Name or PIN: _____

Vision Science II - Monocular sensory aspects of vision

Exam 2

Total points = 33

Reference formulas:

$J_{45} = -(C/2)\sin(2A)$ $\quad M = S + C/2$ $\quad J_{180} = -(C/2)\cos(2A)$

$$C = -2\sqrt{J_{45}^2 + J_{180}^2} \qquad S = M - \frac{C}{2} \qquad A = \frac{1}{2}\tan^{-1}\left(\frac{J_{45}}{J_{180}}\right)$$

$$J_{45} = \left(-2\sqrt{6}\right)C_2^{-2}/y^2 \qquad M = \left(-4\sqrt{3}\right)C_2^{0}/y^2 \qquad J_{180} = \left(-2\sqrt{6}\right)C_2^{2}/y^2$$

1. An aberrometer reports the following second-order Zernike coefficients: C_2^{-2} = -0.05 µm; C_2^{0} = 0.5 µm; C_2^{2} = -0.50 µm. Which of the following is the closest to the equivalent spectacle Rx?

a. -0.11 -0.55 x 003
b. -0.16 -0.79 x 003
c. -0.25 -1.23 x 003
d. Important data is missing so you can't say definitely.

2. For the Zernike coefficients given above, and a pupil diameter of 5.0 mm, which of the following is the closest to the equivalent spectacle Rx?

a. -0.11 -0.55 x 003
b. -0.16 -0.79 x 003
c. -0.25 -1.23 x 003
d. Important data is missing so you still can't say definitely.

3. List the computational steps for finding the mean refractive error (sphere, cylinder, axis) from two sets of second-order Zernike coefficients. (4)

- Convert the first set of Zenike coefficients to the power vector components (J45, M, J180)
- Likewise convert the second set of Zernike coefficients.
- Find the mean of the two J45 values. Do the same for M and J180.
- Convert the mean J45, M and J180 values to sphere, cyl, axis.

4. What is an advantage to using sine wave rather that square wave gratings to measure the MTF of an optical system?

a. Sine wave gratings are the clinical standard for visual acuity testing.
b. Square wave gratings can only be produced with a contrast of 1.0.
c. Square wave gratings are limited since they contain only a single spatial frequency.
d. Sine wave gratings allow you to isolate and test a single spatial frequency.

5. Suppose you want to include a particular photograph on your web page, but it is slightly blurry. One technique you could use to make it seem sharper and clearer is to reduce its size. Based on what you learned about spatial vision, explain why would this work? (2)

- If you shrink the photo, all the spatial frequencies will increase.
- Higher spatial frequencies provide details and sharper edges, so it will make the photo appear clearer.

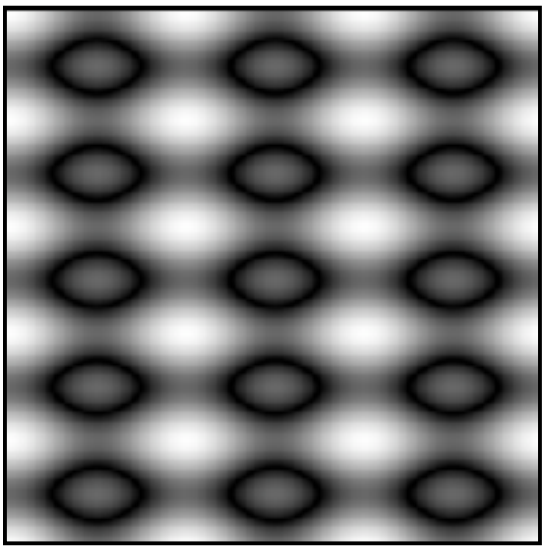
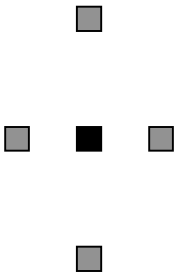
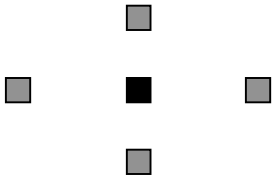
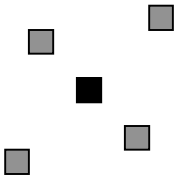
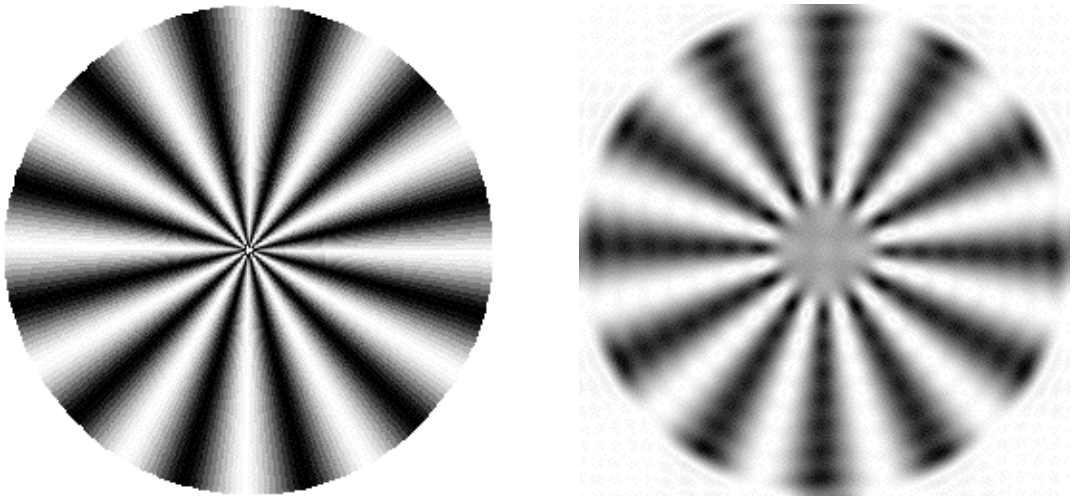


