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 $L_{rW}=Y/90$.

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

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)	**tristimu-lus values**	**SDR office luminance**	**relative luminance**		**$CIELAB_W$ lightness**	**$TUBLOG_U$ lightness**
Contrast W:N (25:1=90:3,6)	***Y***	***L*** **[cd/m²]**	$L_{rU}=L/L_U$	$L_{rW}=L/L_W$	$L^*_{CIELAB\_W}=c_W L_{rW}^{1/3}-16$	$L^*_{TUBLOG\_U}=t_U \log(L_{rU})+50$
White W (paper)	90 =18*5	142 =28,2*5	5	1	96=50+46 $=c(1)^{1/3}-16$	100=50+50 $=t\log(5)+50$
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 $=c(0,04)^{1/3}-16$	0=50−50 $=t\log(0,2)+50$

It is valid: $CIELAB_W$: $c_W=c=116$, $TUBLOG_U$: $t_U=t=50/\log(5)=57$

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