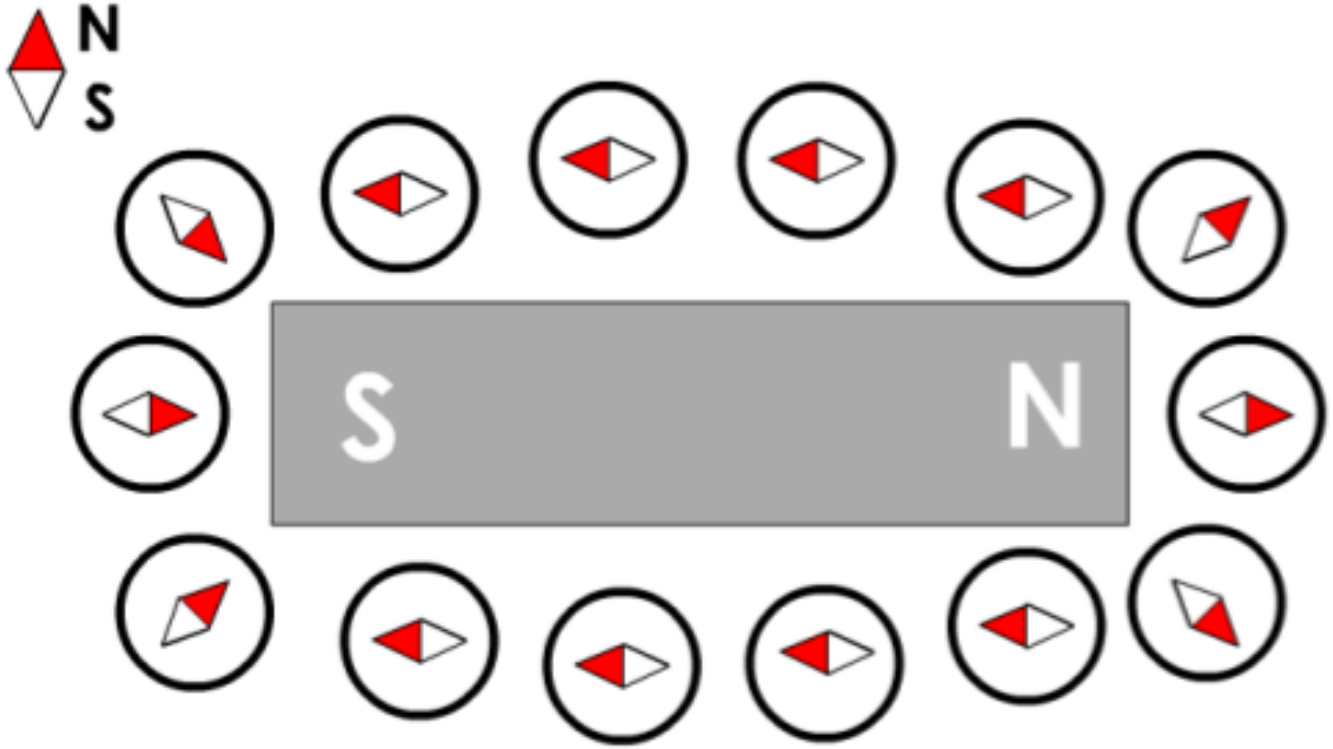
Electricity and Magnetism

Lesson 2

Objectives

- describe how the discoveries of Oersted and Faraday form the foundation of the theory relating electricity to magnetism.
- describe, qualitatively, a moving charge as the source of a magnetic field and predict the orientation of the magnetic field from the direction of motion.

