ScienceCube

Ohm's Law

Understand the relationship between voltage and current by measuring the current and voltage of a nichrome wire, and thereby understand Ohm's Law.

Fundamental Concept

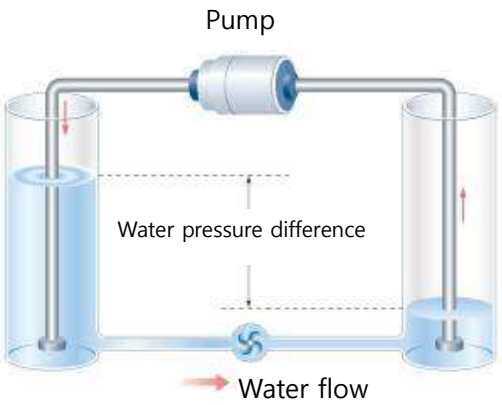
1. Voltage, Current, Resistance

1) Voltage: The ability to make current flow in an electric circuit.

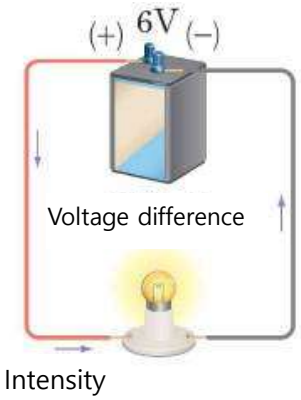
① To keep water flowing, a device that continuously maintains the height difference of water, like a pump, is needed. Similarly, to keep current flowing, a battery is needed to continuously maintain the voltage difference.

② The height difference of water is determined by the performance of the pump, just as the electric difference, or voltage magnitude, is determined by the performance of the battery.

③ Unit: V (Volt)



Water pressure difference



Magnitude of voltage

2) Current: The flow of electric charge.

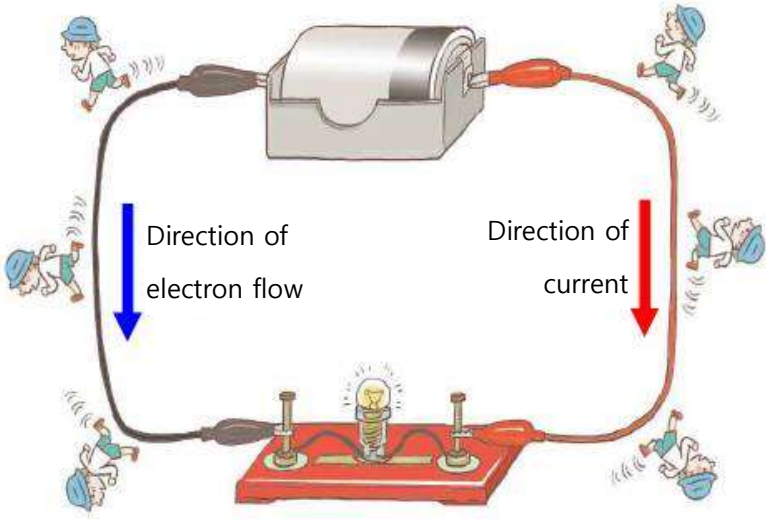
① Direction of electron movement: From the negative (-) pole to the positive (+) pole of the battery.

② Direction of current: From the positive (+) pole to the negative (-) pole of the battery.

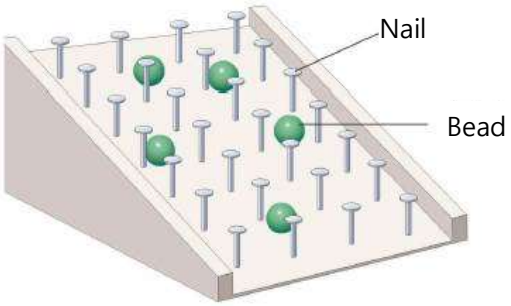
③ Current intensity: The amount of charge flowing per second.

④ Unit: A (Ampere)

(1A: The current Intensity when 6.25 x 10^18 electrons move through a conductor's cross-section per second.)



