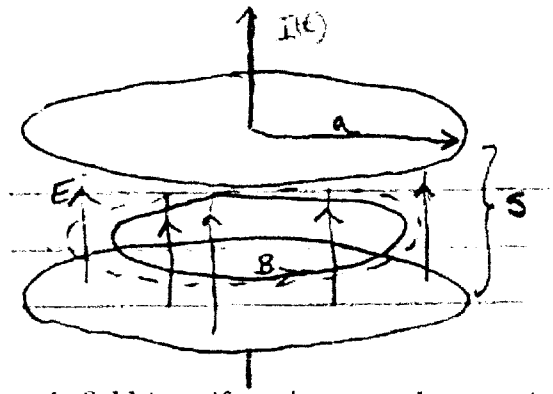
Assignment 12
PHGN361

Homework due April 29

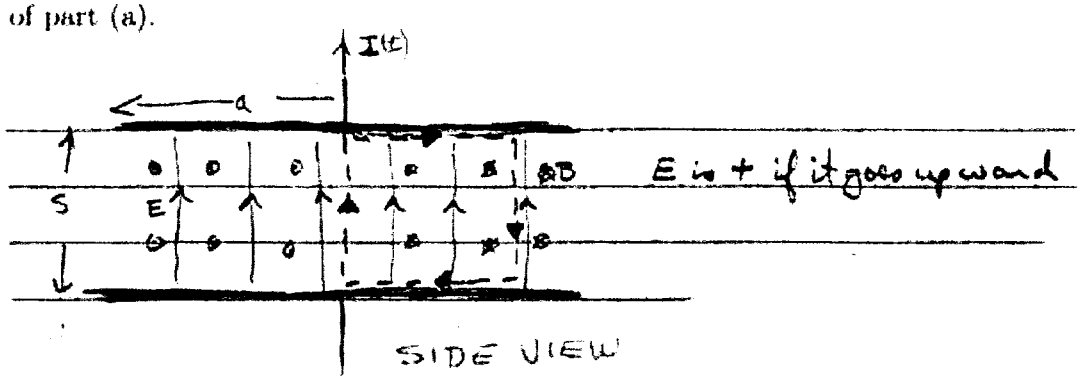
1. Read section 7.3.1 and 7.3.2, 7.3.3.
2. Chapter 7 problems 33, 37, 40, 48, 51, 53, 54

3. Consider a harmonic voltage source attached to a vacuum capacitor (as shown in the figure), which leads to a current given by $I = I_0 exp[i\omega t]$. This problem is designed to demonstrate the complicated effects of Maxwell's contribution to Ampere's law. We will show that this effect is small for audio frequencies in a typical capacitor. Most textbooks do not broach the subject, for fear of confusing students.



(a) Assume as a first approximation that the electric field is uniform between the capacitor plates. Call this field $\mathbf{E}_1 = \mathbf{E}_0 exp[i\omega t]$ (note no spatial dependance). Find an expression for the magnetic field using the new version of Ampere's law. This will be our first approximation for the magnetic field so label it $\mathbf{B}_1$.

(b) Now a changing magnetic field causes an electric field. Use Faraday's law along the path shown to determine the first correction to the assumption that the electric field is uniform. That is, find $\mathbf{E}_2$. From symmetry we assume that the net electric field at $r = 0$ is just the uniform field of part (a).



(c) Now the magnetic field we calculated isn't right because it was derived using only $\mathbf{E}_1$. Go back to the initial figure and calculate $\mathbf{B}_2$ just caused by $\mathbf{E}_2$

(d) This $\mathbf{B}_2$ causes an $\mathbf{E}_3$ using the argument in part (b). Calculate $\mathbf{E}_3$.

(e) Compile your results as the expansion $\mathbf{E} = \mathbf{E}_1 + \mathbf{E}_2 + \mathbf{E}_3 + \ldots$ and $\mathbf{B} = \mathbf{B}_1 + \mathbf{B}_2 + \ldots$.
At what frequencies do these terms play an important role?