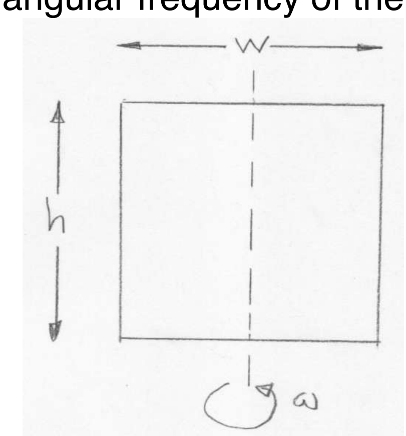
Physics 322, Winter Quarter 2016
Electrodynamics: Homework Assignment 4
(a) Turn in all problems and clearly note all constants and assumptions you use.
(1-point penalty each otherwise)
(b) Use 8½ x 11 paper & staple
(1-point penalty each otherwise)
(c) Due February 4 either 9:00 am in class or 8:45 am in the instructor's mailbox.
Late homework gets 0.

1. A conducting sphere of radius R is somehow kept at a fixed electrostatic potential V_0 by a battery and is immersed in a medium having conductivity σ. Assume the medium has vacuum permittivity and permeability μ_0 and ε_0.
a. Find the total charge on the sphere.
b. Find the total current flowing from the sphere.
c. Suppose the battery is disconnected; how long does it take for the sphere to lose half its charge?

2. A rectangular loop rotates as shown with angular frequency ω. A uniform magnetic field **B** points into the page.
a. Find the *emf* around the loop.
b. Find the angular frequency of the *emf*.



3. Consider the sliding-bar and resistor apparatus in Griffiths figure 7.17. Suppose a constant force of magnitude F pushes the bar through the region of perpendicular magnetic field of magnitude B.
a. Starting from zero velocity, what's the velocity of the bar as a function of time? (For experts: ignore self-inductance.)
b. What's the current as a function of time?

4. (Challenge problem: It won't be graded, but see how far you get.) Within superconductors, Ohm's Law becomes London's Equations:

$$\nabla \times (\lambda \mathbf{J}) = -\mathbf{B}$$

$$\frac{\partial}{\partial t}(\lambda \mathbf{J}) = \mathbf{E}$$

where λ is a constant. Assume the superconducting material has vacuum permittivity and permeability μ_0 and ε_0.
a. Suppose you have superconducting material formed into an infinite slab of thickness d. Everywhere outside the slab on one side is a constant magnetic field parallel to the surface of magnitude B_1. Everywhere outside the slab on the other side is a constant magnetic field parallel to the surface of magnitude B_2. $\mathbf{B}_1$ and $\mathbf{B}_2$ are in the same direction. $\mathbf{E} = 0$ everywhere. You can assume there are no surface currents or surface charges.
a. Find the magnetic field within the slab.
b. Find the current density $\mathbf{J}$ within the slab.
c. Find the pressure on surface of the slab. Hint: you can use Griffiths equation 5.27.

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