8.022 at ESG **Fall 2004**

Problem Set 07 **due Friday October 29**

Reading:

Purcell Chapter 4

Problems from the text:

4.3: We have to crunch numbers once in a while.

4.5: Once you convince yourself that the physical situation is that described, this is sort of simple.

4.11: Again with the number crunch.

4.19: Circuit design! Try the different possible circuit configurations, perhaps discovering some impossible ones.

4.22: The problem needs the result of Problem 4.18, which is optional but recommended. Maybe give 4.18 a try if 4.22 seems tricky.

4.26: This is a standard. The hint is the "obvious" way to do the problem, but expect to see another.

4.27: We'll be using MAPLE to see how to get a machine to get that preposterous formula for R_{eq}, and perhaps even see why it's not that preposterous. That is, the denominator is clearly (do I get to say "clearly"?) the determinant of something. The MAPLE worksheet we'll be using may be downloaded from our web page.

4.32: Another standard, sort of neat math, and good preparation for **8.03**.

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From previous problem sets, you should by now have a reasonable expression for the scalar potential $\varphi(r, \theta)$ corresponding to a conducting sphere of radius R_0 in the presence of an external ("ambient") electric field $\mathbf{E}_{\text{a}} = E_{\text{a}z}\,\hat{\mathbf{z}}$.

Now, find the same result another way, but using the method of **Image Charges for a Conducting Sphere**, as presented in class on Wednesday October 20, and using the result and notation in the online notes by that name.

That is, consider $\mathbf{E}_{\text{a}}$ to be the result of two very large point charges $\pm Q_{\text{a}}$ at distances $R \gg R_0$, on opposite sides of the conducting sphere. The magnitude of the ambient field would then be $|E_{\text{a}z}\,\hat{\mathbf{z}}| = 2\,|Q_{\text{a}}|\,/R^2$. Show that the resultant image charges constitute a dipole, and that in the limit as $R \to \infty$, but keeping $|E_{\text{a}z}\,\hat{\mathbf{z}}|$ constant (by adjusting Q_{a}) you reproduce the previous results.