Uitwerkingen hoofdstuk 6

# 6. Goniometrische functies.

**Opgave 6.1** **Rekenen met de goniometrische verhoudingsgetallen.**

**a** $2\pi \text{ rad} = 360^0 \rightarrow \alpha = 1 \text{ rad} = \dfrac{360^0}{2\pi} = 57{,}3^0$

**b** $\sin(1) = 0{,}841$

$\cos(1) = 0{,}540$ ***Stel de juiste eenheid in op je ZRM***

$\tan(1) = 1{,}56$

**c** $\sin(2) = 0{,}909$

$\cos(2) = -0{,}416$

$\tan(2) = -2{,}19$

**d** $\sin(4) = -0{,}757$

$\cos(4) = -0{,}654$

$\tan(4) = 1{,}16$

**e** $\sin(5) = -0{,}959$

$\cos(5) = 0{,}284$

$\tan(5) = -3{,}38$

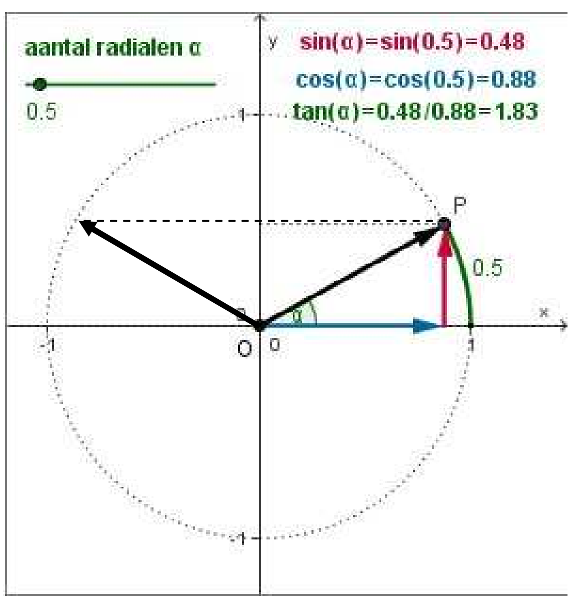
**Opgave 6.2** **Bereken de hoek *α* in radialen.**

***Maak altijd een schetsje met de eenheidscirkel!***

Geef alle mogelijke waardes van $\alpha$ tussen 0 en $2\pi$ als:

**a**

$$\boxed{\begin{array}{l}\sin(\alpha) = 0{,}5 \rightarrow \alpha_1 = \arcsin(0{,}5) = 0{,}524 \text{ rad} \\ \alpha_2 = \pi - 0{,}524 = 2{,}618 \text{ rad}\end{array}}$$



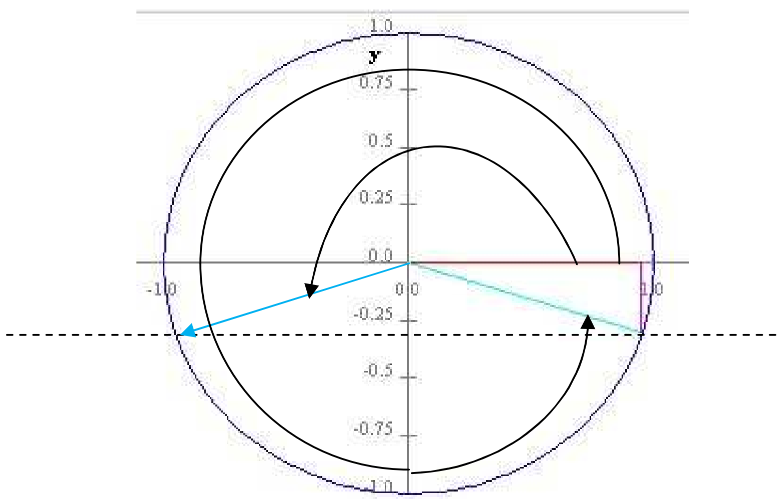
**b** $2\sin(\alpha)=0{,}3 \rightarrow \sin(\alpha)=0{,}15$
$\rightarrow \alpha_1 = \arcsin(0{,}15)=0{,}151 \text{ rad}$
$\alpha_2 = \pi - 0{,}151 = 2{,}99 \text{ rad}$

**c** $\cos(2\alpha)=-0{,}2 \rightarrow 2\alpha = \arccos(-0{,}2)$
$\rightarrow 2\alpha_1 = 1{,}77 \text{ rad} \rightarrow \alpha_1 = 0{,}886 \text{ rad}$
$\rightarrow 2\alpha_2 = 2\pi - 1{,}77 = 4{,}51 \text{ rad} \rightarrow \alpha_2 = 2{,}26 \text{ rad}$
$\rightarrow 2\alpha_3 = 1{,}77 + 2\pi = 8{,}05 \text{ rad} \rightarrow \alpha_3 = 4{,}03 \text{ rad}$
$\rightarrow 2\alpha_4 = 4{,}51 + 2\pi = 10{,}8 \rightarrow \alpha_4 = 5{,}40 \text{ rad}$

**d** $\sin(\alpha+1)=0{,}7 \rightarrow (\alpha_1+1)=\arcsin(0{,}7)=0{,}775$
$\rightarrow \alpha_1 = 0{,}775-1=-0{,}225 \text{ rad}$
$\rightarrow (\alpha_2+1)=\pi-0{,}775=2{,}37 \rightarrow \alpha_2 = 2{,}37-1=1{,}37 \text{ rad}$
$\rightarrow (\alpha_3+1)=0{,}775+2\pi \rightarrow \alpha_3 = 7{,}055-1=6{,}06$

**e** $4\sin(\alpha)=-4 \rightarrow \sin(\alpha)=-1$
$\rightarrow \alpha = \arcsin(-1) \rightarrow \alpha = {}^{3}\!/_{2}\,\pi = 4{,}71 \text{ rad}$

