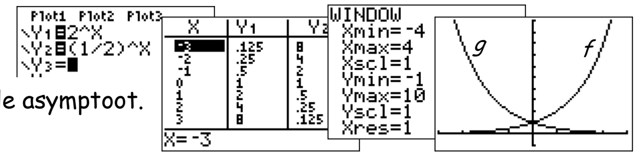
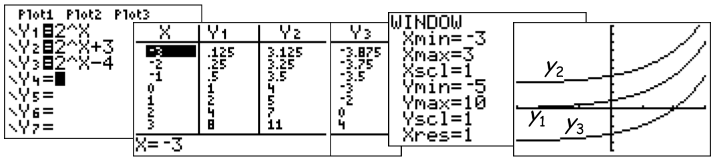


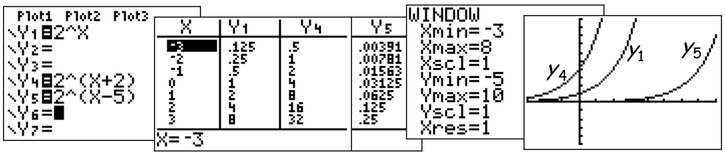
1a Ze zijn elkaars spiegelbeeld ten opzichte van de y-as.

1b Beide grafieken hebben de x-as (de lijn $y = 0$) als horizontale asymptoot.

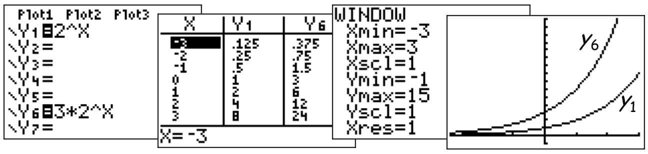
1c $B_f = B_g = \langle 0, \rightarrow \rangle$.



2a Zie de plot hiernaast.
$y_1 = 2^x \xrightarrow{\text{translatie } (0,3)} y_2 = 2^x + 3.$
$y_1 = 2^x \xrightarrow{\text{translatie } (0,-4)} y_3 = 2^x - 4.$

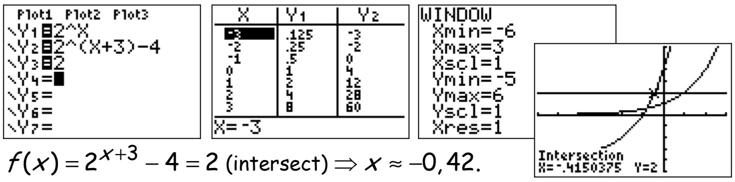


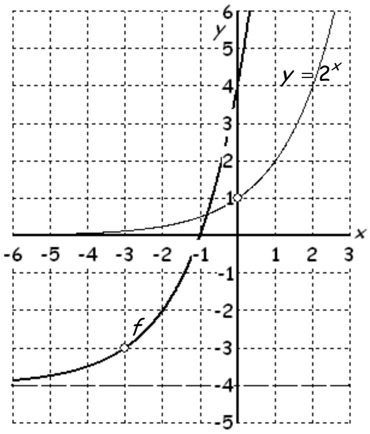
2b Zie de plot hiernaast.
$y_1 = 2^x \xrightarrow{\text{translatie } (-2,0)} y_4 = 2^{x+2}.$
$y_1 = 2^x \xrightarrow{\text{translatie } (5,0)} y_5 = 2^{x-5}.$



2c Zie de plot hiernaast.
$y_1 = 2^x \xrightarrow{\text{verm. } x\text{-as, } 3} y_6 = 3 \cdot 2^x.$

3ab $y = 2^x \xrightarrow{\text{translatie } (-3,-4)} f(x) = 2^{x+3} - 4.$
$B_f = \langle 0, \rightarrow \rangle \quad \Rightarrow \quad B_f = \langle -4, \rightarrow \rangle$
Zie de grafiek hiernaast (maak gebruik van een tabel op de GR).





3c $f(x) = 2^{x+3} - 4 = 2$ (intersect) $\Rightarrow x \approx -0{,}42.$
$f(x) \leq 2$ geeft $x \leq -0{,}42$ (gebruik hierbij de plot of de grafiek).

3d $f(3) = 60$ (zie de tabel) en $B_f = \langle -4, \rightarrow \rangle$.
In de plot lees je dan af: voor $x \leq 3$ is $-4 < f(x) \leq 60$.

4a $y = 3^x \xrightarrow{\text{translatie } (1,5)} f(x) = 3^{x-1} + 5.$
H.A.: $y = 0 \quad \Rightarrow \quad$ H.A.: $y = 5$

4b $y = 3^x \xrightarrow{\text{verm. } x\text{-as, } 5} y = 5 \cdot 3^x \xrightarrow{\text{translatie } (-1,0)} g(x) = 5 \cdot 3^{x+1}.$
H.A.: $y = 0 \quad \Rightarrow \quad$ H.A.: $y = 0 \quad \Rightarrow \quad$ H.A.: $y = 0$
OF: $y = 3^x \xrightarrow{\text{translatie } (-1,0)} y = 3^{x+1} \xrightarrow{\text{verm. } x\text{-as, } 5} g(x) = 5 \cdot 3^{x+1}.$
H.A.: $y = 0 \quad \Rightarrow \quad$ H.A.: $y = 0 \quad \Rightarrow \quad$ H.A.: $y = 0$

4c $y = 3^x \xrightarrow{\text{verm. } x\text{-as, } 4} y = 4 \cdot 3^x \xrightarrow{\text{translatie } (0,-7)} h(x) = 4 \cdot 3^x - 7.$
H.A.: $y = 0 \quad \Rightarrow \quad$ H.A.: $y = 0 \quad \Rightarrow \quad$ H.A.: $y = -7$

4d $y = 0{,}5^x \xrightarrow{\text{verm. } x\text{-as, } -2} y = -2 \cdot 0{,}5^x \xrightarrow{\text{translatie } (0,3)} k(x) = -2 \cdot 0{,}5^x + 3.$
H.A.: $y = 0 \quad \Rightarrow \quad$ H.A.: $y = 0 \quad \Rightarrow \quad$ H.A.: $y = 3$

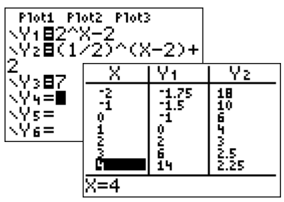
5a $N = 8 \cdot 1{,}5^t - 6$ heeft H.A.: $N = -6$.

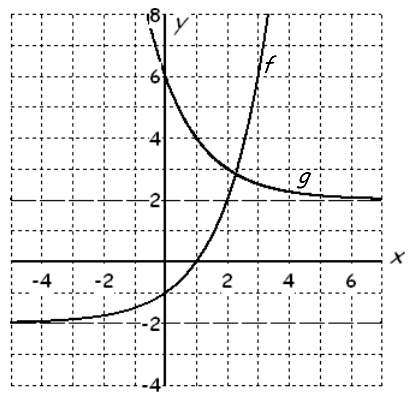
5b $N = -2 \cdot 0{,}8^{t-3} + 5$ heeft H.A.: $N = 5$.

5c $N = -0{,}3^{t-1} + 1000$ heeft H.A.: $N = 1000$.

5d $N = -100 \cdot 0{,}3^t + 100$ heeft H.A.: $N = 100$.

6ac $y = 2^x \xrightarrow{\text{translatie } (0,-2)} f(x) = 2^x - 2.$
$B = \langle 0, \rightarrow \rangle \quad \Rightarrow \quad B_f = \langle -2, \rightarrow \rangle$
$y = (\frac{1}{2})^x \xrightarrow{\text{translatie } (2,2)} g(x) = (\frac{1}{2})^{x-2} + 2.$
$B = \langle 0, \rightarrow \rangle \quad \Rightarrow \quad B_g = \langle 2, \rightarrow \rangle$

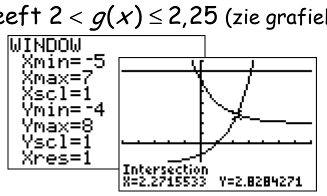




6b Zie de grafieken hiernaast. (gebruik tabellen)

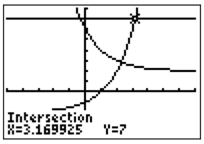
6d $g(4) = 2{,}25$ (zie de tabel) en $B_g = \langle 2, \rightarrow \rangle \Rightarrow x \geq 4$ geeft $2 < g(x) \leq 2{,}25$ (zie grafiek).

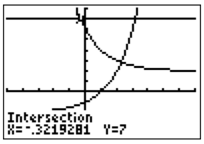
6e $f(x) = g(x)$ (intersect) $\Rightarrow x \approx 2{,}27$.
Lees in de grafiek af: $f(x) \leq g(x)$ voor $x \leq 2{,}27$.

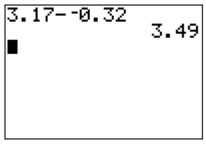


6f $f(x) = p$ heeft geen oplossing voor $p \leq -2$.

6g $f(3) = 6 \Rightarrow A(3,\ 6)$ en $g(3) = 2{,}5 \Rightarrow B(3;\ 2{,}5)$ (zie de tabel).
A ligt 3,5 eenheid boven $B \Rightarrow$ lijnstuk AB is 3,5 lang.

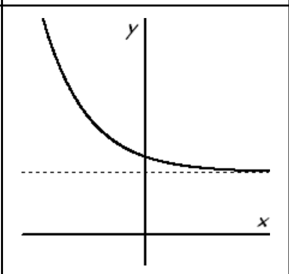
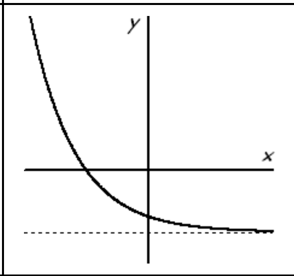
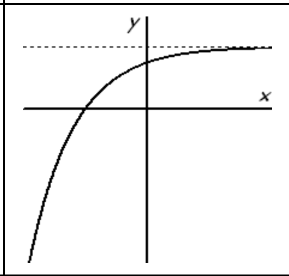
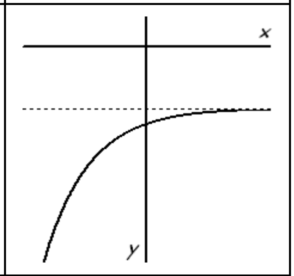
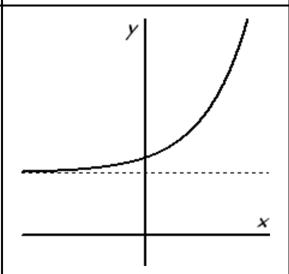
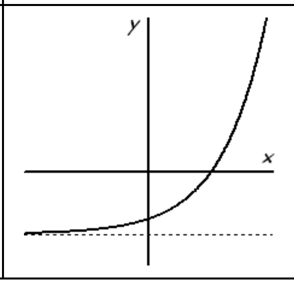
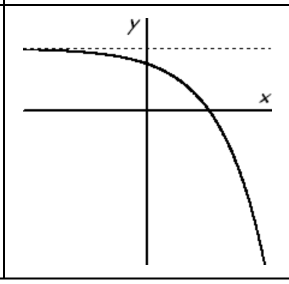
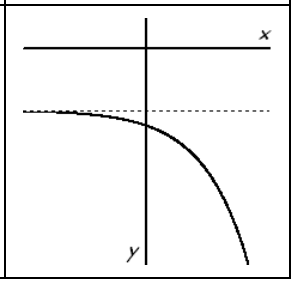






6h $f(x) = 7$ (intersect) $\Rightarrow x \approx 3{,}17 \Rightarrow C(3{,}17;\ 7)$.
$g(x) = 7$ (intersect) $\Rightarrow x \approx -0{,}32 \Rightarrow D(-0{,}32;\ 7)$.
D ligt $3{,}17 + 0{,}32 = 3{,}49$ eenheden links van $C \Rightarrow$ de lengte van lijnstuk CD is 3,49.

7

	$y = a \cdot g^x + b$ (met horizontale asymptoot $y = b$)			
	$a > 0$		$a < 0$	
	$b > 0$	$b < 0$	$b > 0$	$b < 0$
$0 < g < 1$				
$g > 1$				

8a
$2^{x+1} = 64$
$2^{x+1} = 2^6$
$x + 1 = 6$
$x = 5.$

8b
$2^{x-3} = \frac{1}{8}$
$2^{x-3} = \frac{1}{2^3}$
$2^{x-3} = 2^{-3}$
$x - 3 = -3$
$x = 0.$

8c
$3^{4x-1} = \frac{1}{27} \cdot \sqrt{3}$
$3^{4x-1} = \frac{1}{3^3} \cdot 3^{\frac{1}{2}}$
$3^{4x-1} = 3^{-3} \cdot 3^{\frac{1}{2}}$
$3^{4x-1} = 3^{-2\frac{1}{2}}$
$4x - 1 = -2\frac{1}{2}$
$4x = -1\frac{1}{2}$
$x = -\frac{3}{2} \cdot \frac{1}{4} = -\frac{3}{8}.$

8d
$5^{-x+6} = 625$
$5^{-x+6} = 5^4$
$-x + 6 = 4$
$-x = -2$
$x = 2.$

8e
$(\frac{1}{3})^x - 2 = 25$
$(3^{-1})^x = 27$
$3^{-x} = 3^3$
$-x = 3$
$x = -3.$

8f
$5 \cdot (\frac{1}{2})^x + 11 = 91$
$5 \cdot (2^{-1})^x = 80$
$2^{-x} = 16$
$2^{-x} = 2^4$
$-x = 4$
$x = -4.$

8g
$2^{x+3} = \sqrt{2}$
$2^{x+3} = 2^{\frac{1}{2}}$
$x + 3 = \frac{1}{2}$
$x = -2\frac{1}{2}.$

8h
$3^{x+2} = 9 \cdot \sqrt{3}$
$3^{x+2} = 3^2 \cdot 3^{\frac{1}{2}}$
$3^{x+2} = 3^{2\frac{1}{2}}$
$x + 2 = 2\frac{1}{2}$
$x = \frac{1}{2}.$

8i
$4^{2x-1} = 64$
$4^{2x-1} = 4^3$
$2x - 1 = 3$
$2x = 4$
$x = 2.$

9a
$2^{3x+5} = 16 \cdot \sqrt{2}$
$2^{3x+5} = 2^4 \cdot 2^{\frac{1}{2}}$
$2^{3x+5} = 2^{4\frac{1}{2}}$
$3x + 5 = 4\frac{1}{2}$
$3x = -\frac{1}{2}$
$x = -\frac{1}{2} \cdot \frac{1}{3} = -\frac{1}{6}.$

9d
$3^{3x-3} = \frac{1}{3} \cdot \sqrt[4]{3}$
$3^{3x-3} = 3^{-1} \cdot 3^{\frac{1}{4}}$
$3^{3x-3} = 3^{-\frac{3}{4}}$
$3x - 3 = -\frac{3}{4}$
$3x = 2\frac{1}{4} = \frac{9}{4}$
$x = \frac{3}{4}.$

9g
$2^{4x-1} = 2^{2x-3}$
$4x - 1 = 2x - 3$
$2x = -2$
$x = -1.$

9b
$3^{4x} = \frac{1}{81} \cdot \sqrt[4]{9}$
$3^{4x} = \frac{1}{3^4} \cdot \sqrt[4]{3^2}$
$3^{4x} = 3^{-4} \cdot 3^{\frac{2}{4}}$
$3^{4x} = 3^{-3\frac{1}{2}}$
$4x = -3\frac{1}{2} = -\frac{7}{2}$
$x = -\frac{7}{8}.$

9c
$3 \cdot 5^{2x-1} = 0{,}6$
$5^{2x-1} = 0{,}2 = \frac{1}{5}$
$5^{2x-1} = 5^{-1}$
$2x - 1 = -1$
$2x = 0$
$x = 0.$

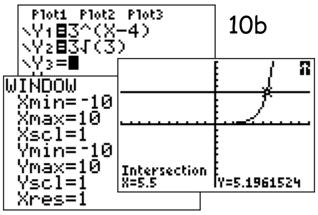
9e
$3 \cdot (\frac{1}{2})^{x-1} - 1 = -0{,}25$
$3 \cdot (\frac{1}{2})^{x-1} = 0{,}75$
$(\frac{1}{2})^{x-1} = 0{,}25 = \frac{1}{4} = (\frac{1}{2})^2$
$x - 1 = 2$
$x = 3.$

9f
$3 \cdot 5^{2x+1} = 75 \cdot \sqrt{5}$
$5^{2x+1} = 25 \cdot \sqrt{5}$
$5^{2x+1} = 5^2 \cdot 5^{\frac{1}{2}}$
$5^{2x+1} = 5^{2\frac{1}{2}}$
$2x + 1 = 2\frac{1}{2}$
$2x = 1\frac{1}{2} = \frac{3}{2}$
$x = \frac{3}{4}.$

9h
$3^{x^2} = 3^{x+6}$
$x^2 = x + 6$
$x^2 - x - 6 = 0$
$(x-3) \cdot (x+2) = 0$
$x = 3 \quad \vee \quad x = -2.$

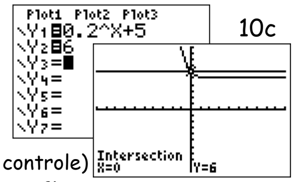
9i
$4^{|2x+1|} = 16$
$4^{|2x+1|} = 4^2$
$|2x+1| = 2$
$2x + 1 = 2 \quad \vee \quad 2x + 1 = -2$
$2x = 1 \quad \vee \quad 2x = -3$
$x = \frac{1}{2} \quad \vee \quad x = -1\frac{1}{2}.$

10a
$3^{x-4} = 3 \cdot \sqrt{3}$
$3^{x-4} = 3^1 \cdot 3^{\frac{1}{2}}$
$3^{x-4} = 3^{1\frac{1}{2}}$
$x - 4 = 1\frac{1}{2}$
$x = 5\frac{1}{2}.$



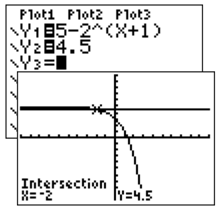
(intersect alleen ter controle)
Nu in een plot aflezen:
$3^{x-4} < 3 \cdot \sqrt{3}$ voor $x < 5\frac{1}{2}.$

10b
$0{,}2^x + 5 = 6$
$0{,}2^x = 1$
$0{,}2^x = 0{,}2^0$
$x = 0.$



(intersect ter controle)
Nu in een plot aflezen:
$0{,}2^x + 5 \geq 6$ voor $x \leq 0.$
(LET OP: het teken klapt om!!!)

10c
$5 - 2^{x+1} = 4\frac{1}{2}$
$-2^{x+1} = -\frac{1}{2}$
$2^{x+1} = \frac{1}{2} = 2^{-1}$
$x + 1 = -1$
$x = -2.$



(intersect slechts ter controle)
Nu in een plot aflezen:
$5 - 2^{x+1} > 4\frac{1}{2}$ voor $x < -2.$
(LET OP: het teken klapt om!!!)

