Name: _____

Period: _____

Magnetic Forces

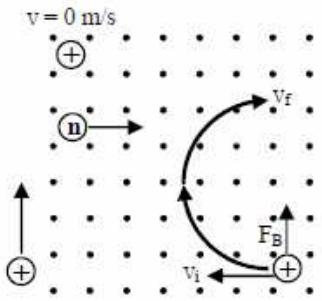
4.2

Charges are not attracted by magnets. A magnetic field will exert a force only on ***moving*** electric charges (both positives and negatives). **Stationary charges** (at rest) **feel no magnetic force.**

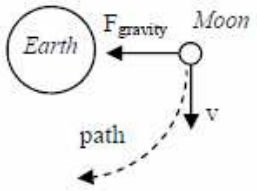
The + charge feels no force because it is not moving. $v = 0$, so $F_B = 0$

A neutron has no charge and is not affected by B. $q = 0$, so $F_B = 0$.

A charge not in the field feels no force. $B = 0$, so $F_B = 0$.



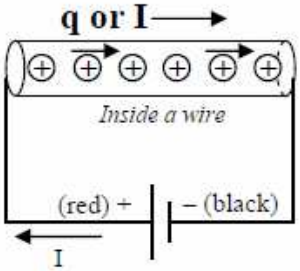
The magnetic field coming out of the page exerts a magnetic force on the moving positive charge. The magnetic force is always perpendicular to both the magnetic field (B) and the velocity of the charge (v), making it a centripetal force and causing a circular path.



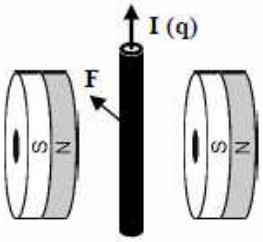
The gravitational force between our moon and the earth is centripetal because the force pulls perpendicular to the moon's velocity, toward the earth.

Charges as Current

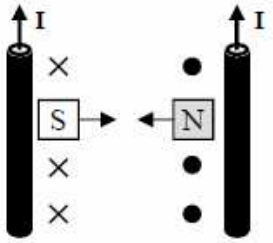
In the lab it is difficult to move and see individual charges. Instead we move many charges thru wires with a battery, which we know to be electric current.



Current (I) is the amount of charges that flow each second. The direction of I is the same as the direction of the charges (q) and is always from the + end of the battery to the −.



The wire deflects backwards.



The two wires are attracted.

Forces on Wires

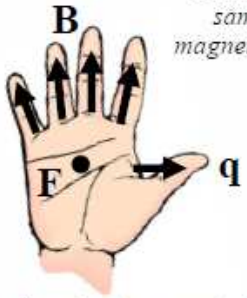
A current carrying wire placed inside a magnetic field deflects (moves) due to the magnetic forces pulling on the charges (the current). Since the charges cannot leave the wire, the wire has to move.

Two current carrying wires near each other also feel magnetic forces. **If the currents in the two wires are going in the same direction, the wires attract each other.** This is because the magnetic fields between the wires are pointing in opposite directions. **If the two currents are in opposite directions, the two wires will repel each other.**

Right Hand Rule

The right hand rule allows you to find the direction of F, q, or B, given two of them.

*Your **palm** points in the direction of the magnetic force (F_B): the direction the wire or charge is moved by the magnetic force.*

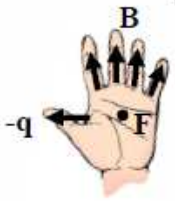


*Your **fingers** point in the same direction as the magnetic field (from N to S).*

*Your **thumb** points the direction the charge or charges (I) are already moving.*

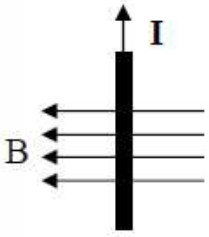
BIG HINT: Once you find the first direction (F, q, or B), keep your hand fixed in that direction. Then rotate your hand to find the second direction.

Left Hand for Negative Charges

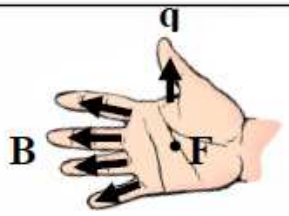


If there is a negative charge moving (or you are following the direction of the electrons in a circuit) use the left-hand rule or reverse the direction you find with your right hand.

