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## Phernell Walker, MBA, ABOM, LDO

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Master in Ophthalmic Optics

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Master in Business Administration

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Bachelor of Science in Business

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Associate of Science in Opticianry

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Past Adjunct Professor – Pacific University College of Optometry

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ABO & NCLE Certified

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Author of text-book, *Pure Optics*

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Joe Bruneni Award in Optics, Association of Schools Colleges of Optometry

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Beverly Meyers Achievement Award in Ophthalmic Optics

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## Contact Information

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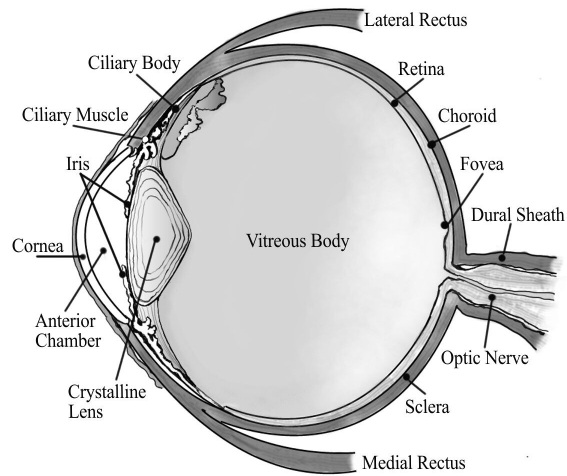
## Refraction - We Bend Light

1. Refraction the process of bending light.
2. The process of measuring the refractive state of the eye.

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## Human Eye



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## Refractive State

### No Refractive Error:

- Emmetropia

### Ametropia (Refractive Errors):

- Myopia
- Hyperopia
- Astigmatism

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## Gullstrand's Model Eye

Cornea: +43.00 D ( $t = .5$  mm)

Crystalline Lens = +19.00 D

Index of Refraction:

- Cornea: 1.376n
- Crystalline lens: 1.416n
- Aqueous/ Vitreous: 1.336n
- Abbe Value: 45

Axial length: 24 mm

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## Emmetropia

No refractive error present

Cornea and lens shaped correctly

Distance between fovea and lens is correct

Axial Length

Light from 20ft. Is focused on the retina

The eye can accommodate for near objects

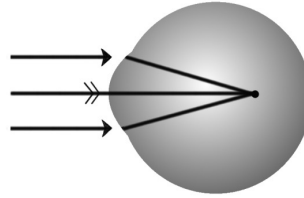
Emmetropia eye needs no corrective lenses

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## Myopia

- Nearsighted
- Eyeball is too long
- Distance lens and fovea is too great
- Light comes to a focus in the vitreous humor
- Sometimes the crystalline lens does not need to accommodate for near vision
- A minus (diverging) lens is use to correct



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## Myopic VA Approximation

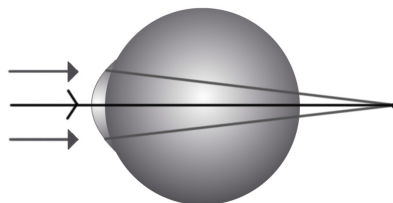
Myopia	Distance Acuity
-1.00D	20/80
-2.00D	20/200
-3.00D	20/400
-4.00D	less than 20/400

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## Hyperopia

- Farsightedness
- Eyeball's axial length is too short
- Light from distance may or may not focus on the retina
- Light from closer source focuses behind the retina
- A plus (converging) lens is used to correct Farsightedness



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## Objective Refraction

Determine the refractive state of the eye without patient input

Examples:

- Auto-Refractor
- Retinoscope



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## Retinoscopy

Process of shining a light into your patients eye and observing the “fundus reflex”.