**f** $-2\sin(\alpha)=0{,}6 \rightarrow \sin(\alpha)=-0{,}3$
$\rightarrow \alpha = \arcsin(-0{,}3) \rightarrow \alpha = -0{,}305 \text{ rad} \rightarrow \alpha_1 = 2\pi - 0{,}305 \text{ rad} = 5{,}98 \text{ rad}$
$\rightarrow \alpha_2 = \pi + 0{,}305 \text{ rad} = 3{,}45 \text{ rad}$




**g** $\tan(\alpha)=3 \rightarrow a_1 = \arctan(3)=1{,}25 \text{ rad}$
$\rightarrow \alpha_2 = \pi + 1{,}25 = 4{,}39 \text{ rad}$

**h** $\tan(2\alpha) = -1 \rightarrow 2a_1 = \arctan(-1) = -0{,}784 \text{ rad}$
$\rightarrow 2\alpha_1 = -0{,}784 + k \cdot 2\pi$
$\rightarrow 2\alpha_1 = -0{,}784 + 2\pi = 5{,}50 \text{ rad} \rightarrow \alpha_1 = 2{,}25\ rad$
$\rightarrow 2\alpha_1 = -0{,}784 + 4\pi = 11{,}78 \text{ rad} \rightarrow \alpha_1 = 5{,}89\ rad$
$\rightarrow 2\alpha_3 = \pi - 0{,}784 + k \cdot 2\pi = 2{,}36 + k \cdot 2\pi$
$\rightarrow 2\alpha_3 = 2{,}36 \rightarrow \alpha_3 = 1{,}18\ rad$
$\rightarrow 2\alpha_4 = 2{,}36 + 2\pi = 8{,}64\ rad \rightarrow \alpha_4 = 4{,}32\ rad$

**i** $\sin(\alpha - 1) = 0{,}6 \rightarrow (\alpha - 1) = \arcsin(0{,}6) = 0{,}644$
$\rightarrow (\alpha_1 - 1) = 0{,}644\ rad \rightarrow \alpha_1 = 1{,}64$
$\rightarrow (\alpha_2 - 1) = \pi - 0{,}644 = 2{,}496 \rightarrow \alpha_2 = 3{,}50$

## Opgave 6.3 Ontbinden van een vector.

**a** $|R = 25\ en\ \theta = 0{,}32 \text{ rad}|$
$R_x = |R| \cdot \cos(\theta) \rightarrow R_x = 25 \cdot \cos(0{,}32) = 23{,}7$
$R_y = |R| \cdot \sin(\theta) \rightarrow R_y = 25 \cdot \sin(0{,}32) = 7{,}86$

**b** $|R| = \sqrt{R_x^2 + R_y^2} \rightarrow |R| = \sqrt{10^2 + 16^2} = 18{,}9$
$\tan(\theta) = \dfrac{R_y}{R_x} \rightarrow \tan(\theta) = \dfrac{16}{10} = 1{,}6 \rightarrow \theta = \arctan(1{,}6) = 1{,}01 \text{ rad}$

**c** $R_x = |R| \cdot \cos(\theta) \rightarrow |R| = \dfrac{R_x}{\cos(\theta)} \rightarrow |R| = \dfrac{10}{\cos(0{,}2)} = 10{,}2$

**d** $R^2 = R_x^2 + R_y^2 \rightarrow R_x^2 = R^2 - R_y^2 \rightarrow R_x^2 = 400 - 144 = 256 \rightarrow R_x = 16$
$\tan(\theta) = \dfrac{R_y}{R_x} \rightarrow \tan(\theta) = \dfrac{12}{16} = 0{,}75 \rightarrow \theta = \arctan(0{,}75) = 0{,}643 \text{ rad}$

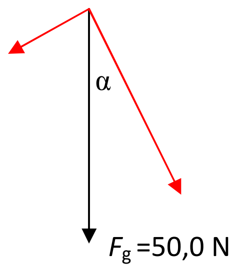
**e** $R_y = |R| \cdot \sin(\theta) \rightarrow |R| = \dfrac{R_y}{\sin(\theta)} \rightarrow |R| = \dfrac{10}{\sin(1{,}2)} = 10{,}7$
$R_x^2 = R^2 - R_y^2 \rightarrow R_x^2 = 10{,}7^2 - 100 = 15{,}1 \rightarrow R_x = 3{,}89$

## Opgave 6.4 Hellend vlak

**a** $\sin(\alpha) = \dfrac{h}{l} \rightarrow \sin(\alpha) = \dfrac{5{,}2}{10} = 0{,}52 \rightarrow \alpha = \arcsin(0{,}52) = 31{,}3°$

**b** $\sin(\alpha) = \dfrac{h}{l} \rightarrow h = l \cdot \sin(\alpha) = 10 \times \sin(35°) = 5{,}7 \text{ m}$ .

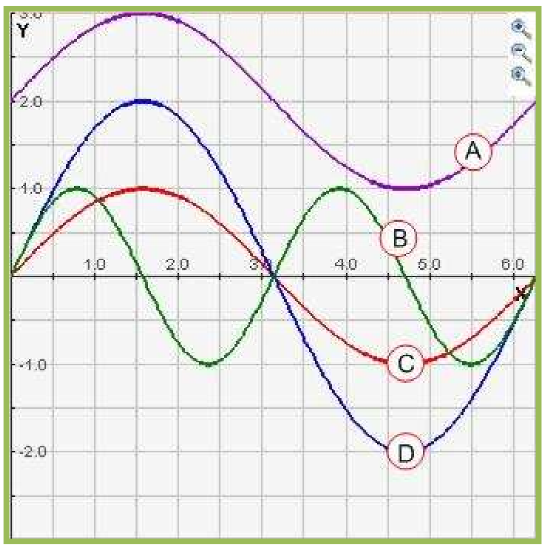
**c**




$$F_1(loodrecht) = F_g \cdot \cos(\alpha) \rightarrow F_1(loodrecht) = 50 \times \cos(25{,}2°) = 45{,}2 \text{ N}$$
$$F_2(evenwijdig) = F_g \cdot \sin(\alpha) \rightarrow F_2(evenwijdig) = 50 \times \sin(25{,}2°) = 21{,}3 \text{ N}$$

