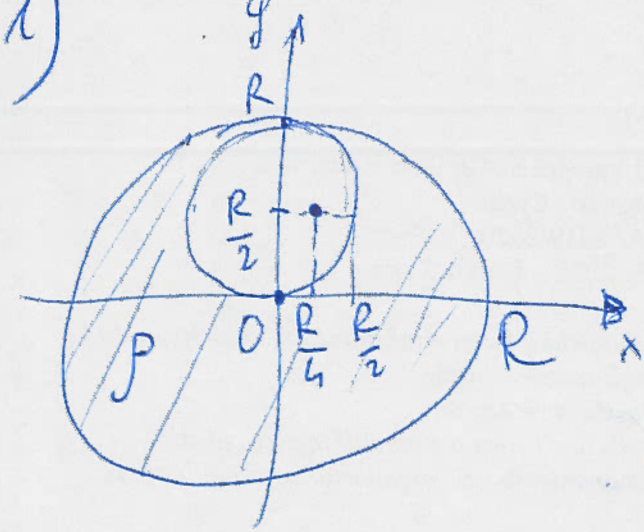
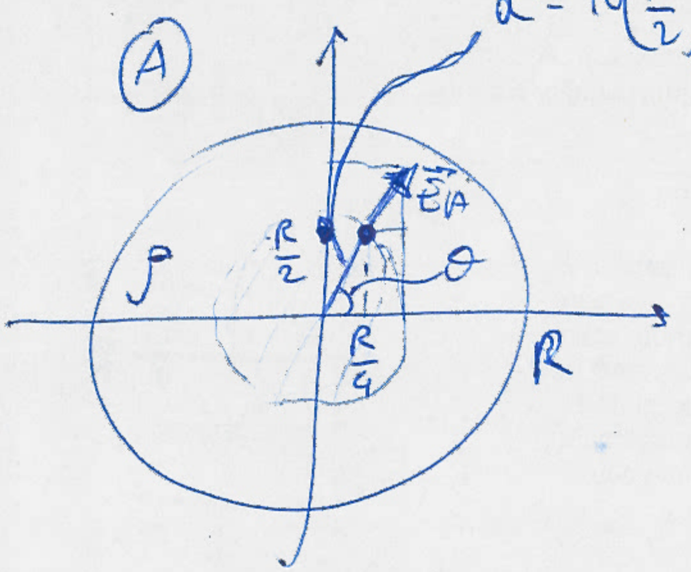
1)



USIAMO LA SOVRAPPOSIZIONE DEGLI EFFETTI

||

$d = \sqrt{\left(\frac{R}{2}\right)^2 + \left(\frac{R}{4}\right)^2}$



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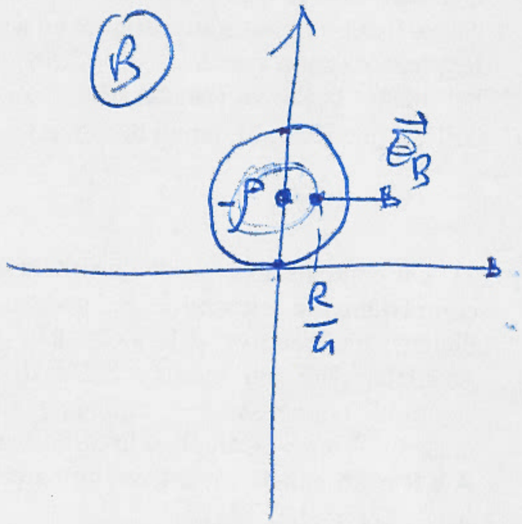


in P $\quad \vec{E}(P) = \vec{E}_A(P) + \vec{E}_B(P)$

$E_A(P) = \frac{1}{4\pi\varepsilon}\rho\cdot\frac{4}{3}\frac{\pi d^{\cancel{3}}}{\cancel{d^2}}$ $\qquad E_A(P)_x = E_A(P)\cos\theta$

$E_A(P)_y = E_A(P)\,\text{sen}\,\theta$

$\cos\theta = \frac{R}{4d} \qquad \text{sen}\,\theta = \frac{R}{2d}$

$E_B(P) = \frac{1}{4\pi\varepsilon}\frac{(-\rho)\frac{4}{3}\pi\left(\frac{R}{4}\right)^{\cancel{3}}}{\cancel{\left(\frac{R}{4}\right)^{2}}}$ $\qquad E_B(P)_x = E_B(P)$