Look for the Motion of the Reflex:

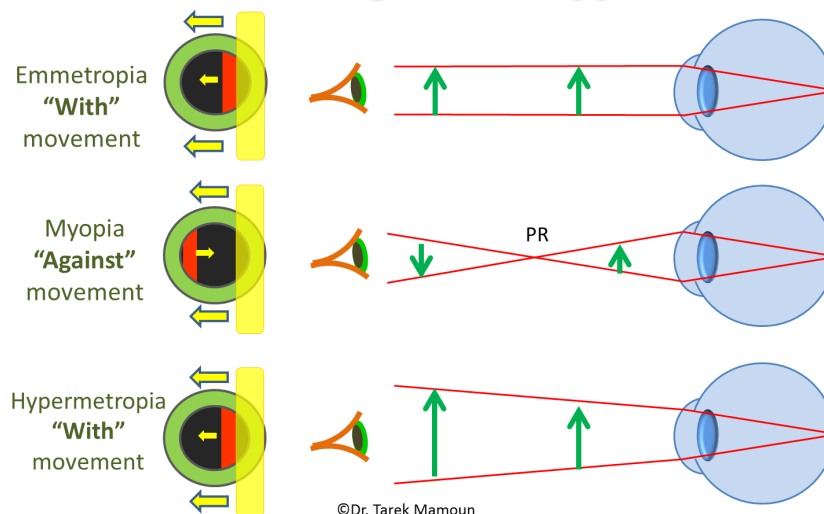
- With Motion
- Against Motion



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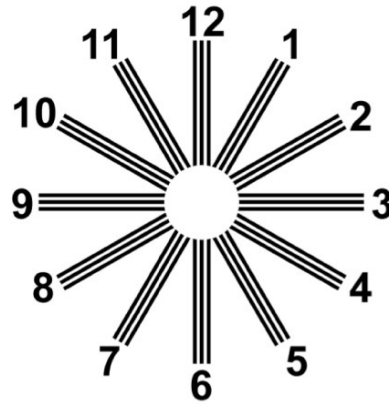
### The Movement of Red Reflex during Retinoscopy



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## Astigmatism

Refractive condition whereby light does not focus on the retina.  
Instead two line foci are created 090 degrees apart.



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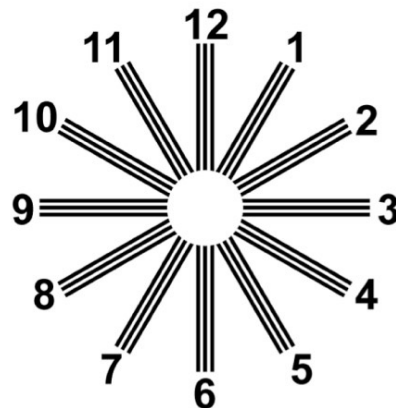
## Clock Dial Method

1. Fog Patient (Plus Power) to ~ 20/40
2. Which lines are clearest?
3. Equally in Focus = 0 Astigmatism
4. Not equally in focus = Astigmatism
5. Multiply the lower number x 30 to determine the axis

### Example:

If 3 & 9 are clear:  $3 \times 30 = 090$

**Answer: Axis = 090**



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## Jackson Cross Cylinder (JCC)

- Jackson Cross Cylinder is a combination of two cylinders (minus & plus power) 090 degrees apart
- JCC Power =  $\pm 0.25$  **or**  $\pm 0.50$
- Red Dots = Minus Power
- White Dots = Plus Power



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## Presbyopia

This is a condition, not a refractive error

Crystalline lens loses natural ability to focus

Ciliary loses its elasticity, ability to accommodate

Accommodation lessens with age

Multifocal's such as Bifocals, trifocals, progressive, SV near are used to correct

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## Astigmatism

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The most common refractive error of all

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The cornea is aspherical in the in the central zone

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Light has different focal points in different meridians creating a *line focus*

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Meridians are usually 90 degrees apart

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Almost 2/3 of the population has astigmatism

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Spherocylindrical lenses are used correct

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## Myopia & Near Point

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The eye has no need to accommodate, and does not converge...

This is not necessarily a good thing!

The myope has a tendency to under accommodate and under converge.

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## Uncorrected Myopia

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Force eyes to converge at near

Alternate vision

Eyes turn outward

Don't use one eye

*Myopes typically lean towards exophoria*

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## Hyperopic Children

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The young hyperopic child can accommodate at near.

In fact, they over accommodate, and over converge and typically have esophoria.

