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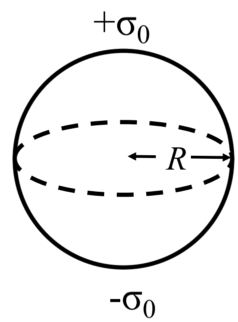
Homework 6

Due Date: All homework submitted by Sunday **10/11** 11:59pm will be graded together. Homework submitted past that time may be graded late. Submit your homework through Canvas as a single pdf file. Do not use solution sets from previous years. You are encouraged to discuss homework assignments with each other, the TAs or myself, but the solutions have to be executed and submitted individually.

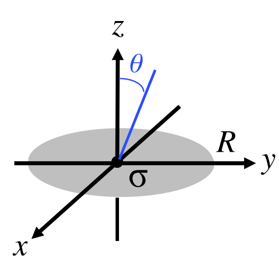
Problem A. The Sphere [50%]. A spherical shell of radius R carries a surface charge density that is constant, $+\sigma_0$, on the entire northern hemisphere, and $-\sigma_0$ on the entire southern hemisphere. There are no other charges present inside or outside the shell.



(1) Use the method of separation of variables in spherical coordinates to find the electrical potential inside V_i and outside V_o the shell. In principle, you will need an infinite sum of terms, but for this question, just work out explicitly what the first and second non-zero terms are, for both $V_i(r < R, \theta)$ and $V_o(r > R, \theta)$. Explain physically why the first zero term really should be zero.

Problem B. The Disk [50%]. A finite insulating disk of radius R carries a uniform surface charge density σ. Way back, we calculated the potential along the axis of such a disk using direct integration. Along the z-axis (θ=0), we got

$$V(z) \equiv V(r, \theta = 0) = \frac{\sigma}{2\epsilon_0}\left(\sqrt{r^2 + R^2} - r\right).$$



(1) Find the potential away from the axis ($\theta \neq 0$) for distances $r > R$, by using the method of separation of variables in spherical coordinates and the above result to inform your boundary conditions. [*Hint: you will have to think mathematically how the formula above behaves for $r \gg R$.*] You will in principle need an infinite sum of terms but for this question, just work out explicitly what the first and second non-zero terms are.