EX0012

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BINDURA UNIVERSITY OF SCIENCE EDUCATION
FACULTY OF SCIENCE AND EGINEERING
DEPARTMENT OF OPTOMETRY

OPT 209: PHYSIOLOGICAL OPTICS II
DURATION: 3 HOURS (100 MARKS)

CANDIDATE NUMBER: | | | | | | | | | |

INSTUCTIONS: THIS PAPER HAS THREE SECTIONS (A), (B) AND (C). ATTEMPT ALL QUESTIONS AS INDICATED IN EACH SECTON.

SECTION A. Attempt ALL questions. Indicate whether the following statements are TRUE or FALSE. (30 marks)

1. Color perception require photon absorption by the 3 classes of receptors with different spectral responses. TRUE/ FALSE
2. Horizontal cells are indicated in two types of responses with respective to colour processing. TRUE / FALSE
3. All LGB neurons carry information from only one cone cell. TRUE/ FALSE
4. Spectrally non opponent cells constitute about 60% of all LGB neurons. TRUE/ FALSE
5. Trichromatic color vision mechanisms extend 20 -30 degrees from the point of fixation. TRUE/FALSE
6. In the far periphery of the retina all color sense is lost. TRUE/ FALSE
7. The very center of the fovea (1/8 degree) is red blind. TRUE/FALSE
8. When the eye is light adapted (daytime), yellow, yellow green, and orange appear brighter than blues, greens, and reds. TRUE/FALSE
9. The cones' peak sensitivity is to light of 492 nm. TRUE/FALSE
10. At dusk, although the brightness of all colors decreases, blues and greens appear to gain in relative brightness when compared with yellows and reds. TRUE/FALSE
11. Normal individual is said to be a Trichromat. TRUE/FALSE
12. Rhodopsin (opsin+ retinal) are the photo pigments present in the cone cells. TRUE/FALSE
13. There are no rods in the fovea. TRUE/FALSE
14. Rods are responsible for photopic vision. TRUE/FALSE
15. The existence of two classes of photoreceptors, each operating under different lighting conditions, leads to what has been referred to as a duplex retina.

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TRUE/FALSE

16. At a time in low illumination all colours appear as grey. TRUE/FALSE
17. Opponent colour cells →ganglion cells and LGB. TRUE/FALSE
18. Double opponent cells→ layer IV of area 17. TRUE/FALSE
19. 3. Complex and hypercomplex colour coded cells layers II, III, V, VI of area 17. TRUE/FALSE
20. The formation of vitamin D involves the process of photochemistry. TRUE/FALSE

SECTION B. Choose the most appropriate option. (30 MARKS)

1. Which entoptic phenomenon would be most useful in diagnosing an incipient retinal branch vein occlusion:
   (A) Haidinger's brushes
   (B) Moore's Lightning Streaks
   (C) Purkinje Tree
   (D) Yellow dancing spots.

2. Flashing spots of light reported by a patient in the temporal visual field may indicate:
   (A) retinal hemorrhage in the nasal retina
   (B) retinal detachment in the nasal retina
   (C) vitreous detachment from the nasal retina
   (D) acute angle closure glaucoma.

3. Using relative entoptic parallax, a patient notices one shadow that moves slowly with and another that moves slowly against the direction of the point source. The two opacities are most likely located respectively in:
   (A) posterior vitreous and cornea
   (B) central lens and anterior vitreous
   (C) anterior chamber and anterior vitreous
   (D) cornea and posterior vitreous.

4. Blue arcs of the retina are the result of:
   (A) leukocytes circulating in the pre-retinal vasculature
   (B) the presence of a blue-sensitive radial analyzer at the macula
   (C) secondary electrical activity in the retina
   (D) branch vein occlusion in the retina.

5. Patients will usually be "entoptically unaware" of cataracts or corneal opacities because:
   (A) under everyday lighting conditions, only posterior opacities in the ocular media cast distinct retinal shadows
   (B) the lenticular halo is only present under darkened conditions, so no retinal shadows will be evident
   (C) corneal edema causes the corneal halo to become indistinct
   (D) the reduced visual acuity caused by these conditions renders retinal shadows indistinct

6. The colors seen in a lenticular halo are primarily the result of:
   (A) interference
   (B) diffraction at multiple slits (diffraction grating)
   (C) chromatic aberration
   (D) diffraction at a circular aperture.