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## Uncorrected Hyperope

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Ignore one image, develop lazy eye

Diplopia

Asthenopia

Alternate vision

Eyes can become crossed-eyed

Typically have esophoria

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## Refraction Methods

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Habitual Rx (WRx)

Auto-Refractor (AR)

Manifest Rx (MRx)

Cycloplegic (CRx) (aka Wet)

Final Rx (Rx)

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## Subjective Refraction

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Subjective refraction is used after the initial objective refraction (used to determine a starting point or for non-communicative patients).

### Basic Order:

1. Find Spherical Power
2. Determine Cylinder Axis & Power
3. Refine the Sphere
4. Binocular Balancing (Dissociated Prism or Duochrome)

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## Lighting Conditions

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Indirect lighting should be used when performing a refraction.

Total darkness, nor bright light should be used. Light with a dimmer switch works best.



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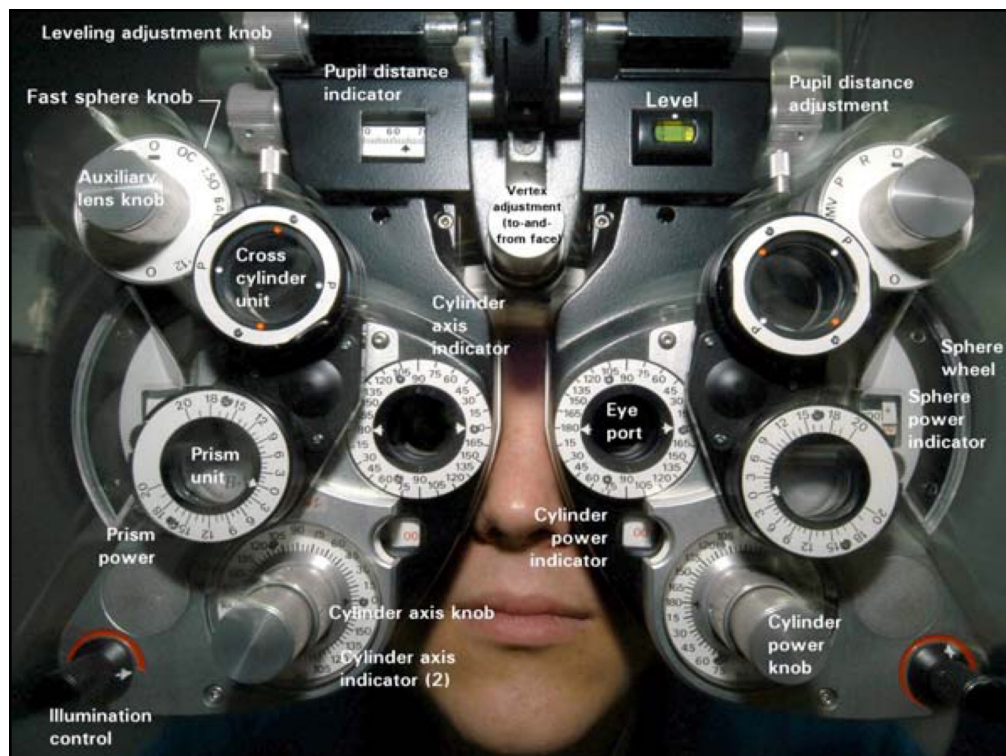
## Phoropter

The phoropter is an instrument used to: determine the refractive state of the eye, measures amount of deviation of the eyes with the use of prisms needed to neutralize the imbalance.