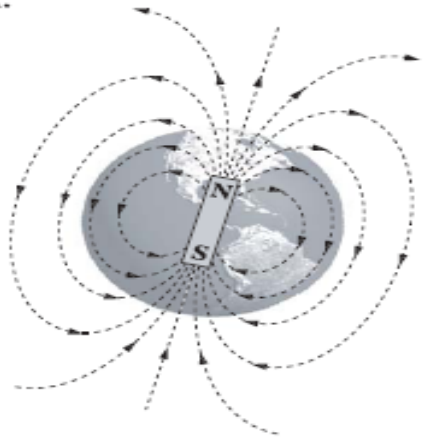
N Pole of Compass lines up with magnetic field



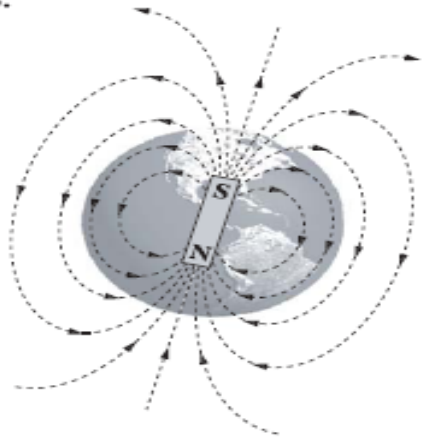
Diploma Question Alert!

19. If the source of Earth's magnetic field were a bar magnet, then the best diagram to show this field would be

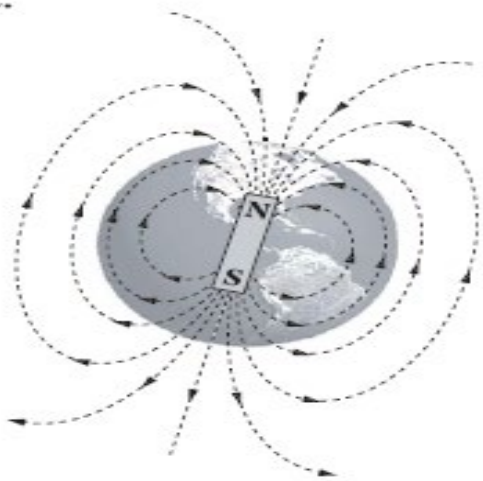
A.



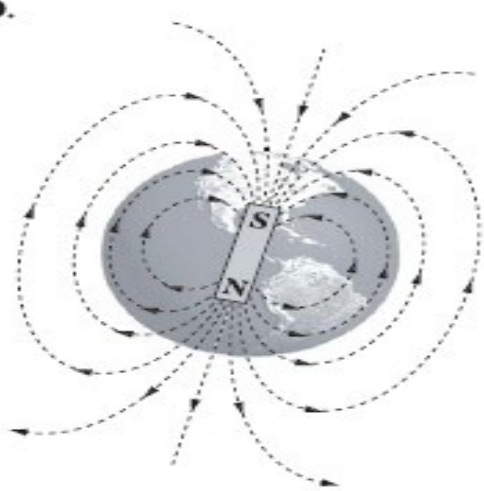
B.



C.



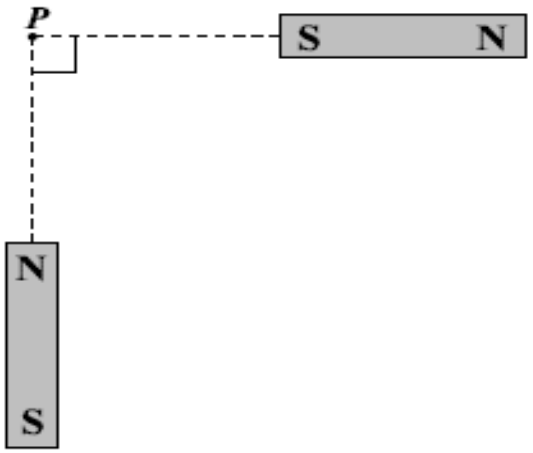
D.



Diploma Question Alert!

Use the following information to answer the next question.

Two bar magnets of equal magnetic strength are placed as shown below. The point ***P*** is the same distance from each of the magnets.



17. The direction of the magnetic field at ***P*** due to the two bar magnets is

A. 

B. 

C. 

D. 