$E_B(P)_y = \emptyset$

QUINDI

$$\vec{E}(P) = \hat{x}\left[E_{A_x}(P) + E_{B_x}(P)\right] + \hat{y}\left[E_{B_x}(P)\right]$$

$$\vec{E}(P) = \hat{x}\left[\frac{1}{\cancel{4\pi\varepsilon}}\rho\frac{4}{3}\pi d\frac{R}{4d} - \frac{1}{4\pi\varepsilon}\rho\frac{4}{3}\pi\frac{R}{4}\right] + \hat{y}\left[\frac{\rho}{4\pi\varepsilon}\frac{4\pi}{3}\frac{dR}{2\cancel{d}}\right]$$

in O $\quad \vec{E}(O) = \vec{E}_A(O) + \vec{E}_B(O)$

MA $\quad \vec{E}_A(O) = 0$ perché per GAUSS NON CI SONO CARICHE INTERNE

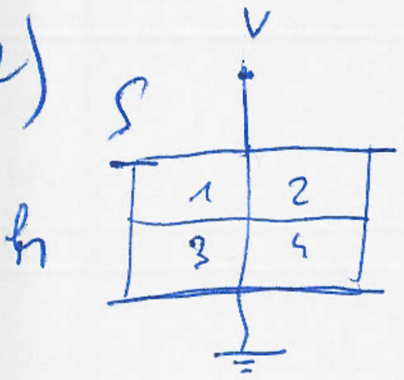
e $\vec{E}_B(O) = E_B(O)(-\hat{y})$ con

$$E_B(O) = \frac{\frac{1}{4\pi\varepsilon}(-\rho)\frac{4}{3}\pi\left(\frac{R}{2}\right)^{\cancel{3}}}{\cancel{\left(\frac{R}{2}\right)^2}}$$

per cui

$$\vec{E}(O) = \hat{y}\,\frac{1}{\cancel{4\pi\varepsilon_0}}\rho\frac{4}{3}\pi\frac{R}{2}$$

2)



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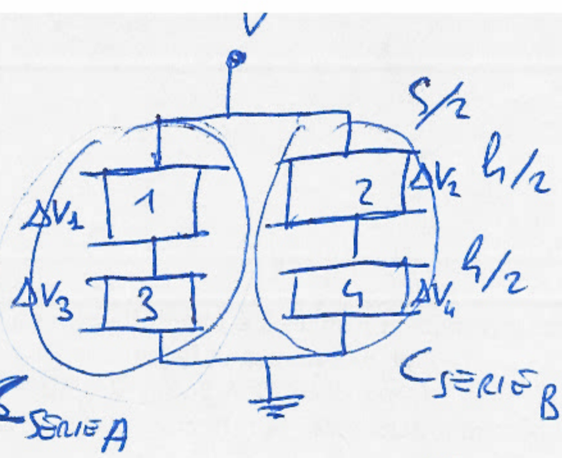

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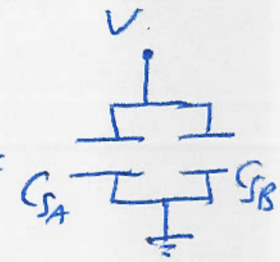


QUINDI C_{SA} C_{SB} $C_{//} = C_{SA} + C_{SB}$

$$C_{SA} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_3}} \qquad C_{SB} = \frac{1}{\frac{1}{C_2} + \frac{1}{C_4}}$$

$$C_1 = \varepsilon_0 k_1 \frac{S \cancel{2}}{\cancel{2} h} = \varepsilon_0 k_1 \frac{S}{h} \qquad C_2 = \varepsilon_0 k_2 \frac{S}{h}$$

$$C_3 = \varepsilon_0 k_3 \frac{S}{h} \qquad C_4 = \varepsilon k_4 \frac{S}{h}$$

$$Q_{SA} = C_{SA} V \qquad Q_{SB} = C_{SB} V \qquad Q_T = Q_{SB} + Q_{SA}$$

$$\Delta V_1 = \frac{Q_{SA}}{C_1} \qquad \Delta V_3 = \frac{Q_{SA}}{C_3} \qquad \Delta V_2 = \frac{Q_{SB}}{C_2} \qquad \Delta V_4 = \frac{Q_{SB}}{C_4}$$

$$V_A = \Delta V_3 + \frac{1}{2}\Delta V_1 \qquad V_B = \Delta V_4 + \frac{1}{2}\Delta V_2$$

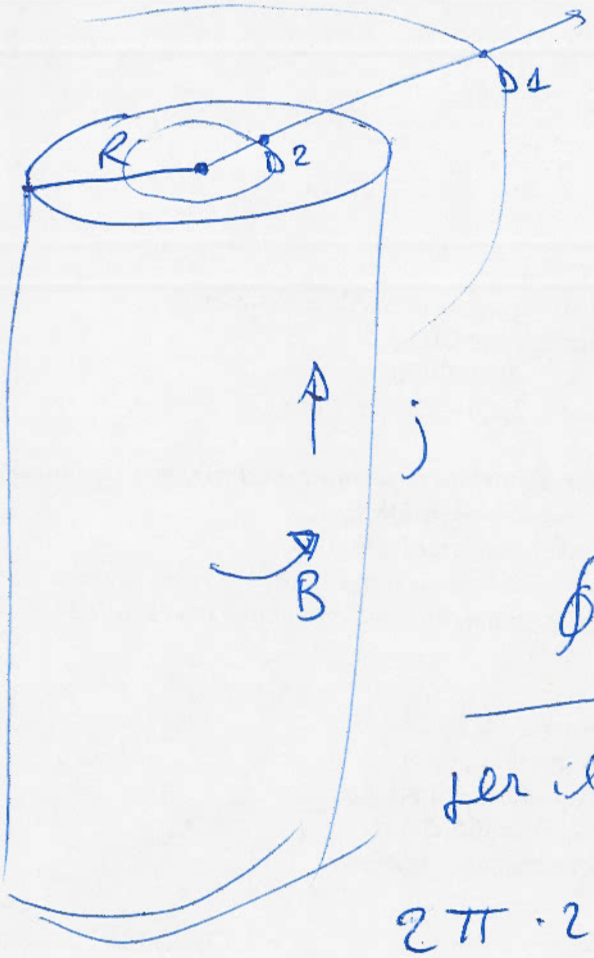
$$V_A - V_B = \Delta V_3 + \frac{1}{2}\Delta V_1 - \Delta V_4 - \frac{1}{2}\Delta V_2$$