11
$2^{4x-1} = 4^{x-3}$
$2^{4x-1} = \left(2^2\right)^{x-3}$
$2^{4x-1} = 2^{2 \cdot (x-3)}$
$4x - 1 = 2x - 6$
$2x = -5$
$x = -2\frac{1}{2}.$

12ab
$2^{x+1} + 2^x = 48$
$2^x \cdot 2^1 + 2^x = 48$
$2 \cdot 2^x + 1 \cdot 2^x = 48$
$3 \cdot 2^x = 48$
$2^x = 16 = 2^4$
$x = 4.$

13a
$2^{x+1} = 4^{3x+1}$
$2^{x+1} = \left(2^2\right)^{3x+1}$
$2^{x+1} = 2^{2 \cdot (3x+1)}$
$x + 1 = 6x + 2$
$-5x = 1$
$x = -\frac{1}{5}.$

13b
$4^{x-1} = 8^{3x-3}$
$\left(2^2\right)^{x-1} = \left(2^3\right)^{3x-3}$
$2^{2 \cdot (x-1)} = 2^{3 \cdot (3x-3)}$
$2x - 2 = 9x - 9$
$-7x = -7$
$x = 1.$

13c
$2^{x^2} = (\frac{1}{4})^x$
$2^{x^2} = \left(2^{-2}\right)^x$
$2^{x^2} = 2^{-2 \cdot x}$
$x^2 = -2x$
$x^2 + 2x = 0$
$x(x+2) = 0$
$x = 0 \quad \vee \quad x = -2.$

13d
$25^{x-3} = 5 \cdot 5^{2-x}$
$\left(5^2\right)^{x-3} = 5^1 \cdot 5^{2-x}$
$5^{2 \cdot (x-3)} = 5^{3-x}$
$2x - 6 = 3 - x$
$3x = 9$
$x = 3.$

13e
$27^x = 3 \cdot 9^{2x}$
$\left(3^3\right)^x = 3^1 \cdot \left(3^2\right)^{2x}$
$3^{3 \cdot x} = 3^1 \cdot 3^{2 \cdot 2x}$
$3^{3x} = 3^{1+4x}$
$3x = 1 + 4x$
$-x = 1$
$x = -1.$

13f
$0{,}5^x = 0{,}25 \cdot 2^x$
$(\frac{1}{2})^x = \frac{1}{4} \cdot 2^x$
$(\frac{1}{2^1})^x = \frac{1}{2^2} \cdot 2^x$
$\left(2^{-1}\right)^x = 2^{-2} \cdot 2^x$
$2^{-x} = 2^{-2+x}$
$-x = -2 + x$
$-2x = -2$
$x = \frac{-2}{-2} = 1.$

14a
$3^{x+2}+3^x=810$
$3^x\cdot 3^2+3^x=810$
$9\cdot 3^x+1\cdot 3^x=810$
$10\cdot 3^x=810$
$3^x=81=3^4$
$x=4.$

14c
$2^{x+3}-2^x=\frac{7}{8}$
$2^x\cdot 2^3-2^x=\frac{7}{8}$
$8\cdot 2^x-1\cdot 2^x=\frac{7}{8}$
$7\cdot 2^x=\frac{7}{8}$
$2^x=\frac{1}{8}=\frac{1}{2^3}=2^{-3}$
$x=-3.$

14e
$3^x-3^{x-1}=2\cdot\sqrt{3}$
$3^{x-1}\cdot 3^1-3^{x-1}=2\cdot\sqrt{3}$
$3\cdot 3^{x-1}-1\cdot 3^{x-1}=2\cdot\sqrt{3}$
$2\cdot 3^{x-1}=2\cdot\sqrt{3}$
$3^{x-1}=\sqrt{3}=3^{\frac{1}{2}}$
$x-1=\frac{1}{2}$
$x=1\frac{1}{2}.$

14b
$2^{x-1}+2^{x+1}=10$
$2^{x-1}+2^{x-1}\cdot 2^2=10$
$1\cdot 2^{x-1}+4\cdot 2^{x-1}=10$
$5\cdot 2^{x-1}=10$
$2^{x-1}=2=2^1$
$x-1=1$
$x=2.$

14d
$3^{x+2}=24+3^x$
$3^x\cdot 3^2=24+3^x$
$9\cdot 3^x=24+1\cdot 3^x$
$8\cdot 3^x=24$
$3^x=3=3^1$
$x=1.$

14f
$5^{x-1}+5^{x-2}=6\cdot\sqrt{5}$
$5^{x-2}\cdot 5^1+5^{x-2}=6\cdot\sqrt{5}$
$5\cdot 5^{x-2}+1\cdot 5^{x-2}=6\cdot\sqrt{5}$
$6\cdot 5^{x-2}=6\cdot\sqrt{5}$
$5^{x-2}=\sqrt{5}=5^{\frac{1}{2}}$
$x-2=\frac{1}{2}$
$x=2\frac{1}{2}.$

15a
$3^{x+1}=9^{x+2}$
$3^{x+1}=\left(3^2\right)^{x+2}$
$3^{x+1}=3^{2\cdot(x+2)}$
$x+1=2x+4$
$-x=3$
$x=-3.$

15d
$5^x+5^{x+1}=\frac{6}{25}$
$5^x+5^x\cdot 5^1=\frac{6}{25}$
$1\cdot 5^x+5\cdot 5^x=\frac{6}{25}$
$6\cdot 5^x=\frac{6}{25}$
$5^x=\frac{1}{25}=\frac{1}{5^2}=5^{-2}$
$x=-2.$

15g
$4^{x^2+1}=8^{x^2-1}$
$\left(2^2\right)^{x^2+1}=\left(2^3\right)^{x^2-1}$
$2^{2\cdot(x^2+1)}=2^{3\cdot(x^2-1)}$
$2x^2+2=3x^2-3$
$-x^2=-5$
$x^2=5$
$x=\sqrt{5}\ \vee\ x=-\sqrt{5}.$

15b
$3^{x+1}-3^{x-1}=8\cdot\sqrt{3}$
$3^{x-1}\cdot 3^2-3^{x-1}=8\cdot\sqrt{3}$
$9\cdot 3^{x-1}-1\cdot 3^{x-1}=8\cdot\sqrt{3}$
$8\cdot 3^{x-1}=8\cdot\sqrt{3}$
$3^{x-1}=\sqrt{3}=3^{\frac{1}{2}}$
$x-1=\frac{1}{2}$
$x=1\frac{1}{2}.$

15e
$5^{x^2+5}=125^{x+1}$
$5^{x^2+5}=\left(5^3\right)^{x+1}$
$5^{x^2+5}=5^{3\cdot(x+1)}$
$x^2+5=3x+3$
$x^2-3x+2=0$
$(x-2)\cdot(x-1)=0$
$x=2\ \vee\ x=1.$

15h
$2^{x+3}-4^{\frac{1}{2}x-1}=3\frac{7}{8}$
$2^{x+3}-\left(2^2\right)^{\frac{1}{2}x-1}=3\frac{7}{8}$
$2^{x+3}-2^{2\cdot(\frac{1}{2}x-1)}=3\frac{7}{8}$
$2^{x+3}-2^{x-2}=3\frac{7}{8}$
$2^{x-2}\cdot 2^5-2^{x-2}=3\frac{7}{8}$
$32\cdot 2^{x-2}-1\cdot 2^{x-2}=3\frac{7}{8}$
$31\cdot 2^{x-2}=\frac{31}{8}$
$2^{x-2}=\frac{1}{8}=\frac{1}{2^3}=2^{-3}$
$x-2=-3$
$x=-1.$

15c
$3^{x^2}=(\frac{1}{3})^{x-6}$
$3^{x^2}=\left(3^{-1}\right)^{x-6}$
$3^{x^2}=3^{-1\cdot(x-6)}$
$x^2=-x+6$
$x^2+1x-6=0$
$(x+3)\cdot(x-2)=0$
$x=-3\ \vee\ x=2.$

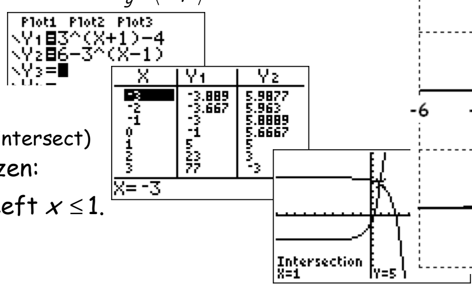
15f
$2^{x+2}-(\frac{1}{2})^{-x+1}=28$
$2^{x+2}-\left(2^{-1}\right)^{-x+1}=28$
$2^{x+2}-2^{x-1}=28$
$2^{x-1}\cdot 2^3-2^{x-1}=28$
$8\cdot 2^{x-1}-1\cdot 2^{x-1}=28$
$7\cdot 2^{x-1}=28$
$2^{x-1}=4=2^2$
$x-1=2$
$x=3.$

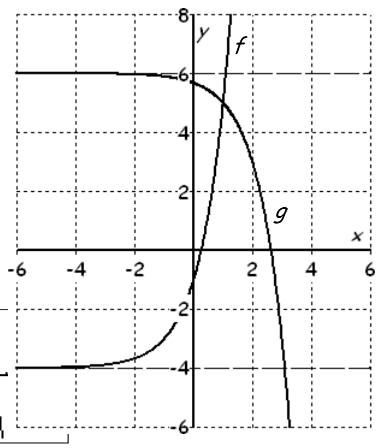
16ac
$y=3^x\xrightarrow{\text{translatie }(-1,-4)}f(x)=3^{x+1}-4.$
$B=\langle 0,\rightarrow\rangle\quad\Rightarrow\quad B_f=\langle -4,\rightarrow\rangle$
$y=3^x\xrightarrow{\text{verm. }x\text{-as, }-1}y=-1\cdot 3^x\xrightarrow{\text{translatie }(1,6)}g(x)=-3^{x-1}+6.$
$B=\langle 0,\rightarrow\rangle\quad\Rightarrow\quad B=\langle\leftarrow,0\rangle\quad\Rightarrow\quad B_g=\langle\leftarrow,6\rangle$

16b Zie de grafieken hiernaast (maak eerst een tabel).

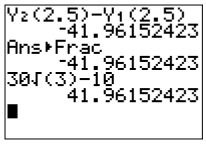
16d
$3^{x+1}-4=6-3^{x-1}$
$3^{x-1}\cdot 3^2=10-3^{x-1}$
$9\cdot 3^{x-1}=10-1\cdot 3^{x-1}$
$10\cdot 3^{x-1}=10$
ga hiernaast verder

$3^{x-1}=1=3^0$
$x-1=0$
$x=1.$ (zie controle met intersect)
Nu in de grafiek aflezen:
$3^{x+1}-4\leq 6-3^{x-1}$ geeft $x\leq 1.$





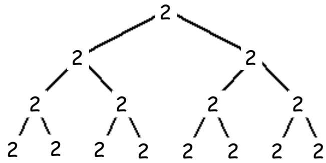
16e $f(2{,}5) = 3^{3{,}5} - 4 = 3^3 \cdot 3^{0{,}5} - 4 = 27 \cdot \sqrt{3} - 4 \Rightarrow A(2{,}5;\ 27 \cdot \sqrt{3} - 4)$.
$g(2{,}5) = 6 - 3^{1{,}5} = 6 - 3^1 \cdot 3^{0{,}5} = 6 - 3 \cdot \sqrt{3} \Rightarrow B(2{,}5; 6 - 3 \cdot \sqrt{3})$.
De lengte van lijnstuk AB is $27 \cdot \sqrt{3} - 4 - (6 - 3 \cdot \sqrt{3}) = 27 \cdot \sqrt{3} - 4 - 6 + 3 \cdot \sqrt{3} = 30 \cdot \sqrt{3} - 10$.



16f $f(x) - g(x) = 80$
$3^{x+1} - 4 - (6 - 3^{x-1}) = 80$
$3^{x+1} - 4 - 6 + 3^{x-1} = 80$ ↗
$3^{x-1} \cdot 3^2 + 3^{x-1} = 90$
$9 \cdot 3^{x-1} + 1 \cdot 3^{x-1} = 90$
$10 \cdot 3^{x-1} = 90$ ↗
$3^{x-1} = 9 = 3^2$
$x - 1 = 2$
$x = 3$.

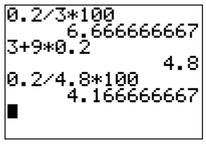
16g $g(x) - f(x) = p$ heeft geen oplossing als $p \geq 10$.
(voor grote negatieve waarden van x nadert $g(x) - f(x)$ naar $6 - -4 = 10$)

17a 30 keer 2 minuten $\Rightarrow$ 60 minuten.
17b Zie het boomdiagram hiernaast.
Dus het duurt 4 keer 4 minuten $\Rightarrow$ 16 minuten.



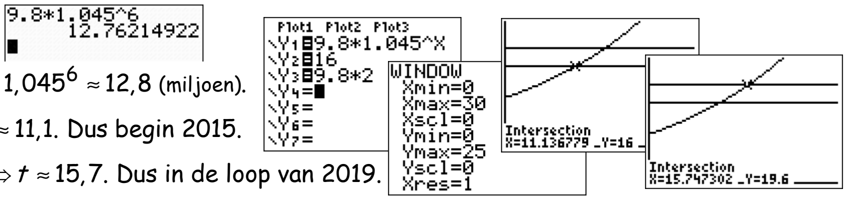
totale tijd	totaal aantal leerlingen
4	2
8	$2 + 4 = 6$
12	$6 + 8 = 14$
16	$14 + 16 = 30$

18a $l = 3 + 0{,}2t$.
18b De eerste dag (van $t = 0$ tot $t = 1$) een toename van 3 naar 3,2 (m) $\Rightarrow$ toename is $\frac{0{,}2}{3} \times 100 \approx 6{,}7\%$.
De tiende dag (van $t = 9$ tot $t = 10$) een toename van 4,8 naar 5 (m) $\Rightarrow$ toename is $\frac{0{,}2}{4{,}8} \times 100 \approx 4{,}2\%$.



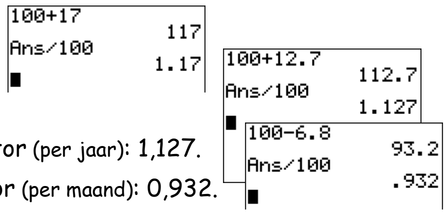
18c $l = 6 \Rightarrow 3 + 0{,}2t = 6 \Rightarrow 0{,}2t = 3 \Rightarrow t = \frac{3}{0{,}2} = 15$. Dus na 15 dagen.

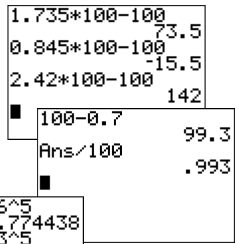
19a $N = 9{,}8 \cdot 1{,}045^t$.
19b In januari 2010 is $t = 6 \Rightarrow N = 9{,}8 \cdot 1{,}045^6 \approx 12{,}8$ (miljoen).
19c $N = 9{,}8 \cdot 1{,}045^t = 16$ (intersect) $\Rightarrow t \approx 11{,}1$. Dus begin 2015.
19d $N = 9{,}8 \cdot 1{,}045^t = 9{,}8 \cdot 2$ (intersect) $\Rightarrow t \approx 15{,}7$. Dus in de loop van 2019.



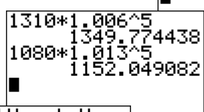
20 Toename van 17% (toename van 100% naar 117% = $\boxed{1{,}17} \times 100\%$) $\Rightarrow$ groeifactor is 1,17.

21a Toename (per jaar): 12,7% (toename van 100% naar 112,7% = $\boxed{1{,}127} \times 100\%$) $\Rightarrow$ groeifactor (per jaar): 1,127.
21b Afname (per maand): 6,8% (afname van 100% naar 93,2% = $\boxed{0{,}932} \times 100\%$) $\Rightarrow$ groeifactor (per maand): 0,932.
21c Groeifactor (per maand): 1,735 (toename van 100% naar $\boxed{1{,}735} \times 100\% = 173{,}5\%$) $\Rightarrow$ groeipercentage (per maand): 73,5%.
21d Groeifactor (per dag): 0,845 (afname van 100% naar $\boxed{0{,}845} \times 100\% = 84{,}5\%$) $\Rightarrow$ afname (per dag): 15,5%.
21e Groeifactor (per jaar): 2,42 (toename van 100% naar $\boxed{2{,}42} \times 100\% = 242\%$) $\Rightarrow$ toename (per jaar): 142%.
21f Afname (per dag): 0,7% (afname van 100% naar 99,3% = $\boxed{0{,}993} \times 100\%$) $\Rightarrow$ groeifactor (per dag): 0,993.

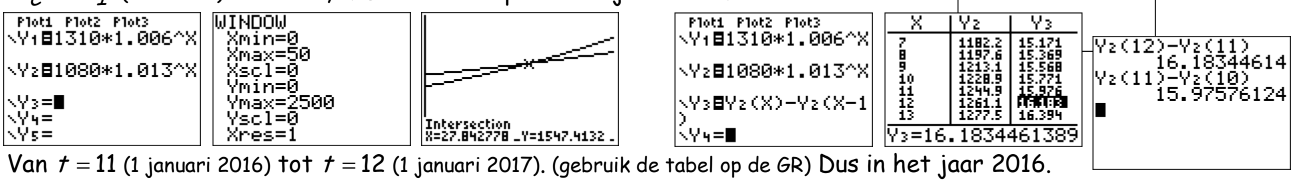




22a $N_C = 1310 \cdot 1{,}006^t$. 22b $N_I = 1080 \cdot 1{,}013^t$.
22c $t = 5$ geeft $N_C = 1310 \cdot 1{,}006^5 \approx 1350$ (miljoen) en $N_I = 1080 \cdot 1{,}013^5 \approx 1152$ (miljoen).

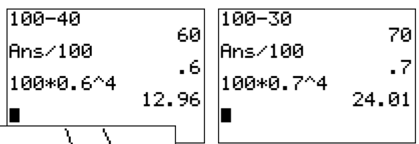


22d $N_C = N_I$ (intersect) $\Rightarrow t \approx 27{,}8$. Dus in de loop van het jaar 2032.

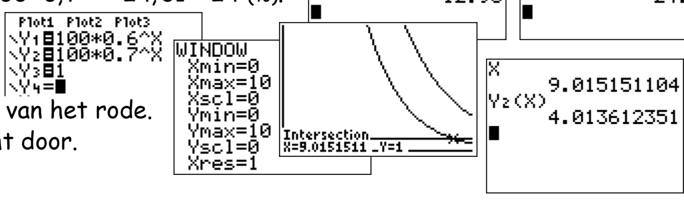


22e Van $t = 11$ (1 januari 2016) tot $t = 12$ (1 januari 2017). (gebruik de tabel op de GR) Dus in het jaar 2016.

23a $R = 100 \cdot 0{,}6^d$ (R het percentage rood licht en d in meters).
$B = 100 \cdot 0{,}7^d$ (B het percentage blauw licht en d in meters).
$d = 4$ geeft $R = 100 \cdot 0{,}6^4 = 12{,}96 \approx 13$ (%) en $B = 100 \cdot 0{,}7^4 = 24{,}01 \approx 24$ (%).



23b $R = 100 \cdot 0{,}6^d = 1$ (intersect) $\Rightarrow d \approx 9{,}015$ (meter).
$B = 100 \cdot 0{,}7^{Ans} \approx 4$ (%).
Op deze diepte nog 4% van het blauwe licht en 1% van het rode.
Dus op deze diepte dringt 4 keer zoveel blauw licht door.



24a Gebruik het basisscherm van de GR hiernaast om de tabel af te maken.

```
                 2
Ans*9
                18
               162
              1458
             13122
            118098
```

24b Per twee jaar met $9 \times 9 = 9^2 = 81$.

