Fisica II

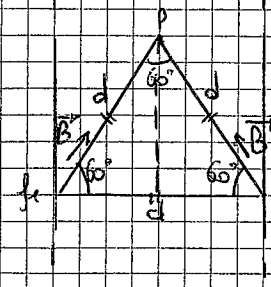
Prova n.3 Ricchiondale - 20/12/2018

① 2 fili paralleli e indefiniti

$d = 0{,}0176\ m$

$I = i_1 = i_2 = 13{,}3\ A$

$\vec{B}\ (\mu T) = ?$



Essendo un triangolo equilatero ho $\alpha = 60°$

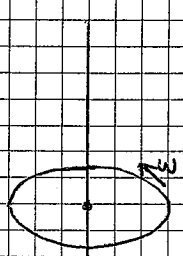
Campo magnetico per un filo indefinito: $\vec{B} = \frac{\mu_0 I}{2\pi\rho}$ con ρ = distanza (d) o raggio (r)

$$\Rightarrow \vec{B}(d) = 2\left(\frac{\mu_0}{2\pi}\frac{I}{d}\right)\cdot \sin\alpha = \frac{2\cancel{\pi}(4\pi\cdot 10^{-7})(13{,}3)}{(2\cancel{\pi})(0{,}0176)}(\sin(60)) = 0{,}000262\ T = 262\ \mu T$$

$$= \frac{N}{A^2}\cdot A\cdot\frac{1}{m}\Big| = \frac{N\,s}{c\,m} = [T] \qquad A = \frac{C}{s}$$

risposta (B)

③



$r = 0{,}0893\ m$

$\sigma = 7{,}17\cdot 10^{-6}\ C/m^2$

$\omega = 787\ rad/s$

$\mu\ (A\cdot m^2) = ?$

dipolo (2 cariche)

$$\begin{cases} \mu = \frac{1}{2} n I S = \frac{I S}{2} \quad (1\ disco,\ n=1) \\ I = \frac{dq}{dt} = \frac{q}{T} = \frac{q}{\frac{2\pi}{\omega}} = \frac{q\omega}{2\pi} \\ dq = \sigma\, dS \rightarrow q = \sigma\cdot S = \sigma\cdot\pi r^2 \end{cases}$$

$$\mu = \frac{1}{2} I S = \frac{1}{2}\frac{q\omega}{2\pi}\cdot S = \frac{1}{2}\frac{\sigma\omega S^2}{2\pi} = \frac{(\sigma)(\omega)(\pi r^2)^2}{4\pi\cdot 10^{-7}} = 2{,}82\cdot 10^{-7}\ A\cdot m^2$$

risposta (C)

⑥ 1 sbarretta conduttrice $\quad V = \begin{cases} 0 & t_0 = 0 \\ V_0 & t_0 = \frac{mR}{B^2 a^2} \end{cases}$

$m = 9{,}85\cdot 10^{-3}\ Kg$

$a = 0{,}205\ m$

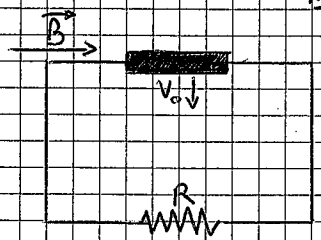
2 fili verticali

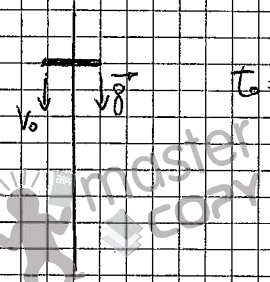
$R = 12{,}8\ \Omega$

$B = 1{,}45\ T$

$\vec{g} = 9{,}81\ m/s^2$

$\vec{V_0}\ (m/s) = ?$



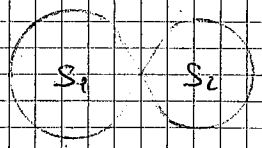


$$t_0 = \frac{mR}{B^2 a^2} = 1{,}43\ s$$

$$V = V_0 - \frac{1}{2}gt^2 \rightarrow V_0 = \frac{1}{2}gt^2 = \frac{1}{2}(9{,}81)(1{,}43)^2 = 7{,}05\ m/s$$

risposta (E)

