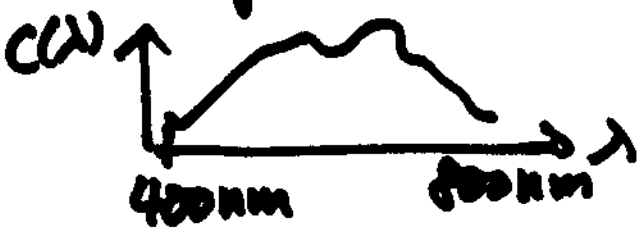
# Trichromatic Theory:

color is perceived by human eyes through visual receptors.

color light $C(\lambda)$




3 types of Cone Receptors


A color is defined by the response values of 3 receptors w.r.t. $C(\lambda)$

$$e_1 = \int_\lambda S_1(\lambda)\, C(\lambda)\, d\lambda$$

$$e_2 = \int_\lambda S_2(\lambda)\, C(\lambda)\, d\lambda$$

$$e_3 = \quad \vdots$$

$\begin{bmatrix} e_1 \\ e_2 \\ e_3 \end{bmatrix}$ : Spectral responses of $C(\lambda)$

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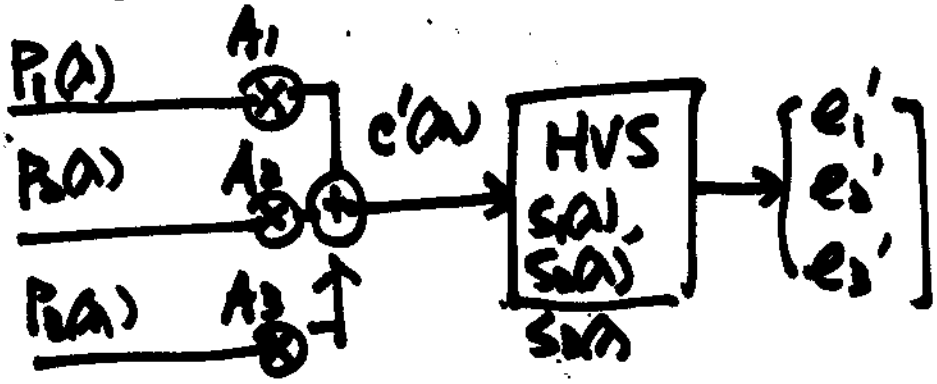
Need an eng. system to reproduce $C(\lambda)$

Color Matching System

Reproduce $C(\lambda)$ $\times$

To match 2 colors : $C(\lambda)$, $C'(\lambda)$

$$\begin{bmatrix} e_1 \\ e_2 \\ e_3 \end{bmatrix} = \begin{bmatrix} e_1' \\ e_2' \\ e_3' \end{bmatrix}$$ Condition




$P_1$, $P_2$, $P_3$ : primary colors

CIE : R G B

$P_1(\lambda) = \delta(\lambda - 700\text{ nm})$ R

$P_2(\lambda) = \delta(\lambda - 546.1\text{ nm})$ G

$P_3(\lambda) = \delta(\lambda - 435.8\text{ nm})$ B


• Spectral Colors

$$C'(\lambda) = \sum_j A_j P_j(\lambda)$$

$$e_i' = \int_\lambda C'(\lambda) \cdot S_i(\lambda)\, d\lambda$$

$$= \int_\lambda \sum_j A_j P_j(\lambda) \cdot S_i(\lambda)\, d\lambda$$

$$= \sum_j A_j \underbrace{\int_\lambda P_j(\lambda) \cdot S_i(\lambda)\, d\lambda}_{K_{ij}}$$

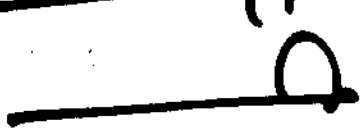
$$= \sum_j A_j K_{ij}$$

$$\begin{bmatrix} e_1' \\ e_2' \\ e_3' \end{bmatrix} = K \begin{bmatrix} A_1 \\ A_2 \\ A_3 \end{bmatrix} = \begin{bmatrix} e_1 \\ e_2 \\ e_3 \end{bmatrix}$$

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} A_1 \\ A_2 \\ A_3 \end{bmatrix} = K^{-1} \begin{bmatrix} e_1 \\ e_2 \\ e_3 \end{bmatrix}$$

$P_1 =$ 

$P_2 =$ 

$P_3 =$ 

Color

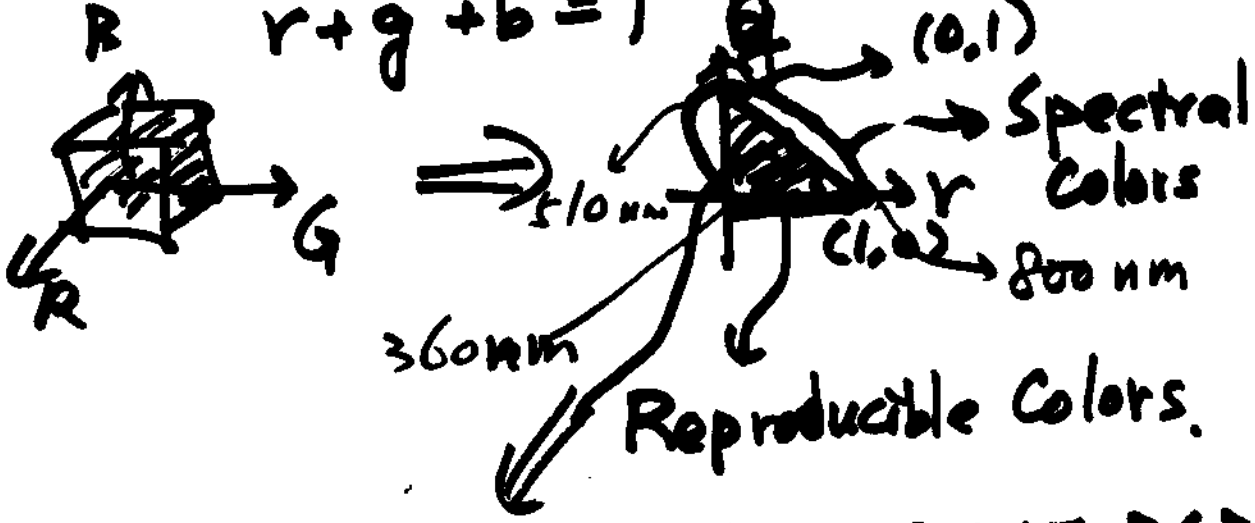
$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 255 \\ 0 \\ 128 \end{bmatrix}$$

# Chromaticity Diagram

R, G, B

$$r = \frac{R}{R+G+B}, \quad g = \frac{G}{R+G+B}, \quad b = \frac{B}{R+G+B}$$

$$r + g + b = 1$$




Color Gamut of CIE RGB System