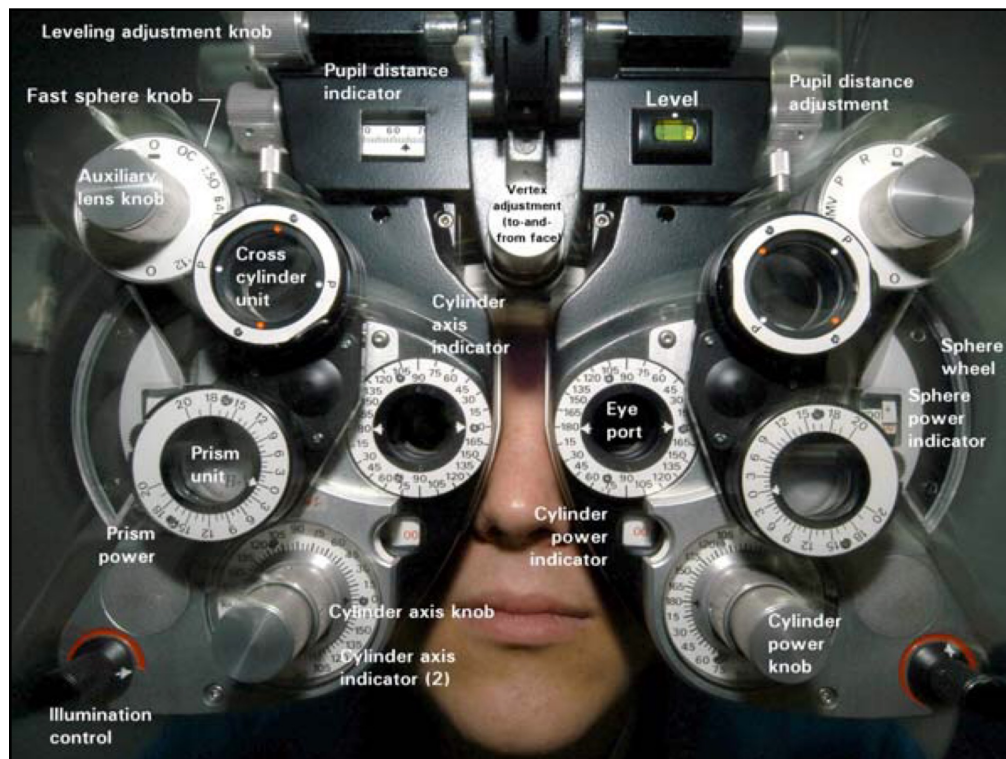
It contains many plus, minus, cylindrical and prism lenses secured in a “lens bank”.

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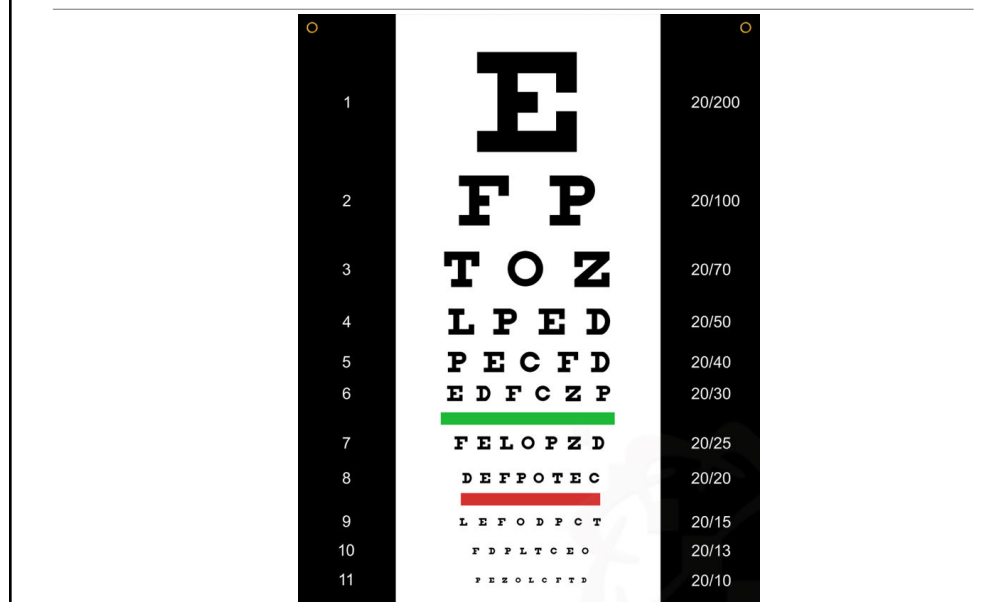