(8)



$S = S_1 + S_2 = (0{,}0548\ m^2) + (0{,}0375\ m^2)$

$B = kt$, con $k = 0{,}0112\ T/s$

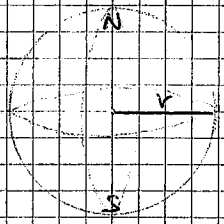
$\mathcal{E}(V) = ?$

$$\begin{cases} \mathcal{E} = -\dfrac{d\Phi_B}{dt} \\ \Phi_B = \int_S B\,dS = BS = B(S_1+S_2) = kt(S_1+S_2) \end{cases}$$

$$\mathcal{E} = -\frac{kt(S_1+S_2)}{dt} = -k(S_1+S_2) = k(S_1+S_2) = 1{,}94\cdot 10^{-4}\ V$$

risposta (B)

(9)



1 sfera

$r = -j_0 \cdot \hat{e}_v$

versore dei meridiani

$J_0 = 3{,}86\ mA/m$

$$q = \begin{cases} 0 & t_0 = 16{,}8\ s \\ q_0 & t_1 = 37{,}35\ s \end{cases}$$

$S = 4\pi r^2 \rightarrow \frac{S}{2} = 2\pi r^2 = 0{,}0104\ m^2$

$$\begin{cases} I = dq/dt \\ I = \int_S J\,dS \end{cases}$$

$$dq = \int J\,dS \cdot dt \rightarrow q = JS\int_{t_0}^{t} dt =$$

$$= (J_0)(2\pi r^2)[t_1 - t_0] = 20{,}3\cdot 10^{-3}\ C = 20{,}3\ mC$$

risposta (B)

(10) 1 particella

$B = 0{,}812\ T$ (costante)

$v = 5{,}04\cdot 10^5\ m/s$

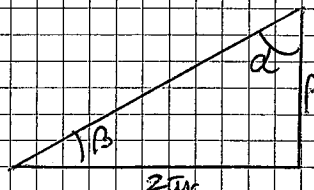
$r = 0{,}206\ m$

$p = 0{,}735\ m$

$\frac{q}{m}\left(\frac{e}{kg}\right) = ?$

Passo dell'elica: $p = v_0 \cos\alpha\ \frac{2\pi m}{qB}$

$$\rightarrow \begin{cases} \dfrac{q}{m} = v_0 \cos\alpha\ \dfrac{2\pi}{pB} = 2{,}96\cdot 10^6\ C/kg \\ \tan\alpha = \dfrac{2\pi r}{p} \rightarrow \alpha = \tan^{-1}\left(\dfrac{2\pi r}{p}\right) = 88{,}56° \end{cases}$$



risposta (B)

(7)

$$B = \begin{cases} B_x = B_0(1-e^{-t/\tau}) \\ B_y = 0 \\ B_z = B_0(1-e^{-t/\tau}) \end{cases}$$

$A = 0{,}0210\ m^2$ $\quad \Delta t = \tau$ $\quad E_{diss} = ?$ $\quad B_z \perp dS$, $B_x \parallel dS$

$R = 67{,}8\ \Omega$

1 spira

$$\mathcal{E}_{ind} = -\frac{d\Phi_B}{dt} = -\frac{\int B\,dS}{dt} = -B_0\frac{1}{\tau}e^{-t/\tau}A = \frac{-B_0Ae^{-t/\tau}}{\tau}$$

$$\mathcal{E} = I\cdot R \qquad P = RI^2 = R\cdot\frac{\mathcal{E}^2}{R^2} = \frac{B_0^2A^2e^{-2t/\tau}}{R\tau^2}$$

