ΠΑΝΕΛΛΑΔΙΚΕΣ ΕΞΕΤΑΣΕΙΣ
Γ΄ ΤΑΞΗΣ ΗΜΕΡΗΣΙΟΥ ΓΕΝΙΚΟΥ ΛΥΚΕΙΟΥ ΚΑΙ ΕΠΑΛ
(ΟΜΑΔΑ Β΄)
ΠΑΡΑΣΚΕΥΗ 29 ΜΑΪΟΥ 2015
ΕΞΕΤΑΖΟΜΕΝΟ ΜΑΘΗΜΑ: ΦΥΣΙΚΗ
ΘΕΤΙΚΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΚΗΣ ΚΑΤΕΥΘΥΝΣΗΣ (ΚΑΙ ΤΩΝ ΔΥΟ ΚΥΚΛΩΝ)

ΘΕΜΑ Α

Α1. α

Α2. β

Α3. α

Α4. δ

Α5. α. Λ

β. Σ
γ. Σ

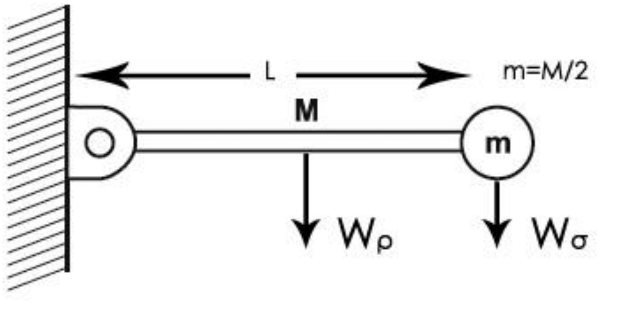
δ. Λ

ε. Σ

ΘΕΜΑ Β

Β1.

(iii) ΣΩΣΤΟ



$$\Sigma\tau_0^{\text{ολική}} = \mathrm{I}^{\text{ολική}}\alpha_\gamma \Rightarrow$$

$$\Sigma\tau_0 = \left(\frac{1}{3}\mathrm{M}L^2 + \frac{M}{2}L^2\right)\alpha_\gamma \Rightarrow$$

$$\Sigma\tau_0 = \frac{5}{6}ML^2 a_\gamma \Rightarrow$$

$$\mathrm{M}g\frac{L}{2} + \frac{M}{2}gL = \frac{5}{6}ML^2 a_\gamma \Rightarrow$$

$$\frac{g}{2} + \frac{g}{2} = \frac{5}{6}L\alpha_\gamma \Rightarrow$$

$$g = \frac{5}{6}L\alpha_\gamma \Rightarrow \alpha_\gamma = \frac{6g}{5L}$$

$$\frac{\Delta L_\rho}{\Delta t} = \Sigma\tau_\rho = \mathrm{I}_\rho \cdot \alpha_\gamma = \frac{1}{3}\mathrm{M}L^2 a_\gamma = \frac{1}{3}\mathrm{M}L^2\frac{6g}{5L} = \frac{2MgL}{5}$$

B2.

(iii) ΣΩΣΤΟ

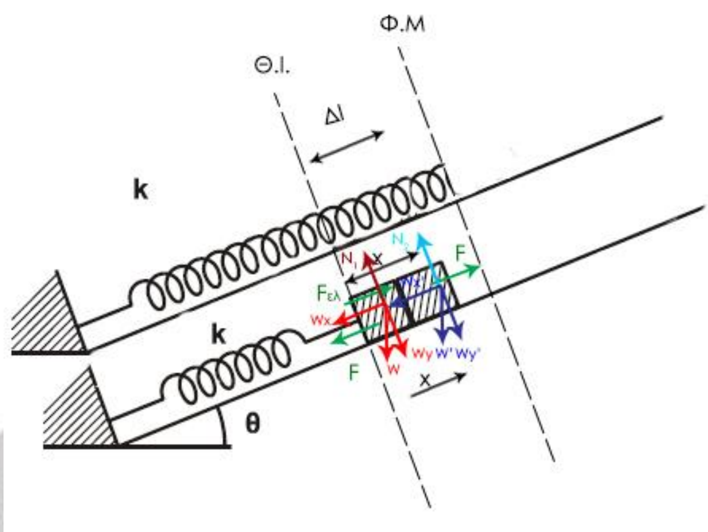
$$X_{3ου\,δεσμου} = \frac{5\lambda}{4}$$

$$Άρα\ \mathrm{X_M} = \frac{5\lambda}{4} + \frac{\lambda}{12} = \frac{16\lambda}{12} \Rightarrow \mathrm{X_M} = \frac{4\lambda}{3}$$

$$\mathrm{A'_M} = \left|2\mathrm{A}\sigma\upsilon\nu\frac{2\pi \mathrm{X_M}}{\lambda}\right| = \left|2\mathrm{A}\sigma\upsilon\nu\frac{2\pi}{\lambda}\frac{4\lambda}{3}\right| = \left|2\mathrm{A}\sigma\upsilon\nu\frac{8\pi}{3}\right| = \left|2\mathrm{A}\left(-\frac{1}{2}\right)\right| = A$$

B3.

