

Weber-Fechner law in CIE 230:2019 for threshold colour differences of surface colours and two ranges $0,2 \leq L_r \leq 1$ and $1 \leq L_r \leq 5$

The *Weber-Fechner* law describes the lightness L_r^* as *logarithmic* function of L_r . The *Stevens* law describes the lightness L_{CIELAB}^* as *potential* function of $L_r=Y/5$. IEC 61966-2-1 uses a similar potential function $L_{IEC}^* = m L_r^{1/2,4}$.

The *Weber-Fechner* law is equivalent to the linear equation: $\Delta L_r = c_i L_r$ ($i=0,1$) [1]

Integration leads to the logarithmic equation: $L_r^* = k_i \log(L_r)$ ($i=0,1$) [2]

Derivation leads for $\Delta L_r^* = 1$ to the linear equation: $L_r / \Delta L_r = k_i$ ($k_0=46, k_1=63$) [3]

For colours in offices the standard contrast range is 25:1=90:3,6.

Table 1: CIE tristimulus value Y , luminance L , and lightnesses L^*

Colour (matte)	Tristimulus value	office luminance	relative luminance	CIE lightness	relative lightness
(contrast) (25:1=90:3,6)	Y	L [cd/m ²]	L_r $=L/L_u$	L_{CIELAB}^* $\sim m L_r^{1/2,4}$	L_r^* $=k \log(L_r)$
White W (paper)	90 $=18 \cdot 5$	142 $=28,2 \cdot 5$	5	94 $=50+44$	44 $=k_1 \log(5)$
Grey Z (paper)	18	28,2	1	50	0 $=k_0 \log(1)$
Black N (paper)	3,6 $=18/5$	5,6 $28,2/5$	0,2	18 $50-32$	-32 $=k_0 \log(0,2)$

For the two lightness ranges it is $k_0=-32/\log(0,2)=-46$ and $k_1=44/\log(5)=63$.