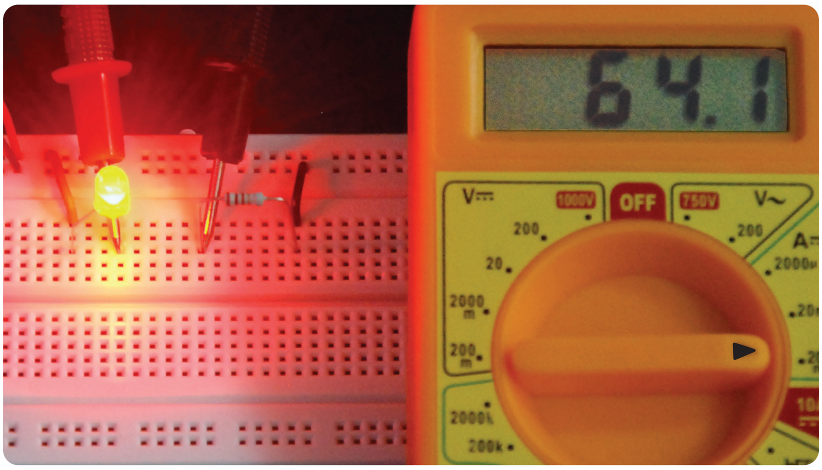

Mand Labs™
step by step

Chapter 5

Ohm's Law

Ohm's Law

The current flowing through a component can be calculated if the voltage drop across it and its resistance are known.

Ohm's law is:
V = R x I, where

V is the voltage drop across the component measured in **volt**, I is the current passing through the component measured in **ampere**, and R is the resistance of the component measured in **ohm**.

Using algebra, when any two of the three values are known, the third one can be calculated. If you are not comfortable using algebra to find the missing value, you can use Ohm's law triangle.

Find: I = ?

From Ohm's Law Triangle:

Result: $I = \frac{V}{R}$

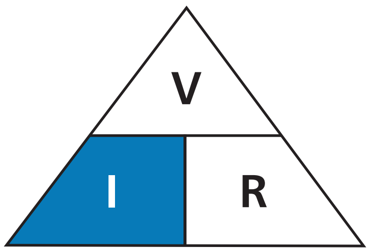

Figure 5-1. The Ohm's law triangle.

This triangle is easy to remember, and we can calculate the third parameter if the other two parameters are known.

This tool is quite simple to use. Just place your finger over the parameter you want to find, and the relative positions of the other two parameters graphically tell you what must do to find the missing value.

For example, if we want to calculate R, place your finger over R. The relative positions of V and I tell us that R = V/I.

Now let us try to calculate the current passing through a 1 kΩ resistor.

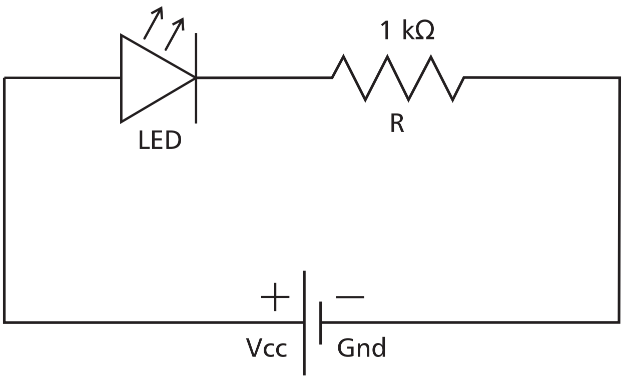

Figure 5-2. Circuit diagram: A resistor connected to a battery.

In this circuit, let us find out the theoretical value of current. We know two quantities here:

1. Voltage, $V = 9\,V$
2. Resistance, $R = 1\,k\Omega = 1000\,\Omega$

According to Ohm's law, $V = R \times I$

$$\text{So, } I = V \div R = 9/1000 = 0.009\,A \text{ (ampere)}$$

$$I = 0.009\,A$$

We can convert the current into miliamperes by multiplying its value by 1000.

$$\text{So, } I = 0.009 \times 1000 = 9 \text{ milliampere} = 9\,mA$$

Note:
milli stands for $10^{-3} = 1/1000$

Experiment 7: Measuring Current in a Circuit Using a Multimeter

An ammeter is a device that measures current and is always connected in series with the circuit. It is denoted by symbol 'A'. A multimeter can be used as an ammeter.