ΣΩΣΤΟ (i)



$$\Theta\mathrm{I}_{σύστημα} : \Sigma F = 0 \Rightarrow F + F_{\varepsilon\lambda} - W_{2x} - W_{1X} - F = 0 \Rightarrow$$

$$\Rightarrow k\Delta l = (m_1 + m_2)g\eta\mu\theta$$

$$\Delta l = \frac{(m_1 + m_2)g\eta\mu\theta}{k}$$

$$D_{\sigma\upsilon\sigma\tau} = \mathrm{K} = (\mathrm{m}_1 + m_2)w^2$$

$$\left.\begin{array}{l} \gamma.\alpha.\tau.\, m_2 : \Sigma F_2 = -D_2 x \Rightarrow \\ D_2 = m_2\omega^2 \Rightarrow D_2 = \dfrac{m_2 k}{m_1 + m_2} \end{array}\right| \Rightarrow F - w_{2x} = -D_2 x \Rightarrow F = w_{2x} - D_2 x$$

μη απώλεια επαφής όσο

$$F > 0 \Rightarrow w_{2X} - D_2 x > 0 \Rightarrow w_{2X} > D_2 x \Rightarrow$$

$$m_2 g\eta\mu\theta > \frac{m_2 k}{m_1 + m_2} x \Rightarrow kx < (m_1 + m_2) g\eta\mu\theta \ \acute{\eta} \ \ x < \Delta l$$

εφόσον έχουμε ταλάντωση με πλάτος Α θα πρέπει

$$k\mathrm{A} < (m_1 + m_2) g\eta\mu\theta$$

ΘΕΜΑ Γ

Γ1.

$$U_E = E - U_B = E - \frac{1}{2}Li^2 \qquad U_E = 8\cdot 10^{-2} - 8\cdot 10^{-2} i^2 \quad \left| \begin{array}{l} E = 8\cdot 10^{-2}\, j \\ \frac{1}{2}L = 8\cdot 10^{-2} \Rightarrow L = 16\cdot 10^{-2}\, H \end{array} \right.$$

$$E = \frac{1}{2}CV^2 \Rightarrow 8\cdot 10^{-2} = \frac{1}{2}C\cdot 16\cdot 10^{-2} \Rightarrow C = 10^{-4}\, F$$

Γ2.

$$T = 2\pi\sqrt{LC} = 8\pi\cdot 10^{-3} s, \omega = \frac{2\pi}{\mathrm{T}} = 250\, rad/s$$

$$\gamma\iota\alpha\, t = 0 \ \ q = CV = 4\cdot 10^{-3} C, \quad i = 0 \ \Rightarrow Q = 4\cdot 10^{-3} C$$

$$\Rightarrow I = \omega Q \Rightarrow I = 1A$$

$$\mathrm{A}\rho\alpha\ \gamma\iota\alpha\ \ t = 0 \quad q = 0$$

συνεπώς

$$q = Q\sigma\upsilon\nu\omega t$$

$$\gamma\iota\alpha\ \ t = \frac{T}{12} \qquad q = Q\sigma\upsilon\nu\frac{2\pi}{\mathrm{T}}\frac{\mathrm{T}}{12} \Rightarrow q = Q\frac{\sqrt{3}}{2}$$

$$\acute{\alpha}\rho\alpha\, U_E = \frac{1}{2}\frac{q^2}{C} = \frac{1}{2}\frac{Q^2}{C}\frac{3}{4} \Rightarrow U_E = \frac{3}{4}E = 6\cdot 10^{-2}\, j$$

