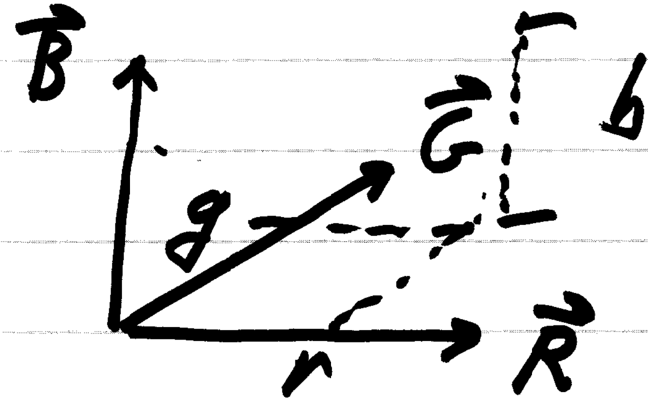
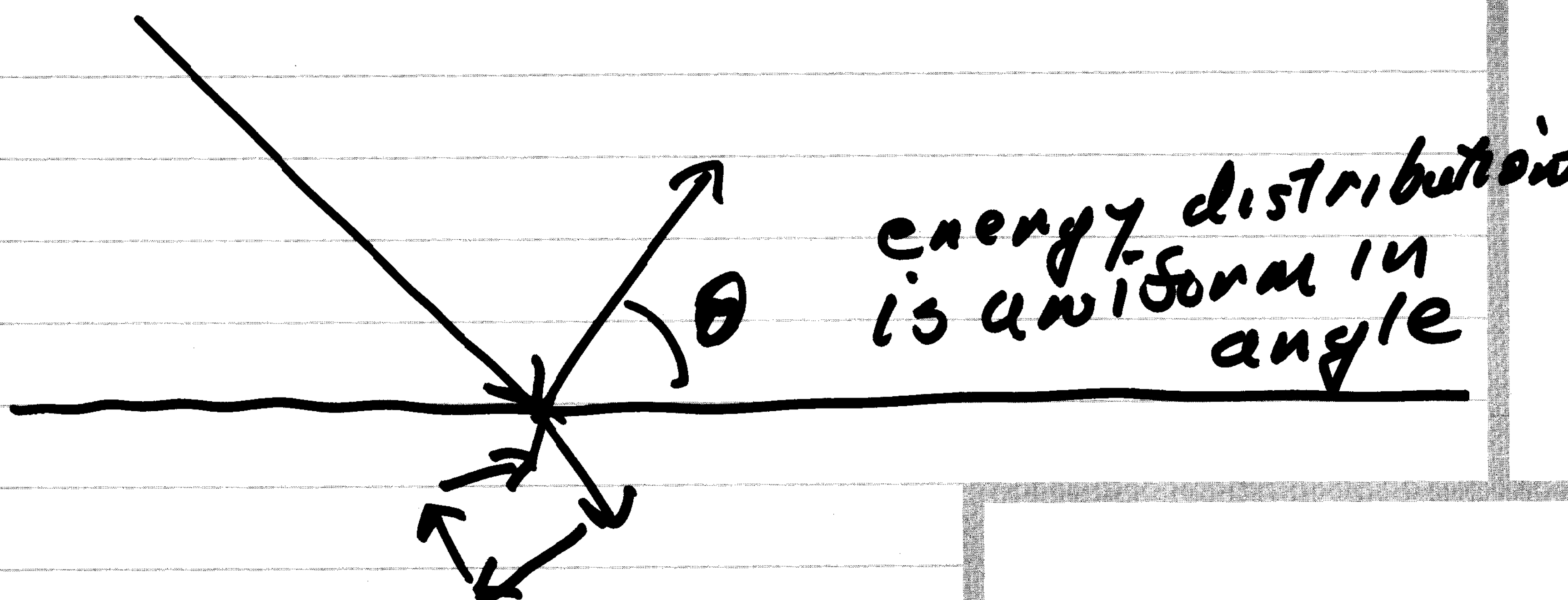
Color Cube



$$\text{“Color”} = \underbrace{\left[\vec{R}, \vec{G}, \vec{B}\right]}_{\text{Basis Vectors}} \overbrace{\begin{bmatrix} r \\ g \\ b \end{bmatrix}}^{\text{Coordinates}}$$

LAMBERTION

↑ spelling?



