Πανελλαδικές εξετάσεις 2021

Φυσική 22/6/2021

Απαντήσεις Θεμάτων

Θέμα Α

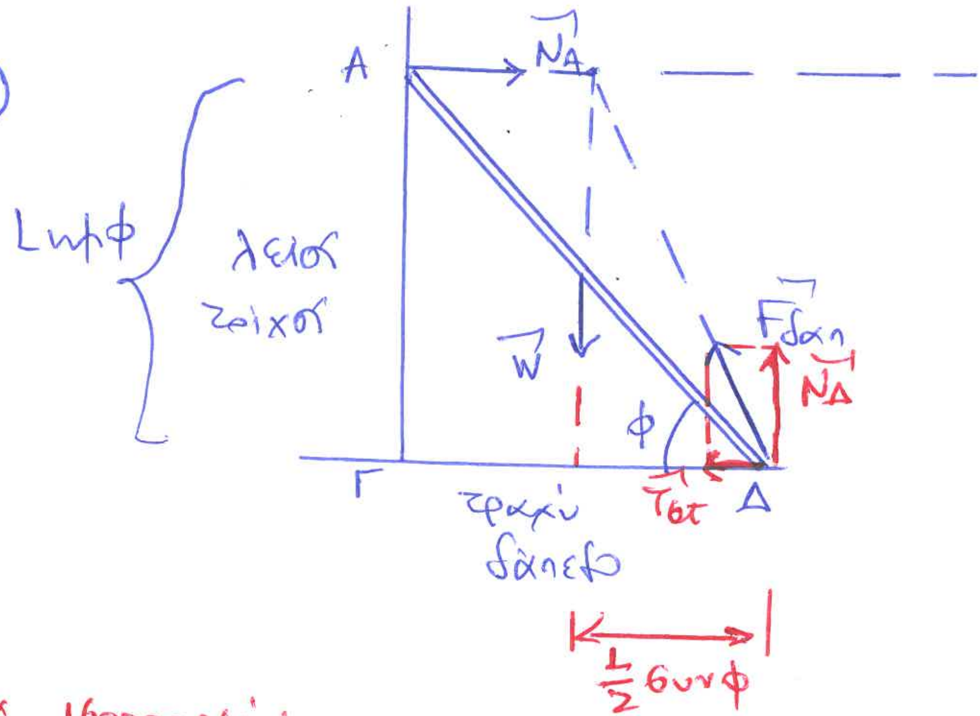
A1 γ A2 δ A3 γ A4 β

A5 α Σ β Λ γ Σ δ Σ ε Λ

Θέμα Β

B1 α) ii

$\mu \to \mu_{sop}$



Η σκάλα ισορροπεί:

$\Sigma\vec{\tau}_{(A)} = \vec{0} \overset{(+)}{\Rightarrow} \Sigma\tau_{(A)} = 0\,Nm \Rightarrow \tau_{N_A(A)} + \tau_{w(A)} + \cancel{\tau_{F_{\delta\alpha\pi}(A)}}^{\,0} = 0\,Nm$

$\Rightarrow -N_A \cdot \cancel{L}\eta\mu\phi + w \cdot \frac{\cancel{L}}{2}\sigma\upsilon\nu\phi = 0 \Rightarrow N_A\,\eta\mu\phi = \frac{w}{2}\sigma\upsilon\nu\phi$

$\Rightarrow N_A = \frac{w\,\sigma\upsilon\nu\phi}{2\eta\mu\phi}$

$\Sigma\vec{F} = \vec{0} \Rightarrow \left.\begin{matrix}\Sigma\vec{F_x} = \vec{0} \\ \Sigma\vec{F_y} = \vec{0}\end{matrix}\right\} \Rightarrow \begin{matrix}|\vec{N_A}| = |\vec{T}_{\sigma\tau}| = \frac{w\,\sigma\upsilon\nu\phi}{2\eta\mu\phi} \\ |\vec{N_\Delta}| = |\vec{w}| = w\end{matrix}$

αρκεί $T_{στ} \le T_{στ\,max} \Rightarrow \frac{w}{2}\frac{συνφ}{ημφ} \le μ_s \cdot N_Δ \Rightarrow$

