4Β87:

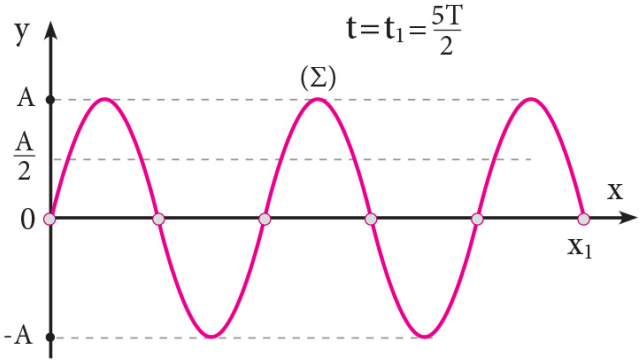
Σωστή η γ.

$x_{\Sigma} = \frac{5\lambda}{4} \Rightarrow t_{\Sigma} = \frac{5T}{4}$

$t_1 = t_{\Sigma} + \Delta t \Rightarrow t_1 = \frac{5T}{4} + \frac{5T}{4} = \frac{5T}{2} \Rightarrow x_1 = \frac{5\lambda}{2}$

$y = A \cdot \eta\mu 2\pi\left(\frac{t}{T} - \frac{x}{\lambda}\right) \overset{t=t_1}{\Longrightarrow} y = A \cdot \eta\mu 2\pi\left(\frac{5}{2} - \frac{x}{\lambda}\right)$

Το στιγμιότυπο την χρονική στιγμή t_1 είναι:



4Β88:

Σωστή η γ.

$y = A \cdot \eta\mu 2\pi\left(\frac{t}{T} - \frac{x}{\lambda}\right)$ (1)

$\begin{cases} (1) \overset{t=T,\ x=\frac{\lambda}{8}}{\Longrightarrow} y_{\Lambda} = A \cdot \eta\mu\frac{7\pi}{4} \Rightarrow y_{\Lambda} = -\frac{A\sqrt{2}}{2} \\ (1) \overset{t=T,\ x=-\frac{3\lambda}{4}}{\Longrightarrow} y_K = A \cdot \eta\mu\frac{7\pi}{2} \Rightarrow y_K = -A \end{cases}$

$\frac{U_K}{U_{\Lambda}} = \frac{\frac{1}{2}Dy_K^2}{\frac{1}{2}Dy_{\Lambda}^2} = \left(\frac{y_K}{y_{\Lambda}}\right)^2 = \left(\frac{A}{\frac{A\sqrt{2}}{2}}\right)^2 = 2 \Rightarrow U_K = 2U_{\Lambda}.$

4Β89:

Σωστή η β.

$y = A \cdot \eta\mu 2\pi\left(\frac{t}{T} + \frac{x}{\lambda}\right) \overset{x=-\frac{\lambda}{6},\ y=0}{\Longrightarrow} \eta\mu 2\pi\left(\frac{t}{T} - \frac{1}{6}\right) = 0 \Rightarrow$

$\begin{cases} \frac{t}{T} - \frac{1}{6} = 2\kappa\pi\ (1) \\ \frac{t}{T} - \frac{1}{6} = 2\kappa\pi + \pi\ (2) \end{cases}$

$v = \omega A \cdot \sigma\upsilon\nu\left(\frac{t}{T} + \frac{x}{\lambda}\right) \overset{x=-\lambda/6}{\Longrightarrow} v = \omega A \cdot \sigma\upsilon\nu\left(\frac{t}{T} - \frac{1}{6}\right) \overset{(1),(2)}{\Longrightarrow}$

$\begin{cases} v = \omega A \cdot \sigma\upsilon\nu 2\kappa\pi > 0\ , \delta\varepsilon\kappa\tau\acute{\eta} \\ v = \omega A \cdot \sigma\upsilon\nu(2\kappa\pi + \pi) < 0 \end{cases}$

$(1) \Rightarrow \frac{t}{T} = 2\kappa\pi + \frac{1}{6} \overset{\kappa=0}{\Longrightarrow} t = \frac{T}{6}.$

2ος τρόπος: $\lambda = v \cdot T\ (1)\ ,\quad x_z = v \cdot t_z\ (2)$

$\frac{(1)}{(2)} \Rightarrow \frac{\lambda}{x_z} = \frac{T}{t_z} \Rightarrow t_z = \frac{T}{\lambda} \cdot x_z = \frac{T}{\lambda} \cdot \frac{\lambda}{6} = \frac{T}{6}.$

4Β90:

Σωστή η α.

$y_1 = 0{,}01 \cdot \eta\mu 2\pi(2t - 0{,}5x)\ (1)$

$(1) \Rightarrow \begin{cases} A_1 = 0{,}01m \\ f_1 = 2Hz \\ \lambda_1 = 2m \end{cases} \Rightarrow \upsilon_1 = \lambda_1 \cdot f_1 \Rightarrow \upsilon_1 = 4\,m/s$

$y_2 = 0{,}05 \cdot \eta\mu 2\pi(2t - 2x)\ (2)$

$(2) \Rightarrow \begin{cases} A_2 = 0{,}05m \\ f_2 = 2Hz \\ \lambda_2 = {}^1\!/_2\, m \end{cases} \Rightarrow \upsilon_2 = \lambda_2 \cdot f_2 \Rightarrow \upsilon_2 = 1\,m/s$

Άρα: $\frac{\upsilon_1}{\upsilon_2} = 4.$

4Β91:

Σωστή η β.

Σχήμα 1: $T = 2s\ ,$ *Σχήμα 2:* $\frac{5\lambda}{2} = 10 \Rightarrow \lambda = 4cm\ ,$

$\upsilon = \frac{\lambda}{T} \Rightarrow \upsilon = 2\,cm/s$

4Β92:

Σωστή η γ.

$\frac{\lambda}{2} = 0{,}8m \Rightarrow l = 1{,}6m\ ,$

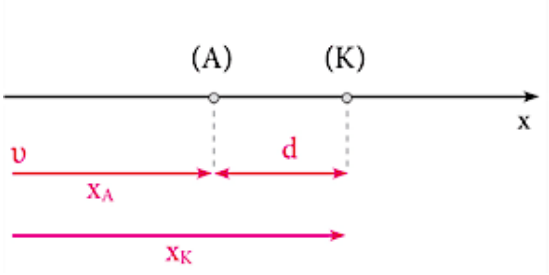
$\Delta\varphi = 2\pi\frac{\Delta x}{\lambda} \Rightarrow \Delta\varphi = 2\pi\frac{2{,}4}{1{,}6} \Rightarrow \Delta\varphi = 3\pi \Rightarrow \Delta\varphi = (2\kappa + 1)\pi\ (\kappa = 1)$

$y_M = A \cdot \eta\mu(\varphi_N + 3\pi) \Rightarrow y_M = -A \cdot \eta\mu\varphi_N \Rightarrow y_M = -y_N$

$v_M = v_{max} \cdot \sigma\upsilon\nu(\varphi_N + 3\pi) \Rightarrow v_M = v_{max}\sigma\upsilon\nu\varphi_N \Rightarrow v_M = -v_N.$

4Β93:

Σωστή η β.



$\begin{cases} f1:\ \Delta\varphi_1 = 2\pi\frac{\Delta x}{\lambda_1} \Rightarrow \Delta\varphi_1 = 2\pi\frac{d}{\upsilon} \cdot f_1\ (1) \\ f2:\ \Delta\varphi_2 = 2\pi\frac{\Delta x}{\lambda_2} \Rightarrow \Delta\varphi_1 + 2\pi = 2\pi\frac{d}{\upsilon} \cdot f_2 (2) \end{cases}$

$(2) \overset{(1)}{\Rightarrow} 2\pi = 2\pi \cdot \frac{d}{\upsilon} \cdot (f_2 - f_1) \Rightarrow \upsilon = d \cdot (f_2 - f_1) \Rightarrow \upsilon = 0{,}8\, m/s.$

4B94:

Σωστή η α

$A = 0{,}01m$

$\frac{9\lambda}{4} = 3{,}5m \Rightarrow \lambda = \frac{14}{9}m$

$\upsilon = \frac{x}{t} = \frac{3{,}5}{1{,}75} = 2\, m/s$

$\upsilon = \lambda \cdot f \Rightarrow f = \frac{9}{7}Hz$

$y = A \cdot \eta\mu 2\pi \left(\frac{t}{T} - \frac{x}{\lambda}\right) \Rightarrow y = 0{,}01 \cdot \eta\mu 18\pi \left(\frac{t}{7} - \frac{x}{14}\right).$

4B95:

Σωστή η γ.

$y = A \cdot \eta\mu 2\pi \left(\frac{t}{T} - \frac{x}{\lambda} + \frac{\varphi_0}{2\pi}\right)$ *, για* $y = 0$ *,* $t = 0$ *,* $x = \frac{\lambda}{2} \Rightarrow$

$0 = A\eta\mu 2\pi \left(-\frac{1}{2} + \frac{\varphi_0}{2\pi}\right) \Rightarrow \varphi_0 = \pi$ *, ώστε* $\upsilon < 0.$

4B96:

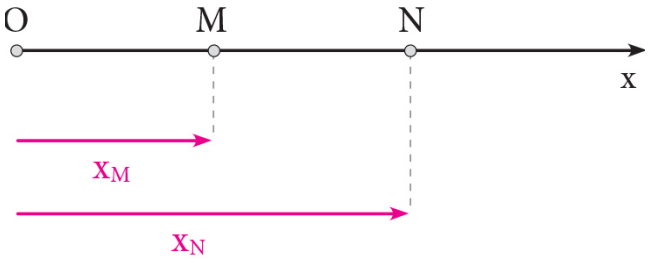
Σωστή η γ.

$\begin{cases} \upsilon = \lambda \cdot f \\ \upsilon = \lambda' \cdot f' \end{cases} \Rightarrow \lambda \cdot f = \lambda' \cdot f' \Rightarrow \lambda \cdot f = \lambda' \cdot 2f \Rightarrow \lambda' = \frac{\lambda}{2}$

$\Delta\lambda = \lambda' - \lambda = -\frac{\lambda}{2}.$

4B97:

Σωστή η α.



$\varphi_M > \varphi_N \Rightarrow 2\pi \left(\frac{t_1}{T} - \frac{x_M}{\lambda}\right) > 2\pi \left(\frac{t_1}{T} - \frac{x_N}{\lambda}\right) \Rightarrow -\frac{x_M}{\lambda} > -\frac{x_N}{\lambda} \Rightarrow x_M < x_N.$

4B98:

Σωστή η β.

