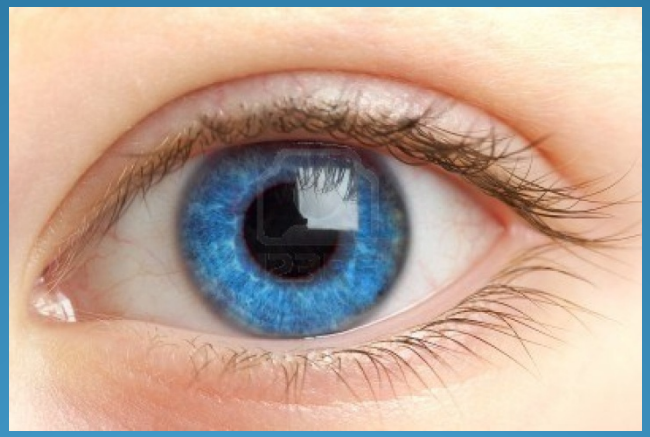
Advanced Anatomy and Physiology of the Eye

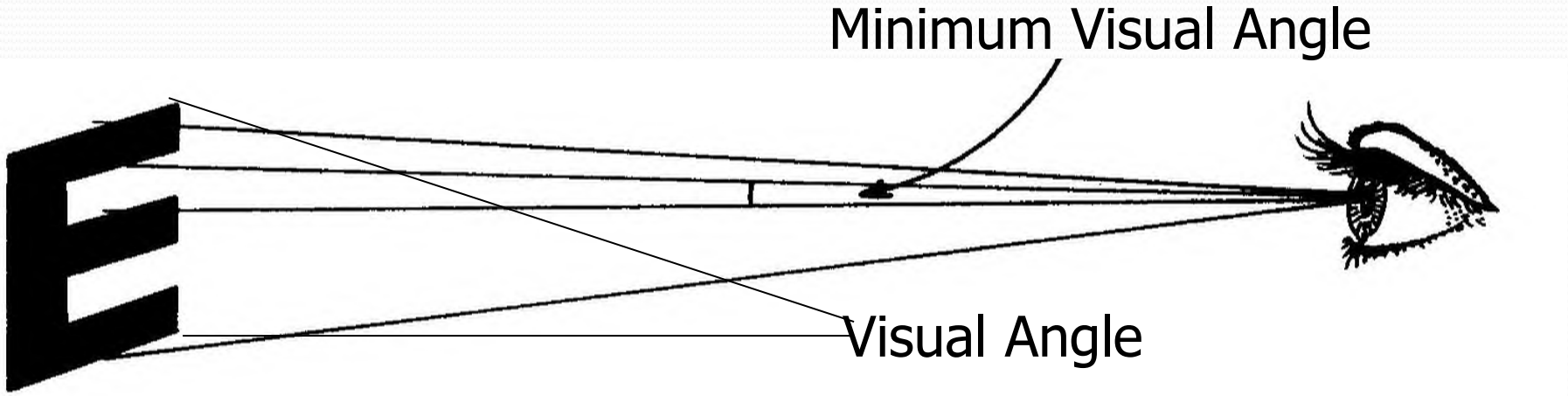


By Diane F. Drake, LDO, ABOM, NCLEM, FNAO

Introduction

- Terminology
- Anatomy
- Refractive Errors
- Spherical Correction
- Cylindrical Correction
- Presbyopia
- Muscle Imbalances
- Unequal refractive errors
- Visualizing the Rx

Visual Angle and Minimum Visual Angle

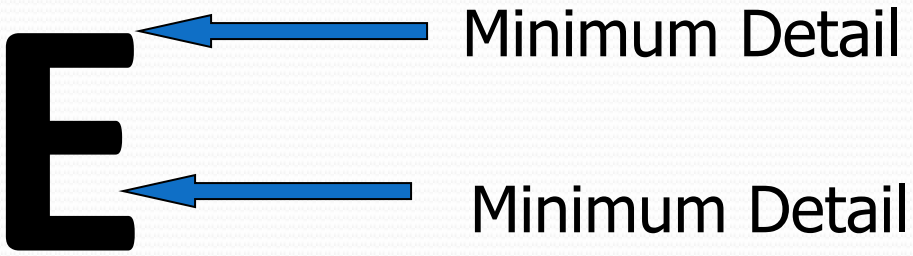


Subtend

- To extend under or to be opposite to
- The angle which is opposite the object being observed

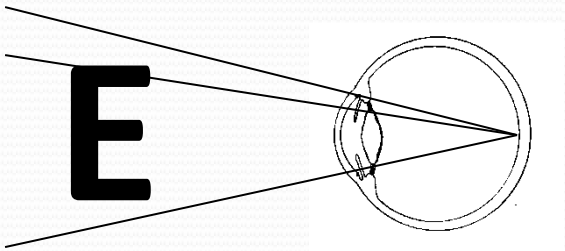
Minimum Detail

- The detail that must be detected on an object to positively identify or distinguish the object



Resolution

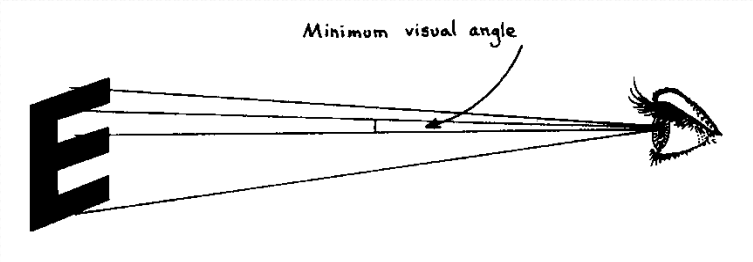
- The ability to detect minimum detail
- The resolving power of the normal eye is a minimum visual angle of 1 minute
- The minimum visual angle of the letter is 1 minute
- The visual angle of the letter is 5 minutes



Visual Acuity

- The measure of the angle subtended by the outer limits of rays of light coming from the minimum detail of an object as they enter the eye

- 20/20 or 6/6

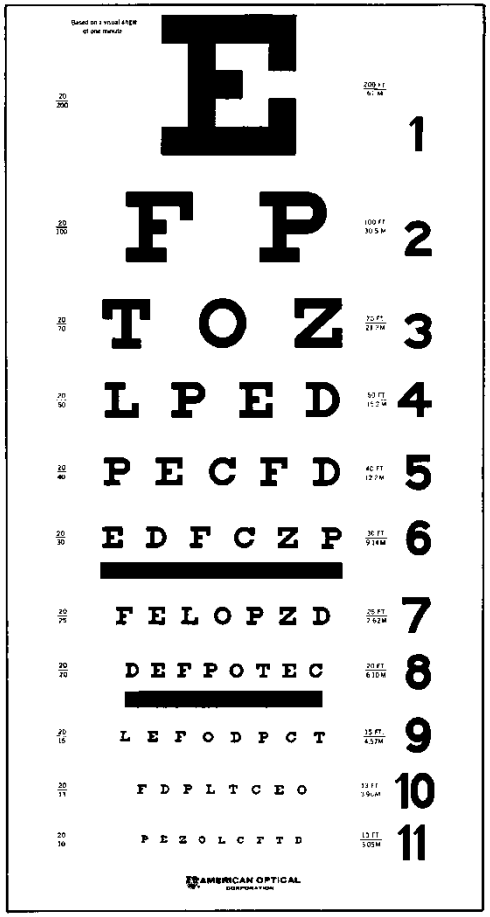


Snell's Law of Refraction

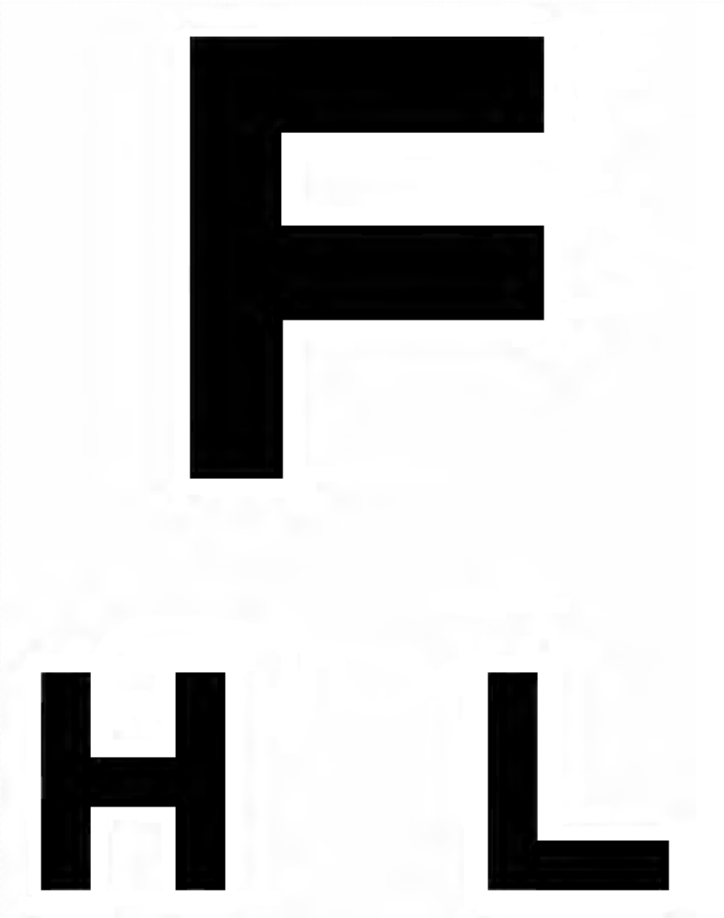
- $n_1 \sin i = n_2 \sin r$

The Snellen Fraction

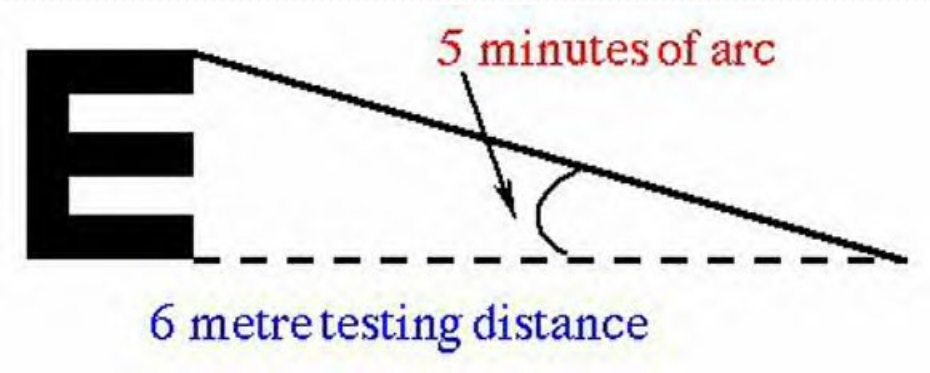
- The distance at which the test is made divided by the distance at which the smallest letter read subtends an angle of 5 minutes