- Color matching functions are normally scaled so that

$$\int x_0(\lambda)\,d\lambda = 1$$

$$\int y_0(\lambda)\,d\lambda = 1$$

$$\int z_0(\lambda)\,d\lambda = 1$$

- So when $I(\lambda) = 1$

$$\Rightarrow [r, g, b] = [1, 1, 1]$$

$\Rightarrow$ white

$$(r, g, b) = (1, 0, 0)$$

$$= \text{red}$$

$$(r, g, b) = (0, 1, 0)$$

$$= \text{green}$$

$$(rg g, b) = (0, 0, 1)$$

$$= \text{blue}$$

So $(r,g,b) = (1,1,1) \Rightarrow$ white

$(r,g,b) = (1,1,0) \Rightarrow$ Yellow

$(r,g,b) = (0,1,1) \Rightarrow$ Cyan

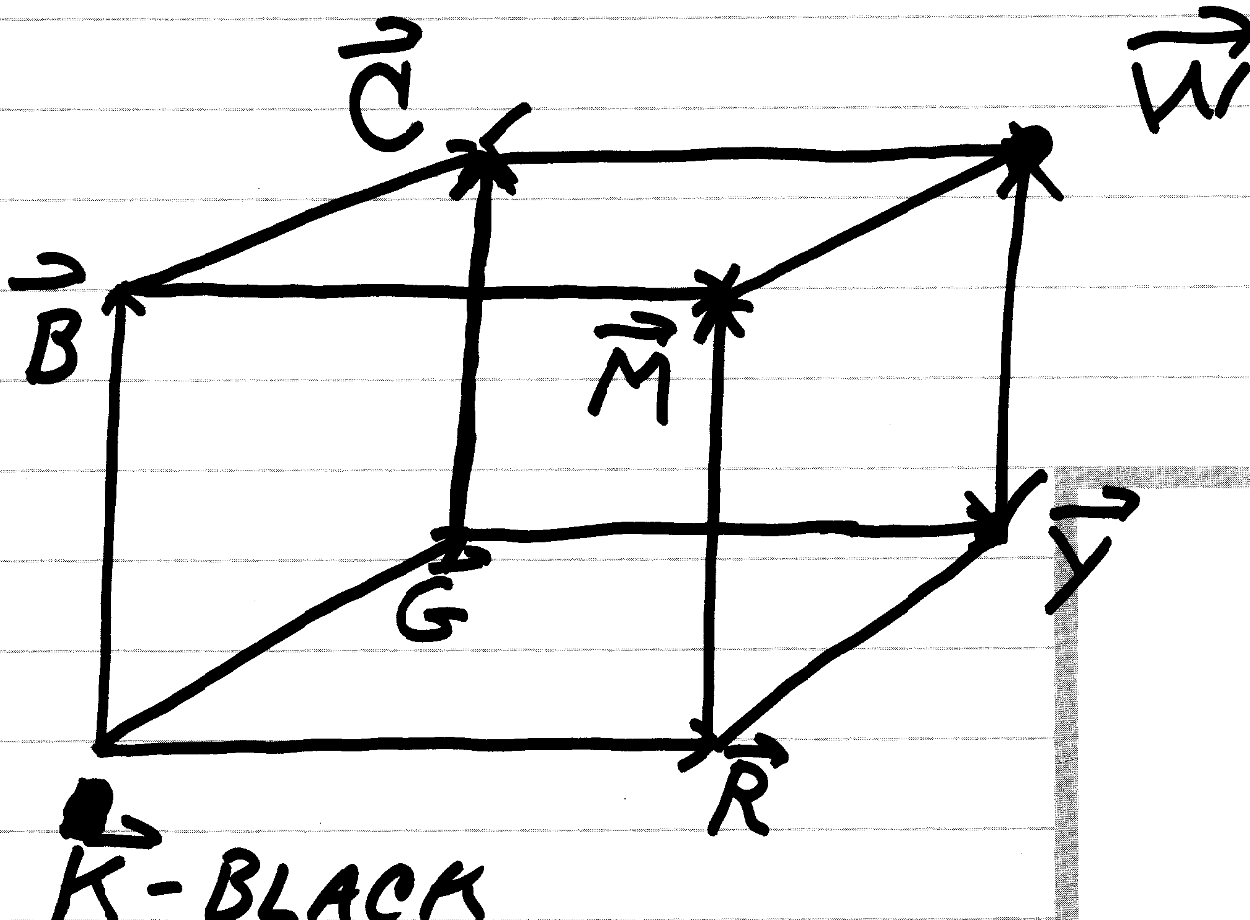
$(r,g,b) = (1,0,1) \Rightarrow$ Magenta

(Cyan, Magenta, Yellow)

