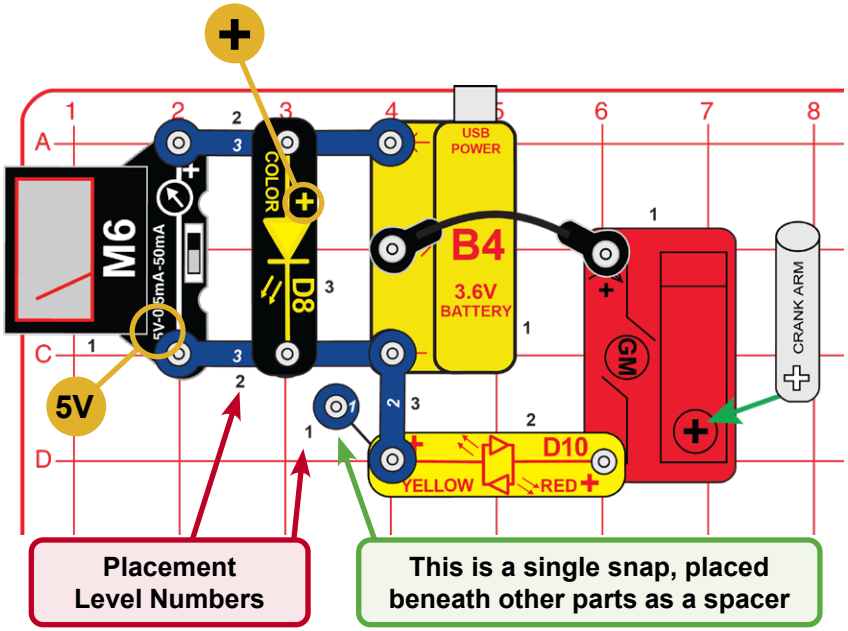
Build the circuit shown by placing all the parts with a black 1 next to them on the clear plastic base grid first. Then, assemble parts marked with a 2. Be sure to place the parts with their (**+**) side oriented as shown. Place the wind fan on the motor (**M4**) shaft, and the crank arm on the geared motor (GM). Turn the crank arm in both directions to make things happen.

Warning: the geared motor and crank arm are sturdy but not indestructible. If you push hard on it or crank it really fast you may break it.



The geared motor uses magnetism to change the mechanical energy of the spinning shaft into electricity.

PROJECT 2 • Crank Charger

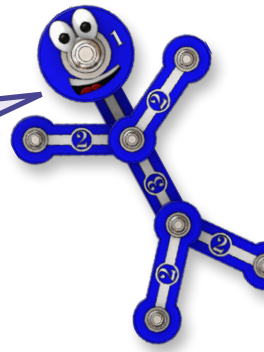


Build the circuit shown here, set the meter (**M6**) to the **5V** setting, and place the crank arm on the geared motor (GM). The meter will measure about 3.6V if the battery is charged up.

Turn the crank arm clockwise. The red/yellow LED (**D10**) comes on yellow when you crank fast, indicating that the crank is charging the battery.

If the battery needs to be recharged, you can use this circuit to charge it, but you may need to crank for a long time to fully charge it.

Although the battery is rated as 3.6V, it may charge to as high as 4.0V. If you are monitoring the voltage using the meter, you may see the voltage quickly reach 3.6V, but this does not mean that the battery is fully charged. When the battery is discharging to power something, the voltage is nearly steady for a long while then drops off quickly. The same thing occurs when it is charging. Recharging the battery will quickly reach around 3.6V but it needs much more charging to avoid a quick drop-off when discharging.



PROJECT 3 • Best Charging Circuits

Your rechargeable battery (**B4**) will need to be recharged often; it can be charged with a USB connection or with solar light using any of these circuits. The USB POWER light on **B4** comes on when it is charging through the USB.

For solar charging, place the solar cell in sunlight or about 12 inches from an incandescent light bulb of 60W or more. It takes a few hours to charge the battery. LED, CFL, and fluorescent lights do not work well with solar cells. When measuring charge current, the current will often be too high to measure on the **0.5mA** setting but too low to measure on the **50mA** setting (you can use either). The current will get lower as the battery approaches full charge.

You can't hurt the battery by overcharging.

Although the battery is rated as 3.6V, it may charge to as high as 4.0V. If you are monitoring the voltage using the meter, you may see the voltage quickly reach 3.6V, but this does not mean that the battery is fully charged. When the battery is discharging to power something, the voltage is nearly steady for a long while then drops off quickly. The same thing occurs when it is charging. Recharging the battery will quickly reach around 3.6V but it needs much more charging to avoid a quick drop-off when discharging. Recharge the battery for several hours.

USB charging

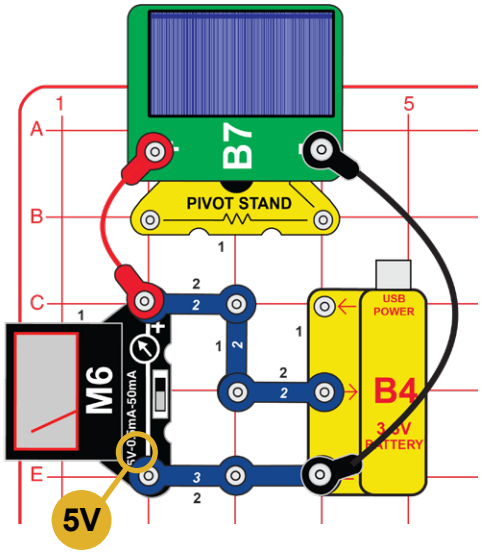
ASSEMBLING PIVOT STAND

1 Place base on flat level surface.

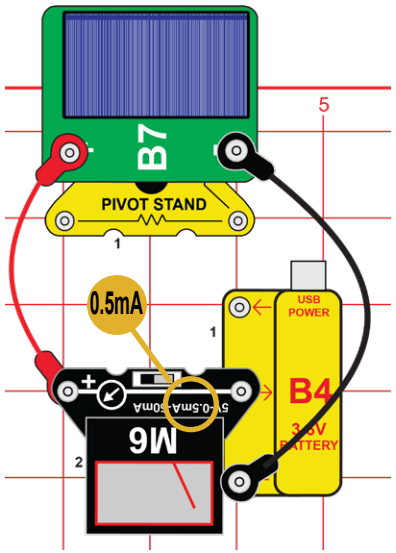
2 Snap ball on pivot post into pivot top.

3 Insert post into base.

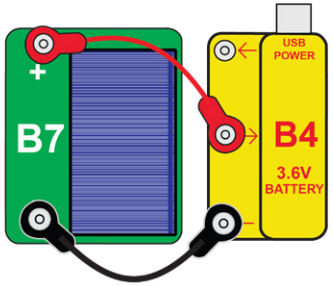
Angle adjustment to light source with voltage measurement:



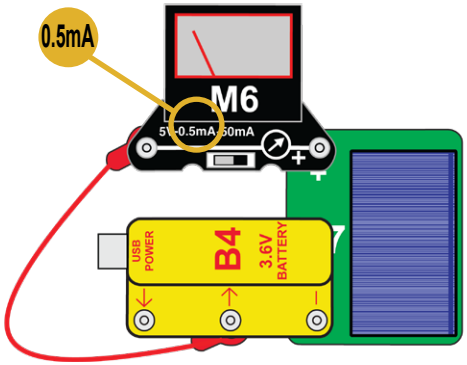
Angle adjustment to light source, measuring charge current:



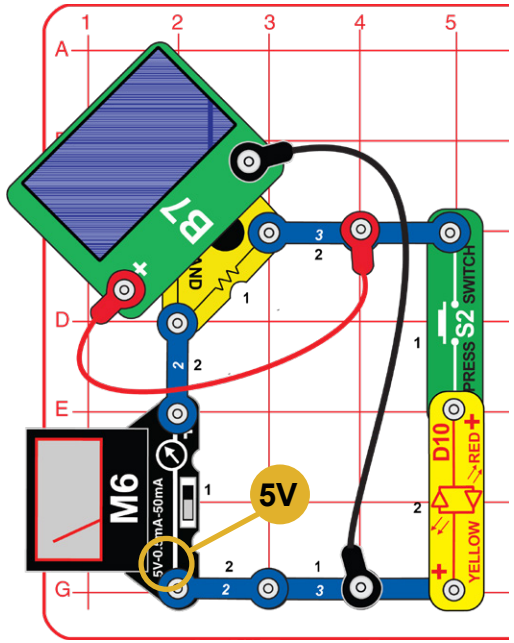
Minimum parts:

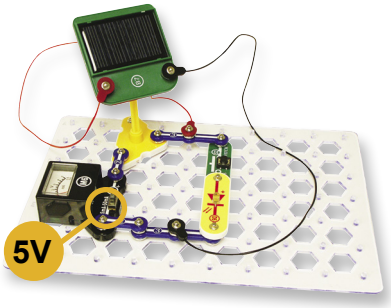


Minimum parts, measuring charge current:



PROJECT 4 • Solar Power





Assemble the pivot, mount the solar cell (**B7**) on it, and place it in the circuit as shown. Place all the parts with a black 1 next to them on the clear plastic base grid first, then parts marked with a 2. The red/yellow LED (**D10**) may be connected in either direction.

Connect the solar cell to the circuit using the red and black jumper wires. Place the circuit so the solar cell is in bright sunlight or close to an incandescent light bulb. Set the meter (**M6**) to the **5V** setting.

The meter is measuring the voltage produced by the solar cell. Adjust the position of the solar cell on the pivot to see how the voltage produced changes depending on the angle to the light source and the brightness.

Position the solar cell to make the highest voltage you can. Now push the press switch to run the red/yellow LED with the solar cell. Notice how the voltage produced drops when the LED is connected.

Compare the voltage and LED brightness when using different light sources (sunlight, incandescent bulbs, LED bulbs, fluorescent bulbs) to see which work best with solar cells.

Note: The voltage produced is actually twice that shown on the meter (so a 3V reading is really 6V), because a resistor in the pivot stand is changing the scale.

Your solar cell makes electricity from sunlight, but only a small amount. In bright sunlight it produces a voltage of about 7V, but this is reduced when lots of current is flowing. That is why the voltage drops when you connect the red/yellow LED.

ASSEMBLING PIVOT STAND

1 Place base on flat level surface.

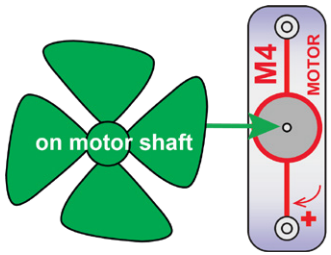
2 Snap ball on pivot post into pivot top.