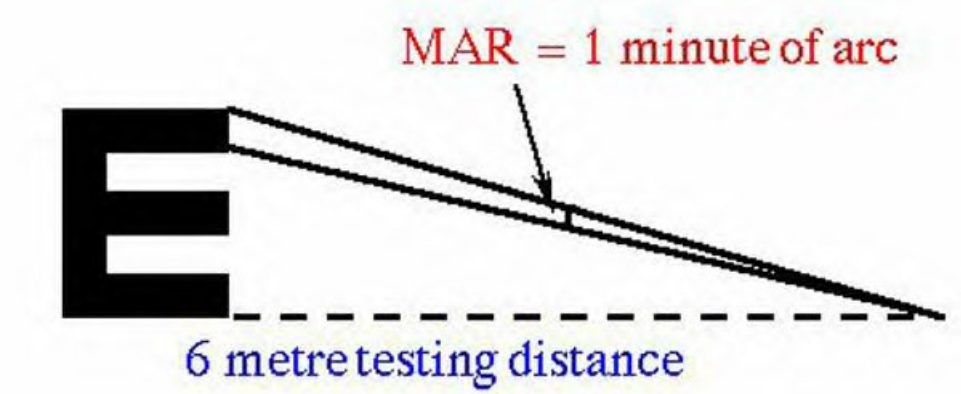
Snellen Letters



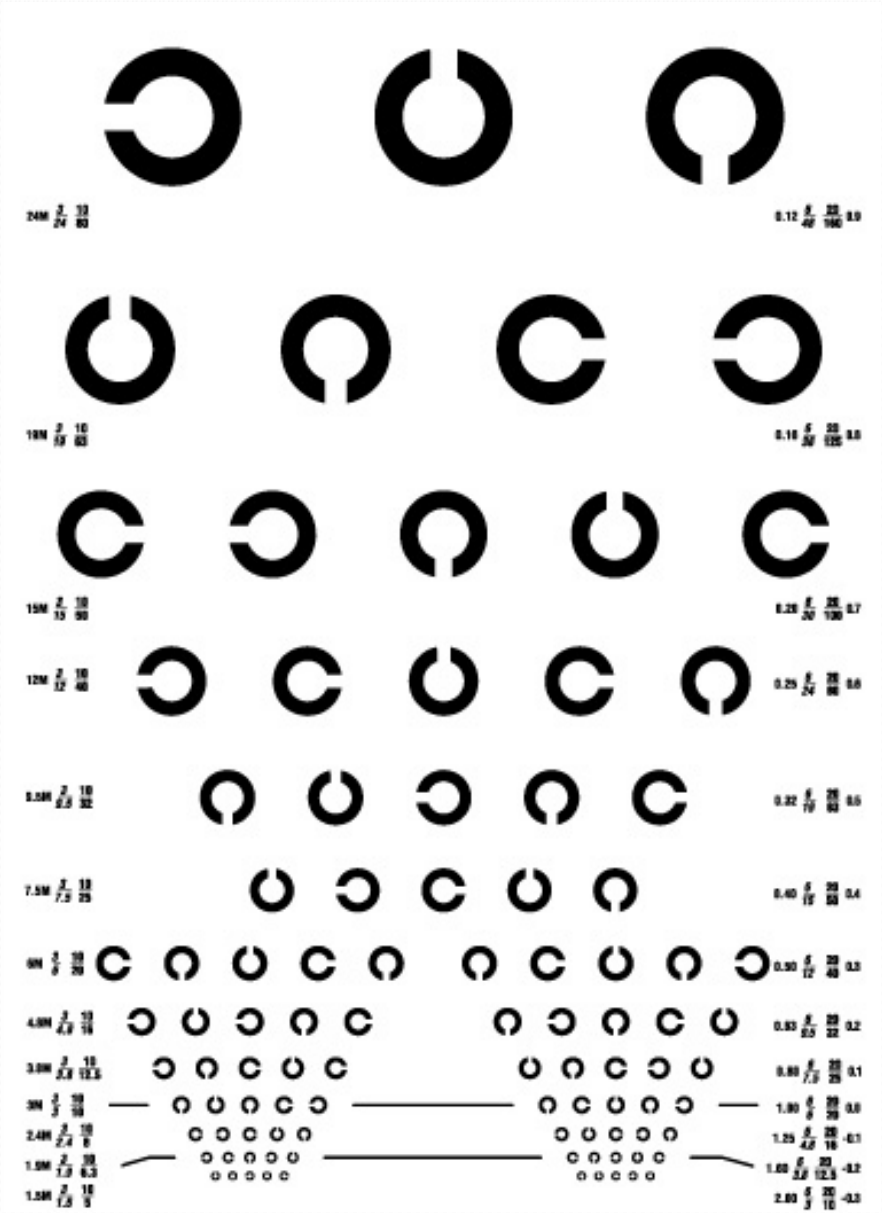
Snellen Letters

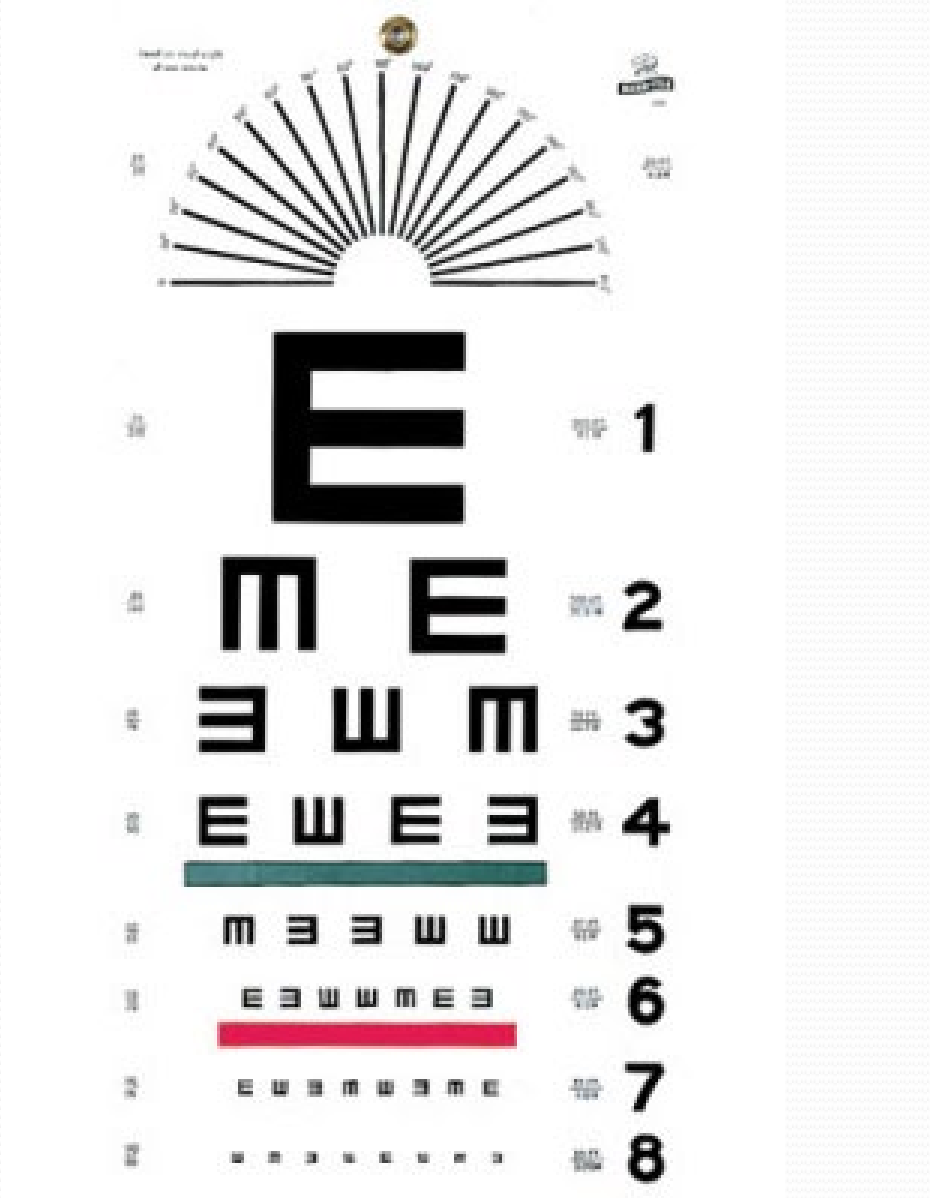


Minimum Angle of Resolution

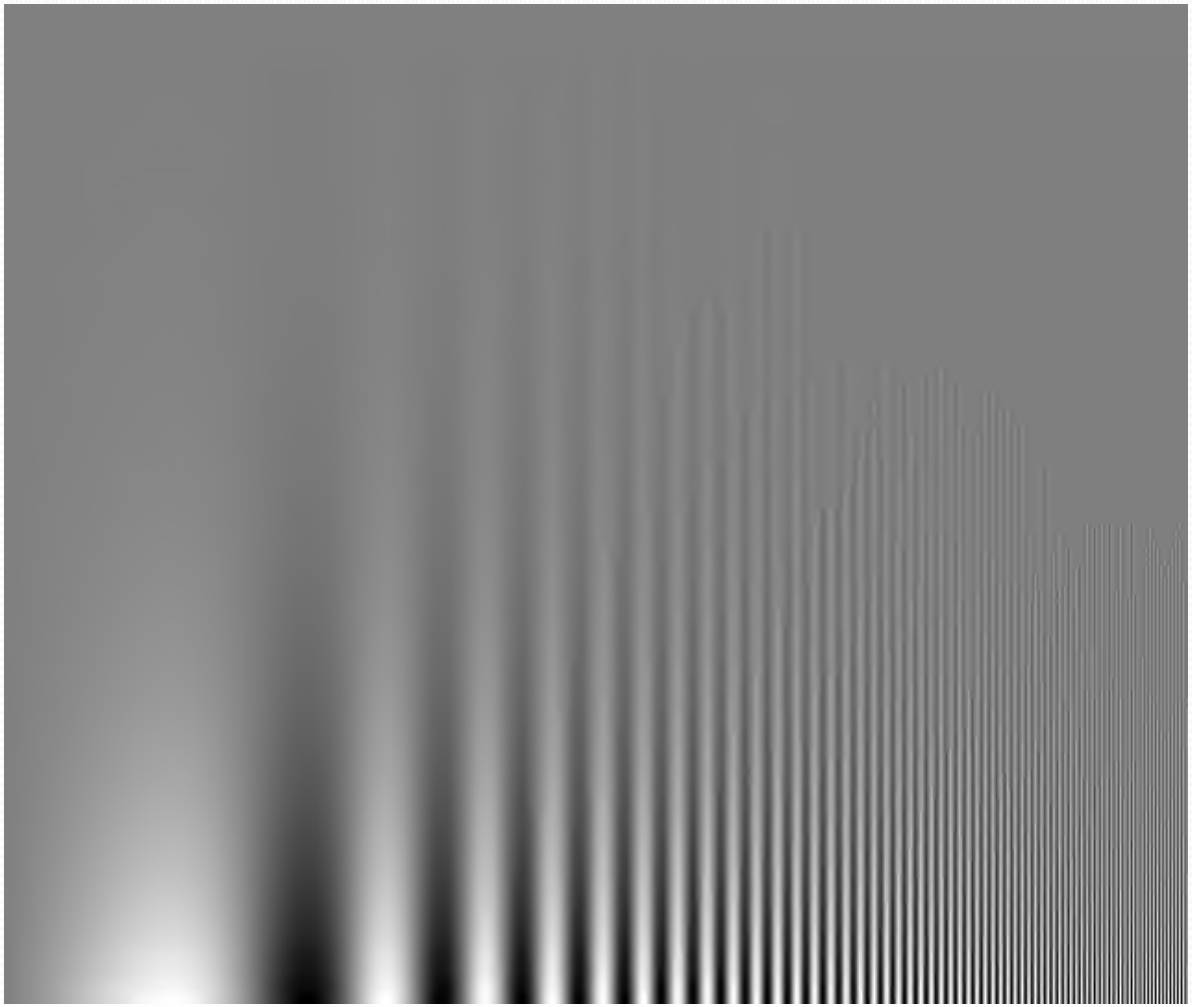


Landolt Ring (C) and the Illiterate E




1
2
3
4
5
6
7
8

Contrast Sensitivity



Terminology

- Emmetropia
- Ametropia
- Myopia
- Hyperopia

Terminology

- Astigmatism
- Corneal astigmatism
- Lenticular astigmatism
- Regular astigmatism
- Irregular astigmatism

