# THEMA 9 – Lopende golven - Oplossingen van OEFENINGEN

## Oefening-1: Bram

Welk punt trilt eerst: P of P'? Antw.: P'

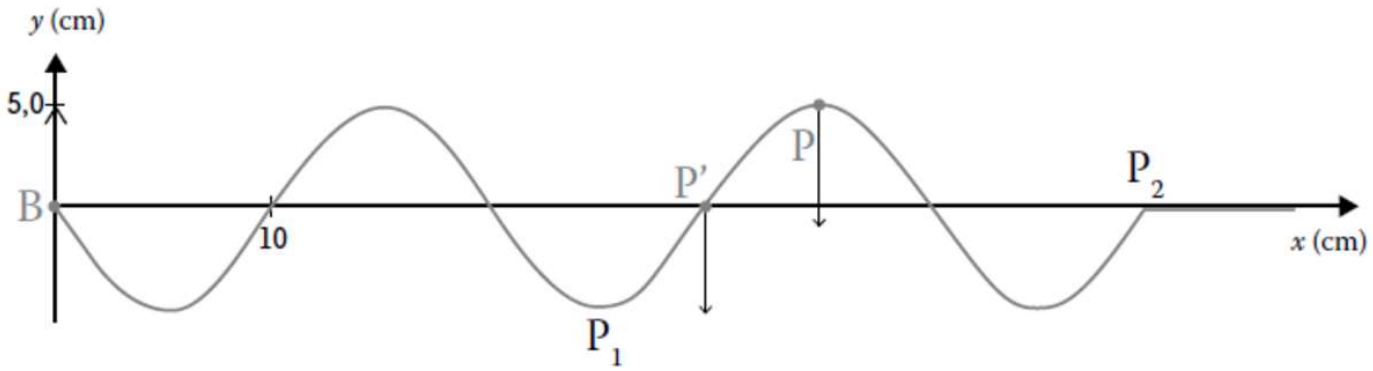
Bewoog Bram het touw eerst naar beneden of eerst naar boven? Antw.: Naar beneden

Hoelang (in termen van periode T) is punt P al aan het trillen? Uitleg: $d = \frac{3}{4}.\lambda \Rightarrow t - t_0 = \frac{3}{4}.T$

Hoelang (in termen van periode T) zal het touw nog trillen nadat Bram stopt?

Antw.: 2,5.T (want de afstand waarover nog storingen zichtbaar zijn is 2,5.λ)

## Oefening-2: 'Bij vorige oefening'



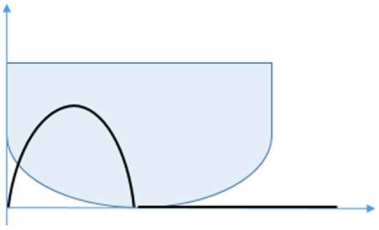

## Oefening-3: Twee tijdstippen

$$2,25.\lambda = 0,090\ m \Rightarrow \lambda = 0,040\ m$$

$$\square\square\square\square \Leftrightarrow 2,0\ s \Rightarrow v = \frac{\Delta x}{\Delta t} = \frac{0,020\ m}{2,0\ s} = 0,010\ \frac{m}{s}$$

$$v = \frac{\lambda}{T} = \lambda.f \Rightarrow f = \frac{v}{\lambda} = \frac{0,010\ \frac{m}{s}}{0,040\ m} = 0,25\ Hz$$

## Oefening-4: visser



$$v_g = \frac{\lambda}{f} = \frac{2,3\ m}{2\ s} = 1,15\ \frac{m}{s}$$

$$y(x,t) = 0,15\ m.\sin\left(\frac{2\pi}{2,0\ s}.t - \frac{2\pi}{2,3\ m}.x\right)$$

$$y(x,1) = 0,15\ m.\sin\left(\pi.1 - \frac{2\pi}{2,3\ m}.x\right) = 0,15\ m.\sin\left(\frac{2\pi}{2,3\ m}.x\right)$$

$$v = 1,15\ \frac{m}{s} \Rightarrow x_e = v_g.t = 1,15\ \frac{m}{s}.1\ s = 1,15\ m$$

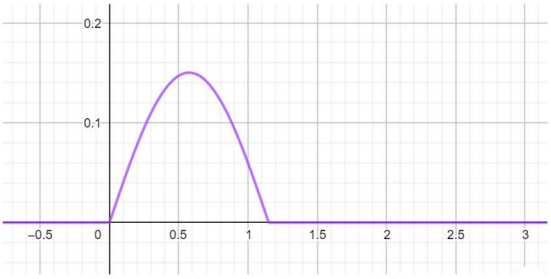
➔ Doel van laatste $x_e$-berekening: voor x > 1,15 is uitwijking nul!!!!