Figure for Question 6.

6. Which of the choices below best represents the spatial frequency spectrum (center portion) corresponding to the figure above? Circle the letter indicating the best choice.

			
a	**b**	**c**	**d**

7. Which of the following could not be used to test contrast sensitivity?
a. sine wave gratings
b. square wave gratings
c. letters
d. Any of the above could be used.



Figures for Question 8.

8. The left pattern above shows what a patient sees with his left eye. The right pattern shows what he sees with his right eye. Which of the following diagnoses for the right eye most likely accounts for this?
a. cataract
b. myopia
c. astigmatism
d. conjunctivitis

9. In lab I was standing 1 foot away from the VectorVision contrast sensitivity chart explaining the procedure. I was not able to see the gratings on a low contrast 3 cycle-per-degree target, but the students standing 10 feet away were able to see it easily. Why were they able to see it more easily than me, even though they were farther away? (Assume all of us have normal vision.) (2)

- If I was 1 foot away, the 3 cycle-per-degree target actually had a much lower spatial frequency (0.3 cycles-per-degree) for me.
- Since the CSF drops off at low frequencies, this would make that target much more difficult for me to see.
- The same target, seen from 10 feet away, would actually have a frequency of 3-cycle-per-degree grating, which is near the peak of the CSF. Thus they would have been able to see it more easily.

10. Under ideal conditions, Vernier acuity thresholds are about
a. 2-10 arc seconds
b. 2-10 arc minutes
c. 2-10 prism diopters
d. 2-10 degrees

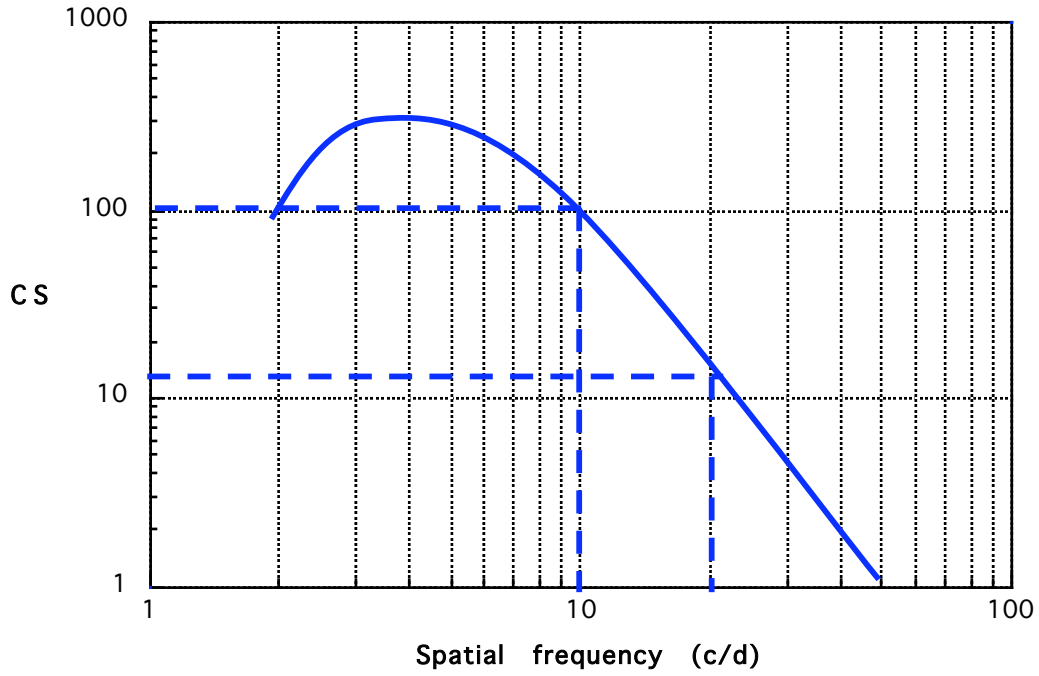


Figure for Questions 11-14.