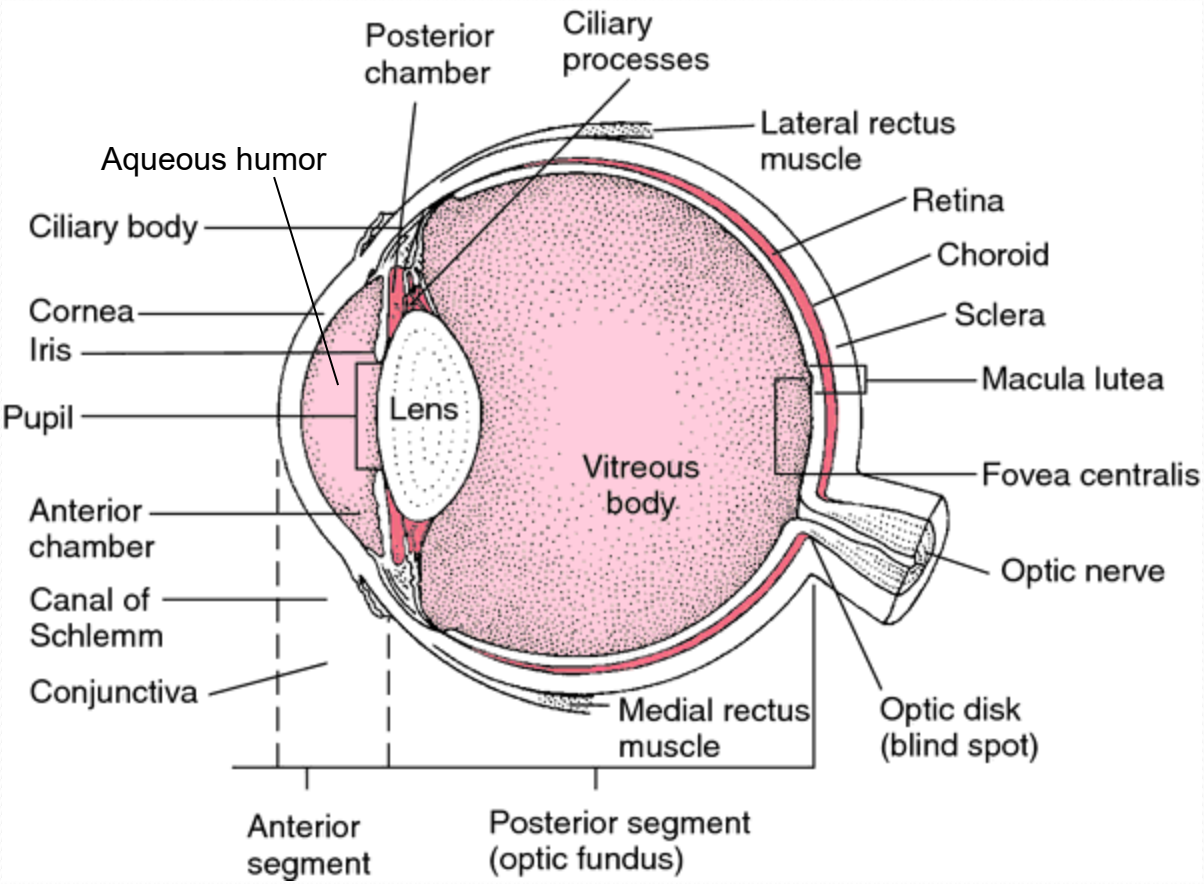
- Simple myopic astigmatism
- Compound myopic astigmatism
- Simple hyperopic astigmatism
- Compound hyperopic astigmatism

Terminology

- Presbyopia

- Greek
  - Presby = Old
  - Opia = Sight

Anatomy


Posterior chamber
Ciliary processes
Lateral rectus muscle
Aqueous humor
Retina
Ciliary body
Choroid
Cornea
Sclera
Iris
Macula lutea
Pupil
Lens
Vitreous body
Fovea centralis
Anterior chamber
Optic nerve
Canal of Schlemm
Conjunctiva
Medial rectus muscle
Optic disk (blind spot)
Anterior segment
Posterior segment (optic fundus)

Four Refractive Mediums of the Eye

- The cornea
- The aqueous humor
- The crystalline lens
- The vitreous humor

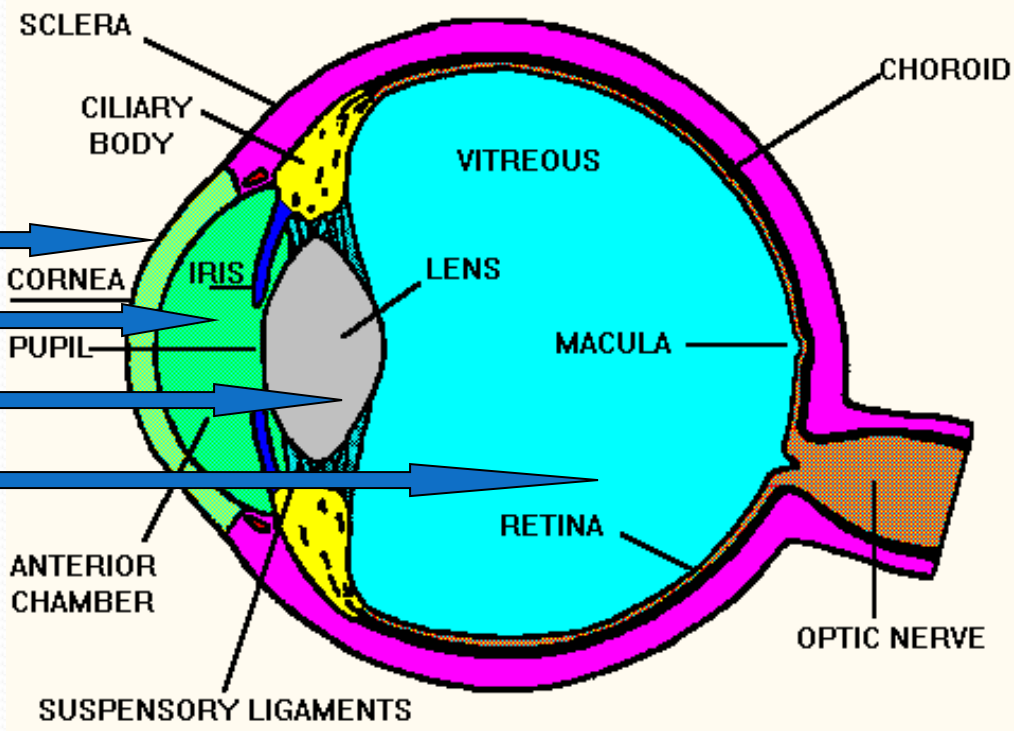
Anatomy

Cornea

Aqueous humor

Crystalline lens

Vitreous humor



Index of Refraction

- Cornea = 1.37
- Aqueous humor = 1.33
- Crystalline lens = 1.42
- Vitreous humor = 1.33

Dioptric Power

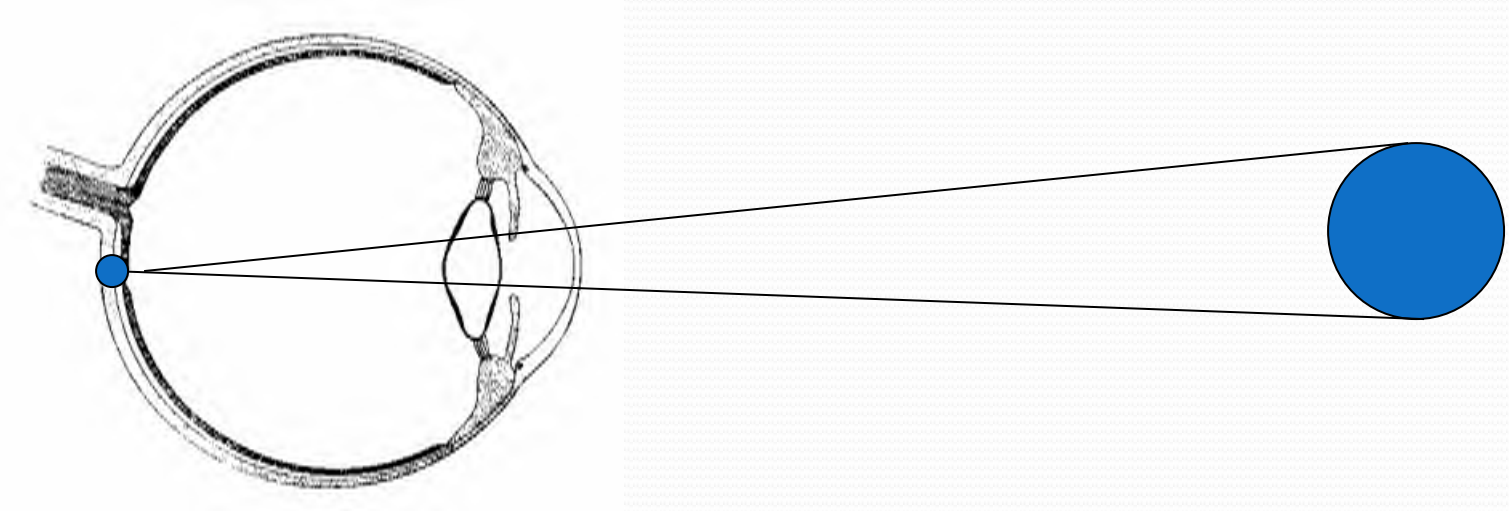
- Cornea
  - +42.00D to +45.00D
  - Performs about 80% of the refraction or bending of light rays within the eye
- Crystalline Lens
  - +12.00 to +15.00D
  - +20.00 D
  - Depending on textbook

Refraction

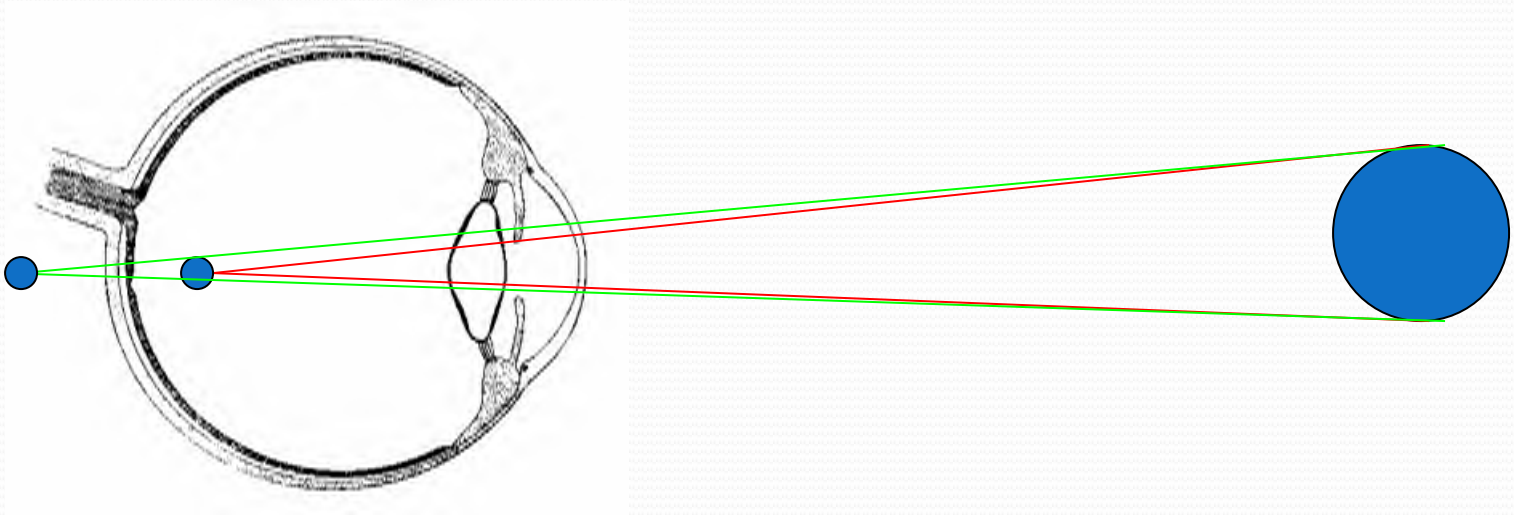
- The “bending” of light as it passes obliquely between two different refractive mediums

