ΠΑΝΕΛΛΑΔΙΚΕΣ ΕΞΕΤΑΣΕΙΣ
ΓΕΝΙΚΟΥ ΛΥΚΕΙΟΥ
(ΠΑΛΑΙΟ ΣΥΣΤΗΜΑ)
ΦΥΣΙΚΗ ΠΡΟΣΑΝΑΤΟΛΙΣΜΟΥ
22 ΙΟΥΝΙΟΥ 2020

ΑΠΑΝΤΗΣΕΙΣ

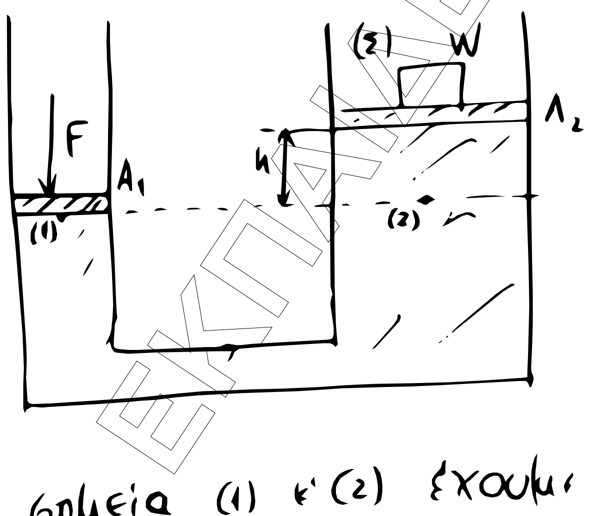
Θέμα Α

Α.1) β), Α.2) γ), Α.3) α), Α.4) α).

Α.5) α) Σωστό, β) Λάθος, γ) Λάθος, δ) Λάθος, ε) Σωστό.

Θέμα Β

Β.1) Σωστή η (ii)

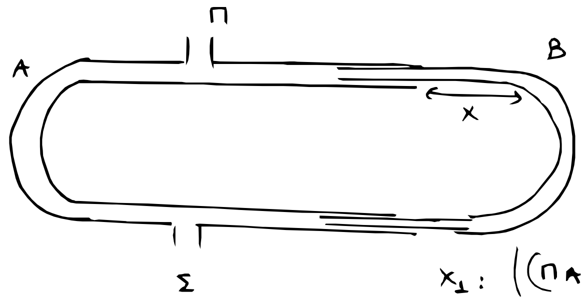


Στα σημεία (1) κ (2) έχουμε την ίδια πίεση αφού είναι το ίδιο υγρό στο ίδιο ύψος.

Άρα $P_1 = P_2 \Rightarrow \frac{F}{A_1} + \cancel{P_{atm}} = \rho \cdot g h + \frac{W}{A_2} + \cancel{P_{atm}} \Rightarrow$

$\Rightarrow \frac{F}{A_1} = \frac{W}{A_2} + \rho g h \Rightarrow \frac{F}{A_1} = \frac{W + \rho \cdot g \cdot h \cdot A_2}{A_2}$

B2.



$x_1: \left|(\Pi A \Sigma) - (\Pi B \Sigma) - 2x_1\right| = N\lambda$

$x_2: \left|(\Pi A \Sigma) - (\Pi B \Sigma) - 2x_2\right| = (2N+1)\frac{\lambda}{2}$

για $x = x_1 \to \Sigma$: ενισχυτική

$x = x_2 = x_1 + 4\,cm$
σε αναιρετική
(1η φορά)

Αφαιρούμε κατά μέλη:

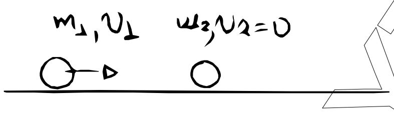
$$\left|\cancel{(\Pi A \Sigma)} - \cancel{(\Pi B \Sigma)} - 2x_2 - \cancel{(\Pi A \Sigma)} + \cancel{(\Pi B \Sigma)} + 2x_1\right| = (2N+1)\frac{\lambda}{2} - N\lambda$$

$$2x_2 - 2x_1 = \cancel{\frac{2N\lambda}{2}} + \frac{\lambda}{2} - \cancel{N\lambda}$$

$$2(\cancel{x_1} + 4_{cm} - \cancel{x_1}) = \frac{\lambda}{2}$$

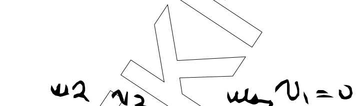
$$\lambda = 8 \cdot 2 \to \underline{\lambda = 16\,cm} \quad \text{(ii)}$$