3 Insert post into base.

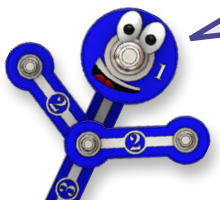
PROJECT 5 Solar Color Power

Replace the red/yellow LED (**D10**) with the color LED (**D8**, with "**+**" towards **S2**) and press the switch. See how it affects the solar cell voltage.

PROJECT 6 • Solar Motor

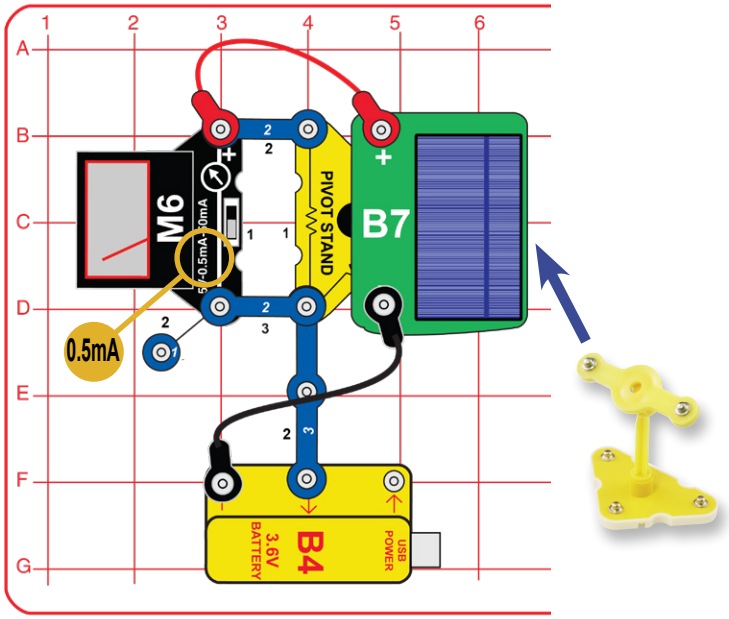


In the preceding circuit, replace the color LED (**D8**) with the motor (**M4**, in either direction) and place the wind fan on it. Now press the switch and watch how the voltage changes as the solar cell runs the fan. Depending on your light source, the fan may need a push to get started or may not work at all.



The motor needs less electricity from the solar cell as it speeds up, so the solar cell voltage is higher as the motor gets faster.

PROJECT 7 • Solar Charger 5mA

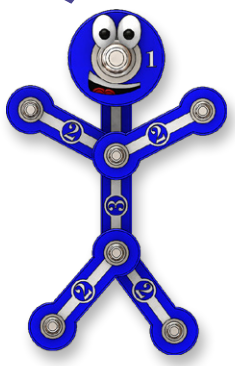


Assemble the pivot, mount the solar cell (**B7**) on it, and place it in the circuit as shown. Connect the solar cell to the circuit using the red and black jumper wires. Place the solar cell in sunlight or near an incandescent light bulb. The solar cell is charging the battery and the meter is measuring the current.

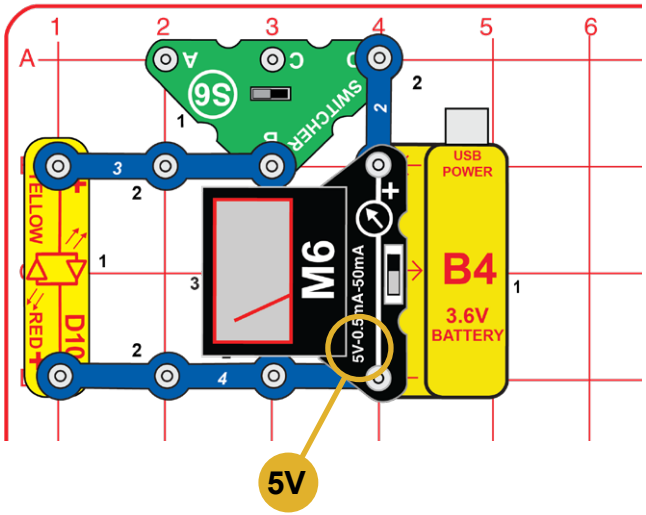
This circuit uses a resistor in the pivot stand to change the **0.5mA** scale on the meter to a 5 mA scale, so read the current on the 0-5 scale. Charging current is usually in this range. Place your hand above the solar cell to see how easily the current changes, and try different light sources.

See project 3 if you need to recharge the battery (**B4**).

Solar energy is free, abundant and causes no pollution. However it is difficult to harvest because even low power solar cells are expensive.



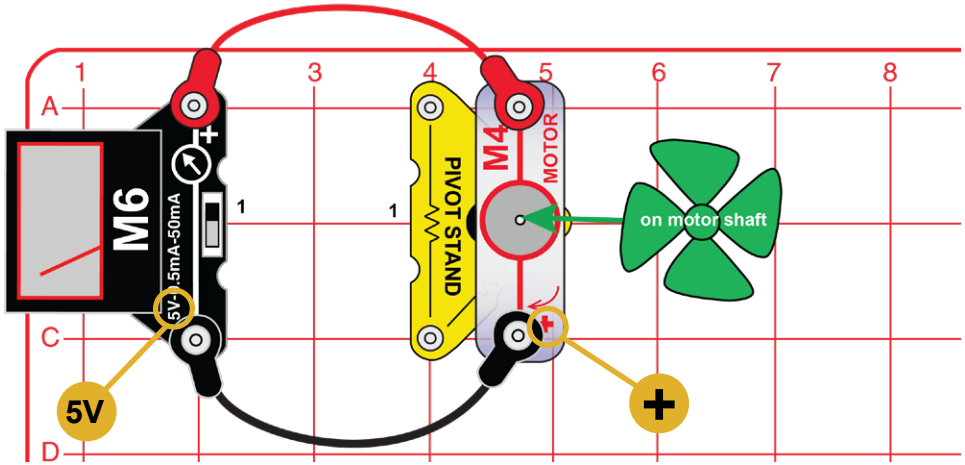
PROJECT 8 • Long Light



Build the circuit and set the meter (**M6**) to the **5V** setting. Set the switcher (**S6**) to the right position and watch the voltage on the meter for a while as the battery runs the red/yellow LED (**D10**). How quickly does the voltage drop?

If your battery was recently recharged then you probably found the voltage drops very, very slowly, and thought this was boring. That was the idea - batteries can run things for a long time and (unlike solar or wind power sources) are hardly affected by changing weather conditions. Batteries can provide power whenever you need it - but, eventually, they do run out.

PROJECT 9 • Windmill



Assemble the pivot stand, mount the wind fan on the motor (**M4**), mount the motor on the pivot, place the pivot on the base grid and connect it to the meter (**M6**) using the red and black jumper wires. Set the meter to the **5V** setting.

Blow on the fan or place it in a strong wind (either outside or near an electric fan). You may need to give the fan a push to get it started. The meter measures how much voltage your "windmill" produces. Adjust the pivot position to see how the voltage produced changes with the angle to the wind.

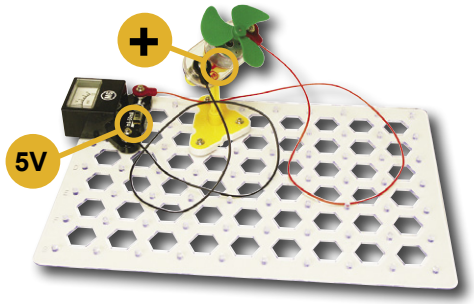
The windmill uses magnetism to change the mechanical energy of the spinning shaft into electricity. The voltage it produces is usually lower than the solar cell, but the current is higher.

ASSEMBLING PIVOT STAND

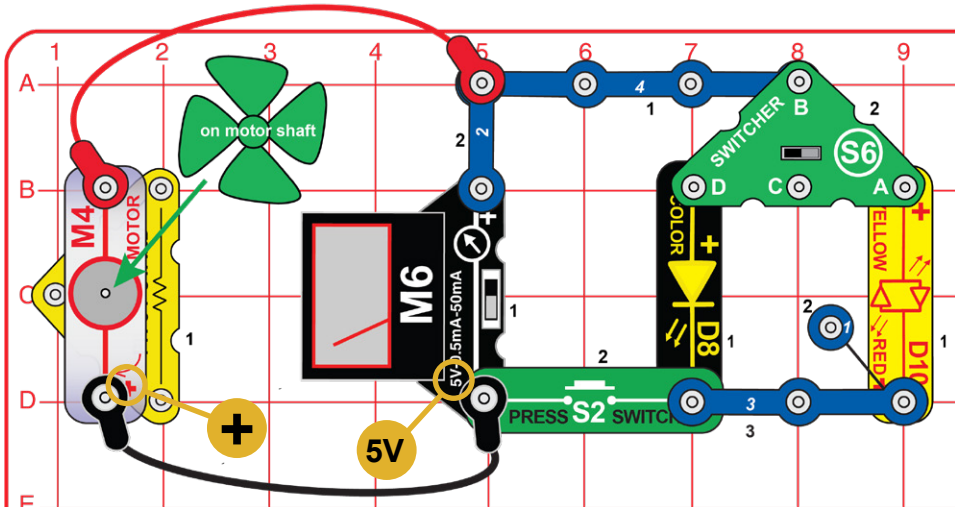
1 Place base on flat level surface.

2 Snap ball on pivot post into pivot top.

3 Insert post into base.



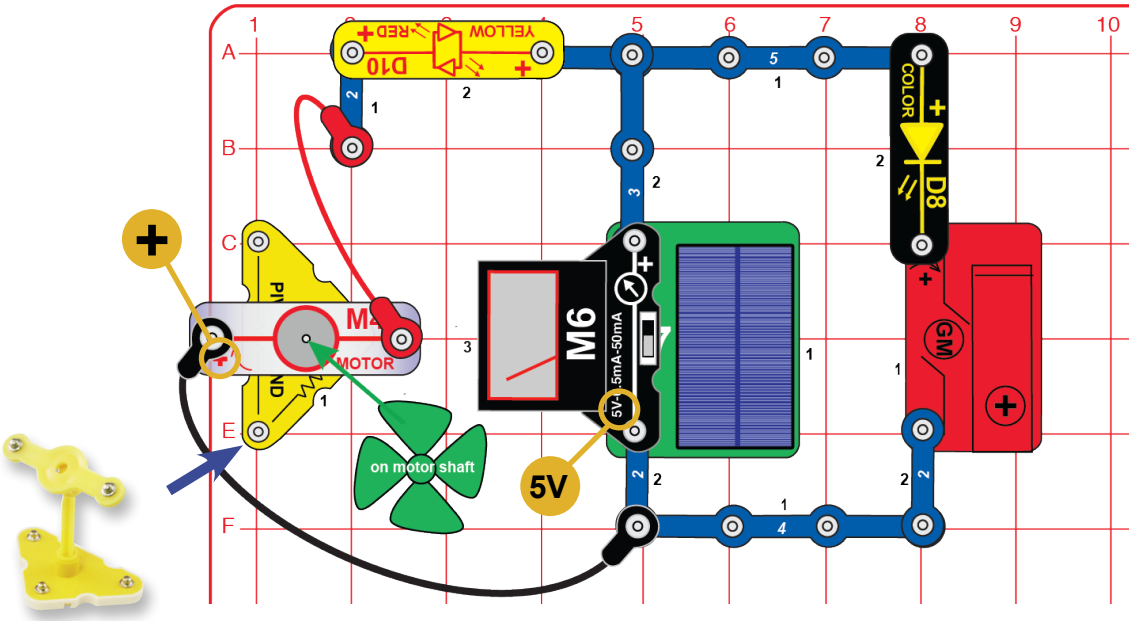
PROJECT 10 • Windy Lights



Build the circuit shown. Set the meter to the **5V** setting, and the switcher (**S6**) to the left or right position. Blow on the fan or place it in a strong wind (either outside or near an electric fan). The meter measures how much voltage your "windmill" produces. You may need to give the fan a push to get it started.

