

**Problem**

What is a color stimulus to a camera? Or what determines the EM spectral characteristics to a camera?

**Solution**

A color that is measured or viewed is called a color stimulus. A color stimulus consists of light that has been reflected or transmitted from an object. The color stimulus results from the light characteristics of both the source and the object. The power spectral distribution of the stimulus is the product of the SPD of the source and the reflectance spectra of the object.

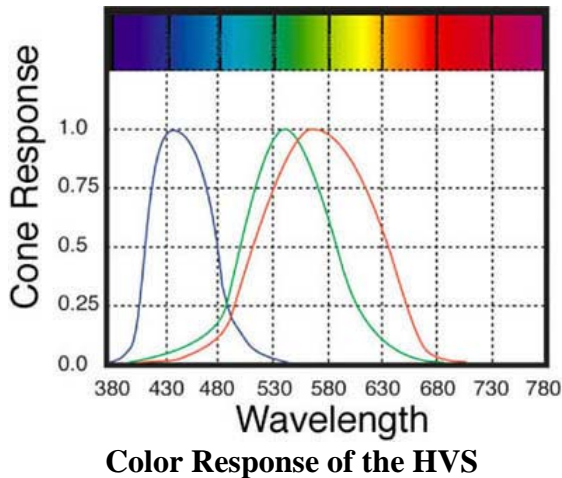
**Problem**

**a.**

What are the characteristics of the human vision system (HVS) that allows it to perceive color?

**Solution**

The human vision system (HVS) is trichromatic and has cones that respond to spectral bands in the blue, green, and red wavelengths. There is little sensitivity at wavelengths below 400nm or above 650nm. The HVS can distinguish approximately 10 million colors. The next picture shows the response of the different cones of the HVS.



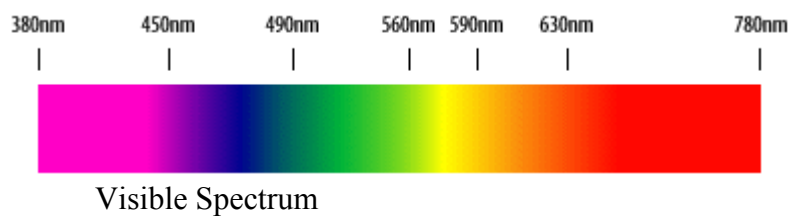
**Figure 1. Eye Spectral Curves ( from [www.adobe.com](http://www.adobe.com) web site)**

**b.**

What is the visible range of the EM spectrum?

**Solution**

The following figure gives the visible spectrum and their colors.



**c.**

Give in micrometers the spectral range for blue, green and red.

**Solution.**

The blue part of the spectrum is .4 to .49 micrometers.

The green part of the spectrum is .5 to .59 micrometers.

The red part of the spectrum is .6 to .69 micrometers.

### Problem

What is the CIE Standard Colorimetric Observer?

### Solution

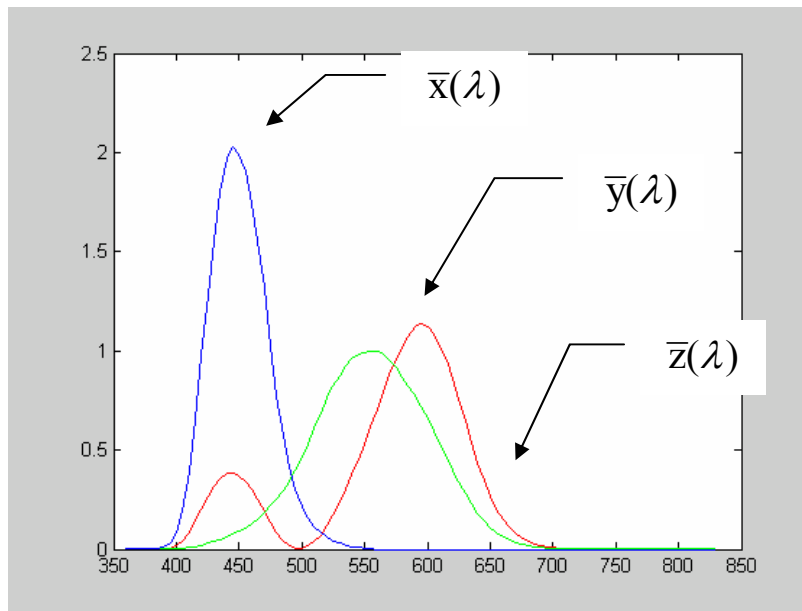
The CIE adopted a set of color matching functions to define a Standard Colorimetric Observer representative of the human population with normal color vision. The matching functions are CIE tristimulus values X, Y, and Z. The X, Y, and Z tristimulus values for a given object (characterized by its reflectance or transmission function) illuminated by a given light source (characterized by its spectral power distribution, SPD) can be determined by summing the products over the wavelength range where  $S(\lambda)$  is the SPD of a light source and  $R(\lambda)$  is the spectral reflectance function of the object. The terms  $\bar{x}(\lambda)$ ,  $\bar{y}(\lambda)$ , and  $\bar{z}(\lambda)$  are the color matching functions of the CIE Standard Colorimetric Observer.