B3.



$$v_2' = \frac{2m_1 v_1}{m_1 + m_2}$$

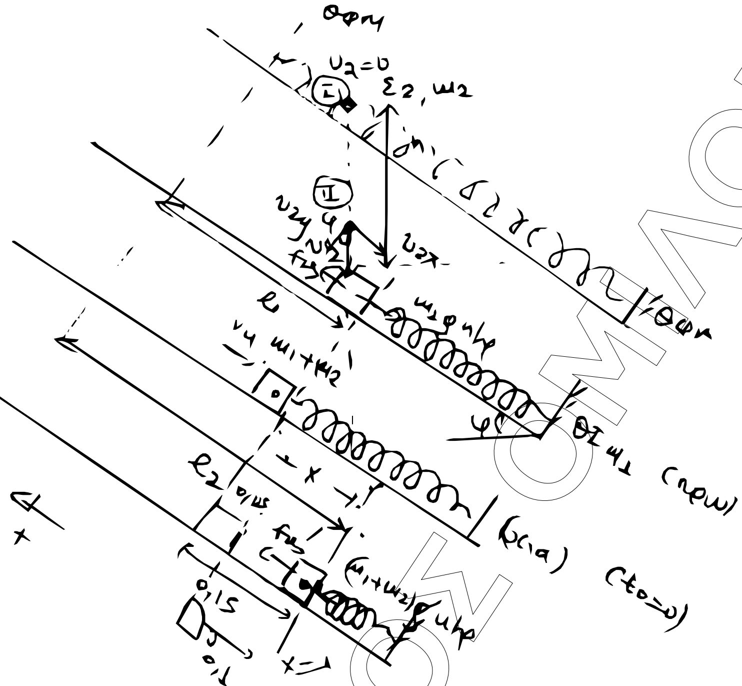
$$\Pi_1 = \frac{K_2'}{K_1} = \frac{\cancel{\frac{1}{2}} m_2 \frac{4 m_1^{\cancel{2}} \cancel{v_1^2}}{(m_1+m_2)^2}}{\cancel{\frac{1}{2}} \cancel{m_1} \cancel{v_1^2}} \Rightarrow \frac{K_2'}{K_1} = \frac{4 m_1 m_2}{(m_1 + m_2)^2}$$



όπου $v_1' = \frac{2 m_2 v_2}{m_1 + m_2}$

$$\Pi_2 = \frac{K_1'}{K_2} = \frac{\cancel{\frac{1}{2}} m_1 v_1'^2}{\cancel{\frac{1}{2}} m_2 v_2^2} = \frac{m_1 \cdot \frac{4 m_2^{\cancel{2}} \cancel{v_2^2}}{(m_1+m_2)^2}}{\cancel{m_2} \cancel{v_2^2}} = \frac{4 m_1 m_2}{(m_1+m_2)^2}$$

Άρα $\boxed{\Pi_1 = \Pi_2}$



ΘΕΜΑ Γ

$m_1 = 1\,kg$

$\theta = 30^\circ$

$k = 100\,N/m$

$h = 0,6\,m$

$m_2 = 3\,kg$

$D = k$

Γ1. $V_\kappa = ;$

Γ2. $A = ;$

Γ3. $x = f(t)$ ↑⊕.