**d**
$$F_N = F_g \cdot \cos(\alpha) = 45{,}2 \text{ N}$$
$$F_f = F_g \cdot \sin(\alpha) = 21{,}3 \text{ N}$$

**Opgave 6.5** **Onderzoek goniometrische functies.**




**A:** $k(x) = \sin(x) + 2$
amplitude $= 1$ 1 periode op $[0{,}2\pi]$ grafiek is 2 naar boven verschoven

*Als $x$ verandert van 0 tot 2π verandert de hoek α van 0 tot 2π rad.*

**B:** $h(x) = \sin(2x)$
amplitude $= 1$ 2 periodes op $[0{,}2\pi]$

*Als $x$ verandert van 0 tot 2π verandert de hoek α van 0 tot 4π rad (2× rond).*

**C:** $f(x) = \sin(2x)$
amplitude $= 1$ 1 periode op $[0{,}2\pi]$

**D:** $f(x) = 2 \cdot \sin(2x)$
amplitude $= 2$ 1 periode op $[0{,}2\pi]$

**Opgave 6.6** **De functie *y* = Acos(*px*) + *b***

Hieronder zijn de afgebeeld:
$f(x) = \cos(x)$ hoort bij B, omdat amplitude = 1 en $T = 2\pi$
$g(x) = 2\cos(x)$ hoort bij A, omdat amplitude = 2
$h(x) = \cos(2x)$ hoort bij D, omdat $T = \pi$
$k(x) = \cos(x) + 2$ hoort bij C omdat de grafiek 2 naar boven verschoven is.

**Opgave 6.7** **Verschuiven, versterken en kortere periode.**

**A:** $k(x) = 2\sin(2x)$
amplitude $= 2$ 2 periodes op $[0,2\pi]$

**B:** $h(x) = \sin(x - \pi/2)$
amplitude $= 1$ 1 periode op $[0,2\pi]$ $\pi/2$ naar rechts verschoven

*De beginhoek $\alpha_0 = -\pi/2$ of $3\pi/2$*

**C:** $g(x) = \sin(x + \pi/2)$
amplitude $= 1$ 1 periode op $[0,2\pi]$ $\pi/2$ naar links verschoven

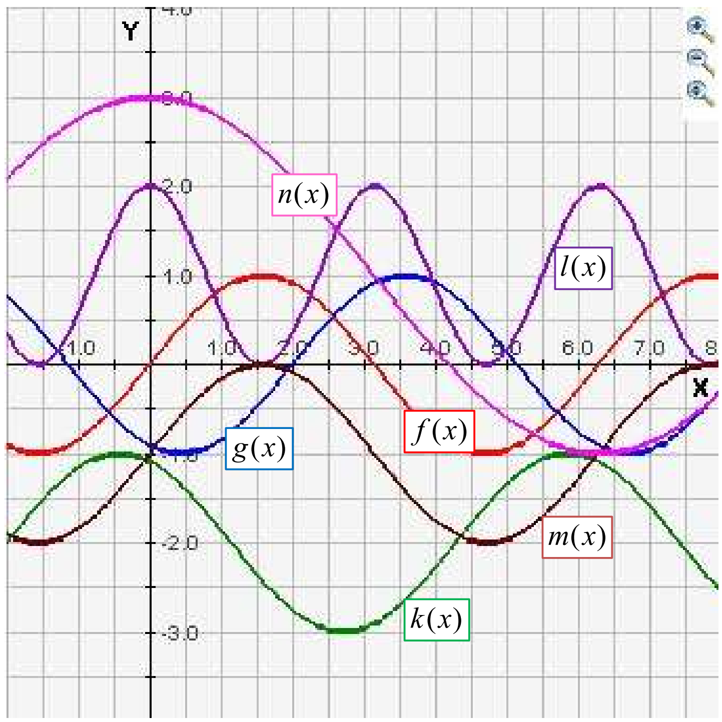
*De beginhoek $\alpha_0 = \pi/2$*

**D:** $f(x) = \sin(x)$
amplitude $= 1$ 1 periode op $[0,2\pi]$

**Opgave 6.8** **De functie**

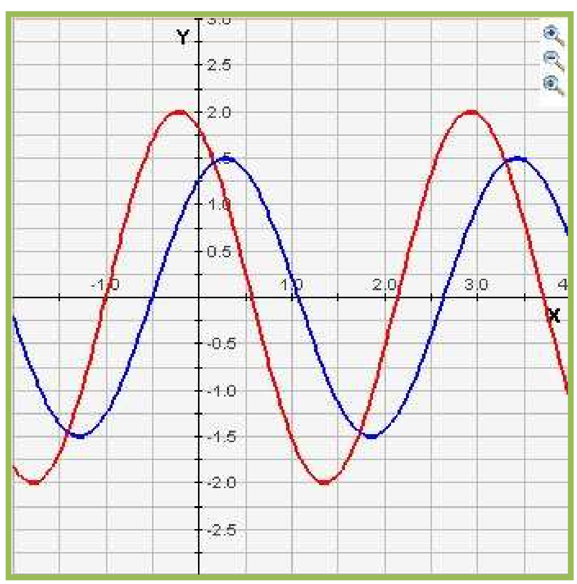
$y$ is de hoogte van het draaiend punt en $x$ bepaald de hoek.
Hieronder zijn de afgebeeld:
$f(x) = \sin(x)$ hoort bij B, omdat de amplitude = 1 en $T = 2\pi$
$g(x) = \sin(x+1)$ hoort bij C, omdat de grafiek 1 naar links verschoven is. $(x + 1) = 0$ als $x = -1$
$h(x) = \sin(2x + 4)$ hoort bij A, omdat $T = \pi$ en de grafiek 4 naar links verschoven is
$k(x) = \sin(x + 1) - 2$ hoort bij D, omdat de grafiek 2 naar beneden verschoven is.

