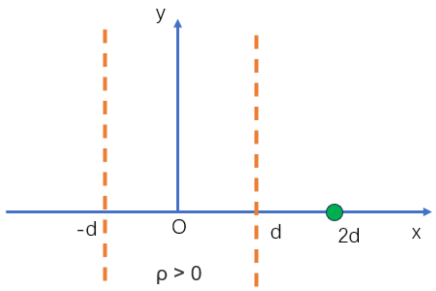
Problem 1 [?? points]: As shown in the figure, volumetric charge density, $\rho > 0$, is constant in the region $-d \leqslant x \leqslant d$. And it is vacuum everywhere else (i.e. $\rho = 0$). Now, a point charge q (q < 0), with mass m is set free from x = 2d. The initial velocity of the point charge is 0. How long does the charge take to move to x = 0, considering electric force only?



Problem 2 [?? points]: A uniformly charged spherical shell (radius R) is located in vacuum and is rotating along one of its symmetric axis (any axis passing through the center of the sphere) at a constant angular velocity $\boldsymbol{\omega}$. The shell is uniformly charged with a surface charge density σ.

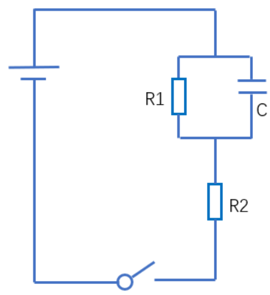
Q1: Find the electric potential energy in space;

Q2: Find the magnetic field **B** along the axis of rotation.

Problem 3 [?? points]: As shown in the figure, a circuit is consisted of two resistors R_1 and R_2, a capacitor and an EMF (V_0). The capacitor is made of two circular disks (radius b) which are parallelly separated by a distance d. Initially (t = 0), the circuit is closed (switch is on, capacitor is charged), then we switch off the circuit (circuit is open).

Q1: Solve for the current in the circuit as a function of time.

Q2: Find the magnetic field **B** between the plates of the capacitor, as a function of time.

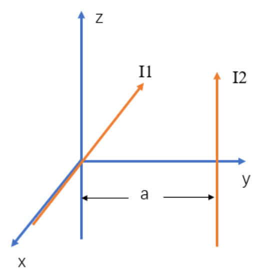


Problem 4 [?? points]: Two <u>infinitely long</u> wires are separated with a distance *a* in vacuum as shown in the figure. One (with I_1) is located along the x axis, the other one (with I_2) is located parallelly to z axis (in yOz plane0. There exists constant current in each one of them I_1 and I_2. Now, considering a segment on I_2 from

$z = -l/2$ to $l/2$ where $l \ll a$.

Q1: What is the net force acted by I_1 on this segment of I_2;

Q2: What is the net torque acted by I_1 on this segment of I_2.



Problem 5 [?? points]: Calculate the magnetic field at the center of a uniformly charged spherical shell, of radius R and total charge Q, spinning at constant angular velocity ω.

Problem 6 [?? points]: An infinite wire carrying a constant current I in the z direction is moving in the y direction at a constant speed v. Find the electric field, in the quasistatic approximation, at the instant the wire coincides with the z axis.

Problem 7 [?? points]: Show that the magnetic field is constant ($\partial \mathbf{B}/\partial t = \mathbf{0}$), inside a perfect conductor. (b) Show that the magnetic flux through a perfectly conducting loop is constant. A **superconductor** is a perfect conductor with the additional property that the (constant) **B** inside is in fact *zero*.