Week 5

Physics 1409/1430 – Physics 2

Hello and Welcome to the weekly resources for PHY 1409/1430 – Physics 2!

This week is Week 5 of classes, and typically in this week of the semester, your professors are covering these topics below. If you do not see the topics your particular section of class is learning this week, please take a look at other weekly resources listed on our website for additional topics throughout the semester.

We also invite you to take a look at the group tutoring chart on our website to see if this course has a group tutoring session offered this semester.

If you have any questions about these study guides, group tutoring sessions, private 30-minute tutoring appointments, the Baylor Tutoring YouTube channel or any tutoring services we offer, please visit our website www.baylor.edu/tutoring or call our drop in center during open business hours, M-Th 9am-8pm on class days, at 254-710-4135.

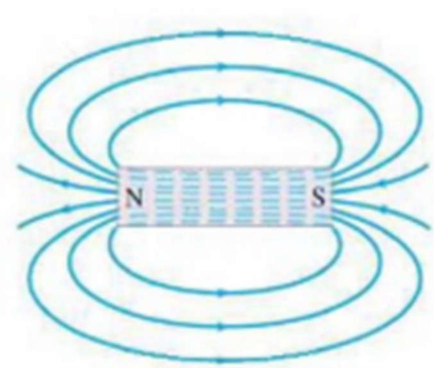
Keywords: Magnetism, Right Hand Rule, Solenoids

Important Notes

Important Conventions

Topic of The Week: Magnetism

Magnets and Magnetic Field



Magnets display amazing properties of attraction to certain metals. We have all played around with them. But they display a property that is much more than just a magic trick. Magnets interact with other objects using the magnetic field. Much like how charges have an electric filed, magnets have a field that exists between their poles, which are north and south. Much like the properties we see in charges, like poles repel one another and unlike poles attract. The magnetic field always goes from the north pole to the south pole.

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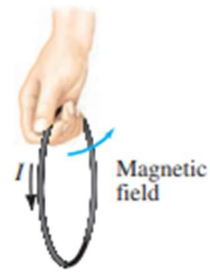
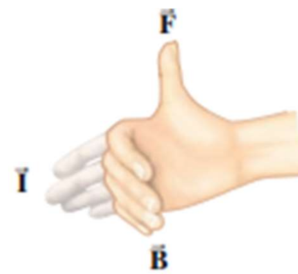
Electric Current and the Magnetic Field

When an electric current is circulating, it produces a magnetic field. The magnetic field produced wraps around the wire. The magnetic field direction can be visualized using the right-hand rule. This will help while analyzing problems. Use your thumb to point in the direction of the current flow. The direction in which your fingers wrap around is the direction of the magnetic field.



Magentic Force on Electric Current

Since the flow of electric current produces a magetic field, when the current carrying wire is present in a magnetic field, it experiences a force due to the magentic field. The magnetic field is denoted by **B**. When it comes to the magentic force experienced, a different right hand rule applies. Instead of wrapping your for fingers, you keep them straight. The four fingers should be pointed in the dirction of the current. the palm of your hand should point in the dierction of the magnetic field. The dierction the the thumb points in is the direction of the force experience. All of this is possible because they are perpendicular to one another at all times.

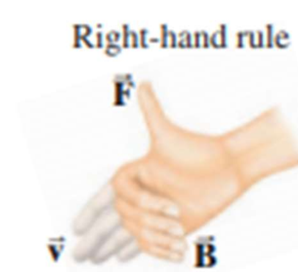


Using the following formula, we can calculate the force experienced by a wire

$$F = I\,l\,B\,\sin\theta$$

Where l stands for the length of a wire. The sinθ component is to ensure the perpendicular components are used. The SI Unit for the magnetic field is tesla (T).

Magnetic Force on Moving Charge:



Moving charges are much like current, the moving charges in an magnetic field experience a force due to the field, which is perpendicular to the magentic field and the direction of motion. This brings use to the third for of the right hande rule. This form matches the rule for the electric current. The four fingers must nor point in the direction of motion of the charge. The palm of the hand should point in the direction of the

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magnetic field and the thumb will point in the direction of the force. The direction of the force described is for the a **positive charge only.**

Using the following formula, we can calculate the force acting on the moving charge.

$$F = q\ v\ B\ \sin\theta$$

Where v stands for the velocity of the moving charge.

Example

Determine the magnitude and direction of the force on an electron travelong 7.75×10^5 m/s horizontally to the east in a vertically upward magnetic field of strength 0.45T.

