

Exam 3 – Color vision & Electrodiagnostics

11/16/05

1. If a monochromat attempts a metameric match of two different monochromatic lights, one with a wavelength of 550 nm and the other with a different wavelength, he will ...
 - a. never be able to achieve a metameric match since he requires at least three wavelengths.
 - b. be able to achieve a metameric match if both lights have the same radiance.
 - c. **be able to achieve a metameric match if both lights have the same luminance.**
 - d. be able to achieve a metameric match when both lights have the same radiance and luminance at the same time.

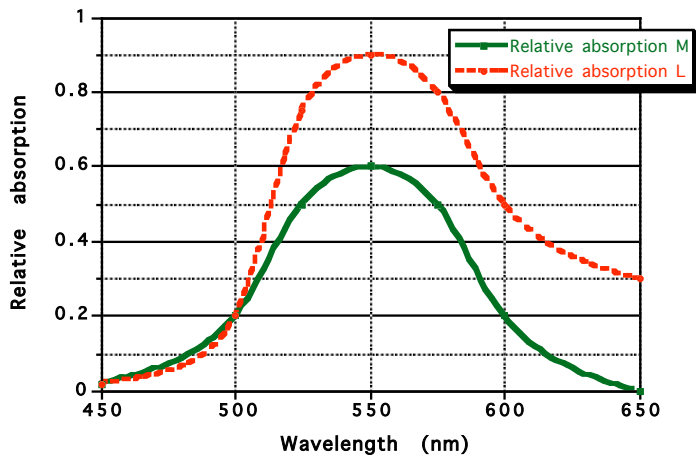


Figure for Question 2.

2. Refer to the figure above, which shows the absorption spectra of two hypothetical cone photopigments. In a color-matching experiment, the subject must mix 500-nm light with another wavelength (λ_A) to achieve a metameric match to of 550 nm light. Assume all three lights have equal radiance. What should λ_A be? Indicate your answer on the figure and write the wavelength, in nm, below. (2)

Between 575 and 585 nm

3. Which of the following best describes the trichromatic theory of color vision?
 - a. The retina has 3 cones types, which absorb either red, green or blue monochromatic light.
 - b. **The retina has 3 cone types, each of which absorbs light across a broad, but different, overlapping spectrum.**
 - c. The retina has one cone type that is capable of absorbing up to three wavelengths, in either the red, green or blue part of the spectrum.
 - d. Any color hue can be specified by three tristimulus values (X, Y, Z) in the CIE system.

4. Assume that one light, which is a mix of ($\lambda_a + \lambda_b$), is a metamer of another light, which is a mix of ($\lambda_c + \lambda_d + \lambda_e$). Next, assume you double the intensity of both lights. Which of Grassman's laws most directly applies and, which of the following will be true?
 - a. **Scalar property. They will still be metamers.**
 - b. Scalar property. They will no longer be metamers.
 - c. Additive property. They will still be metamers.
 - d. Additive property. They will not be metamers.

5. In the Munsell color appearance system, one color is designated 5R 5/14. What does this indicate? Include the names of the three basic color parameters used by Munsell in your explanation. (3)

Hue=5R for a mid-range red
 Value=5 for medium brightness
 Chroma = 14 for high saturation

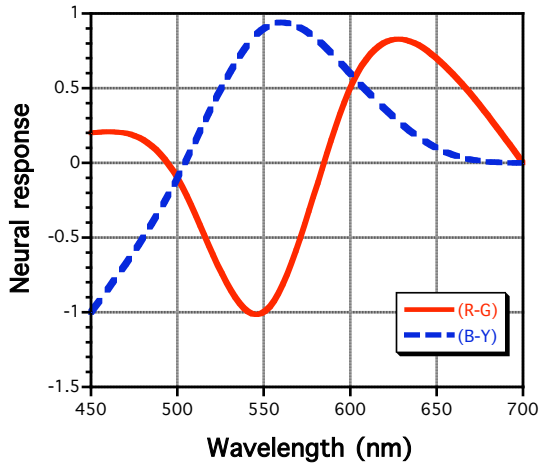


Figure for Question 6.

6. Refer to the figure above, which plots the neural response of the R-G and B-Y color opponent channels. Which of the following best describes the neural signal the brain would receive when the person looks at a monochromatic light with a wavelength of 600 nm?