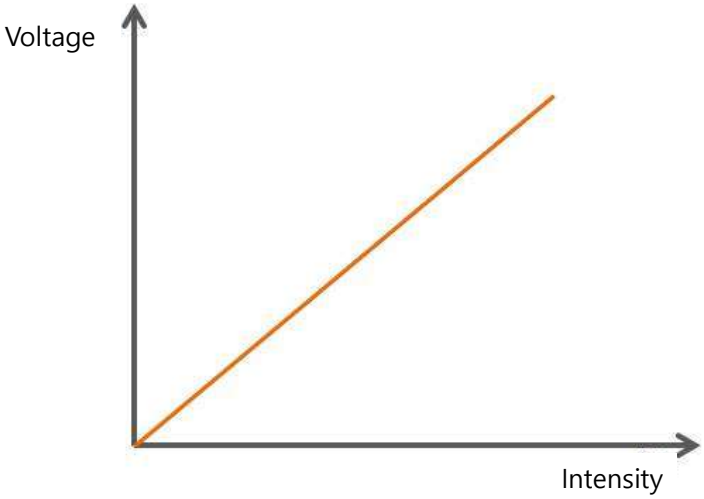
3) Resistance: The degree to which a material opposes the flow of electric current or the property of electrons being hindered in passing through it.



The movement of beads is hindered by nails when they fall, analogous to electrons being hindered by atoms. The inclination of the slope represents the strength of the voltage that helps current flow.

2. Relationship between Voltage and Current

① When the electric resistance of a circuit is constant, the current in the circuit increases with increasing voltage.

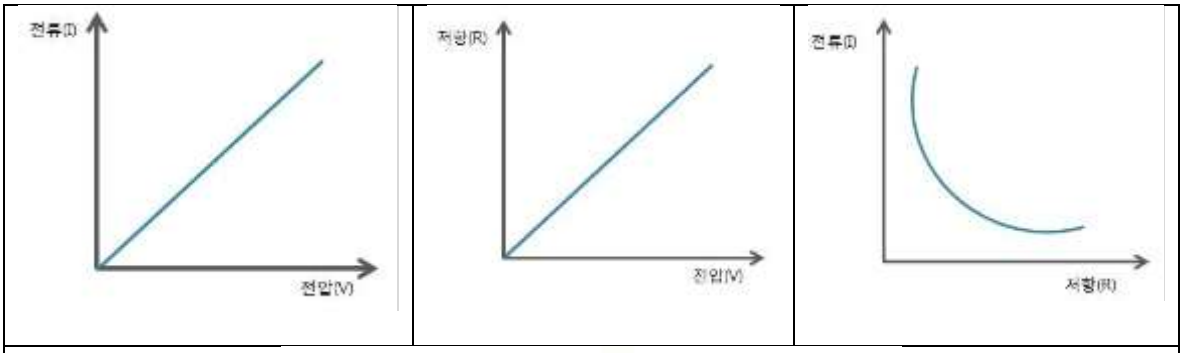


② The ratio of voltage to current is called resistance, and the relationship between them is Ohm's Law.

V (Voltage) = I (Intensity) X R (Resistance)

③ Using Ohm's Law, you can calculate the unknown value from the other two known values.

④ Current intensity (I) is proportional to voltage (V) and inversely proportional to resistance (R).



