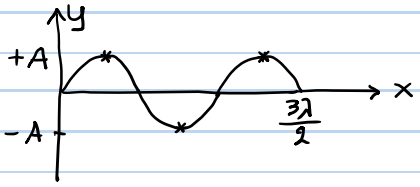
Λύσεις διαγωνίσματος Φυσικής Γ' λυκείου 5/11/2022

ΘΕΜΑ Α

Α1 - δ , Α2 - δ , Α3 - α , Α4 - α , Α5 ΣΣΛΛΛ

ΘΕΜΑ Β

Β1 - β Η θέση $x=0$ στη ΘΙ και 3 σημεία της χορδής έχουν $\upsilon_{max} \rightarrow y = \pm A$



άρα διάδοση κύματος μέχρι τη θέση $\boxed{x_1 = \frac{3\lambda}{2}}$

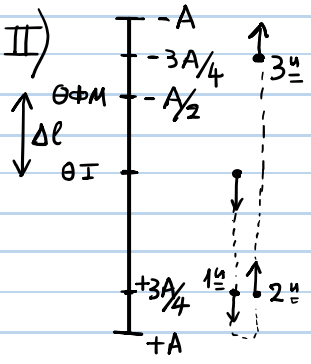
$\Delta t = t_2 - t_1 = \frac{3T}{2} \rightarrow \Delta x = \upsilon \Delta t \Rightarrow x_2 - x_1 = \frac{\lambda}{T}\frac{3T}{2} \Rightarrow x_2 - \frac{3\lambda}{2} = \frac{3\lambda}{2} \Rightarrow \boxed{x_2 = 3\lambda}$ (β)

Β2 Ι-α, ΙΙ-γ Ι) ΘΙ $\Sigma F = 0 \Rightarrow F_{ελ} = mg \Rightarrow k\Delta\ell = mg \Rightarrow \frac{k}{m} = \frac{g}{\Delta\ell}$

$\upsilon_0 = \upsilon_{max} = \omega A$ όπου $D = k = m\omega^2 \Rightarrow \omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{g}{\Delta\ell}}$

$\Rightarrow 2\sqrt{g\Delta\ell} = \sqrt{\frac{g}{\Delta\ell}} A \Rightarrow 4g\Delta\ell = \frac{g}{\Delta\ell} A^2 \Rightarrow A^2 = 4\Delta\ell^2 \Rightarrow \boxed{A = 2\Delta\ell}$ (α)

ΙΙ)



$|y| = 1{,}5\cdot\Delta\ell = 1{,}5\frac{A}{2} \Rightarrow |y| = \frac{3A}{4} \Rightarrow y = \pm\frac{3A}{4}$

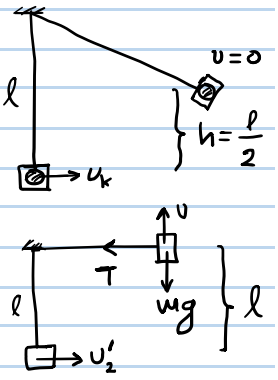
Έστω θετικά προς τα κάτω. Όταν $|y| = \frac{3A}{4}$ για 3η φορά βρίσκεται στη θέση $y = -3A/4$ και από τη ΘΦΜ απέχει $\Delta\ell' = |y| - \Delta\ell = \frac{3A}{4} - \frac{A}{2} \Rightarrow \Delta\ell' = \frac{A}{4}$

$\frac{\upsilon_{ταλ}}{\upsilon_{ελ}} = \frac{\frac{1}{2}ky^2}{\frac{1}{2}k\Delta\ell'^2} = \frac{y^2}{\Delta\ell'^2} = \frac{9A^2/16}{A^2/16} \Rightarrow \boxed{\frac{\upsilon_{ταλ}}{\upsilon_{ελ}} = 9}$ (γ)

Β3 - γ Πλαστική κρούση ΑΔΟ $\vec{P}_{πριν} = \vec{P}_{μετα} \Rightarrow P_1 = P_κ \Rightarrow$