$\Rightarrow \frac{\cancel{w}}{2}\frac{συνφ}{ημφ} \le μ_s \cdot \cancel{w} \Rightarrow μ_s \ge \frac{1}{2}\frac{συνφ}{ημφ}$

άρα $μ_{s\,οριακός} = μ = \frac{1}{2}\frac{συνφ}{ημφ} \Rightarrow \frac{ημφ}{συνφ} = \frac{1}{2μ} \Rightarrow$

$\Rightarrow \boxed{εφφ = \frac{1}{2μ}}$

B2) α) (i)

β) έμβολο ισορροπεί $\Sigma\vec{F} = \vec{0} \Rightarrow |\vec{F}_{ατμ}| + |\vec{w}| = |\vec{F}_{υγρ}|$

$\Rightarrow P_{ατμ}A + w = P_{υγρ} \cdot A$ (1) $(P_{υγρ},\ P_1 = P_{υγρ} + ρgh)$

Εξ. συνέχειας 1, 2 $\cancel{A}v_1 = \frac{\cancel{A}}{2}v_2 \Rightarrow v_1 = \frac{v_2}{2}$

Εξ. Bernoulli ελ. επιφάνεια, 2

$\ldots \Rightarrow \cancel{P_{ατμ}} + ρgH + 0 = \cancel{P_{ατμ}} + \frac{1}{2}ρv_2^2 + 0 \Rightarrow$

$\Rightarrow \frac{1}{2}\cancel{ρ}v_2^2 = \cancel{ρ}gH \Rightarrow v_2^2 = 2gH \Rightarrow |\vec{v}_2| = \sqrt{2gH}$ (2)

Εξ. Bernoulli 1, 2

$P_1 + \frac{1}{2}ρv_1^2 + 0 = P_{ατμ} + \frac{1}{2}ρv_2^2 + 0 \Rightarrow$

$\Rightarrow P_{υγρ} + ρgh + \frac{1}{2}ρ\frac{v_2^2}{4} = P_{ατμ} + \frac{1}{2}ρv_2^2 \Rightarrow$

$\Rightarrow P_{υγρ} = P_{ατμ} + \frac{3}{8}ρv_2^2 - ρgh \overset{(2)}{\Rightarrow}$

$\Rightarrow P_{υγρ} = P_{ατμ} + \frac{3}{4\cancel{8}}ρ \cdot \cancel{2}gH - ρg\frac{H}{4} \Rightarrow$

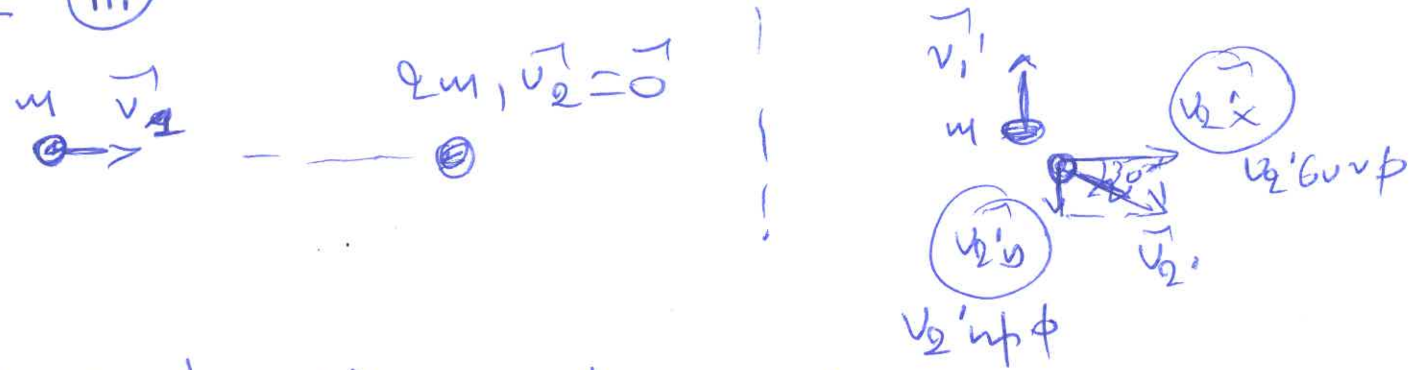
$\Rightarrow P_{υγρ} = P_{ατμ} + \frac{1}{2}ρgH \overset{\cdot A}{\Rightarrow}$

