

## Vision Science II – Monocular Sensory Aspects of Vision

### Exam 1

September 13, 2006

1. What do the following instruments have in common in terms of the clinic information they provide? (1)

Retinoscope

Phoropter

Aberrometer

They can all measure refractive errors of the eye.

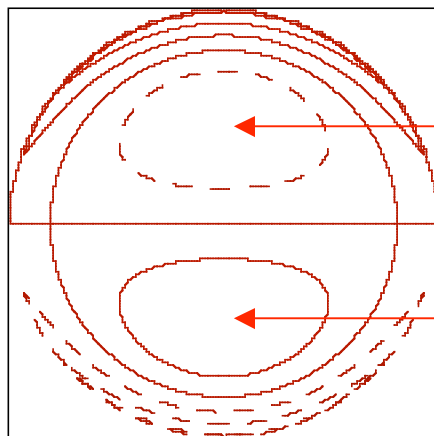
2. Which of the above instruments is most closely associated with psychophysical testing procedures? (1)

Phoropter. Lenses modify optical image quality (physics) and the patient judges visual quality (perception).

3. A refractive surgery clinic reports that most of its LASIK patients have HO RMS values of 0.5  $\mu\text{m}$  or less after surgery. How would you evaluate such an outcome (good, bad, other) and why? (2)

Can't say, since pupil size is not mentioned. This would be within normal for a 6.0-mm pupil, but it would be very bad for a 4.0-mm pupil.

4. Draw a wavefront contour map for Zernike mode  $Z_3^{-1}$  and label the high and low regions. In addition give its name and the mean absolute value expected for this aberration, based on norms from the Oklahoma database. (6)



Vertical coma  
Mean value = 0.14  $\mu\text{m}$   
(6.0-mm pupil)

1 point each for:

- Shape
- Orientation
- Low/high label
- Name
- Value with  $\mu\text{m}$
- Pupil diameter

5. Which of the following higher-order aberrations is most likely described by the mathematical formula shown in the box below? (1)

a. spherical defocus

b. astigmatism

c. trefoil

d. coma

e. spherical aberration

$$\sqrt{5}(6\rho^4 - 6\rho^2 + 1)$$

6. The table below shows the Zernike coefficients for several higher-order aberrations. Complete the table by rescaling the coefficients to a pupil diameter of 4.0 mm. In addition, compute the third-order RMS wavefront error for both pupil diameters. (6)

Pupil dia	Z(3,-3)	Z(3,-1)	Z(3,1)	Z(3,3)	RMS
6 mm	-0.17	0.24	-0.20	0.10	<b>0.37</b>
4 mm	<b>-0.05</b>	<b>0.07</b>	<b>-0.06</b>	<b>0.03</b>	<b>0.11</b>

7. Which of the following scientists improved on an earlier method and developed a technique for measuring higher-order aberrations that is now widely used in astronomy and ocular aberrometry? (1)

- a. Roland Shack
- b. Junzhong Liang
- c. Larry Thibos
- d. Douglas Penisten
- e. Isaac Newton

8. Which of the following scientists first used Shack-Hartmann aberrometry to measure higher-order aberrations of the human eye? (1)

- a. Roland Shack
- b. Junzhong Liang
- c. Larry Thibos
- d. Douglas Penisten
- e. Isaac Newton

10. By correcting the higher-order aberrations of the eye we can improve vision, potentially to supernormal levels. What other important benefit can aberration-correction (adaptive optics) provide for clinical eye care? (1)

Ultra-high resolution fundus photography

11. How well does HO RMS wavefront error correlate with visual acuity? That is, can we accurately predict a patient's visual acuity from his or her RMS value? Briefly state why or why not. (2)

They are poor correlated. (1), because different aberrations with the same RMS value affect VA differently and Zernike modes interact with each other in complex ways, making it hard to predict VA for a given RMS value (2).

