Lesson 1
Power, Control, Action

Overview

In this introductory lesson children will learn the three fundamental components of computer and robotic systems*: Power, Control and Action*. They will start by exploring ways Magcircuits electrical connections can be made between a *Power* block (Battery) and *Action* Block (LED). They will then explore the concept of electrical *Control* with a Variable Resistor and a Push-button On/Off Switch. In this lesson students will learn that control elements in circuits need to be between the power source and the component performing the action.

Note that the Magcircuits rechargeable battery block has a built-in circuit breaker that immediately turns the battery off if it is somehow short-circuited. To reset the battery, simply plug it in to the charger and it will reset to "on".

NGSS Standards

4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.* [Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.] [Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.]

3-5-ETS1 Engineering Design The section entitled "Disciplinary Core Ideas" is reproduced verbatim from A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas. Integrated and reprinted with permission from the National Academy of Sciences. 3-5-ETS1 Engineering Design Students who demonstrate understanding can: 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Disciplinary Core Ideas ETS1.A: Defining and Delimiting Engineering Problems ♣ Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1) ETS1.B: Developing Possible Solutions ♣ Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2) ♣ At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2) ♣ Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3) ETS1.C: Optimizing the Design Solution ♣ Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3

Blocks and Materials

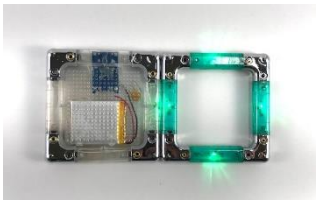
- Battery, LED, Variable Resistor, On/Off Switch, battery charger and cord.

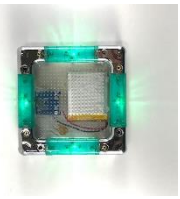
Part A – Power + Action

Guiding Question: *"In what ways can you light up an LED block with a battery block?"*

- Distribute one battery block and one colored LED block to each group.
- Give students the Guiding Question: *"In what ways can you light up an LED block with a battery block?"*
- Observe students connecting the blocks.

Possible working constructions include:





After several minutes ask the them the following questions and guide the resulting discussion:

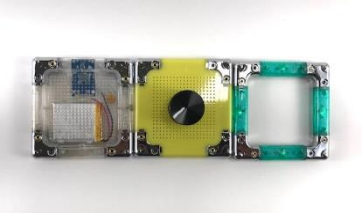
- Will an LED block light up with just one corner connection? (It won't because it forms an incomplete circuit.)
- Will it light up with two corners connecting? (Yes, it will.)
- Will it light up with four corners connecting in a face-to-face arrangement? (It will).

Part B – Power + Variable Resistor Control + Action

Guiding Question: *"How can you control the brightness of the LED with a variable resistor?"*

- Distribute one additional variable resistor block to each group.
- Observe students connecting the blocks.

The possible working construction is:



After several minutes ask the students the following questions and guide the resulting discussion:

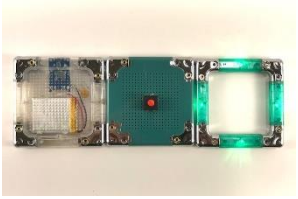
- Will the Variable Resistor control the LED block with the LED block also connecting to the Battery block? (It won't because the electrical current will take the path of least resistance.)
- Will the Variable Resistor control the LED when it is placed in between the battery and LED blocks (It will.)
- Can you think of electrical devices at home or school that use variable resistors? (Answers could include dimmer switches for lights, volume controls on radios or controls on electric space heaters, air conditioners, etc.)

Part C – Power + Push-button Control + Action

Guiding Question: "*How can you control the LED with a Push-button On/Off Switch?*"

- Distribute one additional Push-button On/Off block to each group.
- Observe students connecting the blocks.

The possible working construction is:



After several minutes ask the students the following questions and guide the resulting discussion:

- Will the Push-button control the LED with the LED touching the Battery block? (It won't because the current will take the path of least resistance.)

- Will the Push-button block control the LED when it is placed in between the battery and LED blocks (It will).
- Can you think of electrical devices at home or school that have On/Off Switches? (Answers could include Power button on TV, remote-control, microwave oven, etc.)

Extension

Challenge your students to build a Magcircuit device that is controlled with both a variable resistor and push-button On/Off Switch.

End of Lesson

Have the students put away the Magcircuits according to the diagram provided. Also, make sure they put the battery block in the poly bag with the charger and charging cord.