$$V = I \cdot R \qquad I = \frac{V}{R} \qquad R = \frac{V}{I}$$

V : Voltage I : Intensity R : Resistance

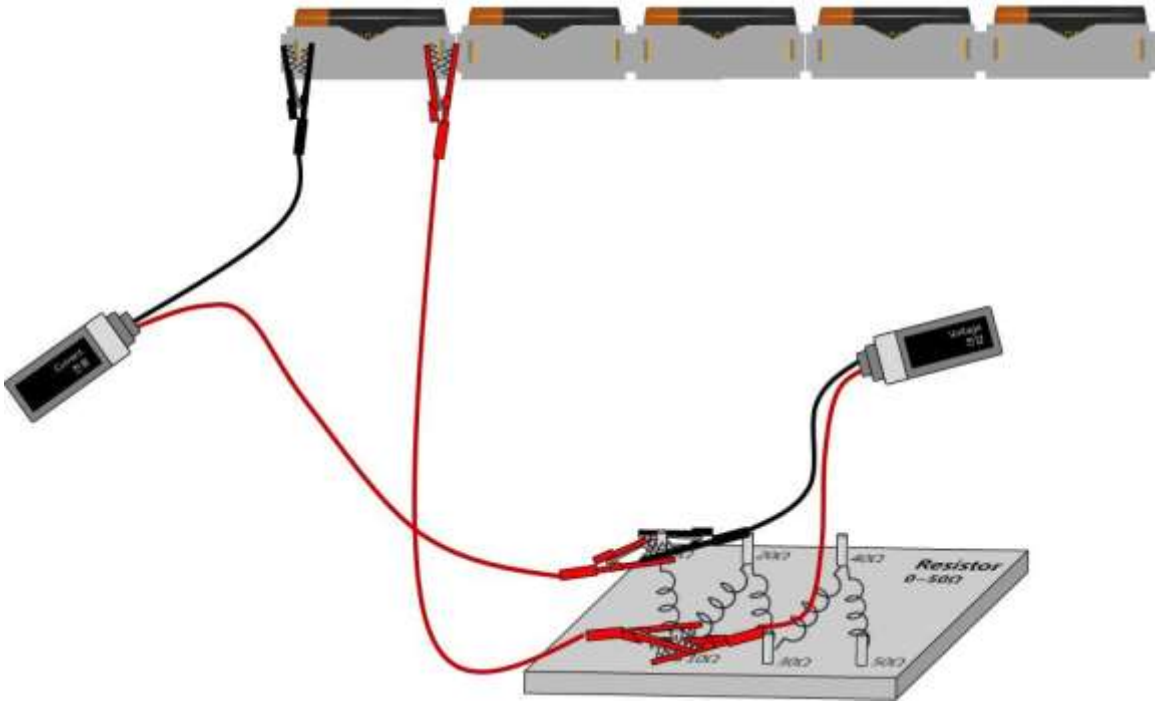
Experiment

Materials Needed

Interface, Science# program, Voltage sensor, Current sensor, Nichrome wire resistance board (10Ω x 5), Alligator clip wires (2), Battery holders (5), 1.5V batteries (5)

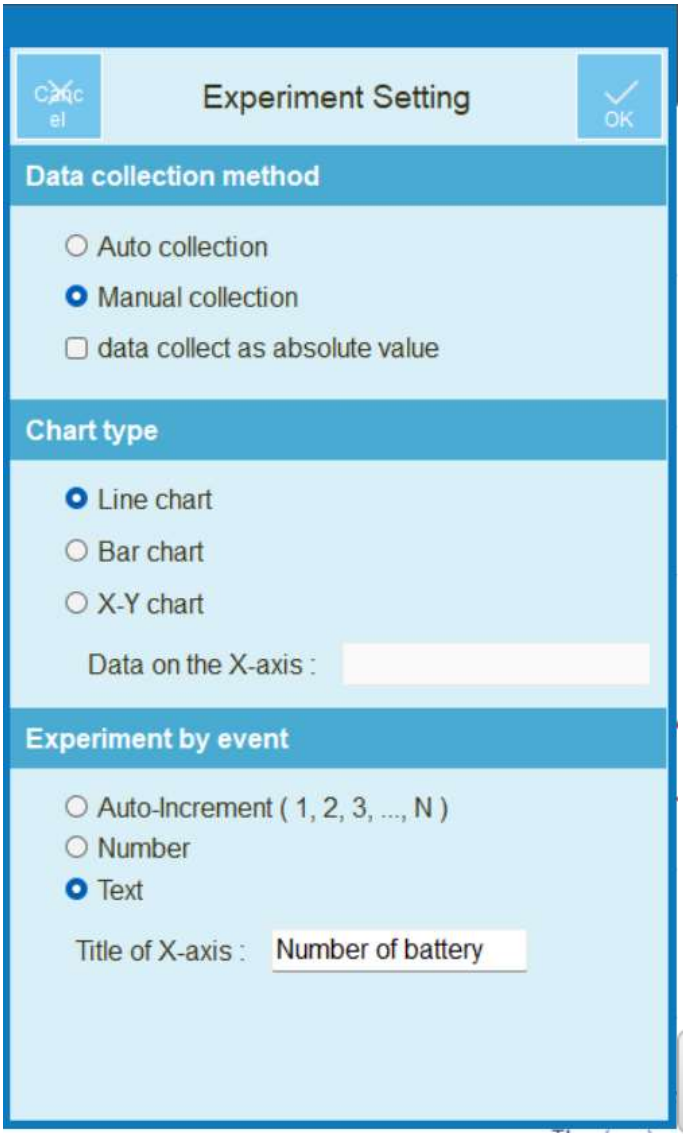
Experimental Setup

1. Insert batteries into the 5 battery holders and connect one battery.
2. Connect the voltage sensor in parallel to the 10Ω resistor and the current sensor in series with the battery to complete the electric circuit as shown below.