= CMY

Color Cube

(Color Gamut)



$$[\vec{R}, \vec{G}, \vec{B}] \begin{bmatrix} r \\ g \\ b \end{bmatrix}$$

$$= \vec{W} + [\vec{R}, \vec{G}, \vec{B}] \left\{ \begin{bmatrix} r \\ g \\ b \end{bmatrix} - \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} \right\}$$

$$\vec{W} = [\vec{R}, \vec{G}, \vec{B}] \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$$

$$= W - [\vec{R}, \vec{G}, \vec{B}] \begin{bmatrix} 1-r \\ 1-g \\ 1-b \end{bmatrix}$$

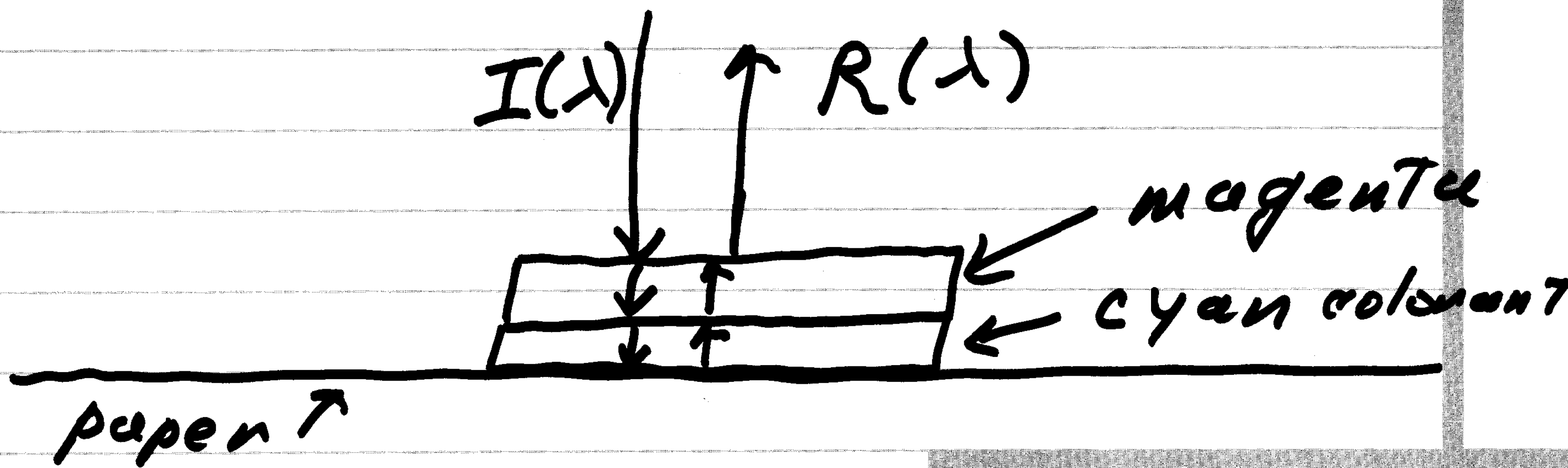
$$\begin{bmatrix} c \\ m \\ y \end{bmatrix} = \begin{bmatrix} 1-r \\ 1-g \\ 1-b \end{bmatrix}$$

$$[\vec{R}, \vec{G}, \vec{B}] \begin{bmatrix} r \\ g \\ b \end{bmatrix} = \vec{W} - [\vec{R}, \vec{G}, \vec{B}] \begin{bmatrix} c \\ m \\ y \end{bmatrix}$$

- This is called a subtractive color system.
- Used in
  - printing
  - paints and dyes