$\Rightarrow m\upsilon_1 = 2m\upsilon_κ \Rightarrow \upsilon_1 = 2\upsilon_κ$

ΘΜΚΕ $K_{τελ} - K_{αρχ} = W_{w_0 λ} g \Rightarrow -\frac{1}{2}m_0\upsilon_κ^2 = -m_0 g\frac{\ell}{2} \Rightarrow \upsilon_κ = \sqrt{g\ell}$



Άρα $\upsilon_1 = 2\sqrt{g\ell}$

Ελαστική κρούση $m_1 = m_2 \rightarrow \upsilon_2' = \upsilon_1 = 2\sqrt{g\ell}$

ΘΜΚΕ $K_{τελ} - K_{αρχ} = W_{wg} \Rightarrow \frac{1}{2}m_2\upsilon^2 - \frac{1}{2}m_2\upsilon_2'^2 = -m_2 g\ell \Rightarrow \upsilon^2 = \upsilon_2'^2 - 2g\ell = 4g\ell - 2g\ell$

$\Rightarrow \upsilon^2 = 2g\ell \rightarrow \Sigma F_K = m_2 a_K \Rightarrow T = m\frac{\upsilon^2}{\ell} = m\frac{2g\ell}{\ell} \Rightarrow \boxed{T = 2mg}$ (γ)

ΘΕΜΑ Γ

Γ1 Η πηγή έχει μέγιστη δυναμική ενέργεια για 3η φορά την $t = T + \frac{T}{4} = \frac{5T}{4}$

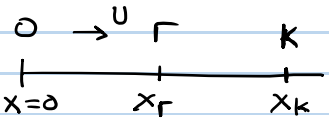
$y = 0,4\,\eta\mu(10\pi t)$ SI $\quad A = 0,4m$, $\omega = 10\pi\ rad/s \Rightarrow \frac{2\pi}{T} = 10\pi \Rightarrow T = 0,2\ sec$

$x_K = v \cdot t_K$, $t_K = t = \frac{5T}{4} = 0,25\ sec$ άρα $v = \frac{x_K}{t_K} = \frac{0,5}{0,25}\ m/s \Rightarrow v = 2\ m/s$.

Ισχύει $v = \frac{\lambda}{T} \Rightarrow \lambda = v \cdot T \Rightarrow \lambda = 0,4m$

$y = A\eta\mu\left(\frac{2\pi t}{T} - \frac{2\pi \cdot x}{\lambda}\right) \Rightarrow \boxed{y = 0,4\,\eta\mu(10\pi t - 5\pi x)\ SI}$

Γ2



$\phi_\Gamma - \phi_K = \frac{3\pi}{2}\ rad \Rightarrow \frac{2\pi t}{T} - \frac{2\pi x_\Gamma}{\lambda} - \frac{2\pi t}{T} + \frac{2\pi x_K}{\lambda} = \frac{3\pi}{2} \Rightarrow \frac{2\pi(x_K - x_\Gamma)}{\lambda} = \frac{3\pi}{2}$

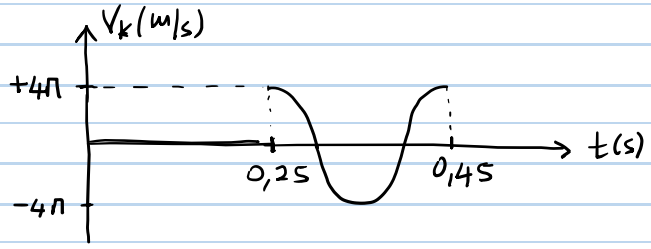
$x_K - x_\Gamma = \frac{3\lambda}{4} \Rightarrow 0,5m - x_\Gamma = 0,3m \Rightarrow \boxed{x_\Gamma = 0,2m}$

Γ3 $V_K = V_{max}\,\sigma\upsilon\nu\left(\frac{2\pi t}{T} - \frac{2\pi x_K}{\lambda}\right)$

