98 You're Repulsive

Purpose

To observe the force on an electric charge moving in a magnetic field, and the current induced in a conductor moving in a magnetic field

Required Equipment/Supplies

cathode ray oscilloscope or computer with monitor
horseshoe magnet
bar magnet
compass
50-cm insulated wire
galvanometer or sensitive milliammeter
masking tape

Discussion

In this lab activity, you will explore the relationship between the magnetic field of a horseshoe magnet and the force that acts on a beam of electrons that move through the field. You will see that you can deflect the beam with different orientations of the magnet. If you had more control over the strength and orientation of the magnetic field, you could use it to "paint" a picture on the inside of a cathode ray tube with the electron beam. This is what happens in a television set.

CAUTION: *Do not bring a strong, demonstration magnet near a color TV or monitor.*

A moving magnetic field can do something besides make a television picture. It can induce the electricity at the generating station to power the television set. You will explore this idea, too.

Procedure

Step 1: If you are using an oscilloscope, adjust it so that only a spot occurs in the middle of the screen. This will occur when there is no horizontal sweep.

Adjust monitor or oscilloscope so dot is centered.

If you are using a computer monitor for the cathode ray tube, use a graphics program to create a spot at the center of the screen. Make a white spot on a black background.

1. The dot on the screen is caused by an electron beam that hits the screen. In what direction are the electrons moving?

Make sketches of different orientations of the magnet.

Step 2: If the north and south poles of your magnets are not marked, use a compass to determine whether a pole is a north or south pole, and label it with tape.

CAUTION: *Do not use large, demonstration magnets in this activity. Such magnets should not be brought close to any cathode ray tube, as they can cause permanent damage.*

Place the poles of the horseshoe magnet 1 cm from the screen. Try the orientations of the magnet shown in Figure A. Sketch arrows on Figure A to indicate the direction in which the spot moves in each case. Try other orientations of the magnet, and make sketches to show how the spot moves.

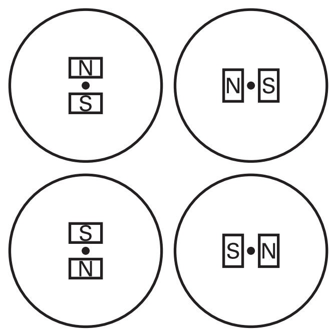

Fig. A

2. Recall that the magnetic field lines outside a magnet run from the north pole to the south pole. The spot moves in the direction of the magnetic force on the beam. How is the direction of the magnetic force on the beam related to the direction of the magnetic field?

Note effects of bar magnet on spot.

Step 3: Aim one pole of a bar magnet directly toward the spot. Record your observations.

Step 4: Change your aim so that the pole of the bar magnet points to one side of the spot. Record your observations.

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3. In general, what are the relative directions of the electron beam, the magnetic field, and the magnetic force on the beam for maximum deflection of the electron beam?

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Step 5: With a long insulated wire, make a three-loop coil with a diameter of approximately 8 cm. Tape the loops together. Connect the ends of the wire to the two terminals of a galvanometer or sensitive milliammeter. Explore the effects of moving a bar magnet into and out of the coil to induce electric current and cause the galvanometer to deflect. Vary the directions, poles, and speeds of the magnet. Also, vary the number of loops in the coil, and try different strengths of magnets.

Explore how moving magnet affects coil of wire.

4. Under what conditions can you induce the largest current and get the largest deflection of the galvanometer?

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5. What do you need to do to cause the galvanometer to deflect in the opposite direction?

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