

Equations: colorimetric transfer from CIELAB hue angle h_{ab} to elementary hue number e^*

Given: CIELAB hue angle h_{ab} ($0 \leq h_{ab} \leq 360$)

CIELAB hue angles $h_{ab,eX}$ of four elementary colours $eX = RJGB$

Aim: Elementary hue number e^* of the given colour ($0 \leq e^* \leq 1$)

Calculate elementary hue angle $h_{ab,e}$ in one of five possible cases for h_{ab} ($0 \leq h_{ab} \leq 360$):

$$\begin{aligned} \text{If } 0 \leq h_{ab} < h_{ab,eR} & \quad h_{ab,e} = 270 + 90 [360 + h_{ab} - h_{ab,eB}] / [360 + h_{ab,eR} - h_{ab,eB}] & (1) \\ \text{If } h_{ab,eR} \leq h_{ab} < h_{ab,eJ} & \quad h_{ab,e} = 0 + 90 [h_{ab} - h_{ab,eR}] / [h_{ab,eJ} - h_{ab,eR}] & (2) \\ \text{If } h_{ab,eJ} \leq h_{ab} < h_{ab,eG} & \quad h_{ab,e} = 90 + 90 [h_{ab} - h_{ab,eJ}] / [h_{ab,eG} - h_{ab,eJ}] & (3) \\ \text{If } h_{ab,eG} \leq h_{ab} < h_{ab,eB} & \quad h_{ab,e} = 180 + 90 [h_{ab} - h_{ab,eG}] / [h_{ab,eB} - h_{ab,eG}] & (4) \\ \text{If } h_{ab,eB} \leq h_{ab} < 360 & \quad h_{ab,e} = 270 + 90 [h_{ab} - h_{ab,eB}] / [360 + h_{ab,eR} - h_{ab,eB}] & (5) \\ \text{Elementary hue number} & \quad e^* = h_{ab,e} / 360 \quad (0 \leq e^* \leq 1) & (6) \end{aligned}$$

Inverse equations: transfer from elementary hue number e^* to CIELAB hue angle h_{ab}

Given: elementary hue number e^* ($0 \leq e^* \leq 1$)

CIELAB hue angles $h_{ab,eX}$ of four elementary colours $eX = RJGB$

Aim: CIELAB hue angle h_{ab} of the given colour ($0 \leq h_{ab} \leq 360$)

$$\text{Elementary hue angle} \quad h_{ab,e} = 360 e^* \quad (0 \leq e^* \leq 1) \quad (1i)$$

Calculate CIELAB hue angle h_{ab} in one of four possible cases for e^* ($0 \leq e^* \leq 1$):

$$\begin{aligned} \text{If } 0,00 \leq e^* < 0,25 & \quad h_{ab} = h_{ab,eR} + [h_{ab,e} / 90] [h_{ab,eJ} - h_{ab,eR}] & (2i) \\ \text{If } 0,25 \leq e^* < 0,50 & \quad h_{ab} = h_{ab,eJ} + [h_{ab,e} / 90 - 1,00] [h_{ab,eG} - h_{ab,eJ}] & (3i) \\ \text{If } 0,50 \leq e^* < 0,75 & \quad h_{ab} = h_{ab,eJ} + [h_{ab,e} / 90 - 2,00] [h_{ab,eG} - h_{ab,eJ}] & (4i) \\ \text{If } 0,75 \leq e^* < 1,00 & \quad h_{ab} = h_{ab,eJ} + [h_{ab,e} / 90 - 3,00] [h_{ab,eG} - h_{ab,eJ}] & (5i) \\ \text{only if } h_{ab} > 360 \text{ then:} & \quad h_{ab} = h_{ab} - 360 \quad 0 \leq h_{ab} \leq 360 & (6i) \end{aligned}$$

ZE200-3

Equations: colorimetric data transfer from LCH^*_a (CIELAB) to nce^* and olv^*_3

Given: adapted CIELAB data of any colour L^* , $C^*_{ab,a}$, $h_{ab,a} = LCH^*_a = LAB^*LCH^*_a$

adapted CIELAB data L^* , $C^*_{ab,a}$, $h_{ab,a}$, a^*_a , b^*_a of eighth basic colours $X = OYLCVMNW$

