COLORIMETRY PROBLEMS

More difficult problems are indicated with an asterisk.

1. Two white lights look identical, but one is produced by an equal energy source and the other by combining two spectral primaries in appropriate proportions. Describe one or two simple experiments to tell which white source is which.

2. What is the hue and saturation of a color with chromaticity coordinates (0.3, 0.2, 0.5)?

3. What are the chromaticity coordinates corresponding to each of the following tristimulus vectors? (a) (5, 10, 25); (b) (-2, 3, -4).

4. Find the missing entry for each of the following chromaticity vectors. (a) (0.1, 0.3, ?); (b) (-.2, ?, .8); (c) (?, 0.0, 0.0).

5. Find the luminance, color coordinates and hue of a light source composed of 200 lx of light with chromaticity coordinates (0.2, 0.1, 0.7) and 800 lx of light with chromaticity coordinates (0.2, 0.7, 0.1).

6.* Explain why three carefully chosen real primaries can reproduce the hue of any color, but not its saturation.

7. Use the relation between tristimulus values and chromaticity coordinates to prove that the sum of the chromaticity coordinates is one.

8. Use the table of distribution coefficients to determine the chromaticity coordinates of light of 470 nm, 500 nm, 550 nm, and 600 nm wavelength. Check your results against the CIE chromaticity diagram.

9. What color are the X and Y colors of the CIE colorimetry system?

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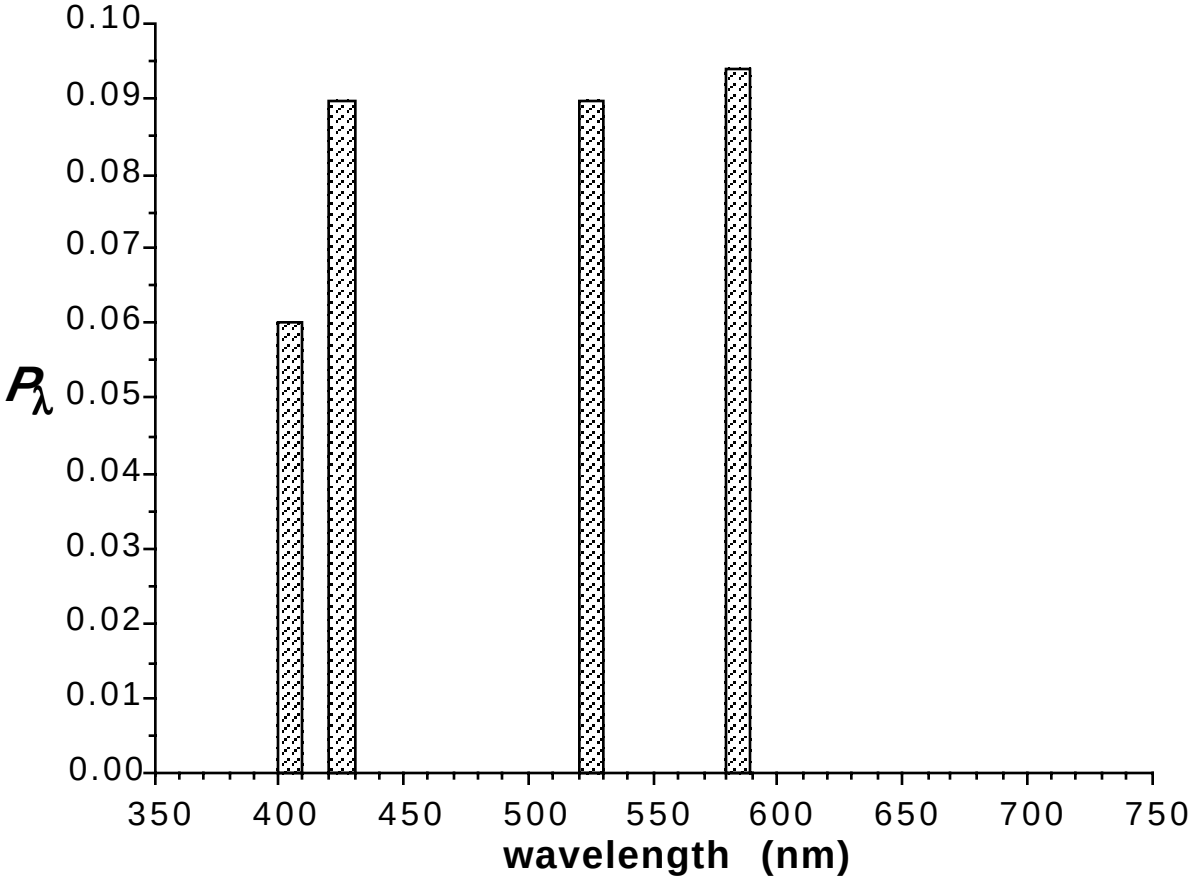
10. Find the chromaticity coordinates of the mercury vapor light with the spectral energy distribution shown below. The spectral power distribution is given in watts/nm.



