

Basic Electricity

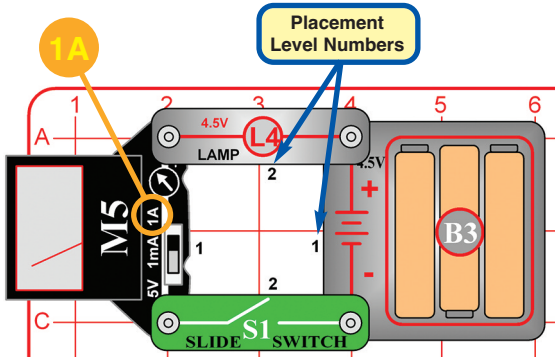
Model SCP-10

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.



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

Project 1 Lamp Current



Snap Circuits® uses electronic blocks that snap onto a base grid to build different circuits. These blocks have different colors and numbers on them so that you can easily identify them. Build the circuit shown by placing all the parts with a black 1 next to them on the clear base grid first. Then, assemble parts marked with a 2. Install three (3) “AA” batteries (not included) into the battery holder (B3).

Set the meter (M5) to the 1A setting.

Turn on the slide switch (S1). The lamp (L4) comes on, and the meter measures how much electric current is flowing.

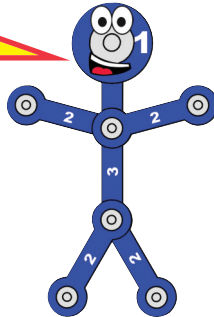
Electricity is the movement of sub-atomic charged particles through a material due to electrical pressure across the material, such as from a battery. Power sources, like batteries, push electricity through a circuit, like a pump pushes water through pipes. Wires carry electricity, like pipes carry water. Devices like lamps use the energy in electricity to do things. Switches control the flow of electricity like valves and faucets control water.

The electrical pressure exerted by a battery or other power source is called **voltage** and is measured in **volts (V)**. The “+” and “-” signs on a battery indicate which direction it will “pump” electricity.

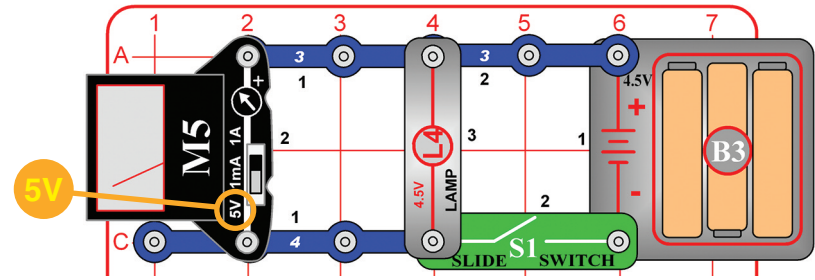
The **electric current** is a measure of how fast electricity is flowing in a wire, just as the water current describes how fast water is flowing in a pipe. It is expressed in **amperes (A)** or **milliamperes (mA = 1/1,000 of an ampere)**.

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 resistance increases, less current flows. Resistance is measured in **ohms (Ω)**.



Project 2 Batteries in Series



Set the meter (M5) to the 5V setting, and turn on the slide switch (S1). The lamp (L4) comes on, and the meter measures the voltage from the 3 batteries.

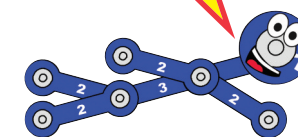
Part B: Remove the left battery from the holder (B3), then snap one side of the red jumper on as shown, and touch metal on the other end to the left spring in the battery holder. Read the voltage on the meter, measuring 2 batteries, and notice how the lamp is dimmer.

Part C: Now also remove the center battery from the holder and touch metal on the end of the red jumper wire to the center spring in the holder. Read the voltage on the meter, measuring 1 battery, and notice how the lamp is dimmer.

