ΦΥΣΙΚΗ 2024

ΘΕΜΑ Α:

1 → δ, 2 → γ, 3 → γ, 4 → β Α5| Σ, Λ, Σ, Σ, Λ

ΘΕΜΑ Β:

Β1. $\varphi_1 = 2\pi\left(10^{15}t - \frac{10^7}{3}\cdot x\right)$

$\varphi_1 = 2\pi\left(\frac{t}{T_1} - \frac{x}{\lambda_1}\right)$

$10^{15}t = \frac{t}{T_1} \Rightarrow T_1 = 10^{-15}\,sec.$

$\frac{10^7}{3}x = \frac{x}{\lambda_1} \Rightarrow \lambda_1 = 3\cdot 10^{-7}\,m.$

- $T_2 = 2T_1$

Wien: $\lambda_1 T_1 = \lambda_2 T_2 \Rightarrow \lambda_1 T_1 = \lambda_2 \cdot 2T_1 \Rightarrow \lambda_1 = 2\lambda_2.$

$\Rightarrow \lambda_2 = \frac{\lambda_1}{2} = 1{,}5\cdot 10^{-7}\,m.$

$\varphi_2 = 2\pi\left(\frac{t}{T_2} - \frac{x}{\lambda_2}\right) = 2\pi\left(\frac{t}{2\cdot 10^{-15}} - \frac{x}{1{,}5\cdot 10^{-7}}\right) \Rightarrow$

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

Σωστή η (ii)

(B2)

$$\left.\begin{aligned} L_1 &= m \cdot v_1 \cdot R_1 \\ L_2 &= m \cdot v_2 \cdot R_2 \end{aligned}\right\} \quad \frac{L_1}{5L_1} = \frac{v_1 R_1}{v_2 R_2} \Rightarrow v_2 R_2 = 5 v_1 R_1$$

$$\Rightarrow v_2 \cdot \frac{m \cdot v_2}{B \cdot |q|} = 5 \cdot v_1 \frac{m \cdot v_1}{B|q|} \Rightarrow v_2^2 = 5 v_1^2 \quad (1)$$

- $K_1 = h \cdot f_1 - \varphi \Rightarrow \frac{1}{2} m v_1^2 = \frac{h \cdot c}{\lambda_1} - \varphi \quad (2)$

- $K_2 = h f_2 - \varphi \Rightarrow \frac{1}{2} m v_2^2 = \frac{h \cdot c}{\lambda_2} - \varphi \quad (3)$

$$\frac{(2)}{(3)}: \quad \frac{v_1^2}{5 v_1^2} = \frac{\frac{h \cdot c}{2\lambda_2} - \varphi}{\frac{hc}{\lambda_2} - \varphi} \Rightarrow \frac{h \cdot c}{\lambda_2} - \varphi = \frac{5hc}{2\lambda_2} - 5\varphi$$

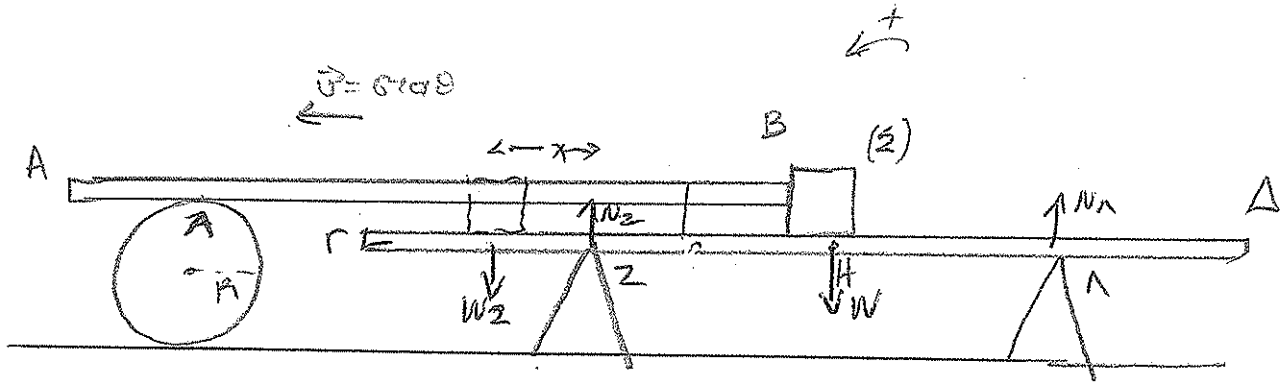
$$\Rightarrow 4\varphi = 1{,}5 \frac{hc}{\lambda_2} \Rightarrow \varphi = \frac{1{,}5}{4} \cdot \frac{1250}{\frac{375}{2}} \Rightarrow$$

$$\Rightarrow \varphi = \frac{1{,}5}{4} \cdot \frac{2500}{375} = \frac{1{,}5 \cdot 2500}{1500}$$

$$\Rightarrow \varphi = 2{,}5 \text{ eV} \rightarrow \underline{\text{Βάρος}}$$

Σωστή η (i)