24c Als per half jaar met 4,5 wordt vermenigvuldigd, dan per jaar met $4{,}5^2 = 20{,}5$.
Per jaar wordt echter met 9 vermenigvuldigd, dus per half jaar met minder dan 4,5.
OF: $x \times x = 9 \Rightarrow x^2 = 9 \Rightarrow x = 3$. Dus per half jaar wordt met 3 $(< 4{,}5)$ vermenigvuldigd.

```
9*9
                81
4.5*4.5
             20.25
```

25a $g_{\text{kwartier}} = 1{,}12 \Rightarrow g_{\text{uur}} = 1{,}12^4 \approx 1{,}574$. De toename per uur is 57,4%.

25b $g_{\text{kwartier}} = 1{,}12 \Rightarrow g_{5\text{ min}} = 1{,}12^{\frac{1}{3}} \approx 1{,}038$. De toename per 5 minuten is 3,8%.

```
(100+12)/100
              1.12
1.12^4
        1.57351936
Ans*100-100
         57.351936
```

```
1.12^(1/3)
        1.03849882
Ans*100-100
       3.849882037
```

26a $g_{\text{dag}} = 0{,}84 \Rightarrow g_{\text{week}} = 0{,}84^7 \approx 0{,}295$. De afname per week is 70,5%.

26b $g_{\text{dag}} = 0{,}84 \Rightarrow g_{\text{uur}} = 0{,}84^{\frac{1}{24}} \approx 0{,}993$. De afname per uur is 0,7%.

```
(100-16)/100
               .84
0.84^7
       .2950903466
Ans*100-100
      -70.49096534
```

```
0.84^(1/24)
       .9927615999
Ans*100-100
      -.7238400138
```

27a $g_{\text{dag}} = 1{,}3 \Rightarrow g_{\text{week}} = 1{,}3^7 \approx 6{,}27$. Het groeipercentage per week is 527%.

27b $g_{\text{dag}} = 1{,}3 \Rightarrow g_{4\text{ uur}} = 1{,}3^{\frac{1}{6}} \approx 1{,}045$. Het groeipercentage per 4 uur is 4,5%.

```
1.3^7
         6.2748517
Ans*100-100
         527.48517
```

```
1.3^(1/6)
       1.044697508
Ans*100-100
       4.469750792
```

28a $g_{\text{uur}} = 0{,}805 \Rightarrow g_{\text{kwartier}} = 0{,}805^{\frac{1}{4}} \approx 0{,}947$. De afname per kwartier is 5,3%.

28b $g_{\text{jaar}} = 1{,}086 \Rightarrow g_{25\text{ jaar}} = 1{,}086^{25} \approx 7{,}87$. De toename per 25 jaar is 687%.

28c $g_{\text{week}} = 2{,}8 \Rightarrow g_{\text{dag}} = 2{,}8^{\frac{1}{7}} \approx 1{,}158$. De toename per dag is 15,8%.

```
(100-19.5)/100
              .805
0.805^(1/4)
       .9472158794
Ans*100-100
      -5.278412057
```

```
(100+8.6)/100
             1.086
1.086^25
       7.865849476
Ans*100-100
       686.5849476
```

```
(100+180)/100
               2.8
2.8^(1/7)
       1.158456468
Ans*100-100
       15.84564682
```

29a $g_{\text{dag}} = 1{,}05 \Rightarrow g_{\text{week}} = 1{,}05^7 \approx 1{,}407$. De toename per week is 40,7%.

```
(100+5)/100
              1.05
1.05^7
       1.407100423
Ans*100-100
       40.71004227
```

29b $g_{\text{dag}} = 1{,}5 \Rightarrow g_{\text{week}} = 1{,}5^7 (\approx 17{,}1)$.

```
1.5^7
        17.0859375
```

29c $g_{\text{uur}} = 0{,}8 \Rightarrow g_{\text{kwartier}} = 0{,}8^{\frac{1}{4}} \approx 0{,}946$. De afname per kwartier is 5,4%.

```
(100-20)/100
                .8
0.8^(1/4)
        .945741609
Ans*100-100
        -5.4258391
```

29d $g_{\text{uur}} = 0{,}7 \Rightarrow g_{\text{kwartier}} = 0{,}7^{\frac{1}{4}} (\approx 0{,}915)$.

```
0.7^(1/4)
       .9146912192
```

30 $g_{20\text{ jaar}} = 9 \Rightarrow g_{\text{jaar}} = 9^{\frac{1}{20}} \approx 1{,}116$. Het groeipercentage per jaar is 11,6%.

```
9^(1/20)
       1.116123174
Ans*100-100
        11.6123174
```

31a $g_{10\text{ jaar}} = 0{,}05 \Rightarrow g_{\text{jaar}} = 0{,}05^{\frac{1}{10}} \approx 0{,}741$. De afname per jaar is 25,9%.

```
(100-95)/100
               .05
0.05^(1/10)
       .7411344491
Ans*100-100
      -25.88655509
```

31b $g_{20\text{ jaar}} = 12 \Rightarrow g_{\text{jaar}} = 12^{\frac{1}{20}} \approx 1{,}132$. Het groeipercentage per jaar is 13,2%.

```
12^(1/20)
       1.132293625
Ans*100-100
       13.22936253
```

31c In 1965 waren er $\frac{14000}{12}$; in 1955 waren er $\frac{14000}{12} : 0{,}05 \approx 23\,000$ (broedparen).

```
14000/12
       1166.666667
Ans/0.05
       23333.33333
```

32a Tussen $t = 5$ en $t = 9$ zit 4 uur $\Rightarrow g_{4\text{ uur}} = \frac{300000}{50000} = 6$.

32b $g_{4\text{ uur}} = 6 \Rightarrow g_{\text{uur}} = 6^{\frac{1}{4}} \approx 1{,}565$.

```
300000/50000
                 6
6^(1/4)
        1.56508458
```

33 $g_{7\text{ uur}} = \frac{4100}{1600} \Rightarrow g_{\text{uur}} = (\frac{4100}{1600})^{\frac{1}{7}} \approx 1{,}144$.

$$\left.\begin{array}{l} N = b \cdot 1{,}144^t \\ \text{voor } t = 3 \text{ is } N = 1600 \end{array}\right\} \Rightarrow 1600 = b \cdot 1{,}144^3 \Rightarrow b = \frac{1600}{1{,}144^3} \approx 1070. \text{ Dus } N = 1070 \cdot 1{,}144^t.$$

```
4100/1600
            2.5625
Ans^(1/7)
       1.143880228
1600/Ans^3
       1069.001519
```

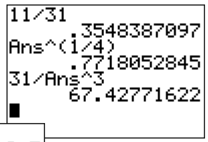
34 $g_{6\text{ dagen}} = \frac{2500}{1000} = 2{,}5 \Rightarrow g_{\text{dag}} = 2{,}5^{\frac{1}{6}} \approx 1{,}165$.

$$\left.\begin{array}{l} N = b \cdot 1{,}165^t \\ \text{voor } t = 4 \text{ is } N = 1000 \end{array}\right\} \Rightarrow 1000 = b \cdot 1{,}165^4 \Rightarrow b = \frac{1000}{1{,}165^4} \approx 540. \text{ Dus } N = 540 \cdot 1{,}165^t.$$

```
2500/1000
               2.5
2.5^(1/6)
       1.164993051
1000/Ans^4
       542.8835233
```

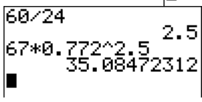
35a $g_{4\text{ dagen}} = \frac{11}{31} \Rightarrow g_{\text{dag}} = (\frac{11}{31})^{\frac{1}{4}} \approx 0{,}772.$

$\left.\begin{array}{l} A = b \cdot 0{,}772^t \\ \text{voor } t = 3 \text{ is } A = 31 \end{array}\right\} \Rightarrow 31 = b \cdot 0{,}772^3 \Rightarrow b = \frac{31}{0{,}772^3} \approx 67.$ Dus $A = 67 \cdot 0{,}772^t$.

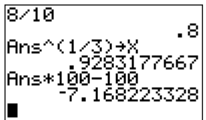


35b De oorspronkelijke wond ($t = 0$) was 67 mm^2.

35c Na 60 uur is $t = \frac{60}{24} = 2{,}5$ (dagen) en $A = 67 \cdot 0{,}772^{2{,}5} \approx 35$ (mm^2).

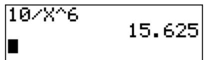


36a $g_{3\text{ minuten}} = \frac{8}{10} = 0{,}8 \Rightarrow g_{\text{minuut}} = 0{,}8^{\frac{1}{3}} \approx 0{,}928.$ De afname per minuut is 7,2%.

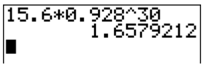


36b $\left.\begin{array}{l} v = b \cdot 0{,}928^t \\ \text{voor } t = 6 \text{ is } v = 10 \end{array}\right\} \Rightarrow 10 = b \cdot 0{,}928^6 \Rightarrow b = \frac{10}{0{,}928^6} \approx 15{,}6.$ Dus $v = 15{,}6 \cdot 0{,}928^t$.

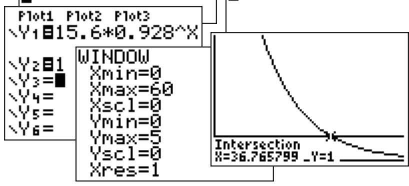
De snelheid v op moment $t = 0$ was 15,6 knopen.



36c Na een half uur is $t = 30$ en $v = 15{,}6 \cdot 0{,}928^{30} \approx 1{,}7$ (knopen).



36d $v = 15{,}6 \cdot 0{,}928^t = 1$ (intersect) $\Rightarrow t \approx 36{,}8$. Dus na 37 minuten.



37a $2^3 = 8.$

37b $2^{-2} = \frac{1}{2^2} = \frac{1}{4}.$

37c $2^{\frac{1}{2}} = \sqrt[2]{2^1} = \sqrt{2}.$

37d $3^2 = 9.$

37e $3^{-3} = \frac{1}{3^3} = \frac{1}{27}.$

37f $3^{\frac{1}{5}} = \sqrt[5]{3^1} = \sqrt[5]{3}.$

38a $^5\log(125) = {}^5\log(5^3) = 3.$

38b $^{10}\log(0{,}1) = {}^{10}\log(\frac{1}{10}) = {}^{10}\log(10^{-1}) = -1.$

38c $^2\log(4) = {}^2\log(2^2) = 2.$

38d $^7\log(49) = {}^7\log(7^2) = 2.$

38e $^2\log(\sqrt{2}) = {}^2\log(2^{\frac{1}{2}}) = \frac{1}{2}.$

38f $^2\log(0{,}5) = {}^2\log(\frac{1}{2}) = {}^2\log(2^{-1}) = -1.$

38g $^4\log(0{,}25) = {}^4\log(\frac{1}{4}) = {}^4\log(4^{-1}) = -1.$

38h $^4\log(4) = {}^4\log(4^1) = 1.$

38i $^4\log(1) = {}^4\log(4^0) = 0.$

39a $^2\log(64 \cdot \sqrt{2}) = {}^2\log(2^6 \cdot 2^{\frac{1}{2}}) = {}^2\log(2^{6\frac{1}{2}}) = 6\frac{1}{2}.$

39b $^3\log(\frac{1}{9} \cdot \sqrt{3}) = {}^3\log(3^{-2} \cdot 3^{\frac{1}{2}}) = {}^3\log(3^{-1\frac{1}{2}}) = -1\frac{1}{2}.$

39c $^3\log(3^{21{,}5}) = 21{,}5.$

39d $^5\log(\frac{1}{125}) = {}^5\log(5^{-3}) = -3.$

39e $^{\frac{1}{3}}\log(\frac{1}{27}) = {}^{\frac{1}{3}}\log((\frac{1}{3})^3) = 3.$

39f $^{\frac{1}{2}}\log(\frac{1}{4}) = {}^{\frac{1}{2}}\log((\frac{1}{2})^2) = 2.$

39g $^2\log(\frac{1}{32} \cdot \sqrt[3]{2}) = {}^2\log(2^{-5} \cdot 2^{\frac{1}{3}}) = {}^2\log(2^{-4\frac{2}{3}}) = -4\frac{2}{3}.$

39h $^5\log(1) = {}^5\log(5^0) = 0.$

39i $^3\log(81 \cdot \sqrt[5]{27}) = {}^3\log(3^4 \cdot \sqrt[5]{3^3}) = {}^3\log(3^4 \cdot 3^{\frac{3}{5}}) = {}^3\log(3^{4\frac{3}{5}}) = 4\frac{3}{5}.$

40a $^2\log(2^8) = 8.$

40b $^3\log(3^{-3}) = -3.$

40c $^5\log(5^{\frac{1}{2}}) = \frac{1}{2}.$

41a $^3\log(x+2) = 2$
$x + 2 = 3^2 = 9$
$x = 7.$

41b $1 + {}^{\frac{1}{2}}\log(x) = 4$
$^{\frac{1}{2}}\log(x) = 3$
$x = (\frac{1}{2})^3 = \frac{1}{8}.$

41c $^3\log(2x+1) = 4$
$2x + 1 = 3^4 = 81$
$2x = 80$
$x = 40.$

41d $5 + {}^4\log(x) = 3$
$^4\log(x) = -2$
$x = 4^{-2} = \frac{1}{4^2} = \frac{1}{16}.$

41e $^{\frac{1}{2}}\log(x-1) = 3$
$x - 1 = (\frac{1}{2})^3 = \frac{1}{8}$
$x = 1\frac{1}{8}.$

41f $^2\log(x^2-4) = 5$
$x^2 - 4 = 2^5 = 32$
$x^2 = 36$
$x = 6 \ \vee \ x = -6.$

42a $4 \cdot {}^3\log(x) = 2$
$^3\log(x) = \frac{2}{4} = \frac{1}{2}$
$x = 3^{\frac{1}{2}} = \sqrt{3}.$

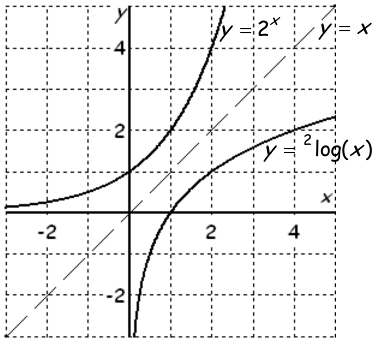
42c $3 + {}^2\log(x) = -1$
$^2\log(x) = -4$
$x = 2^{-4} = \frac{1}{2^4} = \frac{1}{16}.$

42e $^3\log(0{,}4x-5) = 2$
$0{,}4x - 5 = 3^2 = 9$
$0{,}4x = 14$
$x = \frac{14}{0{,}4} = \frac{140}{4} = 35.$

42b $^{3}\log(4x-1)=-2$
$4x-1=3^{-2}=\frac{1}{3^2}=\frac{1}{9}$
$4x=1\frac{1}{9}$
$x=\frac{1\frac{1}{9}}{4}=\frac{10}{9}\cdot\frac{1}{4}=\frac{10}{36}=\frac{5}{18}$.

42d $^{5}\log(3x+2)=1$
$3x+2=5^1=5$
$3x=3$
$x=1$.

42f $4+2\cdot{}^{2}\log(x)=7$
$2\cdot{}^{2}\log(x)=3$
$^{2}\log(x)=\frac{3}{2}=1\frac{1}{2}$
$x=2^{1\frac{1}{2}}=2^1\cdot 2^{\frac{1}{2}}=2\cdot\sqrt{2}$.



43a

x	-3	-2	-1	0	1	2	3
$y=2^x$	$2^{-3}=\frac{1}{8}$	$2^{-2}=\frac{1}{4}$	$2^{-1}=\frac{1}{2}$	$2^0=1$	$2^1=2$	$2^2=4$	$2^3=8$

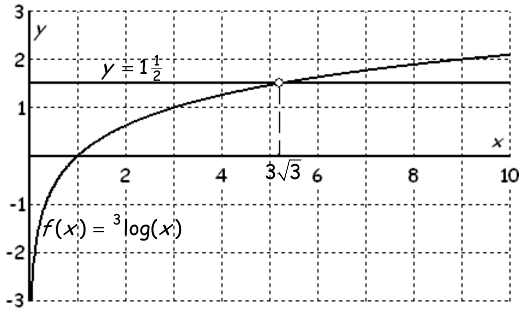
x	$2^{-3}=\frac{1}{8}$	$2^{-2}=\frac{1}{4}$	$2^{-1}=\frac{1}{2}$	$2^0=1$	$2^1=2$	$2^2=4$	$2^3=8$
$y={}^{2}\log(x)$	-3	-2	-1	0	1	2	3

43b Zie de grafieken hiernaast. (gebruik de tabellen hierboven)

43c $f(x)=2^x \xrightarrow{\text{spiegelen in de lijn } y=x \text{ (} x \text{ en } y \text{ verwisselen)}} g(x)={}^{2}\log(x)$.

44a

x	$3^{-2}=\frac{1}{9}$	$3^{-1}=\frac{1}{3}$	$3^0=1$	$3^1=3$	$3^2=9$
$f(x)={}^{3}\log(x)$	-2	-1	0	1	2



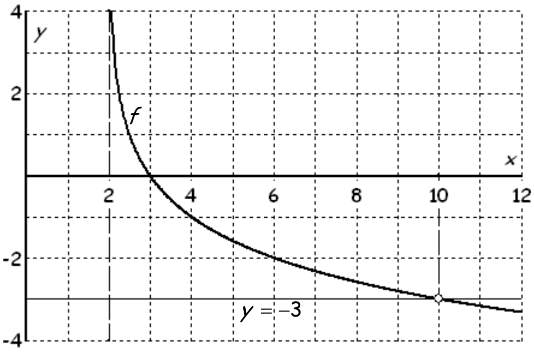
44b Zie de grafiek hiernaast. (gebruik de tabel hierboven)

44c $D_f=\langle 0,\rightarrow\rangle \Rightarrow x$ mag alleen uit $\langle 0,\rightarrow\rangle$ genomen worden.
$f(x)={}^{3}\log(x)=1\frac{1}{2}$
$x=3^{1\frac{1}{2}}=3^1\cdot 3^{\frac{1}{2}}=3\sqrt{3}$.
Met de grafiek vind je dan: $f(x)\le 1\frac{1}{2}$ geeft $0<x\le 3\sqrt{3}$.

44d $x=\sqrt{3}$ geeft $f(\sqrt{3})={}^{3}\log(\sqrt{3})={}^{3}\log(3^{\frac{1}{2}})=\frac{1}{2}$ en $x=27$ geeft $f(27)={}^{3}\log(27)={}^{3}\log(3^3)=3$.
Voor $\sqrt{3}\le x\le 27$ is $\frac{1}{2}\le f(x)\le 3$.

45a

x	6	4	3	$2\frac{1}{2}$	$2\frac{1}{4}$
$f(x)={}^{\frac{1}{2}}\log(x-2)$	-2	-1	0	1	2



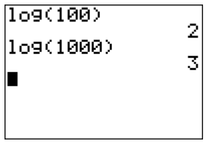
45b Zie de grafiek hiernaast. (gebruik de tabel hierboven)

45c $x=2\frac{1}{8}$ geeft $f(2\frac{1}{8})={}^{\frac{1}{2}}\log(\frac{1}{8})={}^{\frac{1}{2}}\log((\frac{1}{2})^3)=3$.
Voor $x\ge 2\frac{1}{8}$ is $f(x)\le 3$. (gebruik de grafiek)

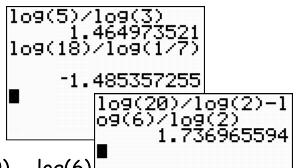
45d $D_f=\langle 2,\rightarrow\rangle \Rightarrow x$ mag alleen uit $\langle 2,\rightarrow\rangle$ genomen worden.
$f(x)={}^{\frac{1}{2}}\log(x-2)=-3$
$x-2=\left(\frac{1}{2}\right)^{-3}=\left(2^{-1}\right)^{-3}=2^3=8$
$x=10$. Gebruik makend van de grafiek en het domein vind je dan: $f(x)\ge -3$ geeft $2<x\le 10$.

