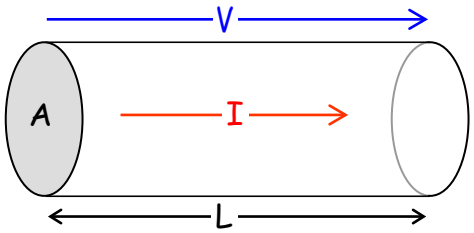
HOMEWORK SET 16: MAXWELL SPEED DISTRIBUTIONS
Due Monday, March 24, 2025

Problem adapted from TZDII[1]

13.40) Consider a cylindrical resistor of length L, cross sectional area A, resistivity ρ, and resistance R. The resistor has a voltage difference V between its ends and carries a current I. Show that Ohm's law V = IR is equivalent to E = jρ, with resistance R related to the resistivity ρ by R = ρL/A.



Helpful Electricity and Magnetism Reminders

Force between point charges at distance r: $\vec{F} = \frac{kQq}{r^2}\hat{r} = \frac{Qq}{4\pi\epsilon_0 r^2}\hat{r}$

Force on a charge in a uniform Field E: $\vec{F} = q\vec{E}$

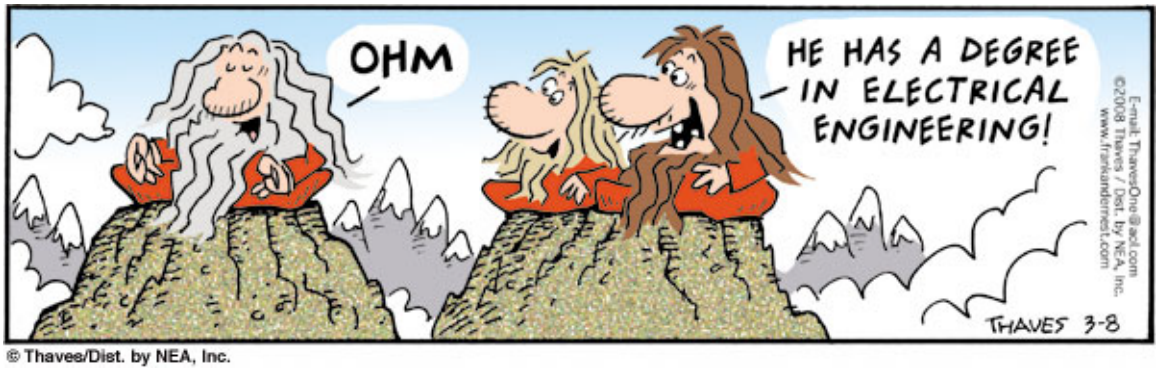
Electric Field = Force per charge: $\vec{E} = \frac{\vec{F}}{q}$

Electric Potential = Potential Energy per charge across L: $V = \frac{U}{q} = \frac{\vec{F}\cdot\vec{L}}{q} = \frac{q\vec{E}\cdot\vec{L}}{q} = EL$

Lorentz Force: $\vec{F} = q\vec{v}\times\vec{B}$

Biot-Savart Law (B due to a current segment): $\vec{F} = \frac{\mu_0}{4\pi r^2} I d\vec{\ell}\times\hat{r}$

Faraday's Law (induced emf): $\mathcal{E} = -N\frac{d\Phi_B}{dt}$



[1] Taylor, Zafiratos, & Dubson, *Modern Physics for Scientists and Engineers*, 2nd Editon, Pearson, Prentice Hall, 2004