B3)



α) • Ισορροπία ΣΔ: $\Sigma F_y = 0 \Rightarrow N_2 + N_A = W_2 + W$ (1)

• Την ελάχιστη $N_A = 0$. (1) $\Rightarrow N_2 = mg + M \cdot g$

$\Rightarrow N_2 = 3Mg$ (2)

• $\Sigma\tau_{(Z)} = 0 \Rightarrow W_2 \cdot x - W \cdot \frac{\ell}{4} = 0 \Rightarrow$

$\Rightarrow 2Mg\,x = Mg\frac{\ell}{4} \Rightarrow x = \frac{\ell}{8}$ (3)

• Άρα $d = \frac{\ell}{4} + \frac{\ell}{8} = \frac{3\ell}{8}$ (ii)

β) $U_A = U \Rightarrow 2U_{cm} = U \Rightarrow U_{cm} = \frac{U}{2}$

$\left.\begin{aligned} x_{cm} &= U_{cm} \cdot t_1 \\ x_\Sigma &= U \cdot t_1 \end{aligned}\right\}$ $x_{cm} = \frac{x_\Sigma}{2} \Rightarrow x_{cm} = \frac{3\ell}{16}$ (i)

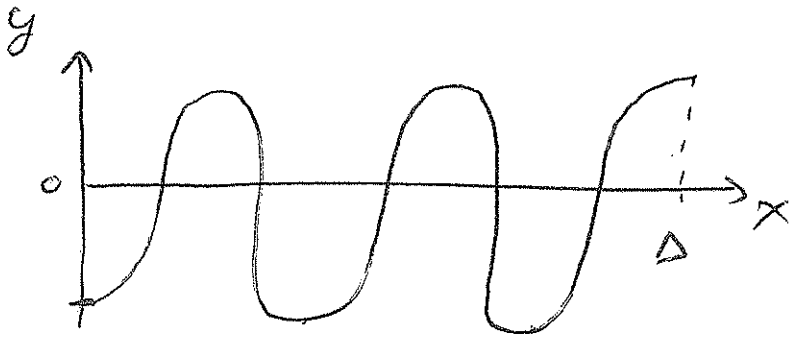
ΘΕΜΑ Γ

Γ1) • 60 φορές από ΘΙ → N = 30 επαναλ. σε Δt = 60sec

• $f = \frac{N}{\Delta t} = \frac{30}{60} = 0,5 Hz$, $T = \frac{1}{f} = 2 sec$.

$\omega = \frac{2\pi}{T} = \pi rad/s$

• $x_\Delta = 2,5 m$



$x_\Delta = 2,5\lambda \Rightarrow \boxed{\lambda = 1m}$, $v_\delta = \lambda \cdot f = 0,5 m/s$.

• $t_\Delta = 2,5T$ Άρα $2m = 10A \Rightarrow \underline{A = 0,2m}$

Γ2) Το σημείο Δ ξεκινάει την t_Δ ό

Μια τυχαία στιγμή t θα ταλαντώνεται για $t - t_\Delta$

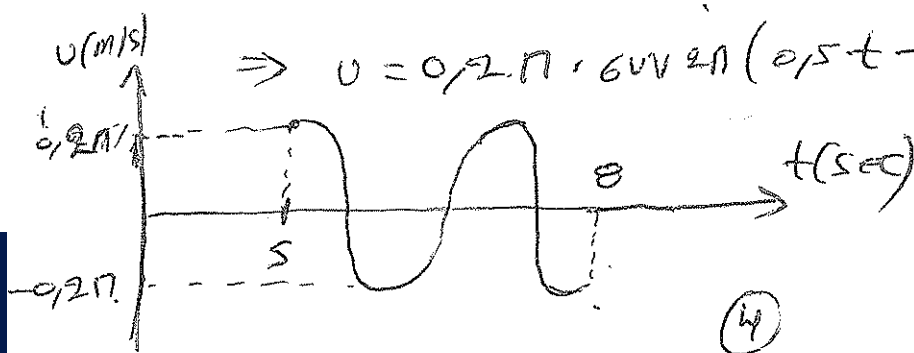
$= t - \frac{x_\Delta}{v_\delta}$.