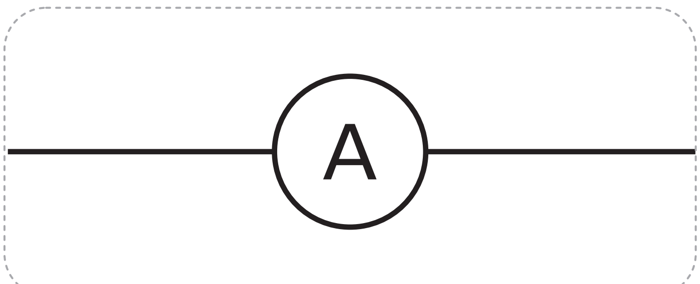

Figure 5-3. Schematic symbol: ammeter.

To measure the current in a circuit, we need to insert the meter in series with the circuit. This is done by creating a gap in the circuit and then filling it with multimeter leads. In the circuit diagram 5-4, 'A' stands for multimeter in ammeter mode.

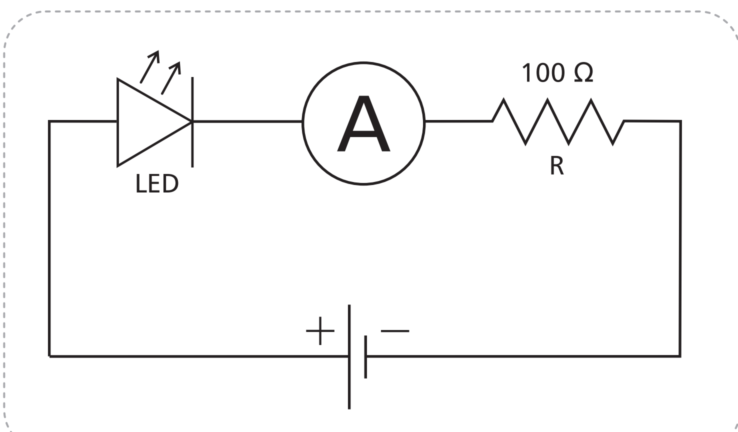

Figure 5-4. Circuit diagram: measuring current using a multimeter.

To measure current, rotate the dial of the meter to the DC region denoted by A ---. It is important to set the meter dial at an appropriate range. The meter in the kit can measure current from 2000 μ to 200m on A --- scale.

$$2000\,\mu = 2000 \text{ micro} = 2000 \times 10^{-6} = 0.002 \text{ A}$$
$$20\text{m} = 20 \text{ milli} = 20 \times 10^{-3} = 0.02 \text{ A}$$
$$200\text{m} = 200 \text{ milli} = 200 \times 10^{-3} = 0.2 \text{ A}$$

Initially, we can set the dial at the 200m position. At the 200m position, we will be able to measure all currents that are less than or equal to 0.2A or 200 mA.

Figure 5-6. The meter dial at the 200m position to measure current.

We will now connect the LED and the resistor on the breadboard in such a way that there is a gap between the negative terminal of the LED and one (left) end of the resistor, as shown in figure 5-7.

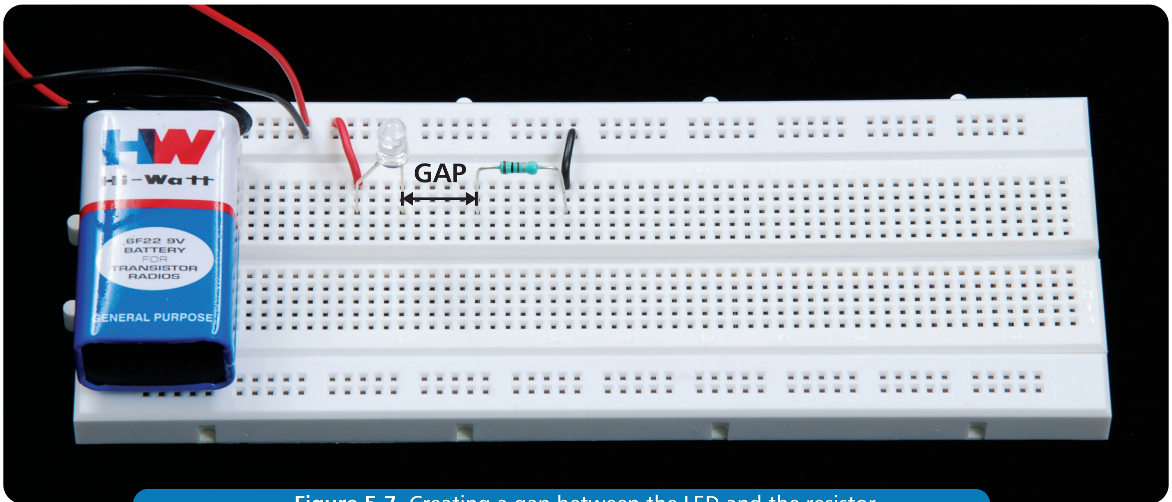

Figure 5-7. Creating a gap between the LED and the resistor.

