Magnetic Field & Magnetic Force on Electric Charges

Universiti Teknologi MARA
Fakulti Sains Gunaan

PHY407: A Physical Science Activity

Name:_____ HP: _____ Lab # 7:

Objectives

The goal of today's activity is to physically investigate the pattern and strength of magnetic field lines produced by a bar magnet and by an electromagnet and to observe the behaviour of charges in a magnetic field.

At the end of this activity, students will be able to:

1. Draw magnetic field lines produced by a bar magnet and by an electromagnet.
2. Describe how the magnetic field strength (intensity) change with distance from the poles of a bar magnet and from an electromagnet.
3. State factors that created a magnetic force on a charged particle.
4. Describe and draw the trajectory of charges moving at a constant speed in a magnetic field.
5. Obtain a simple relationship to determine the quantities affecting the trajectory of moving charges in a magnetic field

Background Information

Background:

Your investigation so far has focused on the electrical field causing charges to accelerate and move. This movement of electrons in conductors is then associated to electric current that flows opposite to the flow of electrons when a source of EMF such as dry cells are connected to devices such as bulbs and other resistive elements. You also investigated how the current changes when the EMF source is changed or different type of resistors are used. This relationship is better known as Ohm's Law. You further investigated how the current, the brightness of bulbs (associated to the power) and the potential difference across bulbs or resistors depend on whether they are connected in series or parallel (the heads and the tails of the devices are connected together). All these investigations got you to determine how to best make connections for household devices.

Your investigation today will involve the magnetic field produced by permanent magnets such as bar magnets and also non-permanent magnets such as the electromagnets. You will find out the differences between electrical field lines and magnetic field lines. You will also investigate how the magnetic field strength changes near and far from a bar magnet and also inside and outside an electromagnet. In addition, you will also investigate how the trajectory of charges which are moving perpendicular to the direction of the magnetic field can change, explain the cause of the change and eventually predict and confirm the factors affecting the strength of the trajectory change. Note that units used for B field is gauss (G) and tesla (T) where 1 G = 10^{-4} T.

Student Activity

Investigation 1-Magnetic Field Lines

Prediction 1: (Make your intelligent guess)
Use the PHET Faraday's Electromagnetic Lab simulation (http://phet.colorado.edu/simulations/sims.php?sim=Faradays_Electromagnetic_Lab) for this section: Uncheck all boxes.

i) Draw your prediction of how the magnetic field lines will look like for the bar magnet.
ii) Draw your prediction of how the magnetic field lines will look like for the electromagnet.

Bar magnet	Electromagnet

Figure 1: Predicted Magnetic Field Lines

Activity 1: (Check ONLY the Show Compass box)

Bring the compass at various locations around the bar magnet and observe the needles. Move the compass at many locations so that you can map the field lines from the needle orientations. Then repeat for the electromagnet with the voltage set at 10 V. (Check ONLY the Show Compass box).

Bar magnet (drawing of the field lines)	Electromagnet (drawing of the field lines)

Figure 2: Observed Magnetic Field Lines

Now check the Show Field Meter box and use the meter to take a few measurements near and far from the magnets and tabulate the strength of the magnetic field. Note that

1G = 10^{-4} T. Use a plastic ruler and place it over your computer screen to measure the distance. Measure the distance from the end of the magnet.

Table 1: Strength of B field

Bar Magnet				Electromagnet			
Left of magnet		Right of magnet		Left of magnet		Right of magnet	
D/cm	B/G	D/cm	B/G	D/cm	B/G	D/cm	B/G

Questions

1. Does changing polarity of the magnet affect the direction of field lines? Explain.
2. Does changing the voltage change the strength of the field for the electromagnet? How? Explain.
3. How does the field strength change as you go further away from it? Explain.

Investigation 2-Charges Moving in B Field (Visit the following website)
(Website:
http://www3.interscience.wiley.com:8100/legacy/college/halliday/0471320005/simulations6e/

Prediction 2:

Predict what happen to a stationary charge when the field is increased from 0.1 T – 0.4 T. Write down your prediction. Then predict what happens if the charge is allowed to have a velocity of 2.0 m/s in the positive X direction (moving to the right)

Activity 2:

i) Run the simulation from the website above. Let the mass and the charge remain constant. Try increasing the initial speed along the positive X direction in increments of 0.5 m/s and until the speed of 3 m/s for fields of 0.1 T. Repeat for fields of 0.2 T, 0.3 T and 0.4 T. For each of the initial speed, observe and draw the trajectory you see. (You will need to click the RESET button before changing the speed.

Table 3: Trajectories of charged particle in a B field

B = 0.1 T						
Speed of charge in m/s						
0.0	0.5	1.0	1.5	2.0	2.5	3.0

B = 0.2 T						
Speed of charge in m/s						
0.0	0.5	1.0	1.5	2.0	2.5	3.0

B = 0.3 T						
Speed of charge in m/s						
0.0	0.5	1.0	1.5	2.0	2.5	3.0

B = 0.4 T						
Speed of charge in m/s						
0.0	0.5	1.0	1.5	2.0	2.5	3.0

Questions

1. What happens to the trajectory as the speed is increased while holding the B field constant?
2. What happens to the trajectory at a certain speed when B is increased?
3. Can you infer what are the factors affecting the trajectory of the charged particle?
4. What caused the charge to change its trajectory when it moved in a B field?
5. Will the trajectory of the charge be different from its original path if the charge is moving opposite to or along the direction of the B field? Explain.
6. Answer all the questions posted on the following website: http://physics.ius.edu/~kyle/physlets/magnetism/magnetH.html