

Examination 1

(April 11, 2003; maximum 73 points)

1. List four different advantages (four distinct categories) of binocular vision compared to monocular vision. (4)

- Larger field of view
- Binocular summation for certain visual functions such as visual acuity, etc.
- Spare eye in case of injury
- Stereopsis and enhanced depth perception at near
- Enhanced performance in other vision-related activities, such as reading, sports, etc.

2. Mention one specific example of a clinical problem in which binocular vision would cause more problems for a patient than if he were monocular. (1)

- Acute ocular muscle paresis that causes diplopia
- Convergence insufficiency, vertical phoria or other problem with motor fusion
- Large anisometropia that makes sensory fusion difficult
- Incorrect refractive balance that causes eye strain
- Etc.

3. Based upon your knowledge of binocular vision and stereopsis, comment on the conclusion of the National Transportation Safety Board that the crash of Delta Airlines Flight 554 was caused by “the inability of the captain, because of his use of monovision contact lenses, to overcome his misperception of the airplane’s position relative to the runway during the visual portion of the approach.” State why you either agree or disagree with their conclusion. (3)

Example answer: I disagree with the NTSB, because under those conditions, it is unlikely that the presence or absence of stereopsis would have made any difference for the pilot in judging distances. Beyond about 165 meters it would have been impossible to judge distances using stereopsis. On the other hand, he had many monocular cues and even multiple monocular illusions that gave him an incorrect impression of the aircraft’s true altitude, which would have negated stereopsis, even if it had been present. (Give one conclusion supported by two reasons.)

4. During the alternate cover test, the patient notices that the eye chart appears to jump downward when you shift the cover paddle from his left to the right eye. What kind of vertical phoria does the patient have? (1)

OS hyper or OD hypo

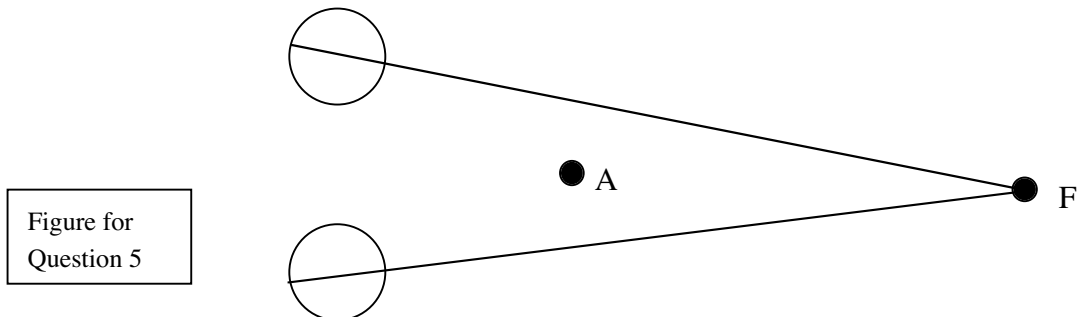
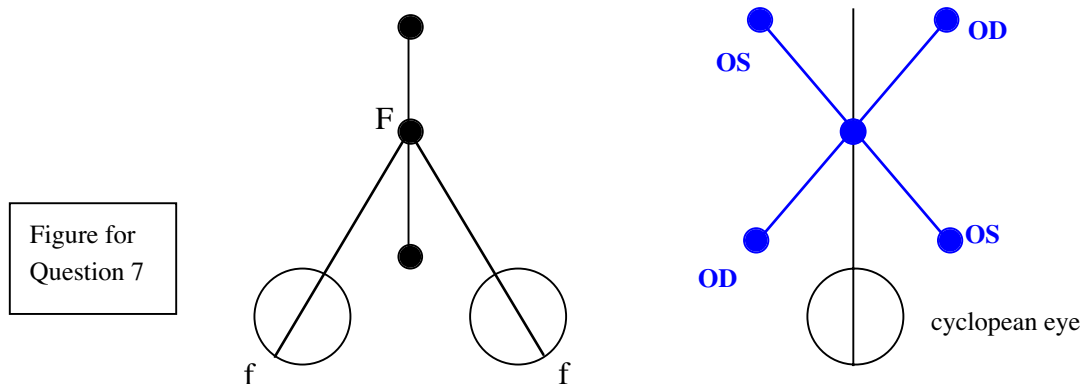


