TFE4120 - Exercise Session 2

January 11, 2021

Exercise 1

In order to organize the exercise tutorials in a efficient way, it is nicer that not everybody starts in the same point. Please try to start at the exercise corresponding to the first letter of your last name and work your way around. E.g., if my last name is Granerud, I will start with Exercise 3, then 4, 1 and 2. Of course if you feel like an exercise is really too difficult to start with you may skip.

Please start here with last name starting with S-Z.

Given a cylindrical charge distribution

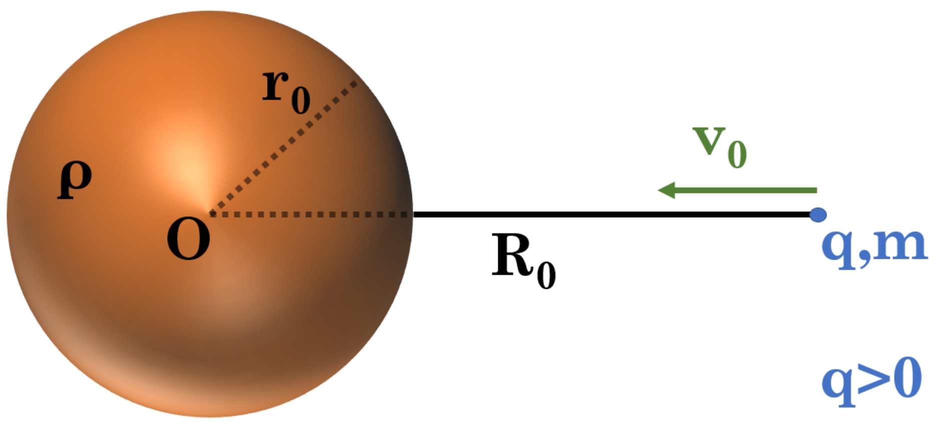
$$\rho(r) = \begin{cases} \rho_0(a - br)\left[\frac{\mathtt{C}}{\mathtt{m}^3}\right] & \texttt{for} \quad r \leq r_0 \\ 0\,\frac{\mathtt{C}}{\mathtt{m}^3} & \texttt{for} \quad r > r_0 \end{cases} \tag{1}$$

having an indefinite height, express analytically the form of the electrostatic field $\vec{E}$ produced.

Exercise 2

Please start here with last name starting with A-F.

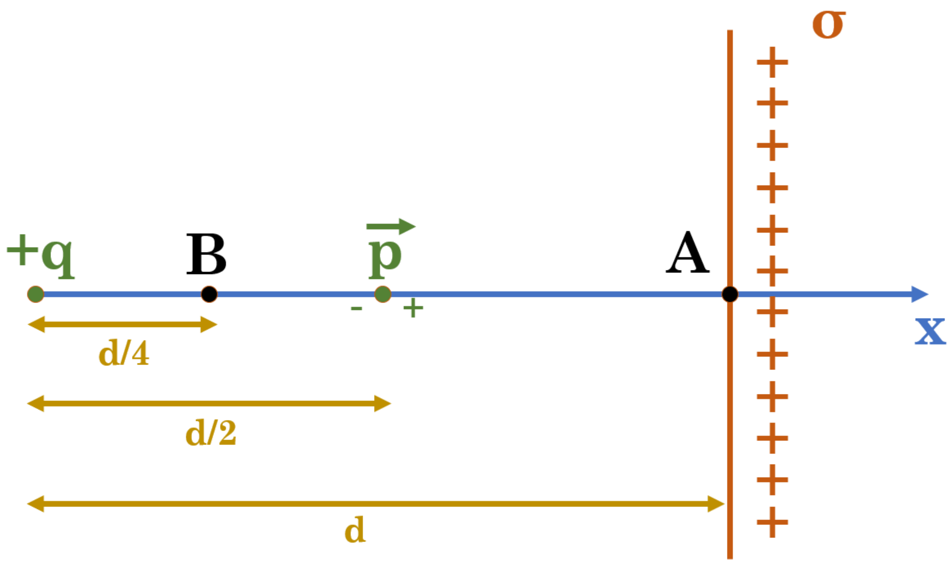
Given the spherical volumetric distribution of charge ρ illustrated in the below figure, determine the initial velocity v_0 that the charged particle must have in order to reach the centre of the sphere O. The charge density is uniform (i.e. $\rho =$cst) and the particle has charge q, mass m and is initially located at a distance R_0 from the centre of the sphere.



Exercise 3

Please start here with last name starting with G-L.

A point-like charge $+q$ is separated by a distance $d = 40$ cm from a uniform planar distribution with charge density $\sigma = 8.86 \cdot 10^{-10} \frac{\mathtt{C}}{\mathtt{m}^3}$. An electric dipole of magnitude $\|\vec{p}\| = 10^{-12}$ C·m is located at a distance $\frac{d}{2}$ from the point-like source. The dipole is oriented parallel to the x-axis, i.e. $\vec{p} = \|\vec{p}\| \cdot \vec{u_x}$. On the dipole, a force of magnitude $\left\|\vec{F}\right\| = 2.25 \cdot 10^{-9}$ N is exerted along the x-direction.



1. Calculate q.

2. Calculate the velocity v_B an electron will have in point B if it leaves from point A with $\vec{v_A} = -3 \cdot 10^6 \frac{\mathtt{m}}{\mathtt{s}} \cdot \vec{u_x}$.

Exercise 4

Please start here with last name starting with M-R.

Express the electrostatic field generated by 3 homocentric spherical distributions of charge having radii $R_1 < R_2 < R_3$ and corresponding charges q_1, q_2 and q_3 on each sphere surface. Find out the analytical expression for the potential too.

Challenge: Try to sketch $\left\|\vec{E}\right\|$ and V for the specific case $q_1 = q$; $q_2 = -q$; $q_3 = q$