- a. Excitation from the R-G system only
- b. Excitation from the B-Y system only
- c. Excitation from the R-G system and inhibition from the B-Y system
- d. Equal excitation of both the R-G system and B-Y systems

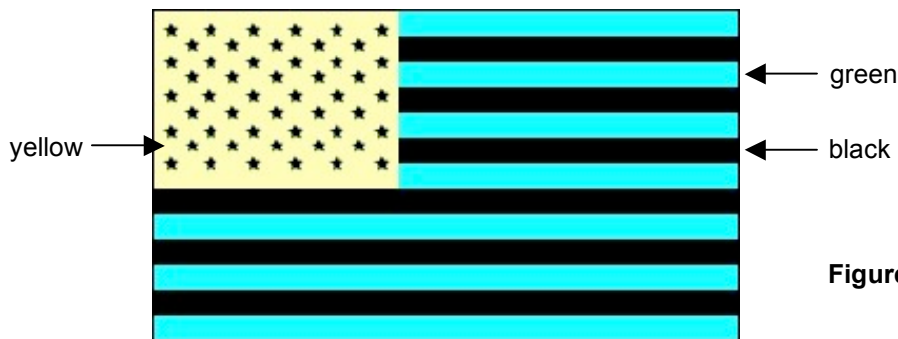
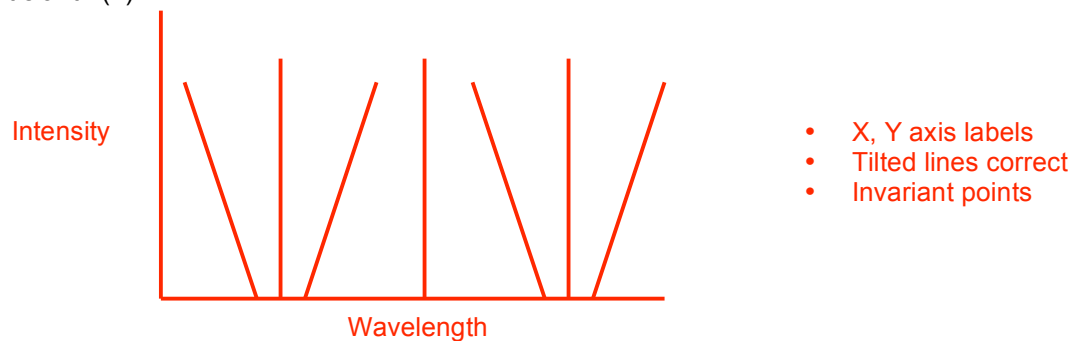


Figure for Question 7.

7. An American flag is drawn with the following color scheme: green and black stripes; a yellow union with black stars (above figure). If a person with normal color vision stares at this flag, then looks at a white page, what will he see and why? Explain this in terms of color opponent theory. (2)

A normal red white and blue flag due to adaptation of the color opponent systems.

8. Draw a simple graph, similar to the figure in Schwartz, which illustrates the Bezold-Brücke phenomenon. Briefly explain why the slanted hue contour lines tilt the way they do, and why some lines don't slant. (7)



With increasing luminance (intensity), some wavelengths, indicated by the tilted lines, change their hue. The lines show how the wavelength of these colors must be changed to maintain the original hue as intensity is increased. For example, for wavelengths above ~500 nm, the hue becomes more yellow, so the lines on either side of yellow tilt away from yellow to maintain the original hue. Wavelengths below ~500 likewise become more like blue with increasing intensity. The vertical lines indicate wavelengths that maintain the same hue, even with changes in intensity.

9. List five characteristics that can be used to differentially diagnose an acquired from a hereditary color anomaly. (5)

An acquired anomaly would have the following characteristics:

- Could be blue/yellow as well as red/green
- Monocular or asymmetric
- Recent onset and progressive
- Color naming errors more common
- Other ocular symptoms or indications of disease
- The patient could be a woman
- Diagnosis as a protan/deutans/tritan defect might not be clear-cut

10. How would the green and red lights of a traffic signal differ for a protanope, compared to a normal trichromat? (3)

- The green would be brighter than normal.
- The red would be dimmer.
- Both colors would be less saturated.

11. A patient mixes monochromatic green and red lights to obtain a metameric match with monochromatic yellow. If he thinks any red-green mixture looks the same hue as the yellow light, which of the following diagnoses is/are possible?

- a. protanomaly
- b. protanopia
- c. deuteranomaly
- d. deuteranopia
- e. none of the above

12. In addition to the adjustment described in Question 11, assume that the patient reduces the radiance of the yellow light below normal when the mixture setting is pure red, and increases the radiance above normal when the mixture is set to pure green. Which of the following diagnoses is/are possible?