46 $2^{{}^{2}\log(8)}=2^{{}^{2}\log(2^3)}=2^3=8$; $3^{{}^{3}\log(9)}=3^{{}^{3}\log(3^2)}=3^2=9$; $2^{{}^{2}\log(\frac{1}{2})}=2^{{}^{2}\log(2^{-1})}=2^{-1}=\frac{1}{2}$.
Dus $2^{{}^{2}\log(8)}=8$; $3^{{}^{3}\log(9)}=9$; $2^{{}^{2}\log(\frac{1}{2})}=\frac{1}{2}$. (algemeen geldt: $g^{{}^{g}\log(a)}=a$)

47a $\log(100)=2$ en $\log(1000)=3$.



47b Het grondtal is 10, omdat $^{10}\log(100)={}^{10}\log(10^2)=2$ en $^{10}\log(1000)={}^{10}\log(10^3)=3$.
(op het toetsenscherm van de GR is ook te zien dat $\boxed{\text{2nd}}\boxed{\text{LOG}}$ hetzelfde is als 10^x)



48a $^{3}\log(5)=\frac{\log(5)}{\log(3)}\approx 1,46$.

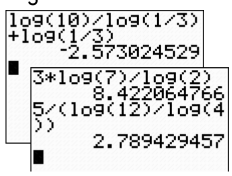
48b $^{\frac{1}{7}}\log(18)=\frac{\log(18)}{\log(\frac{1}{7})}\approx -1,49$.

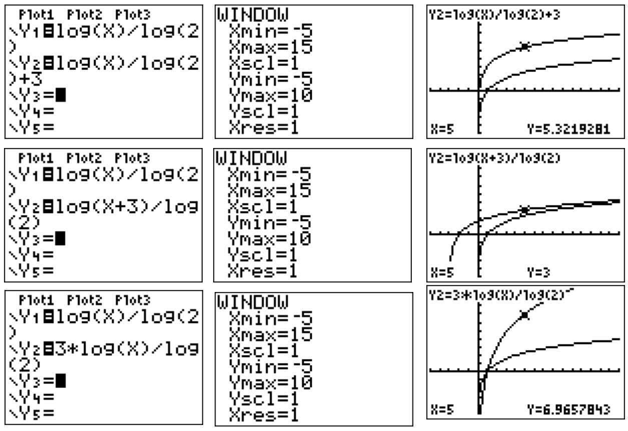
48c $^{2}\log(20)-{}^{2}\log(6)=\frac{\log(20)}{\log(2)}-\frac{\log(6)}{\log(2)}\approx 1,74$.

48d $^{\frac{1}{3}}\log(10)+\log(\frac{1}{3})=\frac{\log(10)}{\log(\frac{1}{3})}+\log(\frac{1}{3})\approx -2,57$.

48e $3\cdot{}^{2}\log(7)=3\cdot\frac{\log(7)}{\log(2)}\approx 8,42$.

48f $\frac{5}{{}^{4}\log(12)}=\frac{5}{\frac{\log(12)}{\log(4)}}\approx 2,79$.





49ad $f(x) = {}^2\log(x) \xrightarrow{\text{translatie } (0,3)} g(x) = {}^2\log(x) + 3.$

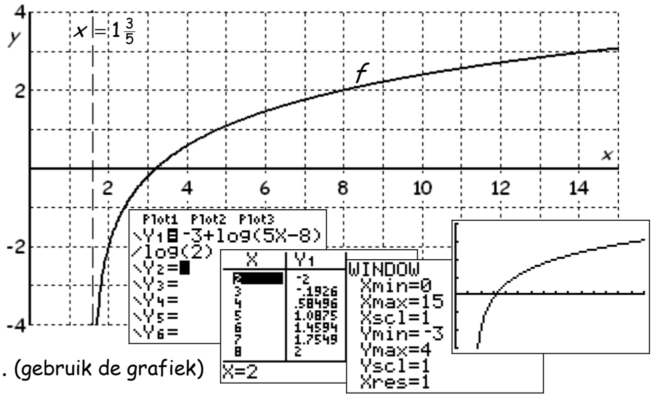
$\begin{cases} D_f = \langle 0, \rightarrow \rangle \\ \text{V.A.: } x = 0 \end{cases} \Rightarrow \begin{cases} D_g = \langle 0, \rightarrow \rangle \\ \text{V.A.: } x = 0 \end{cases}$

49bd $f(x) = {}^2\log(x) \xrightarrow{\text{translatie } (-3,0)} h(x) = {}^2\log(x+3).$

$\begin{cases} D_f = \langle 0, \rightarrow \rangle \\ \text{V.A.: } x = 0 \end{cases} \Rightarrow \begin{cases} D_h = \langle -3, \rightarrow \rangle \\ \text{V.A.: } x = -3 \end{cases}$

49cd $f(x) = {}^2\log(x) \xrightarrow{\text{verm. } x\text{-as, } 3} k(x) = 3 \cdot {}^2\log(x).$

$\begin{cases} D_f = \langle 0, \rightarrow \rangle \\ \text{V.A.: } x = 0 \end{cases} \Rightarrow \begin{cases} D_k = \langle 0, \rightarrow \rangle \\ \text{V.A.: } x = 0 \end{cases}$

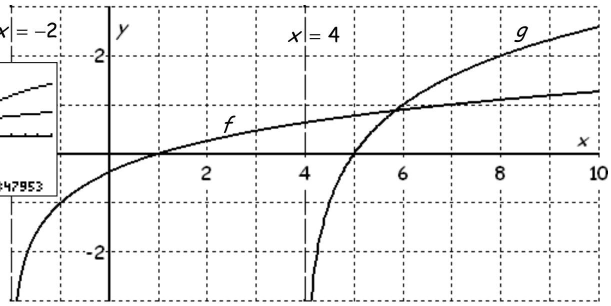


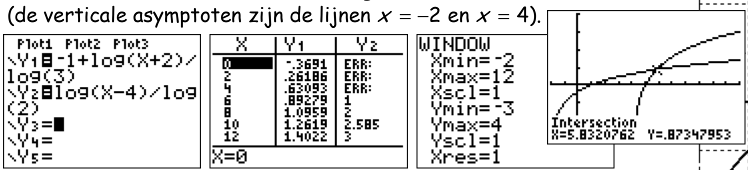
50a Maak een tabel op de GR en dan de grafiek. (zie hiernaast)
$5x - 8 > 0 \Rightarrow 5x > 8 \Rightarrow x > \frac{8}{5}.$
Dus $D_f = \langle 1\frac{3}{5}, \rightarrow \rangle$ (de verticale asymptoot is de lijn $x = 1\frac{3}{5}$).

50b $f(x) = -3 + {}^2\log(5x - 8) = 0$
${}^2\log(5x - 8) = 3$
$5x - 8 = 2^3 = 8$
$5x = 16$
$x = \frac{16}{5} = 3\frac{1}{5}.$
Gebruik nu de grafiek:
$f(x) \le 0$ geeft $1\frac{3}{5} < x \le 3\frac{1}{5}.$

50c $f(8) = 2.$ (zie de tabel)
Voor $x \le 8$ is $f(x) \le 2.$ (gebruik de grafiek)

51a Maak een tabel op de GR en dan de grafiek. (zie hiernaast)
$D_f = \langle -2, \rightarrow \rangle$ (want $x + 2 > 0$) en $D_g = \langle 4, \rightarrow \rangle$ (want $x - 4 > 0$).
(de verticale asymptoten zijn de lijnen $x = -2$ en $x = 4$).





51b $f(x) = g(x)$ (intersect) $\Rightarrow x \approx 5{,}83$ en $y \approx 0{,}87.$

51c Gebruik 51b en de grafiek (LET OP DE DOMEINEN).
$f(x) \ge g(x)$ geeft $4 < x \le 5{,}83$ (voor $x \le 4$ bestaat g niet).

52a $y = {}^2\log(x) \xrightarrow{\text{translatie } (5,-3)} f(x) = {}^2\log(x-5) - 3.$

$\begin{cases} D = \langle 0, \rightarrow \rangle \\ \text{V.A.: } x = 0 \end{cases} \Rightarrow \begin{cases} D_f = \langle 5, \rightarrow \rangle \\ \text{V.A.: } x = 5 \end{cases}$

52b $y = {}^{\frac{1}{2}}\log(x) \xrightarrow{\text{translatie } (-1,3)} g(x) = {}^{\frac{1}{2}}\log(x+1) + 3.$

$\begin{cases} D = \langle 0, \rightarrow \rangle \\ \text{V.A.: } x = 0 \end{cases} \Rightarrow \begin{cases} D_g = \langle -1, \rightarrow \rangle \\ \text{V.A.: } x = -1 \end{cases}$

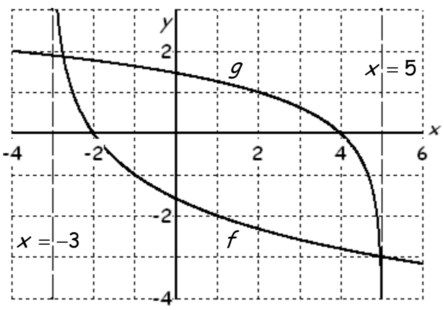
52c $y = {}^2\log(x) \xrightarrow{\text{verm. } x\text{-as } 5} y = 5 \cdot {}^2\log(x) \xrightarrow{\text{translatie } (2,0)} h(x) = 5 \cdot {}^2\log(x-2).$

$\begin{cases} D = \langle 0, \rightarrow \rangle \\ \text{V.A.: } x = 0 \end{cases} \Rightarrow \begin{cases} D = \langle 0, \rightarrow \rangle \\ \text{V.A.: } x = 0 \end{cases} \Rightarrow \begin{cases} D_h = \langle 2, \rightarrow \rangle \\ \text{V.A.: } x = 2 \end{cases}$

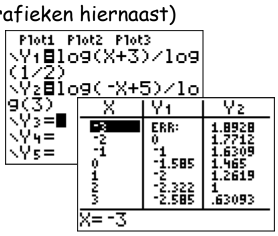
OMGEKEERD KAN OOK: eerst de translatie (2, 0) en dan verm. t.o.v. de x-as met 5.

52d $y = {}^{\frac{1}{3}}\log(x) \xrightarrow{\text{verm. } x\text{-as } -2} y = -2 \cdot {}^{\frac{1}{3}}\log(x) \xrightarrow{\text{translatie } (0,-4)} k(x) = -2 \cdot {}^{\frac{1}{3}}\log(x) - 4.$

$\begin{cases} D = \langle 0, \rightarrow \rangle \\ \text{V.A.: } x = 0 \end{cases} \Rightarrow \begin{cases} D = \langle 0, \rightarrow \rangle \\ \text{V.A.: } x = 0 \end{cases} \Rightarrow \begin{cases} D_k = \langle 0, \rightarrow \rangle \\ \text{V.A.: } x = 0 \end{cases}$



53a Maak een tabel op de GR en dan de grafiek. (zie de grafieken hiernaast)
$D_f = \langle -3, \rightarrow \rangle$ (want $x + 3 > 0 \Rightarrow x > -3$) en
$D_g = \langle \leftarrow, 5 \rangle$ (want $-x + 5 > 0 \Rightarrow -x > -5 \Rightarrow x < 5$).
(de verticale asymptoten zijn de lijnen $x = -3$ en $x = 5$)
Stippel de asymptoten in de grafiek.



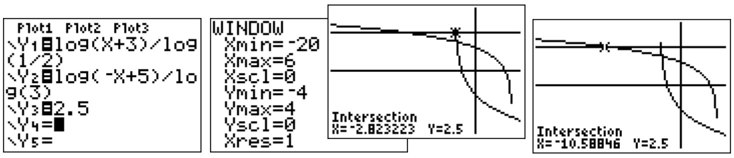
GA DIT ZELF NA

53b $^{\frac{1}{2}}\log(x+3)=5$
$x+3=\left(\frac{1}{2}\right)^5=\frac{1}{32}$
$x=-2\frac{31}{32}$.

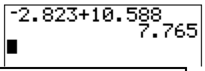
53c $g(-4)={}^3\log(9)={}^3\log(3^2)=2$ (of met TABLE).
Voor $x\ge -4$ is $g(x)\le 2$ (gebruik de grafiek).

53d $^{\frac{1}{2}}\log(x+3)=1$
$x+3=\left(\frac{1}{2}\right)^1=\frac{1}{2}$
$x=-2\frac{1}{2}$. Met de grafiek: $f(x)\ge 1$ voor $-3<x\le -2\frac{1}{2}$.

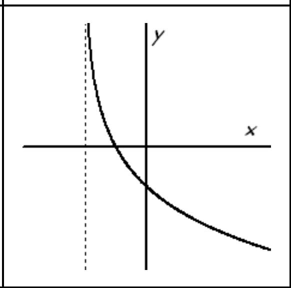
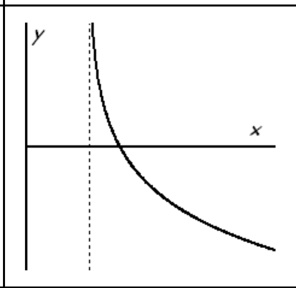
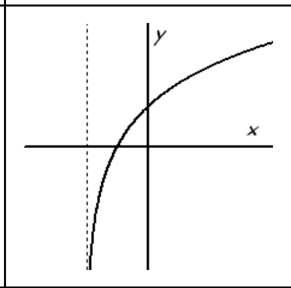
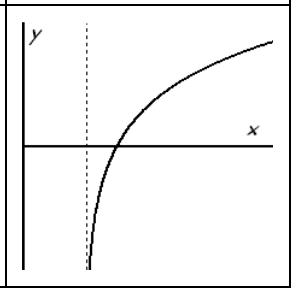
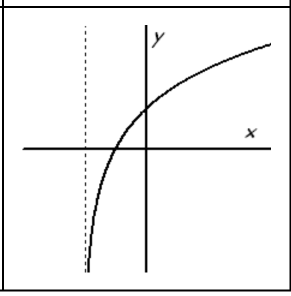
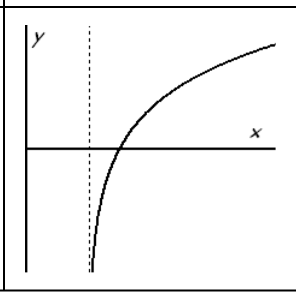
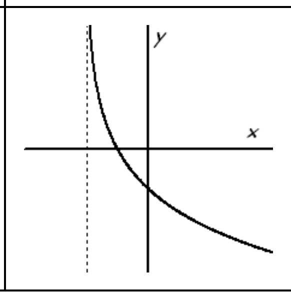
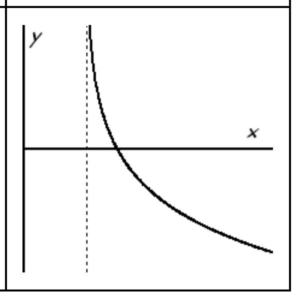
53e $f(x)=g(x)$ (intersect) $\Rightarrow x\approx -2{,}72 \vee x\approx 4{,}96$.
$f(x)\le g(x)$ geeft $-2{,}72\le x\le 4{,}96$ (gebruik de grafiek).



53f $f(x)=2{,}5$ (intersect) $\Rightarrow x\approx -2{,}823$.
$g(x)=2{,}5$ (intersect) $\Rightarrow x\approx -10{,}588$.
De lengte van lijnstuk $AB\approx -2{,}823 - -10{,}588\approx 7{,}77$.

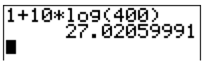


54

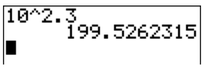
	$y=a\cdot {}^g\log(x+b)$ (met verticale asymptoot $x=-b$)			
	$a>0$		$a<0$	
	$b>0$	$b<0$	$b>0$	$b<0$
$0<g<1$				
$g>1$				

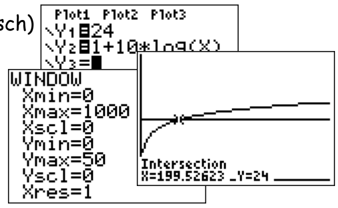
55a $21=1+k\cdot\log(100)$
$20=k\cdot\log(10^2)=k\cdot 2$
$10=k$.

55b din $=1+10\cdot\log(400)\approx 27$.
Dus 27 DIN.

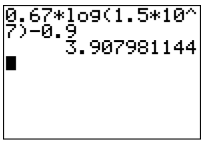


55c $24=1+10\cdot\log(\text{iso})$ (intersect of algebraïsch)
$23=10\cdot\log(\text{iso})$
$\log(\text{iso})=2{,}3$
iso $=10^{2{,}3}\approx 200$.
Dus 200 ISO/ASA.

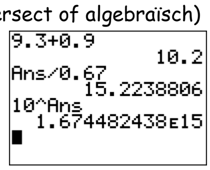


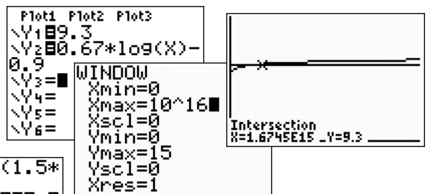


56a $E=1{,}5\cdot 10^7$ (kJ) geeft $R=0{,}67\cdot\log(1{,}5\cdot 10^7)-0{,}9\approx 3{,}9$.

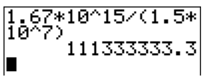


56b $9{,}3=0{,}67\cdot\log(E)-0{,}9$ (intersect of algebraïsch)
$10{,}2=0{,}67\cdot\log(E)$
$\log(E)=\frac{10{,}2}{0{,}67}\approx 15{,}22$
$E\approx 10^{15{,}22}\approx 1{,}67\cdot 10^{15}$ (kJ).





56c $\frac{1{,}67\cdot 10^{15}}{1{,}5\cdot 10^7}\approx 110\,000\,000$. Dus ongeveer 110 miljoen keer zo sterk.



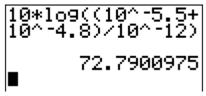
57 Nee, want vanaf 150 decibel moet je rekenen op ernstige beschadigingen van je gehoororganen en dat is bij tien pratende leerlingen niet.

58 $10\cdot\log\left(\frac{I_{\text{vrachtwagen}}}{I_0}\right)=65$ (dB)
$\log\left(\frac{I_{\text{vrachtwagen}}}{10^{-12}}\right)=6{,}5$
$\frac{I_{\text{vrachtwagen}}}{10^{-12}}=10^{6{,}5}$
$I_{\text{vrachtwagen}}=10^{6{,}5}\cdot 10^{-12}=10^{-5{,}5}$ (W/m^2).

$10\cdot\log\left(\frac{I_{\text{trein}}}{I_0}\right)=72$ (dB)
$\log\left(\frac{I_{\text{trein}}}{10^{-12}}\right)=7{,}2$
$\frac{I_{\text{trein}}}{10^{-12}}=10^{7{,}2}$
$I_{\text{trein}}=10^{-4{,}8}$ (W/m^2).