7. Basal corneal epithelial cells have an average diameter of 10 μm. What angle (measured from the center of the pattern) would the blue (450 nm) region of a corneal halo subtend?
   (A) 2.58°
   (B) 3.15°
   (C) 4.01°
   (D) 4.89°

8. One way to differentiate a lenticular halo from the halo produced by corneal edema is to:
   (A) use the stenopeic slit test
   (B) view a rotating polarizer through a blue filter
   (C) use the entoptic perimetry test
   (D) view a bright blue background through a reticle that divides the visual field into four segments.

9. A patient reports the perception of vertical streaks of lightning. When she first noticed them, she also became aware of some floaters. This patient most likely has:
   (A) macular edema
   (B) branch retinal vein occlusion
   (C) vitreous detachment
   (D) retinal detachment

10. Identify the following statement as a requirement for perfect spatial coherence, perfect temporal coherence, or both: "The light source must be a true point source: which does not exist."
   (A) Spatial coherence
   (B) Temporal coherence
   (C) Spatial and temporal coherence.
   (D) Neither.

11. For total destructive interference to occur when two light waves interact, the waves must be:
   (A) 180° out of phase
   (B) Of equal amplitude
   (C) Of equal amplitude and either 90° or 270° out of phase
   (D) Of equal amplitude and 180° out of phase

12. Huygen's principal explains diffraction at a slit based on the fact that:
    (A) plane waves change their direction of travel according to Snell's Law, deviating either toward or away from the normal to the slit
    (B) each point on a wave-front behaves like a point source propagating light in all directions
    (C) more destructive interference occurs at the edge of the slit than at the center
    (D) the surface of tangency of a linear series of points is spherical

13. Optimum resolution for the human eye occurs at around a 3 mm pupil diameter. If we assume the eye to be diffraction-limited, how far apart must two green (587.6 nm) point sources be to be resolved from 6 meters away? (NOTE: multipart problem):
    (A) 1.00 mm
    (B) 1.22 mm
    (C) 1.45 mm
    (D) 3.00 mm

14. The Rayleigh Criterion:
    (A) accurately predicts resolution of the eye for all pupil diameters
    (B) accurately predicts resolution for pupil diameters around 3 mm
    (C) accurately predicts resolution of the eye for pupil diameters up to 1 mm
    (D) does not accurately predict resolution of the eye for any pupil diameter because it ignores aberrations

15. Comparing foveal cone mosaic with the optical constraints for resolution of the human eye, it can be determined that:
    (A) Optics of the eye is nicely matched to foveal anatomy
    (B) Potential resolution afforded by foveal photoreceptor density significantly exceeds the optical resolution limit of the eye
    (C) The optical resolution limit of the eye significantly exceeds the potential resolution afforded by foveal photoreceptor density
    (D) It would be more realistic to relate peripheral retinal photoreceptor (rod) density with optical resolution of the eye because rods are much more sensitive than cones

16. A spectacle lens will fully correct image curvature if:
    (A) the tangential and sagittal focal lines coincide
    (B) the spectacle correction has a very high positive power (~ +19 D)
    (C) a "Plan" lens, producing a "flat-field" image is used
    (D) Petzval's surface matches the far point sphere

17. An optical system has been corrected for all, but one, monochromatic aberration. The system consists of a positive spherical lens and an aperture stop to the right of the lens. For a monochromatic plane object, this system will produce:
    (A) Curvature of field
    (B) Pincushion distortion
    (C) Barrel distortion
    (D) Transverse chromatic aberration

18. An ametropic eye is spectacle-corrected for distance vision. As the eye rotates around its center of rotation, a surface is traced out that corresponds to "where the retina is actually focused". This surface is:
    (A) the Far point sphere
    (B) the tangential image shell
    (C) the sagittal image shell
    (D) Petzval's surface

19. An ametropic eye is spectacle-corrected for distance vision. As the eye rotates around its center of rotation, a surface is traced out that corresponds to the location of the image produced by the spectacle lens. This surface is:
    (A) the Far point sphere
    (B) the tangential image shell
    (C) the sagittal image shell
    (D) Petzval's surface