- a. protanomaly
- b. protanopia
- c. deuteranomaly
- d. deuteranopia
- e. none of the above

13. For which of the following anomalies would the patient accept normal mixture and luminance settings?

- a. protanomaly
- b. protanopia
- c. deuteranomaly
- d. deuteranopia
- e. none of the above

14. Suppose the mixture setting contains a slightly greater-than-normal amount of green but the luminance setting is normal. He probably has ...

- a. protanomaly
- b. protanopia
- c. deuteranomaly
- d. deuteranopia
- e. none of the above

15. Suppose the mixture setting contains a slightly greater-than-normal amount of red but the luminance setting is significantly greater than normal. He probably has ...

- a. deuteranomaly
- b. deuteranopia
- c. protanomaly
- d. protanopia
- e. none of the above

16. The EOG test would be most useful in diagnosing which of the following?

- a. optic neuritis
- b. retinitis pigmentosa
- c. Stargardt's disease
- d. corneal abrasion

17. The standard ERG test would be most useful in diagnosing which of the following?

- a. optic neuritis
- b. retinitis pigmentosa
- c. Stargardt's disease
- d. corneal abrasion

18. The VER test would be most useful in diagnosing which of the following?

- a. optic neuritis
- b. retinitis pigmentosa
- c. peripheral retinal hole
- d. corneal abrasion

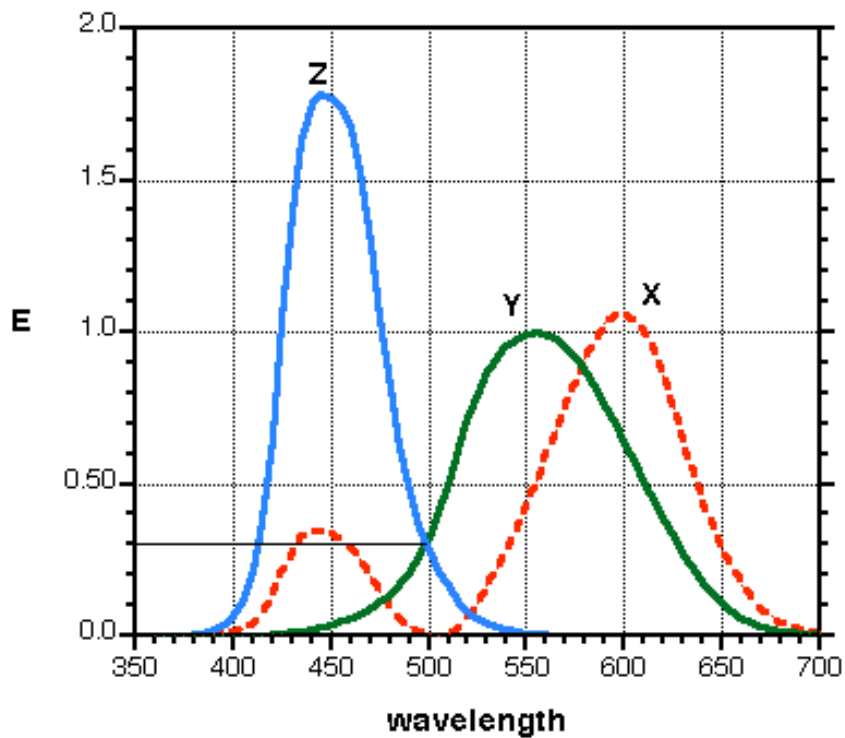


Figure for Question 19.

19. Using the figure above, compute the *chromaticity coordinates* (x , y) for 485, 505, and 625 nm. (3)

	x	y
485	0.07	0.20
505	0.00	0.66
625	0.70	0.30

20. On the CIE chromaticity diagram on the next page, label the points corresponding to the chromaticity coordinates for the three wavelengths mentioned in Question 19 (485, 505, 625 nm). (3)

