

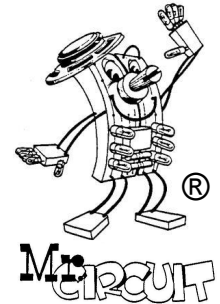
76-PAGE LAB MANUAL



Basic Electronics Lab 1201 Multimeter Fundamentals

"Ohm's Law and More!"

This lab was created to meet the needs of STEM, Automotive, HVAC, and Electronics students to become more proficient in the use of the Digital Multimeter. We have trained many technical people and one of their biggest needs was to know how to use and interpret the readings on a multimeter. In this lab, they will work with formulas for Ohm's Law, Watts Law, resistors in series, and resistors in parallel. This lab teaches how to calculate resistor wattage, resistors values with LEDs, current in series and parallel circuits, voltage drops, and more. It gives practice reading resistance, current, and voltage values and interpreting the readings on the display of a Digital Multimeter. This knowledge and experience will open up many opportunities at employment and entrepreneurship.



G. Gibson,
Author/Educator

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Preface to LAB 1201 Multimeter Fundamentals

“Ohm’s Law and more!” by G. Art Gibson

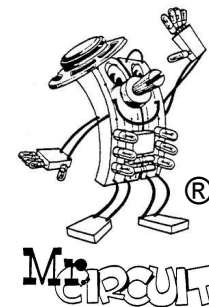
This is Lab #1201 in the Mr Circuit Basic Electronics series. The author sincerely hopes that you will enjoy this hands-on basic electronics lab. It covers many of the fundamentals of electronics as well as gives you practice using a Digital Multimeter.

This lab is also meant to be of particular importance for students of **technology, science, engineering, and math (STEM) and (STEAM)**.

It includes many hands-on activities, all the components for the experiments, a 9-volt battery power source, a solderless circuit board to build circuits, 10 colored 5mm LEDs (red, green, yellow, blue, clear) and 14 resistors for test and measurement, a set of video presentations of the lessons so you can watch the lessons in full-color on your computer or Smart Board at anytime. Even the Digital Multimeter is provided.

In this lab, you will work with formulas for Ohm's Law, Watt's Law, calculate the equivalent resistance of resistors in series and parallel, use a multimeter to determine the ohms of resistors in series and parallel, calculate resistor wattage, calculate resistor values in LED circuits, calculate and measure current in series and parallel circuits, calculate and measure voltage drops, and more. You will get practice reading resistor values, current, and voltage on the display of the Digital Multimeter. You will also get more practice using a solderless circuit board to build electronic circuits. (See the whole **Skill Set** in the front of the lab manual)

Upon completion of the lab, you will have earned the **Certificate of Electronics Training** for the Mr Circuit Basic Electronics Lab 1201 to be signed by your instructor. Good luck and we hope you enjoy learning electronics.



Front cover, and Title Page, Preface, Table of Contents, Skill Set

- 1 Learn schematic symbols for the components in this lab
 - 2 Learn about batteries and cells and their schematic symbols
 - 3 Learn about an LED and its schematic symbol
 - 4 Learn to use the Resistor Color Code for nominal values
 - 5 Learn to use the Color Code with $\pm 5\%$ Resistors
 - 6 Learn to use the Color Code with $\pm 1\%$ Resistors
 - 7 Take inventory of the electronic parts used in this lab
 - 8 Learn how to build a Simple Series circuit
 - 9 Learn about the components used in a Simple Series circuit
 - 10 Learn how to connect components in a Simple circuit
 - 11 Learn the construction of a Solderless Circuit Board (SCB)
 - 12 Learn how to build a Simple Circuit on a Solderless CB
 - 13 Build two LED circuits and compare the LED brightness
 - 14 Learn Ohm's Law and how to use it. $E = I \times R$
 - 15 Learn to use Ohm's Law with resistors in Series
 - 16 Learn to use Ohm's Law with resistors in Parallel
 - 17 Learn that all LEDs do not have the same voltage drop
 - 18 Learn to calculate the resistance needed in a circuit with LEDs
 - 19 Learn how to connect multiple LEDs in a circuit
 - 20 Learn how to use a Digital Multimeter (DMM)
 - 21 Learn how to measure current and do unit Conversion - Amps, mAmps, and uAmps
 - 22 Verify Branch Current with a DMM - Part 1
 - 23 Verify Branch Current with a DMM - Part 2
 - 24 Verify Branch Current with a DMM - Part 3
 - 25 Build a circuit with 470 ohms and measure the current
 - 26 Build a circuit with 1k ohms and measure the current
 - 27 Build a circuit with 3.3k ohms and measure the current
 - 28 Build a circuit with 6.8k ohms and measure the current
 - 29 Learn how to measure DC Volts with a DMM
 - 30 Use Ohm's Law and Watt's Law to calculate wattage
- Answer Keys and Glossary

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Table of Contents
for Mr Circuit's Basic Electronics
LAB #1201
MULTIMETER FUNDAMENTALS
"Ohm's Law and More!"



