ΘΕΜΑ Α

Α1 Β Α2 α Α3 δ Α4 Β

Α5. α Σ β Λ γ Λ δ Σ ε Λ

ΘΕΜΑ Β

Β1. 3 διαδοχικοί μηδενισμοί : $\Delta t = 2T_\Delta$ $\Big\} \Rightarrow \Delta t = 2s$

$$T_\Delta = \frac{1}{|f_1 - f_2|} = 1s$$

$$f_1 = \frac{\omega_1}{2\pi} = 199,5\ Hz$$

$$f_2 = \frac{\omega_2}{2\pi} = 200,5 Hz$$

$\bar{\omega} = \frac{\omega_1+\omega_2}{2} = 400\pi\ rad/s$, $T_{ταλ} = \frac{2\pi}{\omega} = \frac{1}{200}s$

$N = \frac{\Delta t}{T_{ταλ}} = 400$ ταλαντώσεις , διότι το

Β2 Εξίσωση συνέχειας: $\Pi_1 = \Pi_2 \Rightarrow A_1 v_1 = A_2 v_2 \Rightarrow$

$2A_2 v_1 = A_2 v_2 \Rightarrow v_2 = 2v_1$

Εξίσωση Bernoulli : $p_1 + \frac{1}{2}\rho v_1^2 + 0 = p_2 + \frac{1}{2}\rho v_2^2 + 0$

$$p_{atm} + \rho g h_1 + \frac{1}{2}\rho v_1^2 = p_{atm} + \rho g h_2 + \frac{1}{2}\rho 4v_1^2$$

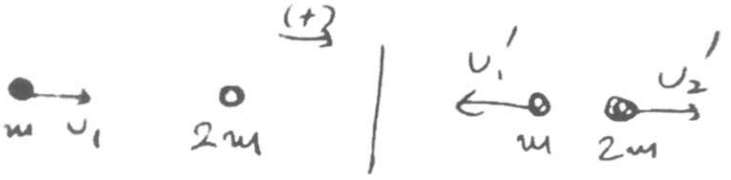
$$g(h_1 - h_2) = \frac{3}{2}v_1^2 \Rightarrow h = \frac{3v_1^2}{2g}$$

Ομοίως $\left.\begin{matrix} h' = \frac{3v_1'^2}{2g} \\ v_1' = 2v_1 \end{matrix}\right\} \Rightarrow h' = \frac{12v_1^2}{2g}$ $\Big\} \Rightarrow h' = 4h$

έτσι το

Β.3

πρόσκρουση Β, Γ



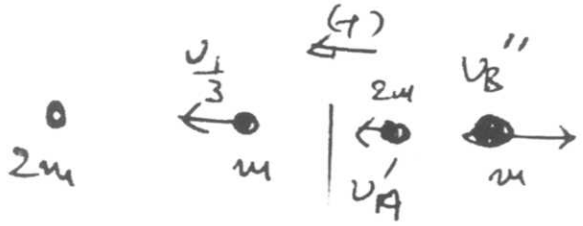
λόγω ΑΔΜΕ

$v_\Gamma = 0$

$$-v_1' = \frac{m-2m}{m+2m} v_1 \Rightarrow v_1' = \frac{v_1}{3}, \text{ αριστερά}$$

$$v_2' = \frac{2m}{3m} v_1 \Rightarrow v_2' = \frac{2v_1}{3}, \text{ δεξιά}$$

κρούση Β, Α



$$-v_B'' = \frac{m-2m}{m+2m} \frac{v_1}{3} \Rightarrow v_B'' = \frac{v_1}{9}, \text{ δεξιά}$$

η σφαίρα Α κινείται δεξιά, η Β με $\frac{v_1}{9}$ (δεξιά) $< v_2'$ άρα δεν θα γίνει άλλη κρούση.

$$\left.\begin{aligned} K_{B_{\text{ΤΕΛ}}} &= \frac{1}{2} m \frac{v_1^2}{81} \\ K_{B_{\text{ΑΡΧ}}} &= \frac{1}{2} m v_1^2 \end{aligned}\right| \Rightarrow \frac{K_{B_{\text{ΤΕΛ}}}}{K_{B,\text{ΑΡΧ}}} = \frac{1}{81}, \text{ δηλαδή το ζ}$$