Push the press switch (**S2**) to connect one of the LEDs (**D8** & **D10**) to the windmill. The voltage produced drops a little, but not as much as for the solar cell circuits. Flip the switcher to the other side to try the other LED. Compare the brightness of the LEDs at different wind speeds.

PROJECT 11 • Multi Power

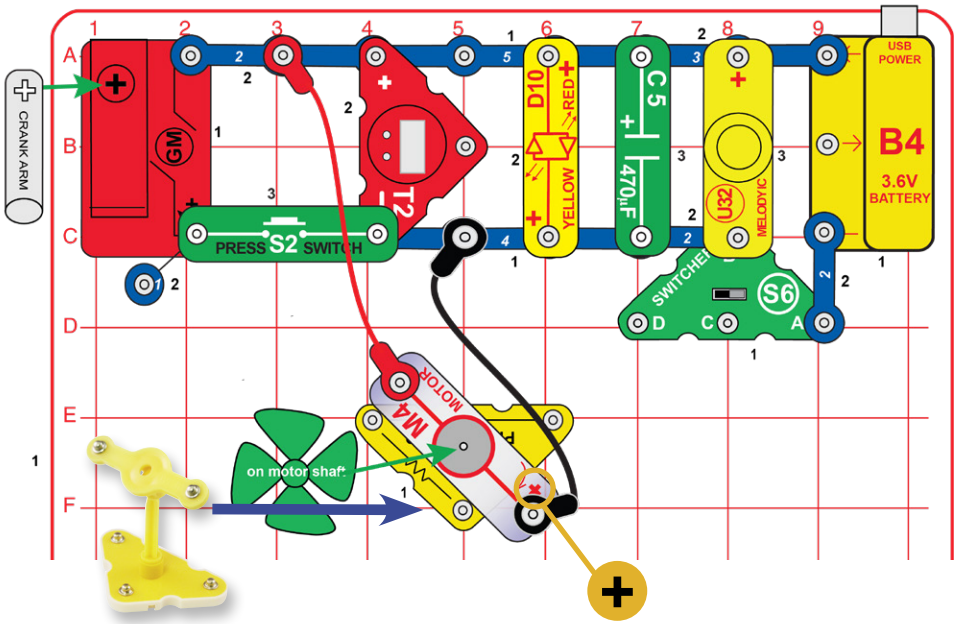


Build the circuit shown and set the meter to the **5V** setting. Set the switcher to the middle position and the meter measures the voltage produced by the solar cell. Next, set the switcher to the left position and blow on the windmill to see the voltage it produces. Next, set the switcher to the right position and turn the crank arm to see the voltage it produces.

You can change the meter setting to **50mA**, to measure the current produced.

The switcher is used to prevent the windmill and hand crank from interfering with each other and the solar cell.

PROJECT 12 • Battery Power



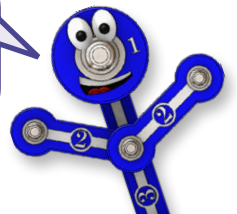
Make sure the battery is charged up (see project 3). Build the circuit with the motor and fan on the pivot stand, and connect the jumper wires as shown. Set the switcher (**S6**) to the right position to turn on the circuit. The battery runs the clock display (**T2**), melody IC (**U32**), red/yellow LED (**D10**), and windmill (**M4**). Push the press switch (**S2**) and the crank arm on the geared motor (GM) will also spin.

Part B: Set the switcher to the left or middle position to disconnect the battery, and blow on the fan or place it in a strong wind. See if your "windmill" will run things as well as the battery, and for how long.

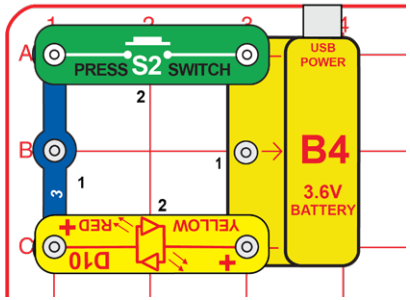
Part C: Leave the switcher at the left or middle position and push the press switch while turning the crank arm to see how well it runs things. Try cranking it in both directions.

See project 3 if you need to recharge the battery (**B4**).

This battery can store lot of energy, so it can run lots of things for a while. It is available whenever you need it, at the flip of a switch.



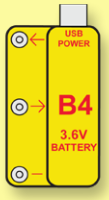
Build the circuit shown and push the press switch (**S2**) to turn on the red LED (**D10**).



See project 3 if you need to recharge the battery (**B4**).

Educational Corner:

What is really happening here?

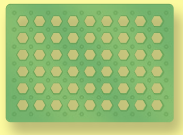


1. The battery (**B4**, containing a 3.6V rechargeable battery with protection circuitry) converts chemical energy into electrical energy and "pushes" it through the circuit, just like the electricity from your power company. A battery pushes electricity through a circuit just like a pump pushes water through a pipe.

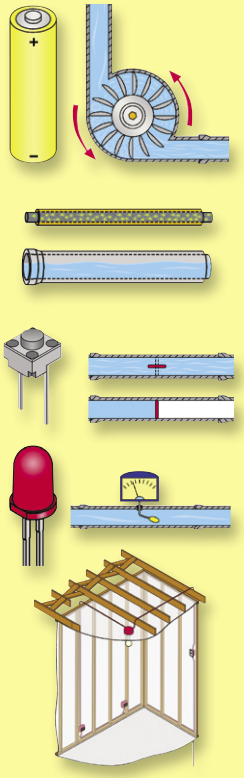
2. The snap wires (the blue pieces) carry the electricity around the circuit, just like wires carry electricity around your home. Wires carry electricity just like pipes carry water.

3. The press switch (**S2**) 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.

4. The red/yellow LED (**D10**, a "light emitting diode") converts electrical energy into light; it is similar to lights in your home. An LED shows how much electricity is flowing in a circuit like a water meter shows how fast water flows in a pipe.

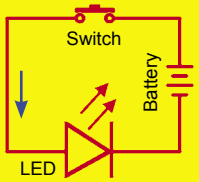


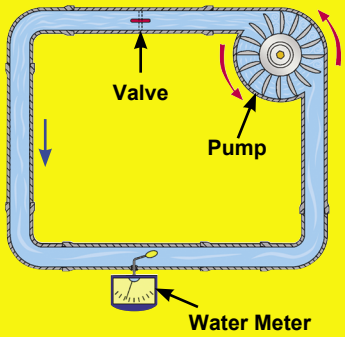
5. The base grid is a platform for mounting the circuit, just like how wires are mounted in the walls of your home to control the lights.



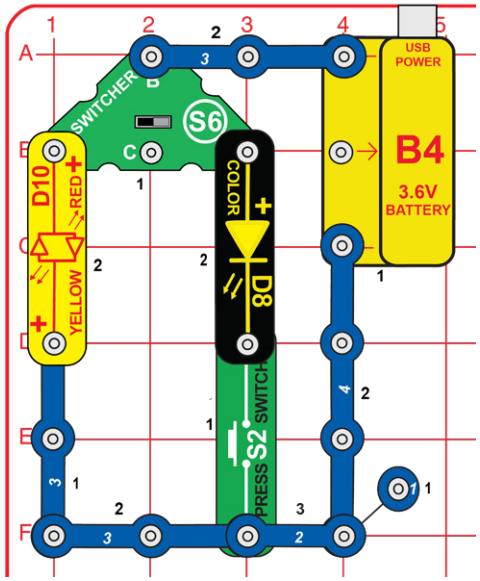
Comparing Electric Flow to Water Flow:

Electric Paths





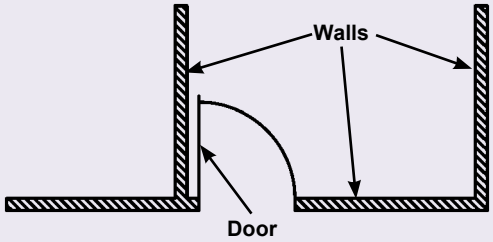
PROJECT 14 • Close the Door



Build the circuit shown. The switcher (**S6**) and press switch (**S2**) control the lights.

See project 3 if you need to recharge the battery (**B4**).

The "on" position of a switch is also called the "closed" position. Similarly, the "off" position is also called the "open" position. This is because the symbol for a simple switch is similar to the symbol for a door in an architect's drawing of a room:

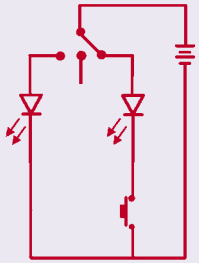


The electronics symbol for a simple switch should be thought of as a door to a circuit, which swings open when the switch is off. The "door" to the circuit is closed when the switch is on. This is shown here:

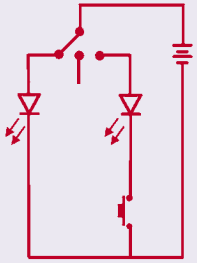
As used in this circuit your S6 switch has 3 positions, so it has a different symbol:

Open Switch (turned off)

Closed Switch (turned on)

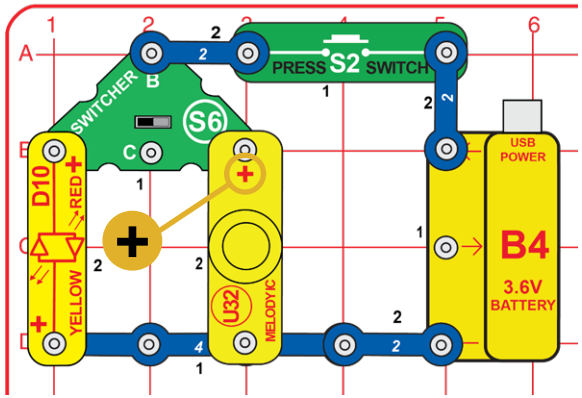


Left Switch Position Open (turned off) Right Switch Position Closed (turned on), right LED controlled by press switch



Left Switch Position Closed (turned on) Right Switch Position Open (turned off)

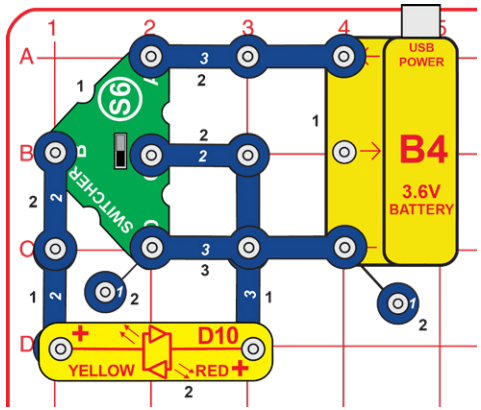
PROJECT 15 • Feeling Switchy



Build the circuit shown and push the press switch (**S2**) to turn on light or sound. Switches can be arranged in many different ways.