Lab #1201

**OHM'S LAW
and more!**

Upon completion of this lab, the student will be able to:

Identify the physical appearance and schematic symbols of a single cell, battery, an LED, and a resistor.
 Explain how cells connected in series form a multicell device called a battery and draw the schematic..
 Describe the schematic symbol for an LED, show the polarity with Anode and Cathode.
 Describe the purpose of the 'flat side' and the 'short lead' on the LED in reference to the Cathode..
 Understand that the long leg of the LED is the positive side or the Anode.
 Understand that the beveled edge on an LED is the way to find the Cathode if the LED is in a wired circuit.
 Understand how to use the Resistor Color Code to identify resistor values for both 5% and 1% resistors.
 Take inventory of electronic components and report any discrepancies.
 Draw a simple circuit schematic with symbols and label them including their polarity.
 Build a basic circuit using the solderless circuit board, an LED, various resistors and a 9-volt battery.
 Match the physical components to their schematic symbol.
 Construct a circuit using a schematic diagram.
 Understand the construction of a solderless circuit board.
 Use Ohm's Law to calculate voltage, current, and resistance.
 Calculate the equivalent resistance of two resistors in series.
 Calculate the equivalent resistance of two resistors in parallel.
 Identify various voltage drops across different colored LEDs.
 Calculate the additional resistance needed in an LED circuit based on voltage of the power source.
 Connect multiple LEDs in a parallel circuit.
 Measure a variety of values of ohms with a digital multimeter.
 Interpret the reading on the multimeter display in the Ohms function. Convert from Amps to mAmps to uAmps
 Set up a multimeter to check the current flowing in a circuit.
 Connect the multimeter to a circuit and measure the current.
 Break a series circuit and connect the multimeter to measure the current.
 Explain that the current flowing in a series circuit is the same amount through each component
 Explain the effect of the amount of current flowing in an LED circuit on the brightness of the LED
 Set up a multimeter to measure DC voltages. Convert from Volts to mVolts to uVolts
 Measure DC voltage and voltage drops across components in an active circuit.
 Calculate the minimum wattage needed in a resistor. **And More!**

Skill Set

for the
 Mr. Circuit
 "Ohm's Law and More!"
**Multimeter
 Fundamentals Lab**

**Lab #1201**

**OHM'S LAW
 and more!**

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Inventory of Parts

Here is a picture of the parts you need to do the Mr Circuit Lab 1201.

In addition to the parts shown on the right, you will receive an alkaline 9-Volt battery similar to the one shown here.



Lab #1201

**OHM'S LAW
and more!**

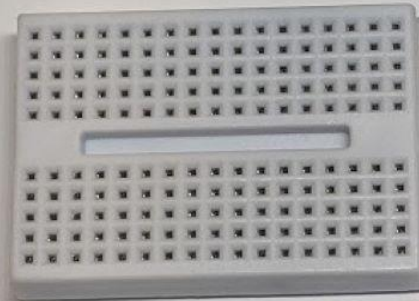
9-volt Battery Snap



(Positive)
Red Wire

+

Solderless Circuit Board



-
Black Wire

LEDs (light-emitting diodes)

RED



YELLOW



GREEN



BLUE



CLEAR



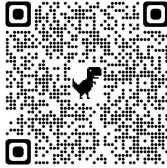
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Resistors	
Brown, Black, Brown, Gold	100 Ohms
Red, Red, Brown, Gold	220 Ohms
Orange, Orange, Brown, Gold	330 Ohms
Orange, White, Brown, Gold	390 Ohms
Yellow, Violet, Brown, Gold	470 Ohms
Brown, Black, Red, Gold	1000 Ohms (1k)
Brown, Red, Red, Gold	1200 Ohms (1.2k)

Orange, Orange, Red, Gold	3300 Ohms (3.3k)
Blue, Gray, Red, Gold	6800 Ohms (6.8k)
Brown, Black, Orange, Gold	10,000 Ohms (10k)
Orange, White, Orange, Gold	39,000 Ohms (39k)
Orange, Orange, Yellow, Gold	330,000 Ohms (330k)
Yellow, Violet, Yellow, Gold	470,000 Ohms (470k)
Brown, Black, Green, Gold	1,000,000 Ohms (1 M)

LESSON 1 Introduction to Components

Watch video
Lesson 1



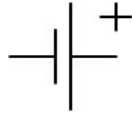
In this lab, we will use a few electronic components. A 9-volt battery is a **multicell** device with six small **1.5** volt cells in series inside of it.

The schematic symbol for an LED has two arrows pointing away which indicates light emitting from the LED.

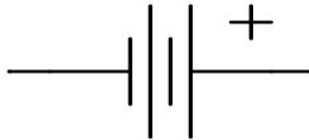
The symbol shown for the resistor has 3 peaks on the bottom and top of the symbol.

Schematic Symbols

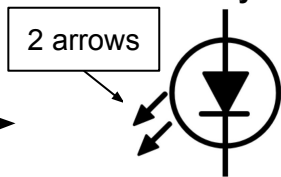
Single-Cell Symbol



Multi-cell Battery Symbol



LED Symbol



Resistor Symbol



Pictures of Components

Single Cell (1 1/2 Volts)



9-Volt Battery w/Snap



LED (light emitting diode)



Resistor



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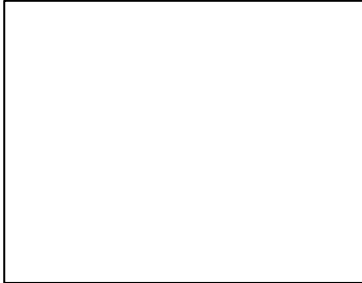


Practice Quiz

Activity Page Lab 1201

Introduction to Components

1b



On this page, draw a schematic symbol under each of these components.

