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

The *Weber-Fechner* law describes the lightness L^* 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 equation: $\Delta L_r = c\, L_\tau$ [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 contrasts 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/m²]	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*5	142 =28,2*5	5	94 =50+44	40 =$k\log(5)$
Grey Z (paper)	18 =18/5	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: $k = 40/\log(5) = 57$

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