In the next step, the meter probes fill the gap between the LED and the resistor. Please note that the red probe of the meter is connected to the negative terminal of the LED and the black probe to the left leg of the resistor. Two probes of the meter complete the circuit, and hence the LED glows.

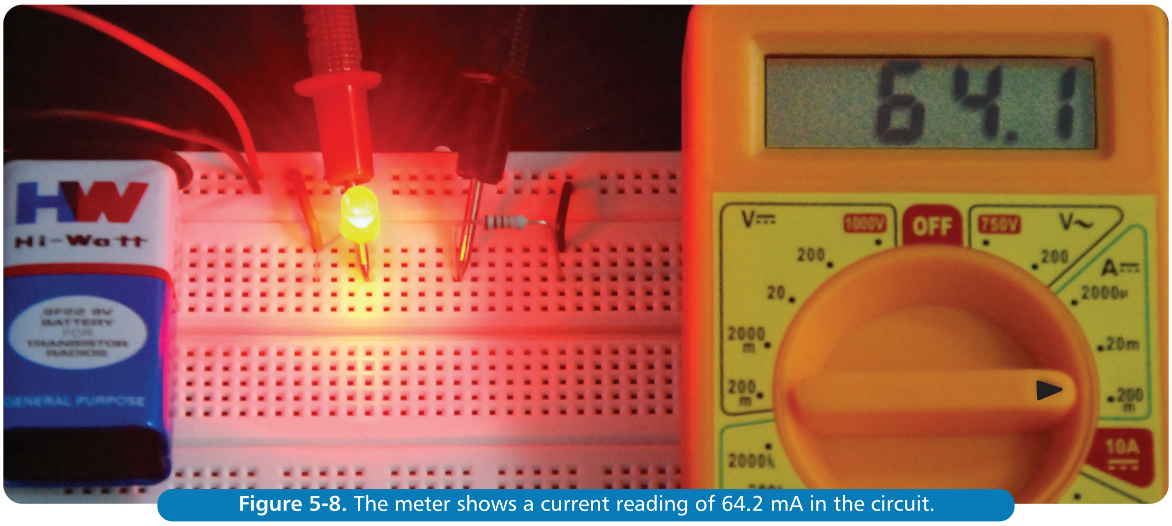

Figure 5-8. The meter shows a current reading of 64.2 mA in the circuit.

Hence, the practical value of current in this case is 64.1 mA.

DYK?

We can also see a 10A scale on the meter. It is used to measure very large currents.
To use the 10A scale, do the following:

1. Remove the red probe from VΩmA and connect it to the 10A slot.
2. Keep the black probe in the COM (ground).
3. Rotate the dial to the 10A scale.
4. Insert the meter in series with the circuit, and take the reading.
5. Actual Current Reading = Multimeter Reading (in ampere)

If multimeter reading = 0.5
Actual Current Reading = 0.5 A = 500 mA (milliampere)

PRECAUTIONS

If we pass too much current, the fuse inside the meter will blow.

Why is an ammeter connected in series with the circuit?

Current is the volume of electrons moving past a certain point every second, and thus to measure it, the circuit must be broken and the meter should be put in line or in series with the quantity being measured.

Q BOX

Ohm's Law Verification

In this circuit, let us find out the theoretical value of current. We know two quantities here:

1. Voltage, V = 9 V
2. Resistance, R = 100 Ω

According to Ohm's law, $V = R \times I$

The voltage, V, is the total voltage available to the circuit.
Battery Voltage = Voltage drop across LED + Voltage drop across resistor

In the above experiments, we have used a red LED in our circuit. A red LED needs a minimum voltage of 1.8-2 V to light up. In doing so, a voltage drop of approximately 2 V takes place across the LED. Hence, the voltage drop across LED = 2V

Voltage across resistor = Battery Voltage − Voltage across LED
= 9 − 2
= 7 V

Thus,

I = Current through resistor = Voltage across resistor/Resistance
I = 7/100
= 0.07 A (Ampere)
Therefore, I = 0.07 A

We can convert the current into miliamperes by multiplying its value by 1000.
So, $I = 0.07 \times 1000 = 70$ mA

The practical value of current is 64.1 mA, which is approximately equal to the theoretical value. Hence, Ohm's law is verified.