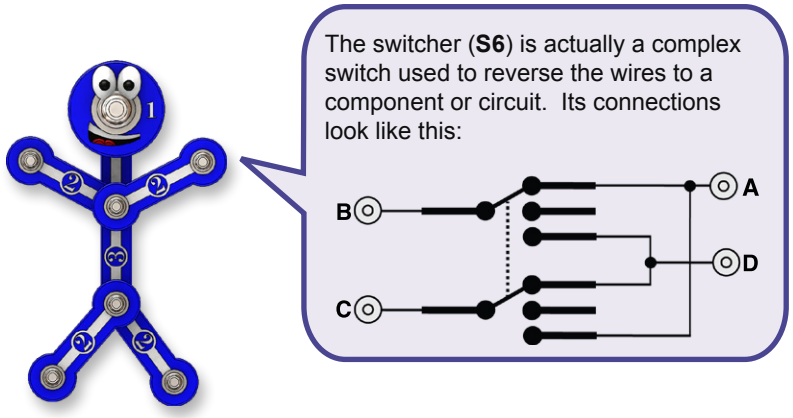
The press switch allows electricity to flow from the battery to the circuit and the switcher (**S6**) directs the electricity to the red LED (**D10**) or the melody IC (**U32**). These switches are like many switches in your home, controlling lights and many other things.

PROJECT 16 • **Reverser**

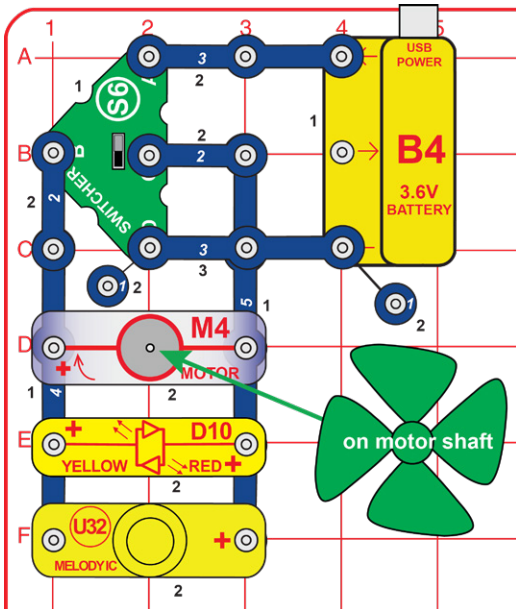


Build the circuit shown. Use the switcher (**S6**) to control the light.

See project 3 if you need to recharge the battery (**B4**).



PROJECT 17 • **Super Reverser**

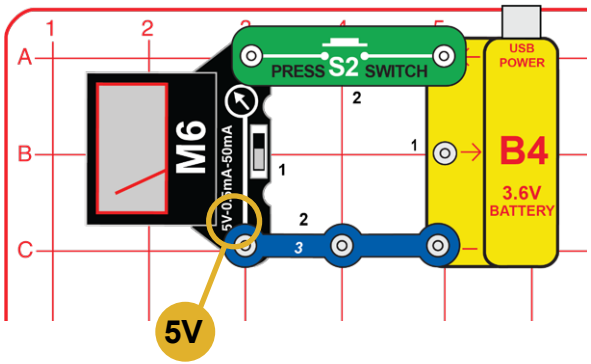


Modify the preceding circuit to be this one. Use the switcher (**S6**) to control light, sound, and motion. The melody IC (**U32**) only works in one direction.

You can replace any of the motor (**M4**), red/yellow LED (**D10**), or melody IC with the color LED (**D8**), clock (**T2**), or geared motor (GM).

See project 3 if you need to recharge the battery (**B4**).

PROJECT 18 • Voltage



See project 3 if you need to recharge the battery (**B4**).

Build the circuit shown. Set the meter (**M6**) to the **5V** setting. Push the switch (**S2**) to connect the meter to the battery and measure its voltage.

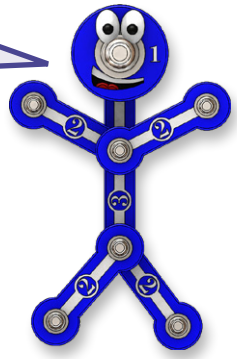
Electricity is the movement of sub-atomic charged particles (called **electrons**) through a material due to electrical pressure across the material, such as from a battery.

The electrical pressure exerted by a battery or other power source is called **voltage** and is measured in **volts** (V). Notice the "**+**" and "–" signs on the battery. These indicate which direction the battery will "pump" the electricity.

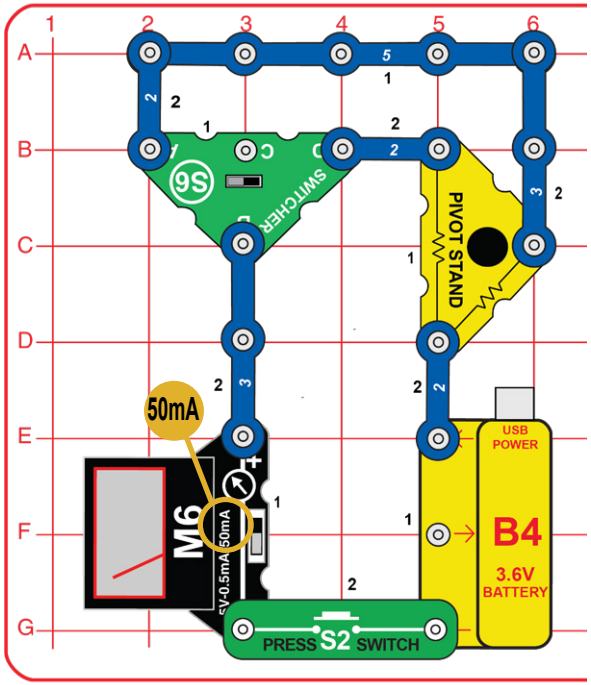
Circuits need the right voltage to work properly. For example, if the voltage to a light bulb is too low then the bulb won't turn on; if too high then the bulb will overheat and burn out.

The **electric current** is a measure of how fast electricity is flowing in a wire, just as the water current describes how fast water is flowing in a pipe. It is expressed in **amperes** (A) or **milliamps** (mA, 1/1000 of an ampere).

The "**power**" of electricity is a measure of how fast energy is moving through a wire. It is a combination of the voltage and current (Power = Voltage x Current). It is expressed in **watts** (W).



PROJECT 19 • Resistors



Build the circuit shown. Set the meter (**M6**) to the **50mA** setting and the switcher (**S6**) to the right position. The pivot stand base has 47Ω and 10KΩ resistors in it. They are used to control the flow of electricity in a circuit.

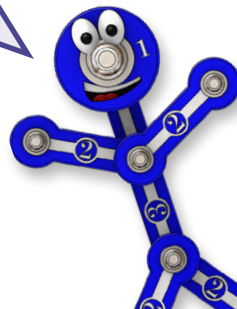
Push the press switch (**S2**) to measure the current through the 47Ω resistor; it should be around **50mA**.

To measure the current through the 10KΩ resistor, set the meter to the **0.5mA** setting and the switcher to the left position. Push the press switch to show the current, it should be around 0.4mA. The current is much lower this time, because the 10KΩ is a higher value resistor.

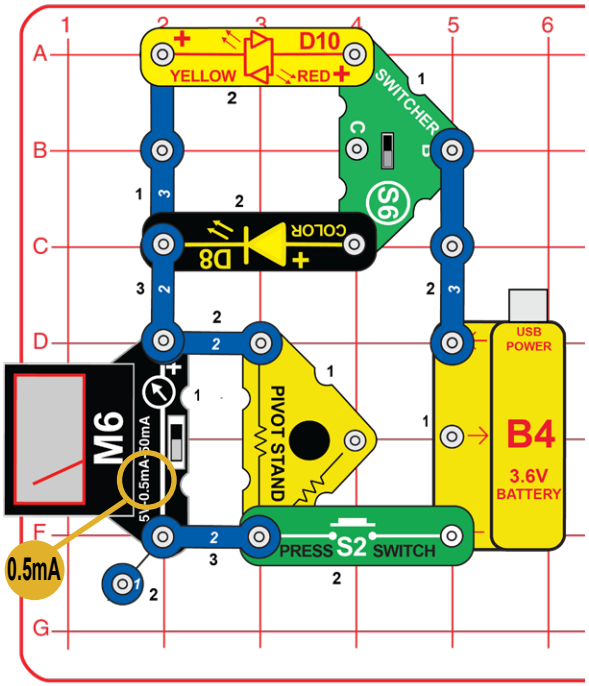
The meter has internal resistors, which scale the measurement it makes into the ranges indicated on it. The 10KΩ resistor can be used with it to double the voltage scale to 10V. Keep the switcher in the left position, set the meter to the **5V** setting, and push the press switch to measure the battery voltage using a 10V scale (double what you read on the **5V** scale).

The resistance of a circuit represents how much it resists the electrical pressure (voltage) and limits the flow of electric current. The relationship is Voltage = Current x Resistance. When there is more resistance, less current will flow unless you increase the voltage. Resistance is measured in ohms (Ω), or kilo ohms (KΩ, 1000 ohms).

What is Resistance? Take your hands and rub them together very fast. Your hands should feel warm. The friction between your hands converts your effort into heat. Resistance is the electrical friction between an electric current and the material it is flowing through; it is the loss of energy from electrons as they move through the material.



PROJECT 20 • Light Emitting Diode



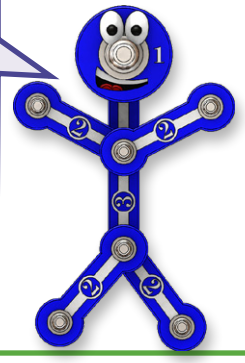
Build the circuit shown. Set the meter (**M6**) to the **0.5mA** setting.