Γ3

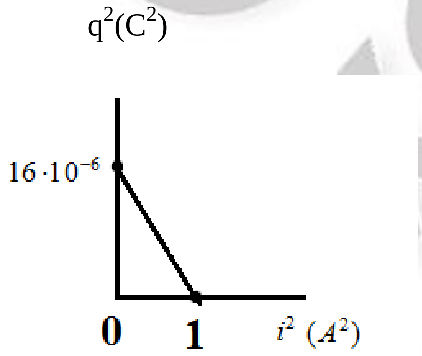
$$i = -\omega Q\eta\mu\omega t \Rightarrow \frac{di}{dt} = -\omega^2 q$$

$$U_E = 3U_B \Rightarrow U_E = 3(\mathrm{E} - \mathrm{U}_E) \Rightarrow 4U_E = 3E \Rightarrow U_E = \frac{3}{4}E \Rightarrow q = \pm Q\frac{\sqrt{3}}{2}$$

$$A\rho\alpha \left|\frac{di}{dt}\right| = \omega^2 Q\frac{\sqrt{3}}{2} = 250\frac{\sqrt{3}}{2}\,A/s = 125\sqrt{3}\,A/s$$

Γ4

Από Διατήρηση Ενέργειας ηλ. Ταλάντωσης



$$U_E = E - U_B$$

$$\frac{1}{2}\frac{q^2}{C} = E - U_B \Rightarrow q^2 = 2\cdot 10^{-4}\cdot 8\cdot 10^{-2}(1-i^2) \Rightarrow$$

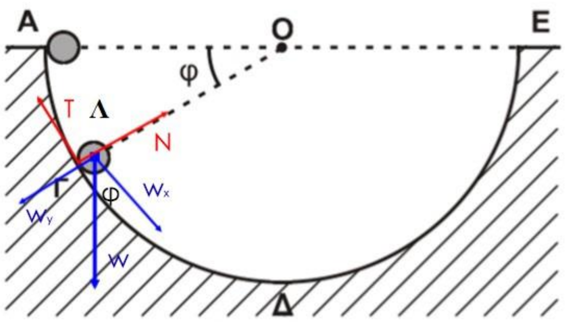
$$q^2 = 16\cdot 10^{-6} - 16\cdot 10^{-6} i^2 \qquad SI$$

ή

$$\frac{1}{2}\frac{q^2}{C} - \frac{1}{2}Li^2 = \frac{1}{2}\frac{Q^2}{C} \Rightarrow q^2 = LC(\mathrm{I}^2 - i^2) \Rightarrow$$

$$\Rightarrow \mathrm{q}^2 = 16\cdot 10^{-6}(1-i^2)$$

ΘΕΜΑ Δ



Δ1.

$$\left.\begin{array}{l}\Sigma F_x = m\alpha_{cm(\Lambda)} \Rightarrow mg\sigma\upsilon\nu\phi - \mathrm{T}_\sigma = m\alpha_{cm} \\ \Sigma\tau_\Lambda = \mathrm{I}_\Lambda\alpha_\gamma \Rightarrow \mathrm{T}_\sigma r = \frac{2}{5}mr^2\alpha_\gamma \Rightarrow \mathrm{T}_\sigma = \frac{2}{5}mr\alpha_\gamma \\ \textit{αλλά επειδή κάνει κύλιση χωρίς ολίσθηση έχουμε} \\ r\cdot\alpha_\gamma = \alpha_{\varepsilon\pi\iota\tau\rho} = \alpha_{cm}\end{array}\right\}$$

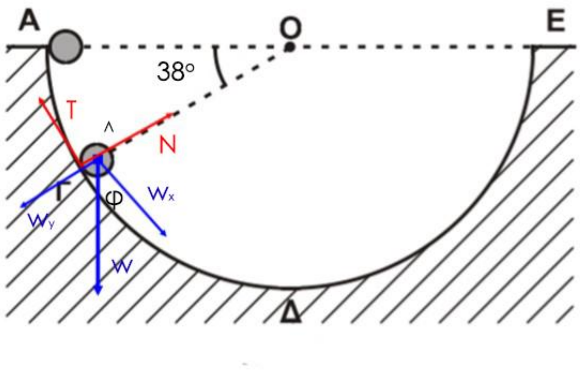
$$mg\sigma\upsilon\nu\phi - \mathrm{T}_\sigma = m\alpha_{cm}$$

$$\mathrm{T}_\sigma = \frac{2}{5}m\alpha_{cm}$$

$$mg\sigma\upsilon\nu\phi = \frac{7}{5}m\alpha_{cm} \Rightarrow \boxed{\alpha_{cm} = \frac{5}{7}g\sigma\upsilon\nu\phi}$$

$$\text{άρα } \mathrm{T}_\sigma = \frac{2}{5}m\frac{5}{7}g\sigma\upsilon\nu\phi \Rightarrow \boxed{\mathrm{T}_\sigma = \frac{2}{7}mg\sigma\upsilon\nu\phi} = \frac{2}{7}1,4\cdot 10\sigma\upsilon\nu\phi = 4\sigma\upsilon\nu\phi$$