όπου $V_{max} = \omega A = 4\pi\ m/s$

$\Rightarrow \boxed{V_K = 4\pi\,\sigma\upsilon\nu(10\pi t - 2,5\pi)\ SI}$

για $t \geq 0,25\ sec$



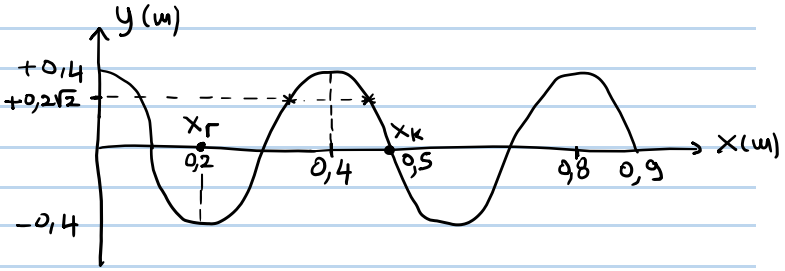
Γ4 $y = f(x)$ $t_1 = 0,45\ sec \rightarrow y = 0,4\,\eta\mu(10\pi \cdot 0,45 - 5\pi \cdot x)$

$y = 0,4\,\eta\mu(4,5\pi - 5\pi \cdot x)$ SI

Η θέση $x = 0$: $y = 0,4\,\eta\mu(4,5\pi) = +0,4m$

Η θέση $x = \frac{\lambda}{4} = 0,1m$: $y = 0,4\,\eta\mu(4\pi) = 0$

Το κύμα έχει φτάσει στη θέση: $x_{T\acute{e}\lambda} = v \cdot t_1 = 0,9m \rightarrow x_{T\acute{e}\lambda} = 9\frac{\lambda}{4}$



Γ5 $\alpha = -\alpha_{max}\,\eta\mu\left(\frac{2\pi t}{T} - \frac{2\pi x}{\lambda}\right) = -\omega^2 A\,\eta\mu\left(\frac{2\pi t}{T} - \frac{2\pi \cdot x}{\lambda}\right) \Rightarrow \alpha = -\omega^2 \cdot y$

Όμως $\alpha = -20\sqrt{2}\pi^2\ m/s^2 \Rightarrow -\omega^2 y = -20\sqrt{2}\pi^2 \Rightarrow -100\pi^2 \cdot y = -20\sqrt{2}\pi^2$

$\Rightarrow y = +0,2\sqrt{2}\ m = +\frac{\sqrt{2}}{2}A$. Άρα τα ζητούμενα σημεία έχουν απομάκρυνση $y = +0,2\sqrt{2}\ m$. (Όπως φαίνεται από το σχήμα είναι 2)

Λύση τριγωνομετρικής: $y = +0,2\sqrt{2}\ m$ την $t_1 = 0,45\ sec$

$\Rightarrow 0,4\,\eta\mu(4,5\pi - 5\pi x) = +0,2\sqrt{2} \Rightarrow \eta\mu(4,5\pi - 5\pi x) = \frac{\sqrt{2}}{2} = \eta\mu\frac{\pi}{4}$

$4,5\pi - 5\pi x = 2k\pi + \pi/4 \Rightarrow 5x = 4,5 - \frac{1}{4} - 2k \Rightarrow x = \frac{17-8k}{20}\ SI$ ①

$4,5\pi - 5\pi x = 2k\pi + \frac{3\pi}{4} \Rightarrow 5x = 4,5 - \frac{3}{4} - 2k \Rightarrow x = \frac{15-8k}{20}\ SI$ ②

Τα ζητούμενα σημεία βρίσκονται $x_\Gamma < x < x_K \Rightarrow 0,2\ m < x < 0,5\ m$

$\Rightarrow \frac{2}{10} m < x < \frac{5}{10} m \Rightarrow \frac{4}{20} m < x < \frac{10}{20} m$

① $\rightarrow \frac{4}{20} < \frac{17-8k}{20} < \frac{10}{20} \Rightarrow 4 < 17-8k < 10 \Rightarrow -13 < -8k < -7$

$\Rightarrow \frac{7}{8} < k < \frac{13}{8} \rightarrow k = 1 \rightarrow \boxed{x = \frac{9}{20} m = 0,45\ m}$

