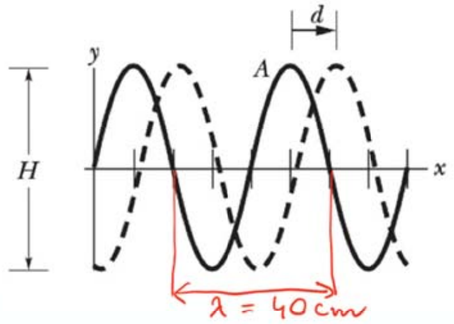
ANSWERS WAVES EXAM, FYSA13

<u>V1 Answers</u>

y_m = 3.00 mm
k = 16 rad m^{-1}
ω = 250 rad s^{-1}
sign: negative

<u>V1 Solutions</u>

V1



$d = 8.0\,\text{cm}$ during $\Delta t = 5.0\,\text{ms}$

$H = 6.00\,\text{mm}$

$$y(x,t) = y_m \sin(kx \pm \omega t)$$

$$y_m = \frac{H}{2} = \underline{3.00\,\text{mm}}$$

$$\left.\begin{aligned} k &= \frac{2\pi}{\lambda} \\ \lambda &= 40\,\text{cm} \end{aligned}\right\} \Rightarrow k = \frac{2\pi}{0.40\,\text{m}} = 15.7\,\text{m}^{-1} = \underline{\approx 16\,\text{m}^{-1}}$$

(rad/m)

$$\omega = 2\pi f$$

$$f = \frac{v}{\lambda}$$

$$v = \frac{d}{\Delta t} = \frac{8.0\times10^{-2}\,\text{m}}{5.0\times10^{-3}\,\text{s}} = 16\,\frac{\text{m}}{\text{s}}$$

$$\Rightarrow f = \frac{v}{\lambda} = \frac{16\,\text{m/s}}{0.40\,\text{m}} = 40\,\text{s}^{-1}$$

$$\omega = 2\pi \times 40\,\text{s}^{-1} = 251\,\text{s}^{-1} \approx \underline{250\,\text{s}^{-1}}$$

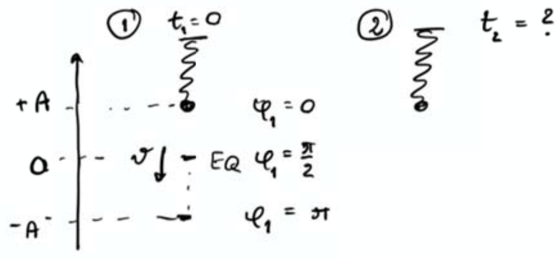
(rad/s)

sign: negative, since the wave travels in the +x direction

V2 Answers

0.70 s

V2 Solutions



$m = 430\,g$

$k = 2.2\,N/m$

wait until $\varphi_1 = \frac{\pi}{2}$, i.e., until the first one passes the equilibrium position for the first time

$$t_2 = \frac{T}{4}$$

$$T = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{0.430\,kg}{2.2\,N/m}} = 2.8\ s$$

$$t_2 = \frac{2.8\,s}{4} = \underline{0.70\ s.}$$

V3 Answers

a) 99.5 dB
b) 16.4%

V3 Solutions

a) $\beta = 10\log\frac{I}{10^{-12}} = 130$

$10^3 = \frac{I}{10^{-12}} \Rightarrow I_{30} = 10^{13}\cdot 10^{-12} = 10\ W/m^2$

$\frac{I_1}{I_{30}} = \frac{r_{30}^2}{r_1^2} = \frac{30^2}{1000^2} = 0{,}0009$

$I_1 = 0{,}0009 \cdot 10 = 0{,}009\ W/m^2$

$\beta = 10\log\frac{0{,}009}{10^{-12}} = 99{,}5\ dB$

b) L → 30.5 m/s, S: $f_L = \frac{v+v_L}{v+v_S} f_s = \frac{340+30{,}5}{340+0} f_s = 1{,}0897 f_s$

S, L → 30,5: $f_L = \frac{v-v_L}{v+v_S} f_s = \frac{340-30{,}5}{340} f_s = 0{,}9103 f_s$

change is $\frac{1{,}0897-0{,}9103}{1{,}0897}\times 100 = 16{,}4\ \%$

V4 Answers

a) A = 0.00185m / r
b) The pressure amplitude changes from 90.4 Pa to 2.7 Pa.

V4 Solutions

a) $I = \frac{1}{2}\rho(\omega A)^2 v \Rightarrow A = \sqrt{\frac{2I}{\rho\omega^2 v}}$

$I = \frac{Power}{4\pi r^2}$

$\Rightarrow A = \sqrt{\frac{2\,Power}{4\pi r^2 \rho\omega^2 v}}$

$I(30m) = 10\,W/m^2 = \frac{Power}{4\pi 30^2} \Rightarrow Power = 10\cdot 4\pi 30^2$

$A = \sqrt{\frac{2\cdot 10\cdot 4\pi\cdot 30^2}{4\pi\rho\omega^2 v}}\cdot\frac{1}{r} = \frac{0.00185m}{r}$

(ρ = 1.20, ω = $2\pi\cdot 572$, v = 340)

b)

Pressure function: $P(x,t) = P_{max}\sin(kx - \omega t)$

$k = \frac{2\pi}{\lambda}$ and $\omega = 2\pi f$ do not change.

$P_{max} = v\rho\omega A$ changes because A changes

$P_{max}(30m) = 340\cdot 1.2\cdot 2\pi\cdot 572\cdot 0.00185/30 = 90.4\,Pa$

$P_{max}(1000m) = 340\cdot 1.2\cdot 2\pi\cdot 572\cdot 0.00185/1000 = 2.7\,Pa$

V5 Answers

a) 1.26 mm
b) 1.33 mm

V5 Solutions

a) $\delta = d\sin\theta$, $\tan\theta = \frac{y}{R} \approx \sin\theta$ $\Rightarrow \delta = d\frac{y}{R}$

Dark bands for $\delta = (m+\frac{1}{2})\lambda \Rightarrow (m+\frac{1}{2})\lambda = d\frac{y}{R}$

$y = \frac{R}{d}(m+\frac{1}{2})\lambda$

$m = 0$: $y_0 = \frac{R}{d}\frac{\lambda}{2}$

$m = 1$: $y_1 = \frac{R}{d}\frac{3\lambda}{2}$

$\Delta y = y_1 - y_0 = \frac{R}{d}\lambda$

$\frac{R}{d} = \frac{\Delta y}{\lambda} = \frac{2.00\cdot 10^{-3}}{632.8\cdot 10^{-9}} = 3161$

$\Delta y(400nm) = 3161\cdot 400\cdot 10^{-9} = 1.26mm$

b) $\Delta y = \frac{R}{d}\lambda$

$R\lambda = d\cdot\Delta y = 200\cdot 10^{-6}\cdot 2.00\cdot 10^{-3} = 4.00\cdot 10^{-7}\,m^2$

$\Delta y = \frac{R\lambda}{d} = \frac{4.00\cdot 10^{-7}}{300\cdot 10^{-6}} = 1.33mm$