Dus:

$$\begin{cases} y(x,1) = 0,15\ m\ .\sin\left(\frac{2\pi}{2,3\ m}.x\right) & voor\ x < 1,15\ m \\ y(x,1) = 0 & voor\ x >= 1,15\ m \end{cases}$$

Geogebra:

$$\begin{cases} 0.15\ \sin\left(3.14 - \frac{2 \cdot 3.14}{2.3}\ x\right) & : 0 \le x \le 1.15 \\ 0 & : \text{anders} \end{cases}$$




## Oefening-5: All-in-one

$$y(x,t) = 20\ cm.\sin\left(\frac{\pi}{6,0\ s}.t - \frac{\pi}{4,0\ cm}.x\right)$$

$$y(x,t) = 20\ cm.\sin\left(\frac{2\pi}{12,0\ s}.t - \frac{2\pi}{8,0\ cm}.x\right)$$

$$Dus: \lambda = 0,080\ m;\ T = 12,0\ s$$

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{12,0\ s}$$

$$k = \frac{2\pi}{\lambda} = \frac{2\pi}{0,080\ m}$$

$$A = 0,20\ m$$

$$v_x = \frac{\lambda}{T} = \frac{0,080\ m}{12,0\ s} = 0,0067\ \frac{m}{s}$$

$$\Rightarrow t_p = \frac{\Delta x}{v} = \frac{2,0.10^{-2}\ m}{0,0067\ \frac{m}{s}} \approx 3\ s$$

$$y(0,t) = 20\ cm.\sin\left(\frac{2\pi}{12,0\ s}.t\right)$$

$$y_P(t) = 20\ cm.\sin\left(\frac{2\pi}{12,0\ s}.(t-3\ s)\right)$$

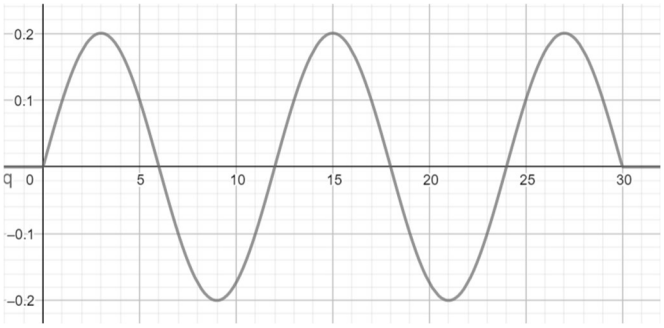
$$y_P(t) = 20\ cm.\sin\left(\frac{2\pi}{12,0\ s}.t - \frac{3\ s.2\pi}{12,0\ s}\right) = 20\ cm.\sin\left(\frac{2\pi}{12,0\ s}.t - \frac{\pi}{2}\right)$$

$$Dus: loopt\ \frac{\pi}{2}\ 'achter'$$

Bron:

$$yB(t) = Als\left(0 \le t \le 30, 0.2\ \sin\left(\frac{2\ a}{12}\ t\right), 0\right)$$

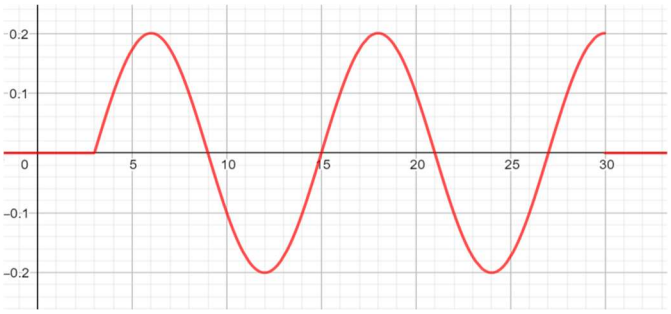
$$\rightarrow \begin{cases} 0.2\ \sin\left(\frac{2 \cdot 3.14}{12}\ t\right) & : 0 \le t \le 30 \\ 0 & : anders \end{cases}$$




**Punt P:**

$$yP(t) = Als\left(3 \le t \le 30, 0.2\ \sin\left(\frac{2\ a}{12}\ (t-3)\right), 0\right)$$

$$\rightarrow \begin{cases} 0.2\ \sin\left(\frac{2 \cdot 3.14}{12}\ (t-3)\right) & : 3 \le t \le 30 \\ 0 & : anders \end{cases}$$




$$y(x,6) = 20\ cm.\sin\left(\frac{2\pi}{12,0\ s}.6\ s - \frac{2\pi}{8,0\ cm}.x\right)$$

$$= 20\ cm.\sin\left(\pi - \frac{2\pi}{8,0\ cm}.x\right) = 20\ cm.\sin\left(\frac{2\pi}{8,0\ cm}.x\right)$$