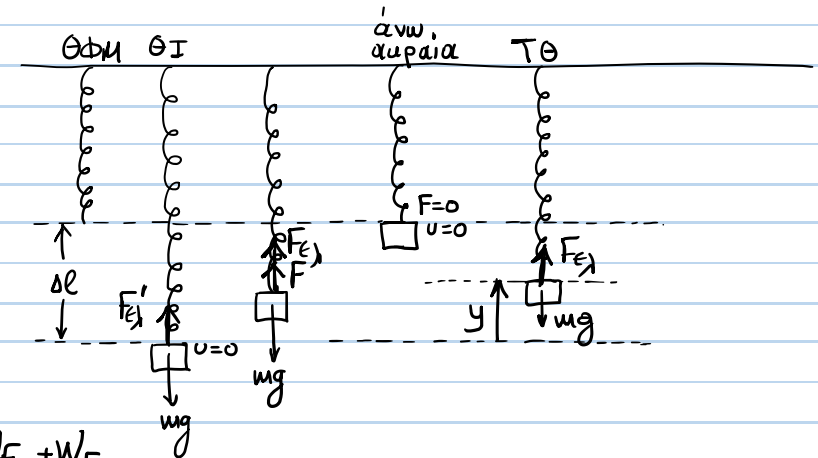
② $\rightarrow \frac{4}{20} < \frac{15-8k}{20} < \frac{10}{20} \Rightarrow 4 < 15-8k < 10 \Rightarrow -11 < -8k < -5$

$\Rightarrow \frac{5}{8} < k < \frac{11}{8} \rightarrow k = 1 \rightarrow \boxed{x = \frac{7}{20} m = 0,35\ m}$

Άρα ανάμεσα στα σημεία Γ και Κ υπάρχουν δύο σημεία με επιτάχυνση $a = -20\sqrt{2}\,\pi^2\ m/s^2$ που βρίσκονται στις θέσεις $x=0,35m$ και $x=0,45m$

ΘΕΜΑ Δ

$m = 2kg,\ K = 50\ N/m$



Δ1| Στη ΘΙ: $\Sigma F = 0$

$\Rightarrow F_{ελ}' = mg \Rightarrow \boxed{K\Delta l = mg}$

$\Rightarrow \Delta l = \frac{mg}{k} = 0,4m$

ΘΜΚΕ $K_{ΘΦΜ} - K_{ΘΙ} = W_{mg} + W_{F_{ελ}} + W_F$

$\Rightarrow 0 - 0 = -mg\Delta l + U_{ελ_{ΘΙ}} - \cancel{U_{ελ_{ΘΦΜ}}}^{0} + F\cdot\Delta l$

$\Rightarrow 0 = -mg\Delta l + \frac{1}{2}K\Delta l^2 + F\Delta l \Rightarrow 0 = -8 + \frac{1}{2}50\frac{16}{100} + 0,4F \Rightarrow \boxed{F = 10N}$

Δ2| Στην Τυχαία θέση Τ.Θ: $\Sigma F = F_{ελ} - mg = K(\Delta l - y) - mg$

$\Rightarrow \Sigma F = \underbrace{K\Delta l - mg}_{0} - Ky \Rightarrow \Sigma F = -Ky \rightarrow \underline{D = K}$

Δ3| $D = K = m\omega^2 \Rightarrow \omega = \sqrt{K/m} = 5\ rad/s$ $\quad A = \Delta l = 0,4\ m$, $U_{max} = \omega A = 2\ m/s$

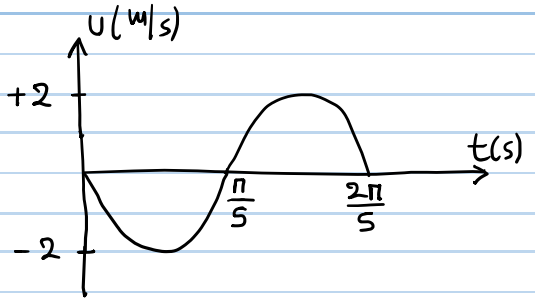
$U = f(t) \Rightarrow U = U_{max}\,\sigma\upsilon\nu(\omega t + \varphi_0)$

Την $t=0$ $y=+A \Rightarrow A\eta\mu(\omega\cdot 0+\varphi_0) = +A$

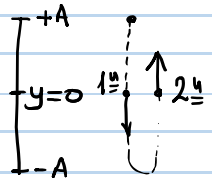
$\Rightarrow \eta\mu\varphi_0 = +1 = \eta\mu\frac{\pi}{2} \rightarrow \varphi_0 = \pi/2$ rad