Δ2.



$$\text{ΑΔΜΕ}: K_\alpha + U_\alpha = K_\tau + U_\tau$$

$$mgh = \frac{1}{2} I_\Lambda \omega_1^2 + \frac{1}{2} m u_1^2$$

$$\eta\mu 30 = \frac{h}{R - \frac{R}{8}} = \frac{h}{\frac{7R}{8}} \Rightarrow h = \frac{7R}{8} \cdot \frac{1}{2} \Rightarrow \boxed{h = \frac{7R}{16}}$$

$$\alpha\lambda\lambda\acute{\alpha}\ u_1 = u_r = \omega r$$

$$mg\frac{7R}{16} = \frac{1}{2}\frac{2}{5} m r^2 \omega_1^2 + \frac{1}{2} m u_1^2 \Rightarrow m u_1^2 = g\frac{7R}{16} = \frac{1}{5} m u_1^2 + \frac{1}{2} m u_1^2 \Rightarrow$$

$$\frac{7gR}{16} = \frac{7}{10} u_1^2 \Rightarrow u_1^2 = \frac{10gR}{16} \Rightarrow u_1 = \sqrt{\frac{10gR}{16}} = \sqrt{\frac{10 \cdot 10 \cdot 1{,}6}{16}} = \sqrt{10}\ m/s$$

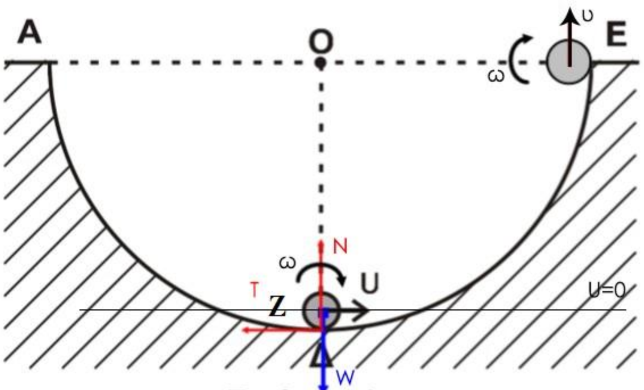
$$\acute{A}\rho\alpha\ \Sigma F_{\alpha\kappa\tau\acute{\iota}\nu\alpha\ \eta\mu\iota\sigma\varphi\alpha\acute{\iota}\rho.} = m\alpha_\kappa = m\frac{u_1^2}{R - \frac{R}{8}} \Rightarrow N - w_y = \frac{m u_1^2}{\frac{7R}{8}} \Rightarrow$$

$$\Rightarrow N - mg\eta\mu 30 = \frac{m}{\frac{7R}{8}} \frac{10gR}{16} \Rightarrow N - \frac{mg}{2} = \frac{8m}{7R}\frac{10gR}{16} \Rightarrow$$

$$\Rightarrow N - \frac{mg}{2} = \frac{80mg}{7 \cdot 16} \Rightarrow N = \frac{mg}{2} + \frac{5}{7} mg \Rightarrow$$

$$\Rightarrow N = \frac{17mg}{14} \Rightarrow N = \frac{17 \cdot 1{,}4 \cdot 10}{14} \Rightarrow \boxed{N = 17N}$$

Δ3.



Σχήμα 4

ΑΔΜΕ νέα σφαίρα:

$$Ka + Ua = K\tau + U\tau$$

$$\frac{1}{2}mu^2 + \frac{1}{2}I_Z\omega^2 = \frac{1}{2}mu'^2 + \frac{1}{2}I_Z\omega'^2 + mg\left(R - \frac{R}{8}\right)$$

$$\frac{1}{2}mu^2 + \frac{1}{2}\frac{2}{5}mr^2\omega^2 = \frac{1}{2}mu'^2 + \frac{1}{2}\frac{2}{5}mr^2\omega'^2 + mg\frac{7R}{8}$$

Ξέρουμε ότι κάνει κύλιση χωρίς ολίσθηση

$$u' = u'_{\lambda o} = \omega' r \quad \kappa\alpha\iota \quad u = \omega r = u_{\gamma\rho}$$