$y = A \cdot \eta\mu\omega\left(t - \frac{x_\Delta}{v_\delta}\right) = A \cdot \eta\mu \frac{2\pi}{T}\left(t - \frac{x_\Delta}{v_\delta}\right) \Rightarrow y = A \cdot \eta\mu 2\pi\left(\frac{t}{T} - \frac{x_\Delta}{\lambda}\right)$.

Γ3) $t_\Delta = 2,5T = 5sec$

• $v_\Delta = v_{max} \cdot \sigma\upsilon\nu 2\pi\left(\frac{t}{T} - \frac{x_\Delta}{\lambda}\right) = 0,2\pi \cdot \sigma\upsilon\nu 2\pi\left(\frac{t}{2} - \frac{2,5}{1}\right)$

$\Rightarrow v = 0,2\pi \cdot \sigma\upsilon\nu 2\pi(0,5t - 2,5)$ SI για $t \geq 5sec$.



(Γ4) Συμφωνία φάσης:

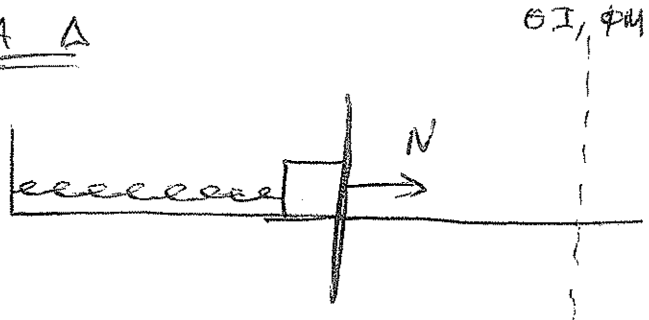
$\Delta x = k \cdot \lambda' \xrightarrow{k=1} 2,5 = \lambda' \Rightarrow \lambda' = 2,5\,m$ (ή $\lambda' = 2,5\,M$)

$u_\delta = \lambda' \cdot f' \Rightarrow f' = \frac{0,5}{2,5} = \frac{1}{5} = 0,2\,Hz$

Άρα $\Delta f = f' - f = -0,3\,Hz$

ΘΕΜΑ Δ

Δ1)



α) Για ράβδο: $\Sigma F_x = m_\rho a \Rightarrow N = -m_\rho \omega^2 x \overset{N=0}{\Rightarrow} x = 0$.

β) • Αρχικά: $\omega = \sqrt{\frac{K}{m_\rho + m}} = 2,5\ rad/s$

• Στην ΘΙ/ΦΜ: $V_K = V_{max} = \omega \cdot A = \omega \cdot \Delta\ell = 1\ m/s$

• Μετά το χάσιμο επαφής:

$V'_{max} = V_{max} = \omega' \cdot A'$ ①

$\omega' = \sqrt{\frac{K}{m_\Sigma}} = 5\ rad/s$

① $\Rightarrow A' = 0,2\ m$

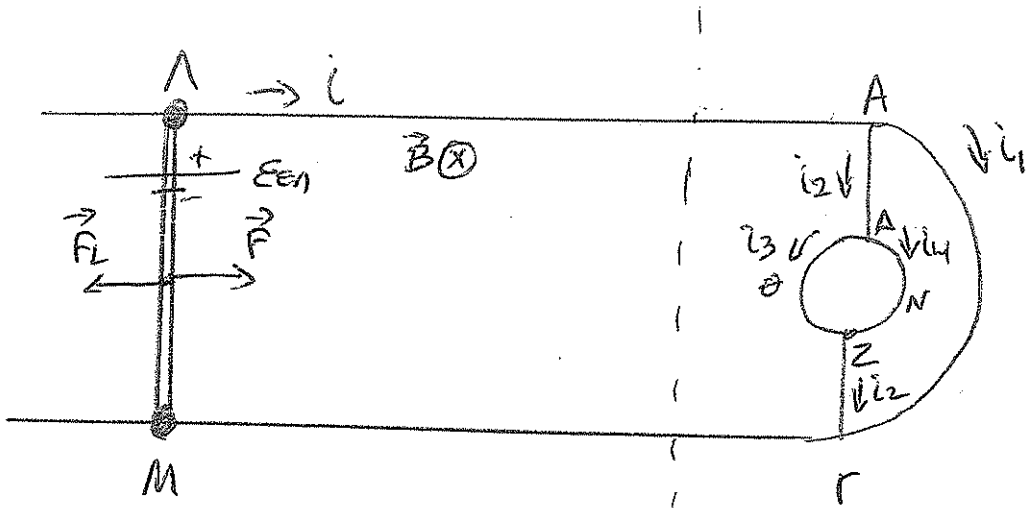
Δ2) Κίνηση ΛΜ → Δφ ... → Επ με Λ(+), Μ(−).

