Please prepare for certification testing with materials from the organization in which you want your certification granted i.e.:
- AOA
- JCAHPO
- ABO
- NCLE
- OT

There are two main refractive bodies in the human eye...

The cornea is the primary refractive element in the eye...

The tear film maintains both the health and optics of the cornea...

- The Visual System
  - Physiology
  - Ametropias
- Ophthalmic Lenses
  - Properties of Light
    - UV, Visible, and Infrared Spectrums
    - Reflection, Refraction, & Absorption
    - Aberrations
  - Lens Designs
    - Fitting
- Basic Optical Formulas
The crystalline lens has a power of around +12-18 diopters...

...it is primarily responsible for changing the eye's focal point...a term referred to as accommodation.

The retina is the “film” or sensory body...

Light is converted to electrical impulses which are sent through the optic nerve...

...the “blind spot” is the point at which the optic nerve connects.

An eye free of refractive error is called “emmetropic.”

An eye with excessive focal power for its length focuses light in front of the retina...

...this refractive error is known as “myopia.”
Visual Anomalies

Ametropias
An eye with insufficient focal power for its length focuses light in behind the retina...
...this refractive error is known as "hyperopia"

Visual Anomalies

Ametropias
Another refractive error can occur if every axis is not refracted evenly...
...this refractive error is known as "astigmatism"

Visual Anomalies

Ametropias
As the eye ages, the crystalline lens loses flexibility...
...this results in a condition known as "presbyopia"

Ophthalmic Lenses

Properties of Light
Like the artist’s paint, the eye requires light to see...
...what is “light,” and how does it work?

Ophthalmic Lenses

- Ophthalmic Lenses
- Properties of Light
  - UV, Visible, and Infrared Spectrums
  - Reflection, Refraction, & Absorption
- Lens Designs
- Lens Materials
particles in the form of a wave
- electromagnetic radiation with wavelengths between 400 and 700 nanometers (a nanometer is 1/1,000,000th mm) is considered the visible spectrum
- white light is composed of all wavelengths

- visible light is a small portion of the overall spectrum of light
- EM surrounding the visible spectrum is hazardous
  - Ultra-Violet is <390nm
  - Infrared is >720nm

- UVB falls farther from the visible spectrum, is the most significant UV most of us experience, and is variably absorbed by ozone...

- UVC light is farthest from the visible spectrum, and is almost completely absorbed by ozone (except at very high altitudes)...

- Infrared is >720nm- the most common source is blown glass...
Ophthalmic Lenses

Properties of Light

Movement of Light

Light moves in wave form along a straight line...

...the distance between peaks determines wavelength

Ophthalmic Lenses

Properties of Light

Movement of Light

As light spreads from a point, it forms a wavefront...

Ophthalmic Lenses

Properties of Light

Movement of Light

Reflection

Every lens has a "critical angle"...

...light striking the lens flatter than this angle will be reflected

Ophthalmic Lenses

Properties of Light

Refraction

Light striking at an angle steeper than critical is refracted...

...the amount of refraction depends on the amount of prism

Ophthalmic Lenses

Properties of Light

Refraction - Prism

Prism bends light towards its base...

...but displaces images towards its apex
Ophthalmic Lenses

Properties of Light
Refraction - Prism

Plus lenses are prisms placed base to base...

Light Rays

...resulting in convergence

Vision & Ametropias

...a minus powered (diverging) lens shifts the focus back to the retina

(focal length of eye + lens)

(unaided focal length of eye)

Ophthalmic Lenses

Properties of Light
Refraction - Prism

Minus lenses are prisms placed apex to apex...

Light Rays

...resulting in divergence

Vision & Ametropias

A hyperopic eye focuses light behind the retina...

Vision & Ametropias

When light is not focused on the retina, an ametropia is present... for example, a myopic eye focuses light in front of the retina...

Vision & Ametropias

...a plus powered (converging) lens shifts the focus up to the retina

(unaided focal length of eye)

(focal length of eye + lens)
**Vision & Ametropias**

Astigmatism causes light along different axes to focus at different planes...

...as the crystalline lens ages, it loses its flexibility- and its ability to adjust focus... this condition is called presbyopia and typically becomes noticeable around age 40.

...a cylindrical lens is prescribed to compensate for astigmatism in the eye- creating a common focal point on the retina...

To restore near vision, the required convergence is supplied by a plus powered lens...

As previously mentioned, the crystalline lens enables the eye to focus on near objects...

