Theoretical Physics
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Chapter E Homework. Differential Form for the Maxwell Equations

HW-E1. Infinite Plane of Charge. An x-y infinite plane at z = 0 has a constant areal surface charge density σ. Use Gauss's Law to calculate the electric field above the plane. Then express your electric field in the form $\vec{E} = E_x \hat{i} + E_y \hat{j} + E_z \hat{k}$ and use the del operator in Cartesian coordinates to calculate the divergence for your electric field above the plane, i.e., calculate $\nabla \cdot \vec{E}$. Show all steps always in homework.

HW-E2. Infinite Line of Charge. An infinite line of charge is situated along the z axis in a cylindrical coordinate system with coordinates (r, θ, z), where $r^2 = x^2 + y^2$ and $x = r\cos\theta$ and $y = r\sin\theta$. The line has constant linear charge density λ. Use Gauss's Law to calculate the electric field at some nonzero distance r away from the wire using cylindrical coordinates. Then, express your electric vector field in Cartesian coordinates and calculate the divergence for this electric field using your Cartesian coordinates for the electric field and the del operator in Cartesian coordinates.

HW-E3. Point Charge. A point charge Q is situated at the origin. Use Gauss's Law in spherical coordinates to calculate the electric field a distance r from the charge. Note that in spherical coordinates $r^2 = x^2 + y^2 + z^2$. For the angles, define these found in (r, ϕ, θ) such that $x = r\sin\theta\cos\phi$, $y = r\sin\theta\sin\phi$, and $z = r\cos\theta$. But also note that you might not need to use all this information. Express your electric vector field in Cartesian coordinates and calculate the divergence for this electric at some nonzero distance away from the charge using your Cartesian form for the electric field and the del operator in Cartesian coordinates.