Electromagnetism and Light Course
HW07 – Building and understanding a homopolar motor

1) Watch lecture 7a, which is also available as a .pdf called lecture7.pdf.

Build a homopolar motor using the supplies in your kit.

Upload a video of your motor spinning. If you have trouble with videos, you may upload photos of your completed motor.

2) You would like to be comfortable explaining how this motor works to your class, so please do that here by answering parts a, b, c, and d.

a) Draw a sketch of your actual wire loop and indicate approximate dimensions in centimeters.

b) Indicate for the orientation of your battery what the direction of current flow is. Show a couple of magnetic field lines where they intersect the wire and show the direction of magnetic field at these lines (assume your battery was North Pole upward). Show on your sketch the result of the cross product and explain why the motor turns, and in which direction. If you are able, sketch the current, the field and the force using different colors of ink.

c) Draw a second sketch. It is same as the first except that you turn your magnet upside down (South pole up). Show the current, B-field and force and which direction the motor spins now.

d) Let us estimate the amount of force and torque that your motor generates. Please note – this is very rough. You will be ESTIMATING. You are only trying to get an answer within a factor of 10 so pleas do not stress about how complicated it is to do these calculations precisely. Estimating is an important skill. The magnets in your kit are Neodymium/Iron/Boron (NIB). If you check this table: https://en.wikipedia.org/wiki/Rare-earth_magnet you will see that the magnetic field at the surface of the magnet is roughly one Tesla. (20,000 X the Earth's field!). If you look at page 24 of Lecture 3 you will see that magnetic field falls off as roughly the cube of distance. Given the characteristic dimension of the magnet as about one centimeter, we will assume the field is one Tesla there.

I) Using an inverse cube law, how far should you be for the field to be only 0.1 Tesla?
II) How far will you need to be for the field to be about 0.01 Tesla? (The answer is roughly 4 cm – calculate this distance to two decimal places)
III) Estimate what length of wire is subject to the 0.1 Tesla field and calculate the force exerted on that wire. You will need to know the current put out by your AA battery. It is about 5 Amperes.
IV) Estimate what length of wire is subject to the 0.01 Tesla field and calculate that contribution to the force.
V) To calculate the torque, multiply the force you got by the wire's distance *from the rotation axis of the motor* (that is, a vertical line through the center of the battery). What is your torque estimate?