

Weber-Fechner law in CIE 230:2019 for threshold colour differences of surface colours; relations between tristimulus value, luminance, and lightness

The *Weber-Fechner* law describes the lightness L^*_{rW} as *logarithmic* function of L_{rW} .

The *Stevens* law describes the lightness L^*_{CIELAB} as *potential* function of $L_{rW}=Y/90$.

$$L^*_{CIELAB} = 116 L_{rW}^{1/3} - 16 = 66 L_{rU}^{1/3} - 16, \text{ Approximation: } L^*_{IEC,sRGB} = 100 L_{rW}^{1/2,4} \quad [1]$$

The *Weber-Fechner* law is equivalent to the equation: $\Delta L_{rW} = c_W L_{rW}$ [2]

Integration leads to the logarithmic equation: $L^*_{rW} = t_W \log(L_{rW})$. [3]

Derivation leads for $\Delta L^*_{rW} = 1$ to the linear equation: $L_{rW} / \Delta L_{rW} = t_W = 57$. [4]

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

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

Colour (matte paper)	tristimulus values	SDR office luminance	relative luminance		CIELAB _W lightness	TUBLOG _U lightness
Contrast W:N (25:1=90:3,6)	Y	L [cd/m ²]	L_{rU} = L/L_U	L_{rW} = L/L_W	$L^*_{CIELAB_W}$ = $c_W L_{rW}^{1/3} - 16$	$L^*_{TUBLOG_U}$ = $t_U \log(L_{rU}) + 50$
White W (paper)	90 =18*5	142 =28,2*5	5	1	96=50+46 = $c(1)^{1/3} - 16$	90=50+40 = $t \log(5) + 50$
Grey U (paper)	18	28,2	1	0,2	49=50-1 = $c(0,2)^{1/3} - 16$	50=50+0 = $t \log(1) + 50$
Black N (paper)	3,6 =18/5	5,6 28,2/5	0,2	0,04	22=50-28 = $c(0,04)^{1/3} - 16$	10=50-40 = $t \log(0,2) + 50$

It is valid: CIELAB_W: $c_W = c = 116$, TUBLOG_U: $t_U = t = 50 / \log(5) = 72$