Interface Setup

1. Run Science#.
2. Connect the voltage sensor and current sensor to the interface.
3. Press the button to set up the experimental environment as shown below or press the button for automatic setup.




[Automatic Setup]

Data Collection

[When 10Ω resistance is constant]

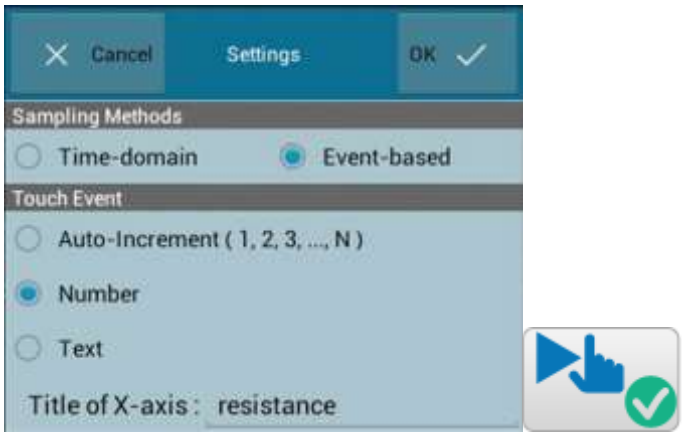
1. Press the button  and press  to measure the voltage and current with one battery connected.
2. Increase the number of batteries in series up to a maximum of 5, and measure and record the voltage and Current for each case..

[When 20Ω resistance is constant]

3. Change the alligator clips to connect to the 20Ω resistor and create a closed circuit with one battery.
4. Press the button and press to measure the voltage and Current with one battery connected.
5. Increase the number of batteries in series up to a maximum of 5, and measure and record the voltage and Current for each case..

[When voltage is constant]

6. Press the button to set up the experimental environment as shown below or press the button for automatic setup.



[Automatic Setup]

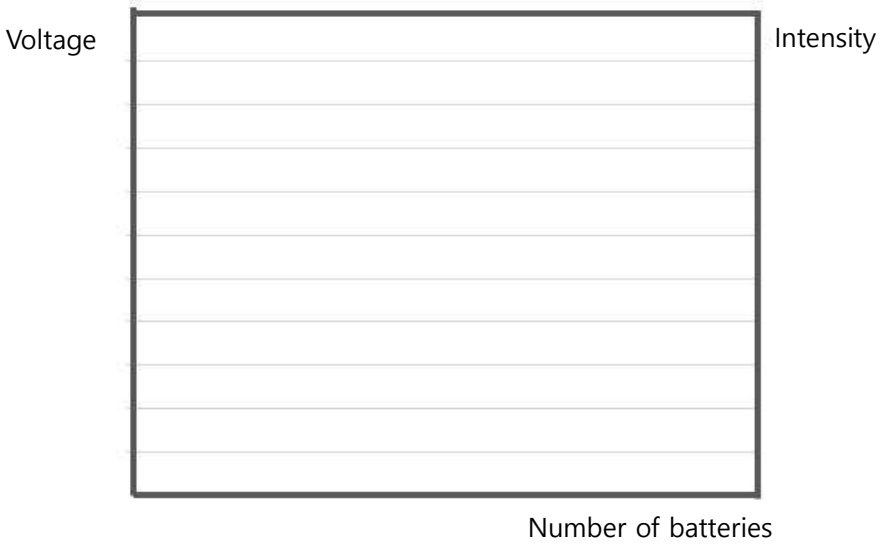
7. Connect two batteries in series.
8. Press the button and press to measure the Current for each of the 10Ω, 20Ω, 30Ω, 40Ω, and 50Ω nichrome wires, and record the values..