For the upper and lower switcher (**S6**) positions, push the press switch (**S2**) to measure the current through one of the LEDs (**D8** & **D10**). Then change the switcher to measure the current with the other LED, and compare them. The current for **D8** changes as it changes colors.

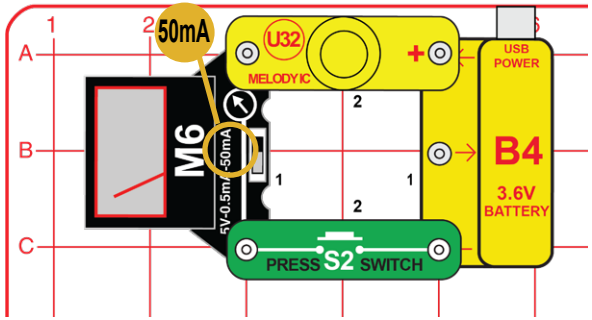
Note: The **0.5mA** meter scale is actually a 5mA scale due to a resistor in the pivot stand being used to scale the current. Change the meter to the **50mA** setting and compare the measurement there (the pivot stand resistor will have little effect on the **50mA** meter scale).

Light emitting diodes (LEDs) are one-way lights with a turn-on voltage threshold. If the voltage is high enough (about 1.**5V** for red or yellow, about 2V for green, and about 3V for blue), they will light. Once an LED is activated, current must be limited by other components in the circuit or the LED can be damaged; your **D8** and **D10** LEDs have 330Ω internal resistors added to protect them.

When electric current flows through an LED, energy is released as light; the color depends on the material. LEDs are much more energy efficient and last longer than ordinary incandescent light bulbs but originally were only used in low-power applications due to power limits, cost, and limited colors. LEDs have since been improved and are now widely used in home lighting.



PROJECT 21 • Play a Tune



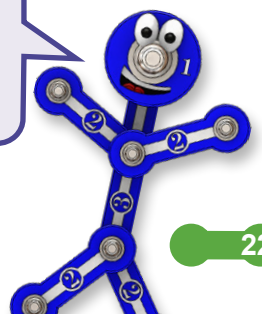
Build the circuit, set the meter (**M6**) to the **50mA** setting. Push the switch (**S2**) to play a tune on the melody IC (**U32**), while the meter measures the current through it.

Compare the current with the melody IC to the current using the LEDs and resistors in projects 21 and 22.

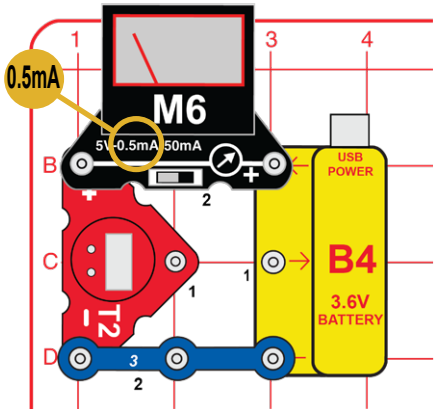
See project 3 if you need to recharge the battery (**B4**).

The melody IC converts electricity into sound energy by making mechanical vibrations. These vibrations create variations in air pressure, which travel across the room. You “hear” sound when your ears feel these air pressure variations.

The current is higher when the sound is louder, because it takes more electrical energy to produce more sound.



PROJECT 22 • Clock

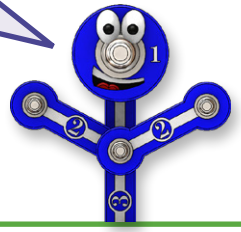


Build the circuit shown. Set the meter (**M6**) to the **0.5mA** setting. The clock display will light, but the meter will not measure any current. See page 4 if you would like to set the time.

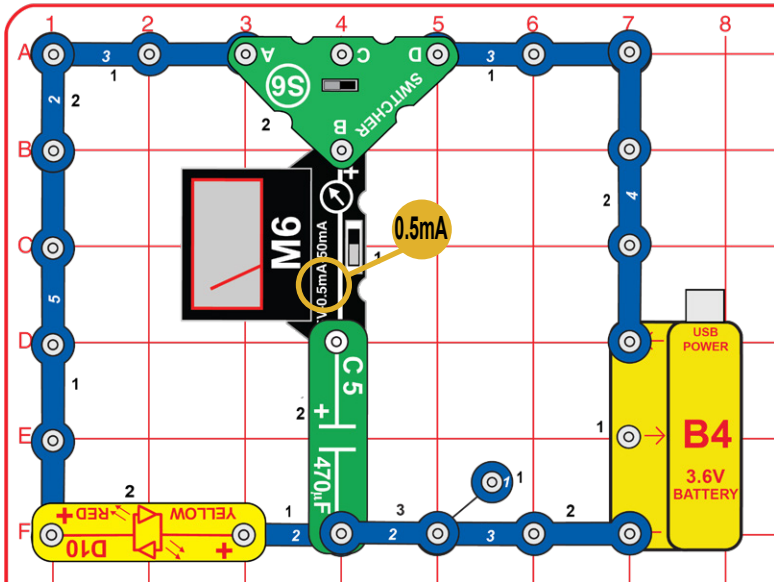
The clock needs only about 0.005mA of current to operate, and this is too small to measure on your meter. The battery can run the clock for a long time without being recharged.

See project 3 if you need to recharge the battery (**B4**).

The clock uses a liquid display (LCD) to show the time. LCDs use very little power, but cannot be viewed in darkness. The electronic circuitry that keeps time, controls the display and allows you to set the current time is complex but has been miniaturized in an integrated circuit (IC).



PROJECT 23 • Capacitor



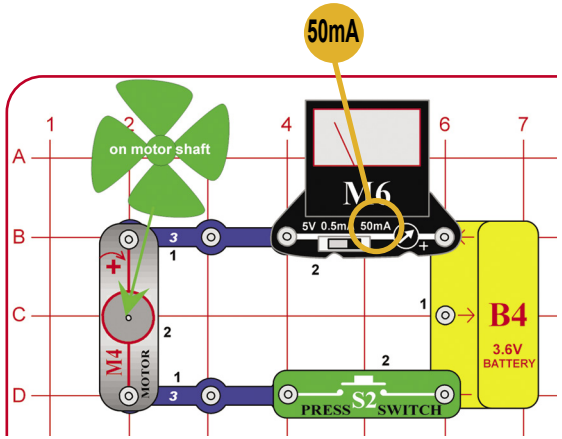
Build the circuit shown. Set the meter (**M6**) to the **0.5mA** setting. Flip the switcher (**S6**) back and forth between its left and right positions to charge and discharge the 470µF capacitor (**C5**).

With the switcher set to the right, a electricity briefly flows from the battery into the capacitor to charge it up, as shown by the meter. With the switcher set to the left, the energy in the capacitor discharges through the red LED (**D10**), which flashes.

The meter only measures current in one direction, but you can flip it around to measure the discharge current.

Capacitors store electricity in an electric field between metal plates, with a small separation between them. This electric field is similar to the magnetic field of a magnet. Compared to batteries (which store energy as separated chemicals), capacitors can only store small amounts of energy, but they can release it quickly, can be made in very small sizes and are inexpensive.

PROJECT 24 • Motor



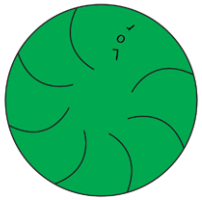
Build the circuit shown. Set the meter (**M6**) to the **50mA** setting and place the wind fan on the motor (**M4**). Push the press switch (**S2**) and watch the current on the meter as the motor speeds up.

Do you know why the current drops as the fan speeds up?

See project 3 if you need to recharge the battery (**B4**).

How does electricity turn the shaft in the motor? The answer is magnetism. Electricity is closely related to magnetism and an electric current flowing in a wire has a magnetic field similar to that of a very, very tiny magnet. Inside the motor is a coil of wire with many loops. If a large electric current flows through the loops, the magnetic effects become concentrated enough to move the coil. The motor has a magnet inside, so as the electricity moves the coil to align it with the permanent magnet, the shaft spins.

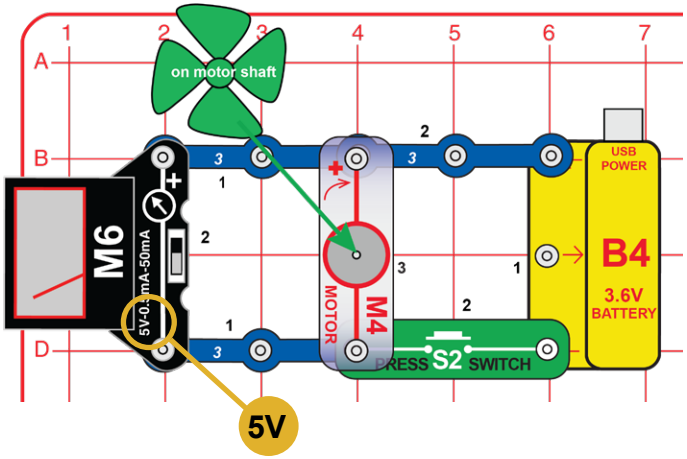
PROJECT 25 • Water Wheel



Remove the wind fan from the motor shaft and replace it with the water wheel. Watch how the current is different with the larger water wheel.

The water wheel is heavier, so it takes more current to spin it, and doesn't get as fast. Try laying something on the water wheel to give it even more weight.

PROJECT 26 • Motor Voltage

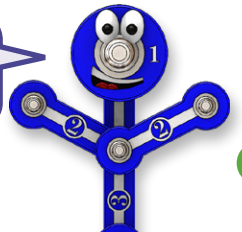


Modify the preceding circuit into this one. Set the meter (**M6**) to the **5V** setting and place the wind fan on the motor (**M4**). Push and release the press switch (**S2**) and watch the voltage on the meter as the motor speeds up and slows down.

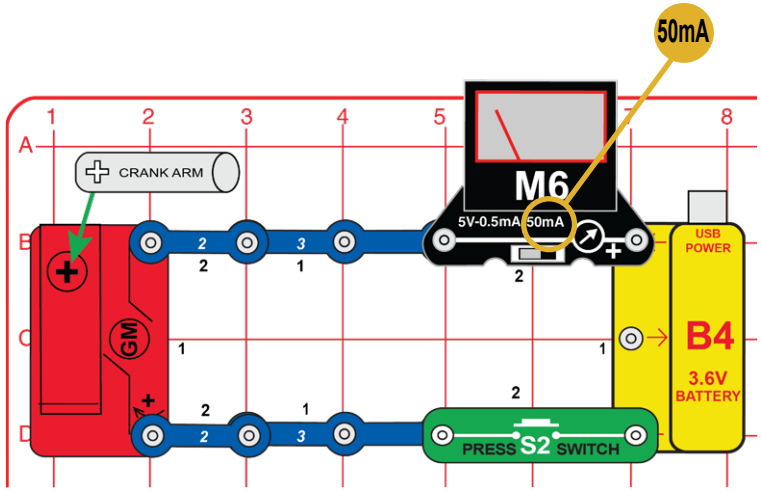
Without pressing the switch, spin the fan clockwise with your finger and watch the voltage. In the preceding project, the current dropped as the fan sped up - now you see why. The spinning fan produces a voltage in the motor; this voltage opposes the voltage from the battery, reducing the current as the motor speeds up.

