Basic Electricity
Model SCP-10

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.

1A

Placement Level Numbers

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

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.

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 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.

Quiz answers:
**Project 3  Triple Voltage Divider**

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).

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.)

**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**

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 it has its own path for electricity to flow along.

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.
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.

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

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 cross left lamps A & B. This voltage will be low when the left lamps are dim. When you remove lamp B, both remaining lamps (A & C) get equally bright fast, and the meter shows a higher voltage across the left lamp (A).

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.
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)

1. __________ is a measure of how fast electricity is flowing in a circuit.
   A. Voltage  
   B. Current  
   C. Power  
   D. Watts

2. When several lamps are wired in __________ with each other, all will have the same electric current flowing through them.
   A. Parallel  
   B. Series  
   C. Both A & B  
   D. Neither A nor B

3. Batteries produce electricity using a __________ reaction.
   A. Nuclear  
   B. Hydrothermal  
   C. Chemical  
   D. Biological

4. Resistance is __________.
   A. Voltage divided by current  
   B. Power times voltage  
   C. Expressed in amperes  
   D. Never important in electrical circuits

5. An incandescent light bulb filament has __________ resistance when it is cold than when it is hot.
   A. More  
   B. Less  
   C. Equal  
   D. All of the above

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