ΛΥΣΕΙΣ 2024

ΘΕΜΑ Α

Α1) δ Α2) γ Α3) γ Α4) β

Α5) α) Σ β) Λ γ) Σ δ) Σ ε) Λ

ΘΕΜΑ Β

Β1 Σωστή απάντηση : (ii)

Νόμος μετατόπισης Wien: $\lambda_{1max} \cdot T_1 = \lambda_{2\cdot max} \cdot T_2$

$\Rightarrow \lambda_{1max} \cdot T = \lambda_{2max} \cdot 2T \Rightarrow \lambda_{2max} = \frac{\lambda_{1max}}{2}$ (1)

$\left.\begin{aligned} \varphi_1 &= 2\pi \cdot 10^{15} t - 2\pi \cdot \frac{10^7}{3} x \\ \varphi_1 &= \frac{2\pi t}{T} - \frac{2\pi x}{\lambda_{1max}} \end{aligned}\right\}$ ΤΑΥΤΟΠΟΙΗΣΗ $\Rightarrow 2\pi \cdot 10^{15} = \frac{2\pi}{T} \Rightarrow T = 10^{-15}\,s$

$\frac{2\pi}{\lambda_{1max}} = \frac{2\pi \cdot 10^7}{3} \Rightarrow \lambda_{1max} = 3 \cdot 10^{-7}\,m$

(1) $\Rightarrow \lambda_{2max} = \frac{3 \cdot 10^{-7}}{2} = 1{,}5 \cdot 10^{-7}\,m$

$v = \frac{\lambda}{T} = \frac{3 \cdot 10^{-7}}{10^{-15}} = 3 \cdot 10^8\,m/s \rightarrow$ Σταθερή

Άρα: $v = \frac{\lambda_{2max}}{T_2} \Rightarrow T_2 = \frac{1{,}5 \cdot 10^{-7}}{3 \cdot 10^8} = 0{,}5 \cdot 10^{-15}\,s$

$\cdot \varphi_2 = \frac{2\pi t}{T_2} - \frac{2\pi x}{\lambda_{2max}} = \frac{2\pi \cdot t}{0{,}5 \cdot 10^{-15}} - \frac{2\pi \cdot x}{1{,}5 \cdot 10^{-7}}$

$\Rightarrow \boxed{\varphi_2 = 2\pi \left(2 \cdot 10^{15} t - \frac{2}{3} \cdot 10^7 x\right)\ (S.I.)}$

B2 Σωστή απάντηση:

Πείραμα 1ο

$\epsilon_1 = \frac{h \cdot c}{\lambda_1} = \frac{1250\ eV \cdot nm}{375\ nm} \Rightarrow \epsilon_1 = \frac{10}{3}\ eV$

$L_1 = m \cdot v_1 \cdot R_1$ με $K_1 = \epsilon_1 - \phi$ (1)

Πείραμα 2ο

$\epsilon_2 = \frac{h \cdot c}{\lambda_2} = \frac{h \cdot c}{\lambda_1/2} = 2 \cdot \frac{hc}{\lambda_1} \Rightarrow \epsilon_2 = 2\epsilon_1$

$L_2 = m \cdot v_2 \cdot R_2$, με $K_2 = \epsilon_2 - \phi$ (2)

$L_2 = 5 \cdot L_1 \Rightarrow m \cdot v_2 \cdot R_2 = 5 m \cdot v_1 \cdot R_1 \Rightarrow v_2 \cdot \frac{m \cdot v_2}{B \cdot |q|} = 5 v_1 \cdot \frac{m v_1}{B \cdot |q|}$

$\Rightarrow v_2^2 = 5 \cdot v_1^2$

$K_2 = \frac{1}{2} m \cdot v_2^2 = \frac{1}{2} \cdot m \cdot 5 \cdot v_1^2 = 5 K_1$ (3)