$y = 0{,}2\eta\mu 2\pi \left(\frac{t}{2} - \frac{x}{4}\right)$ (1)

$(1) \Rightarrow \begin{cases} A = 0{,}2m \\ T = 2s \\ \lambda = 4m \end{cases} \Rightarrow \upsilon = \frac{\lambda}{T} \Rightarrow \upsilon = 2\, m/s$

$\upsilon_{max} = \omega \cdot A = \frac{2\pi}{T} \cdot A = \frac{2\pi}{2} \cdot 0{,}2\, m/s \Rightarrow \upsilon_{max} = 0{,}2\pi\, m/s.$

4B99:

Σωστή η β.

$\begin{cases} \upsilon = \lambda \cdot f \\ \upsilon = \lambda' \cdot f' \end{cases} \Rightarrow \lambda \cdot f = \lambda' \cdot f' \Rightarrow \lambda \cdot f = \lambda' \cdot 2f \Rightarrow \lambda' = \frac{\lambda}{2}$

$y = A \cdot \eta\mu 2\pi \left(\frac{t}{T'} - \frac{x}{\lambda'}\right) \Rightarrow y = A \cdot \eta\mu 2\pi \left(\frac{t}{T/2} - \frac{x}{\lambda/2}\right) \Rightarrow$

$y = A \cdot \eta\mu 4\pi \left(\frac{t}{T} - \frac{x}{\lambda}\right).$

4B100:

Σωστή η α.

$x = \upsilon \cdot t \Rightarrow \upsilon = \frac{8}{2} = 4\, m/s$

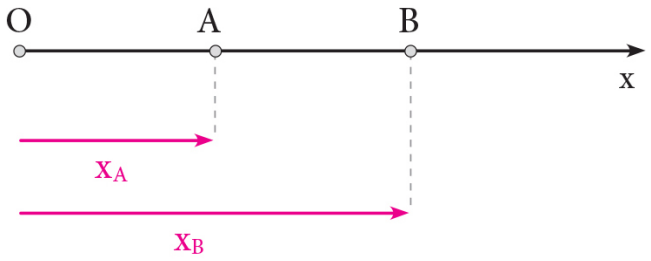
$\Delta\varphi = 2\pi \frac{\Delta x}{\lambda} \Rightarrow 4\pi = 2\pi \frac{8}{\lambda} \Rightarrow \lambda = 4m$

$\upsilon = \frac{\lambda}{T} \Rightarrow T = \frac{4}{4}s \Rightarrow T = 1s$

$y = A \cdot \eta\mu 2\pi \left(\frac{t}{T} - \frac{x}{\lambda}\right) \Rightarrow y = A \cdot \eta\mu 2\pi \left(t - \frac{x}{4}\right).$

4B101:

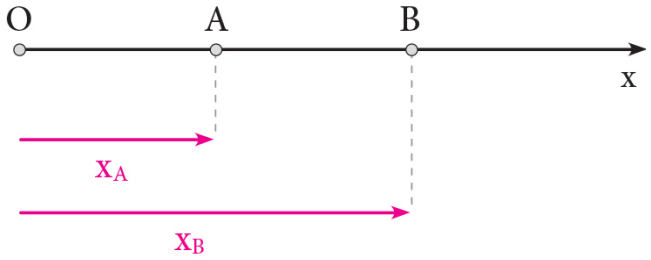
Σωστή η β.



$\Delta\varphi = 2\pi \frac{\Delta x}{\lambda} \Rightarrow \Delta\varphi = 2\pi \frac{2\lambda/8}{\lambda} \Rightarrow \Delta\varphi = \frac{\pi}{2}.$

4B102:

Σωστή η α.



$\begin{cases} y_A = A \cdot \eta\mu\varphi_A \Rightarrow y_A = A \cdot \eta\mu \frac{\pi}{4} \Rightarrow y_A = \frac{A\sqrt{2}}{2} \text{ (1)} \\ y_B = A \cdot \eta\mu\varphi_B \Rightarrow y_B = A \cdot \eta\mu \frac{\pi}{3} \Rightarrow y_B = \frac{A\sqrt{3}}{2} \text{ (2)} \end{cases}$

$$\frac{U_A}{U_B}=\frac{\frac{1}{2}Dy_A^2}{\frac{1}{2}Dy_B^2}\overset{(1),(2)}{\Longrightarrow}\frac{U_A}{U_B}=\left(\frac{\frac{A\sqrt{2}}{2}}{\frac{A\sqrt{3}}{2}}\right)^2=\frac{2}{3}$$

4B103:

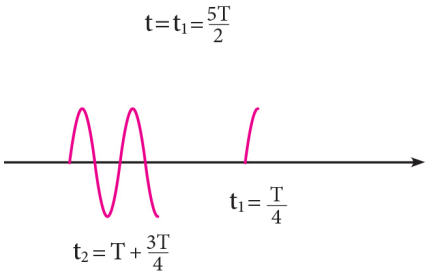
Σωστή η γ.

$$\alpha_{2max}=4\alpha_{1max}\Rightarrow\omega_2^2\cdot A_2=4\omega_1^2\cdot A_1\Rightarrow\left(\frac{f_2}{f_1}\right)^2=\frac{4A_1}{A_2}\Rightarrow$$

$$\left(\frac{f_2}{f_1}\right)^2=16\Rightarrow f_2=4f_1\Rightarrow\frac{\upsilon}{\lambda_2}=4\frac{\upsilon}{\lambda_1}\Rightarrow\lambda_1=4\lambda_2\Rightarrow\frac{\lambda_1}{\lambda_2}=4.$$

4B104:

Σωστή η α.



$$\Delta t=t_2-t_1\Rightarrow\Delta t=\frac{3T}{2},\Delta\varphi=3\pi=2\pi\frac{\Delta x}{\lambda}\Rightarrow 3=2\frac{12}{\upsilon\cdot T}\Rightarrow$$

$$\upsilon=2\,m/s.$$

4B105:

Σωστή η α.

$$\begin{cases}\upsilon_{max}=\omega\cdot A=2\pi\cdot f\cdot A\\ \upsilon=\lambda\cdot f\end{cases}\Rightarrow\frac{\upsilon_{max}}{\upsilon}=\frac{2\pi\cdot A}{\lambda}.$$

4B106:

Σωστή η γ.

$$\upsilon_0=\omega\cdot A\cdot\eta\mu\omega t\overset{t=\frac{T}{8}}{\Longrightarrow}\upsilon_0=\omega\cdot A\cdot\eta\mu\frac{2\pi}{T}\cdot\frac{T}{8}\Rightarrow\upsilon_0=2\pi f\cdot A\frac{\sqrt{2}}{2}\,(1)$$

$$\upsilon=\lambda\cdot f\,(2)$$

$$\upsilon=\upsilon_0\overset{(1),(2)}{\Longrightarrow}2\pi f\cdot A\frac{\sqrt{2}}{2}=\lambda\cdot f\Rightarrow\lambda=\sqrt{2}\cdot\pi\cdot A.$$

4B107:

Σωστή η α.

$$A=0{,}1m,\qquad\lambda=2m$$

$$\upsilon=\frac{\Delta x}{\Delta t}\Rightarrow\lambda\cdot f=\frac{\Delta x}{\Delta t}\Rightarrow f=0{,}5Hz$$

$$y=A\cdot\eta\mu2\pi\left(\frac{t}{T}-\frac{x}{\lambda}\right)\Rightarrow y=0{,}1\eta\mu2\pi\left(\frac{t}{2}-\frac{x}{2}\right)\Rightarrow y=0{,}1\eta\mu\pi(t-x).$$

4B108:

Σωστή η γ.

$$\Delta\varphi=2\pi\frac{\Delta x}{\lambda}\Rightarrow\Delta\varphi=2\pi\frac{\frac{5\lambda}{4}}{\lambda}\Rightarrow\Delta\varphi=\frac{5\pi}{2}.$$

4B109:

Σωστή η β.

$$\Delta\varphi=2\pi\frac{\Delta x}{\lambda}\Rightarrow\Delta x=\frac{\Delta\varphi\cdot\lambda}{2\pi}\Rightarrow\Delta x=\frac{4\pi\cdot 4}{2\pi}\Rightarrow$$

$$\Delta x=8m\Rightarrow 4-x_\Gamma=8\Rightarrow x_\Gamma=-4m.$$

4B110:

Σωστή η α.

$$y=A\cdot\eta\mu2\pi\left(\frac{t}{T}-\frac{x}{\lambda}\right)(1)$$

$$\begin{cases}(1)\overset{t=\frac{3T}{2},\ x=\frac{3\lambda}{4}}{\Longrightarrow}y_1=A\eta\mu2\pi\left(\frac{3}{2}-\frac{3}{4}\right)\Rightarrow y_1=-A\Rightarrow K_1=0\,(2)\\ (1)\overset{t=\frac{3T}{2},\ x=\lambda}{\Longrightarrow}y_2=A\eta\mu2\pi\left(\frac{3}{2}-1\right)\Rightarrow y_2=0\Rightarrow K_2=E\,(3)\end{cases}$$

$$\overset{(2),(3)}{\Longrightarrow}K_1<K_2.$$

4B111:

Σωστή η γ.

$$y=A\cdot\eta\mu2\pi\left(\frac{t}{T}-\frac{x}{\lambda}\right)(1)$$

$$\begin{cases}(1)\overset{t=3T,\ x=\frac{5\lambda}{4}}{\Longrightarrow}y_1=A\eta\mu2\pi\left(3-\frac{5}{4}\right)\Rightarrow y_1=-A\Rightarrow U_1=E\,(2)\\ (1)\overset{t=3T,\ x=\frac{11\lambda}{4}}{\Longrightarrow}y_1=A\eta\mu2\pi\left(3-\frac{11}{4}\right)\Rightarrow y_1=+A\Rightarrow U_2=E\,(3)\end{cases}$$

$$\overset{(2),(3)}{\Longrightarrow}U_1=U_2.$$

4B112:

Σωστή α.