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## Snellen Chart



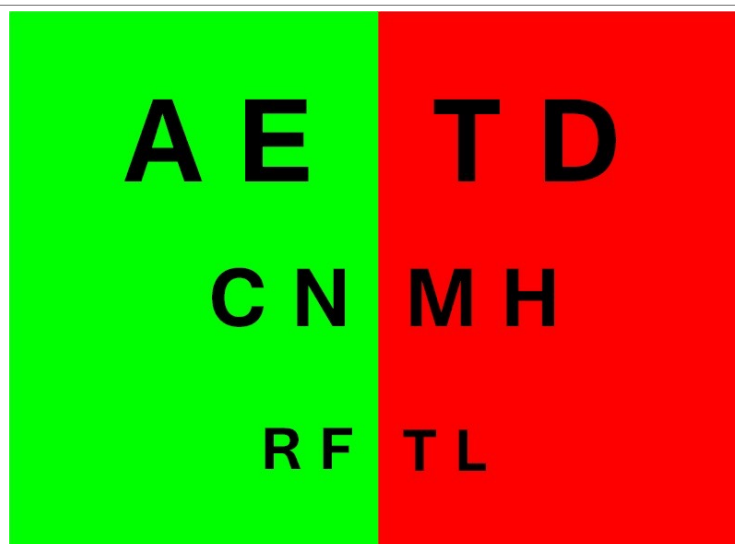
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## 18 Step Refractive Sequence

1. Occlude OS (while OD is open)
2. Check for patient's ability to read 20/30 or more (use starting point: AR, HBx, or Ret)
3. Once 20/30 visual acuity is achieved, show only ½ the 20/30 line
4. Add plus power (blur patient) to relax accommodation, until they tell you to stop
5. Dial 3 clicks or +0.75 D (4 clicks if using 20/40 line)
6. Refine the sphere power (which is better 1 or 2)
7. Check for cylinder in the 0, 045, 90, 135 and 180<sup>th</sup> meridian
8. Example: Which is better #1 Plano or #2 which is -0.50 D
9. If cylinder exist, place JCC in front of the eye using -0.50 D
10. Refine the axis of the cylinder (follow the red dots) minus power
11. Remove JCC, then Duochrome (red green) at 20/30 line
12. Occlude OD, open OS show other ½ of 20/30 line
13. Repeat the (1-12) sequence for OS eye
14. Fog patient (dial down 4 clicks +0.75 D), then open the OD
15. Binocular balance (vertical prism: Better top or bottom?) or Duochrome
16. Remove fog (dial up 4 clicks -0.75 D), then remove the prism
17. Duochrome test OU (R.A.M. or G.A.P.)
18. Red Add Minus or Green Add Plus until equally clear

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## Duochrome Balance



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## Beware

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Pseudomyopia:

Condition of on-going spasm of accommodation. A hyperope or emmetrope becomes falsely myopic.

Correction:

Requires plus lenses

Prism Base In – to relieve convergence from the work of overcoming excessive exophoria & relieve acc/ conv.

Function

Visual Training

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## Add Power

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- An add or additional plus power is typically prescribed for presbyopes.
- This can be measured with a reading rod or estimated by age.

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## Average Add Power

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Age	Myopia	Emmetrope	Hyperope	(low- high)
34 -38	X	X	X	+0.75
39-40	X	+1.00	+0.75	+1.25
44-48	+1.00	+1.25	+1.25	+1.75
49-55	+1.50	+1.75	+1.75	+2.25
56-62	+1.75	+2.00	+2.25	+2.50
63	+2.25	+2.50	+2.50	+2.50

