Exercise Sheet 13

Discussion 10.12.2025

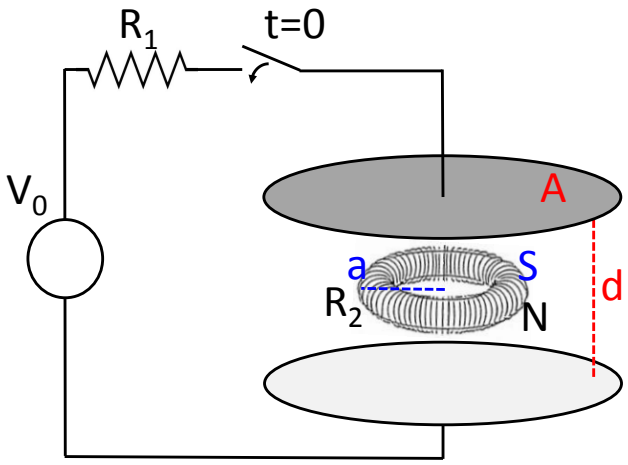
Exercise 1 - Displacement current

Consider a capacitor made of two parallel plates in vacuum of area A at distance $d << \sqrt{A}$. A toroidal solenoid of radius a made of N coils of cross-section S with $a >> \sqrt{S}$ is placed between the two plates. The total resistance of the solenoid is R_2. At the time $t = 0$ a switch closes a circuit which connects the capacitor in series with a resistor R_1 and a battery V_0. The setup is shown in the figure.

a) Calculate the electric field between the plates as function of time.

b) Calculate the induced magnetic field inside the solenoid as function of time.

c) Calculate the amount of charge that flows in the solenoid. For simplicity, do not consider the self-inductance of the solenoid.



Exercise 2 - AC Magnetic Field

A capacitor made of two parallel circular plates of radius a in vacuum is connected to a AC source, thus the total charge in the capacitor varies as $Q(t) = Q_0 \sin\omega t$. Calculate the B-field between the two plates.

Exercise 3 - Waves

Consider a function $\psi = A\sin(Bx)cos(Ct) + D$, where x and t are space and time directions, and A,B,C,D are constants.

a) Show that ψ is a solution of the wave equation.

b) What is the speed of ψ?

Consider a function $\chi = (x - v_1 t)^2 + 1/\sqrt{x + v_2 t}$.

c) Find the condition for v_1 and v_2 in order to let χ be a solution of the wave equation.