

**Exam 1 – Aberrometry to Duplex Retina**

9/15/09

1. Complete the table below by writing the label for each Zernike mode using the standard OSA (Optical Society of America) two-index designation. Starting from the top, each row contains a Zernike order. The 0-th order mode,  $Z(0,0)$ , and the second-order mode,  $Z(2,0)$ , have already been entered. Complete the table for the other modes through the 4th order. (6)

		Z(0,0)		
	Z(1,-1)		Z(1,1)	
	Z(2,-2)	Z(2,0)	Z(2,2)	
Z(3,-3)	Z(3,-1)		Z(3,1)	Z(3,3)
Z(4,-4)	Z(4,-2)	Z(4,0)	Z(4,2)	Z(4,4)

2. Which Zernike coefficients (which modes) may be used to compute the equivalent clinical astigmatism value? (2)

Z(2,-2) and Z(2,2) only

3. Based Dr. Salmon's article, published in the Journal of Cataract and Refractive Surgery in December 2006, what is the average higher-order RMS value for a normal human eye? (1)

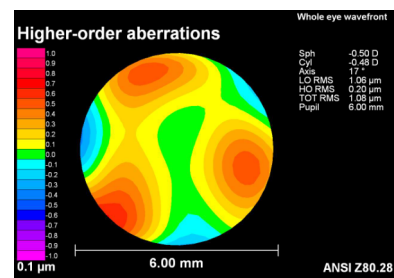
- a. 0.10  $\mu\text{m}$
- b. 0.19  $\mu\text{m}$
- c. 0.33  $\mu\text{m}$
- d. None of the above.

4. Which of the following best summarizes what clinical aberrometers measure? (1)

- a. Visual acuity
- b. The eye's refractive errors
- c. Corneal topography
- d. Higher-order aberrations only
- e. None of the above

5. Which Zernike mode is most dominant in the wavefront map to the right? (1)

- a. Astigmatism
- b. Trefoil
- c. Coma
- d. Spherical aberration
- e. Phototransduction



6. Why is it necessary to convert spherocylindrical refractive data from the standard clinical notation (sphere, cylinder, axis) into power vectors before adding or subtracting? Because ... (1)
- power vectors are faster and easier.
  - you cannot compute the spherical equivalent without power vectors.
  - you cannot directly add or subtract astigmatic powers with different axes.**
  - power vectors take into account the higher-order aberrations.
  - power vectors convert power in diopters to Zernike coefficients in micrometers.

$$J_{45} = -\frac{C}{2} \sin(2A)$$

$$M = S + \frac{C}{2}$$

$$J_{180} = -\frac{C}{2} \cos(2A)$$

$$cylinder = -2\sqrt{J_{45}^2 + J_{180}^2}$$

$$sphere = M - cylinder/2$$

$$axis = \frac{1}{2} \tan^{-1}\left(\frac{J_{45}}{J_{180}}\right)$$

7. A contact lens patient is wearing a soft toric lens with the following power: -3.00 -1.25 x 180. It rotates 10° clockwise on the eye and remains stable in that position. The over-refraction is: +0.50 -0.75 x 060. What is the total refractive power that this patient needs on the eye? Round power to the nearest 0.25 diopter and the axis to the nearest 10 degrees. (3)

Clinical notation			radians	Power vectors		
sphere	cylinder	axis		J45	M	J180
-3.00	-1.25	170	2.97	-0.214	-3.625	0.587
0.50	-0.75	60	1.05	0.325	0.125	-0.188

Math with power vectors			
J45	M	J180	
0.111	-3.500	0.400	
Sphere	cyl	axis	
<b>Sum</b>	-3.09	-0.83	8

**Answer: -3.00 -0.75 x 010 without correcting for rotation.**  
**(After correcting for rotation, the lens you should order is: -3.00 -0.75 x 020)**

8. Fill in the table below with maximum extent of the visual field you should expect in normal eyes. (4)

Direction	Superior	Nasal	Inferior	Temporal
<b>Extent (degrees)</b>	<b>50</b>	<b>60</b>	<b>70</b>	<b>90</b>

9. During a confrontation field screening, you observe that the patient's superior visual field is restricted, but you also notice that he has deep-set eyes. What should you? (1)
- Assume that the restriction is due to his face geometry, and assume the fields are normal.
  - Reschedule the patient for a Humphrey Visual Field exam.
  - Ask the patient to face slightly downward, while looking straight ahead, and re-measure.
  - Ask the patient to face slightly upward, while looking straight ahead, and re-measure.**