Θέμα Γ

Από διάγραμμα ... $\frac{\Delta\varphi}{\Delta t} \to \omega = \frac{20\pi - 0}{4-2} \to \omega = 10\pi\, rad/s$

$T = \frac{2\pi}{\omega} = \frac{2\pi}{10\pi} = 0,2s$, $f = \frac{1}{T} = 5Hz$

Το κύμα φτάνει στο Ρ την $t_P = 2s$: $x_P = \upsilon\, t_P \Rightarrow \upsilon = \frac{1}{2}\, m/s$

και $\lambda = \frac{\upsilon}{f} = \frac{1}{10}\, m$ και κινείται κατά τη θετική φορά του x'x

Γ2) $E = \frac{1}{2} \Delta m\, \omega^2 A^2 \to 16\pi^2 10^{-8} = \frac{1}{2} 2\, 10^{-6} \cdot 10^2 \pi^2 A^2 \to A = 4 \cdot 10^{-2}\, m$ ή $A = 0,04m$

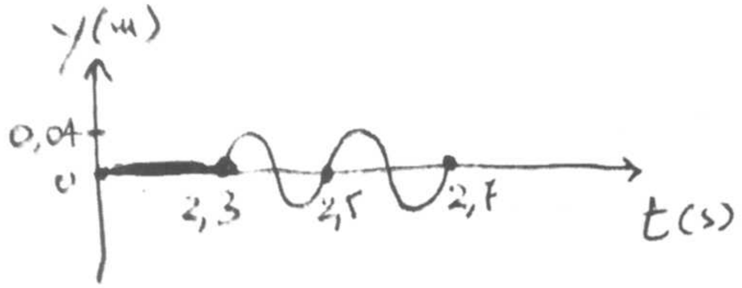
Γ3) $y = A\,\eta\mu(\omega t - \frac{2\pi x}{\lambda}) \Rightarrow y = 0,04\,\eta\mu(10\pi t - 20\pi x)$ SI

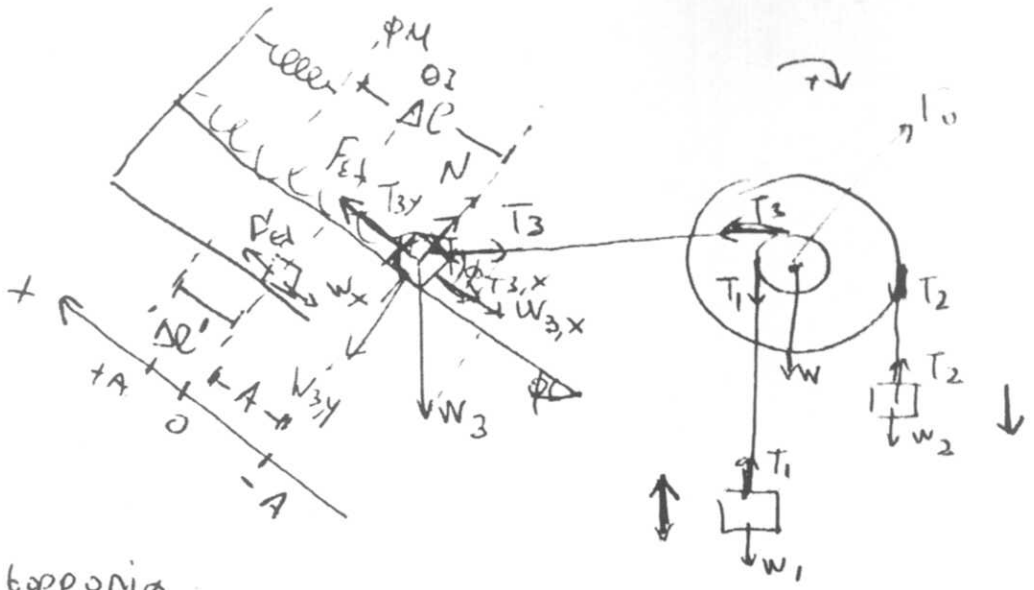
Γ4) Το κύμα φτάνει στο Σ την $t_2 = \frac{x_\Sigma}{\upsilon} = 2,3sec$