Aim: nce^* and rgb device data olv^*_3 of the given colour

$$\begin{aligned} \text{hue angle of the given colour and of } M & \quad h_{ab,a} = H^*_a & (1) \\ \text{CIELAB } LCH^*_{a,M} \text{ data of maximum colour } M & \quad L^*_M = \text{function} [h_{ab,a}] \quad (\text{with table/equation}) & (2) \\ & \quad C^*_{ab,a,M} = \text{function} [h_{ab,a}] \quad (\text{with table/equation}) & (3) \\ & \quad h_{ab,a,M} = h_{ab,a} & (4) \\ \text{relative lightness of the given colour} & \quad l^* = [L^* - L^*_N] / [L^*_W - L^*_N] & (5) \\ \text{relative chroma of the given colour} & \quad c^* = C^*_{ab,a} / C^*_{ab,a,M} & (6) \\ \text{relative triangle lightness of the given colour} & \quad t^* = l^* - [L^*_M - L^*_N] / [L^*_W - L^*_N] c^* + 0,5 c^* & (7) \\ \text{relative blackness of the given colour} & \quad n^* = 1 - t^* - 0,5 c^* & (8) \\ \text{relative whiteness of the given colour} & \quad w^* = 1 - n^* - c^* & (9) \\ \text{elementary hue angle of the given colour} & \quad e^* = \text{function} [h_{ab,a}] \quad (\text{with table or equation}) & (10) \\ \text{relative } olv^*_{3,M} \text{ data of maximum colour } M & \quad o^*_{3,M} = \text{function} [h_{ab,a}] \quad (\text{with table/equation}) & (11) \\ & \quad l^*_{3,M} = \text{function} [h_{ab,a}] \quad (\text{with table/equation}) & (12) \\ & \quad v^*_{3,M} = \text{function} [h_{ab,a}] \quad (\text{with table/equation}) & (13) \\ \text{relative } olv^*_3 \text{ data of the given colour} & \quad o^*_{3} = w^* + c^* o^*_{3,M} & (14) \\ & \quad l^*_{3} = w^* + c^* l^*_{3,M} & (15) \\ & \quad v^*_{3} = w^* + c^* v^*_{3,M} & (16) \end{aligned}$$

ZE200-7

Inverse equations: transfer from standard hue angle $h_{ab,s}$ to CIELAB hue angle h_{ab}

Given: standard hue angle $h_{ab,s}$ ($0 \leq h_{ab,s} \leq 360$)

CIELAB hue angles $h_{ab,s,X}$ of six standard colours $sX = RJGC'BM'$

Aim: CIELAB hue angle h_{ab} of the given colour ($0 \leq h_{ab} \leq 360$)

Remark:

The standard hue angle $h_{ab,s}$ is usually calculated from the data rgb^*_3

relative red-green chroma in system s $a^*_{rs} = r^*_3 \cos(30) + g^*_3 \cos(150)$

relative yellow-blue chroma in system s $b^*_{rs} = r^*_3 \sin(30) + g^*_3 \sin(150) + b^*_3 \sin(270)$

hue angle in standard system s $h_{ab,s} = \arctan [b^*_{rs} / a^*_{rs}]$

Calculate CIELAB hue angle h_{ab} in one of seven possible cases for $h_{ab,s}$ ($0 \leq h_{ab,s} \leq 360$):