Γ4. $\dfrac{F_{\varepsilon\lambda}}{\Sigma F} = ;$ $K = BU$

Γ1. $ΘΜΚΕ_{Σ\to I}$: $\Delta K = W_w \to \frac{1}{2} m_2 \upsilon_2^2 - 0 = m_2 g h$

$\upsilon_2 = \sqrt{2gh} \to \upsilon_2 = \sqrt{2\cdot 10\cdot 0,6} \to$

$\upsilon_2 = \sqrt{12} = \sqrt{3\cdot 4} \to \upsilon_2 = 2\sqrt{3}\,m/s$

ΑΔΟx : $\vec{p}_{\alpha\rho\chi,x} = \vec{p}_{\tau\varepsilon\lambda,x} \Rightarrow m_2 \upsilon_{2x} = (m_1 + m_2) V_\kappa \to$

$V_\kappa = \dfrac{m_2 \upsilon_{2x}}{m_1 + m_2} \to V_\kappa = \dfrac{3\cdot\sqrt{3}}{4} \to \boxed{V_\kappa = \frac{3}{4}\sqrt{3}\,m/s}$

$\upsilon_{2x} = \upsilon_2\,\eta\mu\varphi = \dfrac{\upsilon_2}{2} = \sqrt{3}\,m/s$

Γ2. ΘΙ m_1: $\Sigma F_x = 0 \to F_{\varepsilon\lambda} = w_{1x} \to m_1 g\,\eta\mu\varphi = k\,l_1 \to$

$l_1 = \dfrac{m_1 g\,\eta\mu\varphi}{k} = \dfrac{1\cdot 10\,\frac{1}{2}}{100} \Rightarrow l_1 = \dfrac{5}{100} \to l_1 = 5\cdot 10^{-2}\,m.$

ΘΙ m_1+m_2: $\Sigma F'_x = 0 \to F'_{\varepsilon\lambda} = (w_1 + w_2)_x \to (m_1+m_2) g\,\eta\mu\varphi = k\,l_2 \to$

$l_2 = \dfrac{(m_1+m_2) g\,\eta\mu\varphi}{k} \to l_2 = \dfrac{4\cdot 10\cdot\frac{1}{2}}{100} \to l_2 = 20\cdot 10^{-2}\,m.$

Η κρούση συμβαίνει τη $t=0$ αμέσως μετά τη κρούση.

όπου $x = l_2 - l_1 = 15\cdot 10^{-2}\,m$

ΑΔΕ$_1$ $(t_0=0)$: $E = K_0 + U_0 \Rightarrow \cancel{\frac{1}{2}} k A^2 = \cancel{\frac{1}{2}} m_{ολ} υ^2 + \cancel{\frac{1}{2}} k x^2 \Rightarrow$

$$A = \sqrt{\frac{m_1+m_2}{k} υ^2 + x^2} \Rightarrow A = \sqrt{\frac{4}{100} \cdot \frac{9}{16} \cdot 3 + 225 \cdot 10^{-4}}$$

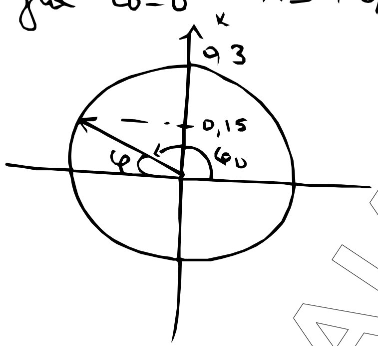
$$A = \sqrt{675 \cdot 10^{-4} + 225 \cdot 10^{-4}} \Rightarrow A = \sqrt{900 \cdot 10^{-4}} \Rightarrow$$

$$A = \sqrt{9 \cdot 10^{-2}} \Rightarrow A = 3 \cdot 10^{-1} m \Rightarrow \boxed{A = 0{,}3 m}$$

Γ3. $x = Aημ(ωt + φ_0)$

$$ω = \sqrt{\frac{k}{m_1+m_2}} = \sqrt{\frac{100}{4}} \Rightarrow ω = \sqrt{25} \Rightarrow \boxed{ω = 5 r/s}$$

για $t_0 = 0$ $x = +0{,}15 m$, $υ < 0$



$φ_0 = π - φ$

$ημφ = \frac{0{,}15}{0{,}3} = \frac{1}{2} \Rightarrow φ = \frac{π}{6}$ $\Big\} \Rightarrow φ_0 = π - \frac{π}{6} \Rightarrow \boxed{φ_0 = \frac{5π}{6} rad}$

Άρα $x = 0{,}3 ημ(5t + \frac{5π}{6})$ (SI)