(1) $\Rightarrow K_1 = \epsilon_1 - \phi$

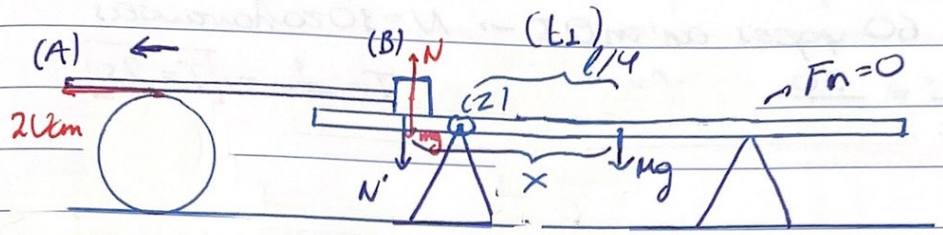
(2) $\overset{(3)}{\Rightarrow} 5K_1 = \epsilon_2 - \phi \Rightarrow K_2 = \frac{2\epsilon_1}{5} - \frac{\phi}{5}$

Τα τραίτα με τη σειρά:

$\epsilon_1 - \phi = \frac{2\epsilon_1}{5} - \frac{\phi}{5} \Rightarrow \frac{4}{5}\phi = \frac{3}{5}\epsilon_1 \Rightarrow \phi = \frac{3}{4} \cdot \epsilon_1 = \frac{3}{4} \cdot \frac{10}{3}$

$\Rightarrow \boxed{\phi = 2{,}5\ eV}$ → Βαρύ

B3 α/ Σωστή απάντηση: ii



Τη στιγμή t_1, χάνεται οριακά η επαφή με το σώμα Λ: $F_{\Lambda}=0$

Για το σώμα Σ: $\Sigma F_y=0 \Rightarrow N=mg \xrightarrow{\Delta-A} N'=N=mg$

Για τη δοκό:

$$\Sigma\tau_{(Z)}=0 \overset{+}{\Rightarrow} mg\left(x-\frac{l}{4}\right)=Mg\cdot\frac{l}{4} \Rightarrow \cancel{m}g\left(x-\frac{l}{4}\right)=\frac{\cancel{M}}{2}g\frac{l}{4}$$

$$\Rightarrow x-\frac{l}{4}=\frac{l}{8} \Rightarrow \boxed{x=\frac{3l}{8}}$$ ii

β/ Σωστή απάντηση: i

$U_{\Sigma}=2Vcm$ (λόγω της αβαρούς ράβδου ΑΒ)

$$x_{\Sigma}=2\cdot x_{cm} \xrightarrow{d/dt} U_{\Sigma}=2Vcm \xrightarrow{d/dt} a_{\Sigma}=2\cdot a_{cm}$$

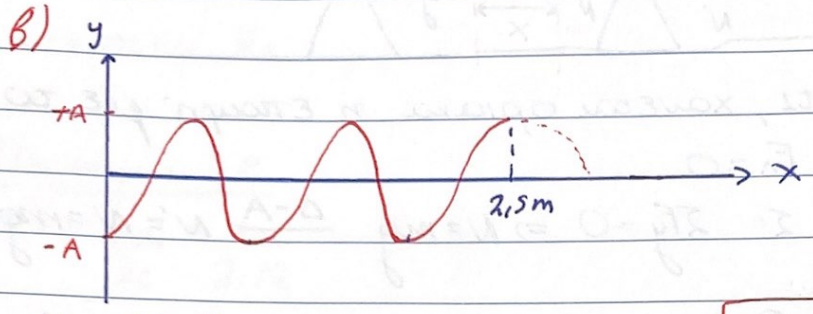
$$x_{\Sigma}=2x_{cm} \Rightarrow x_{cm}=\frac{x_{\Sigma}}{2}=\frac{3l}{16} \rightarrow \boxed{S=x_{cm}=\frac{3l}{16}}$$ i

ΘΕΜΑ Γ

Γ1) α) 60 φορές απ' την ΘΙ → Ν = 30 ταλαντώσεις

$f = \frac{N}{\Delta t} = \frac{30}{60} \Rightarrow f = 0,5\,Hz \rightsquigarrow T = \frac{1}{f} \Rightarrow \boxed{T = 2s}$

β)



$\lambda + \lambda + \frac{\lambda}{2} = x_\Delta \Rightarrow \frac{5\lambda}{2} = 2,5 \Rightarrow \boxed{\lambda = 1m}$