Figure for Question 5

5. Refer to the figure above. While both eyes fixate on Point F, they also see Point A, which is nearer than the fixation point. Which of the following statements correctly describes this situation? (1)
- The oculocentric visual direction of Point A is identical for OD and OS, and both agree with its egocentric direction.
 - The oculocentric visual direction of Point A is different for OD and OS and both are different from the egocentric direction of A.
 - The oculocentric visual direction of Point A for OD agrees with the egocentric direction, but OS disagrees with it.
 - The oculocentric visual direction of Point A for OS agrees with the egocentric direction, but OD disagrees with it.
6. List the six types of vergence eye movements we studied, and mention what stimulates each. (12)
- Disparity vergence – stimulated by retinal disparity
 - Accommodative vergence – stimulated by accommodation
 - Tonic vergence – resting position of the eye when they are not fixating, but receiving normal innervation
 - Vergence adaptation – stimulated by disparity or accommodative vergence; increases over time to take over for disparity and accommodative vergences
 - Proximal vergence – stimulated by an awareness of nearness of an object
 - Voluntary vergence – caused by deliberately crossing the eyes



7. Refer to the figure above. It shows a person's eyes fixating the center bead of a Brock string. Using the cyclopean eye to the right, draw in what the patient would perceive, assuming he had normal binocular vision. Be sure to clearly label which part of the binocularly perceived image came from which eye. (5)
8. A medical laboratory worker complains of eyestrain and headaches whenever he uses a binocular microscope for a long time. He is emmetropic, has no significant heterophoria and has an adequate amplitude of accommodation. Assuming that the symptoms are being caused by over convergence and over accommodation, which of the following prescriptions would be most helpful for him? (1)
- low plus lenses and BI prism
 - low plus lenses and BO prism
 - low minus lenses and BI prism
 - low minus lenses and BO prism
9. Write a brief definition of the term "horopter." (1)

It is the location of points in space, where an object must be placed to stimulate corresponding points on the two retinas.

10. At the abathic distance the AFPP horopter coincides with the ... (1)
- point horopter
 - Vieth-Müller Circle
 - objective fronto-parallel plane
 - Fechner's paradox
11. All of the following except one can contribute to the Hering-Hillebrand deviation? Which would be least likely to contribute? (1)
- binocular summation
 - unequal image sizes on the two retinas
 - fixation disparity
 - asymmetric distribution of local sign across the nasal and temporal retinas
12. Why does the Nonius technique provide the truest estimate of the horopter? (1)
- It is not affected by the Hering-Hillebrand deviation.
 - It uses a vernier alignment technique, which is very accurate.
 - It is designed to locate the true apparent fronto-parallel plane.
 - When a rod appears aligned, it will be in a location that stimulates corresponding points.
13. Think of how you could create a fixation disparity test using software (such as Microsoft Word or PowerPoint) that allows you to draw simple geometric figures on a computer screen. Assume that you will use red-green anaglyph glasses (red over OD/ green over OS) with your test. In the space that follows, draw a picture of our test and label all the parts so it will be clear how it works. (4)

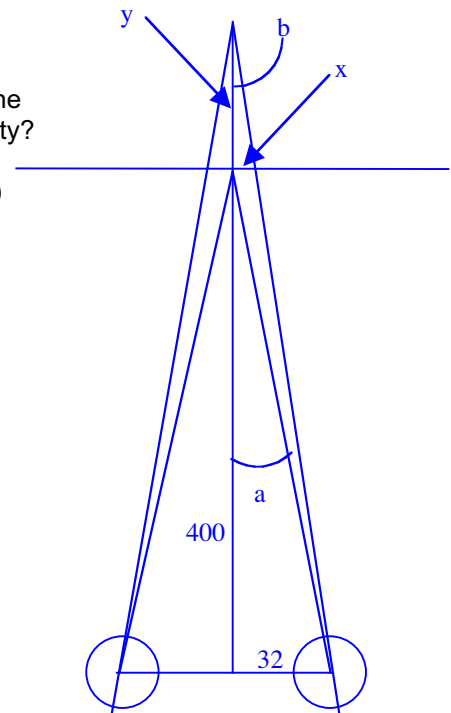
The figure must include:

- A fusion lock, such as black frame, seen by OU.
- A line seen by OD only, such as a green line on a white background, or red line on a black background
- A line seen by OS only
- Some system for determining the magnitude of the fixation disparity