$$\begin{cases}(A):x_1=\frac{3\lambda_A}{2}\\ (B):x_1=\frac{5\lambda_B}{2}\end{cases}\Rightarrow 3\lambda_A=5\lambda_B$$

$$\begin{cases}(A):\upsilon_A=\omega_A\cdot A=2\pi f_A\cdot A=2\pi\frac{\upsilon}{\lambda_A}\cdot A\,(2)\\ (B):\upsilon_B=\omega_B\cdot A=2\pi f_B\cdot A=2\pi\frac{\upsilon}{\lambda_B}\cdot A\,(3)\end{cases}$$

$$\frac{(2)}{(3)}\Rightarrow\frac{\upsilon_A}{\upsilon_B}=\frac{\lambda_B}{\lambda_A}=\frac{3}{5}.$$

4B113:

Σωστή η α.

$$\frac{T}{2}=2s\Rightarrow T=4s\Rightarrow f=\frac{1}{4}Hz$$

$$\upsilon=\frac{x_M}{\Delta t}\Rightarrow\lambda\cdot f=\frac{x_M}{\Delta t}\Rightarrow\lambda=0{,}2m.$$

4B114:

$Σωστή\ η\ β.$

$$\begin{cases} v_Γ = ω \cdot A \cdot συνφ_Γ \overset{t=t_1}{\Longrightarrow} v_Γ = ω \cdot A \cdot συν\dfrac{9π}{4} \Rightarrow v_Γ = ω \cdot A\dfrac{\sqrt{2}}{2}\ (1) \\ v_Δ = ω \cdot A \cdot συνφ_Δ \overset{t=t_1}{\Longrightarrow} v_Δ = ω \cdot A \cdot συν0 \Rightarrow v_Δ = ω \cdot A\ (2) \end{cases}$$

$$\frac{(1)}{(2)} \Rightarrow \frac{v_Γ}{v_Δ} = \frac{\sqrt{2}}{2}.$$

4B115:

$Σωστή\ η\ β.$

$$υ = \frac{Δx}{Δt} = \frac{(x_1 + 6) - x_1}{(t_1 + 2) - t_1} = \frac{6}{2} m/s \Rightarrow υ = 3\ m/s$$

4B116:

$Σωστή\ η\ γ.$

$$(0): Δφ = 2π\frac{Δt}{T} \Rightarrow π = 2π\frac{Δt}{T} \Rightarrow \frac{Δt}{T} = \frac{1}{2} \Rightarrow Δt = \frac{T}{2} \Rightarrow t_2 = 12s + \frac{T}{2}$$

$$Δφ = 2π\frac{Δx}{λ} \Rightarrow \frac{Δφ}{Δx} = \frac{2π}{λ} \Rightarrow εφφ = σταθερό$$

$$εφφ_1 = εφφ_2 \Rightarrow \frac{3π}{x_1} = \frac{4π}{2} \Rightarrow x_1 = 1{,}5m.$$

4B117:

$Σωστή\ η\ γ.$

$$Δφ = 2π\frac{Δx}{λ} \Rightarrow \frac{Δφ}{Δx} = \frac{2π}{λ} \Rightarrow εφφ = σταθερό$$

$$\begin{cases} (1): \dfrac{7π}{x_1} = \dfrac{2π}{λ_1} \\ (2): \dfrac{4π}{x_1} = \dfrac{2π}{λ_2} \end{cases} \Rightarrow \frac{7}{4} = \frac{λ_2}{λ_1}$$

4B118:

$Σωστή\ η\ γ.$

$$\frac{3T}{2} = 0{,}3 \Rightarrow T = 0{,}2s$$

$$\frac{t}{T} = \frac{0{,}35}{0{,}2} = \frac{7}{4} \Rightarrow t = \frac{7}{4}T \Rightarrow x = \frac{7}{4}λ.$$

4B119:

$Σωστή\ η\ α.$

$$φ = 2π\left(\frac{t}{T} - \frac{x}{λ}\right) \overset{t=t_1}{\Longrightarrow} φ = 2π\left(\frac{2}{T} - \frac{x}{λ}\right)(1)$$

$$\begin{cases} (1) \overset{x=0}{\Longrightarrow} 10π = 2π\dfrac{2}{T} \Rightarrow T = 0{,}4s \\ (1) \overset{x=5m}{\Longrightarrow} 5π = 2π\left(\dfrac{2}{4} - \dfrac{5}{λ}\right) \Rightarrow \ λ = 2m \end{cases}$$

$$\frac{|υ|}{|υ_{max}|} = \frac{λ \cdot f}{2πf \cdot A} = \frac{2}{2π \cdot 0{,}1} \Rightarrow \frac{|υ|}{|υ_{max}|} = \frac{10}{π} m/s.$$

4B120:

$Σωστή\ η\ α.$

$$\frac{3T}{2} = 0{,}06s \Rightarrow T = 0{,}04s \Rightarrow f = 25Hz$$

$$υ = \frac{x_M}{Δt} = \frac{0{,}15m}{0{,}03s} \Rightarrow υ = 5\ m/s$$

$$υ = λ \cdot f \Rightarrow λ = 0{,}2m$$

$$y = A \cdot ημ2π\left(\frac{t}{T} - \frac{x}{λ}\right) \Rightarrow y = 0{,}1 \cdot ημ2π(25t - 5x).$$

4B121:

$Σωστή\ η\ γ.$

$$\begin{cases} x_1 = λ_1 \\ x_1 = 2λ_2 \end{cases} \Rightarrow λ_1 = 2λ_2 \Rightarrow λ_2 = \frac{λ_1}{2} \Rightarrow \frac{v}{f_2} = \frac{v}{2f_1} \Rightarrow \frac{f_1}{f_2} = \frac{1}{2}.$$

4B122:

$Σωστή\ η\ β.$

$$x_1 = x_2 \Rightarrow 2λ_1 = 5\frac{λ_2}{4} \Rightarrow \frac{λ_1}{λ_2} = \frac{5}{8}\ (1)$$

$$\frac{v_{1M}}{v_{2M}} = \frac{2πf_1 \cdot A_1}{2πf_2 \cdot A_2} \overset{υ=λ \cdot f}{\Longrightarrow} \frac{v_{1M}}{v_{2M}} = \frac{λ_2 \cdot A_1}{λ_1 \cdot A_2} \overset{(1)}{\Rightarrow} \frac{v_{1M}}{v_{2M}} = \frac{12}{5}.$$

4B123:

$Σωστή\ η\ β.$

$$υ = v_{max} \cdot συνφ\ (1)\ ,\quad φ_K = φ_Λ + π\ (2)$$

$$(1) \overset{φ=φ_Λ}{\Longrightarrow} v_Λ = v_{max} \cdot συνφ_Λ$$

$$(1) \overset{φ=φ_K}{\Longrightarrow} v_K = v_{max} \cdot συνφ_K \overset{(2)}{\Rightarrow} v_K = v_{max} \cdot συν(φ_Λ + π) \Rightarrow$$

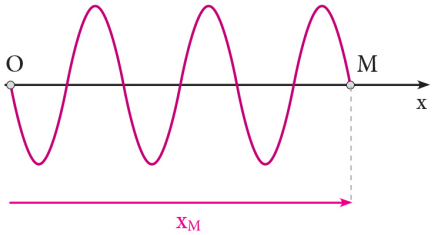
$$v_K = -v_M \cdot συνφ_Λ \Rightarrow v_K = -\frac{\sqrt{2}}{2}ωA.$$

4B124:

$Σωστή\ η\ β.$

$$f = \frac{N}{Δt} \Rightarrow f = \frac{4}{0{,}5} Hz \Rightarrow f = 8Hz$$

$$S_A = N \cdot 4A \Rightarrow A = \frac{1{,}6}{16} m = 0{,}1m$$



$$t_M = 3T = \frac{3}{f} \Rightarrow t_M = \frac{3}{8}s$$

$$\begin{cases} v_{max} = \omega \cdot A \Rightarrow v_{max} = 2\pi \cdot f \cdot A \Rightarrow v_{max} = 1{,}6\, m/s \\ v = \dfrac{x_M}{t_M} \Rightarrow v = \dfrac{1{,}2m}{\frac{3}{8}s} \Rightarrow v = 3{,}2\, m/s \end{cases} \Rightarrow \frac{v_{max}}{v} = \frac{\pi}{2}$$

4B125:

Σωστή η γ.

$$\varphi = 2\pi\left(\frac{t}{T} - \frac{x}{\lambda}\right) \xrightarrow{x=\sigma\tau\alpha\theta.} \Delta\varphi = 2\pi\frac{\Delta t}{T} \xrightarrow{v=\frac{\lambda}{T}} \frac{\Delta\varphi}{\Delta t} = \frac{2\pi\cdot v}{\lambda}\ (1)$$

$$\begin{cases} \Gamma\iota\alpha\ (M)\colon (1) \Rightarrow \dfrac{\Delta\varphi_M}{\Delta t} = \dfrac{2\pi\cdot v}{\lambda_1} \Rightarrow \varepsilon\varphi\theta_1 = \dfrac{2\pi\cdot v}{\lambda_1}\ (2) \\ \Gamma\iota\alpha\ (N)\colon\ (1) \Rightarrow \dfrac{\Delta\varphi_N}{\Delta t} = \dfrac{2\pi\cdot v}{\lambda_2} \Rightarrow \varepsilon\varphi\theta_2 = \dfrac{2\pi\cdot v}{\lambda_2}\ (3) \end{cases}$$

$$\frac{(2)}{(3)} \Rightarrow \frac{\varepsilon\varphi\theta_1}{\varepsilon\varphi\theta_2} = \frac{\lambda_2}{\lambda_1} \Rightarrow \frac{\lambda_1}{\lambda_2} = \frac{\varepsilon\varphi 30^\circ}{\varepsilon\varphi 60^\circ} \Rightarrow \frac{\lambda_1}{\lambda_2} = 3.$$

4B126:

Σωστή η β.