- A beam of light that enters a refractive medium perpendicularly is not refracted, but merely slowed down and the path of the beam is unchanged

Emmetropia

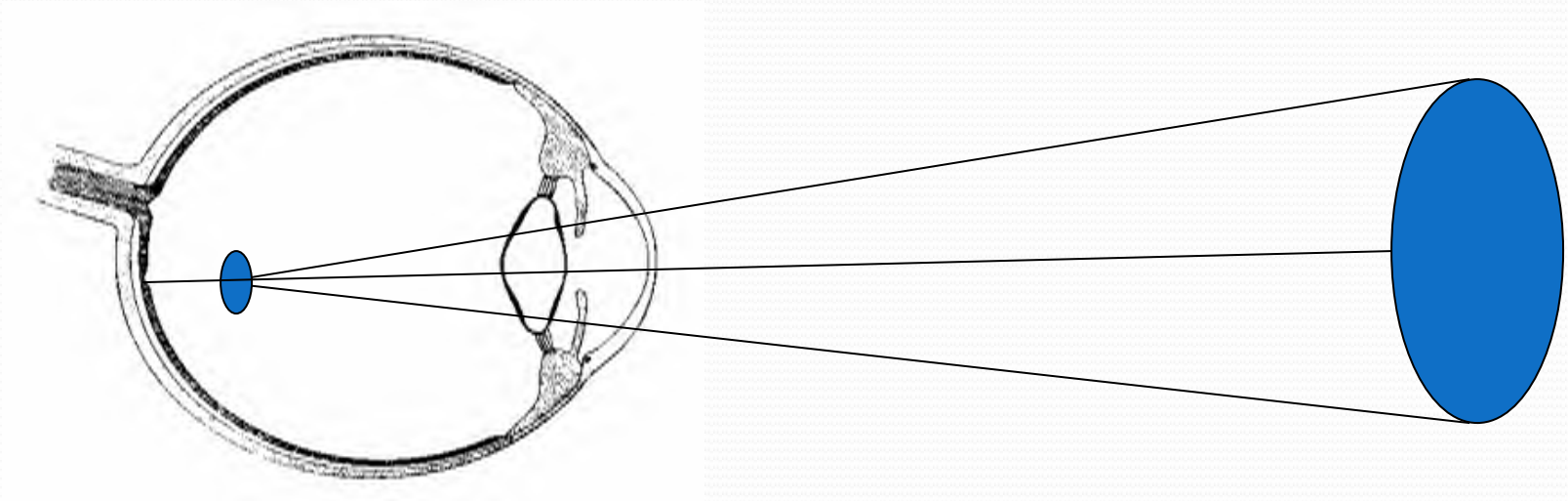


Ametropia

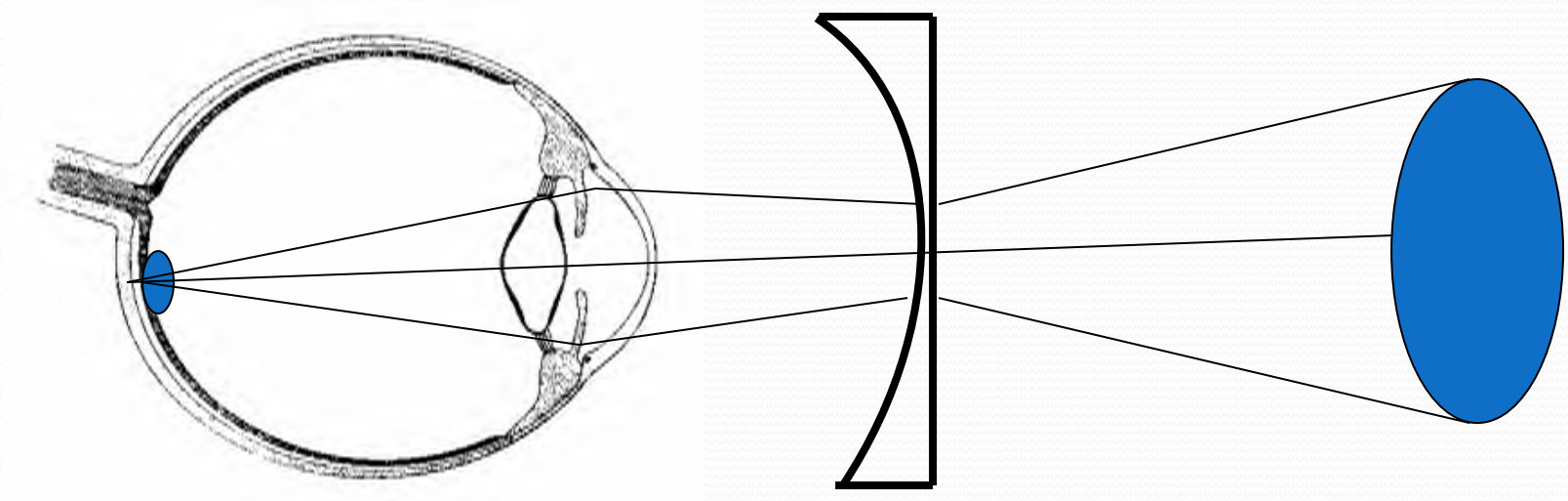


- Myopia
- Hyperopia or Hypermetropia
- Astigmatism

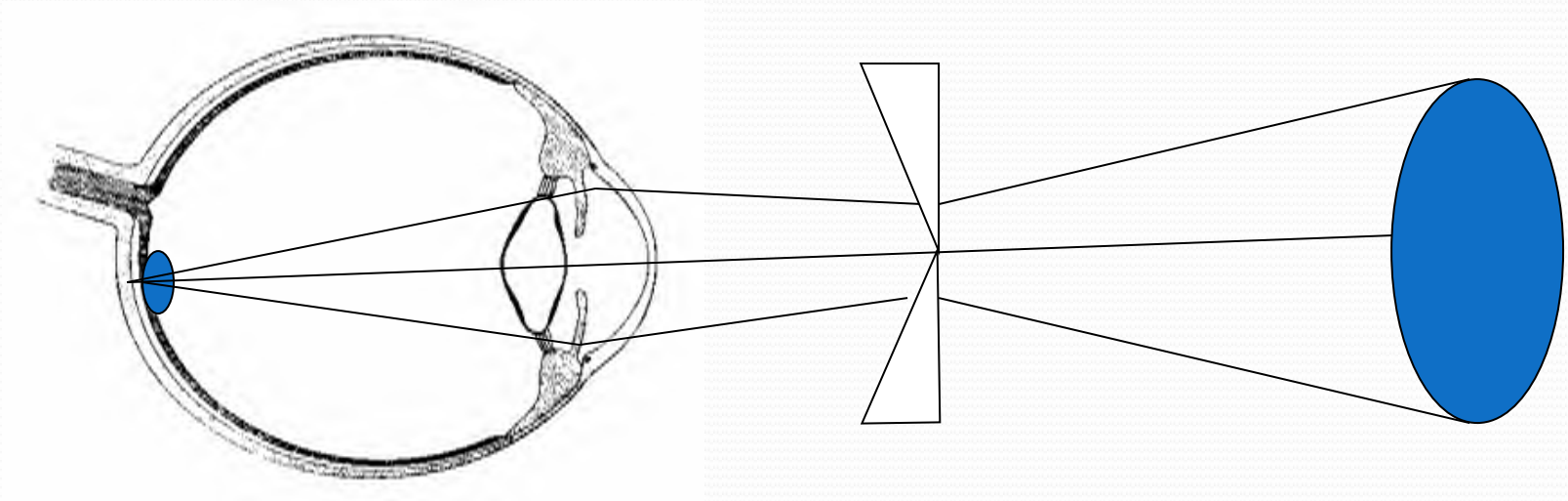
Myopia - Near Sighted - *Short Sight*



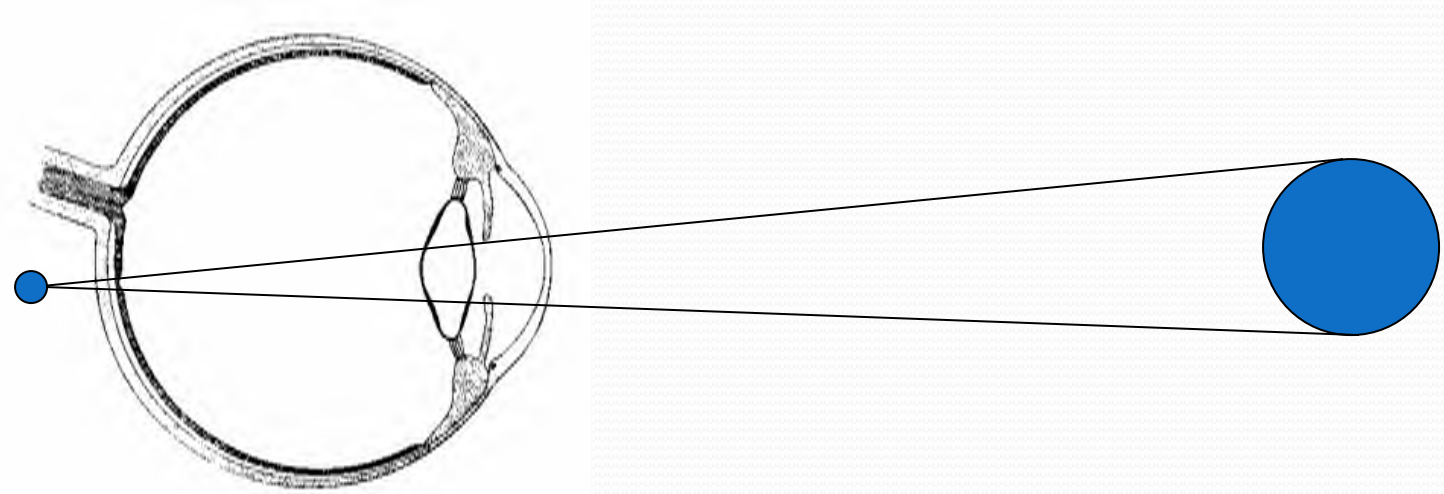
Myopia - Near Sighted - *Short Sight*



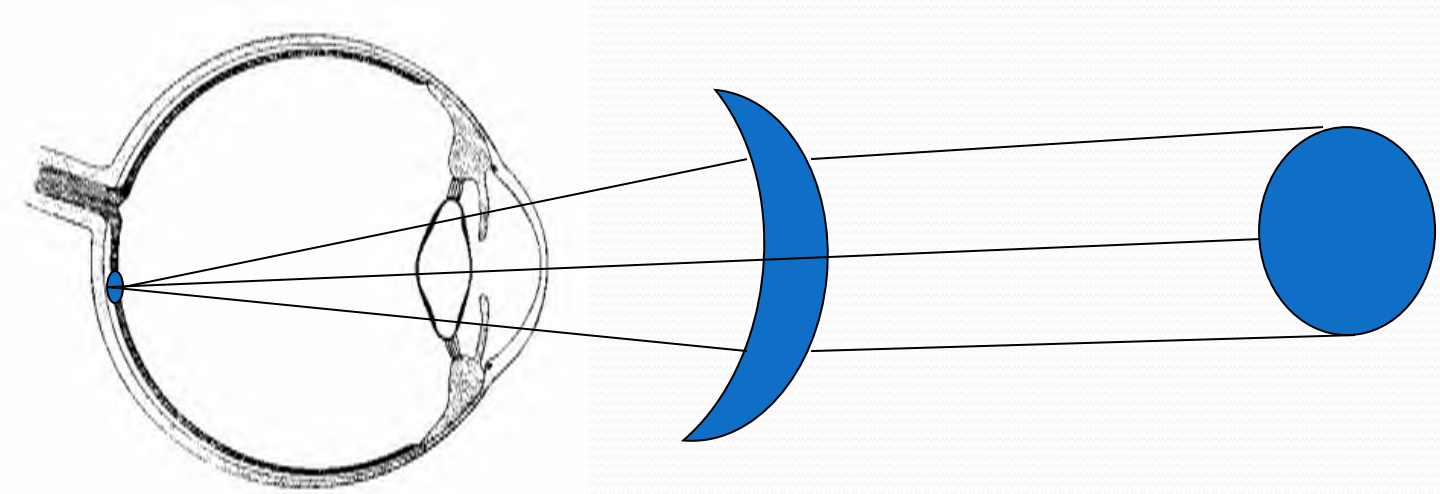
