Color Representations

Task **(a)**

As per the question we are asked to find the RGB representation for a given Illumination, Reflectance, Tristimulus values. We can find the XYZ representation with the provided data and convert it to RGB color space. We are also provided with the RGB to XYZ transformation matrix. We can use it to find the XYZ to RGB transformation matrix.

$$XYZ2RGB = (RGB2XYZ)^{-1}$$

Now we need to find the XYZ values.

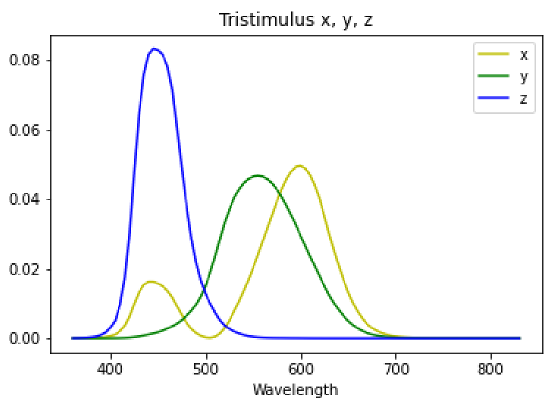
$$X = \int C(\lambda)x(\lambda)d\lambda \quad Y = \int C(\lambda)y(\lambda)d\lambda \quad Z = \int C(\lambda)z(\lambda)d\lambda$$

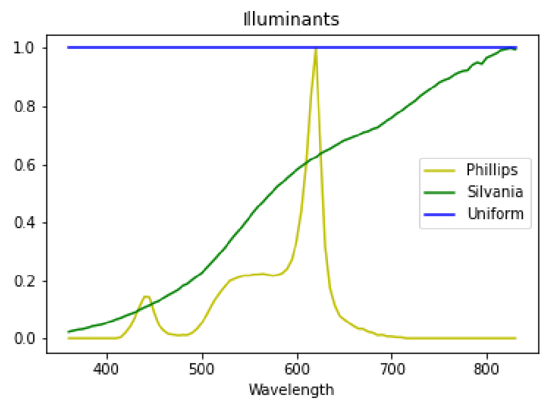
$$C(\lambda) = I(\lambda)\rho(\lambda)$$

In digital form they can rewritten as

$$X = \sum C(\lambda)x(\lambda) \quad Y = \sum C(\lambda)y(\lambda) \quad Z = \sum C(\lambda)z(\lambda)$$

Below are the pictorial representations of the given tristimulus data and three different illuminants.





For this task we are using unity reflectance for all values of lambda λ. $\rho(\lambda) = 1 \ \forall \lambda$
Since the reflectance is unity, the XYZ solely depends upon illuminant and tristimulus values. XYZ and RGB representations are shown below.

```
-------Illuminant Phillips----------

X_p, Y_p, Z_p     :      0.29 0.24 0.06
R_p, G_p, B_p     :      113 51 15

-------Illuminant Silvania----------

X_s, Y_s, Z_s     :      0.48 0.44 0.13
R_s, G_s, B_s     :      173 100 32

-------Illuminant Uniform----------
```

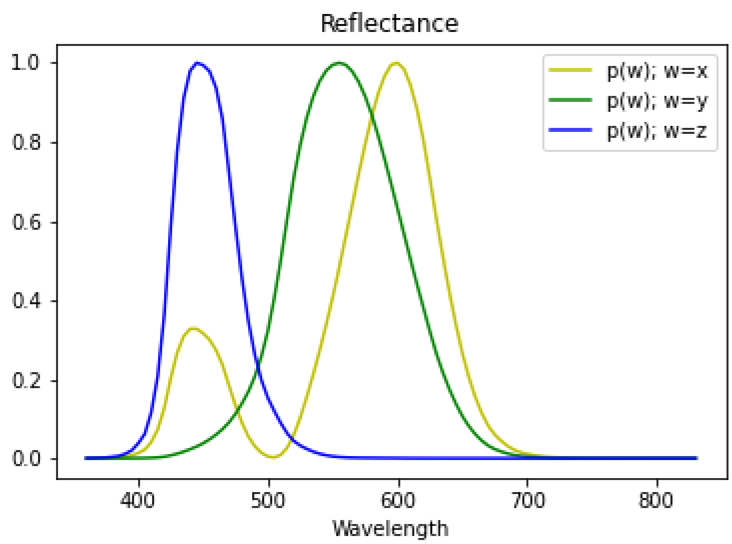
```
X_u, Y_u, Z_u     :      1.0 1.0 1.0
R_u, G_u, B_u     :      255 255 255
```

As we can see phillips illumination only significant around wavelengths of 600nm, it is only contributing to X and Y not Z. Silvania illumination seems like a linear illumination in the given wavelengths, it fares better than phillips illumination for all XYZ. In the uniform illumination, it has maximum illumination across all wavelengths and resulting in a maximum RGB values. All the above statements are evident in the results.

Task **(b)**

In the second task, we are considering only uniform illumination which has maximum and uniform illumination across all wavelengths. But the reflectance is given by

$$\rho(\lambda) \; = \; w(\lambda)/max(w(\lambda)) \; ; \; w \in \{x, \; y, \; z\}$$



Now we are taking reflectance as max normalization of tristimulus data. The normalized reflectance is shown in the above graph.

```
---------Illumination is Uniform and reflectance p=x(lambda)/max(x)------------

X,Y,Z :      0.63 0.5 0.23
R,G,B :      238 104 58

---------Illumination is Uniform and reflectance p=y(lambda)/max(y)------------

X,Y,Z :      0.53 0.72 0.08
R,G,B :      146 194 19

---------Illumination is Uniform and reflectance p=z(lambda)/max(z)------------

X,Y,Z :      0.13 0.04 0.74
R,G,B :      -19 14 190
```

As we can observe from the results, X becomes maximum when P_x is the reflectance, Y is maximum when P_y is the reflectance and Z is maximum when P_z is the reflectance. This is due to the fact that auto correlation is maximum for the same signals. Their RGB representations are also shown above.