Άρα $U = 2\,\sigma\upsilon\nu\left(5t+\frac{\pi}{2}\right)$ SI

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



Δ4



$\frac{dP}{dt} = \Sigma F = -Dy = -ky$

$\frac{dP}{dt} = 0 \rightarrow y = 0$ στη ΘΙ

2η φορά στη ΘΙ την $\boxed{t = \frac{3T}{4} = 0{,}3\pi\,\text{sec}}$

Δ5 $\frac{dK}{dt} =$; $|\alpha| = \frac{\alpha_{max}}{2} \Rightarrow \omega^2|y| = \frac{\omega^2 A}{2} \Rightarrow |y| = A/2 \rightarrow y = \pm A/2$

1η φορά $y = +A/2$, $\upsilon < 0$, 2η φορά $y = -A/2$, $\upsilon < 0$

$\Delta K = W_{\Sigma F} \rightarrow \frac{dK}{dt} = \frac{dW_{\Sigma F}}{dt} = \frac{\Sigma F dx}{dt} = \Sigma F\cdot\upsilon = -ky\cdot\upsilon$

όπου $y = -A/2 = -0{,}2$ m

και από ΑΔΕΤ: $E = K + U \Rightarrow \frac{1}{2}kA^2 = \frac{1}{2}m\upsilon^2 + \frac{1}{2}ky^2 \xrightarrow{\upsilon<0} \upsilon = -\omega\sqrt{A^2-y^2}$

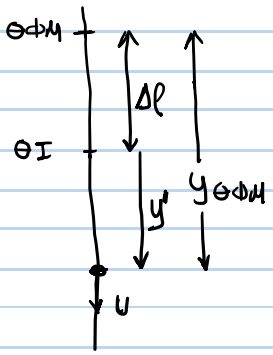
$\Rightarrow \upsilon = -5\sqrt{\frac{16}{100} - \frac{4}{100}} = -5\sqrt{\frac{12}{100}} = -5\frac{2\sqrt{3}}{10} \Rightarrow \upsilon = -\sqrt{3}$ m/s

Άρα $\frac{dK}{dt} = -ky\upsilon = -50(-0{,}2)(-\sqrt{3})$ J/s $\Rightarrow \boxed{\frac{dK}{dt} = -10\sqrt{3}\ \text{J/s}}$

Δ6 Ισχύει $\Sigma F' = m\cdot\alpha' \Rightarrow F' + mg - F_{\epsilon\lambda} = m\alpha' \Rightarrow 50y_{\theta\sigma\eta} + 4 + 20 - 50y_{\theta\sigma\eta} = 2\alpha'$

(όπου $F_{\epsilon\lambda} = k y_{\theta\sigma\eta} = 50\cdot y_{\theta\sigma\eta}$ SI) $\Rightarrow \alpha' = 12\ \text{m/s}^2$

Άρα για $\Delta t = \frac{\sqrt{6}}{6}$ sec εκτελεί ευθύγραμμη ομαλά επιταχυνόμενη κίνηση διανύοντας κατακόρυφη απόσταση $y_{\theta\sigma\eta} = \frac{1}{2}\alpha'\cdot\Delta t^2 = 1$ m και αποκτά ταχύτητα $\upsilon = \alpha\cdot\Delta t = 2\sqrt{6}$ m/s. Τότε από τη ΘΙ απέχει $|y'| = y_{\theta\sigma\eta} - \Delta\ell = 1\ \text{m} - 0{,}4\ \text{m} \Rightarrow |y'| = 0{,}6$ m



ΑΔΕΤ τη στιγμή που καταργείται η F': $E = K + U \Rightarrow$

$\Rightarrow \frac{1}{2}kA'^2 = \frac{1}{2}m\upsilon^2 + \frac{1}{2}ky'^2 \Rightarrow A' = \sqrt{\frac{m}{k}\upsilon^2 + y'^2} \Rightarrow \boxed{A' = 0{,}6\sqrt{5}\ \text{m}}$