$B_0 = 2{,}20\ T$, $\tau = 4{,}88\cdot 10^{-3}\ s$

$$E = \int P\,dt = \int_0^{\tau} \frac{B_0^2A^2}{R\tau^2}e^{-t/\tau} = \frac{B_0^2A^2}{R\tau^2}\left(-\frac{\tau}{2}\right)\left[e^{-\frac{2t}{\tau}}\right]_0^{\tau} = [3{,}22\cdot 10^{-3}](e^{-2}-1) = 2{,}79\cdot 10^{-3}$$

risposta (B)

② 1 disco

$J(10^{-9}\ A/m) = ?$

$\sigma = Kr$, $K = 3{,}57 \cdot 10^{-9}\ C/m^3$

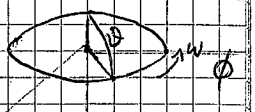
$f(\text{frequenza}) = 503\ \frac{\text{giri}}{\text{minuto}}$

$r_0 = 0{,}561\ m$

$\omega = 2\pi f = 2\pi \cdot \left(\frac{503}{60}\right) = 52{,}65\ rad/s$

$\omega = \frac{2\pi}{T} \rightarrow T = \frac{2\pi}{\omega}$

$\begin{cases} I = \int J\,dl \quad I = \frac{dq}{dt} \quad dq = \sigma\,dS \\ J = \frac{I}{l} \end{cases}$



$\int J\,dl = \frac{dq}{dt} = \frac{\sigma\,dS}{T} = \frac{\sigma\,dS}{\frac{2\pi}{\omega}}$

$J\,dr = \frac{\int_0^{2\pi} Kr \cdot r \sin\vartheta\,d\phi\,dr}{\frac{2\pi}{\omega}}$ con $\vartheta = \frac{\pi}{2}$

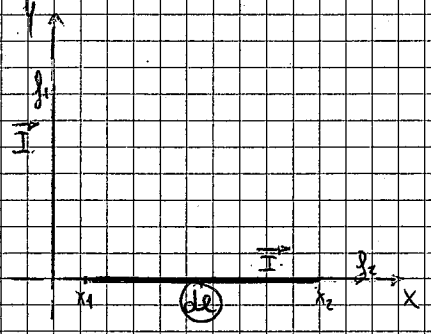
$J = Kr^2 \cdot 2\pi \cdot \frac{\omega}{2\pi} = Kr^2\omega = 59{,}2 \cdot 10^{-9}\ A/m$

risposta (D)

④ 2 fili infiniti

$I = i_1 = i_2 = 85{,}1\ A$

tratto di filo $\begin{cases} x_1 = 0{,}615\ m \\ x_2 = 5{,}06\ m \end{cases}$



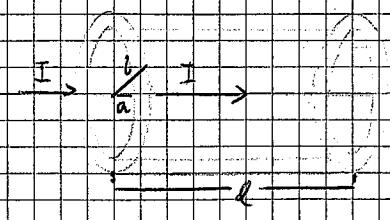
$F_{21}\ (N) = ?$

$\begin{cases} d\vec{F} = I\,d\vec{l} \times \vec{B} \\ B = \frac{\mu_0 I}{2\pi\rho} = \frac{\mu_0 I}{2\pi dl} \end{cases}$

$\frac{dF}{dl} = \frac{\mu_0 I^2}{2\pi l} \rightarrow dF = \int_{x_1}^{x_2} \frac{\mu_0 I^2}{2\pi l}\,dl = \frac{2\pi \cdot 10^{-7}(85{,}1)^2}{2\pi} \int_{x_1}^{x_2} \frac{1}{l}\,dl = (2\pi \cdot 10^{-7})(85{,}1)^2 \left(\ln\left(\frac{x_2}{x_1}\right)\right) =$

$= 2{,}98 \cdot 10^{-3}\ N$ risposta (C)