How will the voltage and current change if you replace the wind fan with the water wheel? Try it.

Electricity is generated when you spin the motor shaft. A coil of wire is on the shaft and as it spins past the permanent magnet an electric current is created in the wire.



PROJECT 27 • Crank Motor



Build the circuit shown. Set the meter (**M6**) to the **50mA** setting. Push the press switch (**S2**) and watch the current on the meter when the crank arm on the geared motor (GM) spins.

Replace the geared motor with the motor (**M4**) and wind fan, red/yellow LED (**D10**), color LED (**D8**, "**+**" on top), or melody IC (**U32**, "**+**" on top) and compare the current measured on the meter.

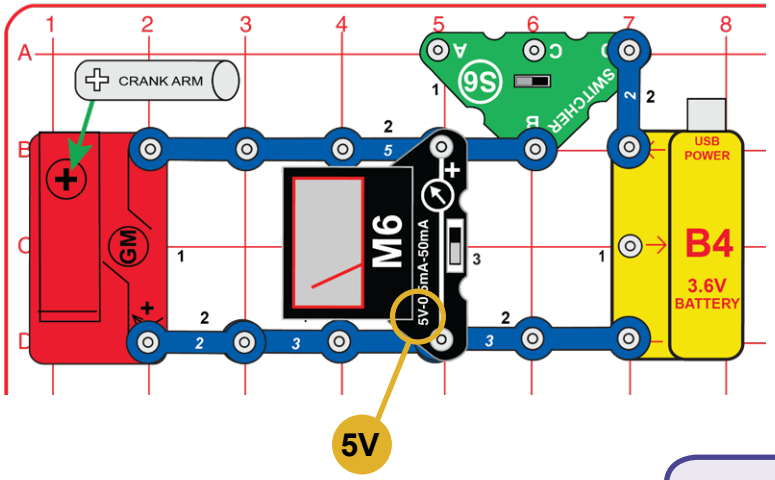
See project 3 if you need to recharge the battery (**B4**).

The geared motor is a motor with a gearbox attached. The gearbox spins the crank handle slower but with more force than when the motor shaft is spinning.

The slow-spinning crank handle may look boring compared to the fast wind fan on the **M4** motor, but using a gearbox allows a low-power motor to move heavier objects than they normally could.

It takes more power to run the geared motor than the other devices, so the current with it will be higher.

PROJECT 28 • Crank Motor Voltage



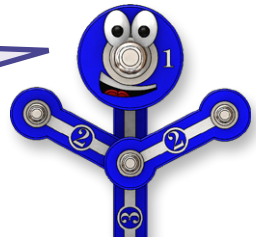
Modify the preceding circuit into this one. Set the meter (**M6**) to the **5V** setting. Set the switcher (**S6**) to the right position and watch the voltage on the meter when the crank arm spins.

Set the switcher to the left or middle position to disconnect the battery. Turn the crank arm counter-clockwise and see how much voltage you generate. You can switch the meter to the **50mA** setting to see how much current you produce when you spin the fan.

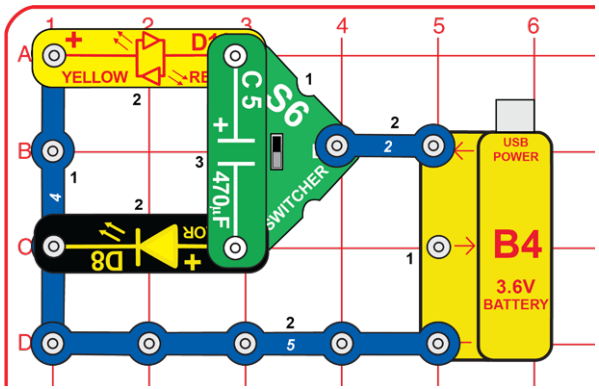
Set the meter back to the **5V** setting and the switcher back to the right position. While it is spinning, CAREFULLY AND WITHOUT USING MUCH FORCE, try to turn the crank handle in both directions. Feel how much easier or harder it is to turn the crank when the battery voltage is helping or opposing you.

USING EXCESSIVE FORCE MAY DAMAGE THE HAND CRANK!

The motor in the geared motor is different from the **M4** motor, but similar. Did you see how much more voltage and current you can generate using the hand crank than with the **M4** motor?



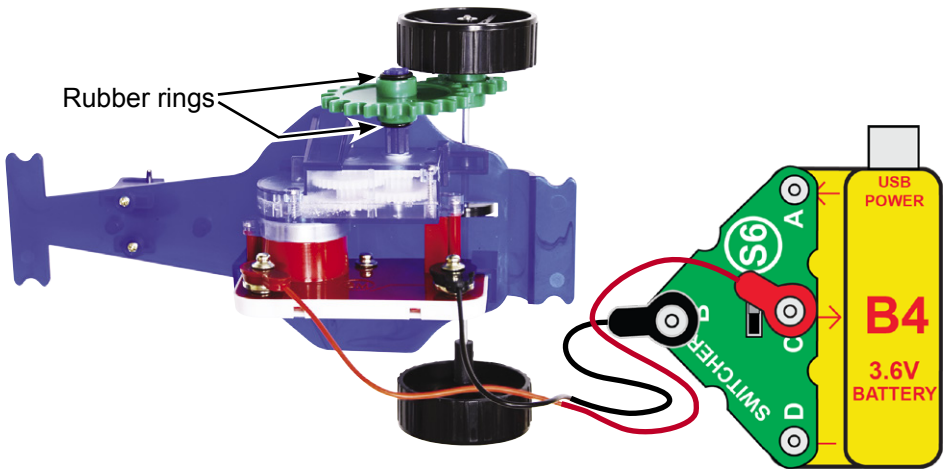
PROJECT 29 • Fade Out



Set the switcher (**S6**) to the top or bottom position. Watch as one LED fades out after a few seconds, then set the switcher to the other side. Do this several times.

The 470µF capacitor (**C5**) stores electricity, and keeps the disconnected LED on for a few seconds after you flip the switch.

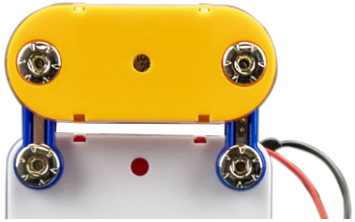
PROJECT 30 • Mini Car with Wired Control



Build the circuit as shown, initially setting the switcher (**S6**) to the middle setting. Mount the 1.75" gear on the geared motor (GM) with the rubber rings to keep it from sliding out of position, place it on the mini car frame, and connect it to the circuit using the red & black jumper wires. Now use the switcher to make the mini car go forward, backward-turning, or stop. You can follow the car around the room or table while using **S6** to control it. Be careful to follow it closely so you don't over-extend the jumper wires, and to keep it from falling off the table.

See project 3 if you need to recharge the battery (**B4**).

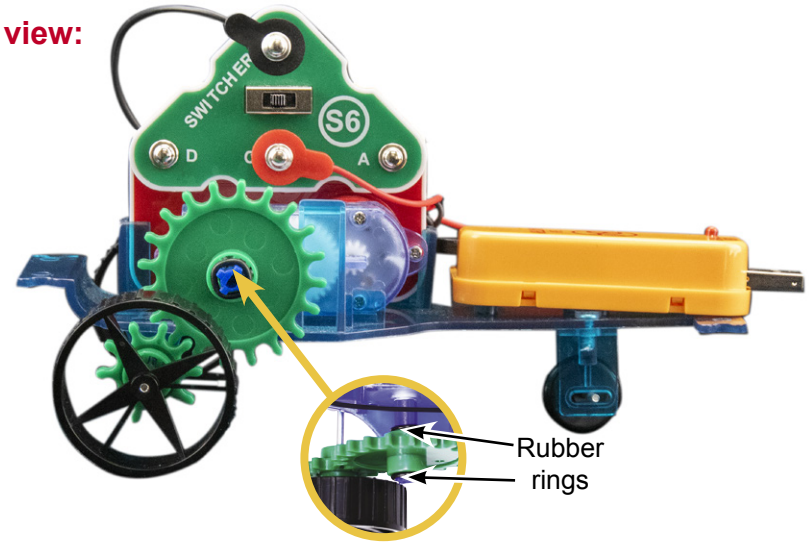
PROJECT 31 • Wired Control Car with Light/Sound



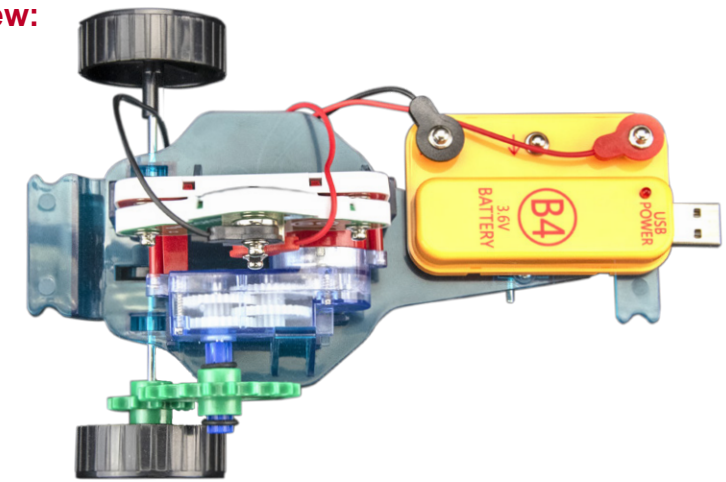
Modify the preceding circuit to include the red/yellow LED (**D10**) and melody IC (**U32**), mounted on the car using two 2-snap wires. A tune plays and the LED lights yellow when the car is going forward, or the LED lights red when the car goes backward-turning.

PROJECT 32 • Mini Car with on-Board Control

Side view:



Top view:



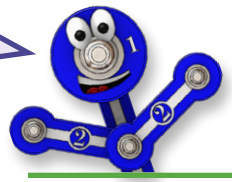
Build the circuit as shown, initially setting the switcher (**S6**) to the middle setting. Mount the 1.75” gear on the geared motor (GM) with the rubber rings to keep it from sliding out of position, place it on the mini car frame, and connect the battery (**B4**), switcher (**S6**) and red & black jumper wires as shown. Use the switcher to make the mini car go forward, backward-turning, or stop.

