On behalf of Vision Expo, we sincerely thank you for being with us this year.

Vision Expo Has Gone Green!

We have eliminated all paper session evaluation forms. Please be sure to complete your electronic session evaluations online when you login to request your CE Letter for each course you attended! Your feedback is important to us as our Education Planning Committee considers content and speakers for future meetings to provide you with the best education possible.

VISION EXPO

ABO Basic Exam Review

Domain I: Ophthalmic Optics

National Federation of Opticianry Schools

Formal Opticianry Education…. We teach the Why

Presented by Tracy E Bennett, LDO, ABO-AC, NCLEC

Content Outline

ABO Test Content Outline	Weight	Approximate number of questions
I. Ophthalmic Optics	34%	39
A. Terminology		4
B. Prescriptions		5
C. Lens Characteristics		4
D. Lens powers and formulas		7
E. Multifocals		3
F. Lens Materials		8
G. Prism		8

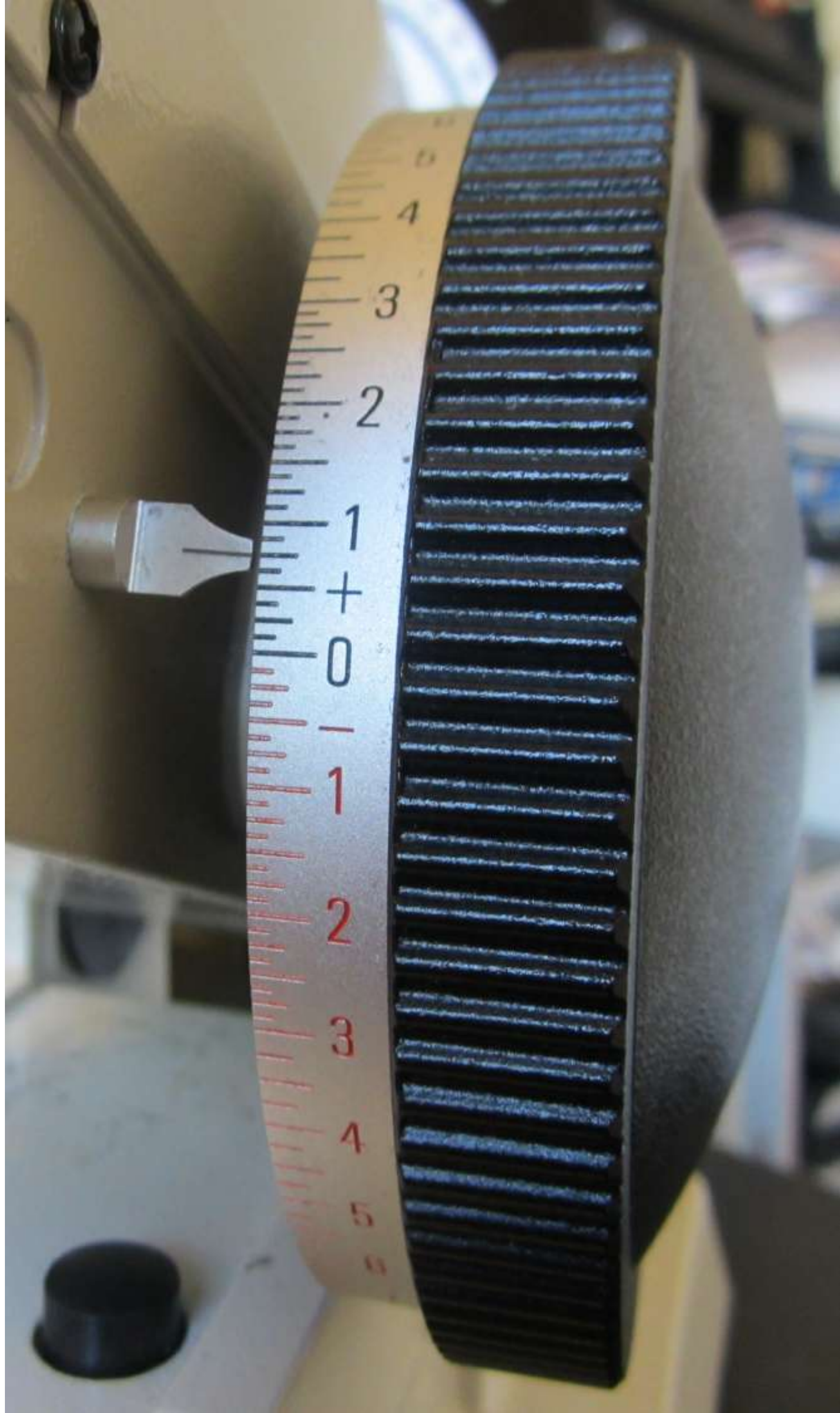
OVERVIEW OF CONTENTS

- **TERMINOLOGY**
- **PRESCRIPTIONS**
- **LENS CHARACTERISTICS**
- **LENS POWERS AND FORMULAS**
- **LENS MATERIALS**
- **MULTIFOCALS**
- **OBLIQUE CYLINDER POWER**
- **PRISM**

DIOPTIC POWER

DIOPTER: A unit of measurement for how much a lens or optical system bends light.

