ScienceCube

Magnetic Field Due to a Straight Current

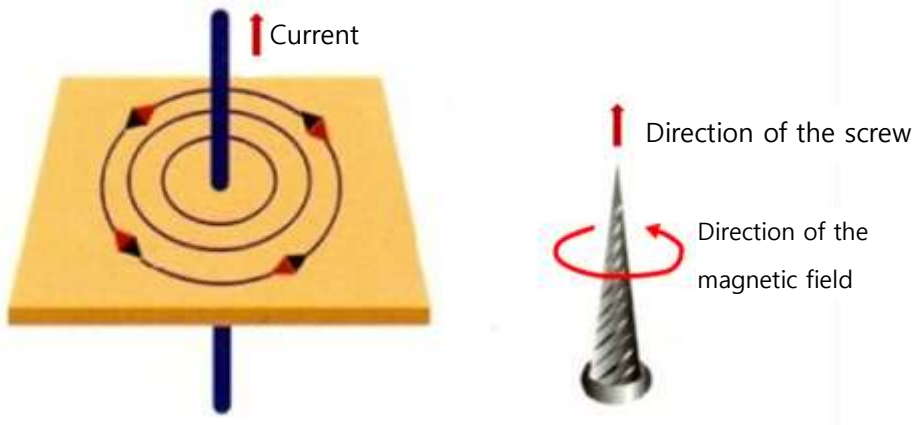
1. **Explain the magnetic field generated around a current-carrying conductor.**
2. **Explain the strength of the magnetic field based on the current intensity and the distance from the conductor.**

Fundamental Concept

When a current flows through a straight conductor, a magnetic field is generated around it. Using the right-hand rule, if the direction of the current is in the direction of the thumb, the direction of the magnetic field is in the direction of the curled fingers. The magnetic field B around a straight conductor is proportional to the current I and inversely proportional to the distance r from the conductor.

$$\mathrm{B} = \mathrm{k}\frac{I}{r}$$

where k=2×10^{-7}N/A^2, and the units of the magnetic field are Tesla (T) or Gauss (G).



