

Weber-Fechner law in CIE 230:2019 for threshold colour differences of surface colours

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 $L^*_{\text{IEC}} = m L_r^{1/2,4}$.

The *Weber-Fechner* law is equivalent to the equation: $\Delta L_r = c L_r$ [1]

Integration leads to the logarithmic equation: $L^*_r = k \log(L_r)$. [2]

Derivation for $\Delta L^*_r=1$ leads to the linear equation: $L_r/\Delta L_r=k=57$. [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
<i>(contrast)</i> (25:1=90:3,6)	Y	L [cd/m ²]	L_r = L/L_u	L^*_{CIELAB} ~ $m L_r^{1/2,4}$	L^*_r = $k \log(L_r)$
White W (paper)	90 =18*5	142 =28,2*5	5	94 =50+44	40 = $k \log(5)$
Grey Z (paper)	18	28,2	1	50	0 = $k \log(1)$
Black N (paper)	3,6 =18/5	5,6 28,2/5	0,2	18 50-32	-40 = $k \log(0,2)$

For the lightness range between $L^*_r=-40$ and 40 the constant is: $k=40/\log(5)=57$