

E & M Qualifying Exam

Fall 2020

Tuesday, August 18, 2020 1:00 pm - 4:00 pm

This exam has four problems, each worth 25 points.

1. For a configuration of charges and currents confined within a volume \mathcal{V} , (a) show that

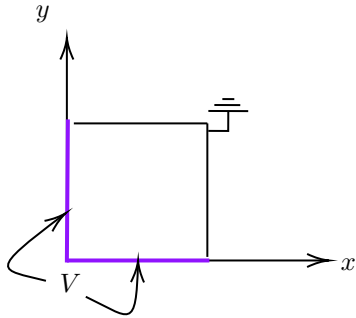
$$\int_{\mathcal{V}} \mathbf{J} d^3x = \frac{d\mathbf{p}}{dt}$$

where \mathbf{p} is the dipole moment. (b) Explain why the relationship $\mathbf{J} = \nabla \times \mathbf{B}/\mu_0$ cannot be used.

2. A total charge Q is uniformly distributed on the surface of a sphere of radius a that rotates with an angular velocity of ω .

Find the magnetic dipole moment \mathbf{m} .

3. A long pipe runs parallel to the z -axis. Two of the surfaces are at a potential V and two are grounded. The cross-section is square and the sides have unit length.



Find the potential inside of the pipe.

4. A line of charge with density λ lies along $-L \leq z \leq L$.

In terms of the spherical harmonics, Y_{lm} , find the potential for $r \gg L$.