12. Among the following clinical tests, circle the one/ones that is/are psychophysical. (1)

- a. confrontation fields
- b. keratometry
- c. visual acuity
- d. pupil reflexes
- e. tonometry

13. Under ideal conditions, a rod photoreceptor can be stimulated by 1 (How many?) photon/photons, and the capture of a minimum of 10 (How many?) photon/photons is sufficient for a person to detect light. (1)

14. If the Humphrey Visual Field Analyzer light source produces a maximum luminance of 10,000 apostilbs (0 decibels), and the sensitivity at one point on the visual field is 29 decibels, what is the luminance of the threshold test spot at that point in nits and apostilbs? (2)

Attenuation factor = 29 decibels =  $10^{2.9} = 794.33$ .  
 10,000 apostilbs/794.33 = 12.59 apostilbs  
 12.59 apostilbs/ $\pi$  = 4.0 nits

15. Assuming that the spot described in Question 14 is projected onto a pure-white (matte) surface, what is the illuminance at that spot? State the quantity and unit. (1)

12.6 lux

16. With the same light source and ND filter settings for the instrument described in Questions 14 and 15, assume that the perimeter surface is dirty and reflects only 80% of the incident light. What would the illuminance be at the spot? State the quantity and unit. (1)

12.6 lux

17. Assume you are doing heterochromic flicker photometry and the reference light, with fixed radiance, has a wavelength of 510-nm. Is it possible to find another wavelength of light that has both the same luminance and radiance as the reference light? Why? (2)

Yes, if the other wavelength has the same  $V(\lambda)$  value (opposite side of  $V(\lambda)$  function peak).

18. List the normal extent of the visual field in the four cardinal directions for a simple visual fields screening test such as confrontation fields. (2)

Superior	Nasal	Inferior	Temporal
50	60	70	90

19. The rod-cone break of the dark adaptation curve will be most prominent when the stimulus is ... (1)

- a. foveal and green
- b. foveal and red
- c. non-foveal and green
- d. non-foveal and red

20. Assume that a patient is having problems with night driving due to higher-order aberrations following LASIK. You decide to prescribe Alphagan eyedrops to reduce pupil size from an average of 6.0 mm to 4.0 mm. This should reduce the aberrations, but it will also reduce retinal illumination. Which of the following best describes the magnitude of the reduction? (1)
- The smaller pupil will reduce retinal illumination to 66% of the large-pupil amount.
  - The smaller pupil will reduce retinal illumination to 44% of the large-pupil amount.**
  - The smaller pupil will reduce retinal illumination to 22% of the large-pupil amount.
  - The smaller pupil will reduce retinal illumination to 11% of the large-pupil amount.

(Note: For comparison, typical sunglasses transmit about 15% of incident light.)

21. If a blue and yellow flower appear equally bright under scotopic conditions, how will they compare for brightness under photopic conditions? (1)
- The blue one will appear brighter.
  - The will be equally bright.
  - The yellow one will appear brighter.**

22. Mention two reasons why you should use a red light to read if you want to preserve dark adaptation. (2)

**Red light won't bleach rhodopsin as much as shorter wavelengths.  
Cones will also be available to help read since they are equally sensitive for red light.**

23. While stargazing you notice a faint star, but when you try to look directly at it, it disappears. Why? (1)

**There are no rods in the fovea, so sensitivity is worse there than in the perifoveal region, where rod density is high.**

24. Which of the standard illuminants is usually recommended for color vision testing? (1)
- A
  - B
  - C**
  - D

25. How does the photostress test help differentiate between diseases of the optic nerve and macula? (1)

**It tests dark adaptation, which depends on regeneration of photopigments in the photoreceptors. An abnormal photostress test indicates a problem with photoreceptors rather than nerves.**

26. Based on dark adaptation and a normal photostress recovery time, how long should you wait (minimum) after doing a BIO exam to do a subjective refraction? (1)

**2 minutes**