Electricity and Magnetism

- **Early physicists treated electricity and magnetism as two different disciplines.**
- **They saw no reasons the two should be related.**
- **And everyone was OK with that...**

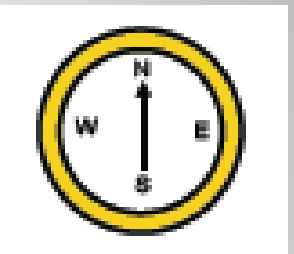
- **everyone but...**

Hans Christian Oersted

- **18th century physics teacher**
- **great lecturer**
- **easy to excite**
- **one of the first to determine a relationship between electricity and magnetism**

The story goes like so…

- **“I was performing an experiment with a wire and a battery.”**
- **“There was a current passing through the wire...”**
- **“…and I noticed my compass (which I always have with me)”**
- **“…started to do some very unusual things...”**

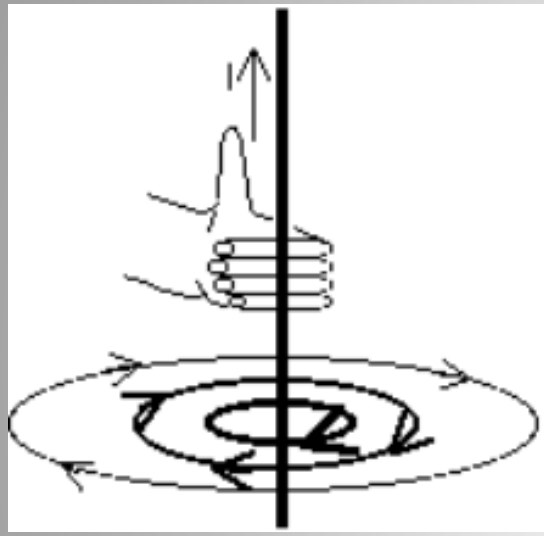


- **“when the current was passing through the wire, the compass deflected from north...”**
- **“…but when the current was turned off, the needle went back to normal."**

It was if a current in a wire produced a magnetic field!

- **“I wanted an easy way of finding the direction of the magnetic field produced by a current carrying wire. So I took out my favorite hand (the left one) and yelled at the top of my lungs...”**
- **“POINT THE THUMB OF YOUR LEFT HAND IN THE DIRECTION OF CURRENT FLOW! LET YOUR FINGERS CURL AROUND THE WIRE! THE DIRECTION OF YOUR FINGERS IS THE DIRECTION OF THE MAGNETIC FIELD!”**
- **This has become known as the First Left Hand Rule**

First Left Hand Rule



the thumb points in the direction of the electron flow, the fingers will point in the direction of the magnetic field

Thumb – current direction
Fingers – magnetic field direction

Don’t Be Shy and Fail…

- **Get used to using these hand rules…you need to do these hand actions! Don’t just ‘envision it in your head’. That stuff is for psychics, not physicists! You’re not a psychic, are you?!?!**

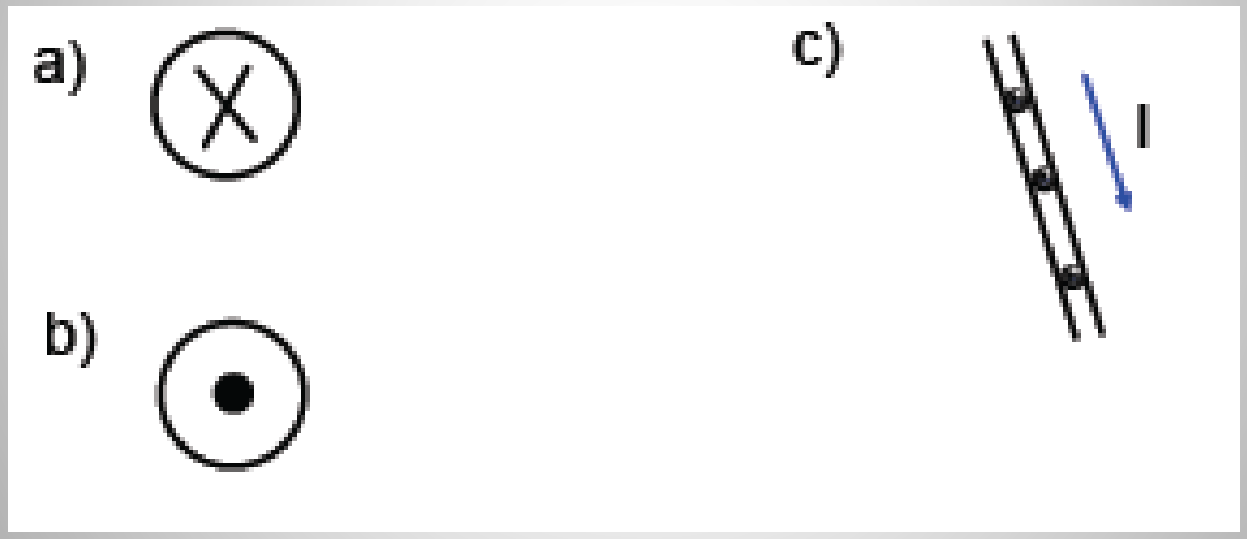
Conventions for Drawing Current Carrying Wires

