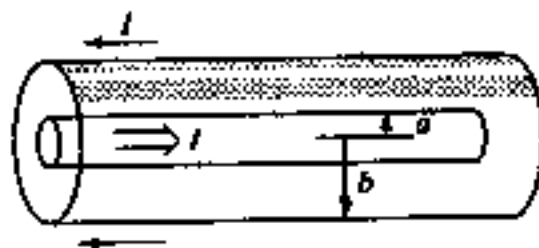


1. Suppose we have a charge  $q$  located at  $[0,0,0]$  in the  $xyz$  coordinate. What is the divergence of the electric at  $[111]$ ? (10 points)
2. Suppose we have an infinite plane carrying a uniform surface charge  $\sigma$ . What is the divergence of the electric field on the surface? (10 points)
3. What is the magnitude of the electric field a distance  $r$  from an infinitely long straight wire that carries a uniform line charge  $\lambda$ ? (10 points)
4. Suppose we have a charged metal sphere of radius  $R$  and total charge  $Q$ . What is the magnitude of the electric field at the center of the metal sphere? (10 points)
5. Suppose we put the charge  $q$  at  $[0,0,-d]$ , the charge  $-q$  at  $[0,0,d]$ , the charge  $q$  at  $[0,d,0]$ , and the charge  $-q$  at  $[0,-d,0]$  in a Cartesian coordinate. Find out the monopole term of the potential at a distance  $r$  far away from these charges. (10 points)

6. A long coaxial cable carries current  $I$  (the current flows down the surface of the inner cylinder, radius  $a$ , and back along the outer cylinder, radius  $b$ ) as shown in below. Find the energy stored in a section of length  $l$ . (10 points)



7. An alternating current  $I = I_0 \cos(\omega t)$  flows down a long straight wire and back along a coaxial conducting cylinder of radius  $R$ . (20 points)
- Find  $E$  as a function of  $r$ .
  - Find the displacement current density,  $J_d$ .
  - Integrate it to get the total displacement current  $I_d = \int J_d \cdot da$
  - Compare  $I_d$  and  $I$  (what's the ratio).

8. Find the fields, and the charge and current distributions, corresponding to

$$V(\mathbf{r}, t) = 0; \quad \mathbf{A}(\mathbf{r}, t) = -\frac{1}{4\pi\epsilon_0} \frac{qt}{r^2} \hat{r} \quad (10 \text{ points})$$

9. Sea water at frequency  $\nu = 4 \times 10^8 \text{ Hz}$  has a permittivity  $\epsilon = 81\epsilon_0$ , permeability  $\mu = \mu_0$ , and resistivity  $\rho = 0.23 \Omega \cdot m$ . What is the ratio of conduction current to displacement current? (10 points)