

Ohm's Law

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Learning Outcome

I highly recommend you to finish this checklist to determine whether you've achieved the learning objectives.

- state Ohm's law
- sketch and explain the I - V characteristics for resistors
- solve problems involving the resistivity of a material.

Leadin

Georg Simon Ohm is a German physicist who is renowned for his great discovery between the p.d. and the current in a *resistor*.

And in memory of his contribution in this field, the law is called *Ohm's Law* and moreover, his name has been lowercased in order to serve as the unit for the *resistance*.

Ohm's Law

You might have already been familiar with Ohm's Law, but let's start from scratch in deciding the I-V characteristics of *ohmic resistor*¹.

Experiment Setup

The circuit is set up as shown in Fig.2

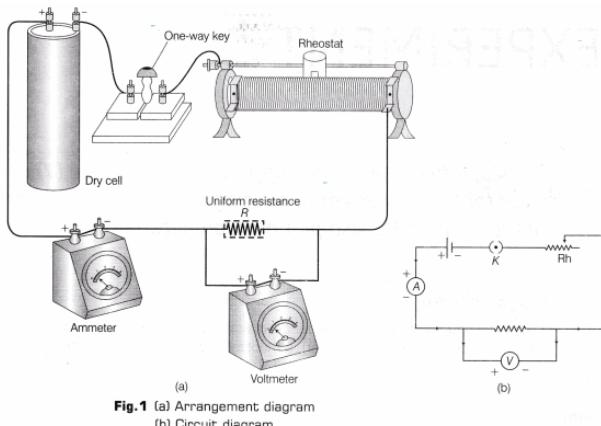


Fig. 1 (a) Arrangement diagram
(b) Circuit diagram

The voltmeter measures the p.d. across the resistor, while the ammeter measures the current in the whole circuit. By sliding the _____, the p.d. across the resistor can be changed, then the currents would change correspondingly. Thus, the *I-V* graph could be drawn.

I-V diagram

Summary

The *I-V* characteristics is a graph of currents against voltage for a particular component of an electrical circuit

The experiment's results may looks like the following:

Task

What does it means when the voltage is negative?



Figure 1: Georg Ohm
1789-1854

¹ def: most metal conductors may be regarded as ohmic resistors

Figure 2: Setup and circuit diagram of investigation on Ohm's Law

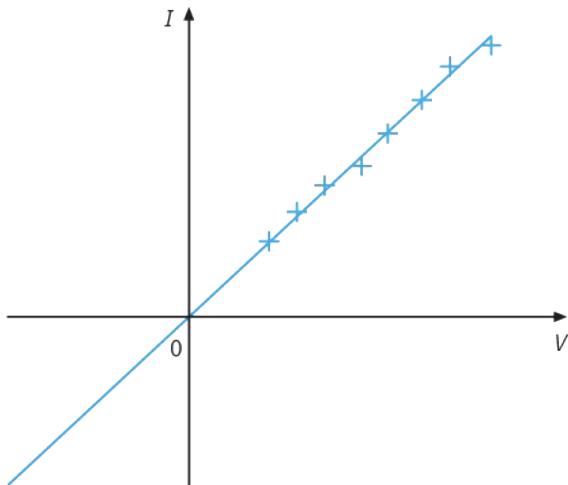


Figure 3: The I - V characteristics of a resistor

Ohm's Law definition

Since the linearity between currents and voltagee could be found, the Ohm's Law is defined as the following:

Summary

Ohm's Law states that: A conductor(resistor) obeys Ohm's law if the _____ in it is directly proportional to the across its ends.

If stated in mathematical formulas:

$$I \propto V$$

Resistance

According to Ohm's Law, due to the proportionality between the p.d.s and currents. Resistance of a material can now be defined.

Summary

Electrical Resistance, R , of a resistor is the ratio of potential difference to current.

$$R = V/I$$

The unit for resistance is _____ . and thus the SI base unit is

Task

Combining the definition and the I - V characteristics, the gradient of the I - V graph is _____ .

The relationship between resistance, current, voltage or p.d. can be described humorously in Fig 4

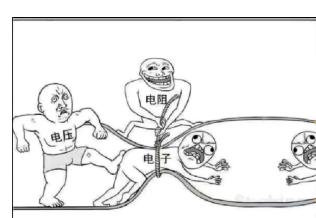


Figure 4: A humorous way to memorize the Ohm's law

Resistivity

The resistance of a metal wire depends on several factors:

- length, L
- cross-sectional area, A
- the material the wire is made from
- the temperature²

² this factor will be discussed when superconductivity are mentioned

resistivity of a material

Resistivity is a property of a material, which only changes based on the material itself. The lowest resistivity discovered is the silver, copper ranking the second, the values are $(1.60 \times 10^{-8} \Omega\text{m})$ and $(1.69 \times 10^{-6} \Omega\text{cm})$ ³. This means silver/copper is the best metal to make conducting wire.

³ Attention, I wrote it on purpose

Task

Specify qualitatively the effect of each factors, for example:
if the length is increased, the wire's resistance will _____.

How rheostat can change the resistance that are connected in a circuit.



Figure 5: Is it an IQ tax when buying silver-coated wire

Determine the resistance

By controlling variables, the resistance of a wire resistor can be determined by the following formula:

Summary

$$R = \frac{\rho L}{A}$$

Alternatively, the resistivity actually comes from the such definition.

$$\rho = RA/L$$

thus, the unit for resistivity is usually _____. You can also change that unit to SI base unit.