If desired, use the voltage measured here (with 3 batteries) and the current measured in project 1 to calculate the resistance and power of the lamp:

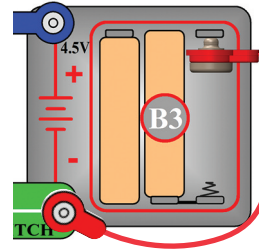
Resistance equals Voltage divided by Current, and should be about 15 ohms. Power equals Voltage times Current, and should be about 1 Watt.

Your results may be different, because M5 is a simple meter with low accuracy, and your battery voltage can vary.

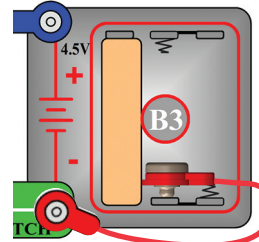


Batteries are like electrical pressure, pushing electricity through a circuit. Adding more batteries increases the flow of electricity, making the lamp brighter.

Part B:



Part C:

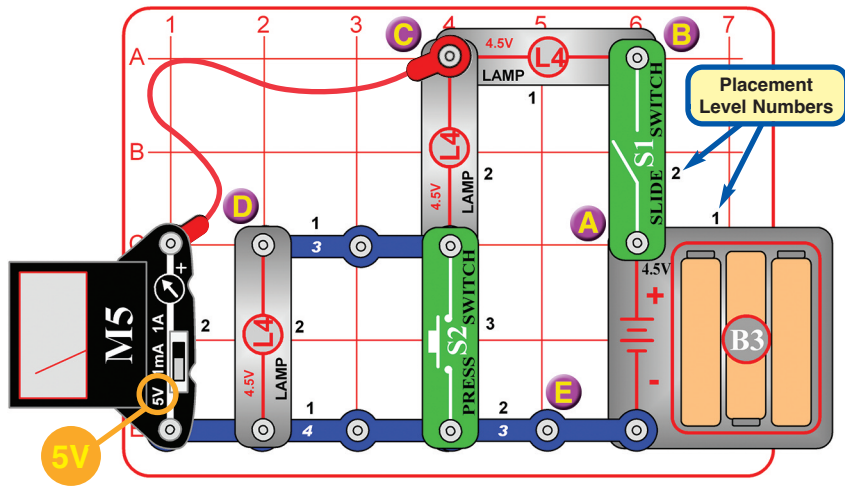


Quiz answers:
1. B 2. B 3. C 4. A 5. B

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Project 3 Triple Voltage Divider



The circuit has three lamps connected in series, or two when S2 is pressed (S2 bypasses the last one).

A. Point A is the "+" battery terminal, so the meter is always measuring the battery voltage.

B. When S1 is on, point B is connected to the batteries, so the voltage will be the same as point A. When S1 is off, the voltage is zero.

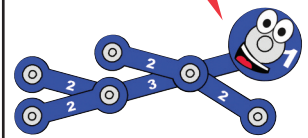
C. Point C measures the voltage after one lamp and across the other two, so should be about 2/3 of the battery voltage. When S2 is pressed, the last lamp is bypassed, so point C is measuring across one of the two remaining lamps, so should be approximately 1/2 of the battery voltage.

D. Point D measures the voltage after two lamps and across the last one, so should be about 1/3 of the battery voltage. When S2 is pressed, the last lamp is bypassed, so point D is zero volts just like point E.

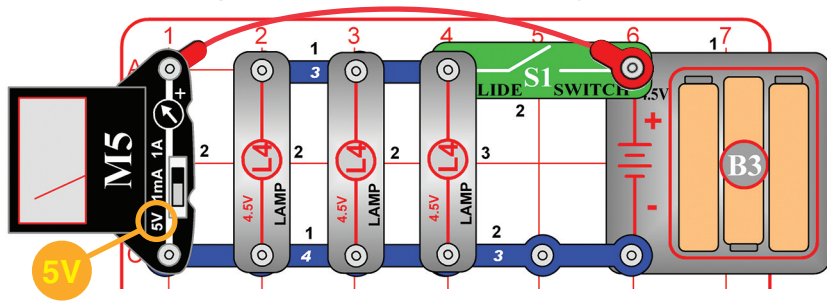
E. Point E is the "-" battery terminal, and will always be zero.