γ) $U = \frac{\lambda}{T} = \frac{1}{2} \Rightarrow \boxed{U = 0,5\,m/s}$

δ) $U = \frac{x_\Delta}{t_{αφ}} \Rightarrow t_{αφ.} = \frac{x_\Delta}{U} = \frac{2,5}{0,5} = 5s$

$t = 5s = 2T + \frac{T}{2} = 2,5T$

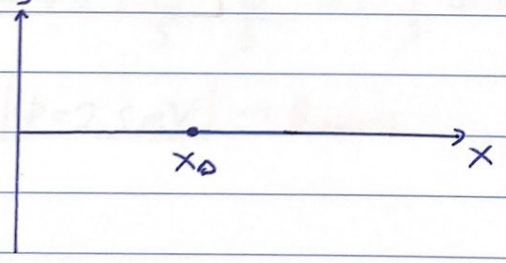
$T = 2s$

Σε $T \longrightarrow 4A$

Σε $2,5T \longrightarrow 2m$

$\Rightarrow 2 \cdot T = 4 \cdot A \cdot 2,5\pi \Rightarrow \boxed{A = 0,2m}$

Γ2)



Εξίσωση πηγής:

$y = A \cdot \eta\mu\,\omega t$ (Σε θέση $x = 0$)

$t_{αφ_\Delta} = \frac{x_\Delta}{U}$

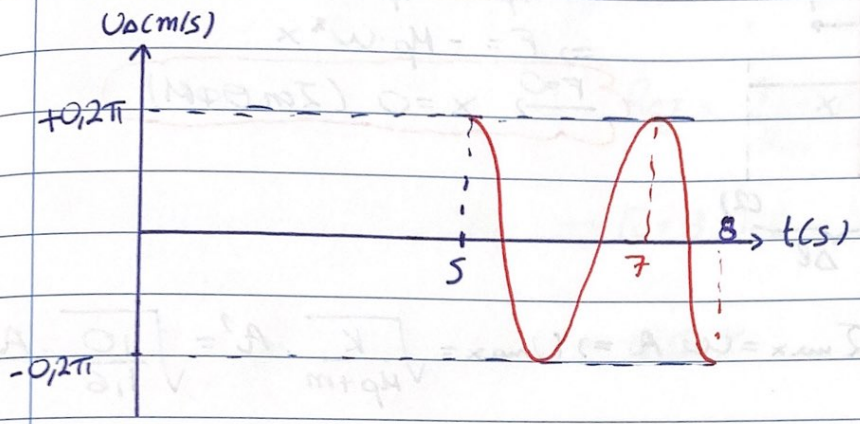
Εξίσωση για το σημείο Δ:

$y_\Delta = A \cdot \eta\mu[\omega(t - t_{αφ_\Delta})] = A \cdot \eta\mu\left[\frac{2\pi}{T}\left(t - \frac{x_\Delta}{U}\right)\right]$

$\Rightarrow y = A \cdot \eta\mu\left(\frac{2\pi t}{T} - \frac{2\pi x_\Delta}{T\,\lambda/T}\right) \Rightarrow \boxed{y = A \cdot \eta\mu\left(\frac{2\pi t}{T} - \frac{2\pi x_\Delta}{\lambda}\right)}$

Γ3) $U_\Delta = U_{max} \cdot \sigma\upsilon\nu\Phi_\Delta = \omega A \cdot \sigma\upsilon\nu\left(\frac{2\pi t}{T} - \frac{2\pi x_\Delta}{\lambda}\right)$

$\Rightarrow$ $U_\Delta = 0{,}2\pi \cdot \sigma\upsilon\nu(\pi t - 5\pi)$ (S.I.), για $t \geq 5s$



Γ4) Ο, Δ: Συμφωνία φάσης

$O\Delta = k \cdot \lambda' = 2{,}5m \xrightarrow[k=1]{\text{διαδοχικά}} \lambda' = 2{,}5m$

$U = \lambda' \cdot f' \Rightarrow f' = \frac{0{,}5}{2{,}5} \Rightarrow f' = 0{,}2Hz$

