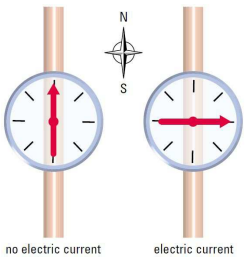
SPH3U UNIVERSITY PHYSICS

ELECTRICITY & MAGNETISM

- Oersted's Discovery (P.553-556)

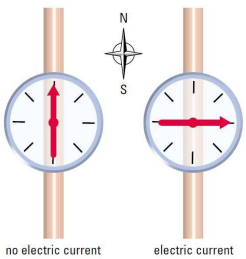
Oersted's Discovery

For centuries, people believed that electricity and magnetism were somehow related, but no one could prove a connecting link between them. Then, in 1819, the Danish physicist Hans Christian Oersted discovered the connection by accident while lecturing on electric circuits.



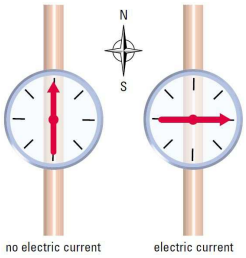
Oersted's Discovery

Oersted noticed that a compass needle placed just above a wire carrying a current would take up a position nearly perpendicular to the wire while the current was flowing. When the electric current was reversed, the compass needle was deflected in the opposite direction.



Oersted's Discovery

Further investigation led to an understanding of the (i) shape, (ii) direction, and (iii) strength of the magnetic field around a straight conductor.



Magnetic Field of a Straight Conductor

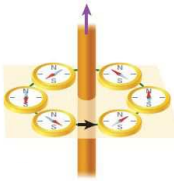
1. *The magnetic field surrounds the conductor in the shape of concentric circles.*

Magnetic Field of a Straight Conductor

2. *The direction of the magnetic field depends on the direction of the current.*

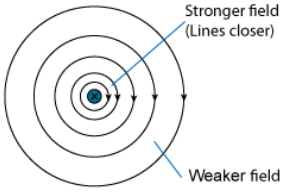
   (a) When no electric current is present in the wire, the compasses point toward Earth's magnetic north pole.

   (b) When an electric current is directed up the wire, the compasses follow the circular magnetic field.



Magnetic Field of a Straight Conductor

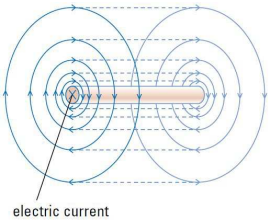
3. *The strength of the magnetic field gets weaker farther away from the conducting wire.*



Magnetic Field of a Straight Conductor

MAGNETIC FIELD OF A STRAIGHT CONDUCTOR

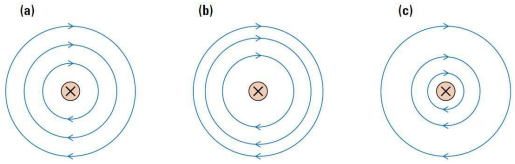
- are concentric circles
- direction depends on direction of current
- magnetic field gets weaker as distance from the conductor increases



Magnetic Field of a Straight Conductor

PRACTICE

1. Choose the diagram below that best illustrates the strength of the magnetic field surrounding a conductor.



(c)

Magnetic Field of a Straight Conductor

PRACTICE

2. You use a current-carrying conductor to produce a magnetic field. Which three properties of the magnetic field can you control?

   on/off – direction – strength

Oersted's Principle

Oersted developed a principle that describes the magnetic field around a current-carrying conductor. ***Oersted's principle*** *states that a charge moving through a straight conductor produces a circular magnetic field around the conductor.*

OERSTED'S PRINCIPLE

- whenever a charge moves through a straight conductor, a circular magnetic field is created in the region around the conductor

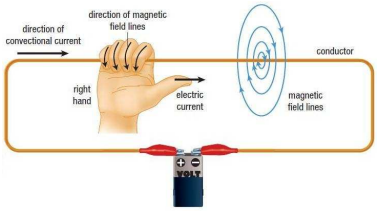
Oersted's Principle

NOTE!

In Oersted's time, the prevailing theory assumed that electric current was directed from the positive terminal to the negative terminal of the power source. Many of the rules of electromagnetism were therefore developed using the conventional current model.

Right-Hand Rule for a Straight Conductor

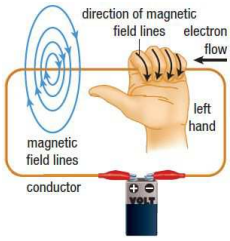
*A learning tool was developed to help determine the direction of the magnetic field around a straight current-carrying conductor. The **right-hand rule for a straight conductor** states that if a straight conductor is held in your right hand with your right thumb pointing in the direction of the conventional current, your curled fingers will point in the direction of the magnetic field lines surrounding the conductor.*



Left-Hand Rule for a Straight Conductor

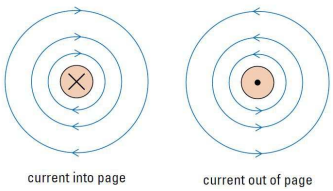
NOTE!

If you want to use the electron flow model instead, then you must use your left hand. The left-hand rule for a straight conductor is similar, except that your left thumb follows the direction of electron flow. The fingers of your left hand still curl in the direction of the magnetic field lines.



Representing Currents & Magnetic Fields

Rather than drawing the conductor as a cylinder and using an arrow to indicate the direction of electric current, it is more convenient to use a circle to represent a cross-section of the conductor. We use an X to represent conventional current moving into the page. A dot represents a conventional current moving out of the page.



Applying Oersted's Principle

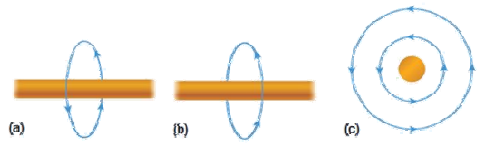
PRACTICE

3. Copy each diagram into your notebook and draw the magnetic field.

Applying Oersted's Principle

PRACTICE

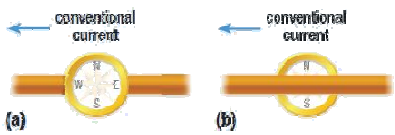
4. Copy each diagram into your notebook and label the direction of the conventional current.



Applying Oersted's Principle

PRACTICE

5. Which way will the compass point in the diagrams below.



Applying Oersted's Principle

PRACTICE

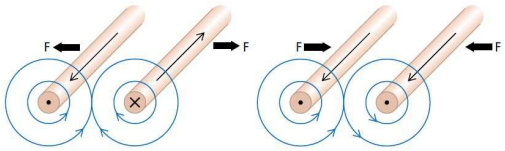
6. You are driving east in your car. Your car is equipped with a magnetic compass display in your rear-view mirror. You happen to drive underneath an electric wire that is labelled high current. You notice that your compass immediately displays south. In which direction is the conventional current flowing in the wire?

west

Applying Oersted's Principle

PRACTICE

7. André-Marie Ampère was fascinated by Oersted's discovery, so he investigated other aspects of electricity and magnetism. Ampère took two parallel wires and conducted an experiment to see if the wires would attract or repel one another when currents were sent through them. In which direction would each set of wires move?



Oersted's Discovery – DYK?

Oersted's discovery forever changed the world, leading to new kinds of technologies, such as motors and generators. He demonstrated that we could use electricity to produce magnetism. Controlling magnetism means that we can turn it on and off and change its strength by increasing or decreasing the current. We can also control the direction of the magnetic field by changing the direction of the electric current.

✔ Check Your Learning

TEXTBOOK

P.556 Q.1-7

P.558 Q.1,2,4,5 (PJ: Wireless Electricity)