$$\varphi = 2\pi\left(\frac{t}{T} - \frac{x}{\lambda}\right) \xrightarrow{t=\sigma\tau\alpha\theta.} \Delta\varphi = 2\pi\frac{\Delta x}{\lambda} \Rightarrow \frac{\Delta\varphi}{\Delta x} = \frac{2\pi}{\lambda}(\mathrm{I})$$

$$\begin{cases} (\mathrm{I}) \xRightarrow{(1)} \dfrac{\Delta\varphi_1}{\Delta x_1} = \dfrac{2\pi}{\lambda_1} \Rightarrow \varepsilon\varphi\theta_1 = \dfrac{2\pi}{\lambda_1}\ (\mathrm{II}) \\ (\mathrm{I}) \xRightarrow{(2)} \dfrac{\Delta\varphi_2}{\Delta x_2} = \dfrac{2\pi}{\lambda_2} \Rightarrow \varepsilon\varphi\theta_2 = \dfrac{2\pi}{\lambda_2}\ (\mathrm{III}) \end{cases}$$

$$\varepsilon\varphi\theta_2 > \varepsilon\varphi\theta_1 \xrightarrow{(\mathrm{II}),(\mathrm{III})} \frac{2\pi}{\lambda_2} > \frac{2\pi}{\lambda_1} \Rightarrow \lambda_1 > \lambda_2 \Rightarrow \lambda_1 f > \lambda_2 f \Rightarrow \upsilon_1 > \upsilon_2.$$

4B127:

Σωστή η β.

$$\varphi = 2\pi\left(\frac{t}{T} - \frac{x}{\lambda} + \varphi_0\right)(1)$$

$$(1) \xrightarrow{t=t_1,\ x=x_B} \varphi_B = 2\pi\left(\frac{t_1}{T} - \frac{x_B}{\lambda} + \varphi_0\right) \xrightarrow{\varphi_B=8\pi,\ x_B=-d}$$

$$2\pi\left(\frac{t_1}{T} + \frac{d}{\lambda} + \varphi_0\right) = 8\pi \Rightarrow \frac{t_1}{T} + \frac{d}{\lambda} + \varphi_0 = 4\ (2)$$

$$(1) \xrightarrow{t=t_1,\ x=x_\Gamma} \varphi_\Gamma = 2\pi\left(\frac{t_1}{T} - \frac{x_\Gamma}{\lambda} + \varphi_0\right) \xrightarrow{\varphi_\Gamma=0,\ x_\Gamma=d}$$

$$\frac{t_1}{T} - \frac{d}{\lambda} + \varphi_0 = 0\ (3)$$

$$(2) + (3) \Rightarrow \frac{2t_1}{T} + 2\varphi_0 = 4 \Rightarrow \frac{t_1}{T} + \varphi_0 = 2\ (4),$$

$$(1) \xrightarrow{t=t_1,\ x=x_A} \Rightarrow \varphi_A = 2\pi\left(\frac{t_1}{T} - \frac{x_A}{\lambda} + \varphi_0\right) \xrightarrow{\varphi_\Gamma=10\pi}$$

$$10\pi = 2\pi\left(\frac{t_1}{T} - \frac{x_A}{\lambda} + \varphi_0\right) \xRightarrow{(4)} 5 = 2 - \frac{x_A}{\lambda} \Rightarrow x_A = -3\lambda.$$

4B128:

Σωστή η α.

$$\varphi_Z = 2\pi\left(\frac{t}{T} - \frac{x_Z}{\lambda} + \varphi_0\right)(1)$$

$$(1) \xrightarrow{t=t_1,\ \varphi_Z=\varphi_1} \varphi_1 = 2\pi\left(\frac{t_1}{T} - \frac{x_Z}{\lambda}\right)\ (2)$$

$$(1) \xrightarrow{t=t_2,\ \varphi_Z=\varphi_2} \varphi_2 = 2\pi\left(\frac{t_2}{T} - \frac{x_Z}{\lambda}\right)\ (3)$$

$$\Delta\varphi = \varphi_2 - \varphi_1 \xRightarrow{(2),(3)} \Delta\varphi = 2\pi\frac{t_2 - t_1}{T}.$$

4B129:

Σωστή η γ.

$$x_1 = \upsilon_1 \cdot t_1 \Rightarrow x_1 = \frac{\lambda_1}{T}\cdot\frac{7}{2}T \Rightarrow x_1 = \frac{7}{2}\lambda_1\ (1)$$

$$y_1 = \upsilon_2 \cdot t_1 \Rightarrow y_1 = \frac{\lambda_2}{T}\cdot\frac{7}{2}T \Rightarrow y_1 = \frac{7}{2}\lambda_2\ (2)$$

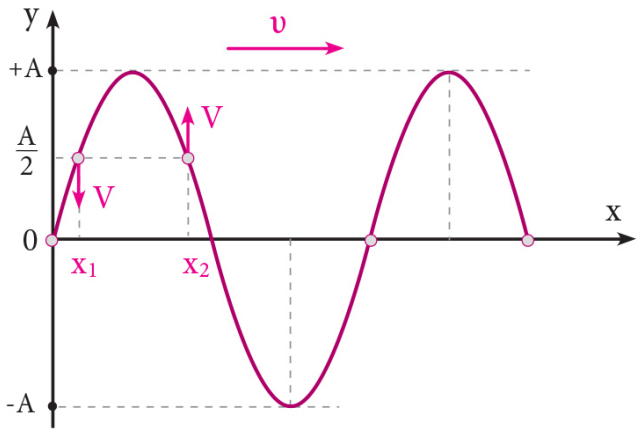
$$\upsilon_2 = \frac{4}{3}\upsilon_1 \Rightarrow \lambda_2 = \frac{4}{3}\lambda_1\ (3)$$

$$(2) \xRightarrow{(3)} y_1 = \frac{7}{2}\cdot\frac{4}{3}\lambda_1\ (4),$$

$$d = \sqrt{y_1^2 + x_1^2} \xRightarrow{(1),(4)} d = \frac{7}{2}\lambda_1 \cdot \sqrt{1 + \frac{16}{9}} = \frac{7}{2}\lambda_1 \cdot \frac{5}{3} \Rightarrow d = \frac{35}{6}\lambda_1.$$

4B130:

Σωστή η β.



Έστω κάποια χρονική στιγμή t_1 το στιγμιότυπο ενός αρμονικού κύ – ματος που διαδίδεται προς τη θετική κατεύθυνση. Τα σημεία που έ – χουν $y = \frac{A}{2}$ και αντίθετες ταχύτητες βρίσκονται στις θέσεις x_1 και x_2 στον άξονα Ox. Για το (1): $y = \frac{A}{2} \Rightarrow A\eta\mu\varphi_1 = \frac{\alpha}{2} \Rightarrow \eta\mu\varphi_1 = \frac{1}{2} = \eta\mu\frac{\pi}{6} \Rightarrow \varphi_1 = 2\kappa\pi + \frac{\pi}{6}$, απορρίπτεται ή $\varphi_1 = 2\kappa\pi + \frac{5\pi}{6}$, δεκτή ώστε $\upsilon < 0$. Για το (2): $y = \frac{a}{2} \Rightarrow A\eta\mu\varphi_2 = \frac{A}{2} \Rightarrow \eta\mu\varphi_2 = \frac{1}{2} = \eta\mu\frac{\pi}{6} \Rightarrow \varphi_2 = 2\kappa\pi + \frac{\pi}{6}$, δεκτή ώστε $\upsilon > 0$, $\varphi_2 = 2\kappa\pi + \frac{5\pi}{6}$, απορρίπεπται. Άρα

$$\varphi_1 - \varphi_2 = \frac{5\pi}{6} - \frac{\pi}{6} \Rightarrow \frac{2\pi(x_2 - x_1)}{\lambda} = \frac{4\pi}{6} \Rightarrow x_2 - x_1 = \frac{\lambda}{3} \Rightarrow \lambda =$$

$$= 3(x_2 - x_1) \Rightarrow \lambda = 7{,}5cm.$$

4Β131:

Σωστή η γ.

$Για\ το\ O: y = A \cdot ημ\frac{\pi}{2}t \Rightarrow \omega = \frac{\pi}{2} rad/s, T = 4s, t_1 = 2{,}5T \Rightarrow t_1 = 10s$

$t_2 = t_1 + 1 = 11s$, $άρα\ y = A \cdot ημ\left(\frac{\pi}{2} \cdot 11\right) = Aημ5{,}5\pi \Rightarrow y = -A.$

4Β132:

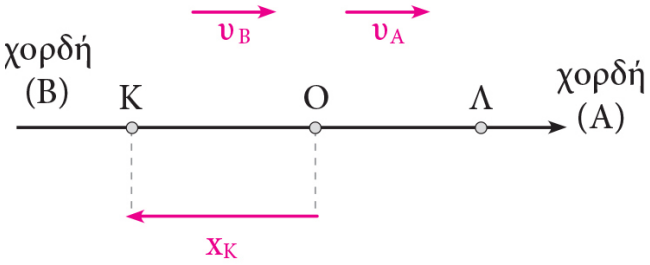
Σωστή η β.

$\Delta\varphi = \frac{2\pi(t_2 - t_1)}{T} \Rightarrow 6\pi = \frac{2\pi \cdot 3}{T} \Rightarrow T = 1s = t_{ενΣ} \Rightarrow x_Σ = \lambda.$

$Άρα\ y_Σ = A \cdot ημ2\pi\left(\frac{t}{T} - \frac{x_Σ}{\lambda}\right) = Aημ2\pi(t-1)\ (SI).$

4Β133:

Σωστή η α.



$v_B = 1{,}5v_A \Rightarrow \lambda_B \cdot f = 1{,}5\lambda_A \cdot f \Rightarrow \lambda_B = 1{,}5\lambda_A$, $\varphi_K = 2\pi\left(\frac{t}{T} - \frac{x_K}{\lambda_B}\right)$

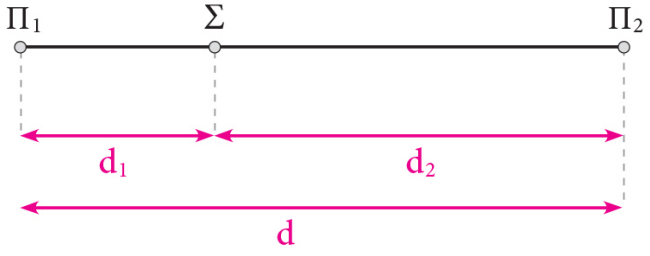
$= 2\pi\left(\frac{t}{T} - \frac{-1{,}5\lambda_A}{\lambda_B}\right) \Rightarrow \varphi_K = 2\pi\left(\frac{t}{T} + 1\right)\ (1), \varphi_Λ = 2\pi\left(\frac{t}{T} - \frac{x_Λ}{\lambda_A}\right)$

$= 2\pi\left(\frac{t}{T} - 1{,}5\right)(2), \varphi_K - \varphi_Λ = 2\pi\left(\frac{t}{T} + 1 - \frac{t}{T} + 1{,}5\right) \Rightarrow$

$\varphi_K - \varphi_Λ = 5\pi\ rad.$

4Β134:

Σωστή η γ.