14. In a Wesson card-type fixation disparity test how far apart would the lines appear to be for patient who had a 4-arc minute exo fixation disparity? Assume that the card is designed to be viewed at 40 cm and the patient has a PD of 64 mm. If you want partial credit, show your work below. (6)

$$\begin{aligned} \text{angle } a &= 4.5739^\circ = 274.435' \\ \text{angle } b &= a - 2' = 272.435' = 4.5406^\circ \\ \text{distance } 400 + y &= 32 / \tan(b) = 402.9489 \text{ mm} \\ \text{distance } y &= 2.9489 \text{ mm} \\ \text{By similar triangles, } x/y &= 32 / 402.9489, \\ \text{therefore } x &= y(32) / (402.9489) \\ x &= 2.9489(32) / (402.9489) \\ x &= 0.234 \text{ mm} \end{aligned}$$

The distance between the lines would be twice this.
Distance between lines = 0.468 mm



15. Assuming OD sees the top line, which direction would the top line appear to be displaced in the above example? (1)

left

16. Using a standard Wesson card with standard polarized spectacles, you can measure a vertical fixation disparity by rotating the card 90 degrees. Assume that the patient continues to wear the same polarized glasses, but you rotate the card 90 counter-clockwise. If the patient now reports that the right line is above center, and the left line is below center, what kind of fixation disparity does he have?

- a. OD hyper
- b. OS hyper
- c. Zero vertical fixation disparity
- d. It can't be determined by this method.

17. Using a vectograph target, you determine the amount of prism necessary to align the vertical limbs of the cross-shaped target. You have measured the ... (1)

- a. fixation disparity
- b. associated phoria
- c. dissociated phoria
- d. prism adaptation

18. If binocular summation were due to probability summation alone, you would expect binocular sensitivity to be better than monocular sensitivity by factor of about ... (1)

- a. 0.7
- b. 1.0
- c. 1.4
- d. 2.0

19. How was Martin able to demonstrate that neural summation does indeed occur when measuring the threshold for detection of light? (4)

- He measured binocular thresholds when binocular fusion occurred.
- He then reduced the possibility that neural summation could occur by presenting lights to the two eyes one after the other, rather than simultaneously.
- For interstimulus intervals greater than 100 msec, neural summation would be impossible, but probability summation would still be possible.
- Significantly lower thresholds (greater sensitivity) for short ISIs than long ISIs were due to neural summation in addition to probability summation.

20. Which of the following is most consistent with Fechner's paradox?

- a. A light viewed binocularly, with an ND filter over one eye, appears dimmer than when viewed monocularly without the ND filter.
- b. A light viewed binocularly, with an ND filter over one eye, appears dimmer when the filter is removed.
- c. A light viewed binocularly without an ND filter is dimmer than the same light viewed monocularly without the ND filter.
- d. binocular facilitation

21. When doing direct ophthalmoscopy, you notice an opacity in the pupil that seems to move in the same direction as your head. It is most likely a ... (1)

- a. persistent pupillary membrane

- b. corneal scar
- c. [Mittendorf dot](#)
- d. episcapsular stars (pigment on the anterior lens)

22. When viewing a scene in a View Master stereoscope normally, you can get a strong sensation of stereoscopic depth; for example, Mickey Mouse in the foreground with the Magic Kingdom in the distance. If you flip the slides, so the right and left eye images are reversed, you don't see a reversal of the position of objects, despite the fact that the disparities are reversed. (That is, you don't see the Magic Kingdom in the foreground and Mickey in the distance.) Why? (2)

[The many monocular depth cues still give you a correct distance perspective. Reversed disparity contradicts these cues, but the brain ignores them since they don't make sense.](#)

23. A stereogram of a pyramid is made up of a red pyramid on a black background slightly to the left and a green pyramid slightly to the right. If you view it with red-green anaglyph glasses (OD red/OS green), the binocularly view image will be seen with (1)

- a. [crossed disparity and the pyramid will appear to come out toward you.](#)
- b. uncrossed disparity and the pyramid will appear to come out toward you.
- c. crossed disparity and the pyramid will appear to recede away from you.
- d. uncrossed disparity and the pyramid will appear to recede away from you.