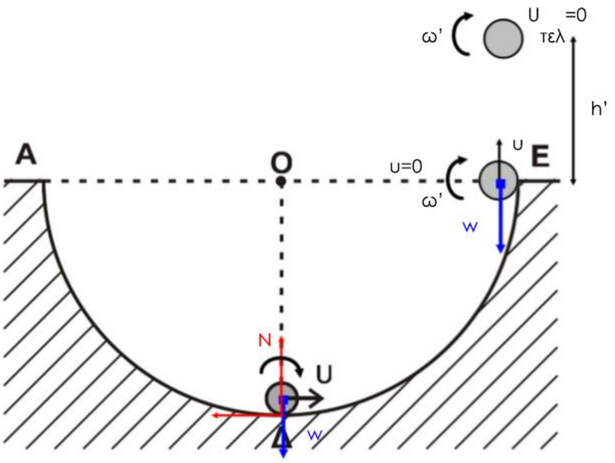
$$\frac{1}{2}u^2 + \frac{1}{5}u^2 = \frac{1}{2}u'^2 + \frac{1}{5}u'^2 + \frac{7gR}{8} \Rightarrow$$

$$\frac{7}{10}36 = \frac{7}{10}u'^2 + \frac{7 \cdot 10 \cdot 1,6}{8} \Rightarrow \frac{36}{10} = \frac{u'^2}{10} + 2 \Rightarrow$$

$$36 = u'^2 + 20 \Rightarrow \quad u'^2 = 16 \quad \Rightarrow \quad u' = \sqrt{16} = 4m/s$$

Άρα $u' = \omega' r \Rightarrow 4 = \omega' \cdot \frac{1,6}{8} \Rightarrow \omega' = \frac{4 \cdot 8}{1,6} \Rightarrow \omega' = 20 \quad rad/s$

Η σφαίρα στο σημείο Ε εγκαταλείπει τον κύκλο άρα η μόνη δύναμη που επιδρά πλέον είναι το βάρος. Συνεπώς, αρχίζει ομαλά επιβραδυνόμενη μεταφορική αλλά και ομαλή στροφική.



Άρα ψηλότερο σημείο έχει $u_{τελ}$=0 αλλά η γωνιακή ταχύτητα εξακολουθεί να είναι ω΄

$Α\Delta ΜΕ$

$$K_{\alpha} + U_{\alpha} = K_{\tau} + U_{\tau} \Rightarrow \frac{1}{2} m u'^2 + \frac{1}{2} I_z \omega'^2 = \frac{1}{2} m u_{\tau\varepsilon\lambda}{}^2 + \frac{1}{2} I_z \omega'^2 + mgh'$$

$$\Rightarrow \frac{1}{2} m u'^2 = mgh' \Rightarrow \frac{1}{2} 16 = 10h' \Rightarrow \boxed{h' = 0{,}8\, m}$$

Δ4. Η μόνη δύναμη που επιδρά μόλις χάσει επαφή είναι το βάρος, που δεν προκαλεί ροπή.

$$\frac{\Delta K_{\sigma\tau\rho}}{\Delta t} = P_{\sigma\tau\rho} = \Sigma\tau \cdot \omega' = \tau_w \omega' = 0 \quad \mu\acute{o}\lambda\iota\varsigma\ \chi\acute{\alpha}\sigma\varepsilon\iota\ \varepsilon\pi\alpha\varphi\acute{\eta}$$

$$\frac{\Delta K_{\mu\varepsilon\tau\alpha\varphi}}{\Delta t} = P_{\mu\varepsilon\tau\alpha\varphi} = \Sigma F \cdot u' = -W \cdot u' = -mgu' =$$

$$= -1{,}4 \cdot 10 \cdot 4 = -56 Watt$$

$$\sigma\upsilon\nu o\lambda\iota\kappa\acute{o}\varsigma\ \rho\upsilon\theta\mu\acute{o}\varsigma\ \mu\varepsilon\tau\alpha\beta o\lambda\acute{\eta}\varsigma\ \tau\eta\varsigma\ \kappa\iota\nu\eta\tau\iota\kappa\acute{\eta}\varsigma\ \varepsilon\nu\acute{\varepsilon}\rho\gamma\varepsilon\iota\alpha\varsigma: \frac{\Delta K_{o\lambda}}{\Delta t} = -56 Watt \left(\frac{Joule}{\sec}\right)$$

$$\kappa\alpha\iota\, \frac{\Delta L}{\Delta t} = \Sigma\tau = 0$$

Επιμέλεια: Αγγελής Γιάννης, Δοξόπουλος Κώστας, Μανελίδης Ν.