10. Which of the following are most consistent with each other and with a patient who has good central vision? (1)

- a. Decibel value of 32, dim stimulus, low threshold
- b. Decibel value of 32, bright stimulus, low sensitivity
- c. Decibel value of 15, bright stimulus, low threshold
- d. Decibel value of 15, low threshold, low sensitivity
- e. Decibel value of 32, bright stimulus, high sensitivity

11. Compute the retinal illumination for a sheet of paper that has a luminance of 30,000 apostilbs, assuming a pupil diameter of 4.0 mm. (1)

Convert luminance in apostilbs to luminance in nits:  $30,000/\pi$   
 Multiply luminance in nits by pupil area:  $(30,000/\pi)(\pi r^2) = 30,000*4 = 120,000$  trolands

12. How much will retinal illumination change if the pupil diameter increases from 4 mm to 8 mm? Express your answer in decibels. (1)

Retinal illumination increases by the square of pupil diameter. A 2x increase in pupil diameter will cause a 4x increase in retinal illumination. The log of 4 = 0.602. This is equal to 6 decibels.

13. Assume you are looking at a book in a room that has an overhead light controlled by a dimmer switch, and you increase the brightness of the light. Which of the following correctly describes what will happen? (1)

- a. The illumination will increase, but the luminance will remain constant.
- b. The illumination will remain constant but the luminance will increase.
- c. Both the illumination and luminance will increase.
- d. Both the illumination and luminance will remain constant.
- e. None of the above is correct.

14. Which of the following all contribute to greater sensitivity of the scotopic system? (1)

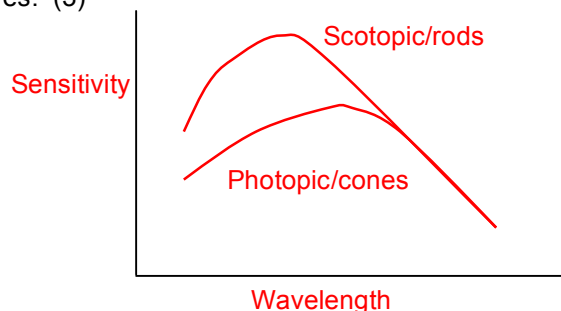
- a. Greater spatial summation, longer critical durations and the Stiles-Crawford Effect.
- b. Greater spatial summation, shorter critical durations and the Stiles-Crawford Effect.
- c. Smaller spatial summation, shorter critical durations and the Stiles-Crawford Effect.
- d. Smaller spatial summation and longer critical durations.
- e. Greater spatial summation and longer critical durations.

15. Which of the following all contribute to better resolution of the photopic system? (1)

- a. Greater spatial summation, longer critical durations and the Stiles-Crawford Effect.
- b. Greater spatial summation, shorter critical durations and the Stiles-Crawford Effect.
- c. Smaller spatial summation, shorter critical durations and the Stiles-Crawford Effect.
- d. Smaller spatial summation and longer critical durations.
- e. Greater spatial summation and longer critical durations.

16. Draw a graph showing the relative sensitivity of the photopic and scotopic systems as a function of wavelength. Label axes and curves. (3)

- Show:
- \* Correct axes labels
  - \* Scotopic curve above and the right shape
  - \* Photopic curve below and the right shape



17. How many minutes will it take for at least 93% of both the rod and cone photopigments to recover? (1)

- a. 5
- b. 10
- c. 15
- d. 20
- e. 25

18. In a heterochromic flicker photometry experiment, a 10-watt reference light of 555 nm is alternated with a test light. The flicker seems to stop when the test light is adjusted to a power of 20 watts. Which of the following is most likely the wavelength for the test light? (1)

- a. 350 nm
- b. 500 nm
- c. 550 nm
- d. 680 nm
- e. 800 nm

19. On the ETDRS logMAR visual acuity chart letter, size doubles every \_\_\_\_\_ line(s). (How many lines?) (1)

- a. one
- b. two
- c. three
- d. four
- e. None of the above

20. In a hypothetical study of vision with three different contact lenses, the mean logMAR visual acuity for Lens A was +0.12, Lens B was -0.08 and Lens C was 0.00. Which lens provided the best visual acuity? (1)

- a. Lens A
- b. Lens B
- c. Lens C
- d. Not enough information to say.

21. Assume that a patient can read down the ETDRS chart as far as the 20/40 line, but he misses two letters. What is the equivalent Snellen visual acuity? Round to the nearest whole Snellen number. (2)

A 20/40 letter has an MAR of 2.0 arc minutes. The log of 2.0 = 0.3.

Each letter missed adds 0.02 to the logMAR score.

The logMAR score is therefore 0.34.

Convert this back to Snellen.  $10^{0.34} = 2.1878$ . Multiply this by 20 to get the Snellen denominator.

$2.1878 \times 20 = 43.75$ .

Answer is: 20/44.