calc_decimal_example

Student Group

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$I.\quad$ Calculation example for decimal value

Idea: The number 2658.47 is only the representation with the numerals $[0..9]$, but what is the value behind it?

$$\begin{align*} \begin{smallmatrix} \color{black}{\text{value}:} & \color{black}{} & \color{black}{2} & \color{black}{6} & \color{black}{5} & \color{black}{8.} & \color{black}{4} & \color{black}{7} \\ \color{white}{\text{index}:} & \color{white}{i} & \color{white}{3} & \color{white}{2} & \color{white}{1} & \color{white}{0 } & \color{white}{-1} & \color{white}{-2} \\ \color{white}{\text{place value}:} & \color{white}{B^i} & \color{white}{10^3} & \color{white}{10^2} & \color{white}{10^1} & \color{white}{10^0} & \color{white}{10^{-1}} & \color{white}{10^{-2}} \\ \color{white}{} & \color{white}{} & \color{white}{1000} & \color{white}{100 } & \color{white}{10 } & \color{white}{1 } & \color{white}{0.1 } & \color{white}{0.01 } \\ \color{white}{\text{numerals}:} & \color{white}{z_i} & \color{white}{2} & \color{white}{6} & \color{white}{5} & \color{white}{8 } & \color{white}{4} & \color{white}{7} \\ \color{white}{\text{calc.}:} & \color{white}{z_i \cdot B^i} & \color{white}{2000} & \color{white}{600} & \color{white}{50} & \color{white}{8 } & \color{white}{0.4} & \color{white}{0.07} \\ \color{white}{\text{result}:} & \color{white}{\sum_i{ z_i \cdot B^i }} & & & \color{white}{2658.47} \\ \end{smallmatrix} \end{align*}$$

$$\begin{align*} \begin{smallmatrix} \color{black}{\text{value}:} & \color{black}{} & \color{black}{2} & \color{black}{6} & \color{black}{5} & \color{black}{8.} & \color{black}{4} & \color{black}{7} \\ \color{blue }{\text{index}:} & \color{blue }{i} & \color{blue }{3} & \color{blue }{2} & \color{blue }{1} & \color{blue }{0 } & \color{blue }{-1} & \color{blue }{-2} \\ \color{white}{\text{place value}:} & \color{white}{B^i} & \color{white}{10^3} & \color{white}{10^2} & \color{white}{10^1} & \color{white}{10^0} & \color{white}{10^{-1}} & \color{white}{10^{-2}} \\ \color{white}{} & \color{white}{} & \color{white}{1000} & \color{white}{100 } & \color{white}{10 } & \color{white}{1 } & \color{white}{0.1 } & \color{white}{0.01 } \\ \color{white}{\text{numerals}:} & \color{white}{z_i} & \color{white}{2} & \color{white}{6} & \color{white}{5} & \color{white}{8 } & \color{white}{4} & \color{white}{7} \\ \color{white}{\text{calc.}:} & \color{white}{z_i \cdot B^i} & \color{white}{2000} & \color{white}{600} & \color{white}{50} & \color{white}{8 } & \color{white}{0.4} & \color{white}{0.07} \\ \color{white}{\text{result}:} & \color{white}{\sum_i{ z_i \cdot B^i }} & & & \color{white}{2658.47} \\ \end{smallmatrix} \end{align*}$$

$$\begin{align*} \begin{smallmatrix} \color{black}{\text{value}:} & \color{black}{} & \color{black}{2} & \color{black}{6} & \color{black}{5} & \color{black}{8.} & \color{black}{4} & \color{black}{7} \\ \color{black}{\text{index}:} & \color{black}{i} & \color{black}{3} & \color{black}{2} & \color{black}{1} & \color{black}{0 } & \color{black}{-1} & \color{black}{-2} \\ \color{blue }{\text{place value}:} & \color{blue }{B^i} & \color{blue }{10^3} & \color{blue }{10^2} & \color{blue }{10^1} & \color{blue }{10^0} & \color{blue }{10^{-1}} & \color{blue }{10^{-2}} \\ \color{white}{} & \color{white}{} & \color{white}{1000} & \color{white}{100 } & \color{white}{10 } & \color{white}{1 } & \color{white}{0.1 } & \color{white}{0.01 } \\ \color{white}{\text{numerals}:} & \color{white}{z_i} & \color{white}{2} & \color{white}{6} & \color{white}{5} & \color{white}{8 } & \color{white}{4} & \color{white}{7} \\ \color{white}{\text{calc.}:} & \color{white}{z_i \cdot B^i} & \color{white}{2000} & \color{white}{600} & \color{white}{50} & \color{white}{8 } & \color{white}{0.4} & \color{white}{0.07} \\ \color{white}{\text{result}:} & \color{white}{\sum_i{ z_i \cdot B^i }} & & &$$