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## Refraction Goal

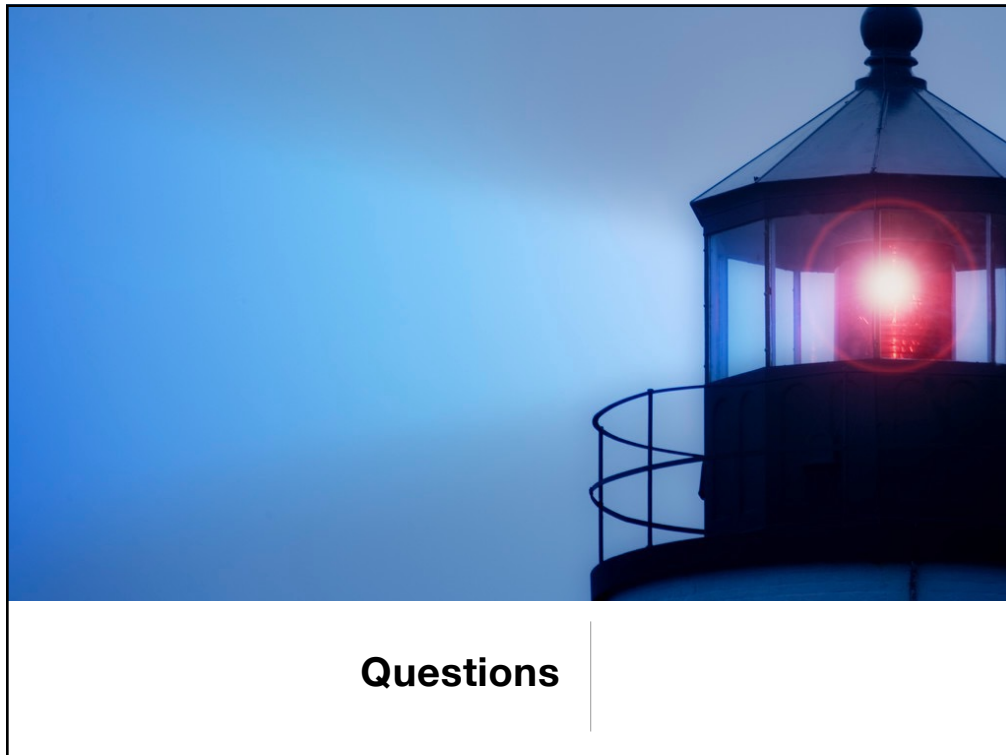
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The goal of a refraction is to provide the patient with the clearest perceived vision as possible!

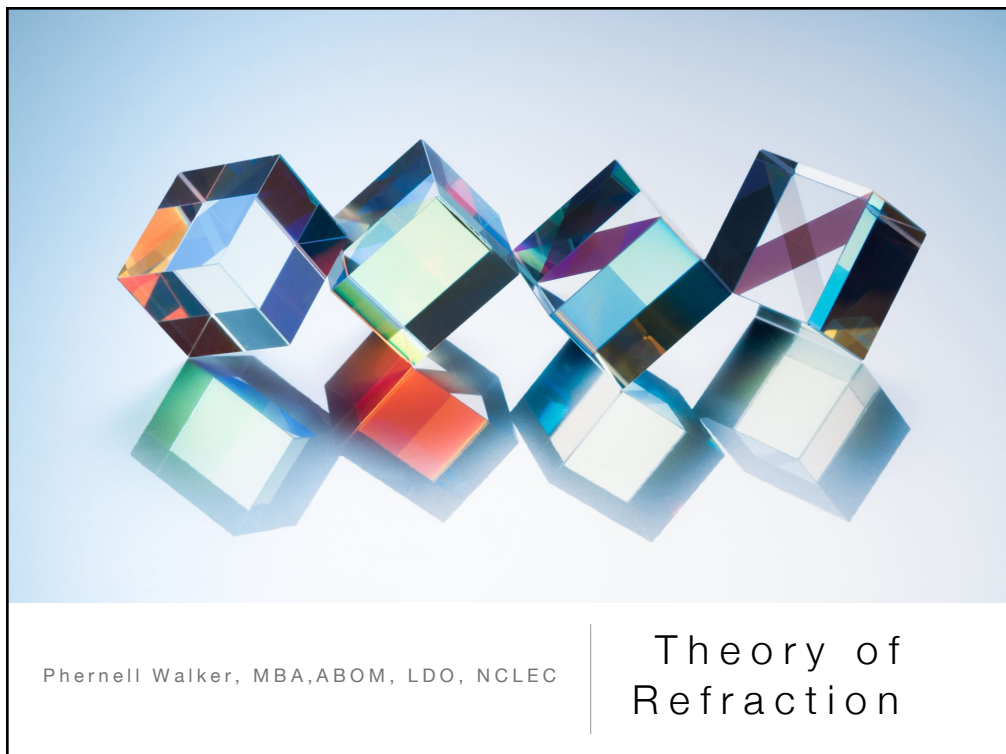
Prescribe the most plus power possible for hyperopes and the least minus power to myopes.

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