Kirchhoff's Voltage Law, an important rule for analyzing circuits, says the total voltage driving a circuit must equal the voltage drops within it. So the voltage drops across all of the lamps should equal the battery voltage. (Your measurements may be a little different, because M5 is a simple meter with low accuracy.)

This circuit is pictured on the front of the box, use that picture to help in building it. Set the meter (M5) to the 5V setting. Turn on the slide switch (S1) and use the meter to measure the voltage at points A, B, C, D, & E in the circuit by connecting the end of the red jumper wire to each of those points (the drawing shows it connected to point C). Next, repeat the voltage measurements at points A, B, C, D, & E while pushing the press switch (S2).



Project 4 Heavy Load



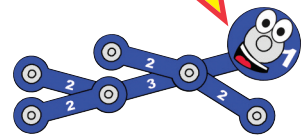
Set the meter (M5) to the 5V setting, and initially keep the switch (S1) off. The meter measures the battery voltage with the lamps (L4) off.

Now turn the switch on to light the lamps, and see if the battery voltage changes. Next, remove one or two of the lamps and compare the voltage.

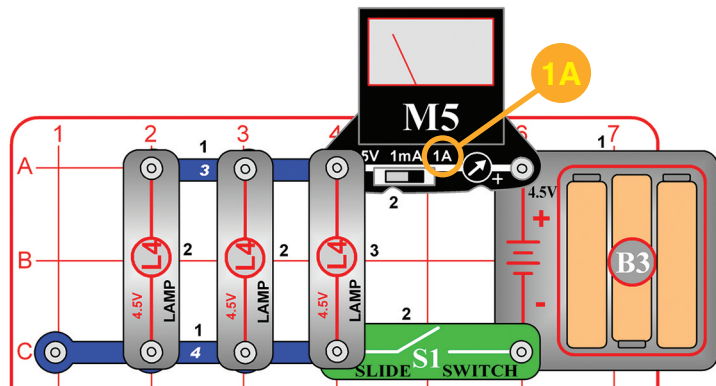
Try this project with both new strong batteries and with old weak ones. Compare how the voltage changes when you turn the switch on.

Batteries produce electricity using a chemical reaction, and only a limited amount of the chemicals can react together at once. Also, the chemical reaction slows as the batteries get weaker. When a circuit wants more electricity than the batteries can supply, the voltage (electrical pressure) drops.

In this circuit, lighting all three lamps takes a lot of electricity, so the voltage drops a little when the switch is turned on. The drop in voltage is much greater for weak old batteries than for strong new ones.