$\Rightarrow P_{υγρ} \cdot A = P_{ατμ}A + \frac{1}{2}ρgHA \overset{(1)}{\Rightarrow}$

$\Rightarrow \cancel{p_{atm}A} + w = \cancel{p_{atm}A} + \frac{1}{2}\rho g H A \Rightarrow$

$\Rightarrow \boxed{w = \frac{\rho g H A}{2}}$

B3 (iii)



ελαστική πλάγια κρούση $m, 2m$

ΑΔΟ $\Sigma\vec{F}_{εξ} = \vec{0} \Rightarrow \vec{p}_{πριν} = \vec{p}_{μετά} \Rightarrow \left.\begin{array}{l} p_{πριν,x} = p_{μετά,x} \\ p_{πριν,y} = p_{μετά,y} \end{array}\right\} \Rightarrow$

$\Rightarrow \left.\begin{array}{l} \cancel{m}|\vec{v}_1| = 2\cancel{m}\,|\vec{v}_2'|συν30° \\ 0 = m|\vec{v}_1'| - 2m|\vec{v}_2'|ημφ \end{array}\right\} \Rightarrow \left.\begin{array}{l} |\vec{v}_1| = 2\frac{\sqrt{3}}{2}|\vec{v}_2'| \\ |\vec{v}_1'| = 2|\vec{v}_2'|\frac{1}{2} \end{array}\right\}$

$\Rightarrow |\vec{v}_1| = \sqrt{3}|\vec{v}_2'| \rightsquigarrow |\vec{v}_2'| = |\vec{v}_1'| = \frac{|\vec{v}_1|}{\sqrt{3}} = \frac{\sqrt{3}}{3}|\vec{v}_1|$

$|\vec{v}_1'| = |\vec{v}_2'|$

(ii)

όμως ΑΔΕ για κρούση ελαστική

$\ldots \Rightarrow K_1 = K_1' + K_2' \Rightarrow \cancel{\frac{1}{2}}\cancel{m}v_1^2 = \cancel{\frac{1}{2}}\cancel{m}v_1'^2 + \cancel{\frac{1}{2}}2\cancel{m}v_2'^2$

$\Rightarrow v_1^2 = v_1'^2 + 2v_2'^2 \overset{|\vec{v}_1'| = |\vec{v}_2'|}{\Rightarrow} v_1^2 = 3v_1'^2 \Rightarrow$

$\Rightarrow |\vec{v}_1'| = \frac{|\vec{v}_1|}{\sqrt{3}} = \frac{\sqrt{3}}{3}|\vec{v}_1|$

Πλ. κρούση $Σ_1, Σ_3$ ... ΑΔΟ $\cancel{m}v_1' = 2\cancel{m}\cdot v_K \Rightarrow$

$\Rightarrow v_K = \frac{v_1'}{2}$

άρα $\dfrac{K_{συσ}}{K_1} = \dfrac{\cancel{\frac{1}{2}} \cdot 2\cancel{m} \cdot v_K^2}{\cancel{\frac{1}{2}}\cancel{m} \cdot v_1^2} = \dfrac{\cancel{2}\,\frac{v_1'^2}{\cancel{4}\,2}}{v_1^2} = \dfrac{v_1'^2}{2v_1^2}$

$= \dfrac{\left(\frac{\sqrt{3}}{3}|\vec{v}_1|\right)^2}{2v_1^2} = \dfrac{\frac{1}{3}\cancel{v_1^2}}{2\cancel{v_1^2}} = \dfrac{1}{6} \Rightarrow \boxed{\dfrac{K_{συσ}}{K_1} = \dfrac{1}{6}}$

Θέμα Γ

$l = 1m \quad m = 0{,}5kg \quad R_{\pi\eta\nu} = 2\Omega \qquad v = V\eta\mu(\omega t) =$
$= V\eta\mu(50\pi t)$

$R_1 = 6\Omega \quad R_2 = 3\Omega$

(Γ1) $δ_1$ κλειστός, $δ_2, δ_3$ ανοιχτοί $\quad \bar{P}_{R_1} = 12W$

$(v_{R_1} = v) \quad \bar{P}_{R_1} = I_{εν}^2 \cdot R_1 \Rightarrow I_{εν} = \sqrt{\dfrac{\bar{P}_{R_1}}{R_1}} = \sqrt{\dfrac{12}{6}}\,A \Rightarrow$