$$\begin{aligned} \text{If } 0 \leq h_{ab,s} < 30 & \quad h_{ab} = h_{ab,s,M'} + [h_{ab,s} + 360 - h_{ab,s,M'}] [h_{ab,s,R} + 360 - h_{ab,s,M'}] / 60 & (1i) \\ \text{If } 30 \leq h_{ab,s} < 90 & \quad h_{ab} = h_{ab,s,R} + [h_{ab,s} - h_{ab,s,R}] [h_{ab,s,J} - h_{ab,s,R}] / 60 & (2i) \\ \text{If } 90 \leq h_{ab,s} < 150 & \quad h_{ab} = h_{ab,s,J} + [h_{ab,s} - h_{ab,s,J}] [h_{ab,s,G} - h_{ab,s,J}] / 60 & (3i) \\ \text{If } 150 \leq h_{ab,s} < 210 & \quad h_{ab} = h_{ab,s,G} + [h_{ab,s} - h_{ab,s,G}] [h_{ab,s,C'} - h_{ab,s,G}] / 60 & (4i) \\ \text{If } 210 \leq h_{ab,s} < 270 & \quad h_{ab} = h_{ab,s,C'} + [h_{ab,s} - h_{ab,s,C'}] [h_{ab,s,B} - h_{ab,s,C'}] / 60 & (5i) \\ \text{If } 270 \leq h_{ab,s} < 330 & \quad h_{ab} = h_{ab,s,B} + [h_{ab,s} - h_{ab,s,B}] [h_{ab,s,M'} - h_{ab,s,B}] / 60 & (6i) \\ \text{If } 330 \leq h_{ab,s} < 360 & \quad h_{ab} = h_{ab,s,M'} + 360 + [h_{ab,s} - h_{ab,s,M'}] [h_{ab,s,R} + 360 - h_{ab,s,M'}] / 60 & (7i) \\ \text{only if } h_{ab} > 360 \text{ then:} & \quad h_{ab} = h_{ab} - 360 \quad 0 \leq h_{ab} \leq 360 & (8i) \end{aligned}$$

ZE201-3

Equations: colorimetric data transfer from olv^*_3 to nce^* data and LCH^*_a data

Given: rgb device data of any colour $olv^*_3 = lab^*olv^*_3$

adapted CIELAB data L^* , $C^*_{ab,a}$, $h_{ab,a}$, a^*_a , b^*_a of eighth basic colours $X = OYLCVMNW$

Aim: $nce^* = lab^*nce^*$ (similar to NCS data) and LCH^*_a data of the given colour ($0 \leq e^* \leq 1$)

$$\begin{aligned} \text{relative chroma of the given colour} & \quad c^* = \max [olv^*_3] - \min [olv^*_3] & (1) \\ \text{relative blackness of the given colour} & \quad n^* = 1 - \max [olv^*_3] & (2) \\ \text{relative triangle lightness of the given colour} & \quad t^* = 1 - n^* - 0,5 c^* & (3) \\ \text{relative red-green chroma in 60 degree system s} & \quad a^*_{rs} = o^*_3 \cos(30) + l^*_3 \cos(150) & (4) \\ \text{relative yellow-blue chroma in 60 degree system s} & \quad b^*_{rs} = o^*_3 \sin(30) + l^*_3 \sin(150) + v^*_3 \sin(270) & (5) \\ \text{hue angle in 60 degree system s} & \quad h_{ab,s} = \arctan [b^*_{rs} / a^*_{rs}] \quad (0 \leq h_{ab,s} \leq 360) & (6) \\ \text{CIELAB hue angle in device system} & \quad h_{ab,a} = \text{function} [h_{ab,s}] \quad (\text{with table/equation}) & (7) \\ \text{elementary hue number of the given colour} & \quad e^* = \text{function} [h_{ab,a}] \quad (\text{with table/equation}) & (8) \\ \text{adapted CIELAB } LCH^*_a \text{ data of maximum colour } M & \quad L^*_M = \text{function} [h_{ab,a}] \quad (\text{with table/equation}) & (9) \\ & \quad C^*_{ab,a,M} = \text{function} [h_{ab,a}] \quad (\text{with table/equation}) & (10) \\ & \quad h_{ab,a,M} = h_{ab,a} & (11) \\ \text{relative lightness of maximum colour } M & \quad l^*_M = [L^*_M - L^*_N] / [L^*_W - L^*_N] & (12) \\ \text{relative lightness of the given colour} & \quad l^* = t^* + l^*_M c^* + 0,5 c^* & (13) \\ \text{adapted CIELAB } LCH^*_a \text{ data of the given colour} & \quad L^* = l^* [L^*_W - L^*_N] + L^*_N & (14) \\ & \quad C^*_{ab,a} = c^* C^*_{ab,a,M} & (15) \\ & \quad h_{ab,a} = h_{ab,a,M} & (16) \end{aligned}$$

ZE201-7

BAM-test chart ZE20; colorimetric coordinate transfer
Equations: hue data transfer between h_{ab} , $h_{ab,s}$ and $h_{ab,e}$

input: rgb (-> olv^*_3) $setrgbcolor$
output: no change compared to input