Dr. Sasha

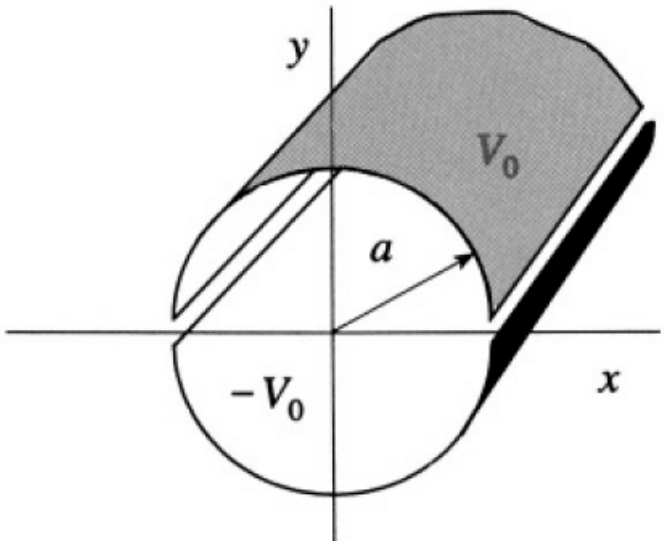
Please, solve this problem and also show the steps to solve it.

9.06.2015 – N17

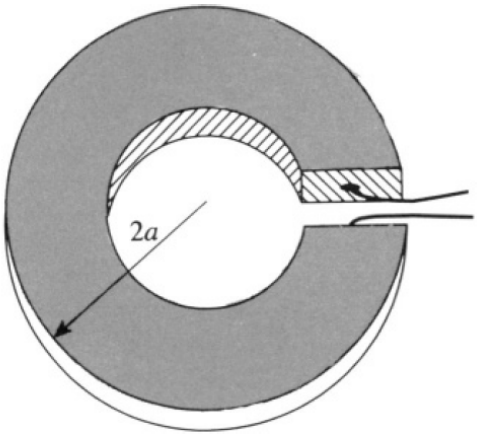
0) Check this equality.

$$\pi = \sum_{k=0}^{\infty} \frac{1}{16^k} \cdot \left(\frac{4}{8k+1} - \frac{2}{8k+4} - \frac{1}{8k+5} - \frac{1}{8k+6} \right)$$

1) Consider an infinitely long conducting cylinder of radius a with its axis coinciding with the $z-$ axis. One half of the cylinder (cut the long way) ($y > 0$) is kept at a constant potential V_0, while the other half ($y < 0$) is kept at a constant potential $-V_0$ (see figure below). Find the potential for all points inside the cylinder and the field $\vec{E}$.



2) A washer is made of a material with a resistivity of ρ. It has a square cross section of length a on a side, and its outer radius is $2a$. A small slit is made on one side and wires of negligible resistance are connected to the faces exposed by the slit (see figure below). If the wires were connected into a circuit, what would be the lumped resistance due to the washer?



3) Radio astronomers detect electromagnetic radiation at 45 MHz from an interstellar gas cloud. They suspect this radiation is emitted by electrons spiraling in a magnetic field. What is the magnetic field strength inside the gas cloud? Determine the direction of the magnetic field.

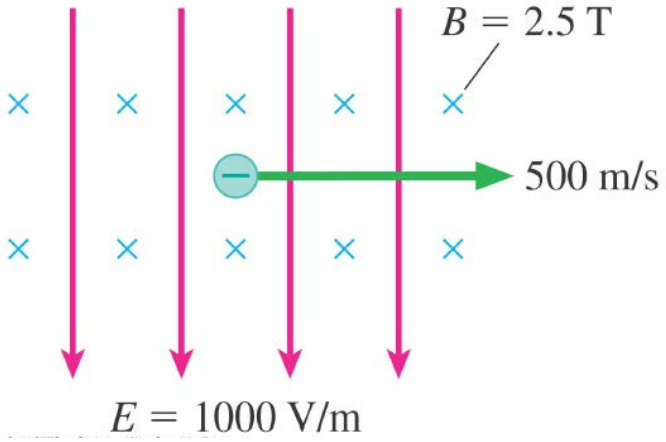
Hint: The frequency of the emitted radiation is equal to the cyclotron frequency (i.e., the frequency of the revolutions).

4) The element niobium, which is a metal, is a superconductor at temperatures below 9 K. However, the superconductivity is destroyed if the magnetic field at the surface of the metal reaches or exceeds 0.10 T. What is the maximum current in a straight, 3 mm-diameter superconducting niobium wire?

5) An antiproton (same properties as a proton except that $q = -e$) is moving in the combined electric and magnetic fields (see figure below).

a) What are the magnitude and direction of the antiproton's acceleration at this instant?

b) What would be the magnitude and direction of the acceleration if $\vec{v}$ were reversed?



Hint: A circle with a dot at its centre ⊙ indicates a vector pointing out of the front of the diagram, toward the viewer. A circle with a cross inscribed in it ⊗ indicates a vector pointing into and behind the diagram.

6) A flat, circular disk of radius R is uniformly charged with total charge Q. The disk spins at angular velocity ω about an axis through its center. What is the magnetic field strength at the center of the disk?