Subtractive Color

- Ink on surface of paper



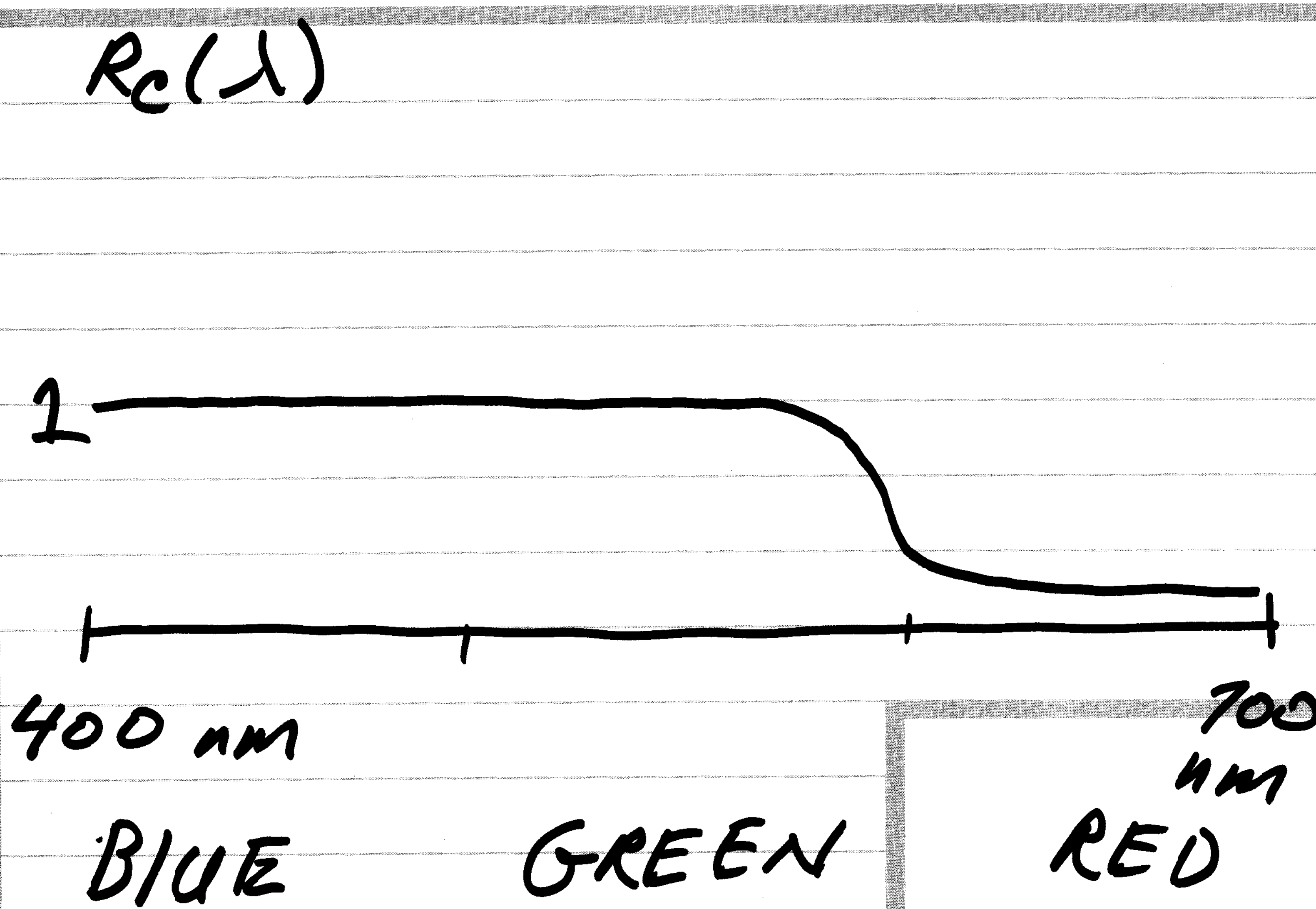
$$R(\lambda) = R_M(\lambda)\, R_C(\lambda)\, I(\lambda)$$

