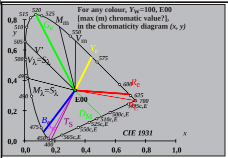

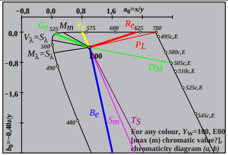

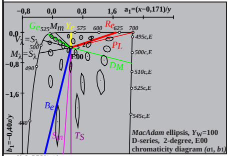

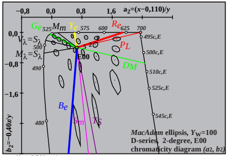

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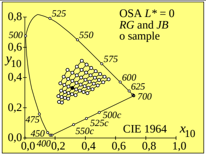

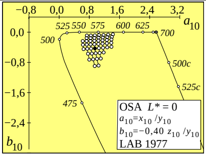

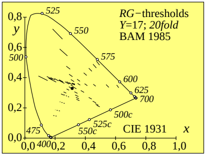

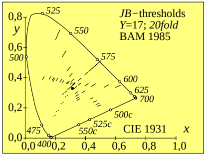

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Line-element equations according to CIE 230:2019

Colour-threshold (t) function $f_t(x) = \Delta Y_t = \Delta x Y_u$ [0]

$\Delta Y_t = (A_1 + A_2 Y)/A_0$ A_0=1,5, A_1=0,0170, A_2=0,0058

$$f_{tu}(x) = \frac{\Delta Y_t}{\Delta Y_{tu}} = \frac{1+bx}{1+b} \quad b=A_2Y_u/A_1 \quad x=Y/Y_u \quad [1]$$

$$F_{tu}(x) = \int \frac{f'_{tu}(x)}{f_{tu}(x)}dx = \int \frac{b}{1+bx}\,dx \quad [2]$$

Example for $L^*_{tu}(x)$, ΔY_t with $x=Y/Y_u$, x_u=1, b=6,141:

$$L^*_{tu}(x) = \frac{L^*_t(x)}{L^*_{tu}(x)} = \frac{\ln(1+bx)}{\ln(1+b)} \quad [3]$$

$$f_{tu}(x) = \frac{\Delta Y_t}{\Delta Y_{tu}} = \frac{1+bx}{1+b} \quad [4]$$

eew60−5a ens00−5n

Line-element equations: loudness – sound level [1]

Simple equation by the ***Weber-Fechner*** law between the loudness N^* and the sound level E

$$\frac{\Delta N^*}{N^*} = n\,\frac{\Delta E}{E} \quad [1]$$

It is assumed at the hearing threshold E_s

$$\frac{\Delta N^*}{N^*+N^*_s} = n\,\frac{\Delta E}{E+E_s} \quad [2]$$

Integration on both sides and requirement N^*=0 for E=0

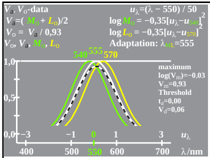
$$N^* = N^*_s\,[\,(1+\frac{E}{E_s})^n - 1\,] \quad [3]$$

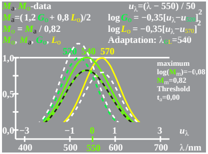
Small change with threshold factor s and N^*=0 for $E=E_s$

$$N^* = N^*_s\,[\,(1+s\frac{E-E_s}{E_s})^n - 1\,] \quad [4]$$

1) *Zwicker E., Feldkeller R., (1967), Das Ohr als Nachrichtenempfänger (the ear as information receiver)*, Hirzel-Verlag, 232 pages, see 133−139

eew60−6a ens00−6n





Line-element equations: lightness – luminance [1]

Simple equation by the ***Weber-Fechner*** law between the lightness L^* and the luminance L

$$\frac{\Delta L^*}{L^*} = n\,\frac{\Delta L}{L} \quad [1]$$

It is assumed at the luminance threshold L_s

$$\frac{\Delta L^*}{L^*+L^*_s} = n\,\frac{\Delta L}{L+L_s} \quad [2]$$

Integration on both sides and requirement L^*=0 for L=0

$$L^* = L^*_s\,[\,(1+\frac{L}{L_s})^n - 1\,] \quad [3]$$

Small change with threshold factor s and L^*=0 for $L=L_s$

$$L^* = L^*_s\,[\,(1+s\frac{L-L_s}{L_s})^n - 1\,] \quad [4]$$

1) *Richter, Klaus., (1969), Antagonistic signals in colour vision and relation with the perceived colour order* (in German), Dis. Universität Basel, 150 pages, see 115-123

eew60−7a ens00−7n

Line-element equations: lightness – tristimulus value

Richter [1] has used the following equation to approximate between the lightness L^* and the tristimulus value Y

$$L^* = L^*_s\,[\,(1+s\frac{Y-Y_s}{L_s})^n - 1\,] \quad [1]$$

The parameters are for the *Munsell Value* function[2]

L^*_s=2,5125 s=0,4250 Y_s=0,1551 n=0,3333 [2]

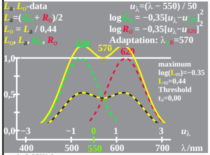
The parameters are for the *CIELAB-lightness* function[3]

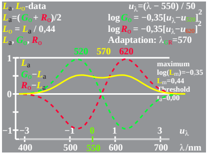
$$L^* = 116\,(Y/Y_n)^{1/3} - 16 \quad (0{,}8<Y<100,\ Y_n=100) \quad [3]$$

L^*_s=2,5125 s=0,4250 Y_s=0,1551 n=0,3333 [4]

1) *Richter, Klaus., (1969), Antagonistic signals in colour vision and relation with the perceived colour order* (in German), Dis. Universität Basel, 150 pages, see 115-123, 74 MB, see for free download https://edoc/unibas.ch/72306/
2) *Newhall, S.M., Nickerson, D., Judd, D.B. (1943), Final report of the O.S.A. subcommittee on the spacing of Munsell Colors, OSA 33, 385-418, see p. 417*
3) ISO/CIE 11664−4:2019 Colorimetry, CIE 1976 L*a*b* colour space

eew60−8a ens00−8n





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eew61−7n

TUB-test chart eew6; Mixture of 4 x 4 images for different applications
This is an example text "case1" for many applications; very short line not allowed