$I_{\text{totaal}}=10^{-5{,}5}+10^{-4{,}8}$ (W/m^2)
$L=10\cdot\log\left(\frac{10^{-5{,}5}+10^{-4{,}8}}{10^{-12}}\right)\approx 73$ (dB).
Het geluidsniveau stijgt met $73-65=8$ dB.

FORMULE HOEF JE NIET TE KENNEN



59a Geluidsintensiteit $I = 10^{-5}$ (W/m^2) $\Rightarrow$ geluidsniveau $L = 10 \cdot \log\left(\frac{10^{-5}}{10^{-12}}\right) = 70$ (dB).

Geluidsintensiteit $I = 0{,}25 \cdot 10^{-5}$ (W/m^2) $\Rightarrow$ geluidsniveau $L = 10 \cdot \log\left(\frac{0{,}25 \cdot 10^{-5}}{10^{-12}}\right) \approx 64$ (dB).

Het geluidsniveau daalt dus met ongeveer 6 dB.

```
10*log(10^-5/10^-12)
                  70
10*log(0.25*10^-5/10^-12)
         63.97940009
```

59b In een open ruimte de afstand tot de geluidsnorm verdubbelen $\Rightarrow$ geluidsintensiteit wordt het vierde deel (gegeven).
Daarna in 59a aangetoond dat het geluidsniveau dan met ongeveer 6 dB daalt.
Nog een keer verdubbelen van de afstand betekent dat het geluidsniveau ook nog eens met ongeveer 6 dB daalt.
Het geluidsniveau op $120 = 2 \times (2 \times 30)$ meter is dan ongeveer $85 - 6 - 6 = 73$ dB.

60

$10 \cdot \log\left(\frac{I_{5\text{ boxen}}}{I_0}\right) = 80$ (dB)

$\log\left(\frac{I_{5\text{ boxen}}}{10^{-12}}\right) = 8$

$\frac{I_{5\text{ boxen}}}{10^{-12}} = 10^8$

$I_{5\text{ boxen}} = 10^8 \cdot 10^{-12} = 10^{-4}$ (W/m^2).

Dus $I_{1\text{ box}} = \frac{10^{-4}}{5} = 0{,}2 \cdot 10^{-4}$ (W/m^2).

$10 \cdot \log\left(\frac{I_{\text{totaal}}}{I_0}\right) = 90$ (dB)

$\log\left(\frac{I_{\text{totaal}}}{10^{-12}}\right) = 9$

$\frac{I_{\text{totaal}}}{10^{-12}} = 10^9$

$I_{\text{totaal}} = 10^9 \cdot 10^{-12} = 10^{-3}$ (W/m^2).

Er komen totaal $\frac{10^{-3}}{0{,}2 \cdot 10^{-4}} = 50$ boxen $\Rightarrow$ 45 boxen er nog bij plaatsen.

61a $\frac{100\,000}{10} = 10\,000$, dus de walvis is 10 000 keer zo zwaar als de wasbeer.
$\frac{100\,000}{0{,}002} = 50\,000\,000$, dus de walvis is 50 000 000 keer zo zwaar als de kolibri.

```
100000/10
               10000
100000/0.002
            50000000
```

61b 100 000 kg = 100 000 000 gram $\Rightarrow$ de getallenlijn moet 100 000 000 mm = 100 000 m = 100 km lang worden.

61c De getallenlijn moet nu 100 mm = 10 cm lang worden.
De eerste acht gewichten komen dan binnen de eerste 0,6 mm en zijn dan niet meer te onderscheiden.

62 $\log(0{,}002) \approx -2{,}7$
$\log(0{,}02) \approx -1{,}7$
$\log(0{,}1) = -1$

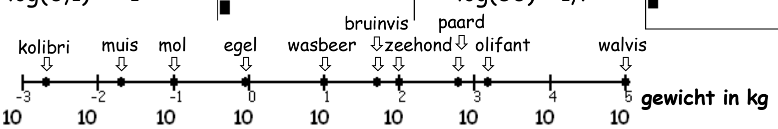
```
log(0.002)
        -2.698970004
log(0.02)
        -1.698970004
log(0.1)
                  -1
```

$\log(0{,}9) \approx -0{,}05$
$\log(10) = 1$
$\log(50) \approx 1{,}7$

```
log(0.9)
        -.0457574906
log(10)
                   1
log(50)
         1.698970004
```

$\log(100) = 2$
$\log(600) \approx 2{,}8$
$\log(1500) \approx 3{,}2$
$\log(100\,000) = 5$

```
log(100)
                   2
log(600)
          2.77815125
log(1500)
         3.176091259
log(100000)
                   5
```



63a $\log(0{,}135) \approx -0{,}9$
$\log(0{,}15) \approx -0{,}8$
$\log(3{,}5) \approx 0{,}5$

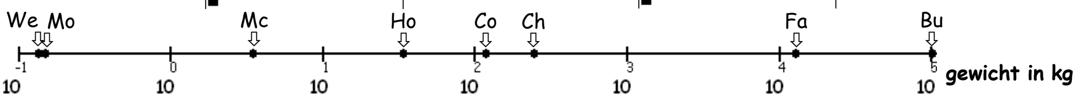
```
log(0.135)
        -.8696662315
log(0.15)
        -.8239087409
log(3.5)
         .5440680444
```

$\log(34) \approx 1{,}5$
$\log(119) \approx 2{,}1$
$\log(245) \approx 2{,}4$

```
log(34)
         1.531478917
log(119)
         2.075546961
log(245)
         2.389166084
```

$\log(12\,860) \approx 4{,}1$
$\log(102\,300) \approx 5{,}0$

```
log(12860)
         4.109240969
log(102300)
         5.009875634
```



63b $\log(G) = -0{,}04 \Rightarrow G = 10^{-0{,}04} \approx 0{,}9$ (kg) $\Rightarrow$ de Technopower radial weegt ongeveer 0,9 kg.
$\log(G) = 3{,}1 \Rightarrow G = 10^{3{,}1} \approx 1260$ (kg) $\Rightarrow$ de Allison V-3420 weegt ongeveer 1260 kg.

```
10^-0.04
         .9120108394
10^3.1
         1258.925412
```

64 $\log(88) \approx 1{,}9$
$\log(225) \approx 2{,}4$
$\log(365) \approx 2{,}6$

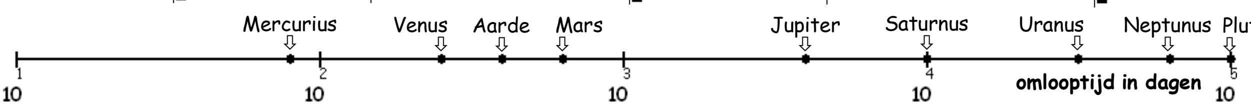
```
log(88)
         1.944482672
log(225)
         2.352182518
log(365)
         2.562292864
```

$\log(687) \approx 2{,}8$
$\log(11{,}86 \cdot 365) \approx 3{,}6$
$\log(29{,}46 \cdot 365) \approx 4{,}0$

```
log(687)
         2.836956737
log(11.86*365)
         3.636377553
log(29.46*365)
         4.031525607
```

$\log(84{,}08 \cdot 365) \approx 4{,}5$
$\log(164{,}8 \cdot 365) \approx 4{,}8$
$\log(248{,}4 \cdot 365) \approx 5{,}0$

```
log(84.08*365)
         4.486985567
log(164.8*365)
         4.779250072
log(248.4*365)
         4.957444456
```



65a A: 1,3 B: 7,5 C: 23 D: 55 E: 150 F: 2 400.

65b Wel bij 550 210 9,5 en 2,4. Niet bij 310 49 1,25 en 0.

65c A: 1300 B: 7 500 C: 23 000 D: 55 000 E: 150 000 F: 2 400 000.

66a Tong: minimale aanvoer 11000×1000 kg = 11 miljoen kg en maximale aanvoer 25000×1000 kg = 25 miljoen kg.

66b In 2001 werd 53000×1000 kg = 53 miljoen kg schol aangevoerd en 2900×1000 kg = 2,9 miljoen kg tarbot.
Dus $\frac{53}{2{,}9} \approx 18$ keer zoveel.

```
53/2.9
         18.27586207
```

66c In 2003 werd 13500×1000 kg $= 13{,}5$ miljoen kg tong aangevoerd en in 1994 was dat 25 miljoen kg (zie 66a).
Dus in 2003 is het $\frac{25-13{,}5}{25} \times 100\% = 46\%$ minder dan in 1994.

```
(25-13.5)/25*100
                46
```

66d De grootste waarde (schol in 1994) is 66000×1000 kg $= 66$ miljoen kg $\Rightarrow$ de grafiek zou 66 cm hoog worden.

67ac Haal de waarden uit de tabel (op de GR) hieronder.

```
Plot1 Plot2 Plot3
\Y1=3^X
\Y2=4*3^X
\Y3=3*4^X
\Y4=5000*0.6^X
\Y5=
\Y6=
\Y7=
```

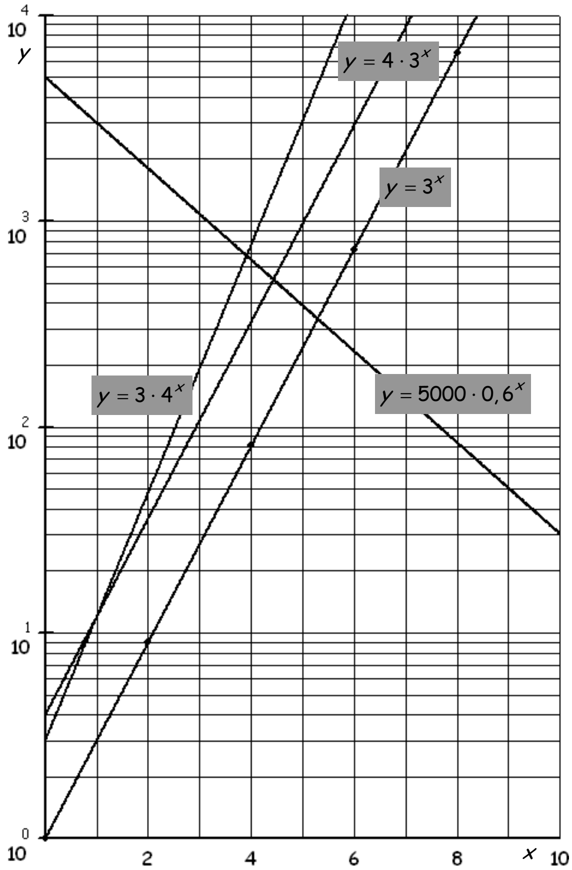
X	Y1	Y2
0	1	4
2	9	36
4	81	324
6	729	2916
8	6561	26244
10	59049	236196
12	531441	2.13E6

X=0

X	Y3	Y4
0	3	5000
2	48	1800
4	768	648
6	12288	233.28
8	196608	83.981
10	3.15E6	30.233
12	5.03E7	10.884

Y4=5000

67bc Zie de grafieken op het logaritmisch papier hiernaast.
De grafieken worden rechte lijnen.



68a Rechte lijn op logaritmisch papier $\Rightarrow N = b \cdot g^t$.
Lijn door $(1, 30)$ en $(7, 400)$, dus

$g_{6\text{ dagen}} = \frac{400}{30} \Rightarrow g_{\text{dag}} = \left(\frac{400}{30}\right)^{\frac{1}{6}} \approx 1{,}540.$

$\left.\begin{array}{l} N = b \cdot 1{,}540^t \\ \text{door } (1, 30) \end{array}\right\} \Rightarrow 30 = b \cdot 1{,}540^1$

$b = \frac{30}{1{,}540} \approx 19{,}5.$

```
400/30
       13.33333333
Ans^(1/6)
       1.539890322
30/Ans
       19.48190698
```

Dus $N = 19{,}5 \cdot 1{,}540^t$.

68b Rechte lijn op logaritmisch papier $\Rightarrow N = b \cdot g^t$.
Lijn door $(2, 100)$ en $(6, 20)$, dus

$g_{4\text{ dagen}} = \frac{20}{100} = 0{,}2 \Rightarrow g_{\text{dag}} = 0{,}2^{\frac{1}{4}} \approx 0{,}669.$

$\left.\begin{array}{l} N = b \cdot 0{,}669^t \\ \text{door } (2, 100) \end{array}\right\} \Rightarrow 100 = b \cdot 0{,}669^2$

$b = \frac{100}{0{,}669^2} \approx 224.$

```
20/100
                .2
Ans^(1/4)
        .668740305
100/Ans²
       223.6067977
```

Dus $N = 224 \cdot 0{,}669^t$.

69a De grafieken van B en C zijn rechte lijnen (op logaritmisch papier), dus daar hoort exponentiële groei bij.

Grafiek B door $(0, 60)$ en $(5, 80) \Rightarrow g_{5\text{ dagen}} = \frac{80}{60} \Rightarrow g_{\text{dag}} = \left(\frac{80}{60}\right)^{\frac{1}{5}} \approx 1{,}059 \Rightarrow L = 60 \cdot 1{,}059^t$.

```
80/60
       1.333333333
Ans^(1/5)
       1.059223841
```

Grafiek C door $(5, 40)$ en $(25, 300) \Rightarrow$ dus $g_{20\text{ dagen}} = \frac{300}{40} = 7{,}5 \Rightarrow g_{\text{dag}} = 7{,}5^{\frac{1}{20}} \approx 1{,}106$

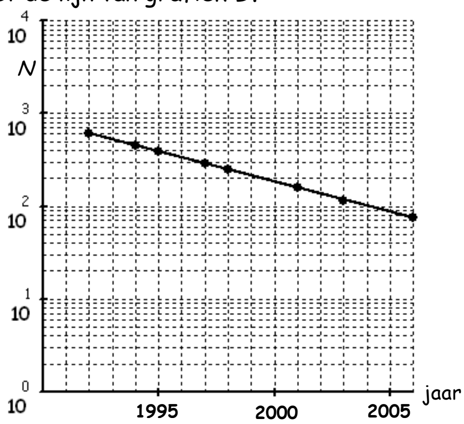
$L = b \cdot 1{,}106^5$ door $(5, 40) \Rightarrow 40 = b \cdot 1{,}106^5 \Rightarrow b = \frac{40}{1{,}106^5} \approx 24 \Rightarrow L = 24 \cdot 1{,}106^t$.

```
300/40
               7.5
Ans^(1/20)
       1.105994744
40/Ans^5
       24.17100318
```

69b Teken in het ▸werkboek de lijn door $(5, 30)$ en $(25, 400)$. ZELF DOEN

69c Teken in het ▸werkboek de lijn door $(10, 50)$ die evenwijdig loopt met de lijn van grafiek B.

70a Teken in het ▸werkboek met de gegevens uit de tabel 8 punten.
Deze punten liggen vrijwel op een rechte lijn. (zie hiernaast)
Dus het aantal patrijzen neemt exponentieel af.



70b Lijn (op logaritmisch papier) door $(2, 610)$ en $(16, 75)$, dus $N = b \cdot g^t$

$g_{14\text{ jaar}} = \frac{75}{610} \Rightarrow g_{\text{jaar}} = \left(\frac{75}{610}\right)^{\frac{1}{14}} \approx 0{,}861.$

$\left.\begin{array}{l} N = b \cdot 0{,}861^t \\ \text{door } (2, 610) \end{array}\right\} \Rightarrow 610 = b \cdot 0{,}861^2$

$b = \frac{610}{0{,}861^2} \approx 823.$

```
75/610
       .1229508197
Ans^(1/14)
       .8609557211
610/Ans²
       822.9400571
```

Dus $N = 823 \cdot 0{,}861^t$ ($t = 0$ in 1990).

71a Teken in het ▸werkboek met de gegevens uit de tabel 7 punten. Ze liggen vrijwel op een rechte lijn (ga dit zelf na).

71b Lijn (op logaritmisch papier) door $(1, 10)$ en $(19; 0{,}5)$, dus $C = b \cdot g^t$

$g_{18\text{ uren}} = \frac{0{,}5}{10} = 0{,}05 \Rightarrow g_{\text{uur}} = 0{,}05^{\frac{1}{18}} \approx 0{,}847.$

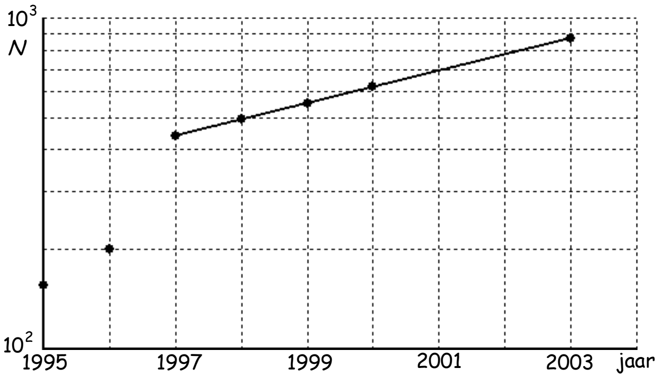
$\left.\begin{array}{l} C = b \cdot 0{,}847^t \\ \text{door } (1, 10) \end{array}\right\} \Rightarrow 10 = b \cdot 0{,}847^1 \Rightarrow b = \frac{10}{0{,}847} \approx 11{,}8 \Rightarrow C = 11{,}8 \cdot 0{,}847^t.$

```
0.5/10
               .05
Ans^(1/18)
        .846682446
10/Ans
        11.8108035
```

```
60/11.8
        5.084745763
```

71c Bij x liter bloed is de concentratie op $t = 0$ gelijk aan $\frac{60}{x}$ mg/l $\Rightarrow \frac{60}{x} = \frac{11,8}{1} \Rightarrow 11,8x = 60 \Rightarrow x = \frac{60}{11,8} \approx 5,1$ (liter bloed).

72a Teken in het ▸werkboek met de gegevens 7 punten.



72b Vanaf 1997 liggen de punten vrijwel op een rechte lijn.
Dus vanaf 1997 is de groei exponentieel.

72c Lijn (op logaritmisch papier) door $(2, 441)$ en $(8, 870)$

$g_{6\text{ dagen}} = \frac{870}{441} \Rightarrow g_{\text{dag}} = \left(\frac{870}{441}\right)^{\frac{1}{6}} \approx 1,12.$

$\left.\begin{array}{l} N = b \cdot 1,12^t \\ \text{door } (2, 441) \end{array}\right\} \Rightarrow 441 = b \cdot 1,12^2$

$b = \frac{441}{1,12^2} \approx 352.$

Dus $N = 352 \cdot 1,12^t$.

```
870/441
        1.972789116
Ans^(1/6)
        1.119902233
441/Ans²
        351.6238853
```

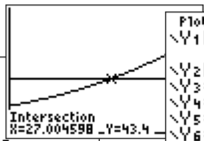
73a $21,7 \cdot 1,026^t = 21,7 \cdot 2$ (intersect) $\Rightarrow t \approx 27$ (jaar).

73b $19,6 \cdot 1,026^t = 19,6 \cdot 2$ (intersect) $\Rightarrow t \approx 27$ (jaar).

73c Verdubbelingstijd hangt niet van de beginhoeveelheid af.