(ή F_L ετσι ε⁻ της ΛΜ προς Λ)

Δ3) $\Sigma F = M_\rho \cdot a \Rightarrow F = M_\rho \cdot a \Rightarrow a = 2,5\ m/s^2$

$U = V_{max} + a \cdot (t_2 - t_1) \Rightarrow U = 6\ m/s$

Δ4)



α)

• $R_{ΔNZ} = R_{ΔΘZ} = \frac{R_2}{2} = 5\Omega$.

• $R_{ΔNZ} // R_{ΔΘZ}$: $R_{ΔNZ,ΔΘZ} = \frac{R_{ΔNZ} \cdot R_{ΔΘZ}}{R_{ΔNZ} + R_{ΔΘZ}} = 2,5\Omega$

• $R_{ολ} = \frac{R_{ΔNZ,ΔΘZ} \cdot R_1}{R_{ΔNZ,ΔΘZ} + R_1} = 2\Omega$

• Ohm: $i = \frac{Εεπ}{R_{ολ}} = \frac{Bυℓ}{R_{ολ}} = 3A$

• Συνεπώς : $F_L = B \cdot i \cdot ℓ = 3N$.

Άρα: $ΣF = F - F_L = 0 \Rightarrow υ = σταθερή \Rightarrow ΕΟΚ$.

β) • $i_1 = \frac{V_{ΠΗ}}{R_1} = \frac{Εεπ}{R_1} = \frac{6}{10} = 0,6A$.

• 1ος ΚΚ: $i = i_2 + i_1 \Rightarrow i_2 = i - i_1 \Rightarrow i_2 = 2,4A$

• $V_{\Delta\Theta Z} = V_{\Delta N Z} \Rightarrow i_3 R_{\Delta\Theta Z} = i_4 \cdot R_{\Delta N Z} \Rightarrow i_3 = i_4$

1ος Κ.Κ: $i_2 = i_3 + i_4 \Rightarrow i_2 = 2 i_3 \Rightarrow i_3 = \frac{i_2}{2} = 12A = i_4$

Δ5) α) $dB_1 = \frac{\mu_0}{4\pi} \cdot \frac{i_1 \cdot dl}{r_1^2} \eta\mu 90^\circ = \frac{\mu_0}{4\pi} \frac{i_1 \cdot dl}{r_1^2}$ (1)

• $B_1 = \Sigma dB_1 = \frac{\mu_0}{4\pi} \cdot \frac{i_1}{r_1^2} \Sigma dl = \frac{\mu_0}{4\pi} \frac{i_1}{r_1^2} \frac{2\pi r_1}{2} \Rightarrow$

$\Rightarrow B_1 = \frac{\mu_0}{4\pi} \cdot \frac{\pi i_1}{r_1} \Rightarrow B_1 = 12\pi \cdot 10^{-8} T$ με $\vec{B}_1 \otimes$.

β) $dB_{\Delta\Theta Z} = \frac{\mu_0}{4\pi} \frac{i_3 \cdot dl}{r_2^2} \eta\mu 90^\circ$ με $\vec{dB}_{\Delta\Theta Z} \odot$

$dB_{\Delta N Z} = \frac{\mu_0}{4\pi} \cdot \frac{i_4 \, dl}{r_2^2} \eta\mu 90^\circ$ με $\vec{dB}_{\Delta N Z} \otimes$

Συνεπώς: $\vec{B}_{συνθ.ου} = \vec{dB}_{\Delta\Theta Z} + \vec{dB}_{\Delta N Z} = 0$.

Άρα $\vec{B}_{ολ} = \vec{B}_1 \Rightarrow |B_{ολ}| = |B_1| = 12\pi \cdot 10^{-8} T$

με $\vec{B}_1 \otimes$ δηλ. με φορά από τον αναγνώστη στην εικόνα.