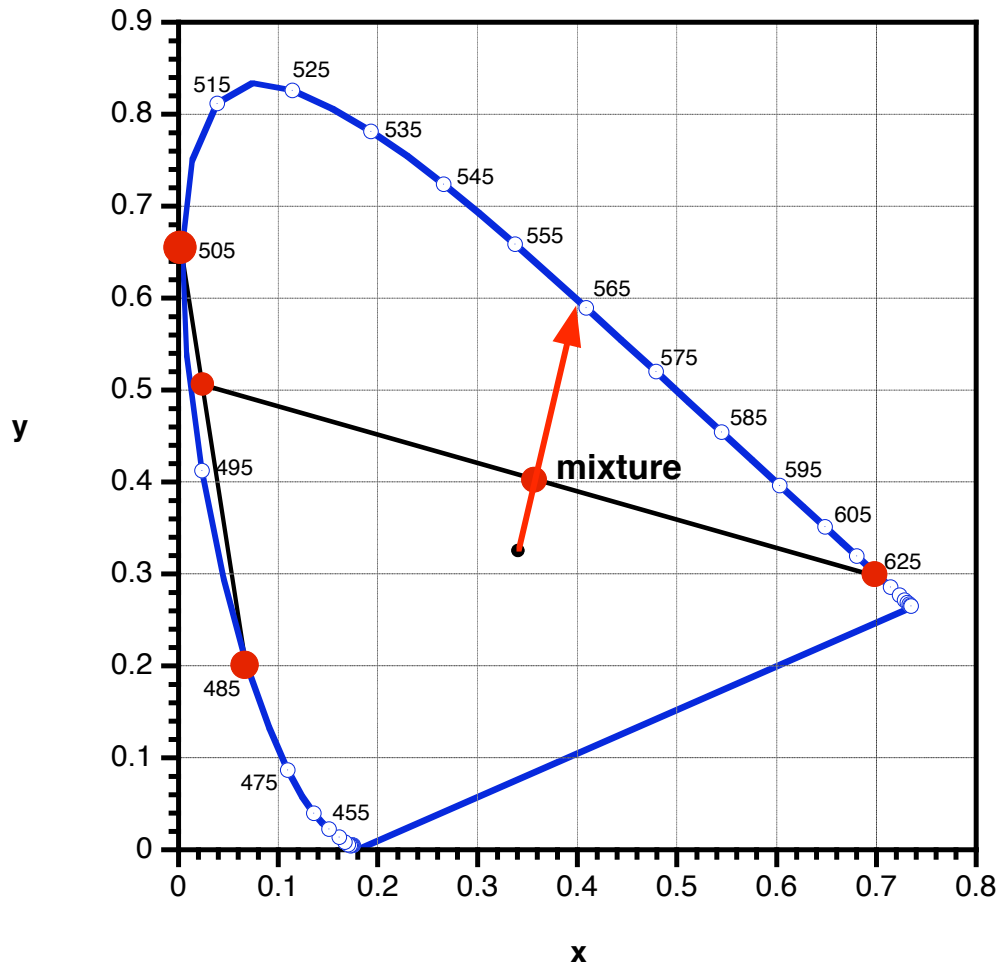
21. On the CIE diagram, indicate the color that results from a mix of the three pure spectral hues (485, 505, 625 nm) in a ratio of 1:2:3. (2)

22. What is the excitation purity of the color you computed in Question 21? (1)

~0.3

23. Draw an arrow on the diagram indicating the dominant wavelength of the color you computed in Question 22. (1)

Figure for Questions 20-23.



24. Describe the testing conditions, procedure and expected response if you use the HRR to evaluate a medium deuteranomalous trichromat. (6)

- Use Standard illuminant C
- Test eye separately (monocularly)
- Start with the 6 screening plates. He should get error in the R-G section.
- Test with the R-G diagnostic series. Record correct responses in the protan or deutan column.
- The column labeled, "deutan" will have more checks.
- The last errors will be in the middle section.

25. How would you differentially diagnose a protan from a deutan using the D-15 test? (2)

See if the crossovers parallel the deutan or protan reference lines.

26. For small central fields < 20 arc minutes in diameter, a color normal person will appear to be a ...

- a. rod monochromat
- b. protanope
- c. deuteranope
- d. tritanope
- e. none of the above

27. If a man who is a congenital protanope marries a woman who does not carry a gene for protanopia, what is the probability that one of their sons will be a protanope?

- a. 100%
- b. 50%
- c. 25%
- d. 12.5%
- e. 0%

28. If the male and female children of the couple described in Question 27 marry mates who do not carry a gene for protanopia, what is the probability that one of the grandchildren will be a protanope?

- a. 100%
- b. 50%
- c. 25%
- d. 12.5%
- e. 0%

Bonus point

29. Which of the following elite individuals, do you think, has the highest probability of winning the Nobel Prize within the next ten years? (1)

- a. Steven Schwartz
- b. Johnny Depp
- c. Ryan Fenska
- d. Douglas Penisten