Myopia - Near Sighted - *Short Sight*



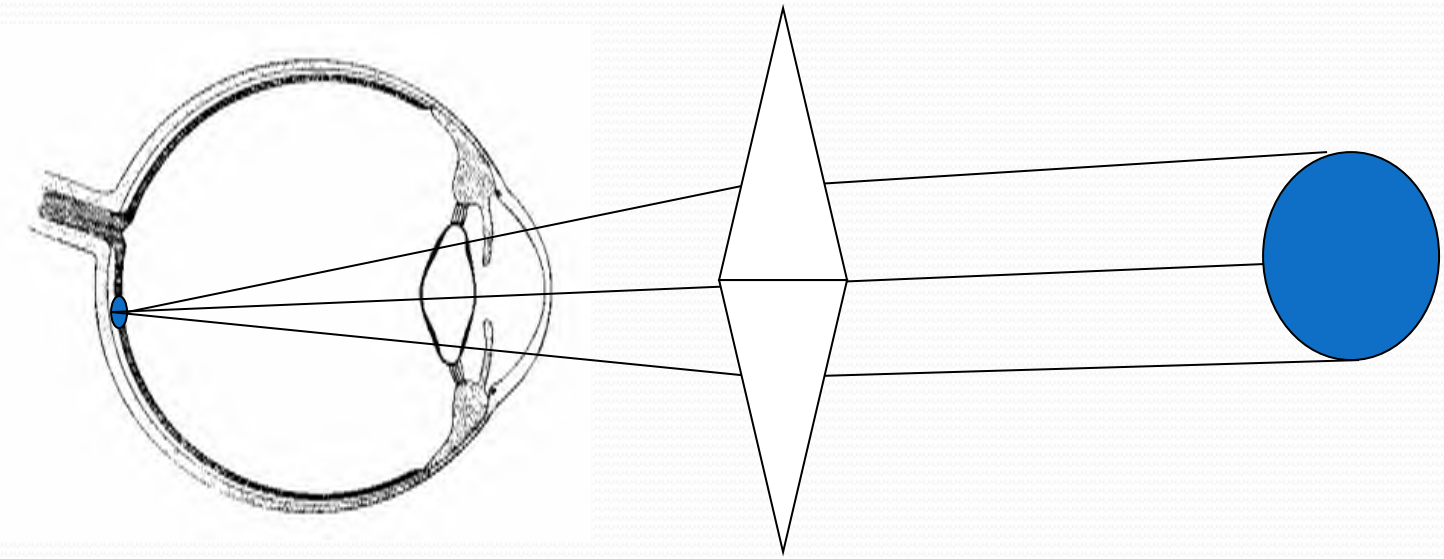
Hyperopia - Farsighted - *Long sight*



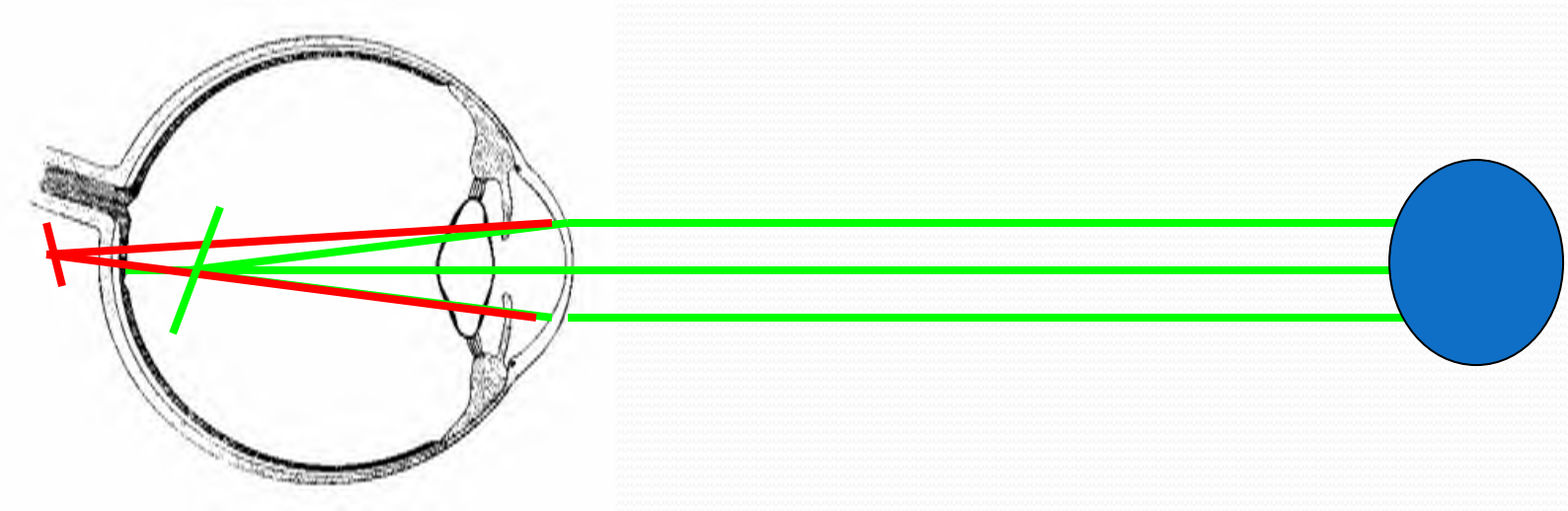
Hyperopia - Farsighted - *Long sight*



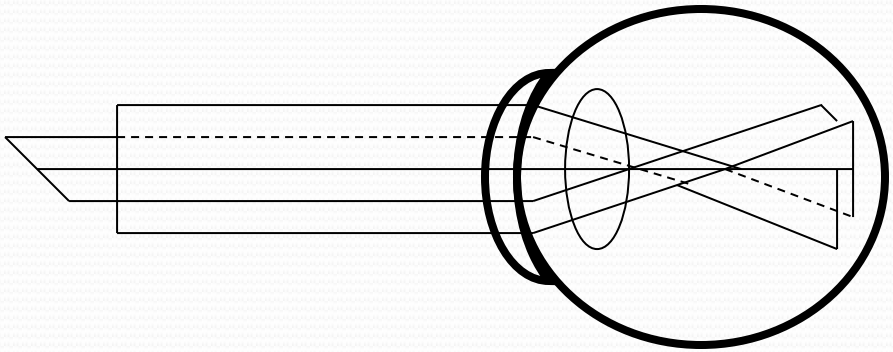
Hyperopia - Farsighted - *Long sight*



Astigmatism



Astigmatism

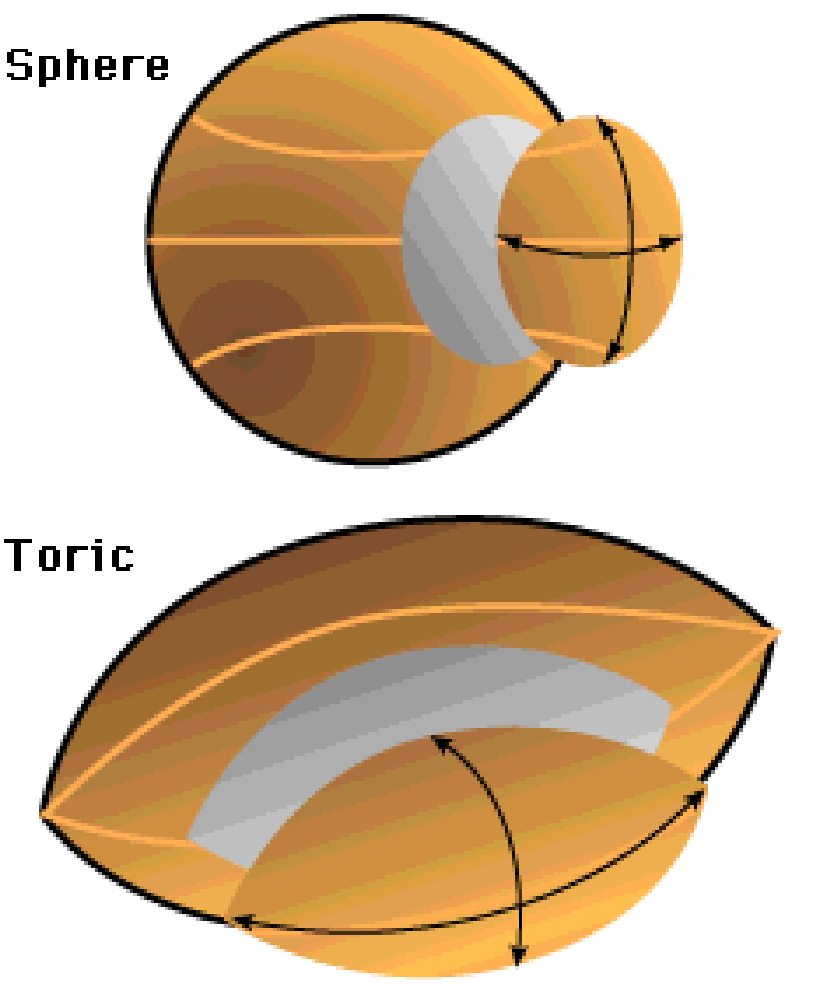


Astigmatism

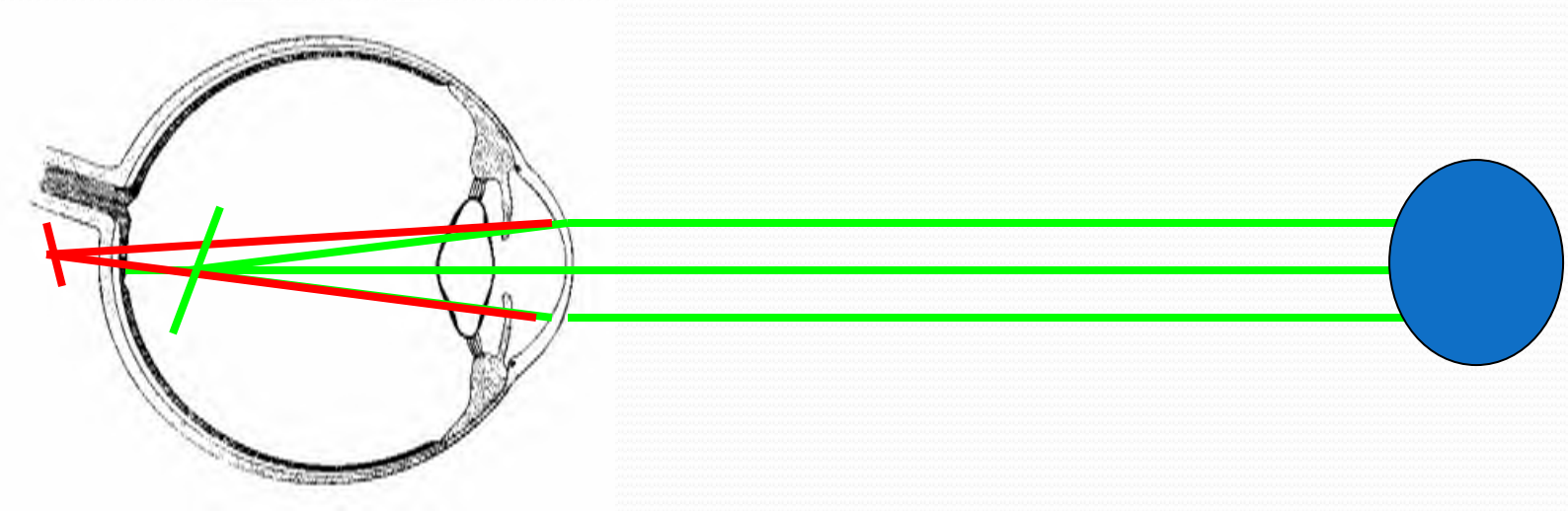
- Corneal astigmatism
- Lenticular astigmatism
- Regular astigmatism
- Irregular astigmatism

