Série 5 - Física Geral

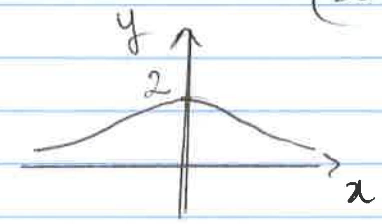
Ondas e propagação/sobreposição

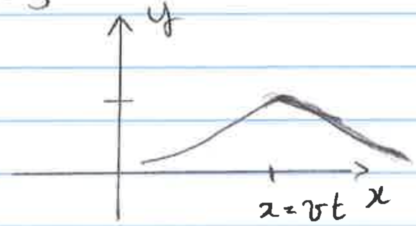
1. Pulso transversal

$t = 0 \quad y = \dfrac{6}{x^2 + 3}$ $\quad v = 4.5\,m/s \rightarrow$

Substituir $x \rightarrow x - vt$ $\quad y(x,t) = y(x - vt)$

$$y(x,t) = \frac{6}{(x - 4.5t)^2 + 3}$$





A forma é a mesma.

2. $t = 0 \quad y = \dfrac{2}{x^2 + 1}$

$t = 1 \quad y = \dfrac{2}{(x - 3.0)^2 + 1}$

$t = 2 \quad y = \dfrac{2}{(x - 6.0)^2 + 1}$

Deslocamento do pulso p. a direita:

Máximo em $x = 0$, $x = 3.0$ e $x = 6.0$.

3. $\lambda = \dfrac{v}{f} = 9,2\,cm$

$k = \dfrac{2\pi}{\lambda} = 69\,m^{-1}$

$T = \dfrac{1}{f} = 0.17\,ms$.

$\omega = 2\pi f = 38.000\,rad/s$.

4. $k = \dfrac{2\pi}{\lambda} = \dfrac{\pi}{0.4}\,rad/m.$ $\quad \omega = 2\pi f = 6\pi\,rad\,s^{-1}$

$y(x,t) = A \sin(kx + \omega t + \phi)$ $\quad \leftarrow$ desl.

$y(0,t) = 0$ qdo $t = 0 \Rightarrow \phi = 0$

$$y(x,t) = 0.08 \sin\left(\frac{\pi}{0.4}x + 6\pi t\right) \quad m$$

b) $y(x,0) = 0$ qdo $x = 10.0\,cm = 0.10\,m$

$$y(0.10, 0) = 0.08 \sin\left(\frac{\pi}{4} + \phi\right) = 0 \Rightarrow \phi = -\frac{\pi}{4}$$

$$y(x,t) = 0.08 \sin\left(\frac{\pi}{0.4}x + 6\pi t - \frac{\pi}{4}\right) \quad m.$$

5. $v = \sqrt{\frac{T}{\mu}}$ $\quad T = v^2\mu \quad \mu = cte$

$$\frac{T'}{T} = \frac{v'^2}{v^2}\frac{\cancel{\mu}}{\cancel{\mu}} \qquad T' = T\left(\frac{v'}{v}\right)^2 = 13.5\,N$$

6. $y(x,t) = A \sin(kx - \omega t + \phi)$

$$P = \frac{E_\lambda}{T} = \frac{1}{2}\mu\,\omega^2 A^2 v \qquad v = \sqrt{\frac{T}{\mu}} = 50\,ms^{-1}$$

$$P_{max} \rightarrow \omega_{max} \qquad \omega_{max} = \left(\frac{2P_{max}}{\mu A^2 v}\right) = 346\ rad\,s^{-1}$$

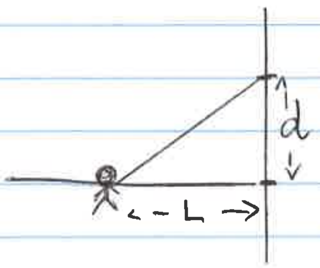
$$f = 55\ Hz$$

7. a) Amplitude resultante $2A\cos(\phi/2)$

$$A_r = 10.00 \times \cos(0.125\pi) \sim 10.0\ m.$$

b) $f = \frac{\omega}{2\pi} = 600\ Hz$

8.