24. Refer to the figure below. Polarizers are used with a flat target that consists of two vectograph lines. OS sees only one line straight ahead, and OD fixates on the right line, but sees another one to the left. This creates a perception of two lines seen in stereoscopic depth—a fixated line and another located at a distance of y closer to the observer. How much must the second line, seen by OD, be offset to the left (distance x to the nearest 0.01 mm), to create a crossed disparity of 40 arc seconds? Assume a PD of 64 mm and a working distance of 40 cm. Show your work for partial credit. (4)

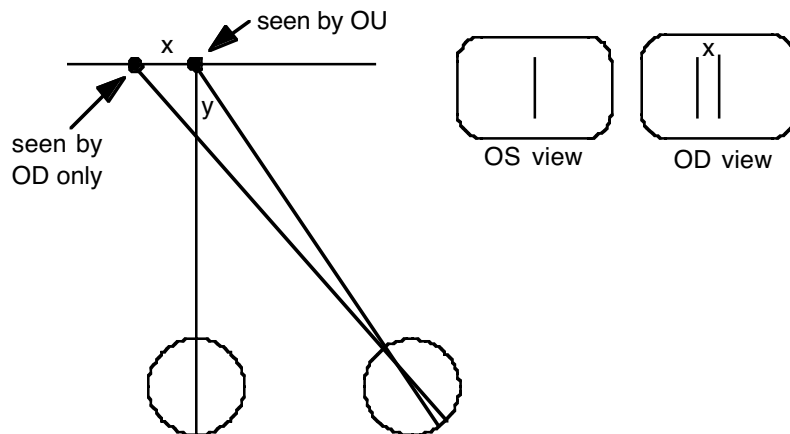


Figure for Question 24.

1. $\text{Convergence angle to the right dot} = \text{atan}(64/400) = 9.09^\circ = 32,725''$
2. Add 40'' for near angle: $32,725 + 40 = 32765 = 9.101^\circ$
3. $\text{Tan}(9.101) = 64/(400-y)$. Solve for $y = 0.50$ mm.
4. Using similar triangles, solve for $x = 64(y)/399.5 = 0.08$ mm

You can also solve for this using the disparity equation.

1. Write the correct formula, solving for $\Delta D = (\text{disparity})^2/64$
2. Convert disparity of 40 arc seconds to radians and insert into equation.
3. Compute ΔD , which is y in the figure = 0.4848
4. By similar triangles, compute dimension x . $0.4848/400 = x/64$

25. If a person with glaucomatous damage to OD experiences the Pulfrich effect, how would a pendulum swinging from left to right in his fronto-parallel plane appear to move? (1)

- a. Away from the person, or in a clockwise elliptical path if seen from above.
- b. Toward the person, or in a counter-clockwise elliptical path if seen from above.
- c. In a circle that contains the fixation point and nodal points of both eyes.
- d. In the opposite direction, that is, right to left in the fronto-parallel plane.

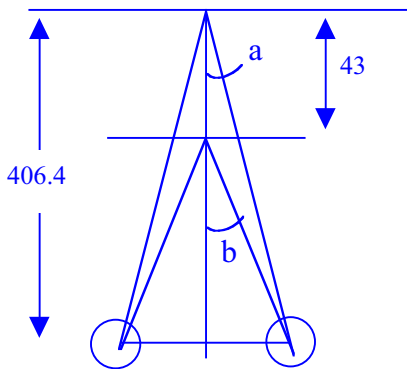
26. Explain how you could create a pair of free-fusion crossed disparity stereograms on a computer. Assume parallel viewing. (4)

- Draw an object with a background or outline.
- Put another object inside the frame
- Create an exact duplicate of this image
- Shift the inner detail slightly to one side; to the left for the OD image and/or to the right for the OS image.

27. Explain how to create a random dot stereogram that stimulates uncrossed disparity. (4)

- Generate a pattern of random dots.
- Duplicate the pattern so you will have one for each eye.
- On one pattern, cut out a center section and shift it slightly to the right if it's the OD slide or the left if it's the OS slide.
- Fill in the remaining uncovered region with random dots.

28. In the Stereo fly test, the wings of the fly appear to be raised 43.0 mm off the page. What is the disparity in arc seconds? Assume PD = 60 mm, viewing distance = 16 inches. (Note: The short disparity equation will have about 10% error for disparities this large. The long disparity equation will have about 20% error since radian measure doesn't approximate the tangent for such large angles. (5)



1. Find angle a. $a = \text{atan}(30/406.4) = 4.22^\circ = 15,199''$
2. Find angle b. $b = \text{atan}(30/363.4) = 4.72^\circ = 16,989''$
3. Calculate the difference between angles a & b = 1791
4. Double this angle = 3,581

You can also use the disparity equation, but it will give only an approximate answer = 3,222. You lose one point for inaccuracy.