- Simple myopic astigmatism
- Compound myopic astigmatism
- Simple hyperopic astigmatism
- Compound hyperopic astigmatism
- Mixed astigmatism

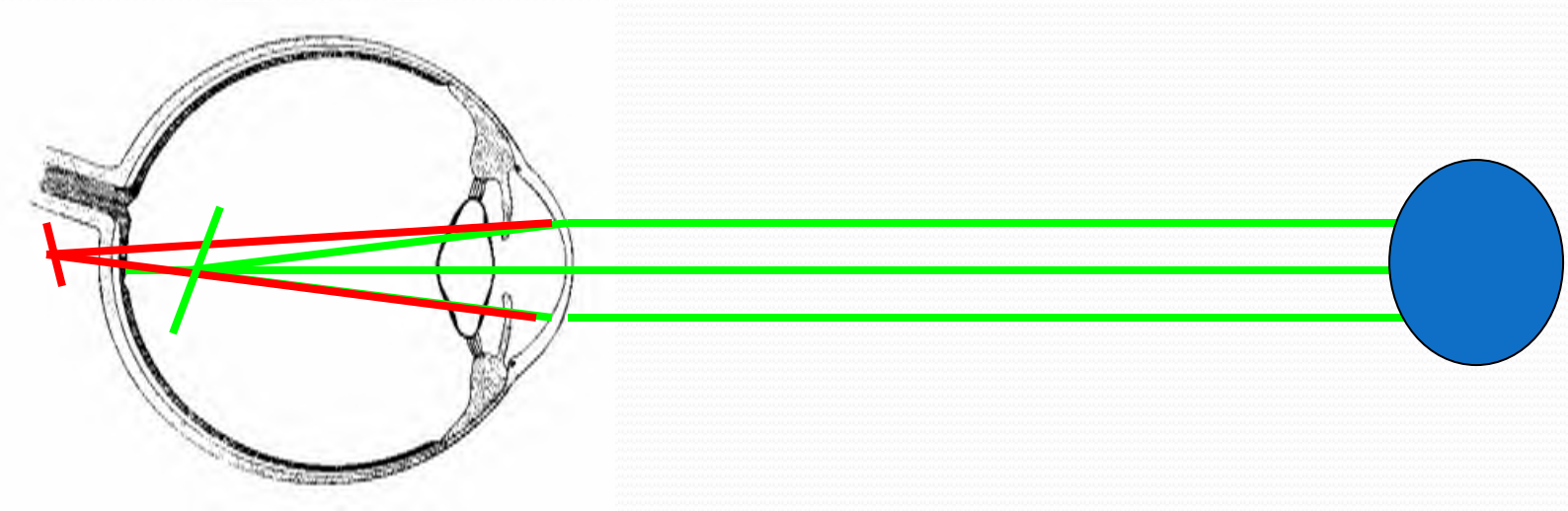
Corneal Astigmatism



Lenticular Astigmatism



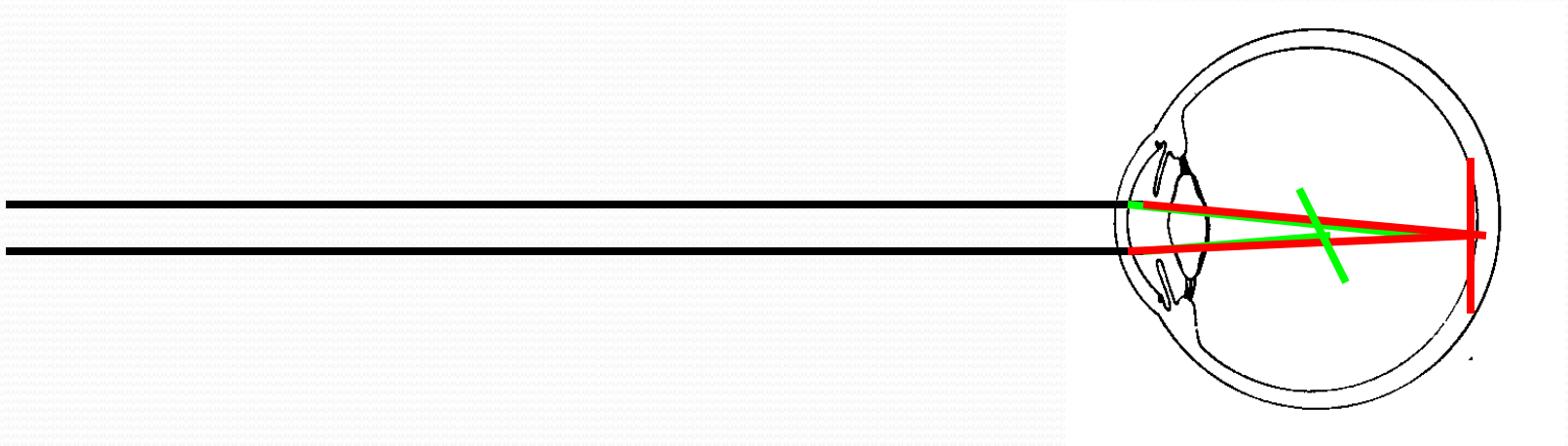
Regular Astigmatism



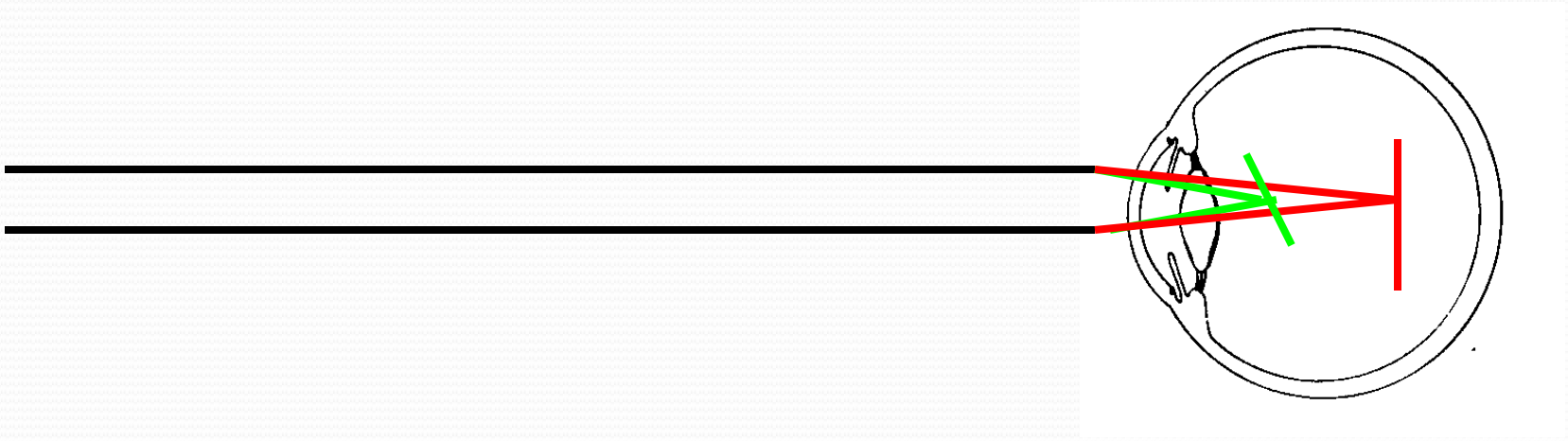
Types of Regular Astigmatism

- Simple myopic astigmatism
- Compound myopic astigmatism
- Simple hyperopic astigmatism
- Compound hyperopic astigmatism
- Mixed astigmatism