Για το Σ όταν είναι σημείο ενισχυτικής συμβολής:

$d_1 - d_2 = N \cdot \lambda\ (1), d_1 + d_2 = d\ (2), (1), (2) \Rightarrow 2d_1 = N\lambda + d \Rightarrow$

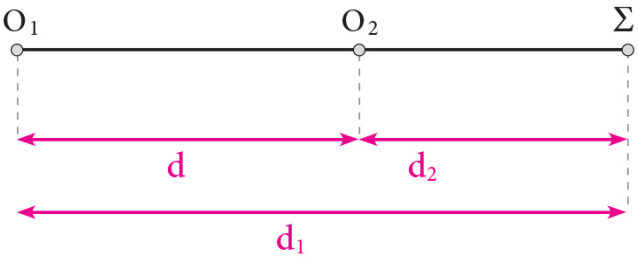
$d_1 = N\frac{\lambda}{2} + \frac{d}{2}, 0 < d_1 < d \Rightarrow -\frac{d}{2} < \frac{N\lambda}{2} < \frac{d}{2} \Rightarrow -\frac{d}{\lambda} < N < \frac{d}{\lambda} \Rightarrow$

$-3{,}6 < N < 3{,}6, N \in Z \Rightarrow$

$N = -3, -2, -1, 0, 1, 2, 3$ *δηλαδή 7 υπερβολές ενισχυτικής συμβολής.*

4Β135:

Σωστή η α.



$d_1 - d_2 = d = 8cm, \quad \lambda = 2cm$ *τότε:* $d_1 - d_2 = N\lambda \Rightarrow 8 = N \cdot 2$

$N = 4$, $άρα\ A' = 2A.$

4Β136:

Σωστή η β.

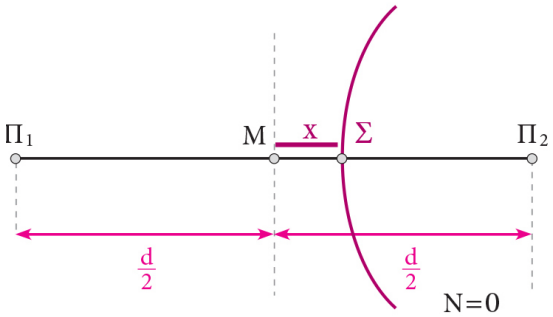
$v = \lambda f \Rightarrow \lambda = 2cm\ (1)$, $Γ: r_1 - r_2 = 4m\ (2), (1), (2) \Rightarrow$

$r_1 - r_2 = N\lambda$, *όπου* $N = 2$. $Άρα\ A_Γ = 2A = 0{,}2m$ *και*

$v_{max} = \omega A_Γ = 2\ m/s.$

4Β137:

Σωστή η β.



$Για\ το\ Σ: r_1 = \frac{d}{2} + x, r_2 = \frac{d}{2} - x \Rightarrow r_1 - r_2 = (2N+1) \cdot \frac{\lambda}{2}$, $με\ N = 0$

$ώστε\ r_1 > r_2.\ Άρα \frac{d}{2} + x - \left(\frac{d}{2} - x\right) = \frac{\lambda}{2} \Rightarrow 2x = \frac{\lambda}{2} \Rightarrow x = \frac{\lambda}{4} = 0{,}25\lambda.$

4Β138:

Σωστή η β.

$M: r_1 - r_2 = 0 = N\lambda$, *ενίσχυσης,* $v_{max(M)} = \omega 2A$

$Σ: d_1 = 5\lambda[(3\lambda)^2 + (4\lambda)^2 = d_1^2]\ (1)$, $d_2 = 4\lambda\ (2)$

$(1), (2) \Rightarrow d_1 - d_2 = \lambda = N\lambda$, $με\ N = 1$, $άρα$ *είναι ενίσχυσης:*

$v_{max(Σ)} = \omega 2A.$

4Β139:

Σωστή η β.

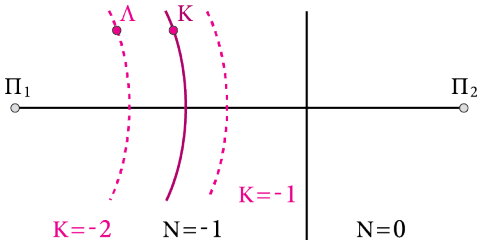
$K: Π_1K - Π_2K = (2k+1)\frac{\lambda}{2}\ (1)$

$Λ: (Π_1K + x) - (Π_2K - x) = (2k'+1)\frac{\lambda}{2}, k' = k + 1\ \ (2)$

$(1),(2) \Rightarrow (2k+1)\frac{\lambda}{2} + 2x = [2(k+1)+1]\frac{\lambda}{2} \Rightarrow 2x = 2 \cdot \frac{\lambda}{2} \Rightarrow x = \frac{\lambda}{2}.$

4Β140:

Σωστή η β.



Είναι $r_{1K} - r_{2K} = -10cm = -1\lambda \Rightarrow \lambda = 10cm.$

Για το Λ: $r_{1\Lambda} - r_{2\Lambda} = (2k+1)\frac{\lambda}{2} \Rightarrow r_{1\Lambda} - r_{2\Lambda} = -3\frac{\lambda}{2} \Rightarrow$

$r_{1\Lambda} - r_{2\Lambda} = 15cm.$

4Β141:

Σωστή η γ.

$\Gamma: r_1 = \frac{3\lambda}{2}, r_2 = 4\lambda - \frac{3\lambda}{2} = 2{,}5\lambda, r_1 - r_2 = -\lambda = N\lambda, N = -1,$ *άρα*

ενίσχυσης, στο οποίο αρχίζει η συμβολή την $t_1 = 1{,}5T$, *άρα τη*

στιγμή $t = 3{,}5T$ *έχει αρχίσει η συμβολή και των δύο κυμάτων και*

έχει: $v_\Gamma = v_1 + v_2 = \omega A\sigma\upsilon\nu 2\pi\left(\frac{t}{T} - \frac{r_1}{\lambda}\right) + \omega A\sigma\upsilon\nu 2\pi\left(\frac{t}{T} - \frac{r_2}{\lambda}\right) \Rightarrow$

$v_\Gamma = \omega A \cdot \sigma\upsilon\nu 4\pi + \omega A \cdot \sigma\upsilon\nu 2\pi = 2\omega A.$

$B: r_1' = 5\lambda$ *(απο πυθαγόρειο θεώρημα),* $r_2' = 3\lambda$ *, άρα η συμβολή*

αρχίζει τη στιγμή $t_1 = 5T$. *Δηλαδή για* $t = 3{,}5T$ *έχει φθάσει μόνο*

το κύμα απο Π_2 *και* $v_B = v_2 = \omega A\sigma\upsilon\nu 2\pi\left(\frac{t}{T} - \frac{r_2'}{\lambda}\right) \Rightarrow v_B = \omega A\sigma\upsilon\nu\pi$

$= -\omega A$ *, άρα* $v_\Gamma / v_B = -2.$

4Β142:

Σωστή η β.

$r_1 - r_2 = N\lambda \Rightarrow 0{,}5 = N \cdot \frac{\upsilon}{f} \Rightarrow f = 10N, N \in Z$ *και* $f > 0$ *άρα* $N_{min} = 1$

και $f = 10Hz.$

4Β143:

Σωστή η α.

$A = 0{,}1m$ *και* $\omega = 10\pi\ rad/s \Rightarrow f = 5Hz, \upsilon = \lambda f \Rightarrow \lambda = 0{,}4m$

$K: r_1 - r_2 = (2k+1)\frac{\lambda}{2} \Rightarrow 0{,}6 = (2k+1) \cdot 0{,}2 \Rightarrow k = 1,$ *άρα το ση –*

μείο είναι αποσβεστικής συμβολής $\Rightarrow A' = 0.$

4Β144:

Σωστή η γ.

$\Delta\varphi = \varphi_1 - \varphi_2 = 2\pi\left(\frac{t}{T} - \frac{r_1}{\lambda}\right) - 2\pi\left(\frac{t}{T} - \frac{r_2}{\lambda}\right) \Rightarrow \Delta\varphi = 2\pi\left(\frac{r_2}{\lambda} - \frac{r_1}{\lambda}\right) \Rightarrow$

$\Delta\varphi = \frac{2\pi \cdot 1}{1/4} = 8\pi\ rad/s$ *, όπου* $\lambda = \frac{\upsilon}{f}$ *και* $f = \frac{\omega}{2\pi} = 2Hz.$

4Β145:

Σωστή η α.

$M: r_1 - r_2 = N\lambda$ *,* $\Lambda: (r_1 + x) - (r_2 - x) = (2k+1)\frac{\lambda}{2}, N = k$

Άρα $N\lambda + 2x = (2N+1)\frac{\lambda}{2} \Rightarrow x = \frac{\lambda}{4} = 0{,}25m.$

4Β146:

Σωστή η β.

$\omega = 8\pi\ rad/s \Rightarrow f = 4Hz$ *,* $\upsilon = 1\,m/s \Rightarrow \lambda = 0{,}25m$

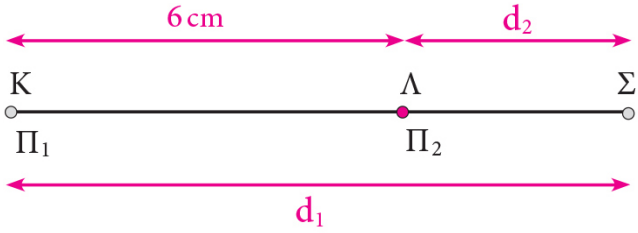
$r_1 - r_2 = N\lambda\ \ (1)$ *,* $r_1 + r_2 = d\ \ (2), (1), (2) \Rightarrow 2r_1 = N\lambda + d \Rightarrow$

$r_1 = \frac{N\lambda}{2} + \frac{d}{2}$ *,* $0 < r_1 < d\ \Rightarrow -\frac{d}{\lambda} < N < \frac{d}{\lambda} \Rightarrow -3{,}2 < N < 3{,}2$ *,* $N \in Z$

$\Rightarrow N = -3, -2, -1, 0, 1, 2, 3$ *δηλαδή 7 σημεία.*

4Β147:

Σωστή η α.



