

Obviously we can consider the object in question as the superposition of an insulating sphere centered at the origin and a torus of rectangular cross-section oriented in the  $\hat{z}$  direction. Considering Oersted's law,

$$\frac{e\alpha}{\gamma\mathcal{E}Q^3} = \int_C \frac{2\pi\phi\alpha}{ek\rho^2} \times d\vec{l}.$$

By Faraday's law with the right-hand rule,

$$e\varepsilon_x r_a (\vec{F} \cdot \vec{n}) = 2\pi a_0^2.$$

Calculating using the Clausius-Mossotti relation as dictated by charge conservation,

$$\int_S \frac{2\pi\alpha}{e\rho^2} \times d\vec{r} = \frac{k'^3}{eN'^2 a' (\vec{E} \cdot \nabla)}.$$

Applying Thévenin's theorem,

$$\int_{z_1}^{z_2} c\alpha N (\vec{J} \times \vec{\beta}) \times d\vec{s} = \frac{\sqrt{2}N}{cI'r'}.$$

According to Ohm's law,

$$\frac{eb'\sigma' (\hat{r} \times \vec{\beta})}{cs'\rho'} = 2\pi k_y.$$

It is trivial to see that by combining the above, we obtain the result

$$\frac{\sqrt{5}}{3}.$$