$\Rightarrow I_{εν} = \sqrt{2}A$, $\quad I_{εν} = \dfrac{I}{\sqrt{2}} \Rightarrow I = \sqrt{2}\,I_{εν} = 2A$

και $V = I \cdot R_1 = 12\,Volt$

(Γ2) $f \to 2f$, $\omega \to 2\omega \qquad 50\pi\,\frac{r}{s} \to 100\pi\,\frac{r}{s}$

$V = N\omega BA$

$V' = N\omega' BA = 2N\omega BA = 24V$

άρα $v'(t) = 24\eta\mu(100\pi t)$ και $i'(t) = \dfrac{v'(t)}{R_1} \Rightarrow$

$\Rightarrow i'(t) = 4\eta\mu(100\pi t)$, (S.I.)

οπότε $P(t) = v'(t) \cdot i'(t) = 96\eta\mu^2(100\pi t)$, (S.I.)

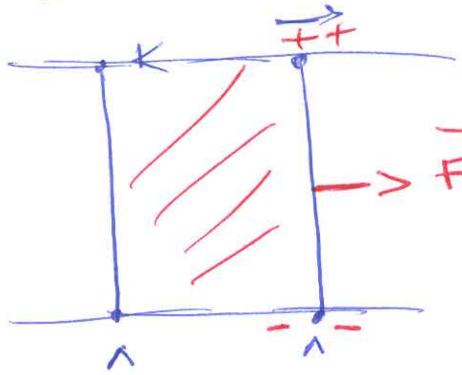
για $t_1 = 5 \cdot 10^{-3}s \to P(t_1) = 96\eta\mu^2(100\pi \cdot 5 \cdot 10^{-3}) =$

$= 96\eta\mu^2\left(\frac{\pi}{2}\right) \overset{(S.I.)}{=} 96 \cdot 1\,\frac{J}{s} = 96W$

Γ3. δ_1 ανοιχτός $F=0{,}5N \rightarrow$

$t=2s$ δ_2, δ_3 κλείσουν $v=6\tau\alpha\vartheta.$

από $0 \rightarrow 2s$

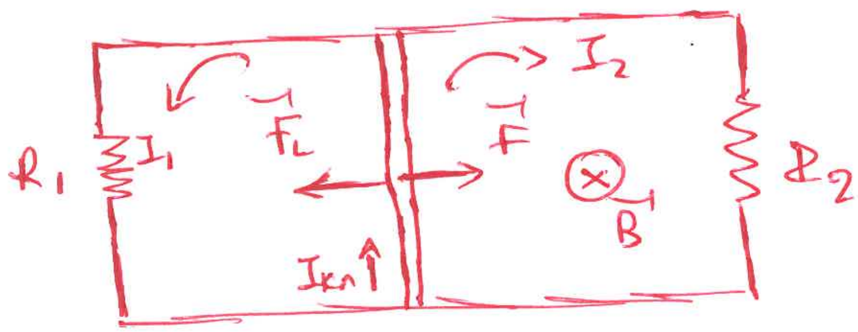


$$E_{\varepsilon\pi} = -N\frac{d\Phi}{dt} \Rightarrow |E_{\varepsilon\pi}| = \cancel{N}^{1}\left|\frac{d\Phi}{dt}\right| = B \cdot l\frac{dx}{dt} = Bvl$$

$$\Sigma\vec{F} = \vec{F} = m \cdot \vec{\alpha} \Rightarrow |\vec{\alpha}| = \frac{|\vec{F}|}{m} = 1\,m/s^2 \quad \text{Ε.Ο.Ε.Κ.}$$

$$v(2) = a \cdot t = 2\frac{m}{s} \quad \rightsquigarrow \quad E_{\varepsilon\pi} = Bvl$$

για $2s$, δ_2, δ_3 κλείσουν



$$v = v_{op},\ \alpha = 0\,m/s^2 \Rightarrow \Sigma F = 0N \Rightarrow |\vec{F}| = |\vec{F}_L| \Rightarrow$$

$$\Rightarrow F = B \cdot I_{K\Lambda} l \quad (1)$$

όμως $V_{R_1} = V_{K\Lambda} = V_{R_2} \Rightarrow I_1 R_1 = E_{\varepsilon\pi} - I_{K\Lambda} \cdot R_{K\Lambda} = I_2 R_2$