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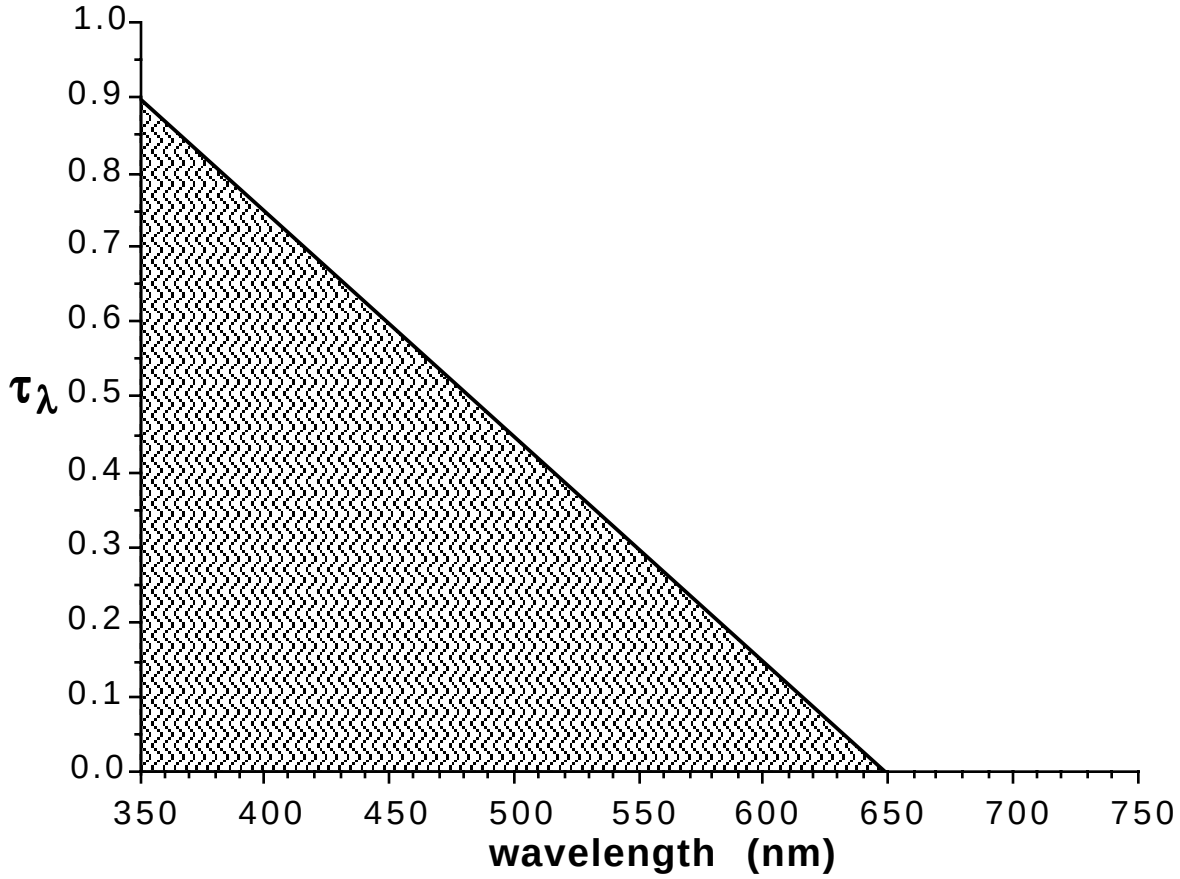
11. Find the chromaticity coordinates, color, and dominant hue of equal energy white light passed through a filter with the spectral transmittance plotted below.



ANSWERS to SELECTED PROBLEMS

1. The light could be sent through a grating or prism to see its line spectrum. A continuous spectrum would be the equal energy source, but the spectral source would show two distinct separated lines.

2. purple, ~50%

3. (a) (0.125, 0.25, 0.625); (b) (0.67, -1.00, 1.33)

4. (a) (0.1, 0.3, 0.6); (b) (-.2, .4, .8); (c) (1.0, 0.0, 0.0)

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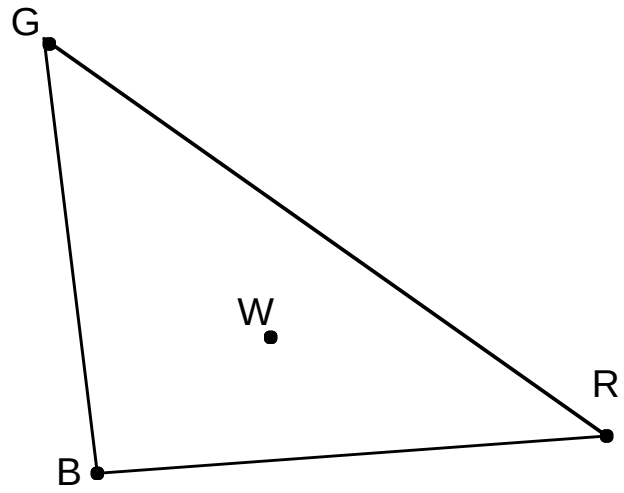
5. 1000 lx with chromaticity coordinates (0.20, 0.58, 0.22), a pastel green

6. An appropriate set of primaries would lie in a triangle which contains point W, as shown below.



By the center of gravity rule, these primaries could only combine to produce colors with chromaticity coordinates within the triangle. But R, G, and B must, since they are real primaries, lie on or within the spectral locus of the chromaticity diagram. Since that locus is convex, especially on its short wavelength leg, no triangle can encompass all the points within the spectral locus, hence the saturation of some stimuli will be imperfectly reproduced. Thus it is impossible to construct a perfect practical trichromatic color reproduction system.

9. The X color is a hypersaturated purple, the Y color a hypersaturated green.

10. The problem is simplified because we only have to sum over four values of P_λ, namely 0.06 at 400, 0.09 at 420 nm and 520 nm, and 0.095 at 580 nm. The resulting chromaticity coordinates are (0.33, 0.46, 0.22) which is a desaturated yellow–green with dominant wavelength ~557 nm.

11. (x, y, z)=(0.22, 0.25, 0.54), the color is desaturated blue

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