$\Sigma: d_1 - d_2 = 6cm = (2k+1)\frac{\lambda}{2} \Rightarrow k = 1$ *, άρα το Σ είναι απόσβεσης.*

4Β148:

Σωστή η α.

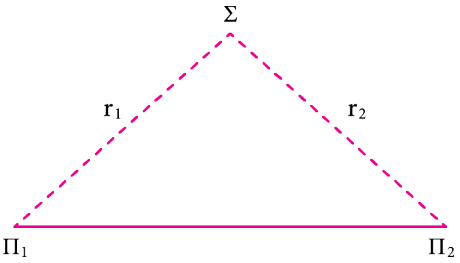
$r_1 - r_2 = 0{,}75m = N\lambda \Rightarrow 0{,}75 = N\frac{1}{f} \Rightarrow f = \frac{N}{3/4} \Rightarrow f = \frac{4}{3}N$ *, πρέπει:*

$6{,}4 < f < 8{,}4Hz \Rightarrow 6{,}4 < \frac{4}{3}N < 8{,}4 \Rightarrow 4{,}8 < N < 6{,}3 \Rightarrow$

$N = 5 \Rightarrow f = \frac{20}{3}Hz$ *,* $N = 6 \Rightarrow f = 8Hz.$

4Β149:

1. *Σωστή η α.*



$r_1 - r_2 = k\lambda \Rightarrow \upsilon \cdot t_1 - \upsilon \cdot t_2 = k\lambda \Rightarrow \upsilon \cdot \Delta t = k \cdot \frac{\upsilon}{f} \Rightarrow f \cdot \Delta t = k \Rightarrow$

$2\pi f \cdot \Delta t = k \cdot 2\pi \Rightarrow \omega \cdot \Delta t = 2k\pi \Rightarrow \Delta\varphi = 2k\pi.$

2.

Α. *Σωστή η α.* Β. *Σωστή η β.*

4Β150:

Σωστή η β.

$r_B + 2x_1 - r_A = k\lambda\ (1), \quad r_B + 2x_2 - r_A = k\lambda + \frac{\lambda}{2}\ (2)$

$(2) - (1) \Rightarrow 2(x_2 - x_1) = \frac{\lambda}{2} \Rightarrow \lambda = 16cm.$

4Β151:

Σωστή η β.

Μέγιστο ήχου: Αρχικά $r_2 - r_1 = N\lambda$ *, τελικά* $r_2 - r_1' = N' \cdot \lambda$

$N' = N - 1$ *ώστε* $r_2 - r'_1 < r_2 - r_1 \Rightarrow r_2 - (r_1 + 2d) = (N-1)\lambda\ (1)$

$r_2 - r_1 = N\lambda\ (2), (1), (2) \Rightarrow N\lambda - 2d = N\lambda - \lambda \Rightarrow d = \frac{\lambda}{2} \Rightarrow \lambda = 0{,}34m.$

Ελάχιστο ήχου: αρχικά $r_2 - r_1 = N\lambda$ *, τελικά* $r_2 - r"_1 = (2k+1)\frac{\lambda}{2}$*,*

$k = N - 1$ *, ώστε η μετατόπιση να είναι η ελάχιστη δυνατή.* $(r_2 - r"_1$

$< r_2 - r_1)$*. Άρα* $r_2 - (r_1 + 2x) = (2N-1)\frac{\lambda}{2}\ (3)$ *,* $r_2 - r_1 = N\lambda\ (4)$

$(3), (4) \Rightarrow N\lambda - 2x = N\lambda - \frac{\lambda}{2} \Rightarrow x = \frac{\lambda}{4} \Rightarrow x = 0{,}085m.$

4Β152:

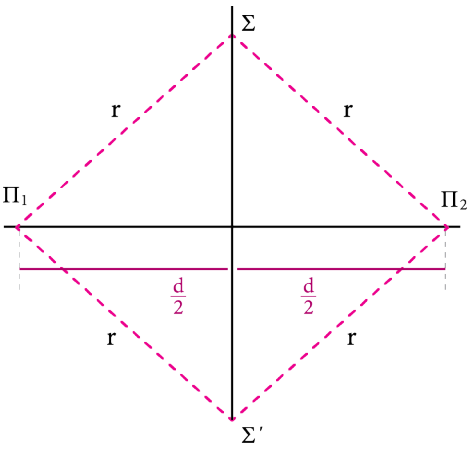
Σωστή η α.

Αρχικά: $r_1 - r_2 = N\lambda = N\frac{\upsilon}{f} \Rightarrow f = \frac{N \cdot \upsilon}{r_1 - r_2}$*. Τελικά: αν* $f' = 2f$ *τότε*

$f' = 2\frac{N \cdot \upsilon}{r_1 - r_2} \Rightarrow r_1 - r_2 = \frac{2N \cdot \upsilon}{f'} = 2N\lambda'.$

4Β153:

Σωστή η β.



$\frac{d}{2} = 2\lambda$ *,* $r > \frac{d}{2} \Rightarrow r > 2\lambda$ *, έως* $r = 3\lambda$ *, αφού για* $t = 3T$ *ζητάμε* $y = 2A$

πρέπει να έχουν φθάσει τα κύματα στο σημείο αυτό. Τότε:

$y_\Sigma = y_{1\Sigma} + y_{2\Sigma} = 2A \Rightarrow y_{1\Sigma} = y_{2\Sigma} = A.\ y_{1\Sigma} = A \cdot \eta\mu 2\pi\left(\frac{3T}{T} - \frac{r}{\lambda}\right) = A$

$\Rightarrow 2\pi\left(3 - \frac{r}{\lambda}\right) = 2k\pi + \frac{\pi}{2} \Rightarrow 3 - \frac{r}{\lambda} = k + \frac{1}{4} \Rightarrow \frac{r}{\lambda} = 2{,}75 - k \Rightarrow$

$r = (2{,}75 - k) \cdot \lambda.$

Για $k = 0: r = 2{,}75\lambda$ *δεκτή , για* $k = 1: r = 1{,}75\lambda < 2\lambda$ *άτοπο ,*

για $k = 2: r = 0{,}75\lambda < 2\lambda$ *άτοπο , για* $k \geq 3: r < 0$ *άτοπο.*

Άρα 2 σημεία , συμμετρικά ως προς το μέσο Μ.

4Β154:

Σωστή η α.

$d = \upsilon t_1 \Rightarrow \upsilon = 1\ m/s\ .\ (\Pi A\Sigma) = \upsilon t_2 = 1m \Rightarrow (\Pi A) = (A\Sigma) = 0{,}5m$

$\upsilon = \lambda f \Rightarrow \lambda = \frac{1}{5} = 0{,}2m$ *και* $(\Pi A\Sigma) - d = 0{,}2m = N\lambda$ *, όπου* $N = 1 \Rightarrow$

ενίσχυση. Άν f' *η νέα συχνότητα τότε* $\lambda' = \frac{1}{f'}$ *και* $\Pi A\Sigma - d = 0{,}2m$

$= N' \cdot \lambda' \Rightarrow 0{,}2 = N' \cdot \frac{1}{f'} \Rightarrow f' = 5N'$*, όπου* $f' > f \Rightarrow 5N' > 5 \Rightarrow$

$N' > 1$ *όμως* $N' \in Z \Rightarrow N' = 2$ *,* $f' = 10Hz \Rightarrow \Delta f = 5Hz$

4Β155:

Σωστή η α.

Η απόσταση d_2 *είναι:* $d_2 = \sqrt{d_1^2 + d^2} = 2{,}5\lambda_1 = 2{,}5\frac{\upsilon}{f_1}\ (1).$

Αν το μήκος κύματος γίνει $\lambda_2 = \frac{\upsilon}{f_2} = \frac{\upsilon}{2f_1} \Rightarrow f_1 = \frac{\upsilon}{2\lambda_2}\ (2)$*, τότε απο*

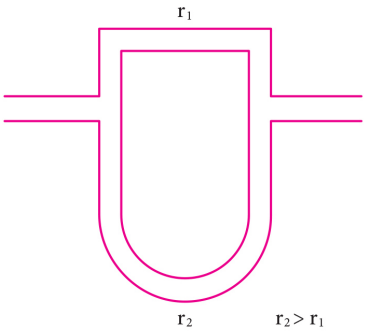
$(1), (2) \Rightarrow d_2 - d_1 = 0{,}5\lambda_1 \Rightarrow d_2 - d_1 = 0{,}5\frac{\upsilon}{f_1} \Rightarrow d_2 - d_1 =$

$0{,}5 \cdot \frac{\upsilon}{\upsilon/2\lambda_2} \Rightarrow d_2 - d_1 = 0{,}5 \cdot 2\lambda_2 \Rightarrow d_2 - d_1 = \lambda_2$ *δηλαδή* $k \cdot \lambda_2$ *όπου*

$k = 1.$

4B156:

Σωστή η β.



$r_2 - r_1 = \pi R - (2R + 2x) = N\lambda > 0 \Rightarrow (\pi - 2)R + 2x = N\lambda \Rightarrow$

$\Rightarrow x = N\frac{\lambda}{2} + (\pi - 2)\frac{R}{2}$ *, για* $N_{min} = 1 \Rightarrow x_{min} = \frac{(\pi - 2)R + \lambda}{2}$.

4B157:

Σωστή η β.

Για τα σημεία απόσβεσης: $r_1 - r_2 = (2N + 1)\frac{\lambda}{2}$ *,* $r_1 + r_2 = d = 5\lambda \Rightarrow$

$r_1 = (2N + 1)\frac{\lambda}{4} + \frac{5\lambda}{2}$ *,* $0 < r_1 < 5\lambda \Rightarrow 0 < (2N + 1)\frac{\lambda}{4} + 2{,}5\lambda < 5\lambda \Rightarrow$

$0 < (2N + 1)\lambda + 10\lambda < 20\lambda \Rightarrow -10 < 2N + 1 < 10 \Rightarrow$

$-5{,}5 < N < 4{,}5$ *,* $N \in Z \Rightarrow N = -5, -4, -3, -2, -1, 0, 1, 2, 3, 4$ *δηλαδή*

10 σημεία απόσβεσης.

4B158:

Σωστή η α.

$\Delta r = N\lambda \Rightarrow \Delta t = N \cdot T$ *ώστε ενίσχυση* $\Rightarrow t_1 - T = NT \Rightarrow t_1 = T + NT$

Για $N_{min} = 1 \Rightarrow t_{1min} = 2T$.

