

## ACTIVITY 5 - PARALLEL AND SERIES CONNECTIONS

### LEARNING OUTCOMES

Students will,

1. Define parallel and series connections
2. Build circuits to show the difference between adding resistors in parallel and in series

This activity should take **~1 hour** to complete:

- 10m group discussion (group discussion - communication)
- 5m review of previous concepts
- 10m introduction to new concepts
- 25m hands-on activity
- 10m reflection

This lesson plan assumes free access to a black-and-white printer, and a classroom with a whiteboard, blackboard, or chart-paper.

### MATERIALS AND COSTS PER STUDENT

Item	Qty.	Cost per Student <sup>1</sup>	Expendable <sup>2</sup>	Supplier
Push Button	3	0.07	y	<a href="#">Aliexpress</a>
LED Assorted 3mm 5mm	1	0.02	y	<a href="#">Aliexpress</a>
Piezo Buzzer 5V 12mm	1	0.19		<a href="#">Aliexpress</a>
Resistors 1/4w, 3x 100 ohm, 3x 680 ohm	6	0.04	y	<a href="#">Aliexpress</a>
9V Battery Snap	1	0.16		<a href="#">Aliexpress</a>
Jumper cables MM 10cm	4	0.08	y	<a href="#">Aliexpress</a>
Breadboard 400 point	1	1.49		<a href="#">Aliexpress</a>
Breadboard Power Supply	1	0.75		<a href="#">Aliexpress</a>
9V Ni-Mh 450mAh	1	5.17		<a href="#">Aliexpress</a>
<b>Total Cost per Student</b>		<b>\$7.97 CAD</b>		

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1. Currency is CAD, 2017-06-10. Assuming one set of parts per student. ↵

2. Likely to be broken or lost during the activity. ↵

## LESSON

Before class: connect each of the power supplies to a breadboard; snap the battery snaps onto the 9V batteries; print student handouts.

### Outline:

1. Group Discussion - Communication
2. Review
3. Parallel vs Series Combinations of Resistors
4. Circuits to Build
5. Challenge and Explore
6. Reflection

### GROUP DISCUSSION - COMMUNICATION

- Ask the "Chicken, Airplane, Crow" question - which of these three things is the odd one out? Discuss with your class-mates.
  - Skill: group discussion
- Ask the students to share their conclusions
  - Skill: oral presentation
- Highlight that the answer is not important, but rather the explanation of how one decided on that answer
- In the club, it is important to be able to communicate your ideas with each other, and be respectful of other people's opinions. That doesn't mean that you have to agree with them, but you should be honest and kind with them.

### REVIEW

- In Activity 1 we built an LED light circuit. Some students explored using 2 buttons to control the circuit. In one orientation we could press either button to turn on the LED. However, in another orientation we needed to press both to turn the light on.
- These different types of connections are called series and parallel.
- Draw the two different circuits.
- Example: a string of lights. Should we connect them in series or parallel? Why? Discuss as a group. If they're connected in series, one light breaking will turn off all the lights!
- Example: plugging appliances into the wall. One can break and others still work, because they're in parallel.

### PARALLEL VS SERIES COMBINATION OF RESISTORS

- Rock-slide analogy
  - Series = more trees on the same hill (less current)
  - Parallel = adding another hill, with it's own trees (more current overall).
- Give some example circuits and ask whether they will have more or less current when resistors are added in a particular way.

## CIRCUITS TO BUILD

- Today we're going to build two circuits. One to control the brightness of an LED using resistors in parallel, and one to control the volume of a buzzer with resistors in series.
- Demonstrate the example circuits
- Draw the circuit diagrams and ask the students
- Distribute the parts: 100 ohm resistors for the buzzer (series), 680 ohm resistors for the LED (parallel)
- As the students build, drop the following questions:
  - Does adding a resistor in parallel to the LED circuit make the light brighter or dimmer? Play around with adding/removing each of the three resistors.
  - Does adding a resistor in series to the speaker circuit make it louder or quieter? Play around with where you apply 5V.

## CHALLENGE AND EXPLORE

Evaluate the students' understanding of the learning objectives by asking them to try the following:

- Add 3 buttons to the light circuit so that pressing each button increases the brightness
  - Skill: Control current using parallel and series connections
  - Skill: Building breadboard circuits
  - Skill: Understanding electricity (rock-slide analogy)
- add three buttons to the LED circuit - two that increase the brightness and one that turns the light on and off (parallel and series)
  - Skill: Control current using parallel and series connections
  - Skill: Building breadboard circuits
  - Skill: Understanding electricity (rock-slide analogy)
- Add a button to the buzzer circuit so that pressing the button makes makes it louder (parallel)
  - Skill: Control current using parallel and series connections
  - Skill: Building breadboard circuits
  - Skill: Understanding electricity (rock-slide analogy)

## REFLECTION

- What did you observe with these two circuits? (open-ended, to see what the students have to comment about in general)
- What did you notice when you removed an LED from the LED circuit? (became less bright)
- What did you notice when you added resistors in series to the speaker circuit? (become more quiet)
- What happens if you pull out one of the resistors in a series connection to the speaker? (it turns off)
- Did today's class help you understand anything that you noticed in the circuits before? Do you have an example?
- Can you think of any projects where you would want to apply this?
- Is there anything from today's class that you're still confused about? (see if there is a student in the class who can help clarify the points that are identified as confusing)