C. Theoretical, Ophthalmic, and Physiological Optics-125 Items (29%)

"Theoretical, Ophthalmic, and Physiological Optics" covers the fundamental knowledge and scientific principles that support the application of these principles in the prevention, diagnosis, treatment and management of refractive, oculomotor and sensory integrative conditions, that can present to the optometrist by patients seeking primary eye care. It is composed of six major subdivisions: Geometrical Optics; Physical Optics; Ophthalmic Optics; Visual Optics; Visual Perception; Ocular Motility.

1. Geometrical Optics (15-19 Items)

A. Refraction at single spherical or plane surfaces
   1. Curvature and sagitta
   2. Refractive index and rectilinear propagation
   3. Vergence and dioptric power
   4. Object-image relationships, including apparent depth
   5. Ray tracing, nodal point, and nodal ray
   6. Lateral (translinear) and angular magnification
   7. Snell's law of refraction

B. Thin lenses
   1. Vergence: dioptric and effective power
   2. Object-image relationships
   3. Lateral (translinear) and angular magnification
   4. Thin lens systems
   5. Prismatic effect (Prentice's rule and prism effectivity)
   6. Ray tracing, optical center, and optic axis

C. Thick lenses
   1. Cardinal points
   2. Vertex power and equivalent power
   3. Lateral (translinear) and angular magnification
   4. Reduced systems

D. Aberrations
   1. Spherical
   2. Coma
   3. Oblique astigmatism
   4. Curvature of field
   5. Distortion
   6. Chromatic (longitudinal and lateral)

E. Stops, pupils and ports
   1. Entrance and exit pupils (size and location)
   2. Depth of focus, depth of field, hyperfocal distance
   3. Field of view and half illumination

F. Spherocylindrical lenses
   1. Location of foci, image planes, principal meridians, and circle of least confusion
   2. Obliquely crossed spherocylindrical lenses
   3. Transposition
   4. Prismatic effect

G. Thin prisms
   1. Unit of measurement (prism diopter)
   2. Prism deviation
   3. Combination of thin prisms
   4. Resolution of oblique prisms into horizontal and vertical components
   5. Total internal reflection
H. Mirrors
1. Planar and spherical reflection
2. Proportion of light reflected from a surface (Fresnel's law)
3. Focal power, focal length, and curvature
4. Object-image relationships
5. Magnification
6. Lens/mirror systems
7. Ray tracing

I. Ophthalmic and optical instruments
1. Direct and indirect ophthalmoscopes
2. Retinoscope
3. Lensometer
4. Biomicroscope
5. Radiuscope
6. Keratometer
7. Diagnostic lenses (gonioscopic, fundus, etc.)

2. Physical Optics (5-7 Items)

A. Wave optics
1. Characteristics of wave motion
2. Classifications of the electromagnetic spectrum
3. Total and partial coherence
4. Diffraction (single slit, circular aperture, limits of resolution, zone plates)
5. Interference (double slit, multiple slits, thin film, anti-reflective coatings, holography)
6. Scattering (Rayleigh vs. Tyndall)
7. Dispersion

B. Interaction of light and matter
1. Atomic energy levels, absorption and emission line spectra
2. Continuous spectra (Black body radiator and gray body radiator characteristics)
3. Fluorescence (photons, energy levels)
4. Lasers (theory of operation, speckle pattern)
5. Spectral transmission

C. Polarization
1. Linearly polarized light
2. Circular and elliptical polarization
3. Polarization by reflection (glare reduction, Brewster's law)
4. Effects of scattering on polarization
5. Transmission through successive polarizers (stress analysis, Malus' law)

D. Image quality
1. Resolving power
2. Point and line spread function
3. Modulation transfer function (Fourier optics)
3. Ophthalmic Optics (16-20 Items)

A. Physical characteristics of ophthalmic lenses
   1. Geometry of lens surfaces (spherical, cylindrical, toric, aspheric)
   2. Base curves (form of lenses)
   3. Lens thickness (center, edge, gradients, iso-thickness curves)
   4. Specification of lens size and shape
   5. Materials (refractive index, dispersion, hardness, specific gravity)