Γ4. $K = 8U$

$E = K + U \Rightarrow E = 8U + U \Rightarrow E = 9U \Rightarrow \cancel{\frac{1}{2}} \cancel{k} A^2 = 9 \cdot \cancel{\frac{1}{2}} \cancel{k} x^2$

$$x = \pm \frac{A}{3}$$

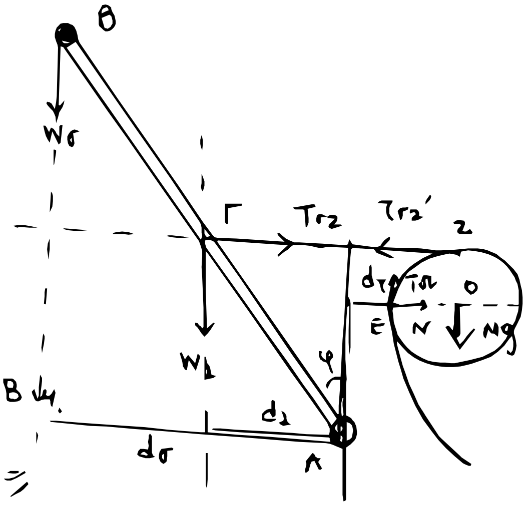
2η φορά $x = -\frac{A}{3} \Rightarrow \boxed{x = -0{,}1 m}$

$F_{ελ} = k(\ell_2 + x) = 100(0,2 + 0,1) = 100 \cdot 0,3$
$= 30\,N$

$\Sigma F = k \cdot x = 100 \cdot 0,1 = 10\,N$

$$\boxed{\frac{F_{ελ}}{\Sigma F} = 3}$$

ΘΕΜΑ Δ



$M_1 = 6\,kg$

$L = 1\,m$

$m = 1\,kg$

$r = 0{,}1\,m$

$KE = R = 3B\,m$

Δ1. i a) $T_{r2} = ;$

ii) $M_2 = ;$

Δ1 i) Ισορροπία για ράβδο:

$$\Sigma\tau_{(A)} = 0 \Rightarrow \tau_{w_\sigma(A)} + \tau_{w_1(A)} - \tau_{T_{r2}(A)} = 0 \Rightarrow$$

$$w_\sigma \cdot \ell\,\eta\mu\varphi + w_1\frac{\ell}{2}\eta\mu\varphi - T_{r2}\cdot\frac{\ell}{2}\sigma\upsilon\nu\varphi = 0$$

$$mg\cancel{\ell}\eta\mu\varphi + M_1 g\frac{\cancel{\ell}}{2}\eta\mu\varphi = T_{r2}\frac{\cancel{\ell}}{2}\sigma\upsilon\nu\varphi \Rightarrow$$

$$1\cdot10\cdot0{,}6 + \frac{6\cdot10\cdot0{,}6}{2} = T_{r2}\cdot\frac{0{,}8}{2} \Rightarrow 0{,}4\,T_{r2} = 6+18$$

$$T_{r2} = \frac{24}{0{,}4} \Rightarrow$$

$$T_{r2} = \frac{240}{4} \Rightarrow \boxed{T_{r2} = 60\,N}$$

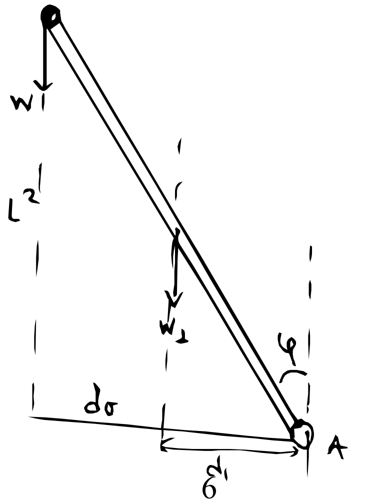
ii)

$$\Sigma\tau_{(E)} = 0 \Rightarrow \tau_{T_{r2}(E)} - \tau_{w(E)} = 0 \Rightarrow$$

$$T_{r2}\cdot\cancel{R} - Mg\cancel{R} = 0 \Rightarrow \quad M = \frac{T_{r2}}{g} \Rightarrow \boxed{M = 6\,kg}$$

Δ2.

