Right Hand Rule (Oersted's Law) Example Lesson

Subject / Course:	**Physics/High School Physical Science**		
Topic:	**Electricity and Magnetism: magnetic fields produced from electrical current**		
Lesson Title:	**Right Hand Rule: Magnetic Field**		
Level:	High School	**Lesson Duration:**	**45 minutes**

Lesson Objectives:

1. Students will explore how electricity flowing through a DC circuit produces a magnetic field around the circuit.
2. Students will be able to identify the direction of the magnetic field produced around an electric current.
3. (Advanced/Next Step) Students will be able to identify how coiled wires looped tightly around iron can create an electromagnet.

Summary of Tasks / Actions:

Considerations for teaching students with blindness or visual impairments:

It will likely be beneficial for students with blindness or visual impairments for you to allow students to feel the way you situate your hand when performing right hand rule checks. Additionally, while using the model, help the students identify the parts of the model, the direction of conventional current, and the direction of the magnetic field around the circuit. Help the students to figure out the right hand rule both on the circuit model and using stand-in objects to represent wires.

Bell Ringer/Introductory Activity: Teacher will provide students with an example circuit (diagram or physical model) and have students identify the flow of electricity through the circuit (both the actual flow of electrons as well as the direction of conventional current, or "positive current".)

Review lesson objectives

Discussion: Begin by describing (or reviewing) the concept that electricity and magnetism are two aspects of electromagnetism and can affect one another. If the students are already familiar with the concept of electrical induction, the instructor can relate back to the idea of how a moving magnet near a coil of wire on a circuit can produce alternating electrical current.

Next, the concept of magnetic fields produced around a current will be introduced. The instructor will describe how magnetic fields are produced around a wire with electricity running through it. The field lines are produced and run circularly around the wire perpendicularly to the direction of positive current flow in the wire. The direction of the magnetic field can be described using the "right hand rule".

Right hand rule (Oersted's Law): Have students hold a wire or other stand-in object (some sort of long, thin object) with their right hand. Have the students point their right thumb along the length of the wire in the direction of positive current flow (or pretend that the object has current flowing through it). The direction that the students' fingers curl around the wire is the North direction of the magnetic field around the wire.

Introduce 3D printed model: For students who are blind or visually impaired (as well as non-disabled students) the printed model shows the direction that the magnetic field points in around a simple circuit. The battery is labeled with a large + and - symbol to show the cathode and anode and to show which direction the positive current is flowing in around the wire. The wire also has arrows printed on it to show the positive current. On the far section of the circuit from the battery, there is a disk object with arrows printed onto its surface. The arrows point circularly around the disk, and the disk is able to rotate in the same direction the arrows point (but cannot rotate the other direction). This is to help model the direction of the magnetic field generated around the wire at that point. Visual diagrams can also be found to represent this for students with vision.

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Practice: Using the original simple circuit from the introductory activity, have students identify the direction of the magnetic field at multiple points along the circuit. Additional circuit examples with parallel circuitry should be used to help reinforce the concept of the right hand rule.

Application discussion: Begin by asking students if they can think of a reason why it would be helpful to understand the direction of the magnetic field around a circuit. After fielding responses to the question, begin describing the creation of an electromagnet (coiled wire around an iron core). Discuss how the magnetic field of each wire coil adds to the others to create an overall field around the core, which creates a North end and a South end to the magnet. A different version of the right hand rule can be applied to this coil of wire (with or without the iron core); the direction of positive current would be indicated by the fingers curling, while the thumb (pointed outward) would indicate the direction of magnetic north for the field lines around the coil.

If time and materials are available (or as an exploratory activity in the next lesson), have students create electromagnets using batteries, copper wire, and iron nails. Have students identify the north end and south end of their electromagnets using the right hand rule, and then test with a permanent magnet (with appropriate labels).

Materials / Equipment:

Primary Discussion Materials:

3D printed right hand rule model

long wire or other long, thin object (for modeling how the right hand rule works)

circuit diagram(s) (tactile/print)

Advanced Discussion/Activity materials:

small, labeled permanent magnets

iron nails

copper wire 1 foot per group, minimum)

9V or two D-cell batteries (per group)

electrical or masking tape for holding materials together.

NGSS Alignment:

HS-PS2-5: Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current. [*Assessment Boundary: Assessment is limited to designing and conducting investigations with provided materials and tools.*]