11. Based on the information in the figure above, what is the Snellen-equivalent high-contrast visual acuity?

20/12

12. What would the visual acuity be if a 7%-contrast chart were used?

20/30

13. What is the contrast threshold for a target that has a size equivalent to 20/60?

1%

14. What is the largest target, in terms of Snellen equivalent, that could be seen with a contrast of 1%?

20/300

15. If the center-to-center distance between two adjacent foveal cones is 2.6 μm, and one degree on the retina spans 312 μm, what is the Nyquist limit, in terms of Snellen acuity, for this retina? (2)

- The width of one cycle would be 2 x 2.6 = 5.2 μm.
- How many cycles can fit into one degree? 312/5.2 = 60
- 60 cycles/degree = 20/10

16. A vision test consists of several rows of 20/60-sized Sloan letters that have high contrast (black on white) on the top row, but gradually decrease in contrast as you go down. This chart is most likely designed to test
a. high contrast visual acuity only.
b. low contrast visual acuity only.
c. contrast sensitivity.
d. the temporal modulation contrast sensitivity function.

17. A visual acuity experiment measures the smallest object that a person can see using a single tiny black dot on a white background. What kind of visual acuity task would this be?
a. resolution
b. recognition
c. minimum detectible
d. hyperacuity

18. Briefly explain how or why a vernier acuity test can help you differentially diagnose whether a cataract patient has a healthy or unhealthy macula. (2)

- Even if the image is blurred due to a cataract, vernier acuity would remain the same if the macular is healthy.
- If the macular is diseased, vernier acuity would be reduced.

19. The temporal modulation transfer function provides information about the visual system, including all of the following, except one. Which one?
a. The frequency (in Hz) at which the eye can best see flicker.
b. The duration (in seconds) for which a single flash of fixed radiant power appears brightest.
c. For a low temporal contrast the fastest flicker that a person can see.
d. For a low temporal contrast the slowest flicker that a person can see.

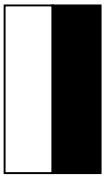
20. According to the Ferry-Porter law, the CFF
a. is directly proportional to stimulus luminance.
b. is directly proportional to the log of the stimulus luminance.
c. is inversely proportional to the log of the stimulus luminance.
d. increases as the log of stimulus area.

21. Which of the following correctly describes the relationship between the size of a flashing light (of fixed radiant power) and how well a person can see high frequency flicker?
a. As a flashing light gets smaller, the flicker will be easier to see.
b. The fastest flicker that a person can see remains constant for flashing lights of any size.
c. As a flashing light gets larger, the flicker will be easier to see.
d. As a light becomes dimmer at the same time it becomes smaller, the flicker becomes easier to see.

22. According to the Broca-Sulzer effect
a. the longer a light (with fixed radiant power) is left on, the brighter it appears to become.
b. lights that enters the peripheral pupil appears dimmer than light entering the center.
c. a light that is flashed on for about 75 msec will look slightly less bright than a steady light of the same radiant power.
d. a light that is flashed on for about 75 msec will look slightly brighter than a steady light of the same radiant power.

23. How does the frequency affect the perceived brightness of a flickering light with fixed radiant power?
a. It will be constant for all rates of flicker below the CFF only.
b. It will be constant for all rates of flicker above and below the CFF
c. It appears brightest if flickered at a frequency of about 10 Hz.
d. It appears to get brighter the faster it is flickered.

24. According to the Talbot-Plateau law, how will the brightness of a light that is flickering above the CFF compare to a steady non-flickering light, which has the same radiance?
a. The flickering light will appear dimmer.
b. The flickering light will have the same brightness.
c. The flickering light will appear brighter.
d. None of the above.

			
Frame 1	**Frame 2**	**Frame 3**	**Frame 4**

25. Assume that an animation loops through the four frames shown above in sequence. Based on George Mather's theory about motion perception, how should the object appear to move? It should
a. rapidly jerk back and forth.
b. appear stationary.
c. move continuously to the left
d. move continuously to the right.

26. Which of the following is not an example of masking, or reduced sensitivity of the visual system caused viewing a visual stimulus?
a. the crowding phenomenon in amblyopia
b. after effect
c. the waterfall illusion
d. the moon illusion

Thank you for your diligence in your studies. I hope you have a nice weekend.

-- Dr. Salmon