και $I_{K\Lambda} = I_1 + I_2$

με $R_1 \| R_2 \Rightarrow R_{1,2} = \frac{R_1 R_2}{R_1 + R_2} = \frac{6 \cdot 3}{6+3} = \frac{18}{9}\Omega = 2\Omega$

$$R_{o\lambda} = R_{1,2} + R_{K\Lambda} = 4\Omega$$

$$I_{K\Lambda} = I_{o\lambda} = \frac{Bvl}{R_{o\lambda}} = \frac{2B}{4} = \frac{B}{2} \ (SI)$$

από ① $\Rightarrow F = B \cdot \frac{B}{2} \ell \Rightarrow B^2 = \frac{2F}{\ell} \Rightarrow$

$\Rightarrow |\vec{B}| = \sqrt{\frac{1}{1}}\ T = 1T.$

Γ4 $\Delta x_{ολ} = \Delta x_{0\to2} + \Delta x_{2\to5} = \frac{1}{2} \alpha \underbrace{t^2}_{(0\to2)} + v_{op} \cdot (5-2) =$

$= \frac{1}{2} 1 \cdot 4 + 2 \cdot 3 \overset{(SI)}{=} 8m$

άρα $W_F = F \cdot \Delta x_{ολ} = 4J$

$Q_{R_2} = I_2^2 \cdot R_2 \cdot \Delta t \qquad (\Delta t = 5-2 = 3s)$

$I_2 = \frac{E_{επ} - I_{κλ} R_{ΚΛ}}{R_2} = \frac{Bvl - \frac{B}{2} \cdot R_{ΚΛ}}{R_2} = \frac{2 - \frac{1}{2} 2}{3}\ A$

$\Rightarrow \boxed{I_2 = \frac{1}{3} A}$ οπότε $Q_{R_2} = \frac{1}{9} \cdot 3 \cdot 3\ J = 1J$