***Example**: A uniform magnetic field is traveling to the left. Current is moving upward in a wire. Find the direction of the force on the wire.*

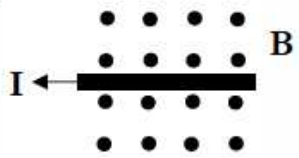


Solution: Point the fingers of your right hand toward the left. With your fingers still to the left, rotate your hand until your thumb points up (the direction the charges are moving). Your palm will be pointing towards you or out-of-the page. Therefore, the wire will move towards you.

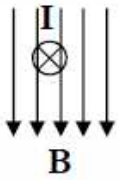


1. A. What is the direction of the magnetic field (the dots)?

   B. Find the direction of the force on the wire.



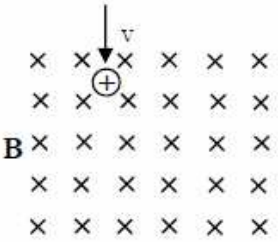
2. The "x" shows the current in the wire.
   A. The current flowing into or out of the page?
   B In what direction does the wire deflect because of the magnetic field?



3. A proton is at rest in a magnetic field. What will be the direction of the magnetic force on the proton?

4. A. If B is going into the page and the charge is moving down as it enters, draw the path of the charge due to F_B.

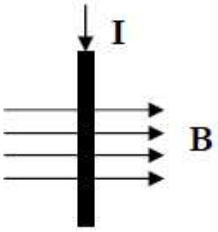
   B. How would the path change if the charge was moving faster?



5. A. Which direction are the charges moving in the wire?

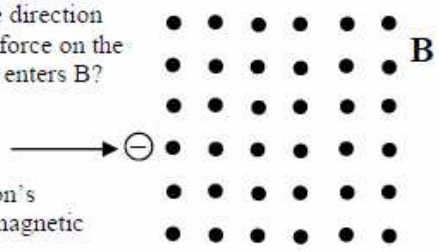
   B. Which side of the wire is connected to the + side of the battery?

   C. Find the direction of the force on the wire.

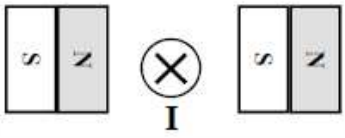


6. A. What will be the direction of the magnetic force on the electron when it enters B?

   B. Draw the electron's path inside the magnetic field.



7. Find the direction of the force on the wire.

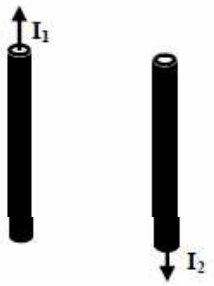


8. A magnetic field pushes a wire into the page, as shown. Which way must the magnetic field point?

9. A. Draw the magnetic fields produced by each wire.

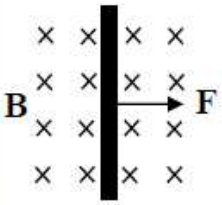
   B. Between the two wires, are their magnetic fields going the same way, or opposite ways?

   C. Do the wires attract or repel?



10. A. Find the direction that the current (the charges) is flowing in the wire.

    B. Label + and – on the wire (how it is attached to the battery).



11. A. Which direction is the current in the wires?

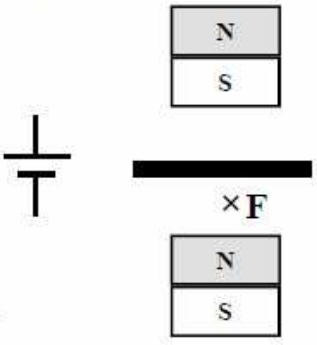
    B. Draw the magnetic fields around each wire.

    C. Will the two wire repel or attract each other?

12. A. Draw the magnetic field between the magnets.

    B. To cause the given force, which direction is the current flowing?

    C. Connect the wire correctly to the battery.



13. A. What is the direction of the force on wire segment 1?

    B. What is the direction of the force on wire segment 2?