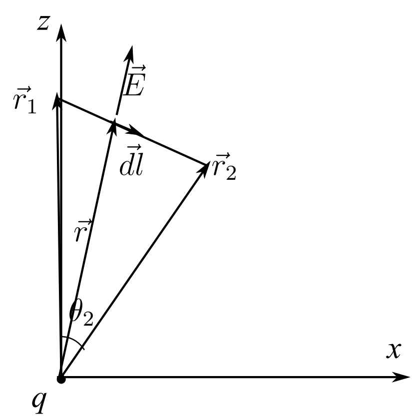
1. **An infinitely long cylindrical cavity of radius b is bored into a bigger cylinder of radius a. The axes of the two cylinders are parallel but the cylinders are not concentric. The remaining part of the cylinder has a cosnstant volume charge density ρ. Show that the electric field inside the cavity is uniform and directed along the line joining the center of the two cylinders.**

2. **Consider a point charge q at the origin. Find the electric potential at a point $\vec{r}_2 : (r = r_2, \theta = \theta_2, \phi = 0)$ with respect to the potential at $\vec{r}_1 : r = r_1, \theta = 0, \phi = 0$ as reference by evaluating the integral $-\int_{\vec{r}_1}^{\vec{r}_2} \vec{E} \cdot \vec{dl}$ along a straight line joining $\vec{r}_1$ to $\vec{r}_2$.**



3. **A hollow spherical shell carries a uniform charge density ρ_0 in the region $a \le r \le b$. Find the electric potential as a function of r.**

4. **(a) A charge distribution $\rho_1(\vec{r})$ produces a potential $\phi_1(\vec{r})$ in a region τ and another charge distribution $\rho_2(\vec{r})$ produces a potential $\phi_2(\vec{r})$ in the region. Prove that**

$$\int_\tau \rho_1 \phi_2 d^3\vec{r} = \int_\tau \rho_2 \phi_1 d^3\vec{r}$$

How do you interpret this result.

(b) **The interaction energy of two point charges q_1 and q_2 placed at $\vec{r}_1$ and $\vec{r}_2$ is given as $\epsilon_0 \int \vec{E}_1 \cdot \vec{E}_2 d^3\vec{r}$ where the integration is done over the whole space. Prove that this is equal to $\frac{q_1 q_2}{4\pi\epsilon_0 r_{12}}$ where $r_{12} = |\vec{r}_2 - \vec{r}_1|$ as is expected.**

5. **Prove the mean value theorem in electrostatics which states that in a chargeless region, the average of the potential over the surface of any sphere is equal to the potential at the center of the sphere.**
   This is true for any regular polyhedron. If the faces of a regular polyhedron having n faces are maintained at potentials $V_1, V_2, ..., V_n$ then the potential at the center of the polyhedron is $(V_1 + V_2 + ... + V_n)/n$. How many such regular polyhedron do you think are possible? Look for platonic solids. Tetrahedron, cube, octahedron, dodecahedron and icosahedron.

6. **Prove that in a chargeless region electrostatic potential cannot have a maxima or a minima.**