...this plus lens may stand alone (NVO) or may work with distance correction (ADD)
Properties of Light

Refraction - Dispersion

All prisms break white light into its component colors...

...this is called dispersion and results in chromatic aberration.

White light is composed of all colors in the rainbow—but all colors can be formed using a combination of three “primary colors:”

- Red
- Yellow
- Blue

Abbe value is used to describe the amount of dispersion a material will create...

...ranges are from 59 (CR-39) to 30 (polycarbonate)

Filters absorb light. Chemical compounds are used to selectively filter single colors.

To create a green filter, only red light must be absorbed. The appropriate chemicals are applied, and a green filter is created.

A dark lens absorbs light...

To create a perfectly neutral—or gray—filter, energy from all three primary points in the spectrum must be absorbed to the same degree.

When creating a filter by absorbing dye into resin, this process is further complicated by the inconsistent nature of the chemicals involved.
Properties of Light

Aberrations

The most common aberrations found in ophthalmic lenses are:

- Power Error
- Material Distortion
- Marginal Astigmatism
- Chromatic Aberration
- Unwanted Prism

Aberrations occur due to various factors:

- Refractive power
- Off-axis viewing of objects
  - lens tilt
  - peripheral objects
- Vertex distance
- Lens material

Aberrations – Power Error

Spherical lenses are stronger in the periphery...

Aberrations – Distortion

Plus lenses create the opposite effect...pincushion effect

Aspheric lenses reduce distortion

...the periphery of an object will be magnified to a greater degree than the center

Aberrations – Distortion

Compare a spherical lens to an aspheric lens of equal power...

...notice the central curve & thickness
Properties of Light
Aberrations – Marginal Astigmatism

Light striking the lens at an oblique axis do not refract evenly...

...unwanted astigmatism occurs

Properties of Light
Aberrations – Chromatic Aberration

As previously discussed, chromatic aberration is the dispersion of white light into its component colors...

...large amounts of prism are necessary for chromatic aberration to affect vision

Lens Types
Single Vision lenses have only one focal length...

...single vision lenses can be used to provide clear distance, intermediate, or near vision for presbyopes

Lens Types – Single Vision

Single Vision lenses have only one focal length...

...single vision lenses can be used to provide clear distance, intermediate, or near vision for presbyopes
The myopic eye focuses light in front of the retina... using a minus powered single vision lens, light is focused on the retina.

"Reading glasses" are also single vision lenses... a plus powered single vision lens restores near vision.

Single vision lenses require measurement of pupillary distance, and occasionally fitting height...

Bifocal lenses have two focal lengths... For distance vision, the lens contains a "carrier" similar to a single vision lens...
For near vision, an extra "reading" segment is added.

Flat-top bifocals are usually fit:
- To lower limbus (seg line @ lower lid)
- Decentered 1.5mm in from Far PD

There are several types of bifocals suited to different needs...
- Flat Tops
- FT28
- FT45
- Smart Seg*
- Curve Top (Cosmolit)
- Executive (E-Line)
- Round Seg (Kryptok)
- Blended

Trifocal lenses have three focal lengths...
- Distance
- Intermediate
- Near
- Generally, the intermediate ADD is 50% of the near ADD

Objects at the focal length of either the near or intermediate segments are focused on the retina...
- Flat-top trifocals are usually fit:
  - To lower edge of the pupil
  - Decentered 1.5mm in from Far PD
There are several types of trifocals suited to different needs...
- Flat Tops
- FTT 7/28
- FTT 8/35
- Smart Seg
- Executive (E-Line)
- Occupational

Progressives are usually fit:
- at pupil center

Progressive Addition Lenses (PALs) have an infinite number of focal lengths across a range...

PALs require precise fitting if the lens is to perform to its potential, this necessitates:
- Monocular pupillary distances
- Verification of fitting height
- Proper frame adjustment

PALs contain a reading ADD that progressively gets stronger—providing many, many focal lengths...

There are literally hundreds of PAL designs available—each with unique characteristics...
- Traditional
  - hard design
  - soft design
  - monodesign
  - multidesign
- Short Corridor
- Customized
- Task Specific
There are perhaps two calculations every person who works with eyewear MUST know...

- Prentice's Rule
- Box Measurements

Measurements of the frames and the eye's relationship to them should be specified...

Box Measurements

A = 58
DBL = 20
FPD = 78
NPD = 60
(78-60)/2 = 9 in

Datum Line

B = 56
Datum (56/2) = 28
Seg Ht = 22
28-22 = 6 down

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