Physics 2145 Homework #11: Magnetic forces and torques

1. In the magnetotron of a microwave oven, the microwaves are produced by having electrons orbit in a magnetic field. (When the electrons do this, they emit electromagnetic waves which we will study in a few weeks). Calculate the strength of the magnetic field that causes electrons to orbit with a frequency of 2.4 GHz.

2. Two parallel straight wires of length 40cm are 0.5cm apart. The upper wire carries a current of 5.0A to the left. The lower wire carries a current of 3.0 A to the left, as shown in the figure.
   a) Calculate the magnitude of the magnetic field of the upper wire at the location of the lower wire.
   b) What is the direction of the magnetic field of the upper wire at the location of the lower wire?
   c) Calculate the magnitude of the force the upper wire exerts on the lower wire.
   d) What is the direction of the force the upper wire exerts on the lower wire?
   e) Repeat parts a-d for the field and force the lower wire exerts on the upper wire.

3. A horizontal wire of mass 1.0g is carrying a current of 2.0 A to the right. It is under the influence of a constant magnetic field so that the wire is levitating (i.e. the magnetic field prevents the wire from falling down.)
   a) What must be the direction of the magnetic force?
   b) What is the direction of the external magnetic field?
   c) Calculate the magnetic field strength.

4. A circular current loop of radius 2cm carries a current of 0.5A. It is in a magnetic field of magnitude 0.5T. The loop axis makes a 30° angle with the magnetic field. Calculate the torque on the loop.

5. A current loop has an area of 0.85cm² and carries a 240mA current in a uniform magnetic field of strength 0.62 T. What is the maximum torque on the current loop?