B. Optical characteristics of ophthalmic lenses
   1. Locations of, and relationships between the optic axis, optical center, geometric center, and major reference points
   2. Principles of corrected curve lens design
   3. Verification of lens prescriptions (lensometer, lens gauge, and hand neutralization)
   4. Writing and transposing lens prescriptions
   5. Effect of lens tilt (spheres and spherocylinders about a principal meridian)
   6. Effective power (for near and for changes in vertex distances)
   7. Spectacle lens processing

C. Ophthalmic prisms and prismatic effects of lenses
   1. Thickness differences across a prism
   2. Prismatic effects in the periphery of a lens (spheres, spherocylinders)
   3. Decentration (prism from decentration, decentering to obtain prism, interpupillary distance)
   4. Correction of vertical prism effect
      a. Slab-off (front, back, top, bottom, reverse)
      b. Double slab-off
      c. Dissimilar segments
      d. Compensated R segments
      e. Prism segments
      f. Multiple corrections
      g. Contact lenses
      h. Fresnel prisms
      i. Fresnel Adds

D. Multifocal lenses
   1. Types (fused, 1-piece, progressive additions and blended lenses)
   2. Methods of producing Add powers
   3. Segment center location
   4. Differential displacement (jump)
   5. Total displacement, horizontal and vertical imbalance
   6. Placement of distance and multifocal optical center
   7. Optical and physical characteristics of segments (design and calculations, progressive Adds, aberrations, surface characteristics)
   8. Specifying multifocal height, size, shape and location of segment

E. Physical characteristics and biological compatibility of frame materials

F. Specification and nomenclature of frames

G. Optical and frame consideration of high powered lenses: spheric, aspheric, and high refractive index materials

H. Spectacle magnification
   1. Shape and power factors
   2. Iseikonic lens design
I. Methods of remedying reflections and ghost images

J. Absorptive lenses
   1. Specification of lens tints and absorptive coatings (including spectral transmission curves)
   2. Characteristics of photochromic lenses
   3. Relationship between lens thickness and spectral transmission
   4. Special occupational requirements

K. Impact resistance
   1. Degrees of resistance of ophthalmic lens materials
   2. Methods of rendering materials impact resistant
   3. Methods of verifying impact resistance
   4. Performance of materials upon, and after, impact
   5. Specifications of occupational safety lenses

L. Optical tolerances and physical requirements of ophthalmic lenses and frame materials (FDA, ANSI Z80 and Z87, OSHA)

M. Optical characteristics of contact lenses
   1. Surface characteristics of the lens and the cornea
   2. Specification of the lens (power, base curve, thickness, and edge characteristics)
   3. Effective power considerations of contact lenses
   4. Tear-lens optical considerations
   5. Prismatic effects
   6. Fabrication, inspection, and verification

N. Optical characteristics of low vision devices
   1. Magnification, field of view, and working distance
   2. Simple magnifiers
   3. Telescopes
   4. Loupes
   5. Microscopes


A. Schematic eye models
   1. Dioptic components
   2. Cardinal points, entrance and exit pupils
   3. Ametropia: far point, near point, correction
   4. Accommodation: amplitude and effectivity
   5. Astigmatism, including correction
   6. Retinal image size, spectacle magnification, and relative spectacle magnification

B. Dioptics of the eye
   1. Characteristics of components (curvature, thickness, separation, refractive indices, and axial length)
   2. Reference angles and axes
   3. Catoptric (Purkinje) images
   4. Retinal image size
   5. Optical function of the pupil

C. Entoptic phenomena
   1. Characteristics and origin of various phenomena (involving the cornea, lens, and vitreous)
   2. Vascular and circulatory phenomena (Purkinje tree, capillary circulation)
   3. Phenomena associated with central vision (Maxwell's spot, Haidinger's brushes)
   4. Phenomena associated with retinal distention or other forms of retinal activity (Moore's lightning streaks, blue arcs of the retina, phosphenes)
D. Quality of the retinal image
   1. Aberrations (spherical, chromatic, coma, curvature, oblique astigmatism, distortion, wavefront sensing aberrometry)
   2. Diffraction
   3. Stray light
   4. Point and line spread functions