Data Analysis

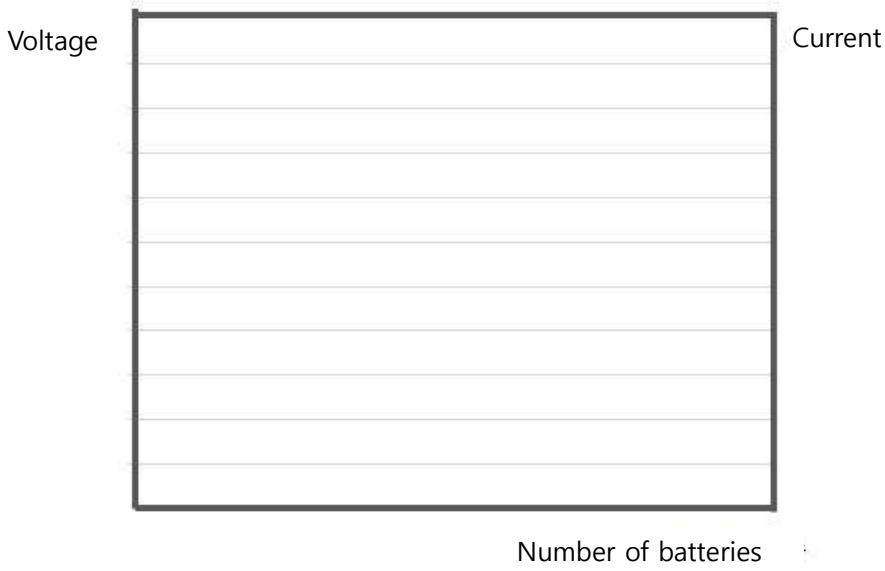
Recording Data

1. Create graphs showing the changes in voltage and current with the number of batteries for 10Ω and 20Ω resistors, and record the values in the table below.

[For 10Ω resistor]



[For 20Ω resistor]

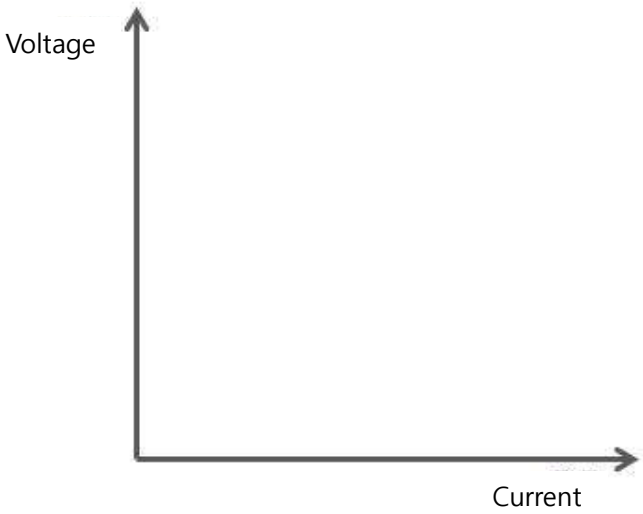


Resistance	10Ω		20Ω	
Number of Batteries	Current (A)	Voltage (V)	Current (A)	Voltage (V)
1				
2				

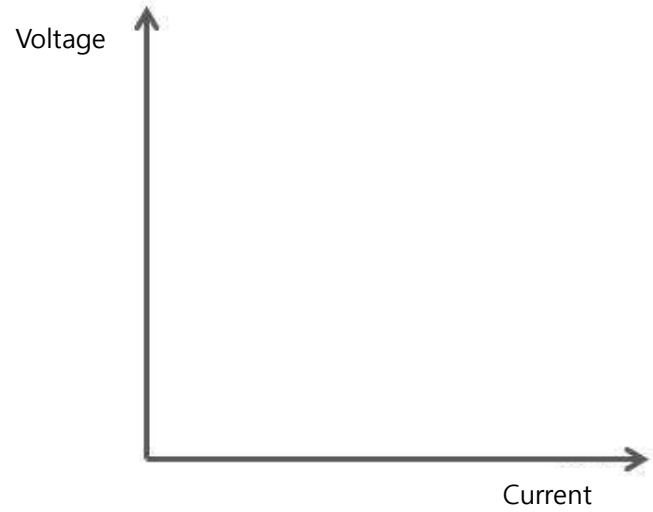
3				
4				
5				

2. Show the relationship between Current and voltage in graphs for 10Ω and 20Ω resistors when the number of batteries increases.