Experiment

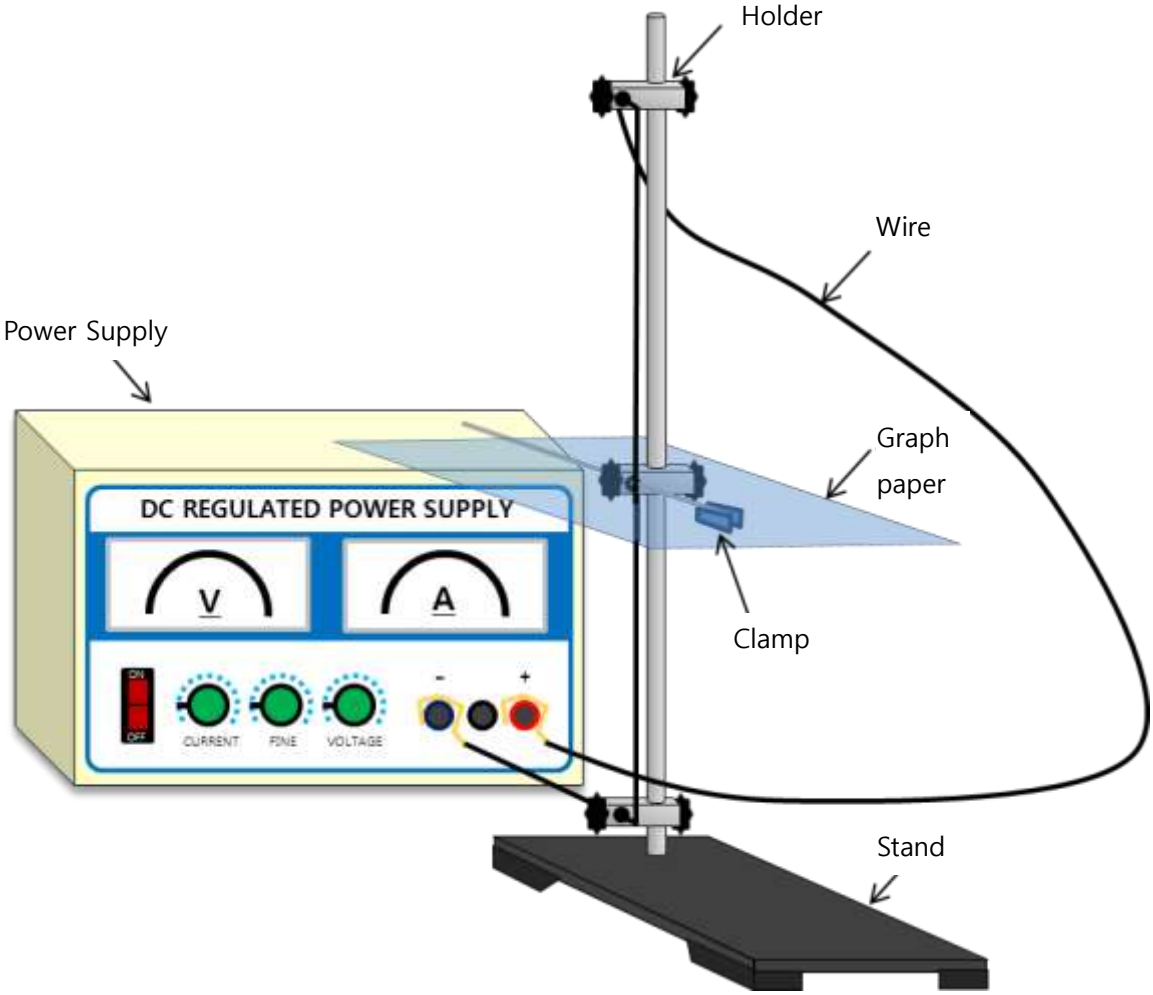
Materials Needed

Interface, Science# Program, Magnetic Field II Sensor (MBL), Stand, Clamp, Holders (3), Thick Wire (3.5 mm^2, 1m), Graph Paper, Power Supply, Wire Stripper, Name Pen, Knife

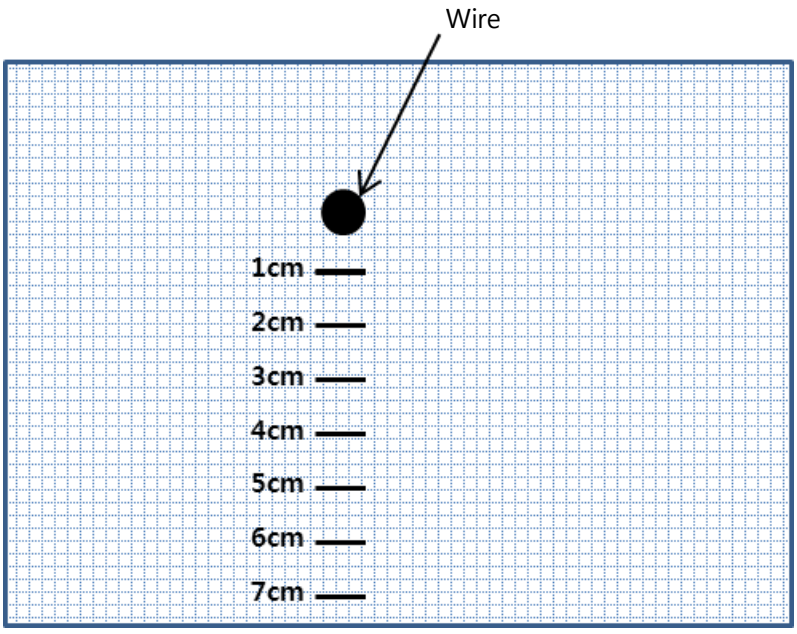
Preparation of Experimental Setup

1. Strip 5 cm off both ends of the 1m wire using the wire stripper.

2. Attach one stripped end of the wire to the negative terminal of the power supply.
3. Insert the wire into the lower holder hole and fix it to the stand.
4. Place the graph paper with holes for the wire and the stand rod, then place it on the upper holder.
5. Fix the graph paper horizontally using a clamp on the holder.
6. Insert the remaining holder into the upper slot of the stand and secure the wire so it remains straight.
7. Attach the remaining end of the wire to the positive terminal of the power supply.

