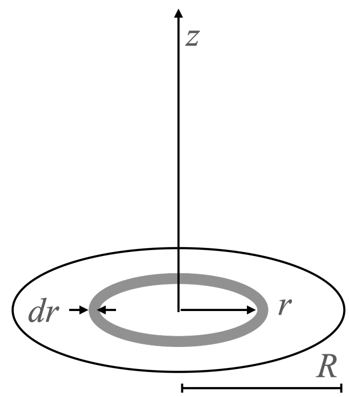
PHYS2502 Mathematical Physics Lab #2 24 Jan 2022

This lab assignment is at 8am, the morning after the date shown, although you should able to complete it easily before the end of the lab period. Email your executed Mathematica *notebook to the instructor.*

A thin disk of charge q and radius R lies in a plane perpendicular to the z-axis as shown:



Every point on the charged thin ring of radius r and thickness dr is obviously at the same distance $\rho = \sqrt{r^2 + z^2}$ from any point on the z-axis. The electric potential due to the thin ring at a point z along the axis is therefore $dV = k\,dq/\rho$ where dq is the charge on the thin ring, and $k = 1$ in Gaussian units, or $k = 1/4\pi\epsilon_0$ in SI units.

Use Mathematica to calculate the potential $V(z)$ from the entire disk. You will likely find it useful to define the planar charge density $\sigma = 1/\pi R^2$. You'll need the Integrate function. In fact, you're likely to find that this function is taking a long time to execute. If that's the case, try including the option Assumptions→{z>0, R>0}.

Then use Mathematica to find the electric field $E(z) = -dV/dz$ using the D function.

Next use the Limit function to find the field as $z \to 0$, that is, right up next to the disk. Does this agree with what you learned in your intro physics course? (It should!)

Finally, use the Limit function to find the field as $z \to \infty$, and check that this agrees with what you learned in your intro physics course. You'll have to "put back in" the dependence you expect on z to check that the limit is correct.

This week in class we'll be learning about Taylor Series, and this is a slicker way to check the limits for near and far fields. If you want to give this a try now, check out the Series function.