Συνεπώς $n\% = \frac{Q_{R_2}}{W_F} 100\% = \frac{1}{4} 100\% = 25\%$

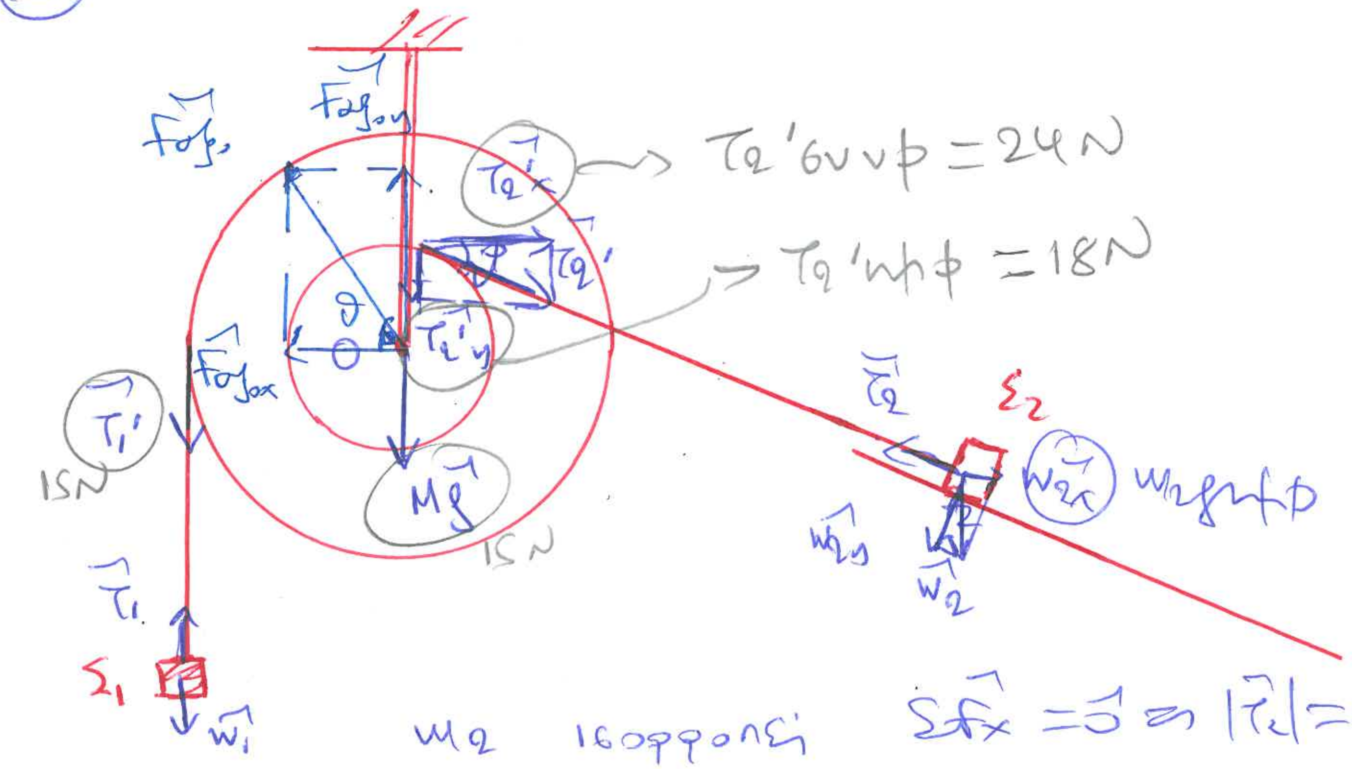
Θέμα Δ

$M = 1,5\,kg$ $\quad r,\ 2r \quad m_2 = 5kg \quad$ λείο κεκλιμένο

$ημφ = 0,6 \quad συνφ = 0,8 \quad m_3 = 5kg\ ,\ k\ ,\ d = 0,2m$

συσπείρωση

Δ1



m_2 ισορροπεί $\quad ΣF_x = 0 \Rightarrow |\vec{T}_2| = m_2 g ημφ$

$\Rightarrow |\vec{T}_2| = 50 \cdot 0,6N = 30N$

τροχαλία $\quad Σ\vec{τ}_{(O)} = \vec{0} \Rightarrow \ldots \Rightarrow +T_1' \cdot 2r - T_2' \cdot r = 0 \Rightarrow$

$\Rightarrow T_1' \cdot 2\cancel{r} = T_2' \cdot \cancel{r} \Rightarrow T_1' = \frac{T_2'}{2} = 15N$

αβαρή νήματα $\quad |\vec{T}_1'| = |\vec{T}_1| = 15N$

$|\vec{T}_2| = |\vec{T}_2'| = 30N$

m_1 ισορροπεί $\quad Σ\vec{F} = \vec{0} \Rightarrow |\vec{w}_1| = |\vec{T}_1| \Rightarrow m_1 g = |\vec{T}_1|$

$\Rightarrow m_1 = \frac{|\vec{T}_1|}{g} = 1,5\,kg \Rightarrow \boxed{m_1 = 1,5\,kg}$

Τροχαλία ισορροπεί

$\Sigma \vec{F} = \vec{0} \Rightarrow \left.\begin{matrix} \Sigma \vec{F}_x = 0 \\ \Sigma \vec{F}_y = \vec{0} \end{matrix}\right\} \Rightarrow$ $|\vec{F}_{\alpha\xi,x}| = |\vec{T}_2{}'_x| = T_2 \sigma\upsilon\nu\varphi = 24N$

$|\vec{F}_{\alpha\xi,y}| = |\vec{T}_1'| + |\vec{w}| + |\vec{T}_2{}'_y| =$

$= (15 + 15 + 18)\ N = 48N$

άρα $\vec{F}_{\alpha\xi} = \vec{F}_{\alpha\xi,x} + \vec{F}_{\alpha\xi,y} \Rightarrow |\vec{F}_{\alpha\xi}| = \sqrt{F_{\alpha\xi,x}^2 + F_{\alpha\xi,y}^2}$

$= \sqrt{24^2 + 48^2}\ N = \sqrt{24^2 + 4 \cdot 24^2}\ N \Rightarrow$

$\Rightarrow |\vec{F}_{\alpha\xi}| = \sqrt{5 \cdot 24^2}\ N = \underline{\underline{24\sqrt{5}\ N}}$

Δ2 $h = 1{,}8m \quad l = \frac{3\pi}{5} m \quad D = k$

Σ_3, Σ_2 κ.ε.κ. στη ΘΦΜ.