The battery may not be able to drive this mini car for long without recharging, so connect it to a USB port to recharge it as needed (it can also be recharged using the solar cell as shown in project 3).

Variant A: Monitor the battery voltage by setting the meter (**M6**) to the **5V** setting and place it on the ends of the red & black jumper wires that are on the battery. Disconnect the meter when you are not using the set because the meter will gradually drain the battery.

Variant B: Instead of the meter, place the clock (**T2**) over the battery using two 1-snap wires, clock (**+**) to battery (←). See page 4 if you would like to set the time.

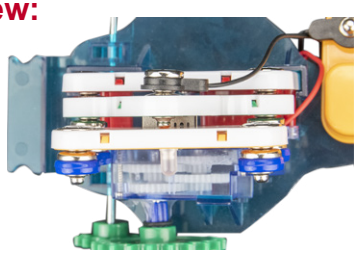
Many cars on our roads are now powered using batteries and electricity instead of gasoline. This mini car is like one of today’s electric cars, with the **B4** rechargeable battery representing the car battery and the USB charger representing charging an electric car battery using your house electricity or at electric car charging station.



PROJECT 33 • Mini Car with on-Board Light

Side view:

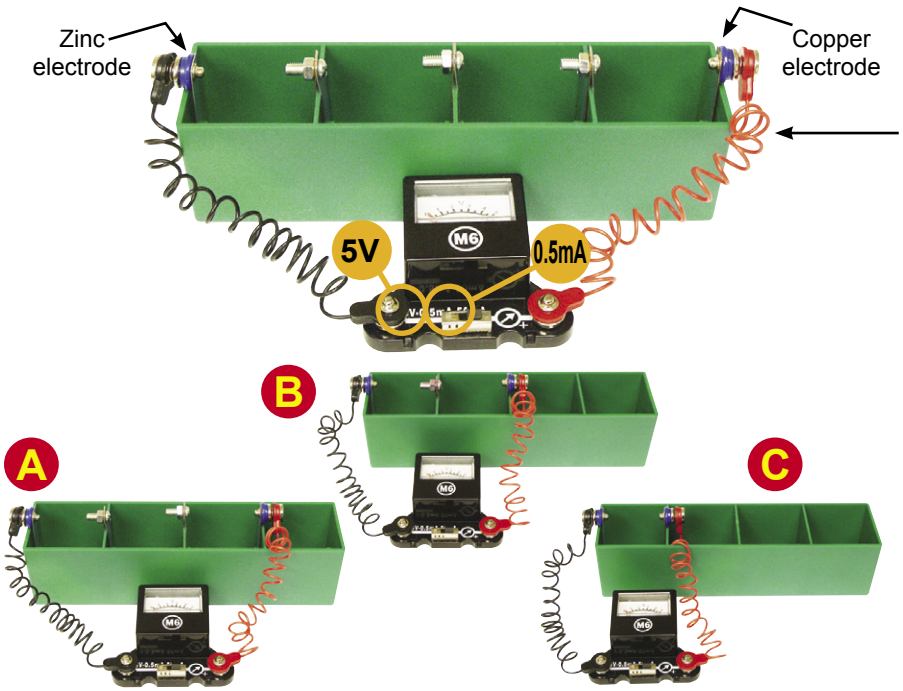
Top view:



Add the red/yellow LED (**D10**) to the preceding circuit using two 1-snap wires and two 2-snap wires, as shown. The LED lights yellow when the car is going forward, or red when it goes backward-turning.

You can replace the red/yellow LED with the color LED (**D8**), but the color LED only lights in one car direction.

PROJECT 34 • Liquid Battery



Assemble the liquid energy source using the instructions on page 4. Connect the red & black jumper wires between the meter (**M6**) and the electrodes, the (**+**) side of the meter goes to the copper one. Set the meter to the **5V** setting. Fill the compartments with cola soda (other flavors also work). The meter should show a voltage of about 3V. Switch the meter to the **0.5mA** setting to measure the current produced.

Move the copper electrode with the snap on it over to the next compartment, as shown ("**A**"). Use the **5V** setting to measure the voltage and the **0.5mA** setting to measure the current. The voltage should only be about 3/4 of what it was, since you have one less compartment. The current should be about the same.

Now move the copper electrode with snap to the next compartment, so only two are used ("**B**") See how the voltage drops even more, but the current changes little.

Now move the copper electrode with snap to the same compartment as the electrode with snap, so you only have one cola "cell" ("**C**"). Measure the voltage and current now.

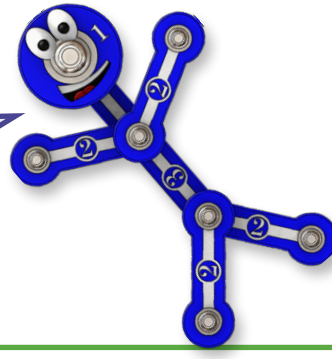
Don't drink any soda or juice used in this project. Wash the electrodes and liquid holder.

Note: Your actual results may vary. Your **M6** meter is a simple meter; don't expect it to be as accurate as normal electronic test instruments.

Cola-flavored soda is lightly acidic. The acid is similar to the material used in some types of batteries but not as strong. The acid in the cola reacts with the copper and zinc electrodes to make an electric current, just like a battery. As some of the acid in the soda is used up, the current produced drops.

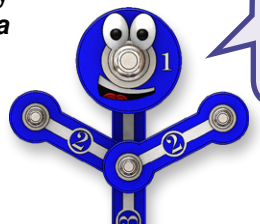
Each of the compartments in the liquid energy source produces about 0.7**5V**, though the current is low. When the four compartments are connected in a series, their voltages add together to make about 3V total, but the current is the same. Each compartment is like a cell of a battery. Your **B4** rechargeable battery actually contains three 1.2V "cells" in a series, just like the "cells" of the liquid energy source.

Soda can be used in this way to produce electricity, but it does not produce very much, so is not widely used. However, biomass power plants, which burn decaying food products and yard waste, are increasingly being used. These plants produce electricity from garbage that would otherwise be filling up landfills, and they don't pollute the environment.



PROJECT 35 • Juice Battery

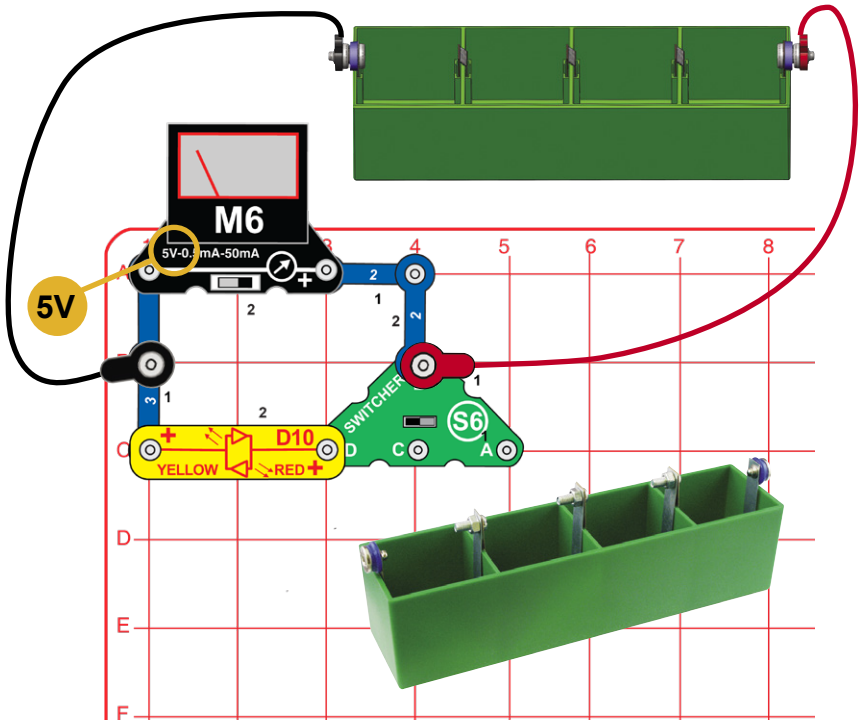
Replace the soda in the liquid energy source with fruit juice. Sour tasting juices like lemon or grapefruit work best. Measure the voltage and current for your juice battery like you did with the soda. Try different juices and compare them. ***Don't drink any soda or juice used in this project. Wash the electrodes and liquid holder.***



Some fruits and vegetables have a sour taste because they are lightly acidic. This acid can be used to produce electricity just like the cola and batteries do.

Using the natural chemical energy in fruit is a very green (environmentally friendly) way to produce electricity.

PROJECT 36 • Cola Light



Assemble the liquid energy source using the instructions on page 4. Build the circuit and connect the red & black jumper wires; the red wire goes to the copper electrode. Set the meter (**M6**) to the **5V** setting. Fill the compartments with cola soda (other soda flavors and lemon, tomato, or grapefruit juice also work). Set the switcher (**S6**) to the right position. The meter shows the voltage produced.

Now set the slide switch to the left position to connect the red/yellow LED (**D10**). The LED should be on, though it may be dim. The voltage shown on the meter may be lower now, because the cola may not be able to make as much electricity as the LED wants. If you watch the circuit for a while, the LED brightness and voltage may slowly drop as the cola reacts with the electrodes to produce electricity.

Remove the meter from the circuit. The LED may be brighter, because all the electricity produced is going to the LED now.

You can move the copper electrode with the snap on it over to the next compartment, as shown in the Liquid Battery project. The LED will be dimmer or not light at all, because the voltage is lower.

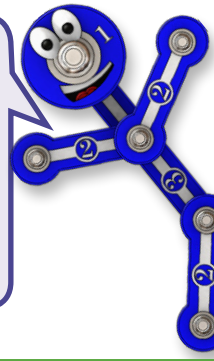
If the copper and zinc electrodes get corroded through use, use sandpaper, steel wool, or a scraper to remove the corrosion and improve performance.

Don't drink any soda or juice used in this project. Wash the electrodes and liquid holder.

When used to measure voltage (**5V** setting), your **M6** has a high resistance of about 10KΩ, which is placed in parallel with the voltage you are measuring. A very small amount of current will be diverted into the meter, but this will usually not have any effect on the circuit. However sometimes, if your voltage source can only produce a small amount of current, it changes the circuit operation. That is why the LED can get brighter when you remove the meter from this circuit.

When used to measure current, your **M6** meter has a resistance of about 500Ω in the **0.5mA** setting and about 10Ω in the **50mA** setting, which is placed in the circuit so the current flows through it. This meter resistance will reduce the current it is trying to measure, but the effect will be small if the meter is set to the appropriate current scale.

Your **M6** meter is a simple meter. Normal electronic test instruments can make better measurements, because they have less effect on the circuits they are measuring, but even they have limitations and they can be very expensive.