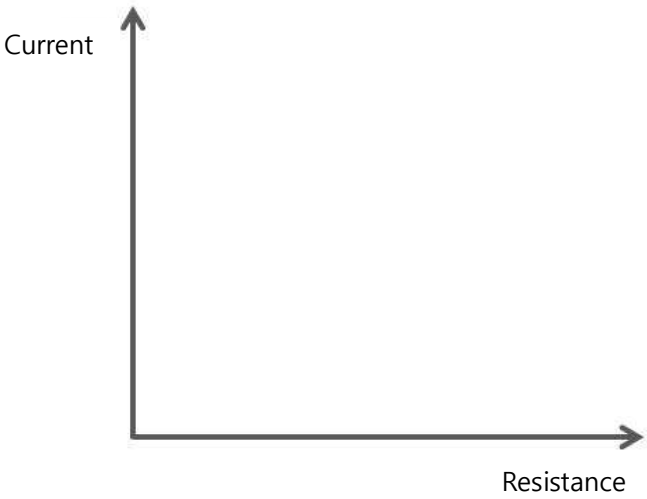
[For 10Ω]



[For 20Ω]



3. Create a graph to show how current changes with resistance when voltage is constant.



4. Record the measured Current values for each nichrome wire resistance in the table below..

Resistance (Ω)	Current (A)
10Ω	
20Ω	
30Ω	

40Ω	
50Ω	

Data Application

1. Write down how the current intensity (I) changes when the voltage (V) is increased or decreased while the resistance is constant, and explain the relationship.

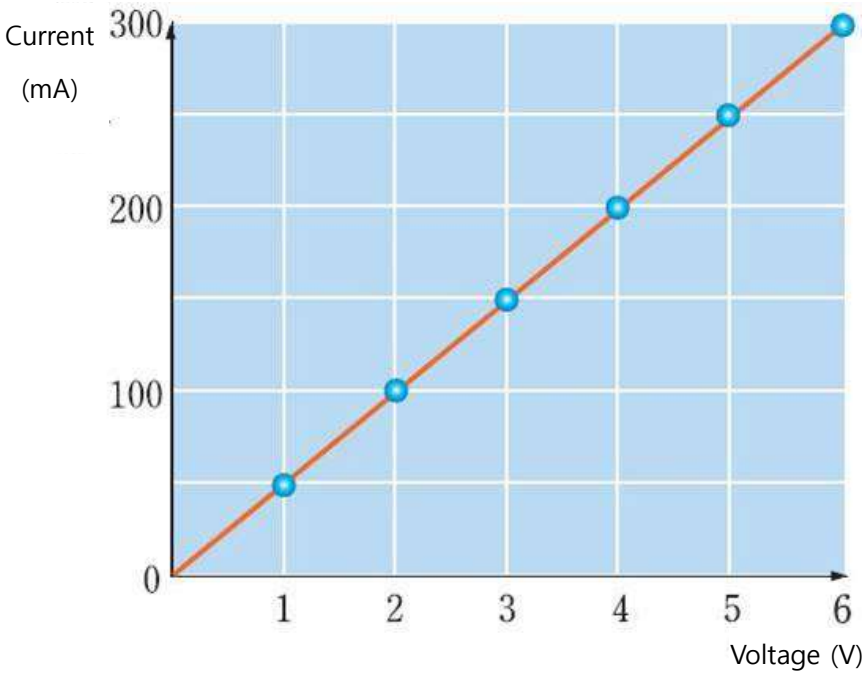
2. Write down how the Current changes with resistance when the voltage is constant, and explain the relationship.

3. Based on the result data, write what the slope of the current-voltage relationship graph represents.

4. Summarize the mathematical relationship between voltage, current, and resistance in an equation.

Extended Activities

1. The following graph shows the measured current and voltage for a nichrome wire..



1) Based on the graph, calculate the resistance of the nichrome wire.

2) If 12V is applied to this circuit, calculate the current flowing in the circuit using Ohm's Law.

2. In an electric circuit with a 3Ω light bulb connected in parallel to two 6V batteries, explain how much current flows in the circuit using Ohm's Law.