Exercise sheet 5
Theoretical Physics 2: SS2016
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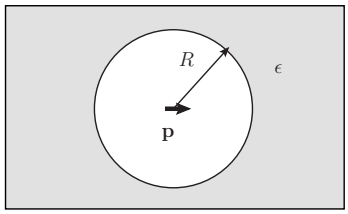
Exercise 1 (30 points): Void in a dielectric

Consider a material carrying a homogeneous dielectric constant ϵ with a spherical void of radius R. At the center of the spherical void there is a point dipole $\mathbf{p}$. Find the electric field everywhere.



Exercise 2 (20 points): Coaxial cylinders

The currents I_1 and I_2 flow through two concentric, (infinite) thin, conductive cylinders with radii $R_1 < R_2$.

Find the magnetic field $\mathbf{B}$ in each region, $r < R_1$, $R_1 < r < R_2$ and $r > R_2$. Sketch the dependence of $\mathbf{B}$.

Exercise 3 (50 points): Helmholz coils

a) (10 points)
A compact circular coil of radius a having N turns of current I lies in the plane with its center at the origin of coordinates. Using the Biot-Savart Law, calculate the magnetic field $\mathbf{B}$ at any point in the axis of symmetry.

b) (20 points)
Two identical coils as in part (a) separated by a distance b are parallel to each other and have the same axis of symmetry —with the origin of coordinates in the point midway between the centers. Obtain the magnetic field $\mathbf{B}$ at any point in the axis of symmetry and give the Taylor expansion in powers or z up to z^4.

c) (20 Points)
For $b = a$ the configuration is known as a pair of Helmholz coils. How does the magnetic field vary in the neighborhood of the center of the system? How far from the center of the axis of symmetry can one move away, without changing the magnetic field in more than 0.1%? What could be the Helmholz coil used for?