This Symbol represents a current carrying wire with the direction of the current going into the page.

This symbol represents a current carrying wire with the direction of the current comming out of the page.

Examples

- **Determine the direction of the B-field around each wire.**



What about my Right Hand?

- We would use the same rule with the right hand for:

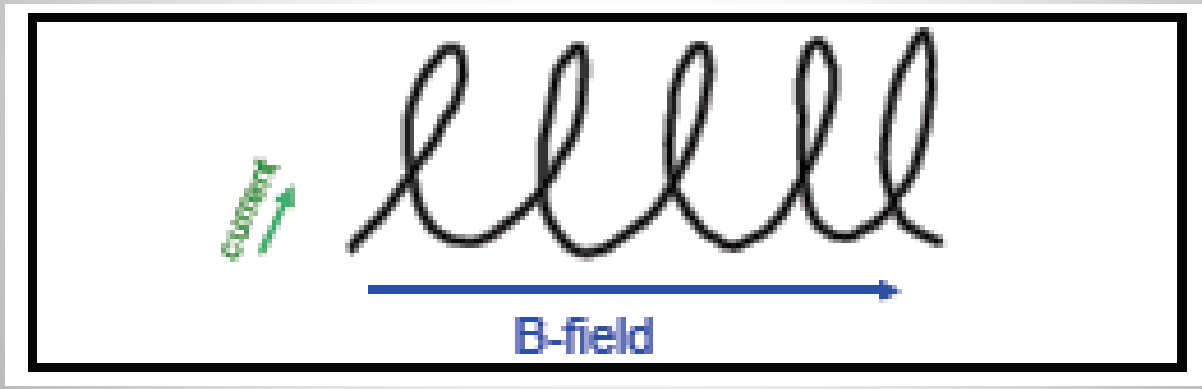
Conventional current

(proton flow)

- **NOTE: conventional current is not actually possible but is still used in some questions to evaluate understanding of principles of magnetism!**

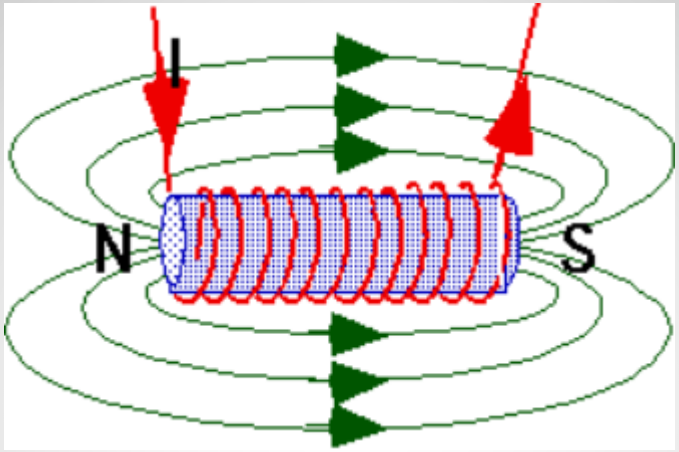
Coiled Wires

- **If a wire is coiled, a uniform field is produced inside the coil. This field is similar to that produced by a bar magnet.**



- **This effect leads to many important technologies, like...**

Solenoids (Electromagnets)