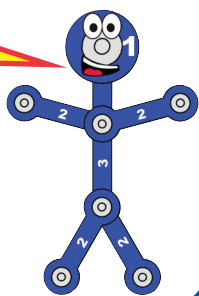
Project 5 Heavy Flow



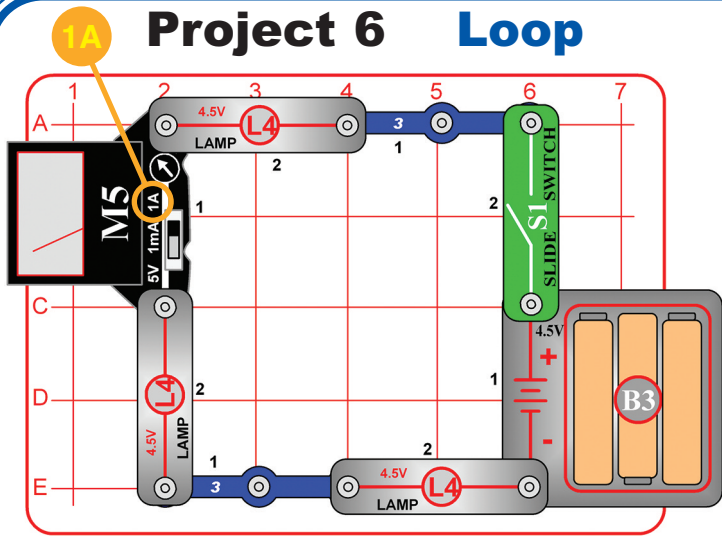
Modify the preceding circuit to match this one. Set the meter (M5) to the 1A setting and turn on the switch (S1). The meter measures the current. Try removing one or two lamps and see how the current changes. Also try this circuit with both new strong batteries and with old weak ones.

In this circuit, electricity flows out of the batteries, through the meter, then divides among the 3 lamps, then all flows back to the batteries through the switch.

The 3 lamps are connected in parallel, because the current flow divides among them. If one of the lamps burns out, the others will still work because has its own path for electricity to flow along.



Project 6 Loop

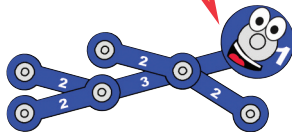


Set the meter (M5) to the 1A setting and turn on the switch (S1). The lamps light and the meter measures the electric current flow. Try rearranging the parts in the circuit (keeping the “+” side of the meter aligned with the “+” side of the batteries) and how it affects the circuit. Next, try replacing any of the lamps (L4) with the press switch (S2) and push it.

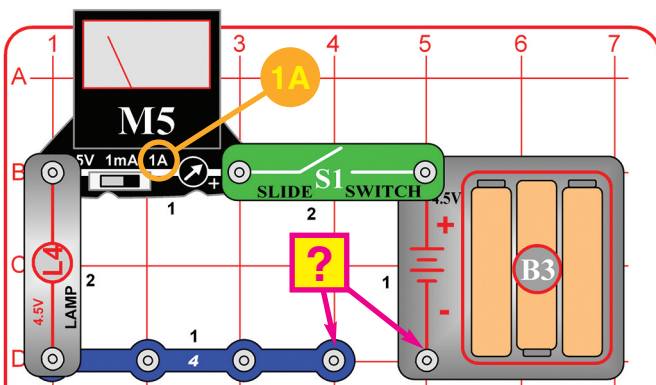
This circuit has the lamps connected in a series (not in parallel, as in project 5). This arrangement makes the lamps dimmer because the battery voltage is divided among the 3 lamps, but also makes the batteries last longer because less current is flowing. Electricity from the batteries flows in a loop, equally through each component in the circuit.

Rearranging the components in a series circuit does not change it, because the same amount of electricity is flowing through each component. Replacing one of the lamps with the press switch increases the current, because the pressed switch has no resistance to the flow of electricity.

If several lamps are arranged in series and one burns out, none will work because the only path for electricity is blocked.



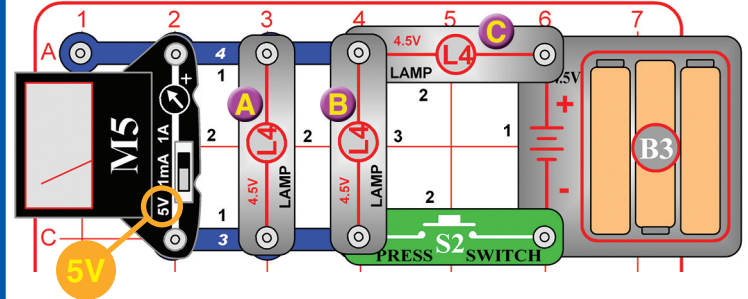
Project 7 Find Your Own Parts



Build the circuit shown; the **?** can be anything you want. Set the meter (M5) to the 1A setting and turn on the switch (S1). Touch various materials between the snaps on the 4-snap wire and battery holder “-” side. Use the red jumper wire to help make a connection if needed. See which materials are good at transporting electricity by watching the meter current and lamp (L4) brightness.