Diferença de percurso

$$\Delta = \sqrt{L^2 + d^2} - L$$

$\Delta \sim 0$ qdo $L \to \infty$ e aumenta até d quando $L = 0$.

$$0 \leq \Delta \leq d$$

Mínimos (interferência destrutiva) quando.

$$\Delta = (2n+1)\frac{\lambda}{2} = \left(n+\frac{1}{2}\right)\lambda \qquad n = 0, 1, 2, \ldots$$

a) o # de mínimos é o maior inteiro que satisfaz

$$d \geq \Delta = \left(n+\frac{1}{2}\right)\frac{v}{f} \qquad n \leq 1.92$$

Dois mínimos: $n = 0$ e $n = 1$

b) $\sqrt{L^2+d^2} - L = \left(n+\frac{1}{2}\right)\frac{v}{f}$

$$L = \left(d^2 - \left(n+\frac{1}{2}\right)^2 \frac{v^2}{f^2}\right) \Big/ \left(2\left(n+\frac{1}{2}\right)\frac{v}{f}\right) \qquad n = 0, 1$$

$n = 0 \qquad L = 9{,}28$ m.

$n = 1 \qquad L = 1{,}99$ m.

9. $y_1 = 0.015 \cos\left(\frac{x}{2} - 4.0t\right)$

$y_2 = 0{,}015 \cos\left(\frac{x}{2} + 4{,}0t\right)$.

a) Onda estacionária.

$$y = y_1 + y_2 = A\left[\cos(a-b) + \cos(a+b)\right]$$

$$\cos(a \pm b) = \cos a \cos b \mp \sin a \sin b$$

$$y = 2A\cos(kx)\cos(\omega t)$$
$$= 0{,}030 \cos\left(\frac{x}{2}\right)\cos(4{,}0t)$$

nodo: $y = 0 \Rightarrow \cos\left(\frac{x}{2}\right) = 0 \qquad \frac{x}{2} = (2n+1)\frac{\pi}{2}, \; n = 0, 1, 2, \ldots$

$$x = \pi, 3\pi, 5\pi, \ldots$$

b) $x = 0{,}40$ m

$$y_{max} = 0{,}30 \cos\left(\frac{0.40}{2}\right) = \underline{0{,}0294 \text{ m}}$$

10. Distância entre nodos $\frac{\lambda}{2}$

Dois nodos nas extremidades e dois em $x = 0{,}5\ m$ e $x = 1{,}0\ m$.

11. 1º modo normal $\lambda_1 = 2L = 1.4\ m$.

$v = \lambda_1 f_1 = 220 \times 1{,}4 = 308\ m/s$.

$\mu = \frac{m}{L} = 1.7 \times 10^{-3}\ Kg/m$

a) $v = \lambda_1 f_1 = \sqrt{\frac{T}{\mu}}$ $\qquad T = v^2 \mu = 163\ N$

b) $v = \lambda_1 f_1 = \lambda_3 f_3$ $\qquad 2L f_1 = \frac{2}{3} L f_3$

$f_3 = 3 f_1 = 660\ Hz$

12. a) $f_1 = 262\ Hz$ $\qquad f_2 = 2 f_1$ e $f_3 = 3 f_1$

$f_2 = 524\ Hz$ e $f_3 = 786\ Hz$

b) $f_{1(lá)} = \frac{1}{2L}\sqrt{\frac{T_{(lá)}}{\mu}}$ $\qquad f_{1(dó)} = \frac{1}{2L}\sqrt{\frac{T_{(dó)}}{\mu}}$

$\frac{T_{lá}}{T_{dó}} = \left(\frac{f_{1,lá}}{f_{1,dó}}\right)^2 = \underline{2{,}82}$