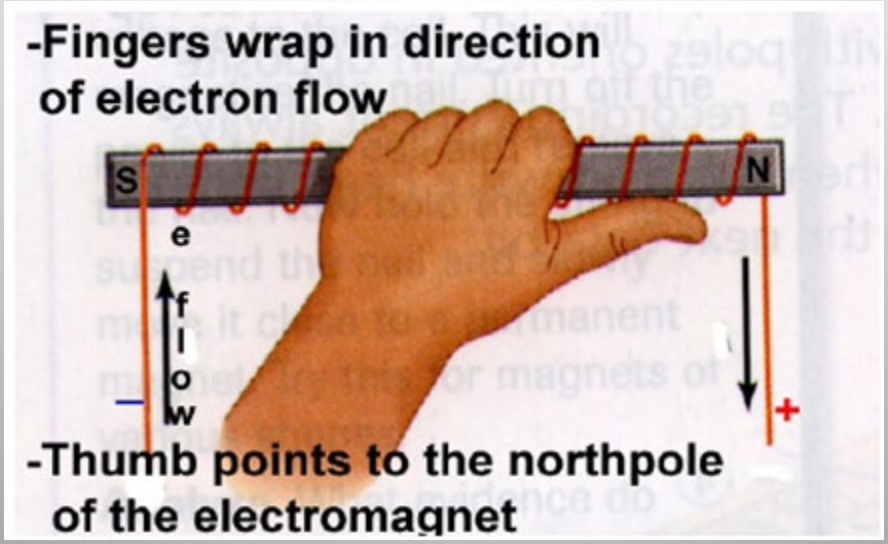
- **The wires produce a magnetic field (electromagnet).**
- **The B-field is uniform and straight inside the solenoid.**
- **Outside the solenoid, the field is comparatively weak and is the same shape as a field around a bar magnet.**

Question: How can we determine the direction of the B-field in a solenoid?

Answer: Develop another Left Hand Rule

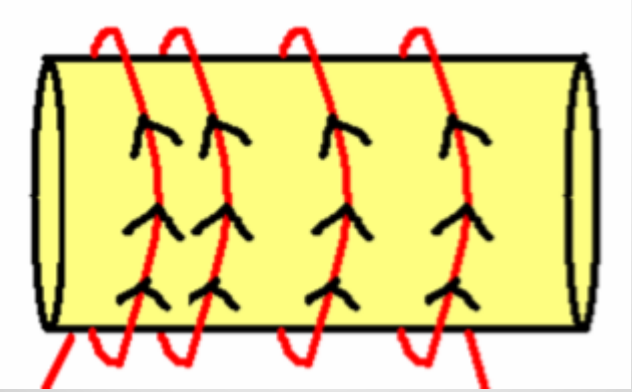
Second Left Hand Rule

- **To determine the direction of current/B-field in a solenoid, curl your fingers and point your thumb, the fingers move in the direction of current flow the thumb moves in the direction of the B-field**



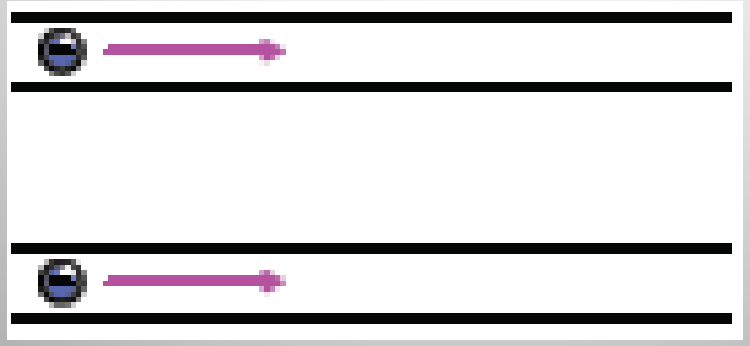
Example

- **Determine the direction of the B-field in this electromagnet. Label the N and S poles on the magnet.**

