Assignment 9

Physics 321
Electrodynamics I

Due on Friday, September 27th, 2024

Class date: September 23rd 2024.
noindent Reading: pp. 74–84.

Problem 4

Griffiths 2.21 – possible electrostatic fields.

Problem 5

a. A uniformly charged rod with charge-per-unit-length λ_0 lies along the $\hat{\mathbf{y}}$ axis, extending from $-L$ to L. Using the one-dimensional form of the integral expression for potential, find V at the field point $\mathbf{r} = z\hat{\mathbf{z}}$.

b. What happens to your expression for V if you send $L \to \infty$, i.e. you consider an infinite line of charge?

c. An alternative here, since we know the electric field of a uniform, infinite line of charge is $\mathbf{E} = \lambda_0/(2\pi\epsilon_0 s)\hat{\mathbf{s}}$ is to use $\mathbf{E} = -\nabla V$ directly to find V. Try it — what is the $V(s)$ such that $-\nabla V(s)$ is the desired $\mathbf{E}$. Is the argument of log dimensionless? If so, good, if not, why not and what could you do to make the argument dimensionless?

Problem 6

Using $\mathbf{E} = -\nabla V$ for the electric field of an infinite sheet of uniform charge σ_0 lying in the xy plane, find $V(z)$. The electric field is not continuous at $z = 0$ (the source is a surface charge), is the potential? Plot the potential for both positive and negative values of z.