\color{white}{2658.47} \\ \end{smallmatrix} \end{align*}

\begin{align*} \begin{smallmatrix} \color{white}{\text{value}:} & \color{white}{} & \color{white}{2} & \color{white}{6} & \color{white}{5} & \color{white}{8.} & \color{white}{4} & \color{white}{7} \\ \color{white}{\text{index}:} & \color{white}{i} & \color{white}{3} & \color{white}{2} & \color{white}{1} & \color{white}{0 } & \color{white}{-1} & \color{white}{-2} \\ \color{white}{\text{place value}:} & \color{white}{B^i} & \color{white}{10^3} & \color{white}{10^2} & \color{white}{10^1} & \color{white}{10^0} & \color{white}{10^{-1}} & \color{white}{10^{-2}} \\ \color{white}{} & \color{white}{} & \color{white}{1000} & \color{white}{100 } & \color{white}{10 } & \color{white}{1 } & \color{white}{0.1 } & \color{white}{0.01 } \\ \color{white}{\text{numerals}:} & \color{white}{z_i} & \color{white}{2} & \color{white}{6} & \color{white}{5} & \color{white}{8 } & \color{white}{4} & \color{white}{7} \\ \color{white}{\text{calc.}:} & \color{white}{z_i \cdot B^i} & \color{white}{2000} & \color{white}{600} & \color{white}{50} & \color{white}{8 } & \color{white}{0.4} & \color{white}{0.07} \\ \color{white}{\text{result}:} & \color{white}{\sum_i{ z_i \cdot B^i }} & & & \color{white}{2658.47} \\ \end{smallmatrix} \end{align*}

\begin{align*} \begin{smallmatrix} \color{blue }{\text{value}:} & \color{blue }{} & \color{blue }{2} & \color{blue }{6} & \color{blue }{5} & \color{blue }{8.} & \color{blue }{4} & \color{blue }{7} \\ \color{blue }{\text{index}:} & \color{blue }{i} & \color{blue }{3} & \color{blue }{2} & \color{blue }{1} & \color{blue }{0 } & \color{blue }{-1} & \color{blue }{-2} \\ \color{blue }{\text{place value}:} & \color{blue }{B^i} & \color{blue }{10^3} & \color{blue }{10^2} & \color{blue }{10^1} & \color{blue }{10^0} & \color{blue }{10^{-1}} & \color{blue }{10^{-2}} \\ \color{blue }{} & \color{blue }{} & \color{blue }{1000} & \color{blue }{100 } & \color{blue }{10 } & \color{blue }{1 } & \color{blue }{0.1 } & \color{blue }{0.01 } \\ \color{blue }{\text{numerals}:} & \color{blue }{z_i} & \color{blue }{2} & \color{blue }{6} & \color{blue }{5} & \color{blue }{8 } & \color{blue }{4} & \color{blue }{7} \\ \color{blue }{\text{calc.}:} & \color{blue }{z_i \cdot B^i} & \color{blue }{2000} & \color{blue }{600} & \color{blue }{50} & \color{blue }{8 } & \color{blue }{0.4} & \color{blue }{0.07} \\ \color{blue }{\text{result}:} & \color{blue }{\sum_i{ z_i \cdot B^i }} & & & \color{blue }{2658.47} \\ \end{smallmatrix} \end{align*}

\begin{align*} \begin{smallmatrix} \color{black}{\text{value}:} & \color{black}{} & \color{black}{2} & \color{black}{6} & \color{black}{5} & \color{black}{8.} & \color{black}{4} & \color{black}{7} \\ \color{black}{\text{index}:} & \color{black}{i} & \color{black}{3} & \color{black}{2} & \color{black}{1} & \color{black}{0 } & \color{black}{-1} & \color{black}{-2} \\ \color{black}{\text{place value}:} & \color{black}{B^i} & \color{black}{10^3} & \color{black}{10^2} & \color{black}{10^1} & \color{black}{10^0} & \color{black}{10^{-1}} & \color{black}{10^{-2}} \\ \color{black}{} & \color{black}{} & \color{black}{1000} & \color{black}{100 } & \color{black}{10 } & \color{black}{1 } & \color{black}{0.1 } & \color{black}{0.01 } \\ \color{black}{\text{numerals}:} & \color{black}{z_i} & \color{black}{2} & \color{black}{6} & \color{black}{5} & \color{black}{8 } & \color{black}{4} & \color{black}{7} \\ \color{black}{\text{calc.}:} & \color{black}{z_i \cdot B^i} & \color{black}{2000} & \color{black}{600} & \color{black}{50} & \color{black}{8 } & \color{black}{0.4} & \color{black}{0.07} \\ \color{black}{\text{result}:} & \color{black}{\sum_i{ z_i \cdot B^i }} & & & \color{black}{2658.47} \\ \end{smallmatrix} \end{align*}

value		2	6	5	8 ,	4	7	
index	i	3	2	1	0	-1	-2	
$\quad\quad$ $\quad\quad$	$\quad\quad$	$\quad\quad$	$\quad\quad$	$\quad\quad$	$\quad\quad$	$\quad\quad$	$\quad\quad$	$\quad\quad$