If the meter reads zero, switch it to the 1mA setting to see if there is just a very small current. With the 1mA meter setting, try placing two of your fingers across the two snaps to see how well you transport electricity; wet your fingers to get better electrical contact. To help protect the meter, always switch back to the 1A scale before testing a new circuit.

Project 8 Fast Bright, Slow Dim



Part A: Set the meter (M5) to the 5V setting. Push the press switch (S2) for several seconds, while watching the meter. The meter is measuring the voltage across the two left lamps (labeled A & B); its reading jumps up when the switch is pressed, then slowly rises more for a few seconds. Push the switch again while closely watching the lamps A & B. Notice how lamps A & B initially are off, but turn on dimly within a second or two.

Note: The voltage measured in this step will be small; in some cases it may even be too small to measure with your M5 meter. M5 is a simple meter, don't expect it to be as accurate as normal electronic test instruments.

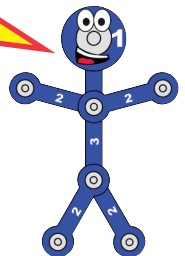
Part B: Remove lamp B, and push the switch again. Now both remaining lamps (A & C) get equally bright fast, and the meter shows a higher voltage across the left lamp (A).

Part C: Replace the right lamp (C) with a 3-snap wire, and push the switch again. Now the left lamp (A) gets the full battery voltage, as shown on the meter.

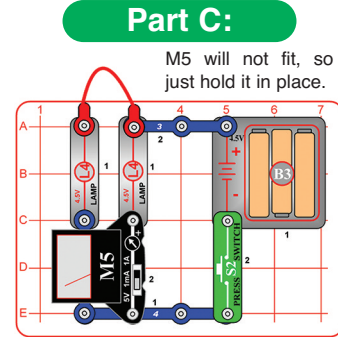
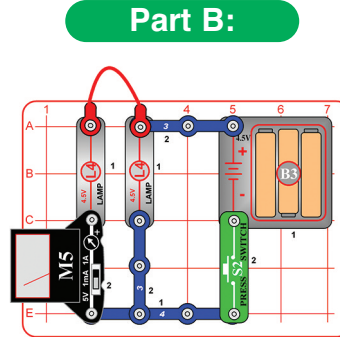
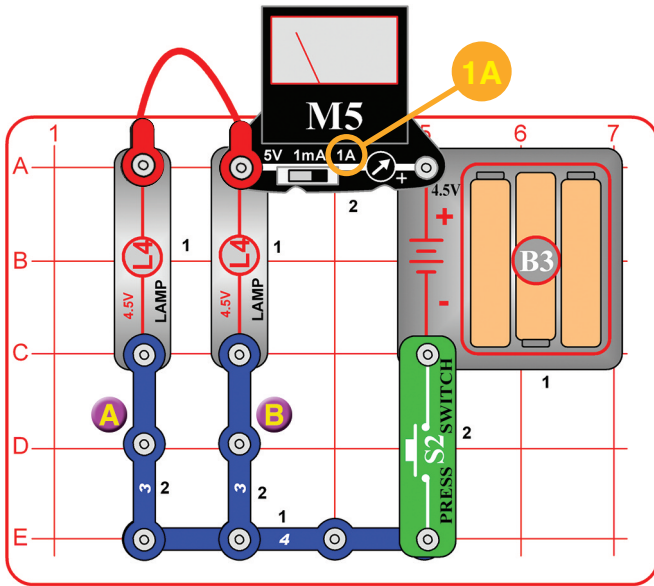
Incandescent light bulbs, like those in the L4 lamps, make light by passing a big electric current through a special resistive wire (the filament), which gets so hot that it glows. The two left bulbs (A & B) get less current than the right bulb (C) so they take longer to heat up and don't get as hot.