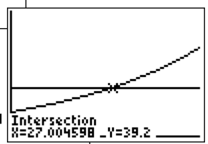
```
Plot1 Plot2 Plot3
\Y1=21.7*1.026^X
\Y2=21.7*2
\Y3=
```

```
WINDOW
 Xmin=0
 Xmax=50
 Xscl=0
 Ymin=0
 Ymax=100
 Yscl=0
 Xres=1
```




```
Plot1 Plot2 Plot3
\Y1=19.6*1.026^X
\Y2=19.6*2
\Y3=
\Y4=
\Y5=
\Y6=
```

```
WINDOW
 Xmin=0
 Xmax=50
 Xscl=0
 Ymin=0
 Ymax=100
 Yscl=0
 Xres=1
```



74 $g_{\text{jaar}} = 0,88 \Rightarrow g_{\text{maand}} = 0,88^{\frac{1}{12}}.$

$\left(0,88^{\frac{1}{12}}\right)^T = \frac{1}{2}$ (T in maanden) $\Rightarrow T = {}^{0,88^{\frac{1}{12}}}\log(\frac{1}{2}) = \frac{\log(\frac{1}{2})}{\log(0,88^{\frac{1}{12}})} \approx 65$ (maanden).

```
log(1/2)/log(0.8
8^(1/12))
        65.06725175
```

75a $1,131^T = 2$ (intersect of) $\Rightarrow T = {}^{1,131}\log(2) = \frac{\log(2)}{\log(1,131)} \approx 5,63$ (jaar).
De verdubbelingstijd is 5 jaar en 8 maanden.

75b $0,915^T = \frac{1}{2}$ (intersect of) $\Rightarrow T = {}^{0,915}\log(\frac{1}{2}) = \frac{\log(\frac{1}{2})}{\log(0,915)} \approx 7,80$ (weken).
De halveringstijd is 7 weken en 6 dagen.

```
(100+13.1)/100
              1.131
log(2)/log(1.131
)
        5.630664575
(Ans-5)*12
        7.567974905
```

```
(100-8.5)/100
               .915
log(1/2)/log(0.9
15)
        7.802968705
(Ans-7)*7
        5.620780933
```

76a $1,011^T = 2$ (intersect of) $\Rightarrow T = {}^{1,011}\log(2) = \frac{\log(2)}{\log(1,011)} \approx 63,4$ (jaar).

76b $1,083^T = 2$ (intersect of) $\Rightarrow T = {}^{1,083}\log(2) = \frac{\log(2)}{\log(1,083)} \approx 8,7$ (blokken van 10 jaar).
De verdubbelingstijd is 87 jaar.

```
(100+1.1)/100
              1.011
log(2)/log(1.011
)
        63.35932173
```

```
(100+8.3)/100
              1.083
log(2)/log(1.083
)
        8.693139256
Ans*10
        86.93139256
```

77a $0,917^T = \frac{1}{2}$ (intersect of) $\Rightarrow T = {}^{0,917}\log(\frac{1}{2}) = \frac{\log(\frac{1}{2})}{\log(0,917)} \approx 8$ (dagen).

77b $0,917^T = \frac{10}{100} = 0,1$ (intersect of) $\Rightarrow T = {}^{0,917}\log(0,1) = \frac{\log(0,1)}{\log(0,917)} \approx 27$ (dagen).

```
(100-8.3)/100
               .917
log(1/2)/log(0.9
17)
        7.999592912
```

```
log(0.1)/log(0.9
17)
        26.57407244
```

78a $g_{10\text{ dagen}} = 2 \Rightarrow g_{\text{dag}} = 2^{\frac{1}{10}} \approx 1,072 \Rightarrow$ het groeipercentage per dag is 7,2.

78b $g_{25\text{ jaar}} = 2 \Rightarrow g_{\text{jaar}} = 2^{\frac{1}{25}} \approx 1,028 \Rightarrow$ het groeipercentage per jaar is 2,8.

78c $g_{28\text{ jaar}} = \frac{1}{2} \Rightarrow g_{\text{jaar}} = \left(\frac{1}{2}\right)^{\frac{1}{28}} \approx 0,976 \Rightarrow$ de afname per jaar is 2,4%.

```
2^(1/10)
        1.071773463
Ans*100-100
        7.177346254
```

```
2^(1/25)
        1.028113827
Ans*100-100
        2.811382666
```

```
(1/2)^(1/28)
         .9755486421
Ans*100-100
        -2.445135795
```

79 Periode 0-1500: $g_{1500\text{ jaar}} = 2 \Rightarrow g_{\text{jaar}} = 2^{\frac{1}{1500}} \approx 1,0005 \Rightarrow$ de toename per jaar is 0,05%.
1500-1800: $g_{300\text{ jaar}} = 2 \Rightarrow g_{\text{jaar}} = 2^{\frac{1}{300}} \approx 1,0023 \Rightarrow$ de toename per jaar is 0,23%.
1800-1950: $g_{150\text{ jaar}} = 2 \Rightarrow g_{\text{jaar}} = 2^{\frac{1}{150}} \approx 1,0046 \Rightarrow$ de toename per jaar is 0,46%.
1950-1986: $g_{36\text{ jaar}} = 2 \Rightarrow g_{\text{jaar}} = 2^{\frac{1}{36}} \approx 1,0194 \Rightarrow$ de toename per jaar is 1,94%.
1986-2005: $g_{19\text{ jaar}} = \frac{4,8+1,7}{4,8} = \frac{6,5}{4,8} \Rightarrow g_{\text{jaar}} = \left(\frac{6,5}{4,8}\right)^{\frac{1}{19}} \approx 1,0161 \Rightarrow$ de toename per jaar is 1,61%.

```
2^(1/1500)
        1.000462205
Ans*100-100
        .0462204904
2^(1/300)
        1.002313162
```

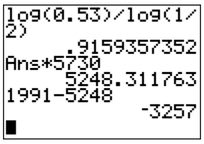
```
2^(1/150)
        1.004631674
2^(1/36)
        1.019440644
```

```
4.8+1.7
                6.5
Ans/4.8
        1.354166667
Ans^(1/19)
        1.016085167
```

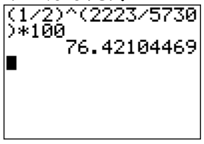
80 $\left(\frac{1}{2}\right)^{\tau} = 0{,}53 \Rightarrow$ het aantal halveringstijden is $\tau = {}^{\frac{1}{2}}\log(0{,}53) = \frac{\log(0{,}53)}{\log(\frac{1}{2})} \approx 0{,}9159.$

$Ans \times 5730 \approx 5248 \Rightarrow$ Ötzi was in 1991 waarschijnlijk al 5248 jaar overleden.

$1991 - 5248 = -3257 \Rightarrow$ Ötzi is waarschijnlijk overleden in 3257 voor Christus.

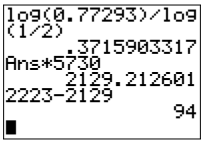


81a $2006 + 217 = 2223 \Rightarrow$ het aantal halveringstijden is $\tau = \frac{2223}{5730} \Rightarrow$ van ${}^{14}_{6}C$ was nog $\left(\frac{1}{2}\right)^{\frac{2223}{5730}} \cdot 100 \approx 76{,}421\%$ over.



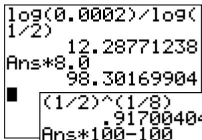
81b $\left(\frac{1}{2}\right)^{\tau} = 0{,}77293 \Rightarrow \tau = {}^{\frac{1}{2}}\log(0{,}77293) = \frac{\log(0{,}77293)}{\log(\frac{1}{2})} \approx 0{,}3716.$

$Ans \times 5730 \approx 2129$ (jaar) $\Rightarrow$ het verschil is $2223 - 2129 = 94$ jaar.

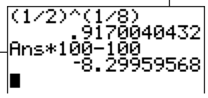


82a $\left(\frac{1}{2}\right)^{\tau} = 0{,}0002 \Rightarrow$ het aantal halveringstijden $\tau = {}^{\frac{1}{2}}\log(0{,}0002) = \frac{\log(0{,}0002)}{\log(\frac{1}{2})} \approx 12{,}3.$

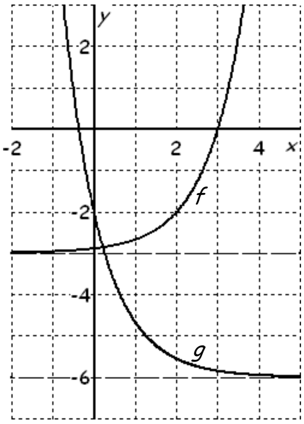
Na $Ans \times 8{,}0 \approx 98$ dagen was nog maar 0,02% van het radioactief jodium over.



82b $g_{8 \text{ dagen}} = \frac{1}{2}$ of $\left(g_{\text{dag}}\right)^{8} = \frac{1}{2} \Rightarrow g_{\text{dag}} = \left(\frac{1}{2}\right)^{\frac{1}{8}} \approx 0{,}917 \Rightarrow$ per dag verdwijnt 8,3%.



Diagnostische toets



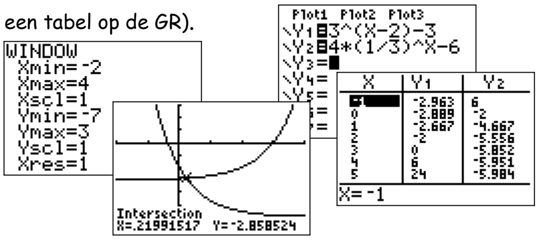
D1ac $y = 3^x \xrightarrow{\text{translatie } (2,-3)} f(x) = 3^{x-2} - 3.$

$B = \langle 0, \rightarrow \rangle \quad \Rightarrow \quad B_f = \langle -3, \rightarrow \rangle$

$y = (\frac{1}{3})^x \xrightarrow{\text{verm. } x\text{-as, } 4} y = 4 \cdot (\frac{1}{3})^x \xrightarrow{\text{translatie } (0,-6)} g(x) = 4 \cdot (\frac{1}{3})^x - 6.$

$B = \langle 0, \rightarrow \rangle \quad \Rightarrow \quad B = \langle 0, \rightarrow \rangle \quad \Rightarrow \quad B_g = \langle -6, \rightarrow \rangle$

D1b Zie de grafieken hiernaast (maak eerst een tabel op de GR).



D1d $f(x) = g(x)$ (intersect) $\Rightarrow x \approx 0{,}22.$
In de grafiek (of een plot) lees je dan af:
$f(x) \geq g(x)$ voor $x \geq 0{,}22.$

D1e $4 \cdot (\frac{1}{3})^x - 6 = 6$

$4 \cdot \left(3^{-1}\right)^x = 12$

$3^{-x} = 3 = 3^1$

$-x = 1$

$x = -1.$ In de grafiek lees je dan af:
$g(x) \leq 6$ geeft $x \geq -1.$

D1f $B_f = \langle -3, \rightarrow \rangle$ en $f(4) = 3^2 - 3 = 9 - 3 = 6$ (of met TABLE).
In de grafiek lees je dan af: voor $x \leq 4$ geldt $-3 < f(x) \leq 6.$

D2a $5^{x-1} = 125 \cdot \sqrt[3]{5}$

$5^{x-1} = 5^3 \cdot 5^{\frac{1}{3}}$

$5^{x-1} = 5^{3\frac{1}{3}}$

$x - 1 = 3\frac{1}{3}$

$x = 4\frac{1}{3}.$

D2b $3^{2x-5} = \frac{1}{27} \cdot \sqrt{3}$

$3^{2x-5} = \frac{1}{3^3} \cdot 3^{\frac{1}{2}}$

$3^{2x-5} = 3^{-3} \cdot 3^{\frac{1}{2}}$

$3^{2x-5} = 3^{-2\frac{1}{2}}$

$2x - 5 = -2\frac{1}{2}$

$2x = 2\frac{1}{2}$

$x = 1\frac{1}{4}.$

D2c $2 \cdot 4^{2x-1} - 3 = 61$

$2 \cdot 4^{2x-1} = 64$

$4^{2x-1} = 32$

$\left(2^2\right)^{2x-1} = 2^5$

$2^{2\cdot(2x-1)} = 2^5$

$4x - 2 = 5$

$4x = 7$

$x = \frac{7}{4} = 1\frac{3}{4}.$

D2d $(\frac{1}{2})^{3x+1} + 6 = 6\frac{1}{8}$

$(\frac{1}{2})^{3x+1} = \frac{1}{8}$

$(\frac{1}{2})^{3x+1} = (\frac{1}{2})^3$

$3x + 1 = 3$

$3x = 2$

$x = \frac{2}{3}.$

D3a $9^{x-1} = 27^{x+1}$

$\left(3^2\right)^{x-1} = \left(3^3\right)^{x+1}$

$3^{2\cdot(x-1)} = 3^{3\cdot(x+1)}$

$2x - 2 = 3x + 3$

$-x = 5$

$x = -5.$

D3b $2^{x+2} + 2^{x-1} = 36$

$2^{x-1} \cdot 2^3 + 2^{x-1} = 36$

$8 \cdot 2^{x-1} + 1 \cdot 2^{x-1} = 36$

$9 \cdot 2^{x-1} = 36$

$2^{x-1} = 4 = 2^2$

$x - 1 = 2$

$x = 3.$

D3c $3^{x+1} = 3^x + 54$

$3^x \cdot 3^1 = 3^x + 54$

$3 \cdot 3^x = 1 \cdot 3^x + 54$

$2 \cdot 3^x = 54$

$3^x = 27 = 3^3$

$x = 3.$

D3d $2^{x^2} = (\frac{1}{8})^x$

$2^{x^2} = (\frac{1}{2^3})^x$

$2^{x^2} = \left(2^{-3}\right)^x$

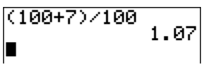
$2^{x^2} = 2^{-3\cdot x}$

$x^2 = -3x$

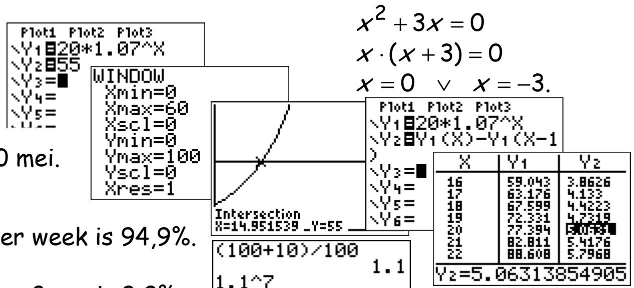
$x^2 + 3x = 0$

$x \cdot (x + 3) = 0$

$x = 0 \quad \vee \quad x = -3.$



D4a $H = 20 \cdot 1{,}07^t$ ($t = 0$ op 1 mei 0:00 uur).

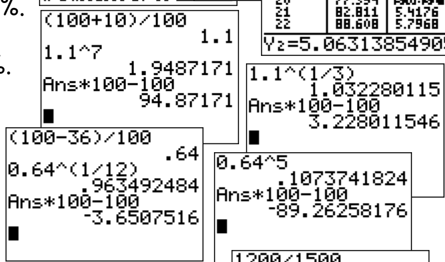


D4b $H = 20 \cdot 1{,}07^t = 55$ (intersect) $\Rightarrow t \approx 14{,}95.$ Dus op 15 mei.

D4c $t = 19$ (20 mei 0:00 uur) tot $t = 20$ (21 mei 0:00 uur). Dus op 20 mei.

D5a $g_{\text{dag}} = 1{,}1 \Rightarrow g_{\text{week}} = 1{,}1^7 \approx 1{,}949.$ Het groeipercentage per week is 94,9%.

D5b $g_{\text{dag}} = 1{,}1 \Rightarrow g_{8 \text{ uur}} = 1{,}1^{\frac{1}{3}} \approx 1{,}032.$ Het groeipercentage per 8 uur is 3,2%.

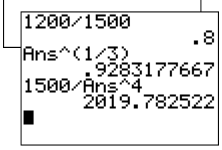


D6a $g_{\text{jaar}} = 0{,}64 \Rightarrow g_{\text{maand}} = 0{,}64^{\frac{1}{12}} \approx 0{,}963.$ De afname per maand is 3,7%.

D6b $g_{\text{jaar}} = 0{,}64 \Rightarrow g_{5 \text{ jaar}} = 0{,}64^5 \approx 0{,}107.$ De afname per 5 jaar is 89,3%.

D7 $g_{3 \text{ dagen}} = \frac{1200}{1500} = 0{,}8 \Rightarrow g_{\text{dag}} = 0{,}8^{\frac{1}{3}} \approx 0{,}928.$

$\left.\begin{array}{l} N = b \cdot 0{,}928^t \\ \text{voor } t = 4 \text{ is } N = 1500 \end{array}\right\} \Rightarrow 1500 = b \cdot 0{,}928^4 \Rightarrow b = \frac{1500}{0{,}928^4} \approx 2020.$ Dus $N = 2020 \cdot 0{,}928^t.$



D8a ${}^3\log(3 \cdot \sqrt{3}) = {}^3\log(3^1 \cdot 3^{\frac{1}{2}}) = {}^3\log(3^{1\frac{1}{2}}) = 1\frac{1}{2}.$

D8b ${}^2\log(\frac{1}{16} \cdot \sqrt[3]{2}) = {}^2\log(\frac{1}{2^4} \cdot 2^{\frac{1}{3}}) = {}^2\log(2^{-4} \cdot 2^{\frac{1}{3}}) = {}^2\log(2^{-3\frac{2}{3}}) = -3\frac{2}{3}.$

D8c $^{\frac{1}{3}}\log\left(\left(\frac{1}{3}\right)^{0,6}\right) = 0,6.$

D8d $^{2}\log\left(\frac{1}{4}\cdot\sqrt{8}\right) = {}^{2}\log\left(\frac{1}{2^2}\cdot\sqrt{2^3}\right) = {}^{2}\log\left(2^{-2}\cdot 2^{\frac{3}{2}}\right) = {}^{2}\log\left(2^{-\frac{1}{2}}\right) = -\frac{1}{2}.$

D9a $^{4}\log(2x-3) = 2$
$2x - 3 = 4^2 = 16$
$2x = 19$
$x = \frac{19}{2} = 9\frac{1}{2}.$

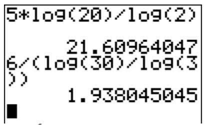
D9b $3 + {}^{3}\log(x) = 7$
$^{3}\log(x) = 4$
$x = 3^4 = 81.$

D9c $^{\frac{1}{2}}\log(x-3) = -4$
$x - 3 = \left(\frac{1}{2}\right)^{-4} = \left(2^{-1}\right)^{-4} = 2^4 = 16$
$x = 19.$

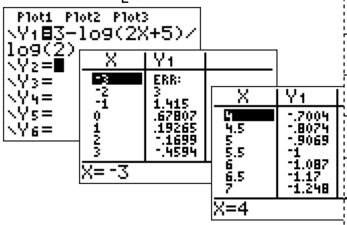
D9d $5 + 3\cdot{}^{2}\log(x) = 20$
$3\cdot{}^{2}\log(x) = 15$
$^{2}\log(x) = 5$
$x = 2^5 = 32.$

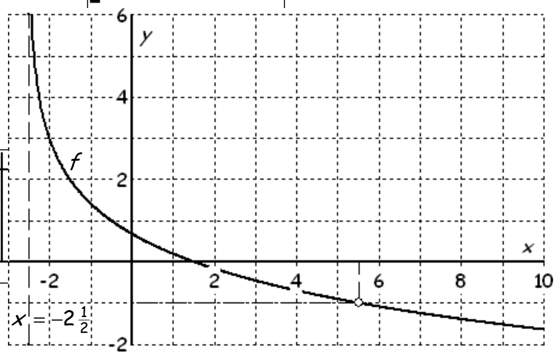
D10a $5\cdot{}^{2}\log(20) = 5\cdot\frac{\log(20)}{\log(2)} \approx 21,61.$

D10b $\frac{6}{^{3}\log(30)} = \frac{6}{\left(\frac{\log(30)}{\log(3)}\right)} \approx 1,94.$



D11a Maak eerst een tabel op de GR en dan de grafiek (zie hiernaast).
$D_f = \left\langle -2\frac{1}{2}, \rightarrow\right\rangle$ (want $2x + 5 > 0 \Rightarrow 2x > -5 \Rightarrow x > -2\frac{1}{2}$).
(de verticale asymptoot is de lijn $x = -2\frac{1}{2}$).