⑤



$l >> a, b$

$a = 0{,}0286\ m$

$b = 0{,}115\ m$

$I = 7{,}81\ A$

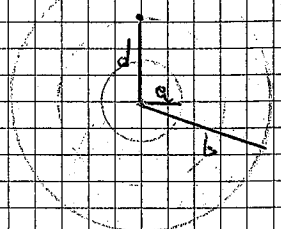
$d = 0{,}0705\ m$

$\vec{B}(d)\ (10^{-4}\ T) = ?$

$\int_l B\,dl = \mu_0 I_c$

mi ricavo prima I_c, con $I = J \cdot S$

$J = \frac{I}{S} = \frac{I}{(\pi b^2 - \pi a^2)}$



quindi $I_c = \frac{I}{(\pi b^2 - \pi a^2)} (\pi d^2 - \pi a^2)$

quindi $B\,2\pi d = \left(\frac{I}{(\pi b^2 - \pi a^2)} (\pi d^2 - \pi a^2)\right) \cdot \mu_0$

$B = \frac{\mu_0}{2\pi d} \frac{\pi (d^2 - a^2) I}{\pi (b^2 - a^2)} = (2{,}83 \cdot 10^{-4})(0{,}334) = 0{,}0742$ Gauss

risposta (E)

Prova n.3 - 20/12/2018 - Aerospaziale

④ 1 solenoide infinito

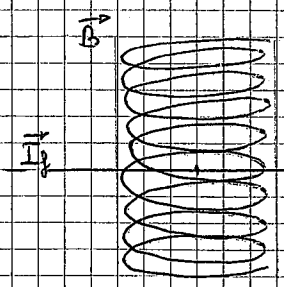
$r = 0{,}136$ m

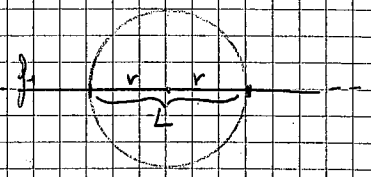
1 filo rettilineo

$I_{filo} = 3{,}03$ A

$F = 4{,}8\ \mu N = 4{,}8 \cdot 10^{-6}$ N

$J\ (A/m) = ?$





$$\begin{cases} F = B \cdot I_f \cdot L \quad \text{con } L = \dfrac{dN}{2\pi r} \\ B = \mu_0 \dfrac{N}{L} I_s \end{cases} \Rightarrow \begin{cases} B = \dfrac{\mu_0 I}{2\pi r} \\ B = \dfrac{F}{I_f L} = \dfrac{F}{I_f 2r} \end{cases}$$

$$\mu_0 \left(\frac{I}{2\pi r}\right) = \frac{F}{I_f \cdot 2r} \rightarrow \frac{I}{2\pi r} = J = \frac{F}{I_f \cdot 2r \cdot \mu_0} = \frac{4{,}8 \cdot 10^{-6}}{3{,}03 \cdot 8\pi (0{,}136)} = 4{,}63\ A/m$$

$$\frac{A}{m} = J$$

risposta (D)

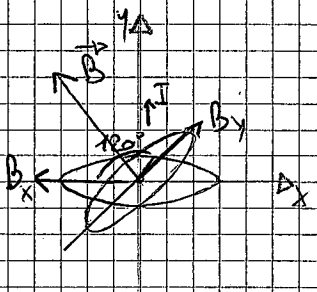
② Due spire circolari concentriche

$R = r_1 = r_2 = 0{,}010$ m

$\vartheta = \frac{2}{3}\pi = 120°$

$B\ (10^{-4}\ T) = ?$ $I = 1{,}15$ A

1 Gauss $= 10^{-4}$ T



campo magnetico per asse spira circolare

$$B = \frac{\mu_0 I R^2}{2(R^2 + z^2)^{3/2}}$$

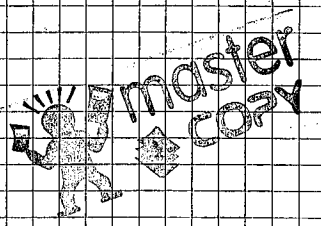
2 spire

$$\vec{B} = 2 \cdot \frac{\mu_0 I R^2}{2(R^2 + z^2)^{3/2}} \left(\cos\frac{\vartheta}{2}\right)$$

$$= \frac{1}{2}\left(4\pi \cdot 10^{-7}\right) \frac{R^2}{R^3} =$$

$$= 2\pi \cdot 10^{-7} \frac{I}{R} = 0{,}715\ G$$

risposta (E)



