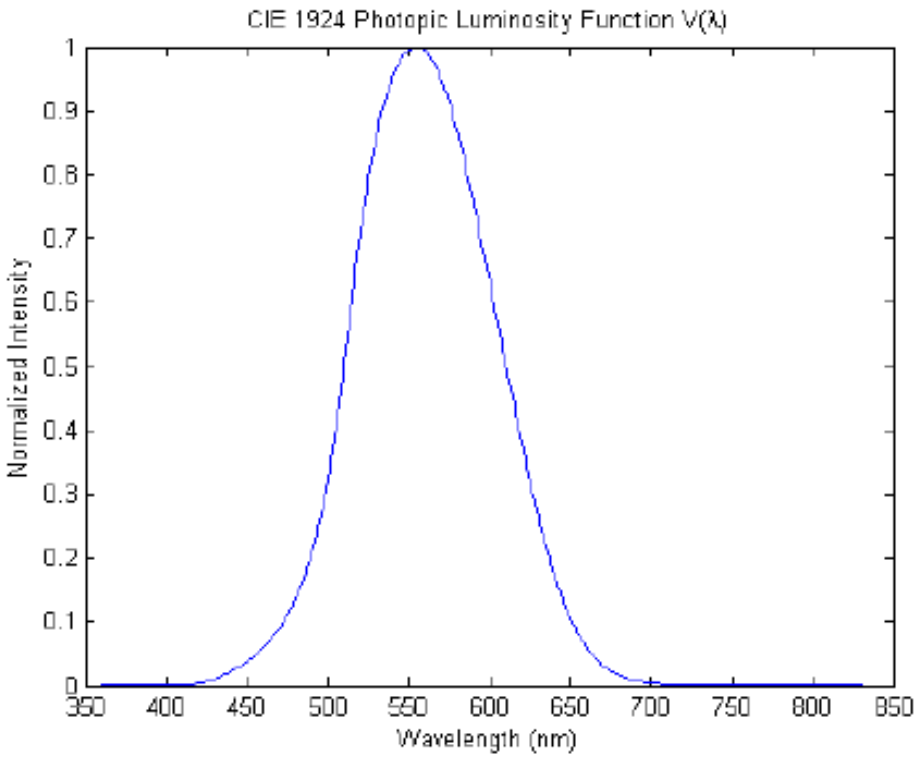
Homework 11.

Photometry.

During last class we discussed photometric units. These units express apparent brightness of a light source, so they are related to the sensitivity of a human eye.

To express a parameter of a light source in photometric units we have to calculate radiant flux of the source, then, using the luminosity function graph (shown in the Figure below) find corresponding luminous flux. The function V(λ) shown in the Figure above is called luminous efficiency. It expresses relative sensitivity of a human eye as a function of the wavelength.



Luminous flux [lumens, lm] = 683 x V(λ) x Radiant flux [W]

With the luminous flux value you will find most of the photometric parameters. They are:

1. Luminous flux (Lumen, lm). Lumen as a unit can be considered as a "photometric watt". But, to get lumen, we multiply optical power to a coefficient which expresses the "visibility" of the light energy.

2.Luminous exitance (lm/m^2) –luminous flux, emitted by a unit area of an emitting object's surface.

3. Illuminance (lm/m^2) –luminous flux, incident to a unit area of the absorbing object's surface.

4. Luminous intensity (candela, cd=lm/sr) –total optical power, emitted into a unit solid angle. A common candle has luminous intensity of approximately 1 cd (this is not a definition of candela!)

Problems:

1. A small monochromatic (emitting at a single wavelength) light source radiating at 500nm, is rated at 500W.

a) Assuming that the source radiates uniformly in all directions, determine its luminous intensity.
b) If the surface area of the source is $50cm^2$, determine its luminous exitance.

c) What is the illuminance on a screen situated 2m from the source, in the point closest to the light source? (The screen surface is normal to the radiant flux).

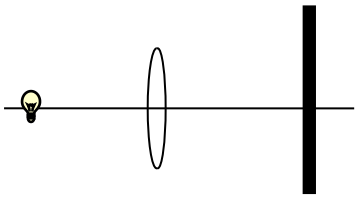
2. A 50mW Cd laser emits at 441.6nm. A 4mw He-Ne laser emits at 632.8nm. The laser beams of equal diameters are directed on a piece of white paper.

a) Compare the illuminances of the bright spots on the paper.

b) What power argon laser emitting at 488nm is required to match the illuminance of the He-Ne laser (with the same beam diameter)?

3. A radiant intensity of the lamp on top of 10m lamp post is 10W/sr and the light wavelength is 610nm. Calculate the illuminance in the point on the ground right below the lamp post.

4. An image of the bulb is created on the screen with a converging lens (see image below) with the magnification of 2. How will the irradiance within the image change if we exchange the places of the screen and the bulb?



5. Objects which are 10m away from the lamp post are illuminated 4 times less than objects which are just 5m away. Why if we stand 10 m away from the lamp post it looks as bright as from the 5 meter distance?