**Opgave 6.9** **Schetsen van de grafiek $y = A\sin(kx + c) + b$**




**Opgave 6.10** **De functie**

Hierna zijn de grafieken afgebeeld van:
$U(t) = 2\sin(2t + 2)$ en $I(t) = 1{,}5\sin(2t + 1)$




**a** De amplitude van $U(t) = 2$
De amplude van $I(t) = 1{,}5$

**b** $\dfrac{2\pi}{T} = 2 \rightarrow T = 3{,}14\ s$

**c** verschuiving van $U(t)$ is -1s of $-\frac{1}{3,14}T = -0,32T$ dus $0,32T$ naar links

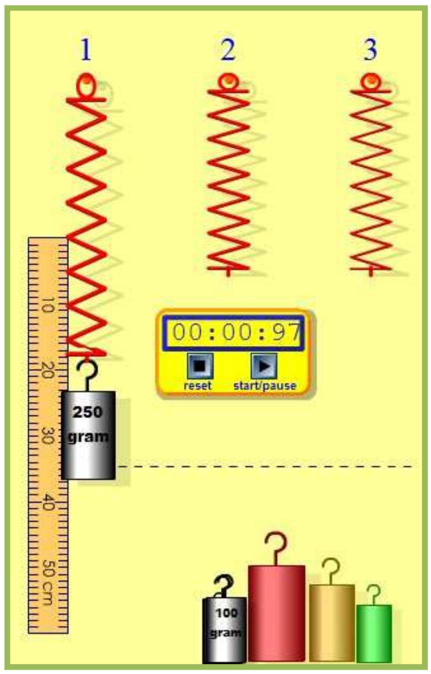
*als t = -1 dan (2t + 2) = 0*

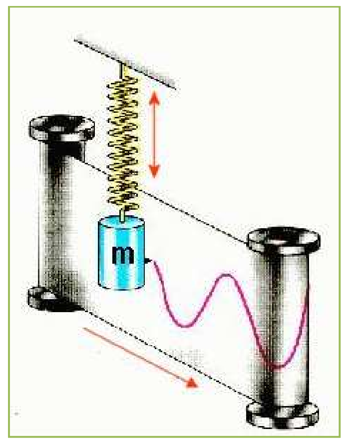
verschuiving van $I(t)$ is -0,5s of $-\frac{0,5}{3,14}T = 0,16T$ naar links

*als t = -0,5 dan (2t + 1) = 0*

**d** voor $U(t)$ : $\alpha_0 = 2$ rad

**Opgave 6.11** **De functie** $u(t) = A\sin(\frac{2\pi}{T}t + \alpha_0)$ **bij een veer-massa systeem.**




*Simulatie van PhET (University of Colorado)*

**a**
$$\boxed{T = 2\pi\sqrt{\frac{m}{C}} \rightarrow T^2 = 4\pi^2 \cdot \frac{m}{C} \rightarrow C = \frac{4\pi^2 m}{T^2} \rightarrow C = \frac{4\pi^2 \times 0,25}{1^2} = 9,87\ \mathrm{N/m}}$$

**b**
$$\boxed{u(t) = A\sin(\frac{2\pi}{T}t + \alpha_0) \rightarrow u(t) = 0,2\sin(\frac{2\pi}{1} \cdot t + 0) \rightarrow u(t) = 0,2\sin(2\pi \cdot t)}$$

**c**
$$\boxed{T = 2\pi\sqrt{\frac{m}{C}} \rightarrow T = 2\pi\sqrt{\frac{0,1}{9,87}} = 0,632\ \mathrm{s} \quad u(t) = 0,2\sin(\frac{2\pi}{0,632} \cdot t) \rightarrow u(t) = 0,2\sin(9,94 \cdot t)}$$

**d**
$$\boxed{u(t) = 0,2\sin(9,94 \cdot t + 3,14)}$$

**e** Voor de beweging van een massa aan een veer geldt:

$$u(t) = 30\sin(1{,}44t + \pi/2)$$

$$\frac{2\pi}{T} = 1{,}44 \rightarrow T = \frac{2\pi}{1{,}44} = 4{,}36 \text{ s}$$

$$T^2 = 4\pi^2 \cdot \frac{m}{C} \rightarrow m = \frac{C \cdot T^2}{4\pi^2} = \frac{9{,}87 \times 4{,}36^2}{4 \times \pi^2} = 4{,}75\ kg$$

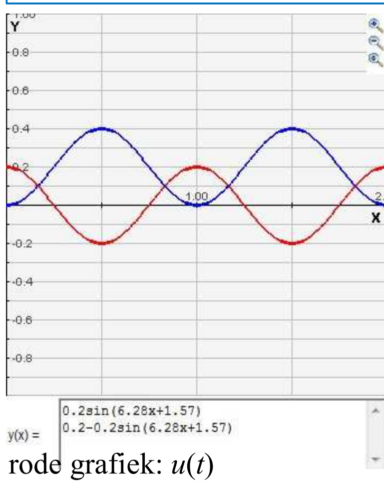
$$\alpha_0 = \pi/2\ rad$$

**Opgave 6.12** **De energieomzetting bij een veer-massa systeem.**

**a** massa begint in bovenste punt $\alpha_0 = \dfrac{\pi}{2}$ rad

**b** $s(t) = A - A\sin(\dfrac{2\pi}{T}t + \dfrac{\pi}{2}) \rightarrow s(t) = 0{,}2 - 0{,}2\sin(2\pi \cdot t + \dfrac{\pi}{2})$

**c**




rode grafiek: $u(t)$
blauwe grafiek: $s(t)$

**d** $E_v(\max) = \tfrac{1}{2}Cs^2 \rightarrow E_v(\max) = \tfrac{1}{2} \times 9{,}87 \times 0{,}6^2 = 1{,}78$ J

**e** $E_v = 0\ als\ s = 0 \rightarrow \alpha = \dfrac{\pi}{2}$ rad

**f**

$$h(t) = A + u(t) = 0{,}3 + 0{,}2\sin(2\pi \cdot t + \frac{\pi}{2})$$

$$E_p(t) = mgh = 0{,}25 \times 9{,}8 \times (0{,}3 + 0{,}2\sin(2\pi \cdot t + \frac{\pi}{2})$$