$I(\lambda) \leftarrow$ Illuminant

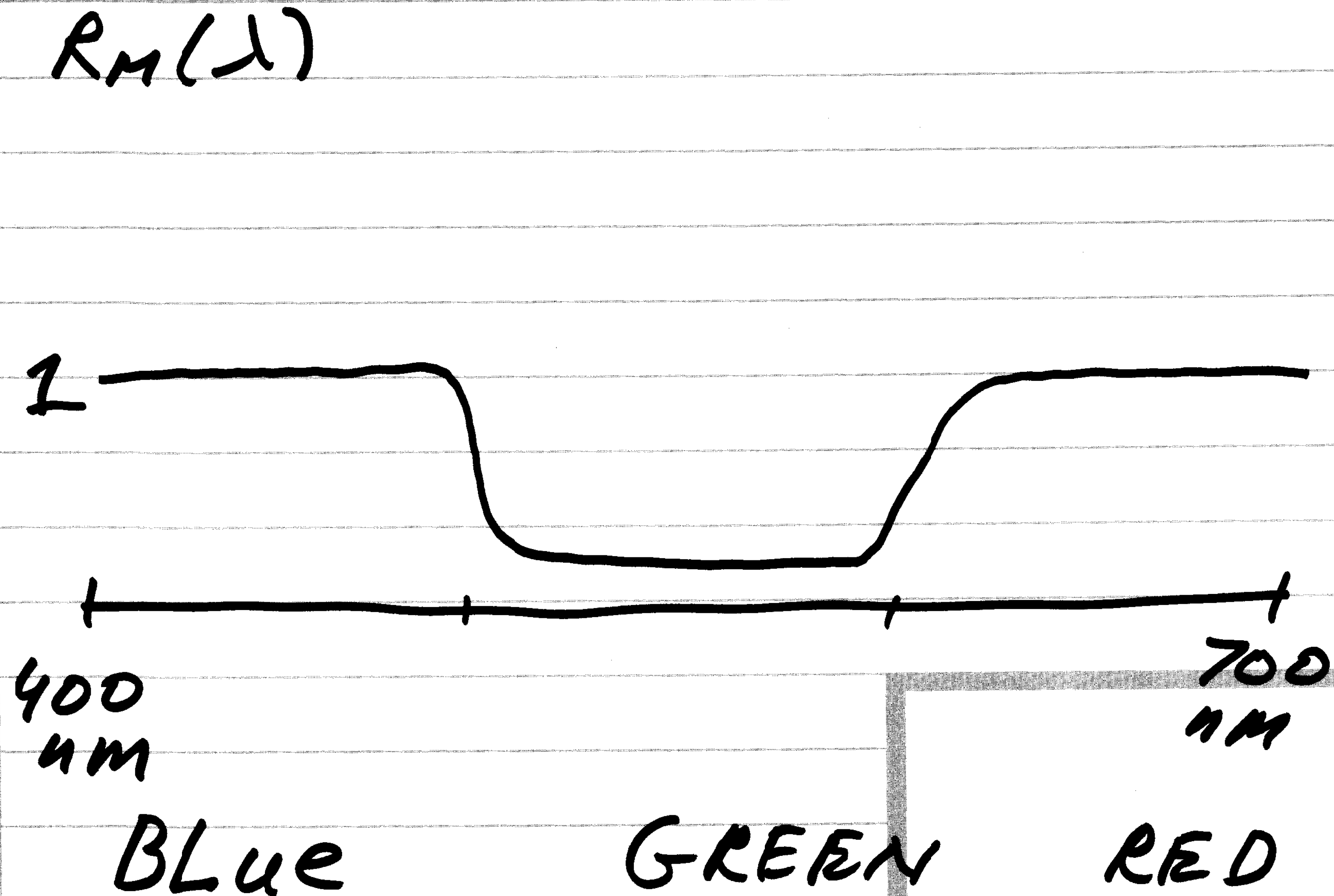
$R_C(\lambda) \leftarrow$ Cyan colorants

$R_M(\lambda) \leftarrow$ Magenta colorant

$R(\lambda) \leftarrow$ reflected light



$R_c(\lambda)$
1
400 nm
700 nm
BLUE
GREEN
RED



$R_M(\lambda)$
1
400 nm
700 nm
BLue
GREEN
RED

$$R_C(\lambda)\, R_M(\lambda)\, \underbrace{I(\lambda)}_{\text{all} \sim 1} = R(\lambda)$$