$I_{\rho(A)} = \frac{1}{3}M_1L^2$



$$I_{\sigma\upsilon\sigma\tau(A)} = I_{\rho(A)} + I_{m(A)} \Rightarrow$$

$$I_{\sigma\upsilon\sigma(A)} = \frac{1}{3}M_1L^2 + mL^2 \Rightarrow$$

$$I_{\sigma\upsilon\sigma(A)} = \frac{1}{3}\cdot6\cdot1^2 + 1\cdot1^2 \Rightarrow$$

$$I_{\sigma\upsilon\sigma\tau(A)} = 2+1 \Rightarrow$$

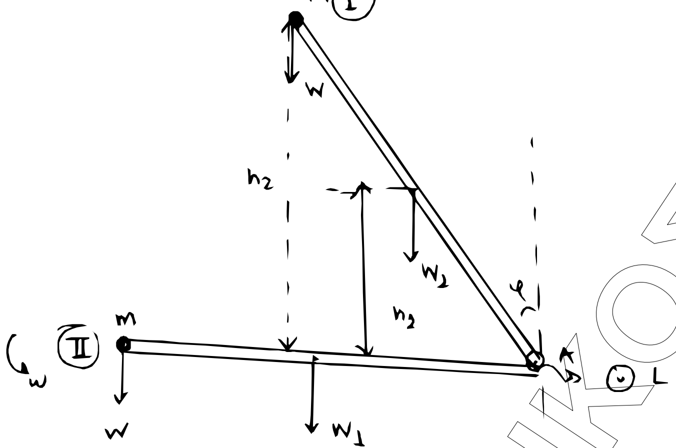
$$\boxed{I_{\sigma\upsilon\sigma\tau(A)} = 3\,kg\,m^2}$$

$\Sigma\tau_{(A)} = I_{(A)}\alpha_{\gamma\omega\nu} \Rightarrow \frac{\tau_{w(A)} + \tau_{w_1(A)}}{I} = \alpha_{\gamma\omega\nu} \Rightarrow$

$$\alpha_{\gamma\omega\nu} = \frac{mg\ell\eta\mu\varphi + M_1 g\frac{\ell}{2}\eta\mu\varphi}{I} \Rightarrow \alpha_{\gamma\omega\nu} = \frac{1\cdot10\cdot1\cdot0,6 + 6\cdot10\frac{1}{2}\cdot0,6}{3} \Rightarrow$$

$$\alpha_{\gamma\omega\nu} = \frac{6+18}{3} \Rightarrow \alpha_{\gamma\omega\nu} = \frac{24}{3} \Rightarrow \boxed{\alpha_{\gamma\omega\nu} = 8\ r/s^2}$$

Δ3. i)



$\Theta M K E_{I\to II}$: $\Delta K = W_{w_1} + W_w$

$$\frac{1}{2} I_{(A)}\omega^2 = m_1 g h_1 + mgh_2 \Rightarrow$$

$$\frac{1}{2} I_{(A)}\omega^2 = m_1 g \frac{\ell}{2}\sigma\upsilon\nu\varphi + mg\ell\sigma\upsilon\nu\varphi$$

$$\omega = \sqrt{\frac{2}{I}\left(m_1 g\frac{\ell}{2}\sigma\upsilon\nu\varphi + mg\ell\sigma\upsilon\nu\varphi\right)} \Rightarrow$$