4B159:

Σωστή η γ.

Η διαφορά αποστάσεων είναι $r_1 - r_2 = k \cdot \lambda$ *,* $r_1 = \pi R$ *,* $r_2 = 2R \Rightarrow$

$(\pi - 2)R = k \cdot \frac{v}{f} \Rightarrow f = \frac{k \cdot v}{R(\pi - 2)}$ *,* k *ακέραιος θετικός.*

4B160:

Σωστή η γ.

Έστω η κοιλία που βρίσκεται στη θέση $x = 0$. *Τότε* $x_\Sigma = \frac{\lambda}{8}$:

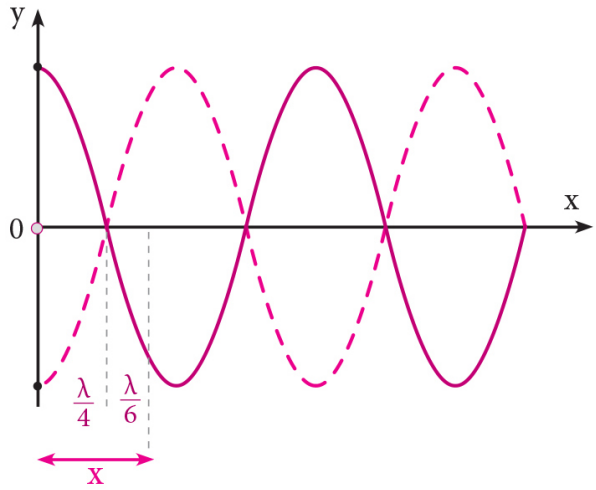
$A' = \left|2A \cdot συν\frac{2\pi \cdot \lambda/8}{\lambda}\right| = 2A\left|συν\frac{\pi}{4}\right| = A\sqrt{2}$

4B161:

Σωστή η γ.

$x = \frac{\lambda}{4} + \frac{\lambda}{6} = \frac{5\lambda}{12}$ (1). $A' = \left|2A \cdot συν\frac{2\pi x}{\lambda}\right| \overset{(1)}{\Rightarrow} A' = \left|2A \cdot συν 2\pi\frac{5}{12}\right| \Rightarrow$

$A' = 2A \cdot \frac{\sqrt{3}}{2} \Rightarrow A' = A\sqrt{3}$



4B162:

Σωστή η γ.

Για t_1: $y_1 = +A' = 4cm$ *για το σημείο* $x = 0$.

Για t_2: $y_2 = +\frac{A'}{2} = 2cm$ *για το σημείο* $x = 0$.

Άρα $U_{ταλ} = \frac{1}{2}Dy_2^2 = \frac{1}{8}DA'^2 = \frac{1}{4}E_{ολ}$ (1). $K + U_{ταλ} = E_{ολ}$ (2).

(1), (2) $\Rightarrow K = \frac{3}{4}E_{ολ} \Rightarrow K = 3U_{ταλ}$.

4B163:

Σωστή η α.

$v = \frac{\Delta x}{\Delta t} = \frac{0{,}8}{4} = 0{,}2\, m/s$. *Είναι* $K = U_{ταλ} \Rightarrow y = \pm 1cm = \pm A' \cdot \frac{\sqrt{2}}{2}$

$\Rightarrow A' = \sqrt{2}cm$ *για τα σημεία που είναι κοιλίες.*

$l = 2\lambda \Rightarrow 0{,}8 = 2\lambda \Rightarrow \lambda = 0{,}4m$. $v = \lambda f \Rightarrow f = 0{,}5Hz$ *και* $\omega = 2\pi f$

$\Rightarrow \omega = \pi\ rad/s$. $v_{max} = \omega A' = \pi \cdot \sqrt{2}\ cm/s$.

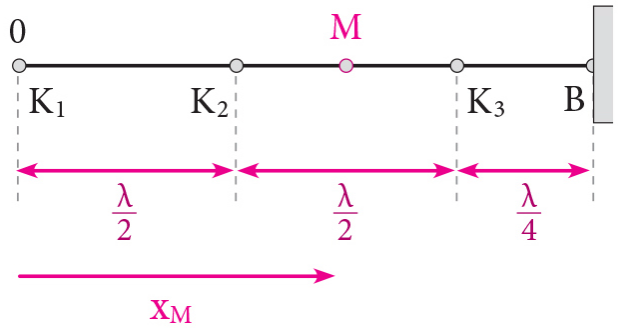
4B164:

Σωστή η β.

Η ενέργεια της κάθε κοιλίας: $E_κ = \frac{1}{2}D(2A)^2 = \frac{1}{2}m\left(\frac{2\pi}{T}\right)^2 \cdot 4A^2$

$\Rightarrow E_{κοιλίας} = \frac{8m\pi^2A^2}{T^2}$. *Άρα* $\frac{E}{E_{κοιλίας}} = 3$, *δηλαδή δημιουργούνται*

3 συνολικά κοιλίες.



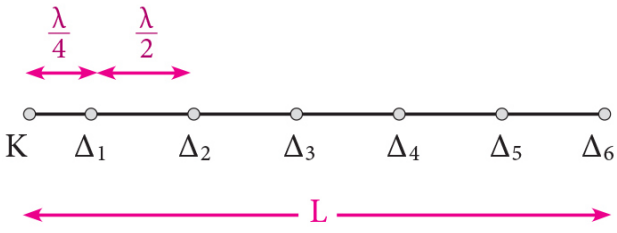
$x_M = \frac{L}{2}, L = \frac{5\lambda}{4} \Rightarrow x_M = \frac{5\lambda}{8}, A'_M = \left|2A \cdot \sigma\upsilon\nu \frac{2\pi x_M}{\lambda}\right| \Rightarrow$

$A'_M = 2A\left|\sigma\upsilon\nu\frac{5\pi}{4}\right| = A\sqrt{2}.\ \upsilon_{max_M} = \omega \cdot A'_M = \omega \cdot A\sqrt{2}.$

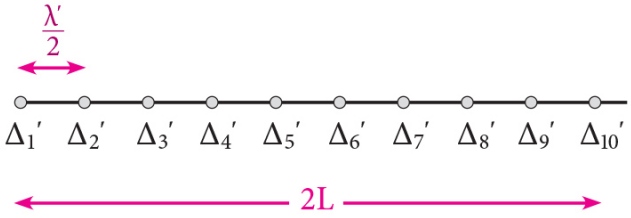
$K_{max_M} = \frac{1}{2}m\upsilon^2_{max_M} = \frac{1}{2}m \cdot \frac{4\pi^2}{T^2} \cdot A^2 \cdot 2 = \frac{4\pi^2 mA^2}{T^2}.$

4B165:

Σωστή η α.



$L = \frac{5\lambda}{2} + \frac{\lambda}{4} = \frac{11\lambda}{4}$ (1).



$2L = \frac{9\lambda'}{2}$ (2).

$(1),(2) \Rightarrow 2 \cdot \frac{11\lambda}{4} = \frac{9\lambda'}{2} \Rightarrow 11\frac{\upsilon}{f} = 9\frac{\upsilon}{f'} \Rightarrow f' = \frac{9f}{11} \Rightarrow \frac{f}{f'} = \frac{11}{9}$

4B166:

Σωστή η α.

Αρχικά: $L = \frac{9\lambda}{2}$ (1). *Τελικά:* $L = \frac{4\lambda'}{2}$ (2).

$(1),(2) \Rightarrow \lambda' = 2{,}25\lambda \Rightarrow \Delta\lambda = 1{,}25\lambda \Rightarrow \frac{\Delta\lambda}{\lambda}\% = 125$

4B167:

Σωστή η β.

Αρχικά: $L = \frac{6\lambda}{2} + \frac{\lambda}{4}$ (1). *Τελικά:* $L = \frac{x\lambda'}{2} + \frac{\lambda'}{4}$ (2).

$(1),(2) \Rightarrow \frac{13\lambda}{4} = (2x+1)\frac{\lambda'}{4} \Rightarrow 13\lambda = (2x+1)\lambda' \Rightarrow$

$13\lambda = (2x+1) \cdot \frac{13\lambda}{9} \Rightarrow x = 4$ *άρα συνολικά στο 2ο μέσο: 5 δεσμοί.*

4B168:

Σωστή η α.

$x_K = \frac{\lambda}{4} - \frac{\lambda}{6} = \frac{\lambda}{12}, A'_K = 2A\left|\sigma\upsilon\nu\frac{2\pi}{\lambda} \cdot \frac{\lambda}{12}\right| = 2A\frac{\sqrt{3}}{2} = A\sqrt{3}.$

$x_\Lambda = \frac{\lambda}{4} + \frac{\lambda}{12} = 4 \cdot \frac{\lambda}{12}, A'_\Lambda = 2A\left|\sigma\upsilon\nu\frac{2\pi}{3}\right| = A$

$\upsilon_{K_{max}} = \omega A\sqrt{3}$ (1), $\upsilon_{\Lambda_{max}} = \omega A$ (2). $(1),(2) \Rightarrow \frac{\upsilon_K}{\upsilon_\Lambda} = \sqrt{3}$

4B169:

Σωστή η β.

$x_M = \frac{\lambda}{4} - \frac{\lambda}{3} = -\frac{\lambda}{12}, A'_M = 2A\left|\sigma\upsilon\nu\frac{2\pi}{\lambda} \cdot \left(-\frac{\lambda}{12}\right)\right| = A\sqrt{3}$

$x_N = \frac{\lambda}{4} + \frac{\lambda}{8} = \frac{3\lambda}{8}, A'_N = 2A\left|\sigma\upsilon\nu\frac{2\pi}{\lambda} \cdot \frac{3\lambda}{8}\right| = A\sqrt{2}$

$\alpha_{max_M} = \omega^2 A'_M$ (1), $\alpha_{max_N} = \omega^2 A'_N$ (2). $(1),(2) \Rightarrow \frac{\alpha_{max_M}}{\alpha_{max_N}} = \sqrt{\frac{3}{2}}$

4B170:

Σωστή η α.

$2A = 0{,}2m, \lambda = 1m, \omega = 5\pi\ rad/s \Rightarrow f = 2{,}5Hz, x_{κοιλίας} = k \cdot \frac{\lambda}{2}$ (1)

$x_\Gamma < x_{κοιλίας} < x_\Delta$ (2), $(1),(2) \Rightarrow 10{,}25 < \frac{k}{2} < 14{,}75 \Rightarrow$

$20{,}5 < k < 29{,}5, k \in z \Rightarrow k = 21,22,23,24,25,26,27,28,29$ *δηλαδή 9 κοιλίες.*

4B171:

Σωστή η γ.