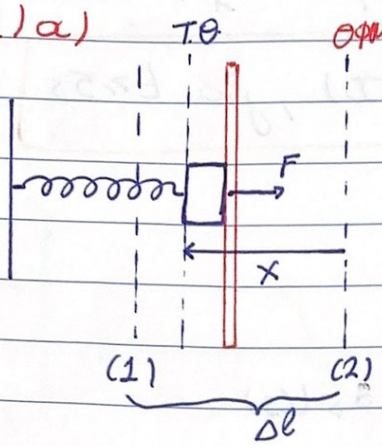
Αρχικά: $f = \frac{1}{T} = 0{,}5Hz$

Άρα: $\Delta f = f' - f = -0{,}3Hz$

Η συχνότητα μειώθηκε κατά 0,3 Hz

ΘΕΜΑ Δ

Δ1) α)



Στην Τ.Θ.:

$\Sigma F_{\text{ελ}} = -D_{\text{ελ}} \cdot x$

$\Rightarrow F = -M_{\text{ρ}} \cdot \omega^2 x$

$F=0 \Rightarrow x=0$ (Στη ΘΦΜ)

β) Στη ΘΦΜ: $U_{max} = \omega \cdot A \Rightarrow U_{max} = \sqrt{\frac{K}{M_{\text{ρ}}+m}} \cdot \Delta l = \sqrt{\frac{10}{1,6}} \cdot 0,4$

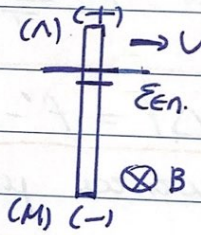
$\Rightarrow U_{max} = 1\ m/s$

Όμως: $U_{max} = U_{1max} \Rightarrow 1 = \omega_1 \cdot A_1 \Rightarrow 1 = \sqrt{\frac{K}{m}} \cdot A_1$

$\Rightarrow 1 = \sqrt{\frac{10}{0,4}} \cdot A_1 \Rightarrow 1 = 5 \cdot A_1 \Rightarrow \boxed{A_1 = 0,2m}$

Δ2) $\mathcal{E}_{\text{επ}} = N \cdot \frac{|\Delta\Phi|}{\Delta t} = N \cdot \frac{|\Delta(B \cdot A)|}{\Delta t} = B \cdot \frac{\Delta(l \cdot x)}{\Delta t} = B \cdot l \cdot \frac{\Delta x}{\Delta t}$

$\Rightarrow \mathcal{E}_{\text{επ}} = B \cdot U \cdot l$, με πολικότητα:

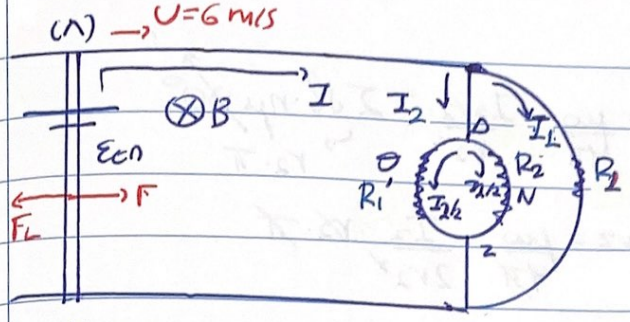


Δ3) $\Sigma F = M_{\text{ρ}} a \Rightarrow F = M_{\text{ρ}} a \Rightarrow 3 = 1,2 \cdot a \Rightarrow \boxed{a = 2,5\ m/s^2}$

$U = U_0 + a \cdot \Delta t = 1 + 2,5 \cdot (3-1) \Rightarrow \boxed{U = 6\ m/s}$

Δ4) Όταν κλείνει ο (δ):

α) $\mathcal{E}_{\text{επ}} = B \cdot U \cdot l = 1 \cdot 6 \cdot 1 = 6V$



$R_1' = R_2' = \frac{R_1}{2} = 5\Omega$

$R_{1,2} = \frac{R_1' \cdot R_2'}{R_1' + R_2'} = \frac{5 \cdot 5}{5+5} = 2,5\Omega$

$R_{ολ} = \frac{R_{1,2}' \cdot R_2}{R_{1,2}' + R_2} = \frac{2,5 \cdot 10}{10+2,5} = 2\Omega$

$I = \frac{Ecn}{R_{ολ}} = \frac{6}{2} = 3A \rightarrow F_L = B \cdot I \cdot \ell = 3N$

Αρα: $\Sigma F = F - F_L = 0 \rightarrow$ Ε.Ο.Κ

Β) Τα ημικυκλικά τμήματα διαρρέονται απο ρεύματα.

