Physics 202: Electromagnetism and Optics

1. **What is the equation for the electric field?**

2. **What is the equation for the electric force?**

3. **What is the equation for the magnetic field of a wire?**

4. **What is the equation for the magnetic force of a wire?**

5. **Two electrons are 3.4 micrometers apart from each other.**
   a. **Find the magnitude of the electric field produced between the electrons.**

   b. **Find the force between the electrons.**

6. **Wire A is to the left of Wire B, 7 cm apart. Both wires have a current of 5 A going into the page and have length of 10 cm. What is the force of Wire B onto Wire A?**

6. **Bonus:**

    a. **Using the right-hand rule, what is the direction in which the force acts on Wire A?**

    b. **Using the right-hand rule, what is the direction in which the force acts on Wire B?**

    c. **Do these wires repel or attract?**

Solutions

1. **What is the equation for the electric field?**

$$E=k(q1)/r^2$$

2. **What is the equation for the electric force?**

$$F= (q2)E=k(q1)(q2)/r^2$$

3. **What is the equation for the magnetic field of a wire?**

$$B(wire) =(\mu 0)I/2\pi r$$

4. **What is the equation for the magnetic force of a wire?**

$$F(wire)=ILB$$

5. **Two electrons are 3.4 micrometers apart from each other.**

   a. **Find the magnitude of the electric field produced between the electrons.**

   First you need to find the right equation. The equation to use is E=k(q1)/r^2. We know that k is the electrostatic constant which is (8.99x10^9), also the charge of an electron is (1.6x10^-19 C). Plug in what is given. E=(8.99x10^9)(1.6x10^-19)/(3.4X10^-6)^2 and you get E=124.429 N/C.

   b. **Find the force between the electrons.**

   For this one you can use either k(q1)(q2)/r^2 or (q2)E, whichever one you want it doesn't matter, they both work. I will use the second one since I already found the E. So for F=(1.6x10^-19)(124.429)=1.99x10-17 N. That is your force between the electrons.

6. **Wire A is to the left of Wire B, 7 cm apart. Both wires have a current of 5 A going into the page and have length of 10 cm. What is the force of Wire B onto Wire A?**

If we want to find the force of B onto A we need to first find the magnetic field of A that is acting on B. For this we use the equation, B(wire) =(μ0)I/2**π**r. We know that (μ0) is a constant which is (.4(**π**)x10^-6). We plug in what we know and we get B(wire) =(.4(**π**)x10^-6)(5)/2**π**(7X10-2)=14.2 μT. Now that we have the B we just use the equation F(wire)=ILB. We plug in what we know and get F of Wire B on to Wire A is =(5A)(10x10^-2 m)(14.2 μT)= 7.14 μN.

6. **Bonus:**

   a. **Using the right-hand rule, what is the direction in which the force acts on Wire A?**

   First, we need to figure out what we know. We know the current is going into the page. So, our index finger points into the page. Second using the right-hand rule #1, we know that the magnetic field of a wire that is to the right of another points upward. So, our middle finger will point upward. Making sure that they are perpendicular to each other we see that the thumb is pointing to the right. Therefore, according to the right-hand rule #3 we know that the force acts pushing the wire to the right.

   b. **Using the right-hand rule, what is the direction in which the force acts on Wire B?**

   We need to do the same thing as above but make some minor changes. We know the current is the same. The magnetic field on the other hand is a bit different because of the fact that the wire providing the magnetic field is on the opposite side. The magnetic field is pointing down; therefore, our middle finger is pointing down. Using RHR #3 we find the force pointing towards the left. Therefore, according to the right-hand rule #3 we know that the force acts pushing the wire to the left.

c. **Do these wires repel or attract?**

The left wire or wire A is pointing to the right and the right wire or wire B is pointing to the left. Therefore, they are attracted to each other.