Solution

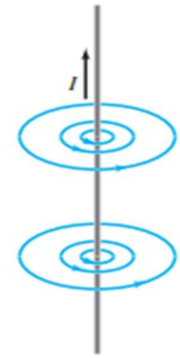
Force = $q\ v\ B\ \sin\theta$

Before we move forward, we must think conceptually. Here is a chance to practice the right hand rule. Think about the staements of the question. Imagine this page has north, east, west and south on its cardinals. We are told that electron travels east and the magnetic field points upward (north). So position your right hand accordingly. Your four fingers should be pointg east and palm facing up. You will notice that the thumb points out of the page. But remember, the rule only applies to positive charges, here we have an electron, so the force mus point in the OPPOSITE direction, so into the page. we have the direction. You will notice the angle is 90° betweem the force and the magnetic field. So

$F = (1.6 \times 10^{-19})\ (7.75 \times 10^5)\ (0.45)$

$F = 5.58 \times 10^{-14}$ N

Magnetic Field in a Wire:



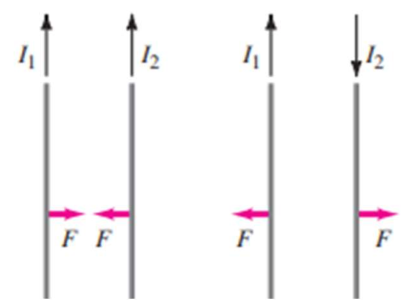
As stated earlier, the flow current in a wire produces a magnetic field in the wire. The magnetic field produced in by the current in the wire can be calculated using the following formula

$$B = \frac{\mu_0}{2\pi}\frac{I}{r}$$

Where r stands for the distance from the wire and μ_0 stands for the permiability of free space, a constant. Due to the magnetic field produced by the current, two wires can exert force on one another due to the presence of the magnetic fields.

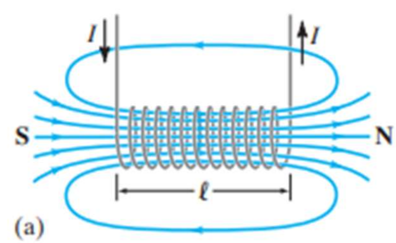
The force exerted by the wires on one another can be calculated using the following formula

$$F_2 = \frac{\mu_0}{2\pi}\frac{I_1 I_2}{d}\ell_2$$



The d stands for the distance between the wires and the l is the length of the other wire. The direction of the flow of the current determines whether the wires attract each other or repel each other. When the current travels in the same direction, the wires attract one another. When the current flows in opposite dierctions, the wires repel one another.

Solenoids



Solenoids are a long coil of wire with multiple loops bunched together. We observed earlier how the magnetic field form in a current carrying wire. The the wire is coiled togther into a solenoid, it forms a magnetic fields that acts very much like that in a regular magnet. The magnetic field in a solenoid can be calculated using the following equation.

$$B = \frac{\mu_0 N I}{\ell}$$

CHECK YOUR LEARNING

1. **1.** Alpha particles (charges q = + 2e, mass m = 6.6×10^{-27} kg) move at 2.7×10^{5} m/s. What magnetic field strength would be required to bend them into a circular path of radius 0.20 m? What would change if it was a identical particle with an opposite charge?
2. **2.** An electron is moving east in a magnetic field point north. In which direction will the charge accelerate in this case?
   a. East
   b. West
   c. North
   d. South
   e. Into the page
   f. Out of the page
3. **3.** Determine the magnitude and direction of the force between two parallel 15 m long and 2 cm apart, each carrying 10 A in opposite directions.
4. **4.** A 2g bullet moves with a speed of 200 m/s perpendicular to the Earth's magnetic field of 5×10^{-5} T. If the bullet possesses a net charge of 3×10^{-9} C, by what distance will it be deflected from its path due to the Earth's magnetic field after its traveled 1 km?
5. **5.** A long horizontal wire carries 20 A of current due north. What is the net magnetic field 10 cm due west of the wire if the Earth's field points upward, 30° below the horizontal and has a magnitude of 5×10^{-5} T?

THINGS YOU MAY STRUGGLE WITH

1. **1.** Determining the direction of the magnetic field or the direction of current or the direction of the force if you are given any two of those. What is essential to get a good grasp of during this section is the right-hand rule and the various conformations of it. This section relies heavily on the conceptual understanding of the magnetic field and its relationship to charges and force.
2. **2.** Understanding the behavior of force with the involvement of magnetic field. More than the math end of such a question, what will matter more is the direction in which the force will act based on the direction of current.
3. **3.** It is important to get comfortable with the magnetic field and its relationships because they hold great importance in the future sections when we attempt to combine electricity and magnetism. Do your best to practice seeing the effect of the magnetic field and the right-hand rule. I highly recommend using the general problems from the back of the chapter. These problems require using many of the concepts you are introduced to during the chapter together and are a great tool to test your understanding.

Thanks for checking out these weekly resources! Don't forget to check out our website for group tutoring times, video tutorials and lots of other resource: www.baylor.edu/tutoring ! Answers to check you learning questions are below!

Answers: 1) 0.028 T, will move in opposite direction around circular path 2) e 3) 0.015 N, repulsive, 4) 1.9×10^{-7} m, 5) $6.1 \times x10^{-5}$ T

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