**Opgave 6.13** **De functie** $u(t) = A\sin(\dfrac{2\pi}{T}t + \alpha_0)$ **bij een slinger.**

**a** $T = 2\pi \cdot \sqrt{\dfrac{l}{g}} \rightarrow T = 2\pi \cdot \sqrt{\dfrac{2}{9{,}81}} = 2{,}84$ s

**b** $u(t) = 0{,}1\sin(\dfrac{2\pi}{2{,}84} \cdot t + 0) \rightarrow u(t) = 0{,}1\sin(2{,}21 \cdot t)$

**c** $$T = 2\pi \cdot \sqrt{\frac{l}{g}} \rightarrow T = 2\pi \cdot \sqrt{\frac{1}{9{,}81}} = 2{,}01 \text{ s}$$

$$\text{u(t)} = 0{,}1\sin(\frac{2\pi}{2{,}01} \cdot t + 0) \rightarrow u(t) = 0{,}1\sin(3{,}14 \cdot t)$$

**d** $$\text{u(t)} = 0{,}1\sin(3{,}14 \cdot t + 3{,}14)$$

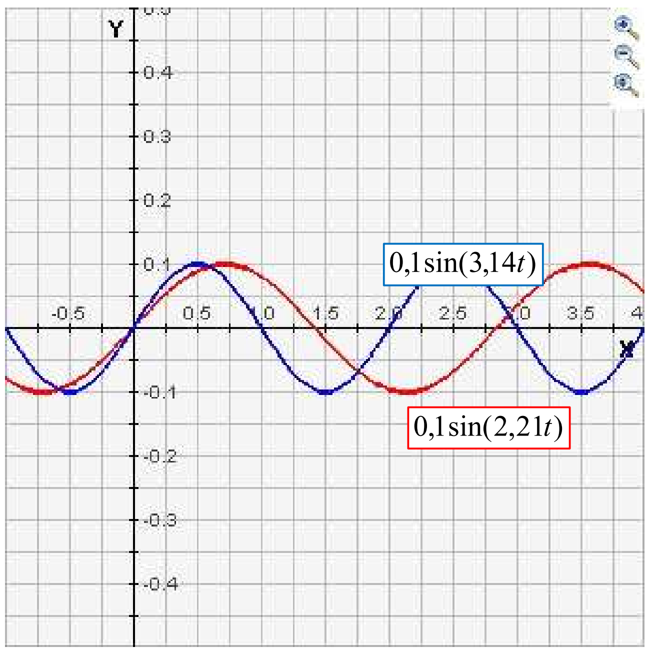
**e** $$\frac{2\pi}{T} = 2 \rightarrow T = \frac{2\pi}{2} = 3{,}14 \text{ s}$$

$$T = 2\pi \cdot \sqrt{\frac{l}{g}} \rightarrow T^2 = 4\pi^2 \cdot \frac{l}{g} \rightarrow l = \frac{T^2 \cdot g}{4\pi^2}$$

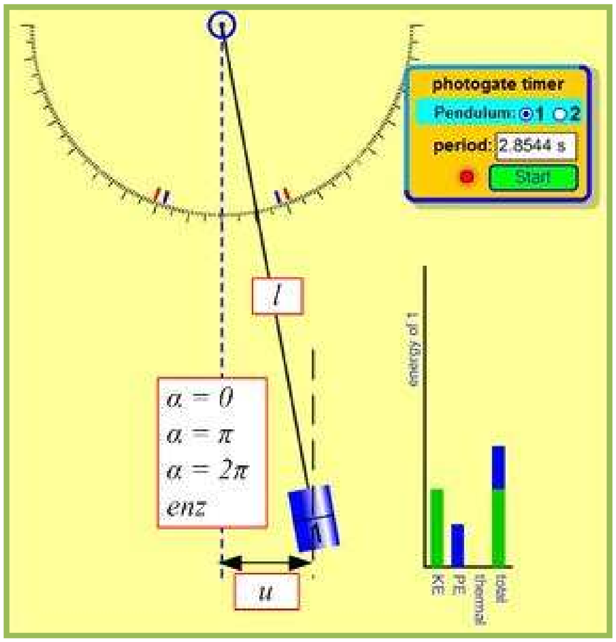
$$\rightarrow l = \frac{3{,}14^2 \times 9{,}81}{4\pi^2} = 2{,}45 \text{ m}$$

$$\alpha_0 = \pi/2$$

**f**



**Opgave 6.14** **De energieomzetting bij een slinger.**




**a**

$$E_{k,\max} = \tfrac{1}{2} m v_{\max}^2$$
$$v_{\max} = \frac{2\pi \times 0{,}2}{2{,}85} = 0{,}44 \text{ m/s}$$
$$E_{k,\max} = \tfrac{1}{2} m v_{\max}^2 = \tfrac{1}{2} \times 1 \times 0{,}44^2 = 0{,}097 \text{ J}$$

**b**

$$E_{k,\max} = E_p \rightarrow 0{,}097 = mg\Delta h \rightarrow \Delta h = \frac{0{,}097}{mg} = 0{,}0099 \text{ m} = 9{,}9 \text{ mm}$$

**c**

$$E_k(t) = \tfrac{1}{2} m v^2 = 0{,}5(0{,}44\cos(\frac{2\pi}{2{,}85}t))^2 = 0{,}097\cos^2(2{,}2t)$$