$y_{K1} = 2A \cdot \sigma\upsilon\nu\frac{2\pi(\lambda/2)}{\lambda} \cdot \eta\mu\left(\frac{2\pi}{T} \cdot \frac{2T}{3}\right) = 2A \cdot \sigma\upsilon\nu\pi \cdot \eta\mu\frac{4\pi}{3} \Rightarrow$

$y_{K1} = A\sqrt{3} > 0$ *και* $\upsilon_{K1} = \omega \cdot 2A \cdot \sigma\upsilon\nu\pi \cdot \sigma\upsilon\nu\frac{4\pi}{3} = \omega A > 0.$

4B172:

Σωστή η β.

Για το σημείο $x = 0$ *την* $t_1 = \frac{5T}{12}$: $\upsilon = \omega \cdot 2A \cdot \sigma\upsilon\nu 0 \cdot \sigma\upsilon\nu\left(\frac{2\pi}{T} \cdot \frac{5T}{12}\right) \Rightarrow$

$\upsilon = \omega \cdot 2A \cdot \left(-\frac{\sqrt{3}}{2}\right) \Rightarrow K = \frac{1}{2}m\upsilon^2 = \frac{3}{4}K_{max} = \frac{3}{4}E_{o\lambda}.$

4B173:

Σωστή η α.

$Για\ t_1 = \frac{1}{8f} = \frac{T}{8}:\ y = 2A \cdot συν\frac{2\pi x}{\lambda} \cdot ημ\frac{\pi}{4} = 2A \cdot συν\frac{2\pi x}{\lambda} \cdot \frac{\sqrt{2}}{2} \Rightarrow$

$\Rightarrow |y| = A' \cdot \frac{\sqrt{2}}{2}, άρα\ U_{ταλ} = \frac{1}{2}Dy^2 = \frac{E_{ολ}}{4}\ και\ K = E_{ολ} - U_{ταλ} = \frac{3E_{ολ}}{4}.$

4B174:

Σωστή η β.

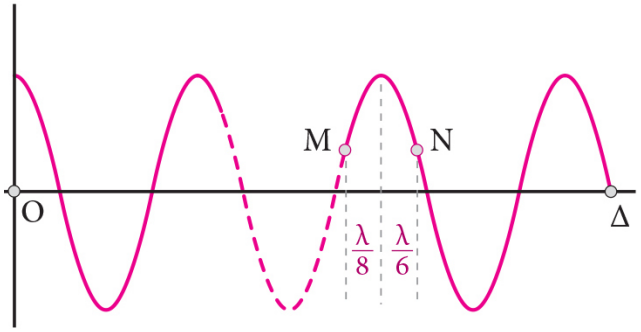
$y = A \cdot συν\frac{2\pi x}{\lambda} \cdot ημ\frac{2\pi t}{T}\ (1), t = \frac{T}{3}\ (2), x = 0\ (3).$

$(1), (2), (3) \Rightarrow 0{,}3\sqrt{3} = 2A \cdot ημ\frac{2\pi}{3} \Rightarrow A = 0{,}3m.$

Απο το σχήμα: $\lambda = 4m.$

4B175:

Σωστή η β.



$A'_M = \left|2A \cdot συν2\pi\frac{x_M}{\lambda}\right| = \left|2A \cdot συν2\pi\frac{\kappa\frac{\lambda}{2} - \frac{\lambda}{8}}{\lambda}\right| = 2A\left|συν2\pi\left(\frac{4\kappa - 1}{8}\right)\right|$

$= 2A \cdot \left|συν\left(\kappa\pi - \frac{\pi}{4}\right)\right| = A\sqrt{2}.\ A'_N = \left|2A \cdot συν2\pi\frac{x_N}{\lambda}\right| =$

$\left|2A \cdot συν2\pi\frac{\kappa\frac{\lambda}{2} + \frac{\lambda}{6}}{\lambda}\right| = 2A\left|συν2\pi\left(\frac{3\kappa + 1}{6}\right)\right| = 2A\left|συν\left(\kappa\pi + \frac{\pi}{3}\right)\right| = A.$

$\frac{E_{A'_M}}{E_{A'_N}} = \frac{\frac{1}{2}DA'^2_M}{\frac{1}{2}DA'^2_N} = 2$

4B176:

Σωστό το α.

$Έστω\ Γ\ το\ σημείο:\ A'_Γ = \left|2A \cdot συν\frac{2\pi x}{\lambda}\right| \Rightarrow A'_Γ = 2A\left|συν2\pi\frac{\kappa\frac{\lambda}{2} + \frac{\lambda}{6}}{\lambda}\right|$

$\Rightarrow A'_Γ = 2A\left|συν\left(\kappa\pi \pm \frac{\pi}{3}\right)\right| \Rightarrow A'_Γ = A.\ \alpha_{max} = \omega^2 \cdot 2A\ (1)$

$\alpha_{max_Γ} = \omega^2 A\ (2), (1), (2) \Rightarrow\ \alpha_{max_Γ} = 5\,m/s^2.$

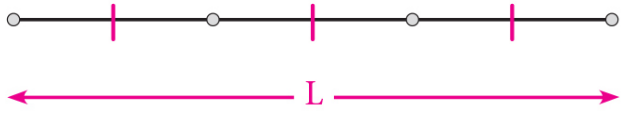
4B177:

Σωστή η γ.

$L = \kappa\frac{\lambda}{2} \Rightarrow 2L = \kappa\frac{v}{f} \Rightarrow f = \frac{\kappa \cdot v}{2L} \Rightarrow f = \kappa \cdot 1{,}25 \overset{\kappa=2}{\Longrightarrow} f = 2{,}5Hz.$

4B178:

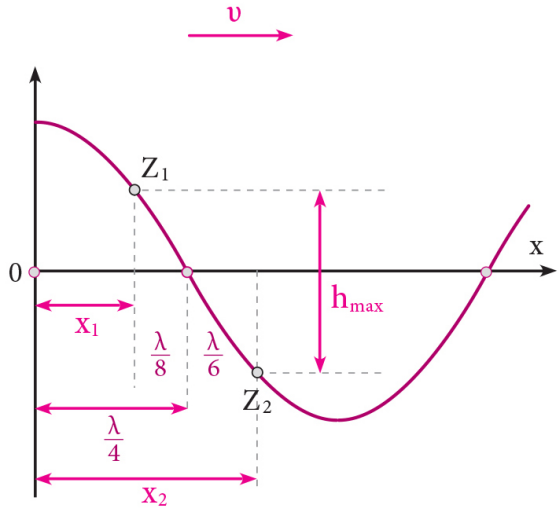
Σωστή η α.



$L = \frac{3\lambda}{2} \Rightarrow L = \frac{3}{2} \cdot \frac{v}{f} \Rightarrow v = \frac{2Lf}{3}.$

4B179:

Σωστή η β.



$x_1 = \frac{\lambda}{4} - \frac{\lambda}{8} = \frac{\lambda}{8}, x_2 = \frac{\lambda}{4} + \frac{\lambda}{6} = \frac{5\lambda}{12}$

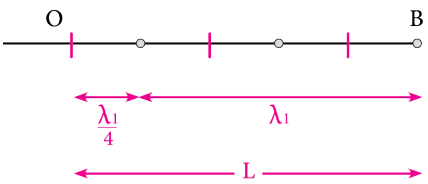
$A'_{z1} = \left|2A \cdot συν2\pi\frac{x_1}{\lambda}\right| = 2A\left|συν\frac{\pi}{4}\right| = A\sqrt{2}$

$A'_{z2} = \left|2A \cdot συν2\pi\frac{x_2}{\lambda}\right| = 2A\left|συν\frac{5\pi}{6}\right| = A\sqrt{3}$

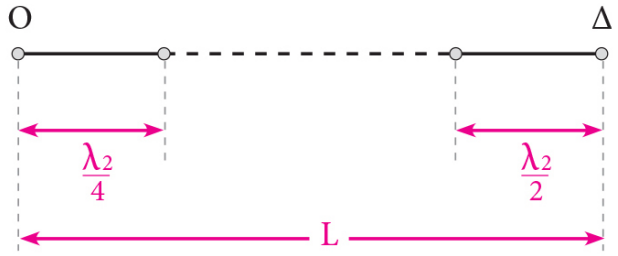
$A_{max} = A'_{z1} + A'_{z2} = A\left(\sqrt{2} + \sqrt{3}\right).$

4B180:

Σωστή η α.



$f = f_1, L = \frac{5\lambda_1}{4} \Rightarrow L = \frac{5}{4} \cdot \frac{v}{f_1}\ (1)$



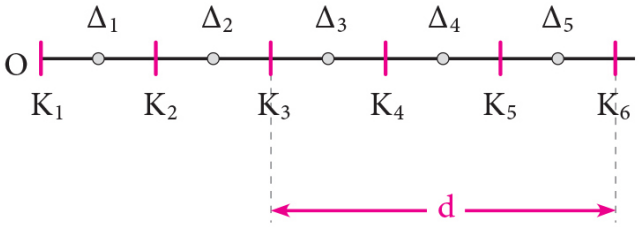
$L = \frac{\lambda_2}{4} + N\frac{\lambda_2}{2} \Rightarrow L = \left(\frac{1}{4} + \frac{N}{2}\right)\lambda_2$

$\Rightarrow L = \left(\frac{1}{4} + \frac{N}{2}\right)\frac{v}{f_2}$ (2). (1), (2) $\Rightarrow \frac{5}{4}\frac{v}{f_1} = \left(\frac{1}{4} + \frac{N}{2}\right)\frac{v}{f_2} \Rightarrow \frac{5}{4}\frac{f_1}{f_2} = \frac{1}{4} + \frac{N}{2} \Rightarrow$

$N = 3$ *άρα 4 δεσμοί.*

4B181:

Σωστή η β.



$d = \frac{\lambda}{4} + \frac{\lambda}{2} + \frac{\lambda}{2} \Rightarrow d = \frac{5\lambda}{4} \Rightarrow 4d = 5\frac{v}{f} \Rightarrow f = \frac{5v}{4d} \Rightarrow f = 5Hz.$