αρχικά Σ_3 

$\Sigma \vec{F} = \vec{0} \Rightarrow |\vec{F}_{\varepsilon\lambda 3}| = |\vec{T}_3| \Rightarrow$

$\Rightarrow k \cdot d = T_3$

Σ_2 ΑΔΕ (ΑΔΜΕ) ... $\cancel{m_2} g h = \frac{1}{2} \cancel{m_2} v_2^2 \Rightarrow$

$\Rightarrow |\vec{v}_2| = \sqrt{2gh} = \sqrt{20 \cdot 1{,}8}\ \frac{m}{s} = 6\ \frac{m}{s}$

$|\vec{v}_2| = \frac{l}{\Delta t} \Rightarrow \Delta t = \frac{l}{|\vec{v}_2|} = \frac{\frac{3\pi}{5}}{6} s = \frac{3\pi}{30} s = 0{,}1\pi\ s$

οπότε το Σ_3 εκτελεί ταλ/ση με $A = d$

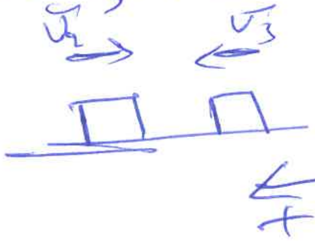
και $T = 2\pi \sqrt{\frac{m_3}{k}}$

Όμως $\Delta t = \frac{T}{4} \Rightarrow T = 4\Delta t = 0{,}4\pi\ s$

$\omega = \frac{2\pi}{T} = \frac{2\pi}{0,4\pi}\frac{r}{s} = 5\frac{r}{s}$

$D = k = m_3\omega^2 = 125\frac{N}{m}$

Δ3



$v_3 = v_{max} = \omega A = 5\cdot 0,2\frac{m}{s} = 1\frac{m}{s}$

$v_2 = -6\,m/s$ (αλγ.)

Κ.Ε.Κ. $m_2 = m_3 = 5\,kg$ ανταλλάσσουν ταχύτητες

$v_3' = v_2 = -6\frac{m}{s}$ και $v_2' = v_3 = 1\frac{m}{s}$

το m_3 ξεκινά νέα ΑΑΤ με $|\vec{v}_3'| = \omega\cdot A' \Rightarrow$

$\Rightarrow A' = \frac{6}{5}m = 1,2m$

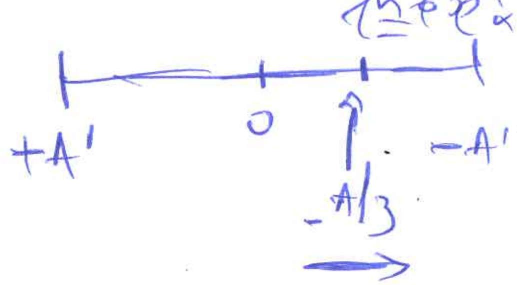
$\left.\begin{array}{l} x(0) = 0m \\ v(0) < 0 \end{array}\right\} \Rightarrow \left.\begin{array}{l} \eta\mu\varphi_0 = 0 \\ \sigma\upsilon\nu\varphi_0 < 0 \end{array}\right\} \overset{\varphi_0 \in [0,2\pi)}{\Rightarrow} \varphi_0 = \pi$

$x(t) = 1,2\,\eta\mu(5t+\pi)$

Δ4) $\left.\begin{array}{l} K_3 = 8U_3 \\ K_3 + U_3 = U_{max} \end{array}\right\} \Rightarrow 9U_3 = U_{max} \Rightarrow$

$\Rightarrow 9\cancel{\tfrac{1}{2}}\cancel{D}x_3^2 = \cancel{\tfrac{1}{2}}\cancel{D}A^2 \Rightarrow$

$\Rightarrow |x_3| = \frac{A'}{3} = 0,4m$



ΑΔΕΤ

$\frac{1}{2}m_3 v_3''^2 = 8\,\frac{1}{2}k\cdot\left(\frac{A'}{3}\right)^2 \Rightarrow$