OPPURE

~~VA = V4~~ $V_A = V - \frac{1}{2}\Delta V_1 \qquad V_B = V - \frac{1}{2}\Delta V_2$

$$\underline{V_A - V_B} = \cancel{V} - \frac{1}{2}\Delta V_1 - \cancel{V} + \frac{1}{2}\Delta V_2 = \underline{\frac{1}{2}(\Delta V_2 - \Delta V_1)}$$

3)



$$\boxed{\begin{array}{ll} j(r) = k r & \text{per } r \le R \\ j(r) = 0 & \text{per } r > R \end{array}}$$

USIAMO LA LEGGE DELLA CIRCUITAZIONE DI AMPÈRE

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 I_c$$

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per il punto in D1 $(r = 2R)$

$$2\pi \cdot 2R \cdot B_1 = \mu_0 \int_0^R k r' \cdot 2\pi r' dr'$$

$$2\pi \cdot 2R \cdot B_1 = \mu_0 k \cdot 2\pi \int_0^R r'^2 dr' = \mu_0 k \cdot 2\pi \cdot \frac{R^3}{3}$$

$$B_1 = \frac{\mu_0 k \cdot \cancel{2\pi}}{\cancel{2\pi} \cdot 2\cancel{R}} \cdot \frac{R^{\cancel{3}\,2}}{3} = \frac{\mu_0 k}{6} R^2$$

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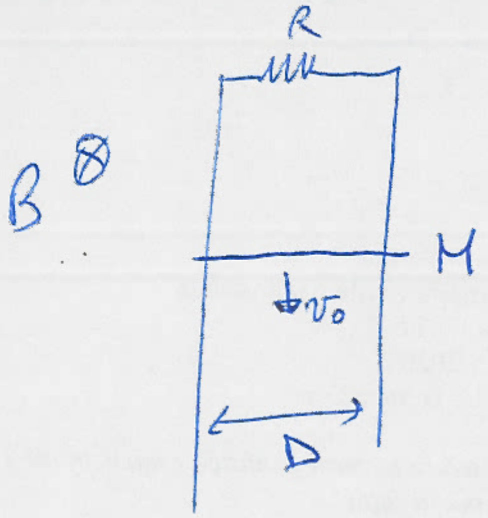
per il punto in D2 $\left(r = \frac{R}{2}\right)$

$$2\pi \cdot \frac{R}{2} \cdot B_2 = \mu_0 \int_0^{\frac{R}{2}} k r' \cdot 2\pi r' dr'$$

$$2\pi \cdot \frac{R}{2} \cdot B_2 = \frac{\mu_0 k \cdot 2\pi}{3} \left(\frac{R}{2}\right)^3 = \frac{\mu_0 k \cdot 2\pi \cdot R^3}{3 \cdot 8}$$

$$B_2 = \frac{\mu_0 k \cdot \cancel{2\pi} \cdot R^{\cancel{3}\,2} \cdot \cancel{2}}{3 \cdot \cancel{8}_4 \cdot \cancel{2\pi} \cdot \cancel{R}} = \frac{\mu_0 k}{12} R^2$$

4)



$v_0 = \text{cost} \to a_{cc} = \emptyset$

$F = M a_{cc} = 0$

LA FORZA TOTALE SULLA SBARRA È NULLA

$F = 0 = Mg + F_B$

per cui $F_B = -Mg$

$$f_{em} = -\frac{d\Phi(B)}{dt} = -\frac{d}{dt}\left(B \cdot D \cdot x\right) = -B \cdot D \frac{dx}{dt} = -BDv_0$$

$$i = \frac{f_{em}}{R} = -\frac{BDv_0}{R}$$

$$F_B = iBD = -\frac{BDv_0}{R} BD = -\frac{B^2 D^2 v_0}{R}$$

$$F_B = -Mg = -\frac{B^2 D^2 v_0}{R} \to B^2 = \frac{RMg}{v_0 D^2}$$

$$B = \sqrt{\frac{RMg}{v_0 D}}$$