$\quad\quad$	$\quad\quad$	$\quad\quad$	$\quad\quad$	$\quad\quad$	$\quad\quad$	$\quad\quad$	$\quad\quad$	
$\quad\quad$	$\quad\quad$	$\quad\quad$	$\quad\quad$	$\quad\quad$	$\quad\quad$	$\quad\quad$	$\quad\quad$	
$\quad\quad$ $\quad\quad$	$\quad\quad$	$\quad\quad$	$\quad\quad$	$\quad\quad$	$\quad\quad$	$\quad\quad$	$\quad\quad$	

value		2	6	5	8 ,	4	7
index	i	3	2	1	0	-1	-2
place value	B^i	$\small{10^3}$ $\small{1000}$	$\small{10^2}$ $\small{100}$	$\small{10^1}$ $\small{10}$	$\small{10^0}$ $\small{1}$	$\small{10^-1}$ $\small{0.10}$	$\small{10^-2}$ $\small{0.01}$
digit	z_i	2	6	5	8	4	7
calc.	$z_i \cdot B^i$	2000	600	50	8	0.4	0.07
Result $\sum_i{ z_i \cdot B^i }$		2658,47					

aus (2+3)	$\color{blue}{I_p} = \color{blue}{I_m} = 0$	I_p und I_m sind damit definiert
$\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$
aus (6)	$\color{blue}{I_o} = I_1 $	I_o ist damit bekannt, wenn I_1 bekannt ist
$\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$
aus (7) und (3)	$I_1 - I_2 -\color{blue}{0} = 0 $	$\quad$
$\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$
$\quad$	$I_1 = I_2 = I_o$	$\quad$
$\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$
$\quad$	$\color{blue}{I_1} = \color{blue}{I_2} = \color{blue}{I_o} $	mit (8) und (9): $I_\boxed{}=\frac{U_\boxed{}}{R_\boxed{}}$ und (5)
$\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$
$\quad$	$\frac{U_1}{R_1}= \frac{U_2}{R_2} = \frac{U_A}{R_1 + R_2}$	Spannungsteilerformel, $I=const.$
$\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$
(10)	$U_2= U_A\cdot\frac{R_2}{R_1+R_2}$	Spannungsteilerformel
$\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$

$II.\quad$ Betrachtung der Spannungsverstärkung

aus (0)	$\color{blue}{A_V}=\frac{U_A}{U_E}$	$\quad$
$\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$
$\quad$	$A_V=\frac{U_A}{\color{blue}{U_E}}$	mit (4): $U_E=U_2+U_D$
$\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$
$\quad$	$A_V=\frac{U_A}{\color{blue}{U_2+U_D}}$	$\quad$
$\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$
$\quad$	$A_V=\frac{U_A}{\color{blue}{U_2}+U_D}$	mit (10): $U_2= U_A\cdot\frac{R_2}{R_1+R_2}$
$\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$
$\quad$	$A_V=\frac{U_A}{\color{blue}{U_A\cdot\frac{R_2}{R_1+R_2}}+U_D}$	$\quad$
$\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$
$\quad$	$A_V=\frac{U_A}{U_A\cdot\frac{R_2}{R_1+R_2}+U_D}$	$\quad$
$\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$
$\quad$	$A_V=\frac{U_A}{U_A\cdot\frac{R_2}{R_1+R_2}+\color{blue}{U_D}}$	mit (1)
$\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$
$\quad$	$A_V=\frac{U_A}{U_A\cdot\frac{R_2}{R_1+R_2}+\color{blue}{\frac{U_A}{A_D}}}$	$\quad$
$\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$
$\quad$	$A_V=\frac{U_A}{U_A\cdot\frac{R_2}{R_1+R_2}+\frac{U_A}{A_D}}$	$\quad$
$\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$
$\quad$	$A_V=\frac{\color{blue}{U_A}}{\color{blue}{U_A}\cdot\frac{R_2}{R_1+R_2}+\frac{\color{blue}{U_A}}{A_D}}$	Erweitern mit $\frac{1}{U_A}$
$\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$
$\quad$	$A_V=\frac{1}{\frac{R_2}{R_1+R_2}+\frac{1}{A_D}}$	$\quad$
$\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$
$\quad$	$A_V=\frac{1}{\frac{R_2}{R_1+R_2}+\color{blue}{\frac{1}{A_D}}}$	mit $\frac{1}{A_D} \xrightarrow{A_D \rightarrow \infty} 0$
$\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$
$\quad$	$A_V=\frac{1}{\frac{R_2}{R_1+R_2}}$	Bruch umformen
$\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$
$\quad$	$A_V=\frac{R_1+R_2}{R_2}$	$\quad$
$\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$	$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$

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