- Bending to a point of focus
  Lens power and **surface curvature** are measured in diopters.
  Ex: -1.00**D**, +3.00**D**, -5.00**D**
  Rx +2.50 -1.75 x 180
- Bending to displace an image
  Prism power is measured in diopters.
  Ex: 0.5**^**, 2**^**, 4**^**



DIOPTRIC INCREMENTS (POWER)

- **DIOPTRIC INCREMENTS: D**
  0.00, 0.12, 0.25, 0.37, 0.50, 0.62, 0.75, 0.87, 1.00, …
- **Quarter diopters: (prescriptions)**
  - 0.25, 0.50, 0.75, 1.00, 1.25, …
  - **Four steps** between increments (four increments in a diopter)
  - Prescriptions are written in quarter diopter increments
- **Eighth diopters: (equipment)**
  - 0.00, <u>0.12</u>, 0.25, <u>0.37</u>, 0.50, <u>0.62</u>, 0.75, <u>0.87</u>, 1.00, <u>1.12</u>, 1.25, …
  - **Eight steps** between increments (eight increments in a diopter)
  - Powers are measured in eighth diopter increments

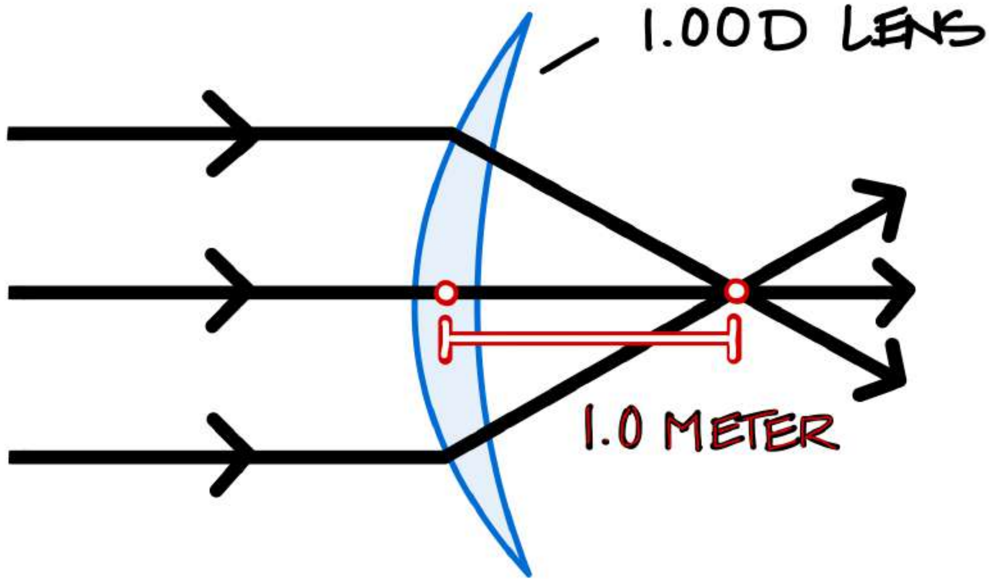
DIOPTRIC INCREMENTS (PRISM)

PRISM DIOPTRIC INCREMENTS: ^

- **Quarter diopters: (prescriptions)**
  - 0.25^, 0.50^, 0.75^, 1.00^, 1.25^, 1.50^, 1.75^, 2.00^, …
  - **Four steps** between increments (four increments in a diopter)
  - Prescriptions are written in quarter diopter increments
- **Tenth diopters: (equipment)**
  - 0.1^, 0.2^, 0.3^, 0.4^, 0.5^, 0.6^, 0.7^, 0.8^, 0.9^, 1.0, …
  - **Ten steps** between increments (eight increments in a diopter)
  - Powers are measured in eighth diopter increments

DIOPTIC POWER : What is it?

