$\approx 10^{\ldots} = 10^{1928} \cdot 10^{0,534\ldots}$

$\approx 3,3428 \cdot 10^{1928}$

$\Rightarrow$ numeroita : $1928 + 1 = \underline{1929}$, alku : $\underline{334}$

11.5 $f(x) = \log_5 (2x+6)$

a) $2x + 6 > 0 \iff 2x > -6 \quad | :2 > 0 \iff \underline{x > -3}$

b) Kuvaaja on piirretty vain arvoilla $x > -3$

11.6 a) $f(x) = \log_{0,5} x$; $0 < 0,5 < 1 \Rightarrow$ $\underline{f \text{ aidosti vähenevä}}$

b) $f(x) = \lg x = \log_{10} x$; $10 > 1 \Rightarrow$ $\underline{f \text{ aidosti kasvava}}$

11.15 a) $\log_5 25 = \underline{2} \quad (5^2 = 25)$

b) $\log_{25} 5 = \underline{\tfrac{1}{2}} \quad (25^{\frac{1}{2}} = \sqrt{25} = 5)$

c) $5^{\log_5 1} = \underline{1}$

d) $5^{\log_5 \frac{1}{5}} = \underline{\tfrac{1}{5}}$

11.17 a) $\log_a 27 = 3 \iff a^3 = 27 \quad | \sqrt[3]{\ } \iff a = \sqrt[3]{27} = \underline{3}$

b) $\log_a 16 = 2 \iff a^2 = 16 \quad | \sqrt{\ } \iff a = \pm\sqrt{16} \overset{a>0}{\Rightarrow} a = \underline{4}$

12.1 a) $\log_2 20 - \log_2 5 = \log_2 \frac{20}{5} = \log_2 4 = \underline{2}$

b) $\log_4 8 + \log_4 2 = \log_4 (8 \cdot 2) = \log_4 16 = \underline{2}$

12.3 $\dfrac{\log_3 x^4 + \log_3 x^3}{\log_3 x^2 - \log_3 x} = \dfrac{4\log_3 x + 3\log_3 x}{2\log_3 x - \log_3 x} = \dfrac{7 \log_3 x}{\log_3 x} = 7$ (vakio) $\quad x > 0,\ x \neq 1$

12.5 $\log_9 36 - \log_3 2 = \dfrac{\log_3 36}{\log_3 9} - \log_3 2 = \dfrac{\log_3 36}{2} - \log_3 2$

$= \frac{1}{2}\log_3 36 - \log_3 2 = \log_3 36^{\frac{1}{2}} - \log_3 2 = \log_3 \frac{\sqrt{36}}{2} = \log_3 \frac{6}{2}$

$= \log_3 3 = \underline{1}$

12.7 a) $\log_2 5^3 = 3\log_2 5$: $\underline{4}$

b) $\log_2 15 = \log_2 (3 \cdot 5) = \log_2 3 + \log_2 5$: $\underline{2}$

c) $\log_2 \frac{3}{5} = \log_2 3 - \log_2 5$: $\underline{1}$

d) $\log_2 \frac{5}{3} = \log_2 5 - \log_2 3$: $\underline{3}$

12.11 a) $\log_6 4 + \log_6 15 - \log_6 5 + \log_6 3$

$= \log_6 \dfrac{4 \cdot 15 \cdot 3}{5} = \log_6 36 = \underline{2}$

b) $\log_{49} 5 + 2\log_{49} 7 - \log_{49} 35 = \log_{49} 5 + \log_{49} 7^2 - \log_{49} 35$

$= \log_{49} \dfrac{5 \cdot 7^2}{35} = \log_{49} 7 = \underline{\tfrac{1}{2}} \quad (49^{\frac{1}{2}} = \sqrt{49} = 7)$

12.12 $\log(xy^2) - 2\log y = \log x + \log y^2 - \log y^2 = \underline{\log x} \quad (x, y > 0)$

12.16 a) $\log_9 (\sqrt{10}+1) + \log_9 (\sqrt{10}-1) = \log_9 ((\sqrt{10}+1)(\sqrt{10}-1))$