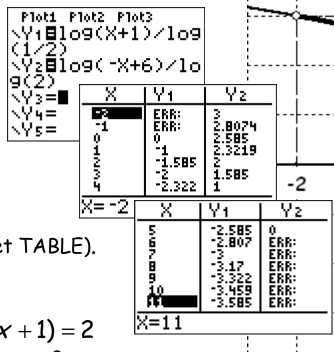


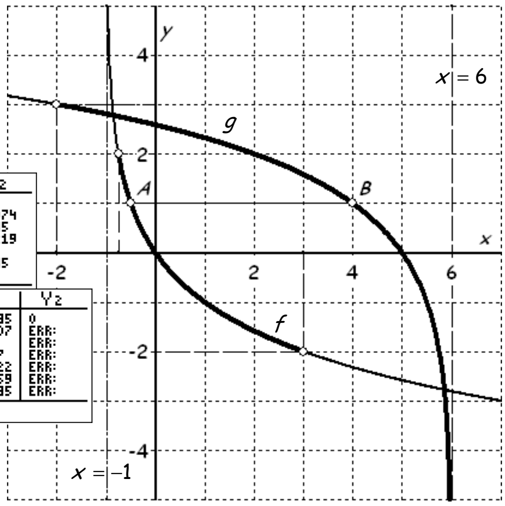


D11b $3 - {}^{2}\log(2x+5) = -2$
$-{}^{2}\log(2x+5) = -5$
$^{2}\log(2x+5) = 5$
$2x + 5 = 2^5 = 32$
$2x = 27$
$x = 13\frac{1}{2}.$
Met de grafiek vind je dan: $f(x) \geq -2$ voor $-2\frac{1}{2} < x \leq 13\frac{1}{2}.$

D11c $f(5\frac{1}{2}) = 3 - {}^{2}\log(16) = 3 - {}^{2}\log(2^4) = 3 - 4 = -1$ (of met TABLE). Voor $x \leq 5\frac{1}{2}$ is $f(x) \geq -1$ (gebruik de grafiek).

D12a Maak eerst een tabel op de GR en dan de grafiek (zie hiernaast).
$D_f = \langle -1, \rightarrow\rangle$ (want $x + 1 > 0 \Rightarrow x > -1$) en
$D_g = \langle \leftarrow, 6\rangle$ (want $-x + 6 > 0 \Rightarrow -x > -6 \Rightarrow x < 6$).
(de verticale asymptoten zijn de lijnen $x = -1$ en $x = 6$).





D12b $^{\frac{1}{2}}\log(x+1) = 4$
$x + 1 = \left(\frac{1}{2}\right)^4 = \frac{1}{16}$
$x = -\frac{15}{16}.$

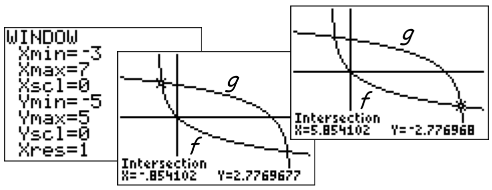
D12c $g(-2) = {}^{2}\log(2+6) = {}^{2}\log(8) = {}^{2}\log(2^3) = 3$ (of met TABLE).
Voor $x \geq -2$ is $g(x) \leq 3$ (gebruik de grafiek).

D12d $^{\frac{1}{2}}\log(x+1) = -2$
$x + 1 = \left(\frac{1}{2}\right)^{-2} = \left(2^{-1}\right)^{-2} = 2^2 = 4$
$x = 3.$

en

$^{\frac{1}{2}}\log(x+1) = 2$
$x + 1 = \left(\frac{1}{2}\right)^2 = \frac{1}{4}$
$x = -\frac{3}{4}.$

Nu in de grafiek aflezen: $-2 \leq f(x) \leq 2$ voor $-\frac{3}{4} \leq x \leq 3.$



D12e $f(x) = g(x)$ (intersect) $\Rightarrow x \approx -0,85 \;\vee\; x \approx 5,85.$
Nu m.b.v. de grafiek: $f(x) \leq g(x)$ voor $-0,85 \leq x \leq 5,85.$

D12f $^{\frac{1}{2}}\log(x+1) = 1$
$x + 1 = \left(\frac{1}{2}\right)^1 = \frac{1}{2}$
$x = -\frac{1}{2}.$

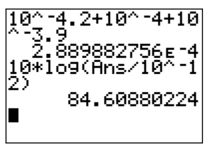
en

$^{2}\log(-x+6) = 1$
$-x + 6 = 2^1 = 2$
$-x = -4$
$x = 4 \Rightarrow$ de lengte van AB is $4 - -\frac{1}{2} = 4\frac{1}{2}.$

D13 $10\cdot\log\left(\frac{I_{\text{Jan}}}{I_0}\right) = 78$ (dB)
$\log\left(\frac{I_{\text{Jan}}}{10^{-12}}\right) = 7,8$
$\frac{I_{\text{Jan}}}{10^{-12}} = 10^{7,8}$
$I_{\text{Jan}} = 10^{7,8}\cdot 10^{-12} = 10^{-4,2}$ (W/m²).

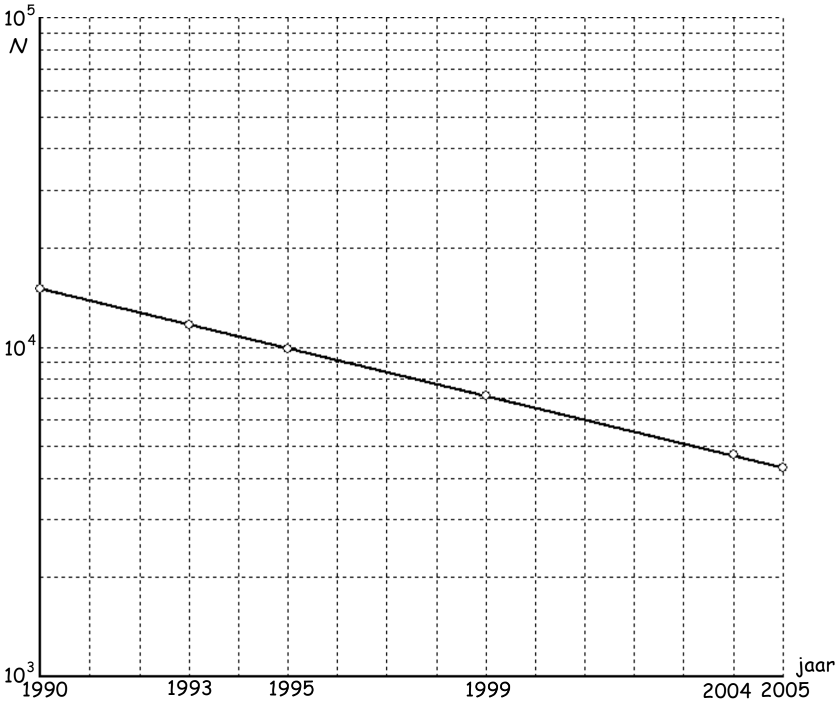
$10\cdot\log\left(\frac{I_{\text{Frits}}}{I_0}\right) = 80$ (dB)
$\log\left(\frac{I_{\text{Frits}}}{10^{-12}}\right) = 8$
$\frac{I_{\text{Frits}}}{10^{-12}} = 10^{8}$
$I_{\text{Frits}} = 10^{-4}$ (W/m²).

$10\cdot\log\left(\frac{I_{\text{Gerrit}}}{I_0}\right) = 81$ (dB)
$\log\left(\frac{I_{\text{Gerrit}}}{10^{-12}}\right) = 8,1$
$\frac{I_{\text{Gerrit}}}{10^{-12}} = 10^{8,1}$
$I_{\text{Gerrit}} = 10^{-3,9}$ (W/m²).



$I_{\text{totaal}} = 10^{-4,2} + 10^{-4} + 10^{-3,9}$ (W/m²) $\Rightarrow$ het totale geluidsniveau is $L_{\text{totaal}} = 10\cdot\log\left(\frac{10^{-4,2}+10^{-4}+10^{-3,9}}{10^{-12}}\right) \approx 85$ (dB).

D14a Teken in het ▸werkboek de gegevens uit de tabel 6 punten. (zie hieronder)

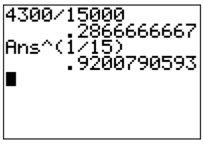


D14b Lijn op logaritmisch papier $\Rightarrow N = b \cdot g^t$.
Lijn door $(0, 15000)$ en $(15, 4300) \Rightarrow$

$g_{\text{15 jaar}} = \frac{4300}{15000} \Rightarrow g_{\text{jaar}} = \left(\frac{4300}{15000}\right)^{\frac{1}{15}} \approx 0{,}920.$

Bij $t = 0$ hoort $N = 15000 \Rightarrow b = 15000$.

Dus $N = 15000 \cdot 0{,}920^t$.



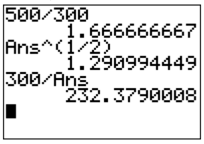
D15a Lijn op logaritmisch papier $\Rightarrow N = b \cdot g^t$.

door $(1, 300)$ en $(3, 500) \Rightarrow g = \left(\frac{500}{300}\right)^{\frac{1}{2}} \approx 1{,}291.$

$\left.\begin{array}{l} N = b \cdot 1{,}291^t \\ \text{door } (1, 300) \end{array}\right\} \Rightarrow 300 = b \cdot 1{,}291^1$

$b = \frac{300}{1{,}291} \approx 230.$

Dus $N = 230 \cdot 1{,}291^t$.



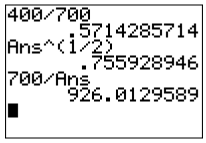
D15b Lijn op logaritmisch papier $\Rightarrow N = b \cdot g^t$.

door $(1, 700)$ en $(3, 400) \Rightarrow g = \left(\frac{400}{700}\right)^{\frac{1}{2}} \approx 0{,}756.$

$\left.\begin{array}{l} N = b \cdot 0{,}756^t \\ \text{door } (1, 700) \end{array}\right\} \Rightarrow 700 = b \cdot 0{,}756^1$

$b = \frac{700}{0{,}756} \approx 930.$

Dus $N = 930 \cdot 0{,}756^t$.



D16a $1{,}002^T = 2$ (T in maanden) $\Rightarrow T = {}^{1{,}002}\log(2) = \frac{\log(2)}{\log(1{,}002)} \approx 346{,}92$ (maanden).

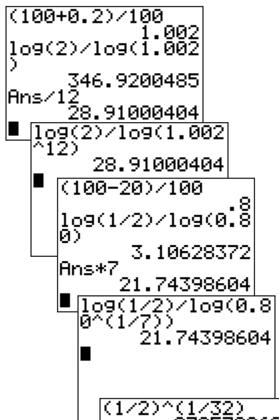
De verdubbelingstijd is ongeveer 29 jaar.

OF: $\left(1{,}002^{12}\right)^T = 2$ (T in jaren) $\Rightarrow T = {}^{(1{,}002^{12})}\log(2) = \frac{\log(2)}{\log(1{,}002^{12})} \approx 29$ (jaar).

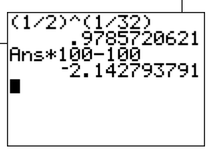
D16b $0{,}80^T = \frac{1}{2}$ (T in weken) $\Rightarrow T = {}^{0{,}80}\log(\tfrac{1}{2}) = \frac{\log(\frac{1}{2})}{\log(0{,}80)} \approx 3{,}1$ (weken).

De halveringstijd is ongeveer 22 dagen.

OF: $\left(0{,}80^{\frac{1}{7}}\right)^T = \frac{1}{2}$ (T in dagen) $\Rightarrow T = {}^{\left(0{,}80^{\frac{1}{7}}\right)}\log(\tfrac{1}{2}) = \frac{\log(\frac{1}{2})}{\log(0{,}80^{\frac{1}{7}})} \approx 29$ (dagen).



D17 $g_{\text{32 dagen}} = \frac{1}{2}$ of $\left(g_{\text{dag}}\right)^{32} = \frac{1}{2} \Rightarrow g_{\text{dag}} = \left(\frac{1}{2}\right)^{\frac{1}{32}} \approx 0{,}979 \Rightarrow$ de afname per dag is 2,1%.



Gemengde opgaven 5. Exponenten en logaritmen

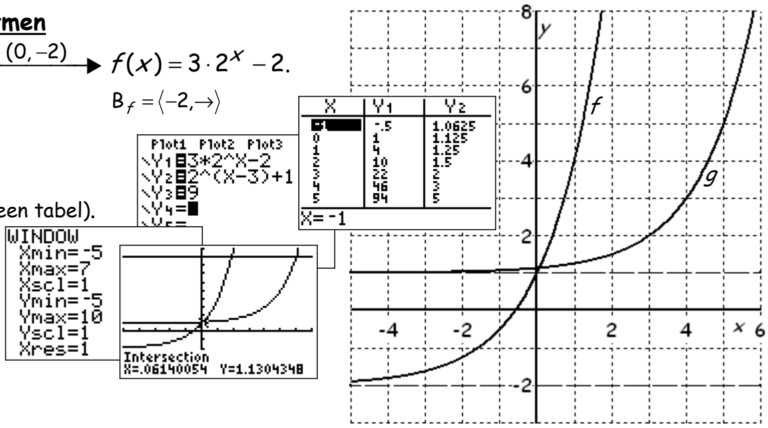
G1ab $y = 2^x \xrightarrow{\text{verm. } x\text{-as, } 3} y = 3 \cdot 2^x \xrightarrow{\text{translatie } (0, -2)} f(x) = 3 \cdot 2^x - 2.$

$\text{B} = \langle 0, \rightarrow \rangle \quad \Rightarrow \quad \text{B} = \langle 0, \rightarrow \rangle \quad \Rightarrow \quad \text{B}_f = \langle -2, \rightarrow \rangle$

$y = 2^x \xrightarrow{\text{translatie } (3,1)} g(x) = 2^{x-3} + 1.$

$\text{B} = \langle 0, \rightarrow \rangle \quad \Rightarrow \quad \text{B}_g = \langle 1, \rightarrow \rangle$

Zie de grafieken hiernaast (maak eerst op de GR een tabel).



G1c $3 \cdot 2^x - 2 = 2^{x-3} + 1$ (intersect) $\Rightarrow S(0{,}06;\ 1{,}13).$

G1d $3 \cdot 2^x - 2 = -\frac{1}{2}$

$3 \cdot 2^x = 1\frac{1}{2}$

$2^x = \frac{1}{2} = 2^{-1}$

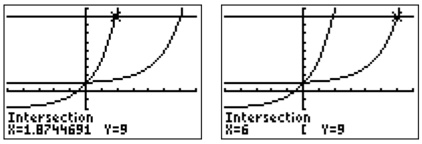
$x = -1.$

G1e $\text{B}_g = \langle 1, \rightarrow \rangle$ en $g(7) = 2^4 + 1 = 17$. Met gebruik van de grafiek vind je dan: voor $x \leq 7$ is $1 < g(x) \leq 17$.

G1f $f(x) = 9$ (intersect) $\Rightarrow x \approx 1{,}87 \Rightarrow A(1{,}87;\ 9).$

$g(x) = 9$ (intersect) $\Rightarrow x = 6 \Rightarrow B(6,\ 9).$

De lengte van lijnstuk AB is (afgerond) $6 - 1{,}87 = 4{,}13.$



G2a $(\frac{1}{2})^{x-5} - 1 = -\frac{3}{4}$

$(\frac{1}{2})^{x-5} = \frac{1}{4} = (\frac{1}{2})^2$

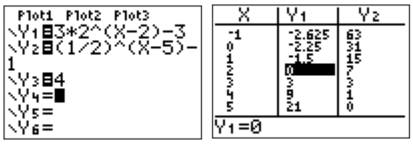
$x - 5 = 2$

$x = 7.$

G2b $\text{B}_f = \langle -3, \rightarrow \rangle$ en $f(2) = 3 \cdot 2^0 - 3 = 3 \cdot 1 - 3 = 0.$

Met een plot (of een tabel) vind je dan:

voor $x \leq 2$ is $-3 < f(x) \leq 0.$



G2c $f(-1) = 3 \cdot 2^{-3} - 3 \Rightarrow 3 \cdot \frac{1}{8} - 3 = \frac{3}{8} - 3 = -2\frac{5}{8} \Rightarrow A(-1,\ -2\frac{5}{8}).$

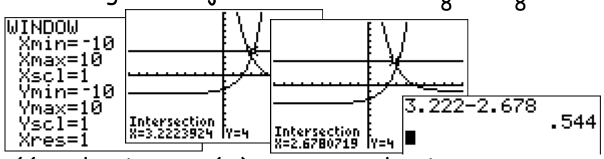
$g(-1) = (\frac{1}{2})^{-6} - 1 = \left(2^{-1}\right)^{-6} - 1 = 2^6 - 1 = 64 - 1 = 63 \Rightarrow B(-1,\ 63)$

$\Rightarrow$ de lengte van lijnstuk AB is $63 - -2\frac{5}{8} = 65\frac{5}{8}.$

G2d $f(x) = 4$ (intersect) $\Rightarrow x \approx 3{,}222 \Rightarrow P(3{,}222;\ 4).$

$g(x) = 4$ (intersect) $\Rightarrow x = 2{,}678 \Rightarrow Q(2{,}678;\ 4).$

De lengte van lijnstuk PQ is (afgeriond) $3{,}222 - 2{,}678 \approx 0{,}54.$



G2e $\text{B}_f = \langle -3, \rightarrow \rangle$ en $\text{B}_g = \langle -1, \rightarrow \rangle \Rightarrow$ voor $-3 < p \leq -1$ heeft $f(x) = p$ één oplossing en $g(x) = p$ geen oplossing.

