# Level 1 - Lesson 2league logo.jpg

## Context:

**Topic**: Electrical Engineering Concepts

**Total learning time:** ~90 minutes

**Number of students:** 1 - 8

**Description:** Introduce students to the basics of electronics, its components and circuits.

## Lesson Objective:

In this lesson, students will learn about:

* Resistors, their role in electronic circuits and how to read and measure their values
* Digital multimeters
* Engineering notations and how to convert them
* Breadboards and how to use them
* Wire gauge system
* ~~DC power supplies~~
* ~~Ohm’s law and its applications to series and parallel resistor circuits~~
* Ohms Law

## Materials/Preparation (Recipes):

* Verified student GitHub accounts with League-EE Level 1 Module 2 with
  + <https://github.com/League-EE/Level-1>
  + Engineering notation worksheet
  + Resistor value worksheet
* Batteries or DC power supplies
* Digital multimeter
* Various values of resistors
* LEDs
* Assorted length/color gauge 32 wire pieces
* Breadboard

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## Introduction and Anticipatory Set:

In the last session we learned about sources of electricity, voltage, current and simple circuits. This session, we will examine resistors, their roles in electronic circuits, and how to read and measure them.

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## Instruction and Guided Practice:

* Prep
  + Fill in the missing components from today’s activity on the whiteboard.
  + Ask students to clone league-EE/level-1/lesson-2. Should contain
    - The engineering notation conversion worksheet
    - Resistor color code scheme
* Engineering notation (10-15 min - 00:00 → 00:15)
  + Scientists and engineers often work with very large and very small numbers. The ordinary practice of using commas and leading zeroes proves to be very cumbersome in this situation. Scientific notation is more compact and less error prone method of representation. The number is split into two portions: a precision part (the mantissa) and a magnitude part (the exponent, being a power of ten). Examples:  
    2300 = 2.3e3  
    0.0005 = 5e-4
  + The Laboratory Manual 10 for DC Electrical Circuits only difference between scientific notation and engineering notation is that for engineering notation the exponent is always a multiple of three. So, for the examples above, we have  
    2300 = 2.3e3  
    0.0005 = 0.5e-3
  + Engineering notation goes one step further by using a set of prefixes to replace the multiples of three for the exponent. The prefixes are:  
    e12 = Tetra (T) e9 = Giga (G) e6 = Mega (M) e3 = Kilo (K)  
    E-3 = milli (m) e-6 = micro (m) e-9 = nano (n) e-12 = pico (p)
* Quick engineering notation exercise (10 min - 00:15 → 00:25)
* Resistance (25-30 min - 00:25 → 00:55)
  + What is resistance
    - The inherent property of material to control the flow of current (electrons)
    - Similar to a pipe where friction between water molecules and pipe wall causes resistance, electrons experience resistance when they jump from atom to atom. In some material (metal in general) electrons can jump more freely than others (plastic)

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* + - Similar to friction, electric resistance converts energy to heat that is wasted. Electrons are doing work to overcome resistance, and that work is converted to heat.
    - Resistors are man made components that control current (rate of electron flow) in a predictable manner.
  + Discussion:
    - Why would we want to reduce the flow rate of electrons?
      * Protect the component that is doing work (light bulb, LED, electric motor…)
      * Use resistance as fuses to protect the rest of the house wiring
      * Use resistance to convert electricity into heat as in electric heaters
      * Use resistance to convert electricity into light as in incandescent light bulbs
      * Control the time in which something is done (more advanced topic that we will get to in AC electronics class)
  + Determining resistance of simple objects
    - Resistance in electricity increases as length of the wire increases (as in water flow resistance in pipes)
    - Resistance also increases as the diameter of the wire decreases (as in water flow resistance in pipes)
    - Resistance also changes based on the type of material used (similar to if the material used in a pipe is more smooth or more rough)
    - Formula for determining resistance of simple cylindrical objects is given by where r (ohm/m) is a constant, l is length in meter and A is area in m2
  + Resistance color coding scheme
    - Display (or draw on the board) the resistance color coding scheme including the tolerances
    - Go over the meaning of each band and how the *nominal* resistance value is determined from the colors
    - Go over tolerance band and how minimum and maximum values are determined from the *nominal* value
  + Power ratings of resistors
    - Power equation P = IV
* Quick Break (5 min - 00:55 → 01:00)
* Lab & Demos (20-30 min - 01:00 → 01:30)
  + Engineering notation conversion
  + Resistor measurements
    - Measure a spool of wire and compare with formula Ar/l
    - Measure different gauge wires and again if possible compare to the formula

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* + - Estimate the resistance of a pencil lead based on the lead’s diameter, length and lead constant.
    - Measure the resistance of a pencil lead and compare the the estimate above.
    - Measure various resistor values and compare with the printed value
  + ~~LED circuit with different resistor values~~

## Independent Practice:

* Have students work on the engineering notation conversion sheet.
* Resistor exercise: Have students
  + Read resistor values and their tolerances
  + Record the values in engineering notation including the tolerance range. For example, for a 1K resistor with a 10% tolerance, the recorded value would be 1000 = 1K, and the tolerance range would be 900 to 1100
* Cruise the room and help students who are stuck.

## Assessment:

* Informal assessment is made by teacher during guided and independent practice.
* Formal assessment will be made by checking the engineering notation conversion worksheet and the resistor exercise

## Closure:

* Review resistor types and resistance concepts with the students.
* You are doing exactly what freshman EE students do in college.

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