$= \log_9 ((\sqrt{10})^2 - 1^2) = \log_9 (10-1) = \log_9 9 = \underline{1}$

b) $2\log_3 \sqrt{2} - \frac{1}{2}\log_3 36 = \log_3 (\sqrt{2})^2 - \log_3 36^{\frac{1}{2}}$

$= \log_3 2 - \log_3 6 = \log_3 \frac{2}{6} = \log_3 \frac{1}{3} = \underline{-1}$

13.1 a) $\log_4 (x-1) = 2 \quad | 4^{()}$, $x - 1 > 0 \iff x > 1$

$\iff x - 1 = 4^2 \iff \underline{x = 17}$ ✓.

b) $\log_7 (2x+5) = 1 \quad | 7^{()}$, $2x + 5 > 0 \iff 2x > -5 \iff x > -\frac{5}{2}$

$\iff 2x + 5 = 7^1 \iff 2x = 2 \iff \underline{x = 1}$ ✓.

13.3 a) $\log_2 (x+1) + \log_2 (x+4) = 2$, $\left.\begin{matrix} x+1 > 0 \\ x+4 > 0 \end{matrix}\right\} \Rightarrow x > -1$

$\iff \log_2 ((x+1)(x+4)) = 2 \quad | 2^{()}$

$\iff (x+1)(x+4) = 2^2 \iff x^2 + 4x + x + 4 = 4$

$\iff x^2 + 5x = 0 \iff x(x+5) = 0 \iff x = \begin{cases} 0 \text{ ✓} \\ -5 \text{ ✗} \end{cases} \Rightarrow x = 0$

b) $\log_6 x + \log_6 (x-1) = 1$, $\left.\begin{matrix} x > 0 \\ x - 1 > 0 \end{matrix}\right\} \Rightarrow x > 1$

$\iff \log_6 (x(x-1)) = 1 \quad | 6^{()}$

$\iff x(x-1) = 6^1 \iff x^2 - x - 6 = 0 \iff x = \begin{cases} 3 \text{ ✓} \\ -2 \text{ ✗} \end{cases} \Rightarrow \underline{x = 3}$

13.5 a) $\log_5 (x-2) + \log_5 (x-3) = \log_5 6$, $\left.\begin{matrix} x-2 > 0 \\ x-3 > 0 \end{matrix}\right\} \Rightarrow x > 3$

$\iff \log_5 ((x-2)(x-3)) = \log_5 6 \quad | 5^{()}$

$\iff (x-2)(x-3) = 6 \iff x^2 - 5x + 6 = 6 \iff x^2 - 5x = 0 \iff x = \{$

$\Rightarrow \underline{x = 5}$

b) $\log_7 (x^2 + 5x) - \log_7 x = \log_7 18$, $x > 0$

$\iff \log_7 \dfrac{x^2 + 5x}{x} = \log_7 18 \quad | 7^{()}$

$\iff \dfrac{x^2 + 5x}{x} = 18 \quad | \cdot x \iff x^2 + 5x = 18x \iff x^2 - 13x = 0$

$\iff x(x - 13) = 0 \iff x = \begin{cases} 0 \text{ ✗} \\ 13 \text{ ✓} \end{cases} \Rightarrow \underline{x = 13}$

13.6 a) $\lg(x-1) + \lg(x-2) + \lg(x+3) = \lg 6$, $\left.\begin{matrix} x-1 > 0 \\ x-2 > 0 \\ x+3 > 0 \end{matrix}\right\} \Rightarrow x > 2$

$\iff \lg((x-1)(x-2)(x+3)) = \lg 6 \quad | 10^{()}$

$\iff (x-1)(x-2)(x+3) = 6 \iff (x^2 - 3x + 2)(x+3) = 6$

$\iff x^3 - 7x + 6 = 6 \iff x^3 - 7x = 0 \iff x(x^2 - 7) = 0$

$\iff x = 0$ tai $x = \pm\sqrt{7} \Rightarrow \underline{x = \sqrt{7}}$

b) $2\log_3 (x+1) = \log_3 (x+7) + \log_3 x$, $\left.\begin{matrix} x+1 > 0 \\ x+7 > 0 \\ x > 0 \end{matrix}\right\} \Rightarrow x > 0$

$\iff \log_3 (x+1)^2 = \log_3 ((x+7)x) \quad | 3^{()}$

$\iff (x+1)^2 = (x+7)x \iff x^2 + 2x + 1 = x^2 + 7x$

$\iff 5x = 1 \iff \underline{x = \tfrac{1}{5}}$ ✓.

