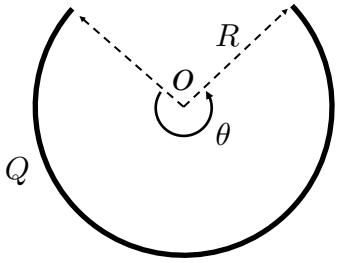
Exercise Sheet 6

Discussion 15.10.2025

Exercise 1 - Circular charged wire

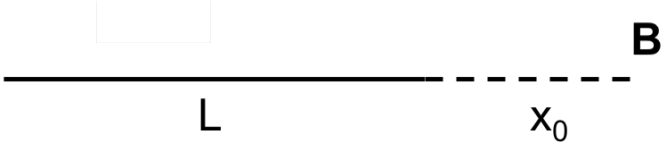
a) A circular wire with radius R is homogeneously charged with charge Q. Determine the E-field at the central z-axis as a function of distance from the ring and plot the E-field magnitude.

b) For a circular charged wire with a total charge Q and radius R, calculate the E-field at the point O as a function of the angle θ, whereby $0 < \theta < 2\pi$. Using the obtained expression evaluate the electric field for a semi circle ($\theta = \pi$) and for a $\left(\frac{3}{4}\right)^{th}$ of a circle ($\theta = \frac{3}{2}\pi$).



Exercise 2 - Electric field and potential of a straight wire/rod

Consider a wire of length L charged with a uniform line charge density λ shown in the Figure below.



a) During the lecture the E-field and potential next to a long rod were derived, we now consider the situation at a point B a distance x_0 away from the end of the rod as illustrated in the Figure. Calculate the electric field and potential at point B.

b) Now we replace the rod by a cylinder with radius R, length L, and volume charge density ρ. Set up and solve the integral to calculate the E-field at point B.

Exercise 3 - Drilling into a disk

The electric field directly above a charged disk has been discussed in the lectures. Consider now that a hole of radius R_2 (where $R \gg R_2$) has been drilled into the disk. Calculate the E-field at point P a distance z above the disk when the centre of the disk and the hole coincide.

Exercise 4 - Asymmetric charge distribution

An important dipole in solid state physics is that of a charge distribution with positive (negative) charges at the north (south) pole of a sphere. This charge distribution can be described by $\sigma = \sigma_0 \cos\theta$. Use the superposition principle to determine the dipole moment of this charge arrangement. More specifically, consider two slightly displaced and oppositely charged spheres with volume charge density $\pm\rho$.

Exercise 5 - Potential of a quadrupole

Determine the potential of a linear quadupole formed by three point charges separated by a distance d. Assume $d \ll r$, where r is the distance from the quadrupole to the point of interest.