Lesson 2
Resistors in Series and Parallel

Overview

In this lesson children will learn how to control computer and robotic systems with *Resistors*. They will start by exploring how the arrangement of fixed resistors control Action and then learn how different types of variable resistors control Action.

Note that one of the variable resistors in this lesson is referred to as a photo resistor. Photo resistors are also known as Light-Dependent Resistors (LDRs) and can act as a type of light sensor.

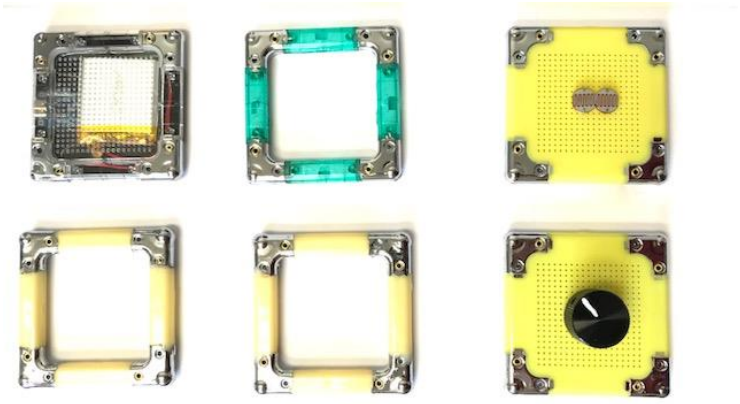
NGSS Standards

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



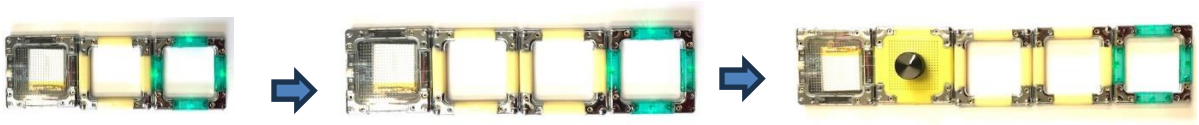
- Battery, LED, 2- 470 Ohm Resistors, Variable Resistor, battery charger and cord.

Part A – Resistors in Series

Guiding Question: *"How can you decrease the brightness of an LED by adding Resistors?"*

- Distribute the Battery, 2-470 Ohm Resistors, and LED block to each group.
- Give students the Guiding Question.
- Observe students connecting the blocks.

Possible working constructions include:



After several minutes ask the following question and guide the resulting discussion:

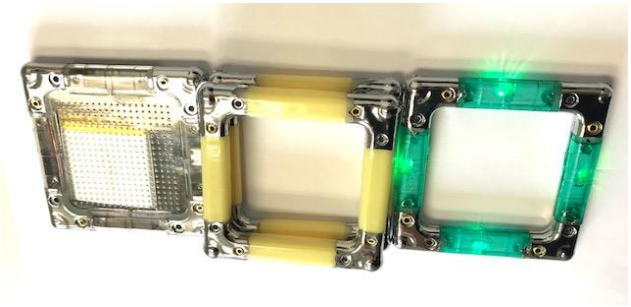
- What happens to the brightness of the LED when a chain of resistors is added between the battery and LED? (Answer; it decreases)
- Will the brightness change if the LED is connected directly to the battery? (Answer; no, the electricity will take the path of least resistance.)

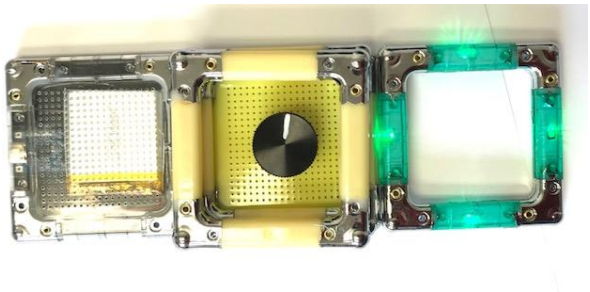
Part B – Resistors in Parallel

Guiding Question: "*How can you increase the brightness of an LED with resistors?*"

- Give students the Guiding Question.
- Observe students connecting the blocks.

Examples of possible working constructions. Note that this occurs when resistors stacked on top of each other:





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

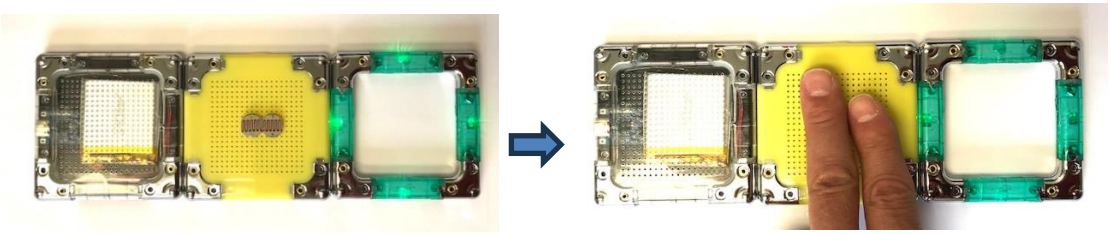
- Will the LED get brighter if resistors are stacked on top of each other? (Answer; yes, adding resistors in a stacking arrangement decreases the total resistance by providing more pathways for the electricity to travel.)

Part C – Photo resistor

Guiding Question: *"How can you control the LED with a Photo Resistor?"*

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

One of the possible working construction is:



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

- How does changing the amount of light affect the brightness of the LED?
- Can you think of electrical devices at home or school that have photo sensors? (Answers could include streetlights which turn on automatically at night, etc.)

Extension

Challenge your students to build a Magcircuit device that has variable resistors and photo resistors in series, parallel or combination arrangements.

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.