13.7 a) $\log_2 x - \log_2 (2-x) = 0$, $\left.\begin{matrix} x > 0 \\ 2 - x > 0 \end{matrix}\right\} \Rightarrow 0 < x < 2$

$\iff \log_2 x = \log_2 (2-x) \quad | 2^{()}$

$\iff x = 2 - x \iff 2x = 2 \iff \underline{x = 1}$

b) $\log_2 x - \log_2 (2-x) = 1$, $0 < x < 2$

$\iff \log_2 \dfrac{x}{2-x} = 1 \quad | 2^{()}$

$\iff \dfrac{x}{2-x} = 2^1 \quad | \cdot (2-x) \iff x = 2(2-x)$

$\iff x = 4 - 2x \iff 3x = 4 \iff \underline{x = \tfrac{4}{3}}$ ✓.

13.14 a) $f(x) = \log_2 (x+3) + \log_2 (x-3) = 4$, $\left.\begin{matrix} x+3 > 0 \\ x-3 > 0 \end{matrix}\right\} \Rightarrow x > 3$

$\iff \log_2 ((x+3)(x-3)) = 4 \quad | 2^{()}$

$\iff (x+3)(x-3) = 2^4 \iff x^2 - 9 = 16 \iff x^2 = 25 \iff x = \pm 5$

$\Rightarrow \underline{x = 5}$

b) $g(x) = \log_2 (x^2 - 9) = 4 \quad | 2^{()}$, $x^2 - 9 > 0$; -3, 3 ; $x < -3$ tai $x > 3$

$\iff x^2 - 9 = 2^4 \iff x^2 = 25 \iff \underline{x = \pm 5}$ ✓.

13.16 $M = 0,67 \lg E - 4,8$

$\iff 0,67 \lg E = M + 4,8 \quad | :0,67$

$\iff \lg E = \dfrac{M + 4,8}{0,67} \quad | 10^{()}$

$\iff E = 10^{\frac{M+4,8}{0,67}}$

a) $M = 4,1$: $E = 10^{\frac{4,1+4,8}{0,67}} \approx 1,92124 \cdot 10^{13}\,(\mathrm{J}) \approx \underline{19\ \mathrm{TJ}}$

b) $P = \dfrac{E}{t} \iff t = \dfrac{E}{P} = \dfrac{1,92124 \cdot 10^{13}\,\mathrm{J}}{192 \cdot 3,6 \cdot 10^{9}\,\frac{\mathrm{J}}{h}} \approx 27,796\,h \approx \underline{28\,h}$

$M_2 = 9,0$: $E_2 = 10^{\frac{9,0+4,8}{0,67}} \approx 3,9538 \cdot 10^{20}\,\mathrm{J}$

$\dfrac{E_2}{E} \approx 2,0579 \cdot 10^7 \approx \underline{21 \cdot 10^6}$

13.17 a) $\log_3 (x+2) > 4 \quad | 3^{()}$, 3^x aidosti kasvava ($3 > 1$)

$\Rightarrow$ järjestys säilyy , $x + 2 > 0 \iff x > -2$

$\iff x + 2 > 3^4 \iff \underline{x > 79}$ ✓.

b) $\log_{0,5} (x-1) \geq 2 \quad | 0,5^{()}$, $0,5^x$ aidosti vähenevä ($0 < 0,5 < 1$)

$\Rightarrow$ järjestys kääntyy , $x - 1 > 0 \iff x > 1$

$\iff x - 1 \leq 0,5^2$

$\iff x \leq 1,25 \iff \underline{1 < x \leq 1,25}$