PROJECT 37 • Yellow Cola

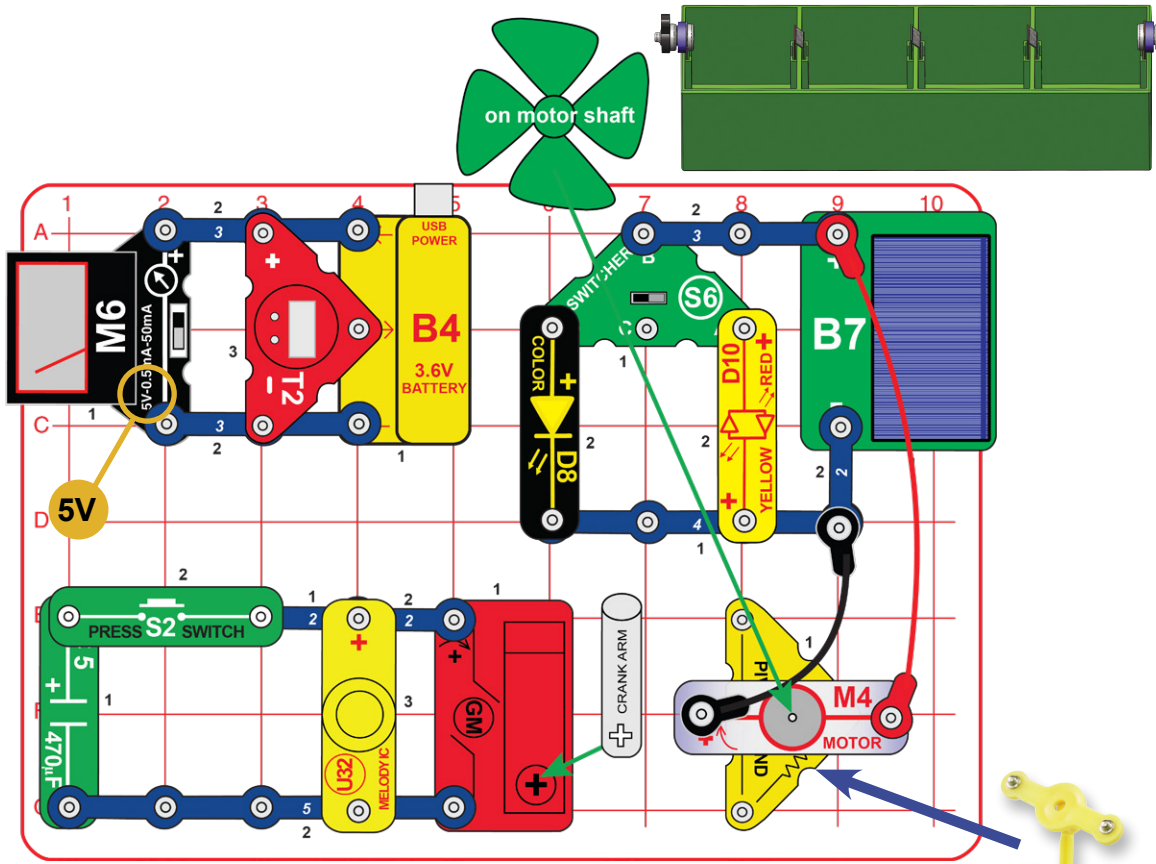
Replace the red/yellow LED (**D10**) with the color LED (**D8**). Compare the LED brightness and voltage change to the red/yellow LED in the preceding project.

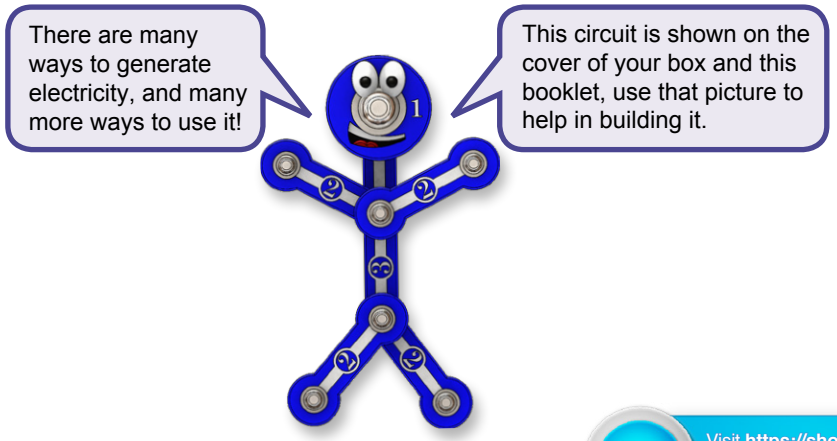
The liquid energy source does not produce enough electricity to run the melody IC (**U32**) or motor (**M4**).

It takes higher voltage to turn on the green and blue light effects than red, so those colors will be dimmer.

If you had pipes pumping fresh cola into the liquid cells and removing some of the used liquid, then the LED would stay lit as long as the flow was maintained - it would be a fuel cell.

PROJECT 38 • Everything Circuit





This project combines several circuits to demonstrate what you can do with Snap Circuits® Green Energy. This circuit may be shown on your box or manual cover.

Assemble the circuits shown. Set the meter (**M6**) to the **5V** setting and place the crank arm on the geared motor (GM). See page 4 if you would like to set the time on the clock (**T2**).

The battery (**B4**) runs the clock, while the meter (**M6**) monitors the battery voltage. Turn the crank arm clockwise to run the melody IC (**U32**); pushing the press switch (**S2**) makes the sound louder. Place the solar cell (**B7**) in sunlight or near an incandescent light bulb to light one of the LEDs (**D8** & **D10**), depending on the switcher (**S6**) position.

Note: You should not connect the jumper wires to the LED circuit if you want to run them using the solar cell.

The LEDs may also be powered by wind or liquids. Assemble the pivot stand and place the motor with wind fan on it. Connect it to the circuit near the solar cell using the red & black jumper wires. Blow on the wind fan or place it in a strong wind to use it to light the LEDs.

To run the LEDs using liquid, assemble the liquid energy source using the instructions on page 4. Move the red and black jumper wires from the windmill motor to the electrodes (red wire to the copper electrode, black wire to zinc electrode). Fill the compartments with cola or juice. The solar cell is still connected to the circuit, so you may cover it to prevent it from helping the liquid run the LED.

You may re-arrange the LEDs, clock, and melody IC between the different mini-circuits, but some energy sources may not be able to operate them.

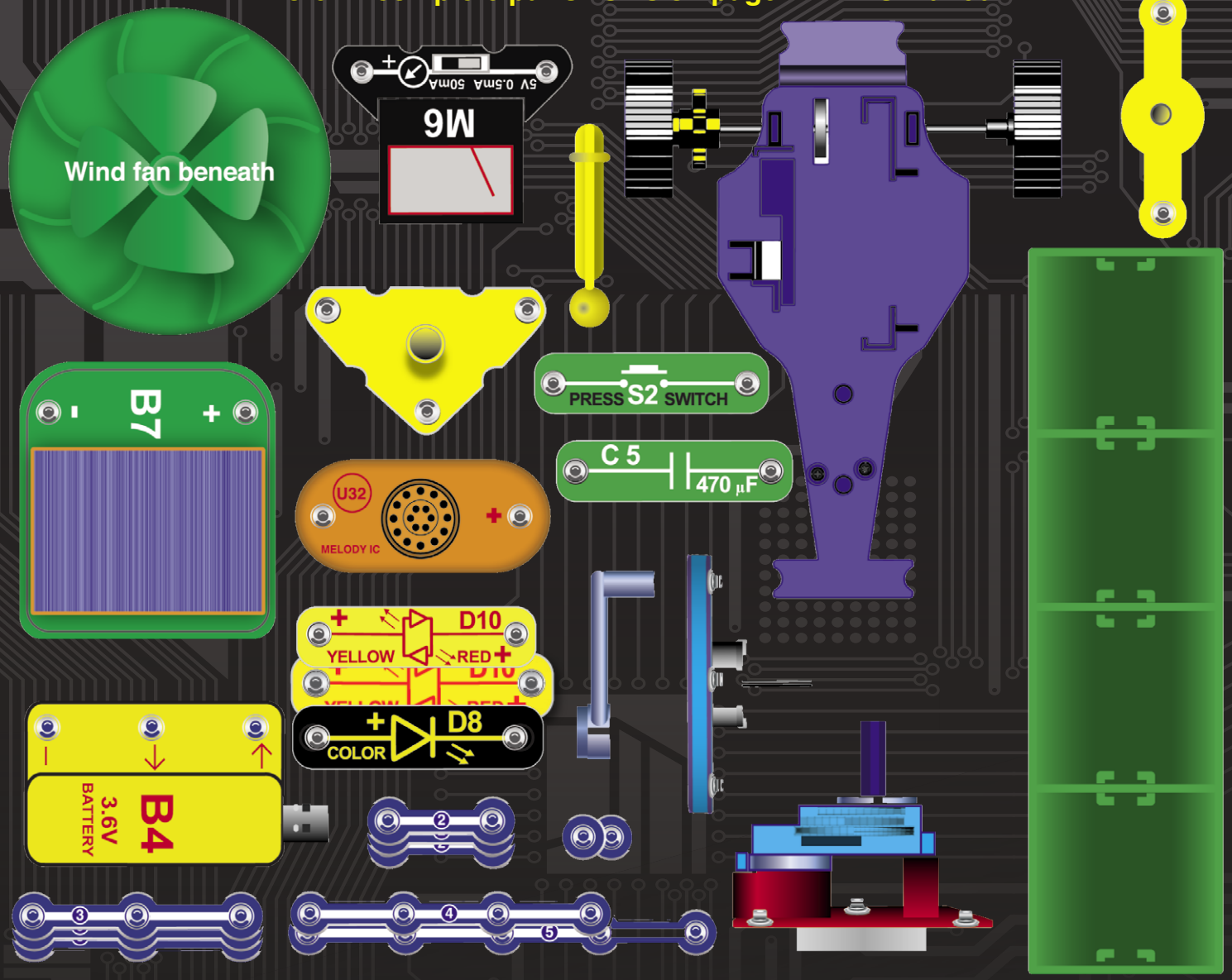
See project 3 if you need to recharge the battery (**B4**).

Don't drink any water or liquids used in this project.

Visit **https://shop.elenco.com/consumers/snap-circuits-green-energy.html** to download projects 39-133

SCG-225 Snap Circuits® Green Energy Block Layout

Important: If any parts are missing or damaged, DO NOT RETURN TO RETAILER.
Go to www.elenco.com/replacement-parts or e-mail us at: support@elenco.com.
150 Carpenter Ave. Wheeling, IL 60090 U.S.A. • (847) 541-3800
Note: A complete parts list is on page 2 in this manual.



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Base grid (11”x 7.7”) overlays many parts.