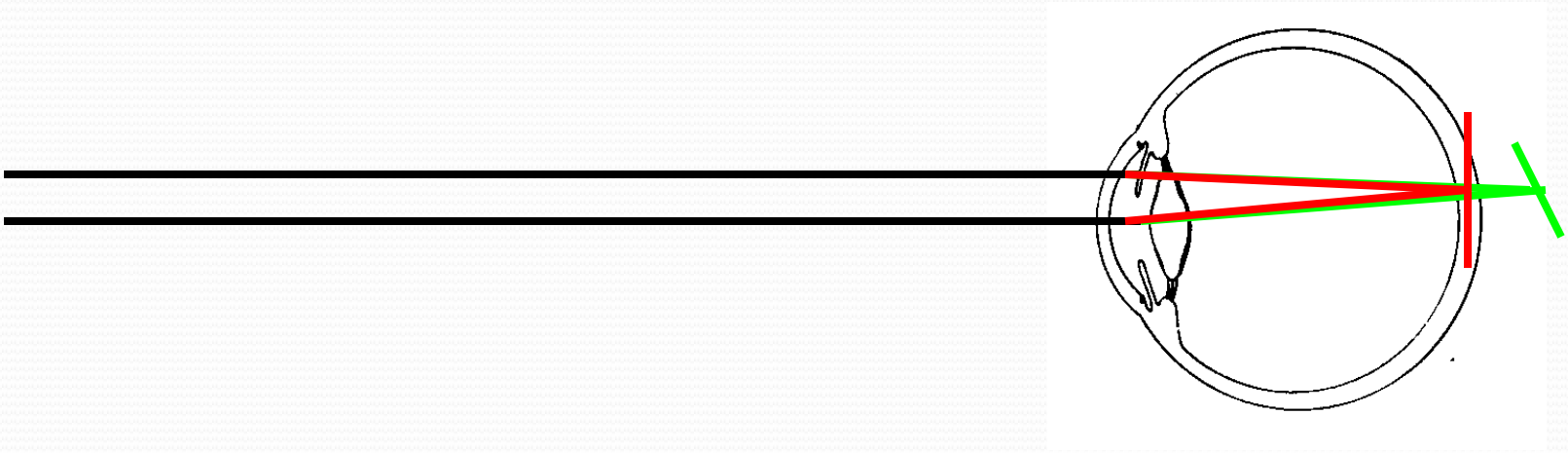
Simple Myopic Astigmatism



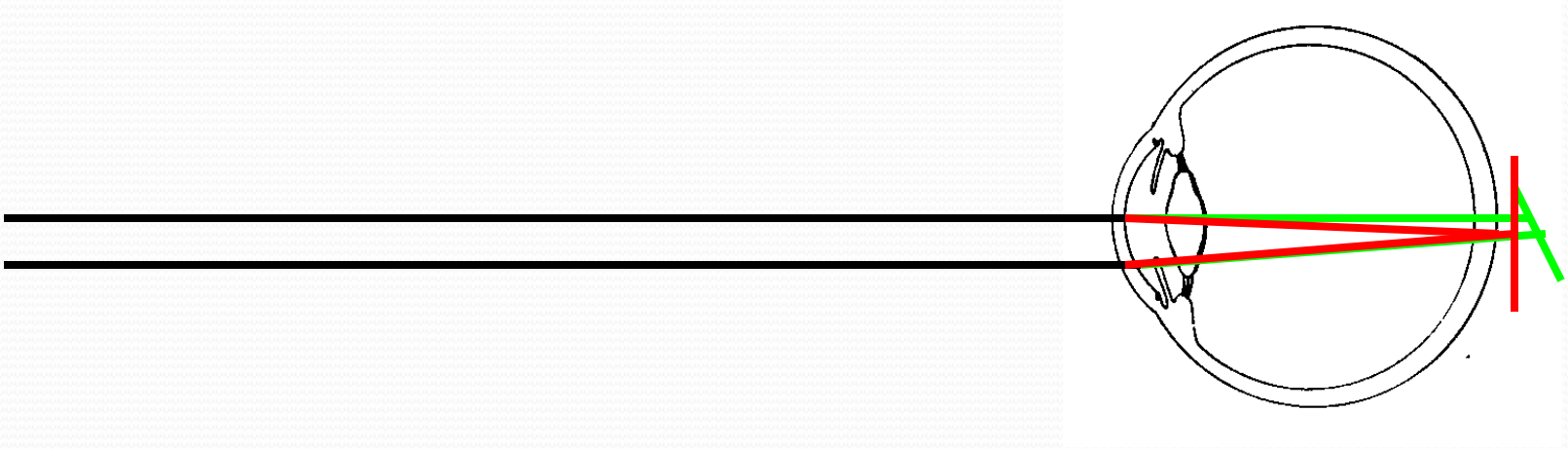
Compound Myopic Astigmatism



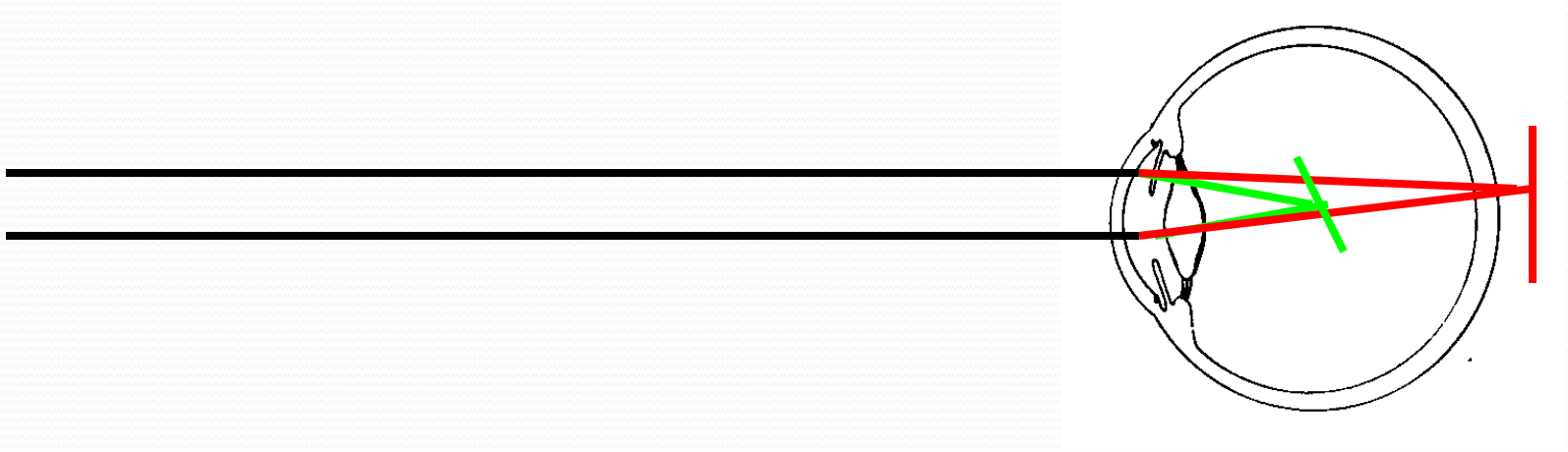
Simple Hyperopic Astigmatism



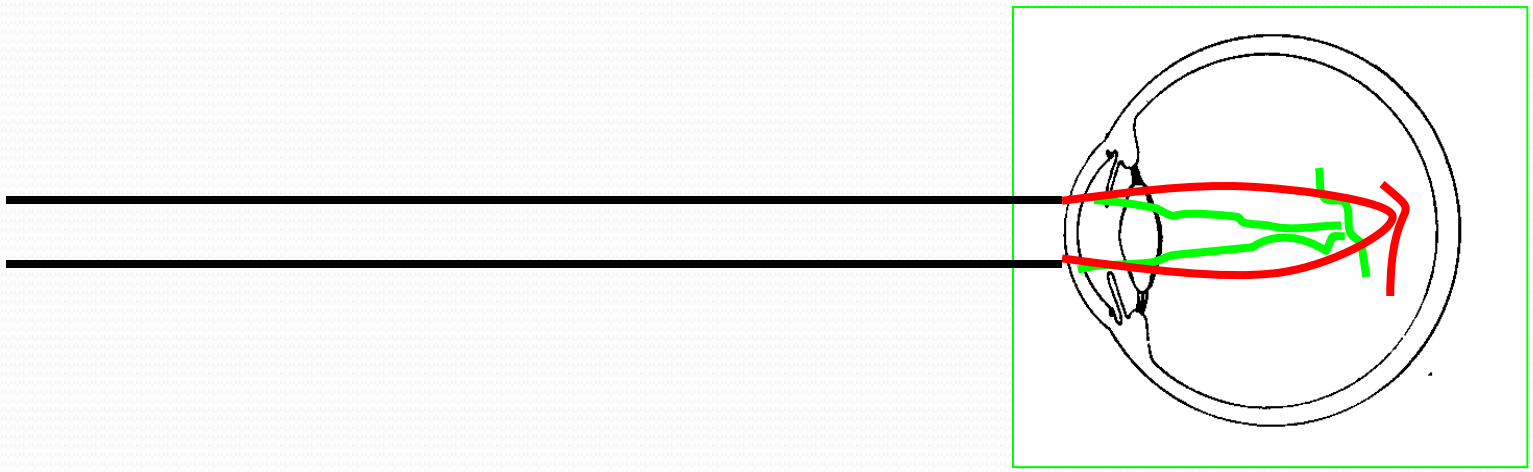
Compound Hyperopic Astigmatism



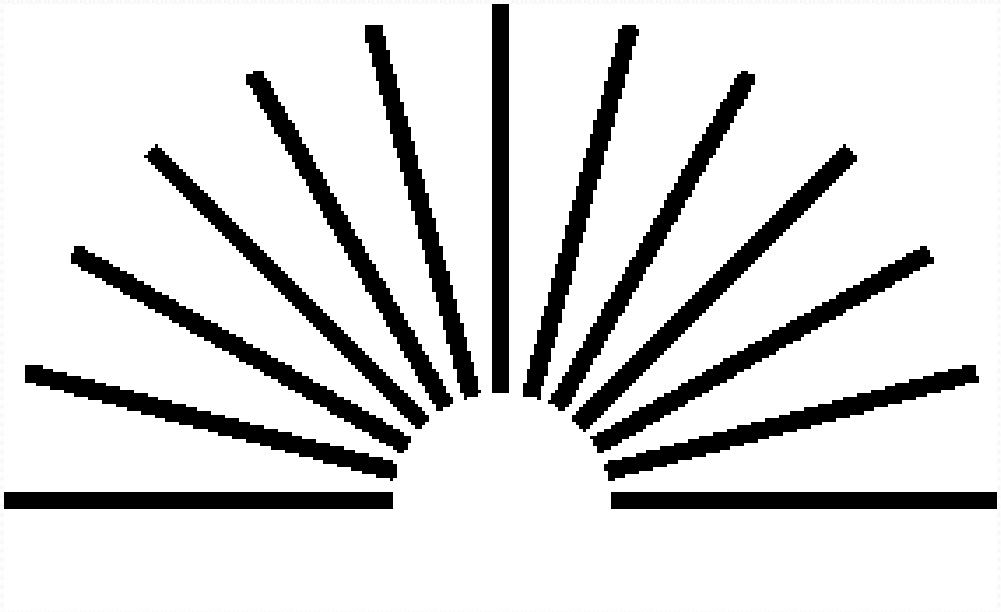
Mixed Astigmatism



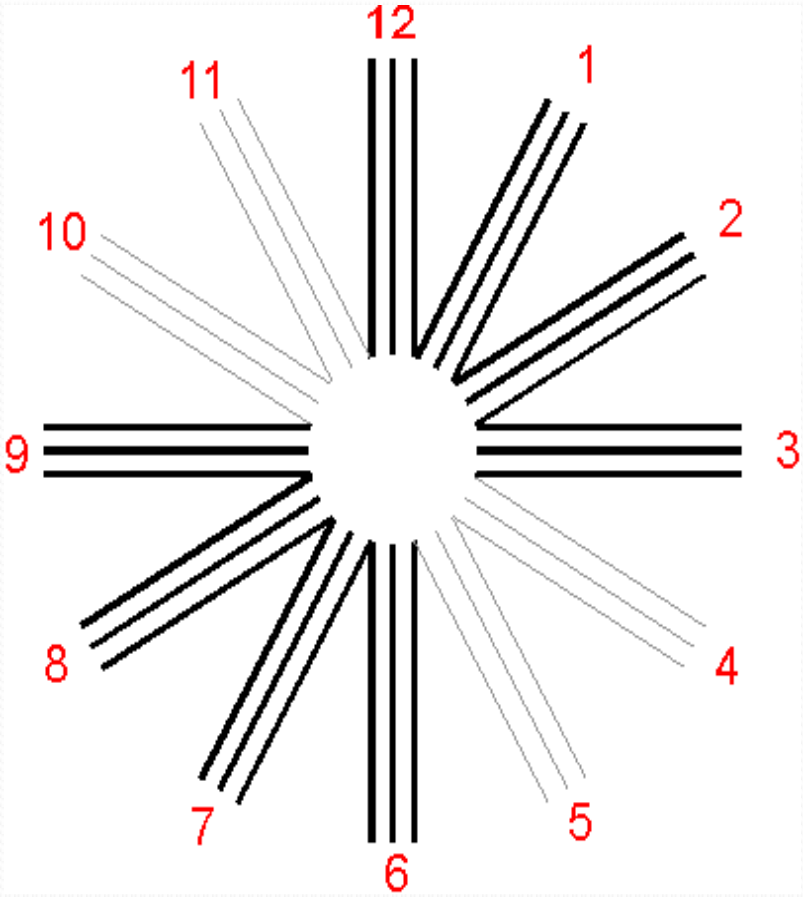
Irregular Astigmatism



Astigmatism



Astigmatism



Cylindrical Lenses

- Cylinder Lenses
- Toric Lenses
- Sphero-Cylindrical Lenses
- Flat and Toric Transposition
- Spherical Equivalent
- Contact Lenses

