

Physics 8.07, Fall 1999
Homework #4 (Short problem set; quiz Thursday, October 7)

Reading for Tuesday, October 5: Griffiths pp. 202–234

Quiz on Thursday, October 7.

Quiz covers material through September 30 lecture (Griffiths chapters 1–4).

Problem Set #4

Due **Tuesday, October 5** by 9:30 AM in the 8.07 homework box in 4-339B.

1. Griffiths problem 4.10: sphere with nonuniform polarization
2. Griffiths problem 4.19: capacitor with 1/2 dielectric
3. Griffiths problem 4.28: dielectric oil between conducting cylinders
4. **(Practice problem—will not be graded).**

A solid dielectric sphere of radius R and relative permittivity ϵ_r is placed with its center at the origin. A point charge q is placed at the point $(0, 0, d)$ outside the sphere ($d > R$).

- (a) Find the electrostatic potential V at all points in space as an expansion in Legendre polynomials. [Hint: You will probably find it helpful to first calculate the expansion of the potential from the point charge in free space in the regions $r > d$ and $r < d$. The expansion of the potential after the dielectric is included will be different in each of the three regions $r < R$, $R < r < d$, and $d < r$.]
- (b) Show that your answer from (a) agrees with the answer in free space in the case $\epsilon_r = 1$.
- (c) Show that your answer from (a) agrees with the answer for a conducting sphere in the limit $\epsilon_r \rightarrow \infty$.
- (d) Is it possible to interpret your answer in the region $r > R$ as arising from a single image charge inside the sphere when $\epsilon_r < \infty$? (Explain your answer.)