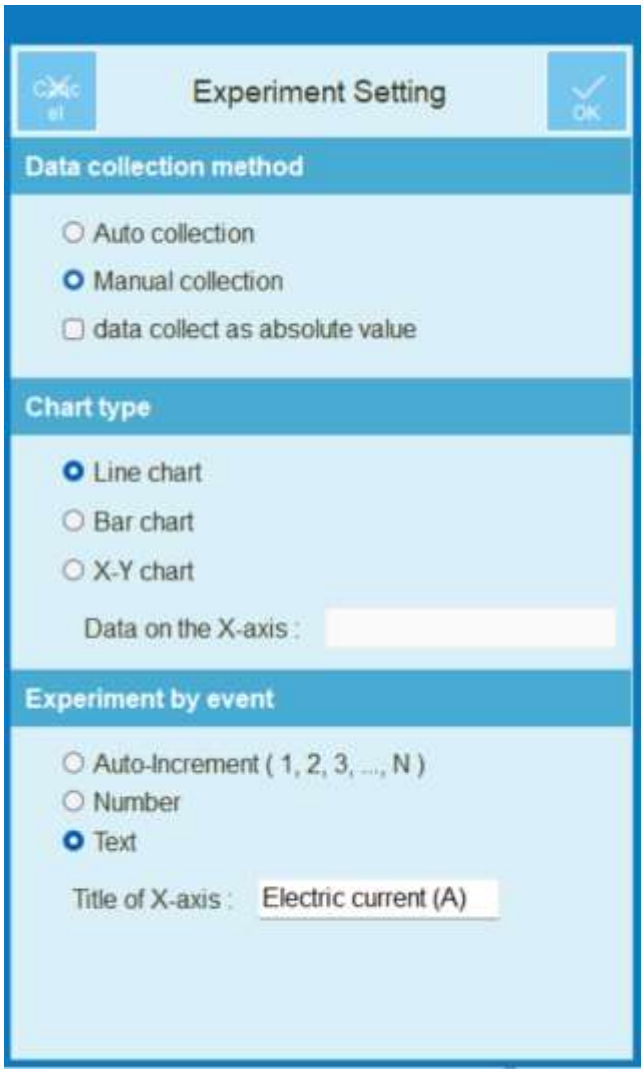


8. Mark distances at 1 cm intervals from the wire hole on the graph paper.



Interface Setup

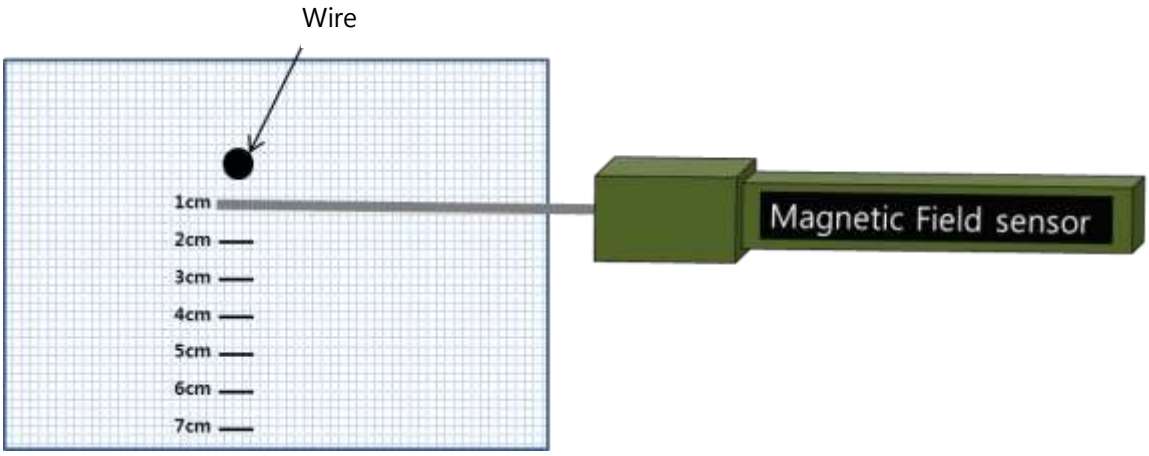
1. Launch the Science# program.
2. Connect the magnetic field sensor to the interface.
3. Press to zero the sensor, ensuring that there are no objects around that could affect the magnetic field.
4. Set up the experimental environment as shown below, or use the automatic setting option..