Άρα $y_2 = 0$ για $0 \le t < 2,3sec$

$y_\Sigma = 0,04\,\eta\mu(10\pi t - 23\pi)$ $2,3 \le t < 2,7s$

όπου εκτελεί $N = \frac{\Delta t}{T} = \frac{2,7-2,3}{0,2} = 2T$





Ισορροπία

Δ1

m_1 : $\Sigma F_1 = 0 \Rightarrow T_1 = m_1 g = 10N$

m_2 $\Sigma F_2 = 0 \Rightarrow T_2 = m_2 g = 15N$

τροχ : $\Sigma \tau_{(O)} = 0 \Rightarrow T_2 2R - T_1 R - T_3 R = 0 \Rightarrow T_3 = 2T_2 - T_1$

$\Rightarrow T_3 = 20N$

m_3 : $\Sigma F_x = 0 \Rightarrow F_{ελ} = W_{3,x} + T_{3,x} \Rightarrow$

x'x

$F_{ελ} = m_3 g \eta\mu\phi + T_3 \sigma\upsilon\nu\phi = 24 + 12 \Rightarrow F_{ελ} = 36N$

$F_{ελ} = K\Delta\ell \Rightarrow \Delta\ell = \frac{F_{ελ}}{K} = \frac{36}{300} \Rightarrow \Delta\ell = 0,12m$

Δ2/m_3 : ισορ. με κέντρο το σημείο όπου $\Sigma F = 0 \Rightarrow F_{ελ}' = W_x$

$\Rightarrow K\Delta\ell' = m_3 g \eta\mu\phi \Rightarrow 300\Delta\ell' = 24 \Rightarrow \Delta\ell' = \frac{24}{300} = 0,08m$

όταν πάτησε το νήμα $\upsilon = 0$ άρα το m_3 σε Α.Θ.

άρα $A = \Delta\ell - \Delta\ell' = 0,04m$.

$\omega_T = \sqrt{\frac{D}{m}} = \sqrt{\frac{K}{m}} = 10 rad/s$

Β' για $t=0$ $x = -A \Rightarrow \phi_0 = \frac{3\pi}{2}$

$x = A\eta\mu(\omega t + \phi_0)$

$\Downarrow$

$x = 0,04\eta\mu(10t + \frac{3\pi}{2})$

$\frac{\Delta p}{\Delta t} = \Sigma F = -Dx \Rightarrow \frac{\Delta p}{\Delta t} = -kA\eta\mu(\omega t + \phi_0) = -12\eta\mu(10t +$

για $t_1 = \frac{\pi}{15} s$: $\frac{\Delta p}{\Delta t} = -12\eta\mu\left(\frac{10\pi}{15} + \frac{3\pi}{2}\right) = -12\eta\mu\left(\frac{13\pi}{6}\right) =$

άρα $\left|\frac{\Delta p}{\Delta t}\right| = 6N$

$$\left.\begin{aligned} T_1' - m_1 g &= m_1 a_1 \\ m_2 g - T_2' &= m_2 a_2 \\ T_2' - T_1' R &= \tfrac{1}{2} M R^2 a_\gamma \\ a_1 &= a_{\text{εφ.ρ}} = a_\gamma R \\ a_2 &= a_{\text{εφ.ρ}} = a_\gamma \cdot 2R \end{aligned}\right\} \Rightarrow \begin{aligned} T_1' - m_1 g &= m_1 a_\gamma R \quad (1) \\ 2m_2 g - 2T_2' &= 2m_2 a_\gamma R \quad (2) \\ 2T_2' - T_1' &= 2M R a_\gamma \quad (3) \end{aligned}$$

$$2m_2 g - m_1 g = (m_1 + 4m_2 + 2M) R a_\gamma$$

$$20 = 10\, 0{,}1\, a_\gamma \Rightarrow a_\gamma = 20\ \text{rad/s}^2$$

$$a_1 = 2\ \text{m/s}^2$$

$$a_2 = 4\ \text{m/s}^2$$

$$h = S_1 + S_2 \Rightarrow$$

$$h = \tfrac{1}{2} a_1 t^2 + \tfrac{1}{2} a_2 t^2 \Rightarrow 3t^2 = 0{,}48$$

$$t^2 = 0{,}16 \Rightarrow t = 0{,}4\ \text{s}$$

(Στιγμή που φτάνουν στο ίδιο επίπεδο.)

$$\omega = a_\gamma t = 8\ \text{rad/s}$$

άρα $L = I\omega = 2MR^2\omega = 0{,}24\ \text{Kg}\,\frac{\text{m}^2}{\text{s}}$ (j·s