20. Many patients who have had photorefractive keratectomy (PRK) experience a significant glare problem at night. The basis of the glare problem is primarily:
    (A) Spherical aberration
    (B) coma
    (C) oblique astigmatism
    (D) chromatic aberration

21. The main reason that the Rayleigh criterion breaks down for larger pupil diameters is:
    (A) the fact that diffraction ceases to occur when pupil diameter exceeds 3.5 mm
    (B) paraxial defocus
    (C) chromatic aberration
    (D) spherical aberration

22. A broad slit-lamp beam is directed into the eye of a patient with anterior uveitis. "Aqueous flare" is observed due to the presence of numerous aqueous inflammatory cells in the path of the beam. Aqueous flare is a result of:
    (A) Rayleigh scatter
    (B) Mie scatter
    (C) Diffraction
    (D) Veiling glare

23. The Tyndall Effect allows clinicians to detect "aqueous flare" with a broad slit lamp beam, due to the presence of inflammatory cells. It is the result of:
    (A) non-directional Rayleigh scatter in the aqueous humor
    (B) directional Rayleigh scatter in the aqueous humor
    (C) non-directional Mie scatter in the aqueous humor
    (D) directional Mie scatter in the aqueous humor.

24. Transverse chromatic aberration:
    (A) increases with aperture diameter at the same rate as transverse spherical aberration, but at a lower rate than longitudinal spherical aberration
    (B) increases at the same rate with aperture diameter as longitudinal chromatic aberration since both have the same linear dependence on aperture diameter
    (C) increases with aperture diameter, but not as rapidly as longitudinal spherical aberration
    (D) increases with aperture diameter, but at a lower rate than longitudinal chromatic aberration.

25. The aberration that causes variable transverse magnification with incident height is:
    (A) spherical aberration
    (B) coma
    (C) oblique astigmatism
    (D) curvature of field

26. Two light waves have amplitudes of 4 units and 9 units respectively. The relative intensities of the two waves are:
    (A) 64 and 243
    (B) 16 and 81
    (C) 4 and 9
    (D) 2 and 3

27. Monochromatic light of wavelength 415.4 nm in the vitreous (n = 1.336) elicits the maximum sensitivity response from retinal cones under daylight (photopic) conditions. What wavelength in air will elicit the maximum photopic cone response?
    (A) 310.9 nm
    (B) 415.4 nm
    (C) 555.0 nm
    (D) 751.4 nm

28. As a light wave propagates away from a point source:
    (A) Vergence decreases because wavefront curvature decreases
    (B) Vergence decreases because wavefront curvature increases
    (C) Vergence increases because wavefront curvature decreases
    (D) Vergence increases because wavefront curvature increases

29. Rectilinear propagation of light waves refers:
    (A) only to the fact that light waves travel in straight lines
    (B) only to the fact that parallel incident light waves are perpendicular to their direction of propagation
    (C) to the fact that all light waves propagate in straight lines that are perpendicular to the wavefront
    (D) to the fact that at the moment of emission from a light source, light waves have a flat, rectangular profile

30. Snell's Law can be explained in terms of the following property of light:
    (A) When light passes from a medium of lower index to one of higher index, it refracts toward the normal
    (B) Light waves slow down when they enter a medium of higher index
    (C) Rectilinear propagation of light
    (D) For any given light wave, frequency is invariant.

SECTION C. Attempt all questions in this section. (50 MARKS)

1. Define the following as applied in colour vision. [6 marks]
   i. Hue
   ii. Saturation
   iii. Lightness
   iv. Dyschromatopsia
   v. Protanopia
2. What **four** mechanisms to enable us to see over a wide range of light intensities? [6 marks]
3. Explain what is meant by Purkinje shift. [2 marks]
4. List **five** factors that could affect dark adaptation in an individual. [4 marks]
5. Describe the techniques involved in the operation of the Goldmann Weekes Adaptometry. [6 marks]
6. With the aid of a diagram illustrate the mechanism involved in the visual cycle of dark adaptation. [7 marks]

END OF PAPER