The meter measures the voltage across left lamps A & B. This voltage will be low when the left lamps are dim. When you remove lamp B, both remaining lamps have the same voltage across them and the same current through them.

In part A, you might have expected left lamps A & B to be half as bright as the right lamp (C), because the current through lamp C should divide equally between lamps A & B, but instead lamps A & B are much dimmer. This occurs because bulb filaments offer less resistance to the flow of electricity when they are cold, and increase in resistance as they heat up. Your L4 lamps have resistance of less than 5 ohms when they are cold, and about 15 ohms then bright.

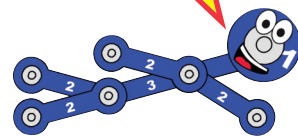


Project 9 Current Divider



The current from the batteries splits up between the two lamps, because they are connected in parallel. If you add up the current you measured through circuit branches A & B, it should be the same as the current you measured from the batteries. (Your result may be a little different, because M5 is a simple meter with low accuracy.)

Kirchhoff's Current Law, an important rule for analyzing circuits, says that all current flowing into a point must flow out of it.



Set the meter (M5) to the 1A setting, and push the press switch (S2). The lamps (L4) come on, and the meter measures the current from the batteries.

Part B: Swap the location of the meter with the 3-snap wire marked "A" (place "+" side towards L4). Push the switch to measure the current through circuit branch "A".

Part C: Swap the "A" location of the meter with the "B" 3-snap. Note that M5 will not fit; just hold it in place for this test. Push the switch to measure the current the "B" branch.

Quick Quiz: (answers on bottom left of page 1)

- _____ is a measure of how fast electricity is flowing in a circuit.
 - Voltage
 - Current
 - Power
 - Watts
- When several lamps are wired in _____ with each other, all will have the same electric current flowing through them.
 - Parallel
 - Series
 - Both A & B
 - Neither A nor B
- Batteries produce electricity using a _____ reaction.
 - Nuclear
 - Hydrothermal
 - Chemical
 - Biological
- Resistance is _____.
 - Voltage divided by current
 - Power times voltage
 - Expressed in amperes
 - Never important in electrical circuits
- An incandescent light bulb filament has _____ resistance when it is cold than when it is hot.
 - More
 - Less
 - Equal
 - All of the above

PARTS LIST

Qty.	ID	Name	Part #
<input type="checkbox"/>	2	3-snap wire	6SC03
<input type="checkbox"/>	1	4-snap wire	6SC04
<input type="checkbox"/>	1	Battery holder	6SCB3
<input type="checkbox"/>	1	Base grid	6SCBGMF
<input type="checkbox"/>	1	Red jumper wire	6SCJ2
<input type="checkbox"/>	3	L4 4.5V Lamp	6SCL4
<input type="checkbox"/>	1	M5 Meter	6SCM5
<input type="checkbox"/>	1	S1 Slide switch	6SCS1
<input type="checkbox"/>	1	S2 Press switch	6SCS2

Important: If any parts are missing or damaged, **DO NOT RETURN TO RETAILER.** Call toll-free (800) 533-2441 or e-mail us at: help@elenco.com.
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You may order additional / replacement parts at our website: www.snapcircuits.net

BATTERIES:

- Use only 1.5V AA type (alkaline recommended, not included).
- Insert batteries with correct polarity.
- Non-rechargeable batteries should not be recharged. Rechargeable batteries should only be charged under adult supervision, and should not be recharged while in the product.
- Do not mix alkaline, standard (carbon-zinc), or rechargeable (nickel-cadmium) batteries.
- Do not mix old and new batteries.
- Remove batteries when they are used up.
- Do not short circuit the battery terminals.
- Never throw batteries in a fire or attempt to open its outer casing.
- Batteries are harmful if swallowed, so keep away from small children.

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