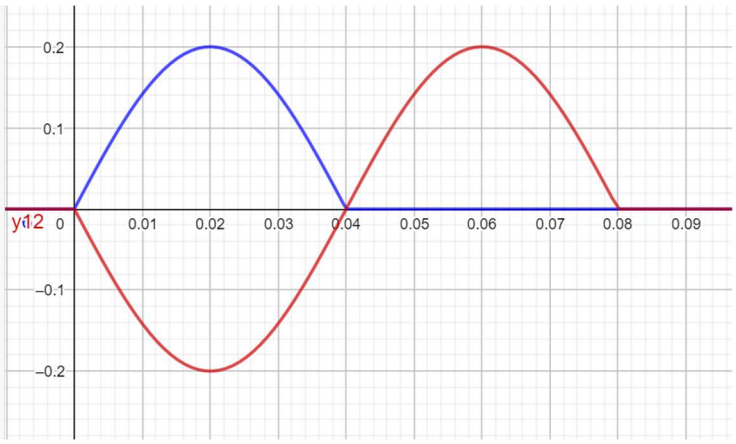
Dus kortweg: $y(x,6) = 20\ cm.\sin\left(\pi - \frac{2\pi}{8,0\ cm}.x\right)$

$$y6(x) = Als\left(0 \le x \le 0.04, 0.2\ \sin\left(\frac{2\ a \cdot 6}{12} - \frac{2\ a\ x}{0.08}\right), 0\right)$$

$$\rightarrow \begin{cases} 0.2\ \sin\left(\frac{2 \cdot 3.14 \cdot 6}{12} - \frac{2 \cdot 3.14\ x}{0.08}\right) & : 0 \le x \le 0.04 \\ 0 & : anders \end{cases}$$

$$y12(x) = Als\left(0 \le x \le 0.08, 0.2\ \sin\left(\frac{2\ a \cdot 12}{12} - \frac{2\ a\ x}{0.08}\right), 0\right)$$

$$\rightarrow \begin{cases} 0.2\ \sin\left(\frac{2 \cdot 3.14 \cdot 12}{12} - \frac{2 \cdot 3.14\ x}{0.08}\right) & : 0 \le x \le 0.08 \\ 0 & : anders \end{cases}$$



## Oefening-6: popfestival

Uit $L_{dB} = 10\text{ dB} \cdot \log \frac{I}{I_0}$

volgt $L_1 = 10\text{ dB} \cdot \log \frac{I_1}{I_0}$ en $L_2 = 10\text{ dB} \cdot \log \frac{I_2}{I_0}$.

Daaruit kun je afleiden:

$$\Delta L = L_2 - L_1 = 10\text{ dB}\left(\log \frac{I_2}{I_0} - \log \frac{I_1}{I_0}\right) = 10\text{ dB}\,[(\log I_2 - \log I_0) - (\log I_1 - \log I_0)]$$
$$= 10\text{ dB}\log \frac{I_2}{I_1}.$$

Het geluid verspreidt zich over een boloppervlak met straal $x$, met de bron in het middelpunt, zodat geldt:

$$I = \frac{P}{4\pi \cdot x^2}.$$

Aangezien het vermogen $P$ constant is, geldt:

$$\Delta L = 10\text{ dB}\log \frac{I_2}{I_1} = 10\text{ dB}\log \frac{x_1^{\,2}}{x_2^{\,2}} = 10\text{ dB}\log \frac{1}{4} = -6\text{ dB}.$$

## Oefening-7: nachtegaal

$$L_{dB_1} = \log\left(\frac{P}{4\pi x_1^2}\right) \quad (1)$$

$$L_{dB_2} = \log\left(\frac{P}{4\pi x_2^2}\right) \quad (2)$$

Aangezien $x_2 = 2x_1$ volgt uit $(2)$:

$$L_{dB_2} = \log\left(\frac{P}{4\pi 4x_1^2}\right) = \log\left(\frac{P}{4\pi x_1^2}\right) - \log 4$$
$$= L_{dB_1} - \log 4 = L_{dB_1} - 0{,}60\ B$$

## Oefening-8: luidspreker op festival

$$L_{dB} = 10dB.\log\left(\frac{I}{I_0}\right)$$

$$a)\ L'_{dB} = 10dB.\log\left(\frac{100.I}{I_0}\right) = 10dB.\left[\log 10^2 + \log\left(\frac{I}{I_0}\right)\right] = L_{dB} + 20dB$$

$$b)\ L'_{dB} = L_{dB} - 30dB = 10dB.\log\left(\frac{I}{I_0}\right) - 10dB.\log 10^3 = 10dB.\log\left(\frac{10^{-3}.I}{I_0}\right)$$

$$Dus: I' = \frac{1}{1000}.I$$

$$c)\ I' = \frac{P}{4\pi r'^2} = \frac{P}{4\pi (5r)'^2} = \frac{P}{25.4\pi (r)'^2} = \frac{1}{25}.\frac{P}{4\pi (r)'^2} = \frac{I}{25}$$

$$\Rightarrow L'_{dB} = 10dB.\log\left(\frac{I'}{I_0}\right) = 10dB.\log\left(\frac{\left(\frac{I}{25}\right)}{I_0}\right) = 10dB.\log\left(\frac{5^{-2}.I}{I_0}\right) = L_{dB} - 14dB$$

$$d)\ I' = I + I = 2I \Rightarrow L'_{dB} = 10dB.\log\left(\frac{2.I}{I_0}\right) = 30dB + L_{dB}$$