$$X=k \sum_{\lambda=380}^{780} S(\lambda)R(\lambda)\bar{x}(\lambda)$$

$$Y=k \sum_{\lambda=380}^{780} S(\lambda)R(\lambda)\bar{y}(\lambda)$$

$$Z=k \sum_{\lambda=380}^{780} S(\lambda)R(\lambda)\bar{z}(\lambda)$$

The following figure gives the responses of 1931 CIE standard observer.



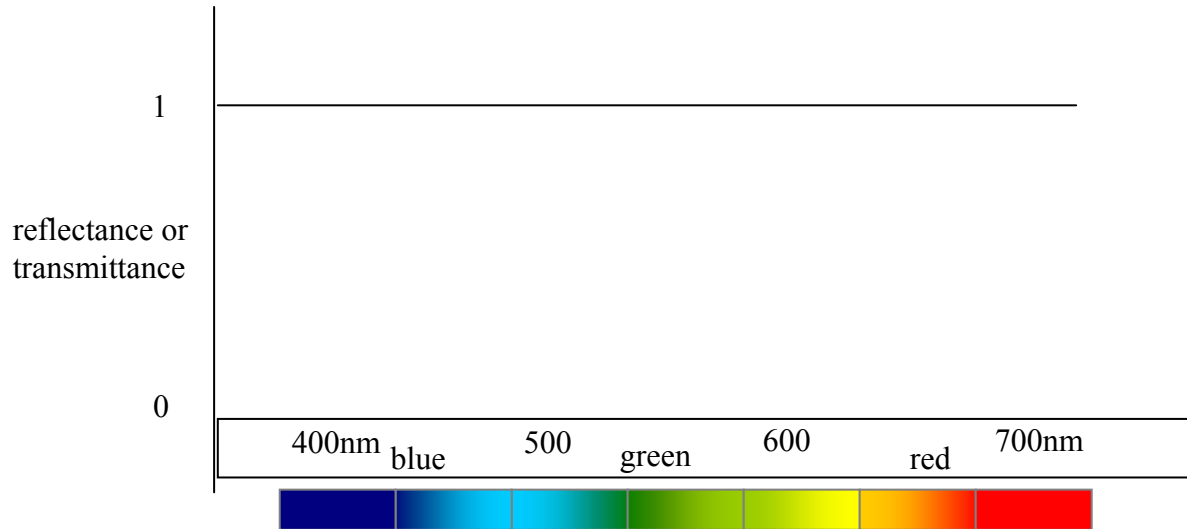
**CIE Standard Observer Spectral Curves-10 degree**

**Problem.**

What is the its spectral reflectance of a perfect white diffuser surface?

**Solution**

A perfect white diffuser is an ideal reflectance ( or transmittance) equal to one over the spectrum color.



**Figure 2. Perfect white**

**Problem****a.**

What light source does CIE standard illuminate A correspond to?

**Solution****b.**

What light source does CIE standard illuminate D65 correspond to?

**Solution**

CIE illuminates B, C and D correspond to daylight. Standard illuminate B approximates noon sunlight with a CCT of 4878K. Standard illuminate C corresponds to daylight and has a CCT (correlated color temperature) of 6774 K. The standard illuminants D50, D55, D65, and D75 represent daylight with CCTs of 5000K, 5500K, 6500K, and 7500K. Most spectrometers use a pulse of xenon light that approximates illuminant D. The D65 illuminate is a good approximation to natural daylight.