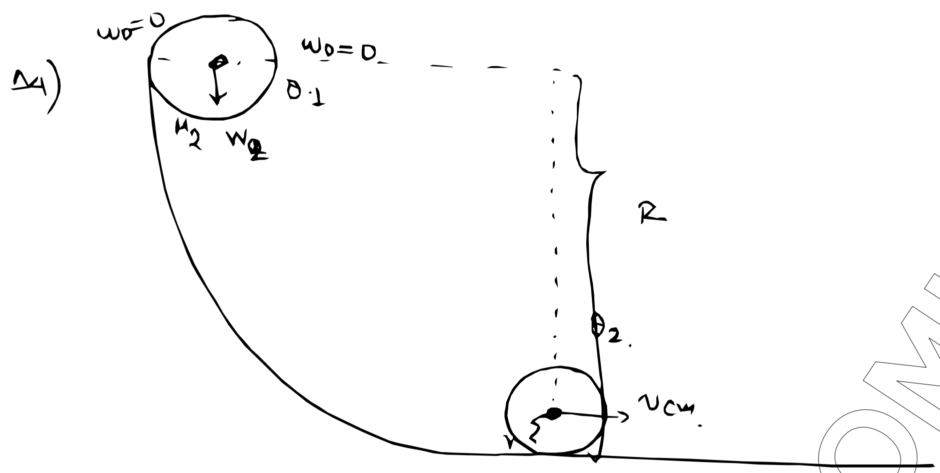
$$\omega = \sqrt{\frac{2}{3}\left(\overset{3}{\cancel{6}}\cdot10\cdot\frac{1}{\cancel{2}}\cdot0,8 + 1\cdot10\cdot1\cdot0,8\right)} \Rightarrow$$

$$\omega = \sqrt{\frac{2}{3}(24+8)} = \sqrt{2\cdot\frac{32}{3}} = \sqrt{\frac{64}{3}} = \frac{8}{\sqrt{3}} \Rightarrow \boxed{\omega = \frac{8\sqrt{3}}{3}\ r/s}$$

$$\Delta L = L_{\tau\epsilon\lambda} - \underbrace{\cancel{L_{\alpha\rho\chi}}}_{0,\ \omega_0=0} \Rightarrow \Delta L = I\omega \Rightarrow \boxed{\Delta L = 8\sqrt{3}\ kg\,m^2/s}$$

ii) ⊙ ΔL

Δ4)



$I_{cm\,\sigma} = \frac{1}{2} m_2 r^2$

ΘΜΚΕ $_{1\to 2}$: $\Delta K = W_w \Rightarrow$

$$\frac{1}{2} I_2 \omega^2 + \frac{1}{2} m_2 v_{cm}^2 = m_2 g (R - r) \Rightarrow$$

$$\frac{1}{2}\,\frac{1}{2} m_2 \cancel{r^2} \frac{v_{cm}^2}{\cancel{r^2}} + \frac{1}{2} m_2 v_{cm}^2 = m_2 g (R - r) \Rightarrow$$

$$\frac{1}{4} \cancel{m_2} v_{cm}^2 + \frac{1}{2} \cancel{m_2} v_{cm}^2 = \cancel{m_2} g (R - r) \Rightarrow$$

$$\frac{3}{4} v_{cm}^2 = g (R - r) \rightarrow \quad v_{cm} = \sqrt{\frac{4}{3} g (R - r)} \Rightarrow$$

$$v_{cm} = \sqrt{\frac{4}{3} \cdot 10 (2{,}7)} = \sqrt{4 \cdot 9} \rightarrow \quad v_{cm} = 2 \cdot 3 \rightarrow$$

$$\rightarrow \boxed{v_{cm} = 6\, m/s}$$

Δ.5).i) Το κέντρο μάζας του δίσκου διαγράφει τόξο $\widehat{\Delta S}_{cm} = \Delta\theta \cdot R_{cm} \xrightarrow[R_{cm}=R-r]{} \widehat{\Delta S}_{cm} = \frac{\pi}{2}(R-r)$.

Ως γνωστόν το cm του δίσκου μετακινείται όσο "τόξο απλώνει" στην επιφάνεια επαφής ο δίσκος

άρα $\widehat{\Delta S}_{cm} = N \cdot 2\pi r$ όπου N οι στροφές του δίσκου

κ' $2\pi r$ η περιφέρεια του.

Άρα $N\, 2\cancel{\pi} r = \frac{\cancel{\pi}}{2}(R-r) \rightarrow N = \frac{R-r}{4r} = \frac{2,7}{0,4} = \boxed{\frac{27}{4} \text{ περιστροφές}}$

ii) Όμοια κ' στο οριζόντιο $\Delta X_{cm} = N' 2\pi r \Rightarrow$

$\rightarrow \pi = N' \cdot 2\pi r \Rightarrow N' = \frac{1}{2r} = \boxed{5 \text{ περιστροφές}}$