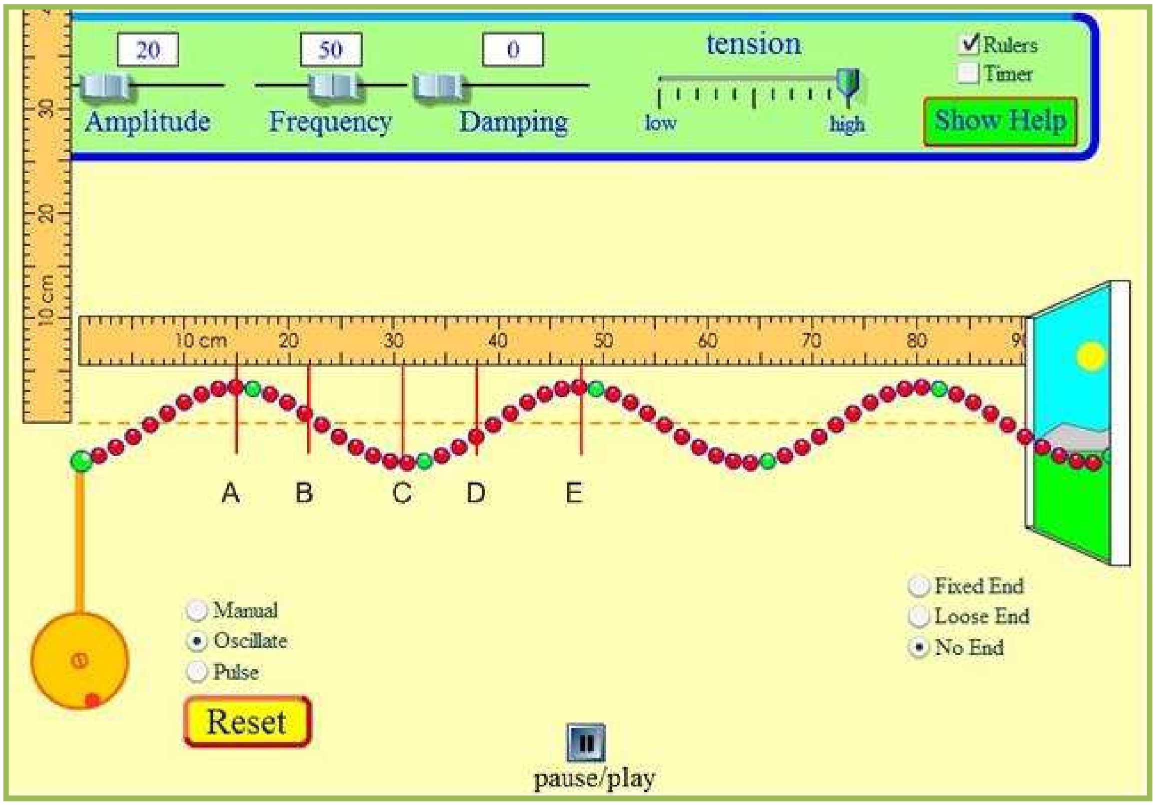
**d** Voor de beweging van een massa aan een slinger geldt:

$u(t) = 3\sin(3{,}14t + \pi/2)$ $\quad u$ in cm

$$\frac{2\pi}{T} = 3{,}14 \rightarrow T = 2{,}00 \text{ s}$$
$$T = 2\pi\sqrt{\frac{l}{g}} \rightarrow T^2 = 4\pi^2\frac{l}{g} \rightarrow l = \frac{T^2 \cdot g}{4\pi^2} = 0{,}994 \text{ m}$$
$$\alpha_0 = \pi/2 \text{ rad}$$
$$\sin(\text{max. hoek slinger}) = \frac{3}{99{,}4} = 0{,}030 \rightarrow \text{max}\cdot\text{hoek} = 0{,}030 \text{ rad}$$

**Opgave 6.15** **Lopende golf**

Voor punt A geldt : $u(t) = 4\sin(100\pi \cdot t)$




**a** $\boxed{\lambda = \text{AE} = 47 \text{ cm} - 15 \text{ cm} = 32 \text{ cm} = 0{,}32 \text{ m}}$

**b**

$$\lambda = v \cdot T \rightarrow v = \frac{\lambda}{T}$$

$$\frac{2\pi}{T} = 100\pi \rightarrow T = \frac{2\pi}{100\pi} = 0{,}02 \text{ s}$$

$$v = \frac{0{,}32 \text{ m}}{0{,}02 \text{ s}} = 16 \ {}^{\text{m}}\!/_{\text{s}}$$

**c**

$$u_A(t) = 4\sin(100\pi \cdot t)$$
$$u_E(t) = 4\sin(100\pi \cdot t - 2\pi)$$

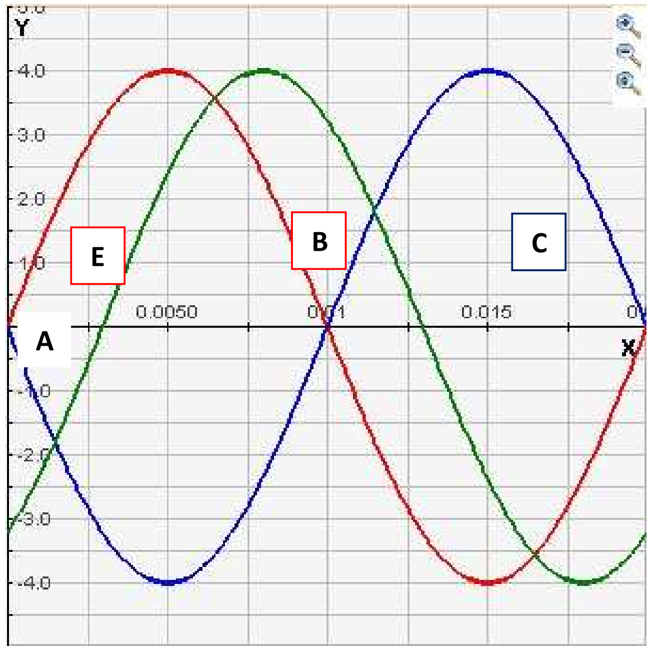
**d**

$$u_A(t) = 4\sin(100\pi \cdot t)$$
$$u_C(t) = 4\sin(100\pi \cdot t - \pi)$$

**e**

$$u_A(t) = 4\sin(100\pi \cdot t)$$
$$u_B(t) = 4\sin(100\pi \cdot t - \frac{7}{47} \cdot 2\pi) = 4\sin(100\pi \cdot t - 0{,}936)$$

f




**Opgave 6.16** **Experiment om de viscositeit van een vloeistof te bepalen.**

**a** $\boxed{\frac{2\pi}{T} = 4 \rightarrow T = 1{,}57 \text{ s} \rightarrow f = \frac{1}{T} = 0{,}637 \text{ Hz}}$

**b** $\boxed{T = 2\pi\sqrt{\frac{l}{g}} \rightarrow T^2 = \frac{4\pi^2 \cdot l}{g} \rightarrow l = \frac{T^2 \cdot g}{4\pi^2} = 0{,}61 \text{ m}}$