$I_1' = I_2' = \frac{I_1}{2}$

Ομως: $V_{1,2}' = V_2 \Rightarrow I_2 \cdot R_{1,2}' = I_1 \cdot R_1 \Rightarrow I_2 \cdot 2,5 = I_1 \cdot 10$

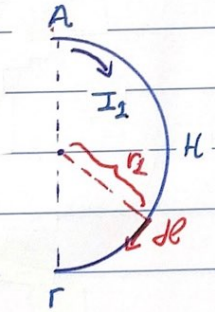
$\Rightarrow I_2 = 4I_1$

$I_1 + I_2 = I \Rightarrow 5I_1 = 3 \Rightarrow \boxed{I_1 = 0,6A}$

Αρα: $I_2 = 4I_1 = 2,4A \rightarrow \boxed{I_1' = I_2' = 1,2A}$

Δ5) α)

ΑΗΓ: $dB = \frac{\mu_0}{4\pi} \cdot \frac{I_1 dl}{r_1^2} \cdot \underbrace{\eta\mu 90^\circ}_{1}$

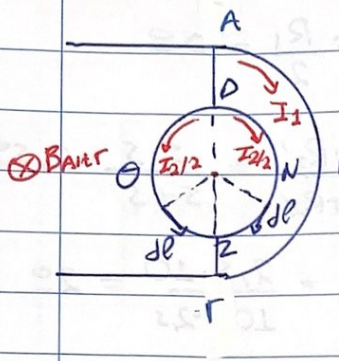


• $B_{ΑΗΓ} = \frac{\mu_0}{4\pi} \cdot \frac{I_1}{r_1^2} \cdot \Sigma dl \hookrightarrow r_1 \cdot \pi$

$\Rightarrow B_{ΑΗΓ} = \frac{\mu_0}{4\pi} \cdot \frac{I_1}{r_1^2} \cdot r_1 \cdot \pi$

$\Rightarrow B_{ΑΗΓ} = \frac{4\pi \cdot 10^{-7}}{4} \cdot \frac{0,6}{0,5} \Rightarrow \boxed{B_{ΑΗΓ} = 1,2\pi \cdot 10^{-7} T}$

B)



- $B_{ONZ} = \frac{\mu_0}{4\pi} \cdot \frac{I_2/2}{r_2^2} \cdot \sum d\ell \cdot \eta\mu 90^\circ$ (1), $\sum d\ell = r_2 \cdot \pi$

$\Rightarrow B_{ONZ} = \frac{\mu_0}{4\pi} \cdot \frac{I_2}{2r_2^2} \cdot r_2 \cdot \pi$

$\Rightarrow B_{ONZ} = \frac{\mu_0 \cdot I_2}{8 r_2}$ ⊗

- $B_{OEF} = \frac{\mu_0}{4\pi} \cdot \frac{I_2/2}{r_2^2} \cdot \sum d\ell \, \eta\mu 90^\circ$, $\sum d\ell = r_2 \cdot \pi$

$\Rightarrow B_{OEF} = \frac{\mu_0}{4\pi} \cdot \frac{I_2}{2r_2^2} \cdot r_2 \cdot \pi \cdot 1 \Rightarrow B_{OEF} = \frac{\mu_0 \cdot I_2}{8 r_2}$ ⊙

$\vec{B}_{O\lambda} = \vec{B}_{OEF} + \vec{B}_{ONZ} + \vec{B}_{AHF}$

$\overset{\otimes(+)}{\Rightarrow} B_{O\lambda} = -\frac{\mu_0 \cdot I_2}{8 r_2} + \frac{\mu_0 \cdot I_2}{8 r_2} + B_{AHF}$

$\Rightarrow \boxed{B_{O\lambda} = 1{,}2\pi \cdot 10^{-7} T}$