Experimental Physics III

Submission due: January 12, 2023, before the lecture starts

Exercise Sheet 11

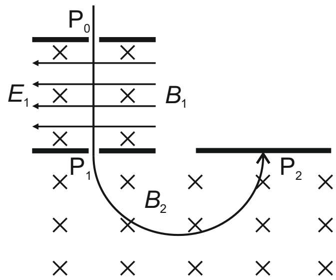
11.1

A new antenna is built to eliminate a mobile phone dead zone in a town. The transmitting antenna of one station is an electric dipole antenna located atop a mountain 2 km above the sea level. Another mountain is 4 km away from the antenna and is also 2 km above the sea level. At that mountain the signal's intensity is measured with 4×10^{-12} W/m^2. Calculate the intensity of the signal at the town that is located at sea level and 1.5 km from the transmitter.

11.2

Positively charged ions enter perpendicularly crossed fields at an electric field strength of $E_1 =$ 250 V/m and a magnetic flux density of $B_1 = 10^{-3}$ T at the position P_0. One part of the ions straightly traverses the setup and passes an aperture P_1 into a magnetic field at a flux density $B_2 = 1$ T. The ions are deflected there and impinge on a screen at P_2 ($\overline{P_1P_2} = 10$ cm).

- Calculate the velocity of the ions, which straightly traverse the crossed fields and exit at P_1.
- Calculate the specific charge q/m of the ions, which impinge on the screen at P_2.



11.3

α particles with a kinetic energy of $E_{\mathrm{kin}} = 5$ MeV are scattered at a gold foil.

- Calculate the impact parameter b for a scattering angle of 90°.
- Calculate the minimal distance to a gold atom for backward scattering (i.e., $\theta = 180°$).
- Calculate the fraction of all α particles that are scattered by an angle of $\theta \geq 90°$ at a gold foil with a thickness of $5 \cdot 10^{-6}$ m ($\rho = 19.3$ g/cm^3, $M = 197$ g/mol).
- Calculate the fraction of all α particles that are scattered by an angle of $45° \leq \theta \leq 90°$.

11.4

Consider the photoelectric effect of a wolfram (tungsten) slab with a work function of $W_{\mathrm{A}} = 4.6$ eV. The photocurrent vanishes at a counter-voltage of $U = 2.5$ V. Calculate the wavelength range of the incident photons.

11.5

A Franck–Hertz tube filled with neon gas is used to experimentally determine the energy levels of neon. Additionally, a photocell, working in the opposing field mode, serves for the verification of the light emitted by the neon atoms. Initially, the voltage of the opposing field is zero. By continuously increasing the acceleration voltage U_{acc} in the Franck–Hertz tube from $U_{\mathrm{acc}} = 0$ V on, an abrupt photocurrent can be detected in the photocell at $U_{\mathrm{acc}} = 16.6$ V, which can be canceled if an opposing voltage of $U_{\mathrm{opp}} = 10.9$ V is applied in the photocell. Determine which material the cathode of the photocell is made of.