③ 1 particella

$B = 0{,}495$ T

$v = 4{,}54 \cdot 10^7$ m/s

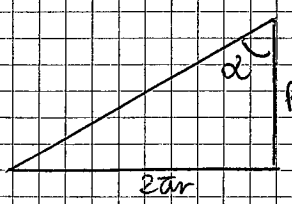
$r = 0{,}243$

$p = 0{,}775$ m

$\frac{q}{m}\left(\frac{C}{kg}\right) = ?$

$$p = v \cos\alpha \frac{2\pi m}{qB}$$

$$\begin{cases} \dfrac{q}{m} = v \cos\alpha \dfrac{2\pi}{Bp} = 3{,}71 \cdot 10^8\ C/kg \\ \tan\alpha = \dfrac{2\pi r}{p} \Rightarrow \alpha = 79{,}78° \end{cases}$$



risposta (C)

master copy

④ coo. (x,y,z)

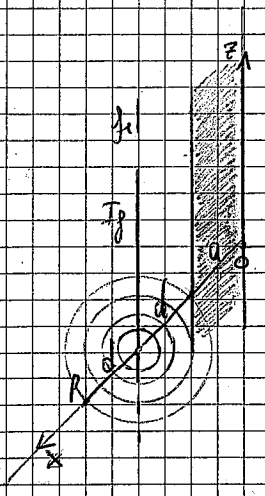
nastro conduttore infinito $\in y=0$

$a = 0{,}025\,\Omega$ (larghezza)

$I_n = 1{,}66\,A$

Jdl = uniforme

$d = 0{,}03\,14$





$$\begin{cases} B_f = \dfrac{\mu_0 I_f}{2\pi d} \\ B_N = \dfrac{\mu_0 I_n}{2\pi a}\ln\left(\dfrac{2d+a}{2a}\right) \end{cases} \rightarrow \frac{\mu_0 I_f}{2\pi d} = \frac{\mu_0 I_n}{2\pi a}\ln\left(\frac{2d+a}{2a}\right)$$

$$I_f = \frac{I_n}{a}\, d \cdot \ln\left(\frac{2d+a}{2a}\right) = 0{,}698\,A$$

risposta (E)

⑤ $J = kr$, con $k = 3{,}01 \cdot 10^{-3}\ A/m^3$

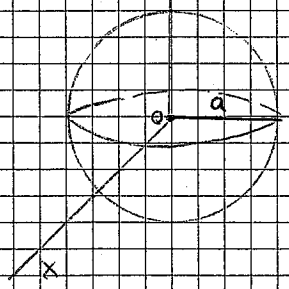
$a = 0{,}241\,m$ (raggio sfera)

1 sfera (con centro $O(0;0;0)$)

$\rho = 6{,}05 \cdot 10^{-6}\ \frac{C}{m^3}$

$dq = \rho \cdot dV$

$t = 60\,s$



$$\begin{cases} I = \dfrac{dq}{dt} \\ J = kr \end{cases} \quad \begin{cases} I = \int J\,dS \\ dq = \rho\,dV \end{cases}$$

$$\frac{dq}{dt} = \int J\,dS$$

$$\frac{q}{t} = \int kr\,dS$$

$$\Delta q = \left(\int kr \cdot r^2 \sin\vartheta\, d\vartheta\, d\varphi\, dr\right) \cdot t =$$

$$= k\frac{r^3}{3} 4\pi (60) = \frac{A}{m^3} \cdot m^3 \cdot s = \frac{C}{s} \cdot s = [C]$$

$$= 0{,}0106 \cdot 10^{-6}\,C$$

$$q = \int \rho\, dV = \rho \frac{4}{3}\pi a^3 = 0{,}354 \cdot 10^{-6}\,C$$

$$\rightarrow q = (0{,}354 - 0{,}0106) \cdot 10^{-6}\,C = 0{,}343 \cdot 10^{-6}\,C$$

risposta (C)