G3a $30 - 3^{3x+1} = 3$

$-3^{3x+1} = -27$

$3^{3x+1} = 27 = 3^3$

$3x + 1 = 3$

$3x = 2$

$x = \frac{2}{3}.$

G3c $4 \cdot {}^3\log(3x - 5) = 20$

${}^3\log(3x - 5) = 5$

$3x - 5 = 3^5 = 243$

$3x = 248$

$x = \frac{248}{3} = 82\frac{2}{3}.$

G3e $2^{x^2 - 2} = 32$

$2^{x^2 - 2} = 2^5$

$x^2 - 2 = 5$

$x^2 = 7$

$x = \sqrt{7} \ \vee \ x = -\sqrt{7}.$

G3g $2 \cdot (\frac{1}{3})^{x-1} + 5 = 59$

$2 \cdot (\frac{1}{3})^{x-1} = 54$

$\left(3^{-1}\right)^{x-1} = 27$

$3^{-1 \cdot (x-1)} = 3^3$

$-x + 1 = 3$

$-x = 2$

$x = -2.$

G3b $5 \cdot 3^{2x} = 15 \cdot \sqrt[4]{3}$

$3^{2x} = 3 \cdot \sqrt[4]{3}$

$3^{2x} = 3^1 \cdot 3^{\frac{1}{4}}$

$3^{2x} = 3^{1\frac{1}{4}}$

$2x = 1\frac{1}{4} = \frac{5}{4}$

$x = \frac{5}{8}.$

G3d $6 - {}^{0,5}\log(3x) = 8$

$-{}^{0,5}\log(3x) = 2$

${}^{0,5}\log(3x) = -2$

$3x = 0{,}5^{-2} = \frac{1}{0{,}5^2}$

$3x = \frac{1}{0{,}25} = 4$

$x = \frac{4}{3} = 1\frac{1}{3}.$

G3f $2 + 3 \cdot {}^{\frac{1}{2}}\log(6x + 1) = -4$

$3 \cdot {}^{\frac{1}{2}}\log(6x + 1) = -6$

${}^{\frac{1}{2}}\log(6x + 1) = -2$

$6x + 1 = (\frac{1}{2})^{-2}$

$6x + 1 = (2^{-1})^{-2} = 2^2 = 4$

$6x = 3$

$x = \frac{1}{2}.$

G3h $4^{3x+1} = \frac{1}{8} \cdot \sqrt{2}$

$\left(2^2\right)^{3x+1} = \frac{1}{2^3} \cdot 2^{\frac{1}{2}}$

$\left(2^2\right)^{3x+1} = 2^{-3} \cdot 2^{\frac{1}{2}}$

$2^{2 \cdot (3x+1)} = 2^{-2\frac{1}{2}}$

$6x + 2 = -2\frac{1}{2}$

$6x = -4\frac{1}{2} = -\frac{9}{2}$

$x = -\frac{9}{12} = -\frac{3}{4}.$

G4a $5^{1-3x} = \frac{1}{5} \cdot \sqrt[3]{25}$

$5^{1-3x} = 5^{-1} \cdot \sqrt[3]{5^2}$

$5^{1-3x} = 5^{-1} \cdot 5^{\frac{2}{3}} = 5^{-\frac{1}{3}}$

$1 - 3x = -\frac{1}{3}$

$-3x = -\frac{4}{3}$

$x = \frac{4}{9}.$

G4b $4^{3x - x^2} = (\frac{1}{2})^{3-x}$

$\left(2^2\right)^{3x - x^2} = \left(2^{-1}\right)^{3-x}$

$2^{2 \cdot (3x - x^2)} = 2^{-1 \cdot (3-x)}$

$6x - 2x^2 = -3 + x$

$-2x^2 + 5x + 3 = 0 \ \nearrow$

abc-formule:

$x = \frac{-5 \pm \sqrt{5^2 - 4 \cdot (-2) \cdot 3}}{2 \cdot (-2)}$

$x = \frac{-5 \pm \sqrt{49}}{-4} = \frac{-5 \pm 7}{-4}$

$x = \frac{2}{-4} = -\frac{1}{2} \ \vee \ x = \frac{-12}{-4} = 3.$

G4c
$3^{x-3}+3^{x-4}=\frac{4}{3}\cdot\sqrt{3}$
$3^{x-4}\cdot 3^1+3^{x-4}=\frac{4}{3}\cdot\sqrt{3}$
$3\cdot 3^{x-4}+1\cdot 3^{x-4}=\frac{4}{3}\cdot\sqrt{3}$
$4\cdot 3^{x-4}=\frac{4}{3}\cdot\sqrt{3}$
$3^{x-4}=\frac{1}{3}\cdot\sqrt{3}=3^{-1}\cdot 3^{\frac{1}{2}}=3^{-\frac{1}{2}}$
$x-4=-\frac{1}{2}$
$x=3\frac{1}{2}.$

G4e
$(\frac{1}{3})^{x+2}=9^{2x-5}$
$\left(3^{-1}\right)^{x+2}=\left(3^2\right)^{2x-5}$
$3^{-1\cdot(x+2)}=3^{2\cdot(2x-5)}$
$-x-2=4x-10$
$-5x=-8$
$x=\frac{-8}{-5}=1\frac{3}{5}.$

G4g
$(\frac{1}{2})^{-x+2}+2^{x+3}=4\frac{1}{8}$
$\left(2^{-1}\right)^{-x+2}+2^{x+3}=4\frac{1}{8}$
$2^{x-2}+2^{x+3}=4\frac{1}{8}$
$2^{x-2}+2^{x-2}\cdot 2^5=4\frac{1}{8}$
$1\cdot 2^{x-2}+32\cdot 2^{x-2}=4\frac{1}{8}$ ↗
$33\cdot 2^{x-2}=\frac{33}{8}$
$2^{x-2}=\frac{1}{8}$
$2^{x-2}=\frac{1}{2^3}=2^{-3}$
$x-2=-3$
$x=-1.$

G4d
$3-{}^2\log(x-5)=1$
$-{}^2\log(x-5)=-2$
${}^2\log(x-5)=2$
$x-5=2^2=4$
$x=9.$

G4f
$2^{x+2}-2^{x-1}=14\cdot\sqrt{2}$
$2^{x-1}\cdot 2^3-2^{x-1}=14\cdot\sqrt{2}$
$8\cdot 3^{x-4}-1\cdot 2^{x-1}=14\cdot\sqrt{2}$
$7\cdot 2^{x-1}=14\cdot\sqrt{2}$
$2^{x-1}=2\cdot\sqrt{2}=2^1\cdot 2^{\frac{1}{2}}=2^{1\frac{1}{2}}$
$x-1=1\frac{1}{2}$
$x=2\frac{1}{2}.$

G4h
$5-3\cdot{}^{\frac{1}{3}}\log(x^2)=-1$
$-3\cdot{}^{\frac{1}{3}}\log(x^2)=-6$
${}^{\frac{1}{3}}\log(x^2)=2$
$x^2=(\frac{1}{3})^2$
$x=\pm\sqrt{(\frac{1}{3})^2}=\pm\frac{1}{3}$
$x=\frac{1}{3}\quad\vee\quad x=-\frac{1}{3}.$

G5a $g_{\text{jaar}}=1{,}096\Rightarrow g_{10\text{ jaar}}=1{,}096^{10}\approx 2{,}50$. De toename per 10 jaar is 150%.

```
(100+9.6)/100
           1.096
1.096^10
     2.500953065
Ans*100-100
     150.0953065
```

G5b $g_{\text{jaar}}=1{,}096\Rightarrow g_{\text{maand}}=1{,}096^{\frac{1}{12}}\approx 1{,}008$. De toename per maand is 0,8%.

```
1.096^(1/12)
     1.007668183
Ans*100-100
     .7668183456
```

G5c $1{,}096^T=2\Rightarrow T={}^{1{,}096}\log(2)=\frac{\log(2)}{\log(1{,}096)}\approx 7{,}56$ (jaar).
De verdubbelingstijd is 7 jaar en 7 maanden.

```
log(2)/log(1.096
)
     7.561562558
Ans-7
     .5615625581
Ans*12
     6.738750697
```

G5d $1{,}096^t=10\Rightarrow t={}^{1{,}096}\log(10)=\frac{\log(10)}{\log(1{,}096)}\approx 25{,}1$ (jaar).

```
log(10)/log(1.09
6)
      25.1189671
```

G6a $g_{\text{dag}}=0{,}83\Rightarrow g_{\text{week}}=0{,}83^7\approx 0{,}271$. De afname per week is 72,9%.

```
(100-17)/100
             .83
0.83^7
     .2713605099
Ans*100-100
    -72.86394901
```

G6b $g_{\text{dag}}=0{,}83\Rightarrow g_{\text{uur}}=0{,}83^{\frac{1}{24}}\approx 0{,}992$. De afname per uur is 0,8%.

```
0.83^(1/24)
     .9922663275
Ans*100-100
    -.7733672497
```

G6c $0{,}83^T=\frac{1}{2}\Rightarrow T={}^{0{,}83}\log(\frac{1}{2})=\frac{\log(\frac{1}{2})}{\log(0{,}83)}\approx 3{,}72$ (dagen).
De halveringstijd is 3 dagen en 17 uur.

```
log(1/2)/log(0.8
3)
      3.72000617
Ans-3
     .7200061702
Ans*24
     17.28014808
```

G6d $0{,}83^t=\frac{1}{4}\Rightarrow t={}^{0{,}83}\log(\frac{1}{4})=\frac{\log(\frac{1}{4})}{\log(0{,}83)}\approx 7{,}4$ (dagen).

```
log(1/4)/log(0.8
3)
      7.44001234
```

G7a Teken in het ▸werkboek met de gegevens uit de tabel 7 punten. Ze liggen vrijwel op een rechte lijn (ga dit zelf na).

G7b $P=b\cdot g^h$ door $(0, 1013)$ en $(4{,}750; 567)\Rightarrow g=\left(\frac{567}{1013}\right)^{\frac{1}{4{,}750}}\approx 0{,}885.$
$P=b\cdot 0{,}885^h$ door $(0, 1013)\Rightarrow P=1013\cdot 0{,}885^h.$

```
(567/1013)^(1/4.
750)
     .8849970303
Ans^(1/5)
     .9758619006
Ans*100-100
    -2.413809945
```

G7c $g_{\text{km}}=0{,}885\Rightarrow g_{200\text{ m}}=0{,}885^{\frac{1}{5}}\approx 0{,}976$. De afname per 200 m is 2,4%.

G7d $h=7{,}5\Rightarrow P=1013\cdot 0{,}885^{7{,}5}\approx 405$ (hPa).

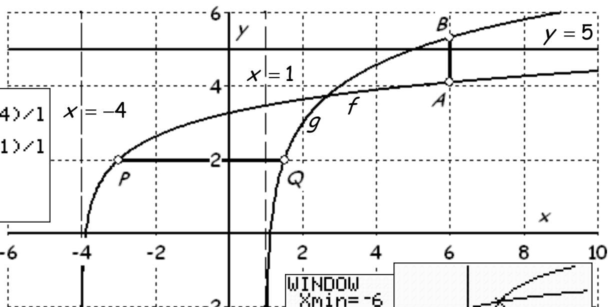
```
1013*0.885^7.5
     405.2135651
```

G8a $y={}^3\log(x)\xrightarrow{\text{Tr. }(-4,2)} f(x)={}^3\log(x+4)+2.$
$\begin{cases}D=\langle 0,\rightarrow\rangle\\ \text{V.A.: } x=0\end{cases}\Rightarrow\begin{cases}D_f=\langle -4,\rightarrow\rangle\\ \text{V.A.: } x=-4\end{cases}$

$y={}^2\log(x)\xrightarrow{\text{Tr. }(1,3)} g(x)={}^2\log(x-1)+3.$
$\begin{cases}D=\langle 0,\rightarrow\rangle\\ \text{V.A.: } x=0\end{cases}\Rightarrow\begin{cases}D_g=\langle 1,\rightarrow\rangle\\ \text{V.A.: } x=1\end{cases}$

```
  Plot1  Plot2  Plot3
\Y1=2+log(X+4)/l
og(3)
\Y2=3+log(X-1)/l
og(2)
\Y3=
```

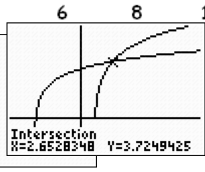
X	Y1	Y2
-3	2	ERR:
-1	3	ERR:
1	3.465	ERR:
3	3.7712	4
5	4	5
7	4.1827	5.585
9	4.3347	6
X=-3		



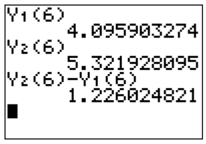
G8b Zie de grafiek hiernaast. (gebruik TABLE)

G8c $f(x)=g(x)$ (intersect) $\Rightarrow x\approx 2{,}65.$
$f(x)\geq g(x)$ (gebruik de grafiek) geeft $1<x\leq 2{,}65.$
(niet $-4\leq x\leq 2{,}65$ want voor $x\leq 1$ is er geen grafiek van g)

```
WINDOW
 Xmin=-6
 Xmax=10
 Xscl=0
 Ymin=-2
 Ymax=6
 Yscl=0
 Xres=1
```



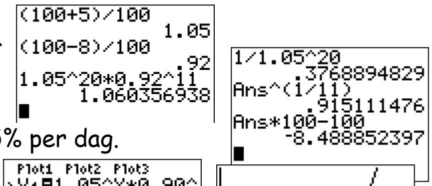
G8d $2+{}^{3}\log(x+4)=5$
$^{3}\log(x+4)=3$
$x+4=3^3=27$
$x=23.$
$2+{}^{3}\log(x+4)\le 5$ (gebruik de grafiek) geeft $-4<x\le 23$.



G8e $f(6)\approx 4{,}096$ en $g(6)\approx 5{,}322 \Rightarrow AB\approx 5{,}322-4{,}096\approx 1{,}23$.

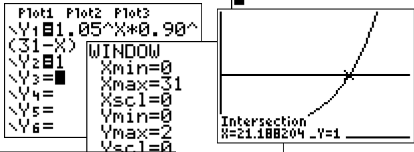
G8f $2+{}^{3}\log(x+4)=2$ en $3+{}^{2}\log(x-1)=2$
$^{3}\log(x+4)=0$ — $^{2}\log(x-1)=-1$
$x+4=3^0=1$ — $x-1=2^{-1}=\frac{1}{2}$
$x=-3\Rightarrow P(-3,\,2)$. — $x=1\frac{1}{2}\Rightarrow Q(1\frac{1}{2},\,2)$. Dus de lengte van PQ is $1\frac{1}{2}--3=4\frac{1}{2}$.

G9a Van 1 mei tot 21 mei zijn 20 dagen; van 21 mei tot en met 31 mei zijn 11 dagen.
Op 31 mei zijn er $1\cdot 1{,}05^{20}\cdot 0{,}92^{11}\approx 1{,}06$ miljoen bacteriën.



G9b $1{,}05^{20}\cdot g^{11}=1\Rightarrow g^{11}=\frac{1}{1{,}05^{20}}\Rightarrow g=\left(\frac{1}{1{,}05^{20}}\right)^{\frac{1}{11}}\approx 0{,}915$. Dus een afname van 8,5% per dag.

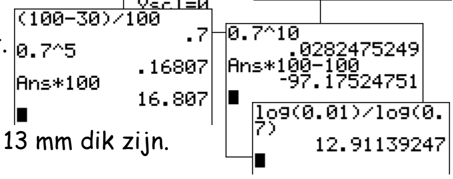
G9c Stel de toename duurt n dagen dan is er daarna nog $31-n$ dagen een afname.
Er geldt: $1{,}05^{n}\cdot 0{,}90^{31-n}=1$ (intersect) $\Rightarrow n\approx 21{,}2$. Hierbij hoort 22 mei.



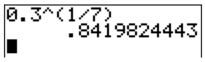
G10a $g_{\text{mm}}=0{,}7\Rightarrow g_{5\text{ mm}}=0{,}7^5\approx 0{,}168$.
Door de plaat van 5 mm komt nog maar 16,8% van het oorspronkelijke licht.

G10b $g_{1\text{ cm}}=g_{10\text{ mm}}=0{,}7^{10}\approx 0{,}028$. Er wordt dus 97,2% geabsorbeerd.

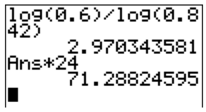
G10c $0{,}7^{n}=0{,}01$ (intersect of) $\Rightarrow n={}^{0,7}\log(0{,}01)=\frac{\log(0{,}01)}{\log(0{,}7)}\approx 12{,}9$. De plaat moet 13 mm dik zijn.



G11a $g_{\text{week}}=0{,}3\Rightarrow g_{\text{dag}}=0{,}3^{\frac{1}{7}}\approx 0{,}842$.

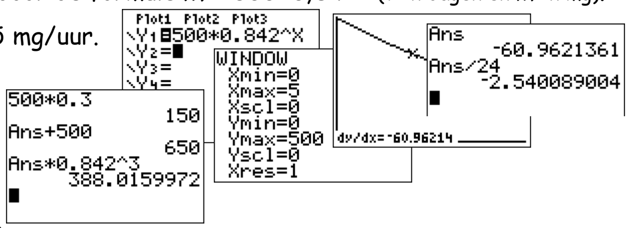


G11b Er is dan nog 60% van de hoeveelheid toegediende medicijn in het lichaam over, dus:
$0{,}842^{t}=0{,}6$ (intersect of) $\Rightarrow t={}^{0,842}\log(0{,}6)=\frac{\log(0{,}6)}{\log(0{,}842)}\approx 2{,}97$ (dagen). Dus ongeveer 71 uur.



G11c De hoeveelheid van de toegediende medicijn wordt gegeven door de formule $M=500\cdot 0{,}842^{t}$ (t in dagen en M in mg).
Voer de formule in op de GR $\Rightarrow \left[\frac{dy}{dx}\right]_{x=2}\approx -61$ mg/dag $\approx -2{,}5$ mg/uur.
Dus de hoeveelheid medicijn neemt af met 2,5 mg/uur.

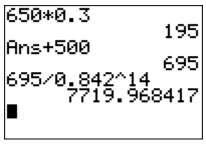
G11d Op $t=7$ (dagen) vlak voor de inname: $M=500\cdot 0{,}3=150$ (mg).
Op $t=7$ (dagen) vlak na de inname: $M=150+500=650$ (mg).
Op $t=10$ (dagen) is $M=650\cdot 0{,}842^3\approx 388$ (mg).



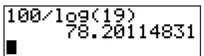
G11e Op $t=14$ (dagen) vlak voor de inname: $M=650\cdot 0{,}3=195$ (mg).
Op $t=14$ (dagen) vlak na de inname: $M=195+500=695$ (mg).

$$\left.\begin{array}{l} M=b\cdot 0{,}842^{t} \\ \text{voor } t=14 \text{ is } M=695 \end{array}\right\}\Rightarrow 695=b\cdot 0{,}842^{14}$$
$$b=\frac{695}{0{,}842^{14}}\approx 7\,720.$$

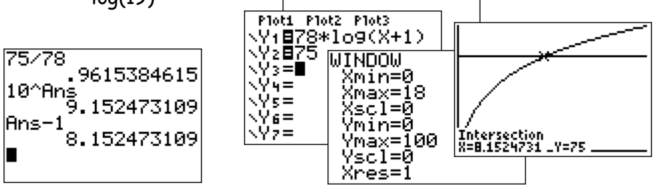
Dus voor $14<t<21$ is $M(t)=7\,720\cdot 0{,}842^{t}$.



G12a Voor $x=18$ is $P=100\Rightarrow 100=a\cdot\log(19)\Rightarrow a=\frac{100}{\log(19)}\approx 78{,}201$.



G12b $78\cdot\log(x+1)=75$ (intersect of)
$\log(x+1)=\frac{75}{78}$
$x+1=10^{\frac{75}{78}}$
$x=10^{\frac{75}{78}}-1\approx 8{,}15$. Dus op stand 8,2.



G12c $k=-1{,}3$ (bij een knop van 0 tot 6 zou de knop 1,7 aanwijzen) $\Rightarrow x=\frac{1{,}7}{6}\cdot 18=5{,}1$.
$P=78\cdot\log(5{,}1+1)\approx 61{,}3$.
Dus P is ongeveer 61%