Automatic setup

Data Collection

1. Position the tip of the magnetic field sensor 1 cm from the wire as shown below.



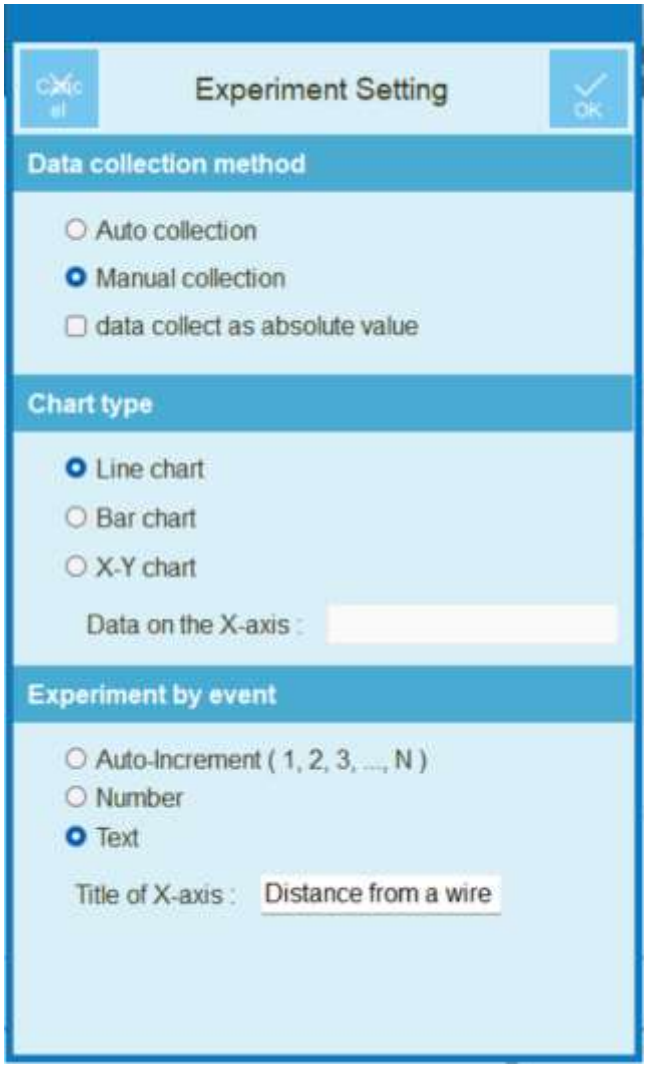
2. Press to start collecting data.

[Magnetic Field Based on Current Intensity]

3. Press and enter "0" to measure the magnetic field value when no current is flowing.
4. Fix the magnetic field sensor 1 cm away from the wire and measure the magnetic field value with a current intensity of 1A.
5. Increase the current intensity by 1A up to 5A, measuring the magnetic field value for each current intensity.
6. Press to end data collection.

[Magnetic Field Based on Distance]

7. Reset the experimental environment as shown below, or use the automatic setting option..



Automatic setup

8. Press and draw 새 차트 a new chart.
9. Allow a current of 4A to flow through the wire.
10. Position the magnetic field sensor 1 cm from the wire and press .
11. Increase the distance by 1 cm increments until the magnetic field value reaches 0 Gauss, measuring the magnetic field value at each distance.
12. Press to end data collection..

Data Analysis

Recording Data

[Magnetic Field Based on Current Intensity

1. Measure the magnetic field values for different current intensities through a straight conductor and plot a graph.

2. Refer to the graph above and complete the table below with the magnetic field values corresponding to the current intensity through the straight conductor..

