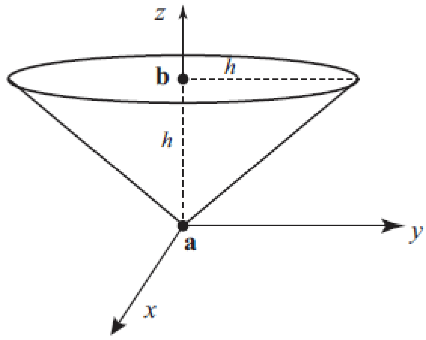
Problem 5.1: A conical surface carries a uniform surface charge σ. The height of the cone is h, and the radius of the top is also h (see figure). Find the potential difference between the points **a** and **b**.

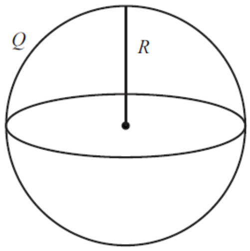


Problem 5.2: The electric potential of some configuration is given by the expression $V(\mathbf{r}) = A\frac{e^{-\lambda r}}{r}$, where A and λ are constants.
(a) Find the electric field $\mathbf{E}(\mathbf{r})$.
(b) What is the charge density $\rho(r)$?
(c) What is the total charge Q?

Problem 5.3: The potential V ($\mathbf{r}$) at $\mathbf{r}$ due to a localized charge distribution is given as $V(r) = \frac{1}{4\pi\varepsilon_0}\int \frac{\rho(\mathbf{r}')}{\mathscr{r}} d\tau'$
where $\rho(\mathbf{r}')$ is the charge density at $\mathbf{r}'$ and $\mathscr{r}$ is the separation between $\mathbf{r}$ and $\mathbf{r}'$. Verify that the above equation satisfies Poisson's equation.

Problem 5.4: Consider two concentric spherical shells of radii a and b. Suppose the inner one carries a charge q and the outer one charge $-q$ (both of them uniformly distributed over the surface).
(a) Calculate the energy of this configuration.
(b) How much of this is the interaction energy between the two shells?

Problem 5.5: (a) A metal sphere of radius R carries a total charge Q. What is the force of repulsion between the northern and the southern hemispheres (see figure)?
(b) A uniformly charged sphere of radius R carries a total charge Q. What is the force of repulsion between the northern and the southern hemispheres (see figure)?



Problem 5.6: Find the capacitance per unit length of two coaxial metal cylindrical cylinders, of radii a and b (see figure).