Tutorial 3: Solution

Q1.

$$x = \frac{r}{r+g+b} = 0.25 \qquad y = \frac{g}{r+g+b} = 0.25$$

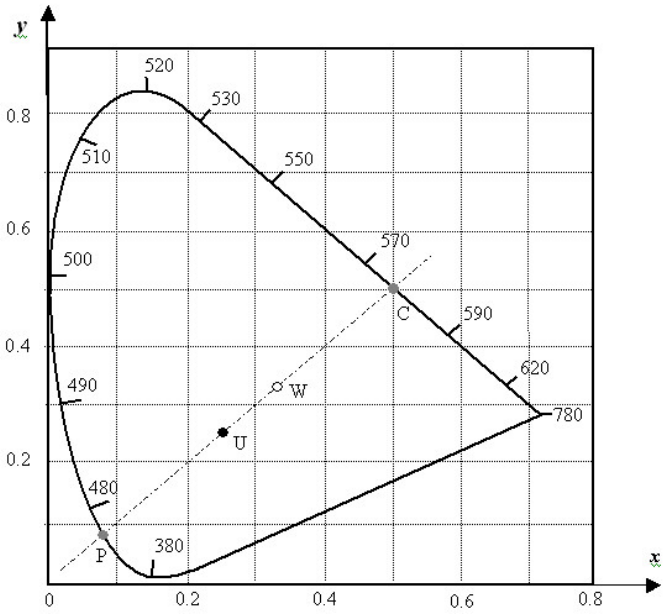
Q2. In the CIE plot below, the point U represents $(x, y) = (0.25, 0.25)$. The white point is W.

i. The point representing the pure hue is P, wavelength 388

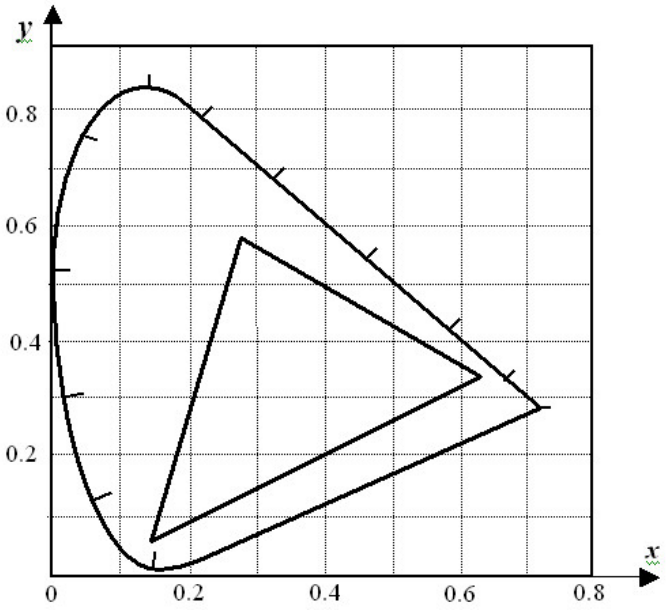
ii. The complement is point C, wavelength 575

iii. (0.08,0.09)

iv. The saturation is the ratio of the distances: $WU/WP \approx 0.335$



Q3. With the values given, the monitor can display colours inside the triangle shown below.



Q4. The RGB values need to be normalised in the range [0, 1] and, using the CIE coordinates for the monitors three phosphors, the transformation from (r, g, b) to (x, y, z) is given as follows:

$$\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \frac{1}{255} \begin{pmatrix} 0.62 & 0.27 & 0.15 \\ 0.34 & 0.59 & 0.07 \\ 0.04 & 0.14 & 0.78 \end{pmatrix} \begin{pmatrix} r \\ g \\ b \end{pmatrix}$$

We can multiply the constant into the matrix to get:

$$\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 0.0024 & 0.0011 & 0.0006 \\ 0.0013 & 0.0023 & 0.0003 \\ 0.0002 & 0.0005 & 0.0031 \end{pmatrix} \begin{pmatrix} r \\ g \\ b \end{pmatrix}$$

Q5. The RGB values are approximately (37, 69, 150):

$$\begin{pmatrix} 542 & -228 & -84 \\ -316 & 574 & 9 \\ 29 & -91 & 330 \end{pmatrix} \begin{pmatrix} 0.25 \\ 0.25 \\ 0.5 \end{pmatrix} \approx \begin{pmatrix} 37 \\ 69 \\ 150 \end{pmatrix}$$

Q6.

$$V = max(r, g, b) = 150$$

$$S = \frac{max(r, g, b) - min(r, g, b)}{max(r, g, b)} = \frac{150 - 37}{150} \approx 0.75$$

To find H, note that we have $g < r$ and $b < r$ so

$$H = 120 + 120 \times \frac{(b - r)}{(g - r) + (b - r)} = 120 + 120 \times \frac{(150 - 37)}{(69 - 37) + (150 - 37)} \approx 215$$

Q7. First we find out what the corresponding RGB values would be:

$$\begin{pmatrix} 542 & -228 & -84 \\ -316 & 574 & 9 \\ 29 & -91 & 330 \end{pmatrix} \begin{pmatrix} 0.1 \\ 0.2 \\ 0.7 \end{pmatrix} \approx \begin{pmatrix} -50 \\ 90 \\ 216 \end{pmatrix}$$

Since the red component is negative we can mix light from the red source (intensity 50) with the given test colour to obtain a match. The matching will be done with a mixture of green (intensity 90) and blue (intensity 216).