Current (A)	0	1	2	3	4	5
Magnetic Field (Gauss)						

[Magnetic Field Based on Distance]

3. Measure the magnetic field values at various distances from the wire when a current flows through a straight conductor and plot a graph.

4. Refer to the graph above and complete the table below with the magnetic field values corresponding to the distance from the conductor..

Distance	1	2	3	4	5	6	7	8	9

(cm)									
Magnetic Field (Gauss)									

Data Application

1. Based on the results, explain the relationship between the current intensity through a straight conductor and the magnetic field..

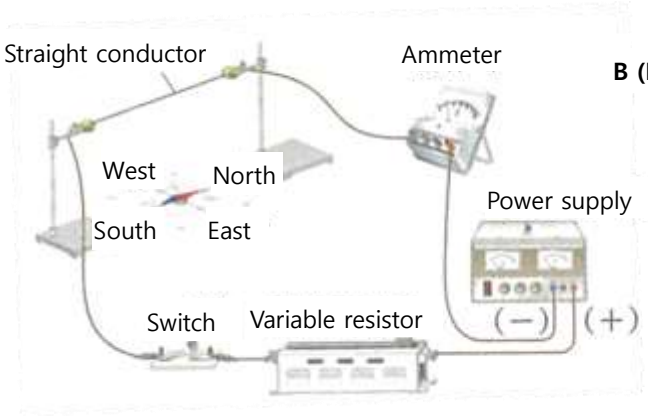
2. Based on the results, explain the relationship between the distance from the conductor and the magnetic field.

Extension Activities

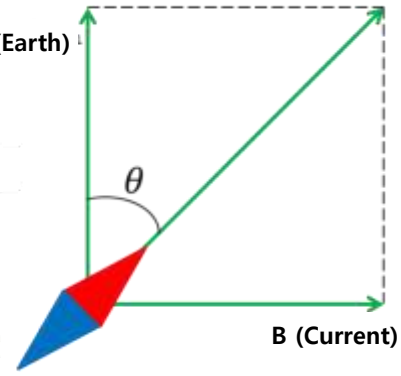
1. When a current was passed through a circular conductor, the magnetic field strength at

the center was B. Calculate the magnetic field strength at the center if the radius of the circular conductor is halved and the current is doubled.

2. Place the straight conductor parallel to the compass needle as shown in (Figure 1) and close the switch to allow current to flow through the conductor. (Figure 2) shows the deflection angle of the compass needle with respect to the Earth's magnetic field (Bearth) and the magnetic field due to the straight current (Bcurrent).



(Figure 1)

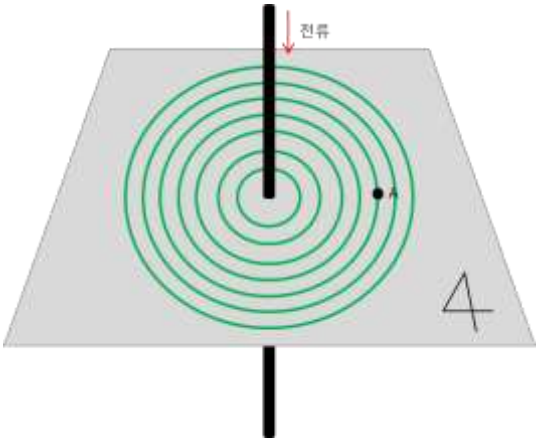


(Figure 2)

Explain the relationship between the deflection angle of the compass needle's north pole and the current intensity..

3. The following diagram shows the magnetic field generated around a straight conductor when current flows. Identify the incorrect statement about this magnetic field from the options below and explain why..

Current



< Options >

A. The magnetic field weakens as the distance from the conductor increases.

B. The direction of the magnetic field around the conductor is clockwise.

C. As the current intensity increases, the spacing of the magnetic field lines decreases.

D. If the current direction is reversed, the direction of the magnetic field also reverses.

E. If a compass is placed at point A, the north pole of the needle points east.