

## 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  $L_{\text{CIELAB}}^*$  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
(contrast) (25:1=90:3,6)	$Y$	$L$ [cd/m <sup>2</sup> ]	$L_r$ = $L/L_u$	$L_{\text{CIELAB}}^*$ $\sim m L_r^{1/2,4}$	$L_r^*$ = $k \log(L_r)$
White W (paper)	90 = $18 \cdot 5$	142 = $28,2 \cdot 5$	5	94 = $50+44$	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:  $k = 40 / \log(5) = 57$