

Workbook



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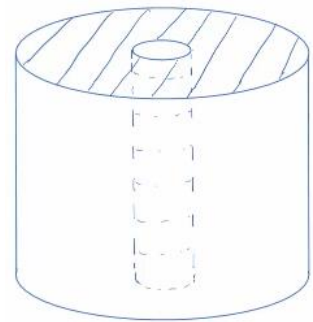
Resistors, Current and Current Density2
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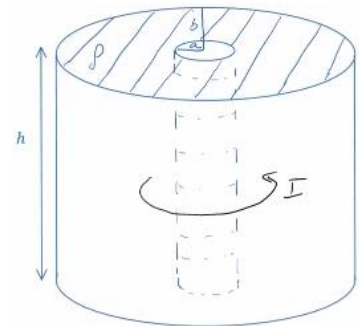
Resistors, Current and Current Density

Questions

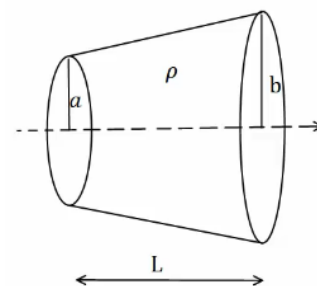
- 1) A cylindrical shell of height h , inner radius a and outer radius b is given. Between $0 < r < a$ the space is empty, and between $a < r < b$ the cylinder is filled by a material of given resistivity, ρ . A voltage source, V_0 , is connected to the cylindrical shell as shown.
- Calculate the total resistance.
 - Calculate the current density.
 - Calculate the electric field inside of the conductor.



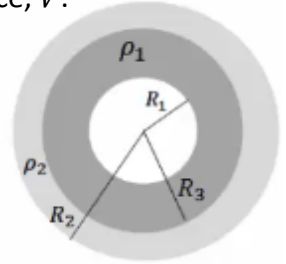
- 2) A cylindrical shell of height h , inner radius a and outer radius b is given. Between $0 < r < a$ the space is empty, and between $a < r < b$ the cylinder is filled by a material of given resistivity, ρ . The current flows in the θ direction.
- Calculate the total resistance.
 - Calculate the current density.
 - Calculate the electric field inside of the conductor.



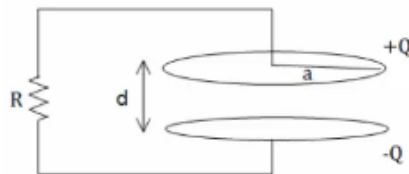
- 3) A conical frustum of length L , small base radius a , and large base radius b is given. Its resistivity is ρ . Calculate the resistance between the two bases.



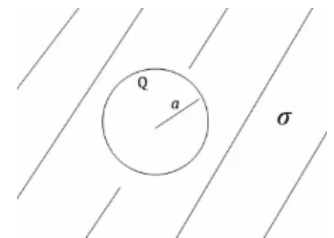
- 4) A spherical shell shaped resistor, of inner radius R_1 and outer radius R_2 , is made of a material with resistivity ρ_1 in the region $R_1 < r < R_2$ (see diagram), and resistivity ρ_2 in the region $R_2 < r < R_3$.
- The current is in the radial direction. Calculate the total resistance of the shell.
 - Calculate the current density in the resistor if it is connected to a voltage source, V .
 - What is the electric field in the resistor?
 - Calculate the surface and volumetric charge distribution of the shell.



- 5) A parallel plate capacitor, of charge Q , is connected to a resistor, of resistance R . The radius of the capacitor plate is a and the distance between the plates is d , such that $d \ll a$.
- Calculate the current in the circuit.
 - Calculate the current density on the capacitor plate.
 - The resistor is removed. A material of resistivity ρ fills the gap between the capacitor plates. Given this information, answer questions 1 and 2.

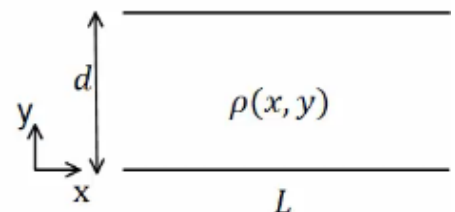


- 6) A conducting spherical shell of radius a is placed inside a material of conductivity σ . The charge on the shell is $q(t = 0) = Q$.
- Calculate the charge on the shell as a function of time.
 - Calculate the current density and the electric field inside the resistor.



- 7) Two parallel plates of dimension $L \times L$ are placed a distance d from one another, such that $L \gg d$. Between the two plates a conducting material of resistivity $\rho(x, y)$ is inserted. Calculate the resistance along the y -axis when:

- $\rho = \rho_0 \sin\left(\frac{\pi y}{d}\right)$
- $\rho = \rho_0 \frac{\sin\left(\frac{\pi y}{d}\right)}{\sin\left(\frac{\pi x}{L}\right)}$



*for the solutions go see the videos