**Station 1**

F =qvBsinθ

F =BILsinθ

1. Explain each of the above variables, including what the angle is measured with respect to.
   1. [Force] = [charge][velocity of charge][Magnetic field strength] sin[angle between velocity and Bfield]
   2. [Force] = Magnetic field strength][current][length of wire] sin[angle between current direction and Bfield]
2. A completely ionized gold atom (79 protons) flies perpendicularly through a magnetic field with strength of 1.2 T at a speed of 500 m/s. What is the magnitude of the force on the atom?
   1. 7.58 x 10-15
3. A wire runs at 300 North of West with a current of 2.5 A. Michael, an electrical engineer, wants to place the wire in a magnetic field pointing due North with a strength of 3.4T. He knows that the wire can only support a force of 2 N before breaking. What is the maximum length of wire that Michael can use?
   1. 0.27m

**Station 2**

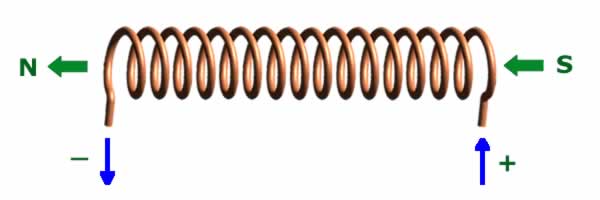
qvB=mv2/r

τ=NIABsinϕ

1. Explain each of the above variables, including what the angle is measured with respect to.
   1. [charge][velocity][Magnetic field strength] = [mass][velocity]2/[radius of motion]
   2. [torque] = [Number of loops][current][area][Bfield strength]sin[angle between the normal of the area and the B field]
2. How fast would an ionized helium atom (2 protons, 2 neutrons) need to be moving in order to orbit the Earth at the equator where the magnetic field has a strength of 50 microtesla. [rEarth = 6370 km, mn≈mp=1.67 x 10-27kg)
   1. 1.53 x 1010 m/s (Faster than the speed of light)
3. The maximum torque experience by a coil in a 0.75 T magnetic field is 8.4 x 10-4 N·m. The coil is circular and consists of only one turn. The current in the coil is 3.7A. How long of a piece of wire is required?
   1. 0.062 m

**Station 3**

1. A proton is moving due South in a magnetic field that points down. What is the direction of the force on the proton.
   1. East
2. An electron is moving due West and experiences a magnetic force that points upwards. What is the direction of the magnetic field?
   1. North
3. An ionized carbon atom (6 protons) is travelling due South in Earth magnetic field, which runs parallel to the ground. What is the direction of the magnetic field? What is the force on the carbon atom?
   1. B-field points North
   2. Zero
4. An electric current flows through a wire at 300 North of West and experiences a downward force. What is the direction of the magnetic field (with angle)?
   1. 30o East of North, 60o North of East
5. A solenoid is pictured below. Which end of the solenoid acts as the North Pole.



* 1. Left side

1. A wire is shown below with current flowing to the right. A charge is moving downward on the page, as shown below. What is the direction of force that this wire exerts on a the charged particle?
2. To the right.

**Station 4**

Φ=BAcosϕ

Emf = -N ΔΦ/Δt

1. Explain each of the above variables, including what the angle is measured with respect to.
   1. [Magnetic flux] = [Bfield][area] cos[angle between the normal of the area and the magnetic field]
   2. [emf voltage] = -[number of turns or loops] [change in flux]/[change in time]
2. A magnetic field is perpendicular to a 0.040m x 0.060m rectangular coil of wire that has 100 turns. In a time of 0.050 s, an average emf with a magnitude of 1.5V is induced in the coil. What is the magnitude of the change in the magnetic field?
   1. 0.313T
3. A 25 turn circular coil of radius 0.50m rotates in a magnetic field of 2.2T. The face of the loop rotates from parallel to perpendicular with respect to the magnetic field in a time of 1.5s. What is the induced emf?
   1. 28V
4. A square loop with side length of 1 meter is deformed into the shape of a rectangle (Note: the total amount of wire must remain constant). This occurs in magnetic field of strength 7.8 T and produces an average emf of 2.6V over a time of 0.75 s. What are the dimensions of the final rectangle?
   1. 1.5m, 0.5m

**Station 5**

Emf=NABωSin(ωt)

ω=2πf

1. Explain each of the above variables.
   1. [emf voltage]=[# loops][area][B field][rotational velocity] sin [rot. Vel.][time]
   2. [rotational velocity] =2π [frequency in hertz]
2. When would be an appropriate time to use the first equation?
   1. When calculating the emf output of a generator
3. A home’s generator runs at 200 rpm (revolutions per minute). The motor contains a coil with 250 turns and an area of 0.75 m2. If I need an Emf of 5.0V, how strong of a magnetic field do I require?
   1. 0.0016 T
4. A generator has a square coil consisting of 248 turns. The coild rotates at 79.1 rad/s in a 0.170 T Magnetic field. The peak output of the generator is 75.0V. What is the length of one side of the coil?
   1. 0.15 m

**Station 6**

I=(V-Emf)/R

1. Explain each of the above variables.
   1. [output current] = ([input voltage]-[Back emf])/[resistance of load]
2. When is the back emf at a maximum?
   1. When the motor is running at top speed.
3. What would the net current be when a motor is running at half of its maximum speed if the load has a resistance of 1.5kΩ?
   1. 3.3 x 10-4 A

**Station 7**

Emfs = -M ΔIp/Δt

Vs/Vp = Ns/Np

1. When would be appropriate times to use the above equations
   1. Given the mutual inductance of a two coil system
   2. Situations involving transformers
2. A particular coil system produces 120V, which is produced by an AC current which peaks at +5A and troughs at -5A over a time of 0.025s. What is the mutual inductance of this system?
   1. 0.30 Henries (H)
3. In a simple city the powerplant produces 1500 V, which is transferred to a home via a transformer that has 52 loops in the secondary coil. If this house runs on 240 V, how many turns were in the primary coil?
   1. 325

**Station 8**

1. At this station you will find a copper pipe and a small magnet. Drop the magnet down the pipe and note what happens.
   1. Falls very slowly, at a constant speed
2. Using your understanding of the interaction between electricity and magnetism, explain why this phenomenon occurs.
   1. As the magnet falls it produces a current in the copper pipe.
   2. This current produces a magnetic field that flows in the opposite direction as the magnets’ (as described by lens’ law).
   3. The opposing magnetic field creates a force on the magnet directed up the pipe.
   4. As the magnet gains speed by the influence of gravity, the greater speed produces a greater magnetic field
   5. At some point the force of gravity is countered perfectly by the force from the induced magnetic field. Thus it falls at a constant speed.