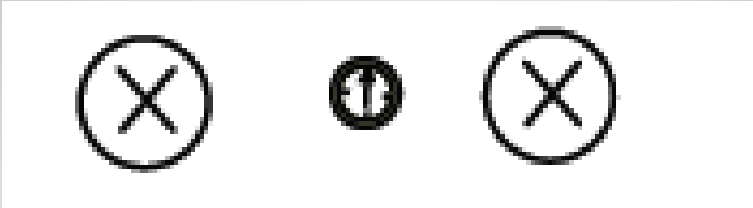


Interactions of B-Fields

- **Field Lines move out from north poles into south poles.**
- **Like poles repel…**
- **Unlike poles attract…**
- **What about current carrying wires?**



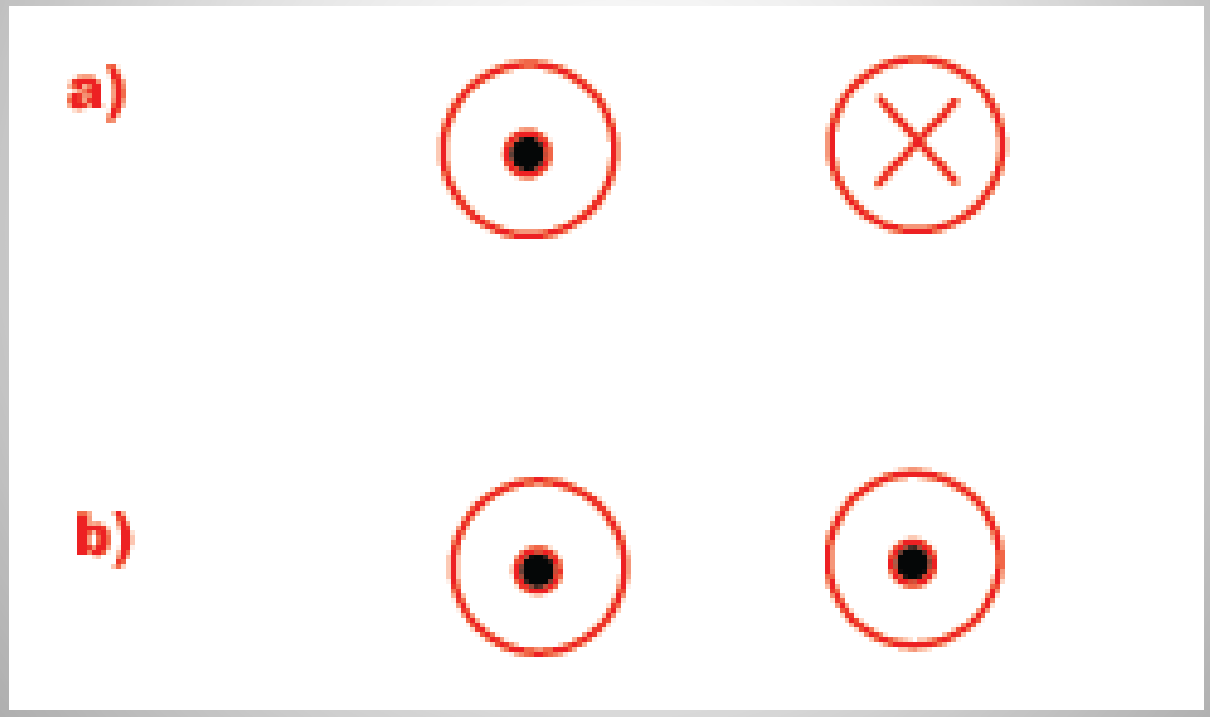
- **To determine the interaction between two current carrying wires:**



- Draw the wires and direction of magnetic field.
- Recall: direction of magnetic field is direction that a compass points.
- Place a small imaginary bar magnet along each field line.
- Check if the wires repel or attract.

Example

- **What is the interaction between the wires?**



Diploma Question Alert!

Use the following diagram to answer the next question.

Electron Flow in a Wire Loop

15. In an apparatus such as the one shown above, the direction of the magnetic field at point ***P*** due to the electron flow would be

A. into the page

B. out of the page

C. toward the left side of the page

D. toward the right side of the page