**c** $U_1$ hoort bij de grafiek ,waarvan de amplitude het sterkst afneemt omdat de $e^{-0{,}5t}$ sterker afneemt dan $e^{-0{,}2t}$

**Opgave 6.17** **Spanning van de wandcontactdoos.**

**a** $\boxed{U(t) = 325\sin(\frac{2\pi}{0{,}02} \cdot t) \rightarrow U(t) = 325\sin(100\pi \cdot t)}$

**b** $\boxed{U(t) = 325 \cdot \sin(100\pi t)}$

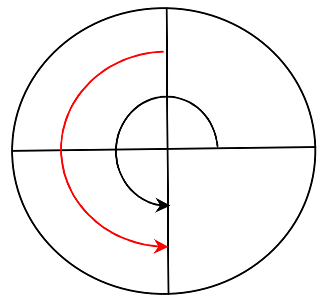
**Opgave 6.18** **Faseverschil tussen spanning over weerstand en spoel wisselstroom.**

**a** Stel het functievoorschrift op voor $U_R$ en $U_L$ op.
Kies $t = 0$ bij 338 s.

$$U_R = 5\sin(\frac{2\pi}{2}t) = 5\sin(\pi t)$$

$$U_L = 10\cos(\pi t)$$

**b** Schets in één cirkel het verloop van $U_R$ en $U_L$ op.



**Opgave 6.19** **Enkele goniometrische vergelijkingen.**

**a**

$3\sin(4x) \geq 1$

$3\sin(4x) = 1 \rightarrow \sin(4x) = \frac{1}{3}$ $\arcsin(1/3) = 0{,}340$ rad

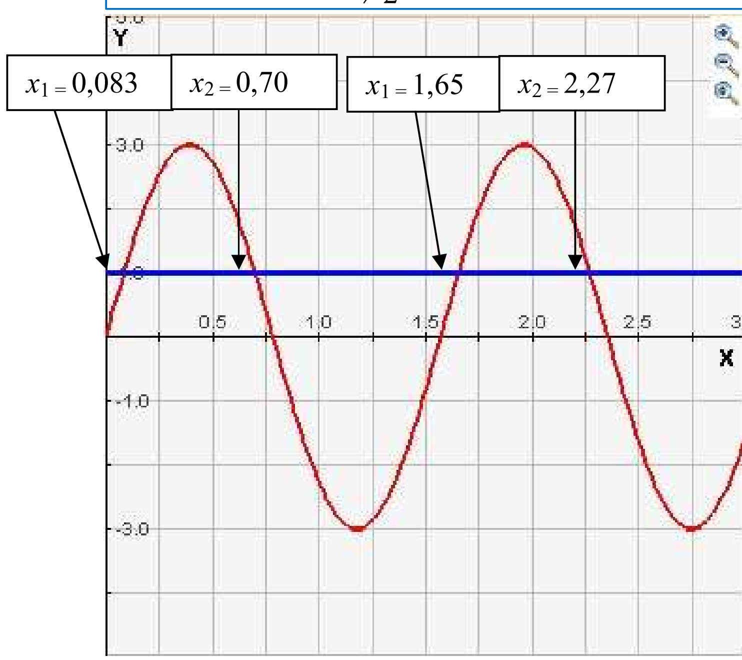
$\sin(4x_1) = \sin(0{,}340) \rightarrow 4x_1 = 0{,}34 + k \cdot 2\pi \rightarrow x_1 = 0{,}0834 + k \cdot 1/2\,\pi$

$x_1 = 0{,}0834;\ 1{,}65 \bmod(1/2\,\pi)$

*en*

$\sin(4x_2) = \sin(\pi - 0{,}34) \rightarrow 4x_2 = 2{,}80 \rightarrow x_2 = 0{,}70 + k \cdot 1/2\,\pi$

$x_2 = 0{,}70;\ 2{,}27 \bmod(1/2\,\pi)$

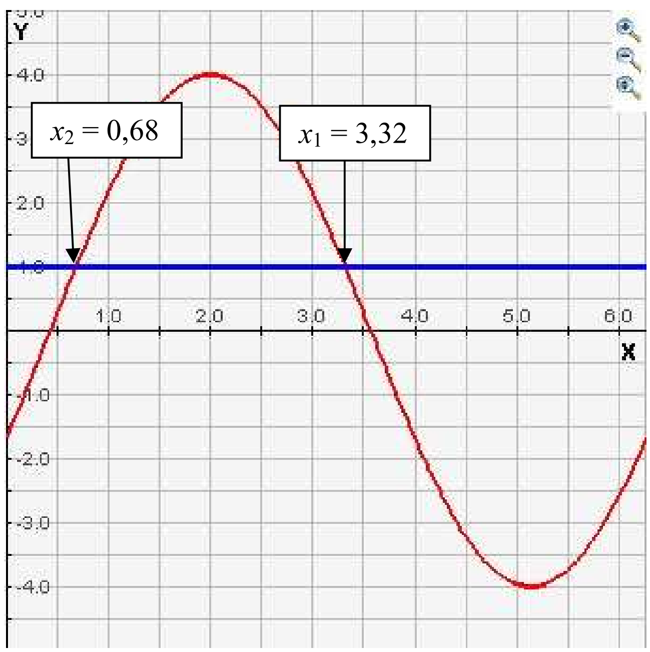



oplossing $3\sin(4x) \geq 1$:

$0{,}0834 \leq x \leq 0{,}70 \bmod(1/2\,\pi)$

**b**

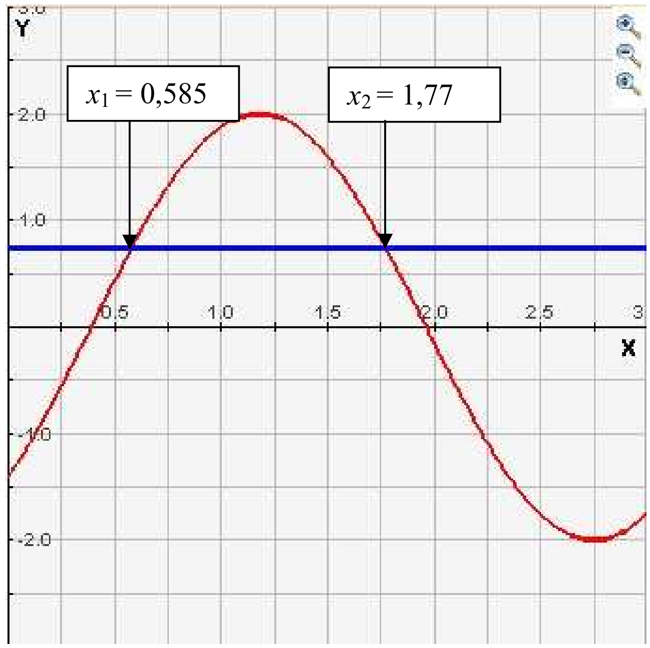
$$4\cos(x-2)=1$$
$$\cos(x-2)=0{,}25 \quad \arccos(0{,}25)=1{,}32$$
$$\cos(x_1-2)=\cos(1{,}32)\rightarrow x_1-2=1{,}32+k\cdot 2\pi$$
$$\rightarrow x_1=3{,}32+k\cdot 2\pi$$
*en*
$$\cos(x_2-2)=\cos(2\pi-1{,}32)\rightarrow x_2-2=2\pi-1{,}32+k\cdot 2\pi$$
$$\rightarrow x_2=0{,}68+k\cdot 2\pi$$




oplossing $4\cos(x-2)<1$:
$-2{,}96 \le x \le 0{,}68 \bmod(2\pi)$

**c**

$$2\sin(2x-\frac{\pi}{4})\ge 0{,}75$$
$$2\sin(2x-\frac{\pi}{4})=0{,}75\rightarrow \sin(2x-\frac{\pi}{4})=0{,}375 \quad \arcsin(0{,}375)=0{,}384$$
$$\sin(2x_1-\frac{\pi}{4})=\sin(0{,}384)\rightarrow 2x_1-\frac{\pi}{4}=0{,}384+k\cdot 2\pi$$
$$\rightarrow 2x_1=1{,}17+k\cdot 2\pi \rightarrow x_1=0{,}585+k\cdot\pi$$
*en*
$$\sin(2x_2-\frac{\pi}{4})=\sin(\pi-0{,}384)\rightarrow 2x_2-\frac{\pi}{4}=2{,}76+k\cdot 2\pi$$
$$\rightarrow 2x_2=3{,}54+k\cdot 2\pi \rightarrow x_2=1{,}77+k\cdot\pi$$




oplossing $2\sin(2x - \pi/4) \geq 0,75$:
$0,585 \leq x \leq 1,77 \text{ mod}(\pi)$

**d**

$$0,5\tan(0,5x - \frac{\pi}{3}) > 2$$

$$0,5\tan(0,5x - \frac{\pi}{3}) = 2 \to \tan(0,5x - \frac{\pi}{3}) = 4 \quad \arctan(4) = 1,33$$

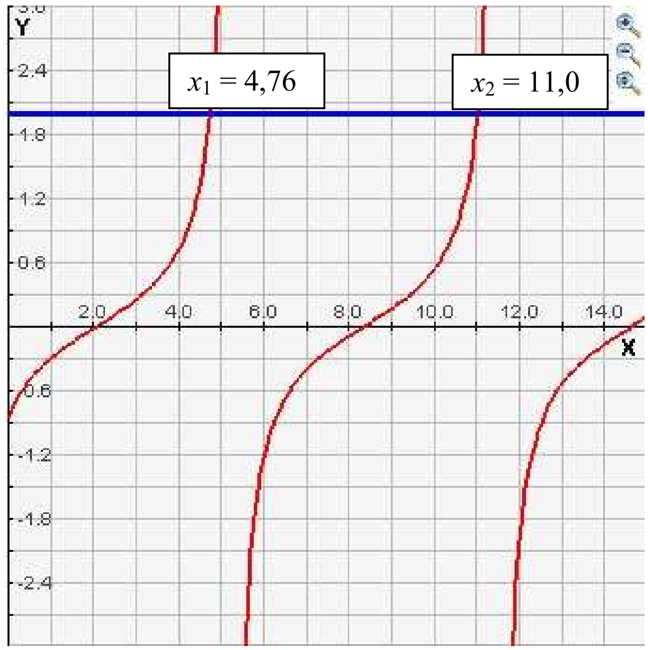
$$\tan(0,5x_1 - \frac{\pi}{3}) = \tan(1,33) \to 0,5x_1 - \frac{\pi}{3} = 1,33 + k \cdot 2\pi$$

$$\to 0,5x_1 = 2,38 + k \cdot 2\pi \to x_1 = 4,76 + k \cdot 4\pi$$

*en*

$$\tan(0,5x_2 - \frac{\pi}{3}) = \tan(\pi + 1,33) \to 0,5x_2 - \frac{\pi}{3} = 4,47 + k \cdot 2\pi$$

$$\to 0,5x_2 = 5,52 + k \cdot 2\pi \to x_2 = 11,0 + k \cdot 4\pi$$




oplossing $0,5\tan(0,5x - \pi/3) > 2$ :
$4,76 \leq x \leq 11 \bmod (4\pi)$