Terminology

- Presbyopia

- Greek
  - Presby = Old
  - Opia = Sight

Presbyopia

- Causes
- Treatment
  - Spectacles
  - Contact Lenses

Understanding Presbyopia

- Age-Related Vision Changes

  As we age, our visual system undergoes major changes

- Decline of accommodation
- Senile miosis
- Loss of visual acuity
- Lowered contrast sensitivity
- Increased lighting sensitivity
- Slower speed of visual processing

Change in the Mean Amplitude of Accommodation With Age

Age (Years)	Amplitude (Diopters)
10	10.6 - 13.5
15	10.1 - 12.5
20	9.5 - 11.5
30	6.6 - 8.9
35	5.8 - 7.3
40	4.4 - 5.9
45	2.5 - 3.7
50	1.6 - 2.0
55	1.1 - 1.3
60	0.7 - 1.0

Measured by moving the target toward the subject until first blur is reported (Borish 1970; Turner 1958)

Corrections for Presbyopia

- Rx reading glasses
- OTC readers
- PAL's
- Segmented lenses
- Contacts *(Soft and Rigid)*
  - Mono
  - Bifocals
  - Modified
- Surgery
  - Explain limitations to your patients
- Others

Muscle Imbalances

- Terminology
- Muscles of the Eye
- Possible Corrections

The bony orbit

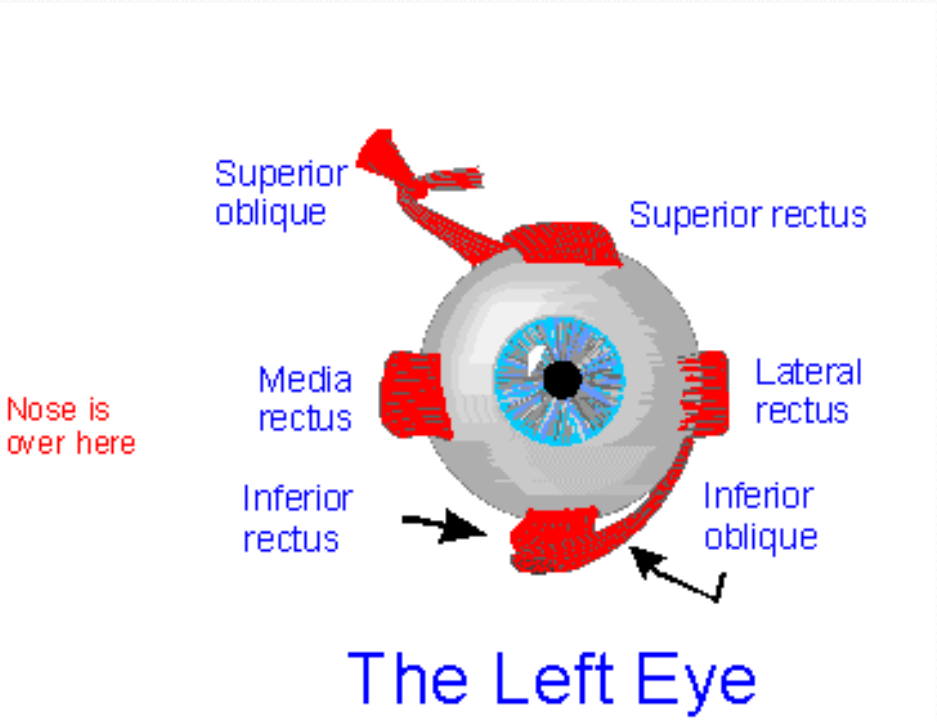
- Quadrilateral pyramid
- Influenced by age, trauma, as well as chronic sinus infections.
- Bed ridden, non-mobile person
- Contain the muscles of the eye

Extraocular Muscles

- •**Medial rectus (MR)**—moves the eye toward the nose
- •E**xternal rectus (ER)**—moves the eye away from the nose
- •**Superior rectus (SR)**—primarily moves the eye upward and secondarily rotates the top of the eye toward the nose
- •**Inferior rectus (IR)**—primarily moves the eye downward and secondarily rotates the top of the eye away from the nose
- •**Superior oblique (SO)**—primarily rotates the top of the eye toward the nose and secondarily moves the eye downward
- •**Inferior oblique (IO)**—primarily rotates the top of the eye away from the nose and secondarily moves the eye upward

Extraocular Muscles

- Superior Rectus
  - Moves the eye up
- Superior Oblique
  - Rotates the eye so that the top moves toward nose
- Medial Rectus
  - Moves eye toward nose
- Lateral Rectus
  - Moves eye away from nose
- Inferior Rectus
  - Moves the eye down
- Inferior Oblique
  - Rotates the eye so that the top of eye moves away from nose



Muscle Imbalances - Terminology

- Eso-
- Exo-
- Hyper-
- Hypo-
- -phoria
- -tropia

Muscle Imbalances - Terminology

- Tonicity
- Fusion
- Diplopia

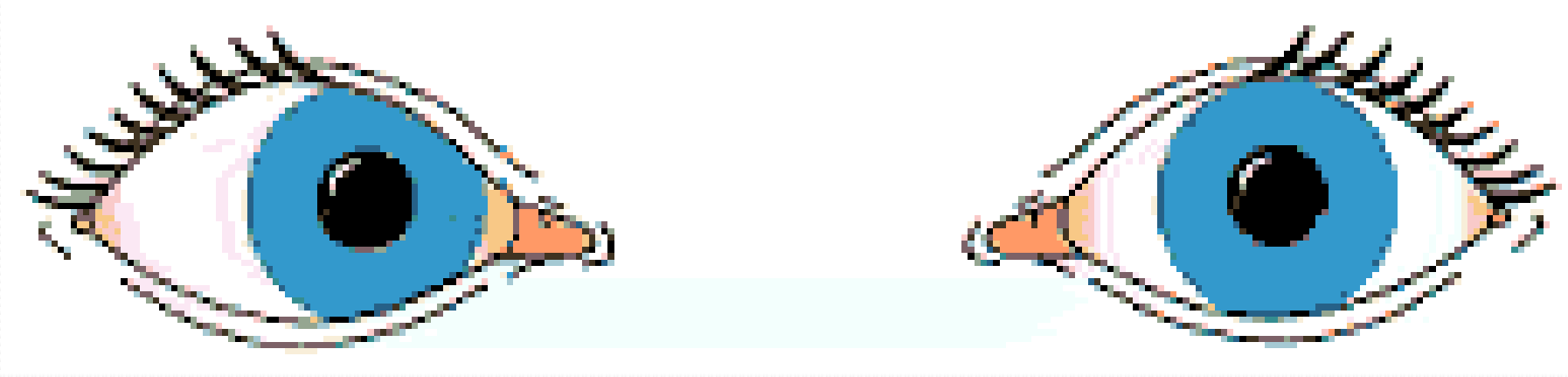
Muscle Imbalances - Terminology

- Orthophoria
- Heterotropia
- Strabismus - Can lead to Lazy eye or Amblyopia

Treatment

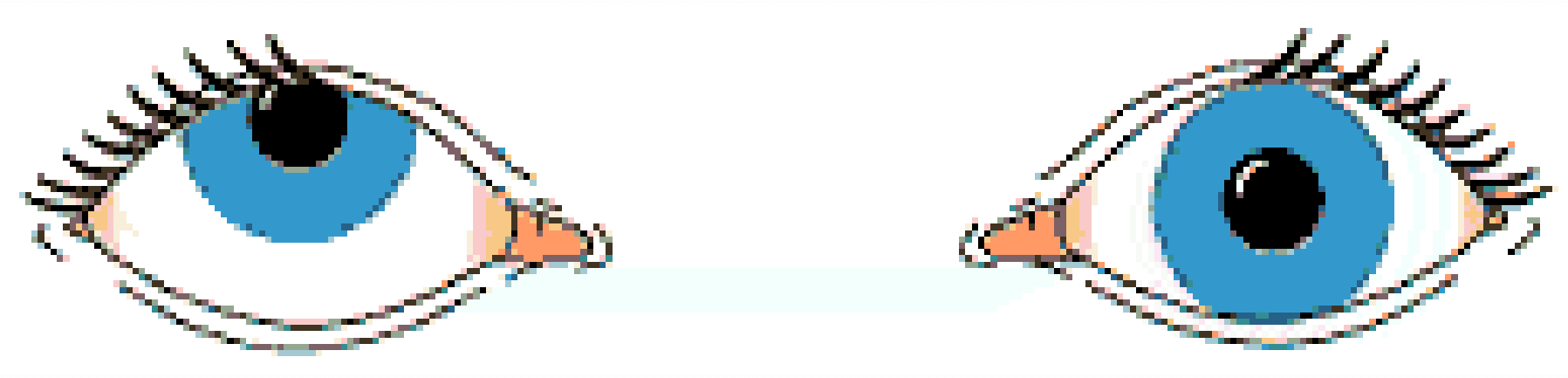
- Glasses
- Patching
- Surgery
- Vision Therapy

Esotropia
(convergent squint) Eye turned in Cross-eyed Boss-eyed



Exotropia
(divergent squint) Eye turned out Wall eyes

Hypertropia
(vertical) Eye turned up



Hypotropia
(vertical) Eye turned down

Anisometropia

- “unequal measure”
- The condition when the two eyes require a different degree of correction (1.00 or more) but the same kind of correcting lens (+ or -)
- The condition may cause vertical prism imbalance at near or cause a difference in the retinal image sizes between the two eyes

Anisometropia

- Example Rx:

  OD -7.00 D. sphere

  OS -3.00 D. sphere

- Example Rx:

  OD +7.25 sphere

  OS +5.25 sphere

Antimetropia

- “opposite measure”
- The condition when the two eyes require opposite kinds of corrective lenses (+ or -)
- The condition may cause vertical prism imbalance at near or cause a difference in the retinal image sizes between the two eyes

Antimetropia

- Example Rx:

  OD +1.75 sphere

  OS -1.00 sphere

- Example Rx;

  OD -2.25 sphere

  OS +1.50 sphere

Aniseikonia

- “unequal images”
- Anisometropia or antimetropia may result in the condition whereby two unequal images are sent by the eyes to the brain
- More prevalent due to refractive surgeries

- Meridional Aniseikonia
  - Normal or less aniseikonia in one meridian and more in another due to high astigmatism in that meridian

Iseikonic lenses

- A lens or pair of lenses used to correct aniseikonia
- The following variables are used:
  - Base curve
  - Thickness
  - Vertex distance
  - Index of refraction

Analyzing and Interpreting the Rx

- Concave Lenses
- Convex Lenses
- Contact Lenses

Visualization of Rx

- What we see
- What the patient sees

Your Prescription

	Sphere	Cylinder	Axis
OD	-2.25	-1.50	180
OS	+3.75	+1.50	090

ADD OU +2.25

Conclusion

Thank you