E. Refractive state of the eye
   1. Emmetropia
   2. Myopia
   3. Hyperopia
   4. Astigmatism
   5. Anisometropia and aniseikonia
   6. Accommodation
   7. Aphakia and pseudophakia (optics of intraocular implants)
   8. Empty field and night myopia

F. Mechanisms of presbyopia
   1. Effects of aging on the ciliary muscle and accommodation

G. Radiation and the eye
   1. Radiometry (radiant intensity, radiance, and irradiance)
   2. Photometry (luminosity function, luminous intensity, luminance, and illuminance, Lambertian surfaces- cosine laws)
   3. Spectral transmission of the ocular media
   4. Retinal illuminance
   5. Effects of incoherent radiation (e.g., infrared, visible, ultraviolet) on tissue
      Mechanisms of damage
      Wavelength, energy levels, thresholds for reactions
      Protective measures
   6. Effects of coherent radiation (lasers) on tissue
      a. Mechanisms of damage
      b. Wavelength, energy levels, thresholds for reactions
      c. Ophthalmic applications (argon, excimer, YAG, helium neon, krypton, holmium)
      d. Protective measures


A. Color perception
   1. Chromatic discrimination (hue and saturation) for normal and defective color vision
   2. Color mixture and appearance
   3. Color contrast, constancy, and adaptation
   4. Color specification and colorimetry (CIE)
   5. Spectral sensitivity of normal and defective color vision
   6. Mechanisms of color deficiencies

B. Space perception
   1. Direction and depth discrimination (monocular and binocular cues, oculocentric and egocentric localization)
   2. Characteristics of sensory function (binocular interactions including summation, binocular suppression and rivalry; corresponding points including horopter criteria)
   3. Development of sensory fusion and binocular vision
   4. Disturbances of perceived direction and distance (aniseikonia and amblyopia)
   5. Sensory-motor interactions (fixation disparity, past pointing, visually guided behavior, body posture and perceived orientation, and self-motion)
C. Form perception
   1. Static visual acuity (including test configurations, various acuity tasks, and factors influencing acuity including blur, intensity and contrast); specification of visual acuity
   2. Spatial contrast sensitivity function (including factors influencing the function)
   3. Illusions, constancies, and figure-ground relations
   4. Simultaneous contrast and spatial interactions (Mach bands)

D. Light perception
   1. Detection characteristics at the absolute light threshold (including spectral, spatial, and temporal aspects)
   2. Brightness-difference thresholds at various adaptation levels (Weber's and DeVries-Rose laws); specification of contrast
   3. Dark and light adaptation processes and theories
   4. Spatial and temporal summation characteristics (Ricco's, Piper's and Bloch's laws)

E. Motion perception
   1. Factors involved in the detection of real and apparent motion, detection of displacements
   2. Motion after-effects
   3. Dynamic visual acuity, visual performances with a moving object, and visual performances with a moving observer

F. Temporal perception
   1. Critical flicker fusion frequency, including factors influencing test object (size, location and adaptation level)
   2. Subfusional flicker phenomena (Bartley brightness enhancement)
   3. Successive contrast and masking
   4. Temporal contrast sensitivity function
   5. Stabilized retinal images and monocular suppression (Troxler effect)
   6. Saccadic suppression

6. Ocular Motility (16-22 Items)

A. Pupil and Accomodation
   1. Purposes and roles for vision
   2. Dynamics of muscle action
   3. Biomechanics of pupillary and accommodative reflexes
   4. Interrelationships between pupillary changes, accommodation, and convergence (the near reflex)
   5. Factors affecting pupil size

B. Eye Movements
   1. Purpose and roles for vision
   2. Dynamics and kinematics of eye movements
   3. Specification of direction of gaze and ocular orientation (torsion)
   4. Reflex movements, including compensatory movements
   5. Small movements associated with steady fixation
   6. Versional movements (pursuits and saccades)
   7. Vergence movements (tonic, accommodative, including models of accommodative/vergence interaction, fusional, and proximal)
   8. Optokinetic nystagmus
   9. Vestibulo-ocular reflex and vestibular nystagmus

C. Eyelid Function
   1. Purposes and roles for vision
   2. Characteristics
   3. Lid reflexes