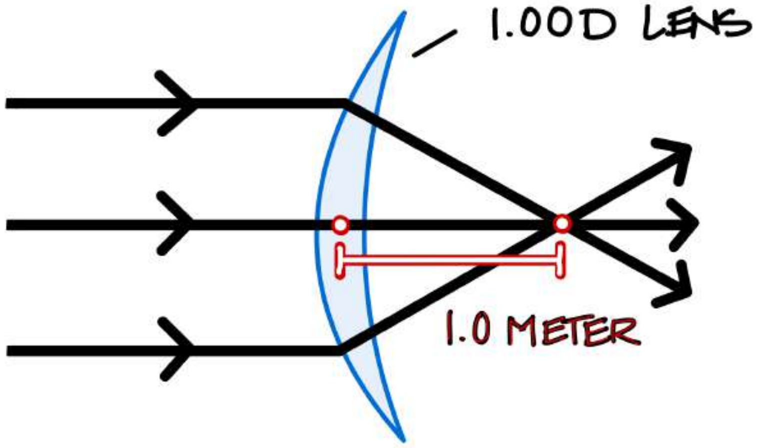
One diopter lens will focus/converge parallel light rays **one meter** from the back surface of a lens.

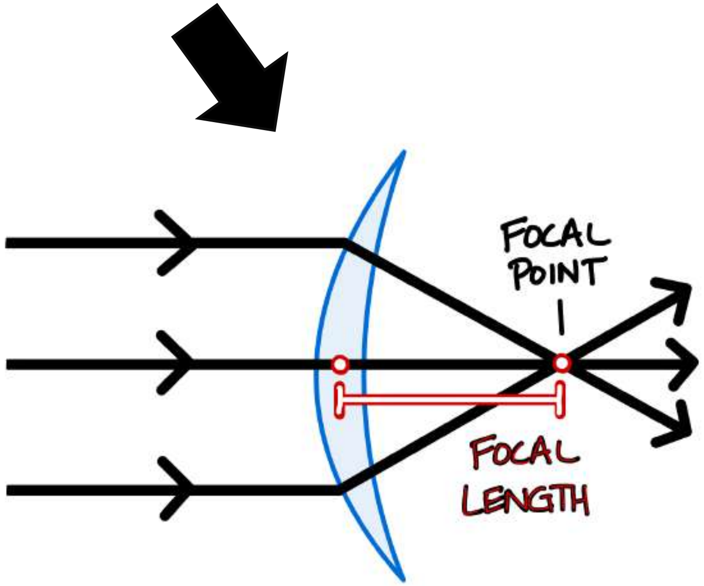


FOCAL LENGTH TERMINOLOGY

FOCAL POINT– point where light rays converge

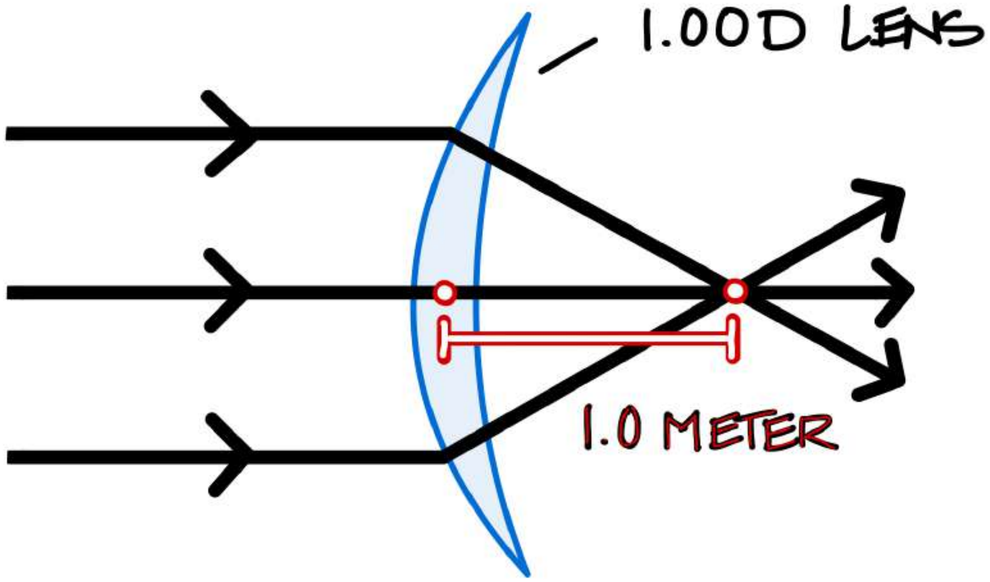
FOCAL LENGTH (DISTANCE)– the distance it takes them to converge





FOCAL LENGTH FORMULA

One diopter lens will focus/converge parallel light rays **one meter** from the back surface of a lens.



<u>Expressed as a formula</u>

$$D = \frac{1}{f_{METERS}}$$

FOCAL LENGTH : DIOPTRIC POWER

The dioptric power of a lens is the reciprocal of its focal length, and vice versa. If you know one, you can determine the other.

$$D = \frac{1}{f_{METERS}} \quad \cdots \quad \frac{1}{D} = f_{METERS}$$

What is the focal length of a **+2.00D** lens?

We have the dioptric power – we need the focal length.

$$\frac{1}{D} = f_{\text{METERS}}$$

$$\frac{1}{+2.00} = 0.5_{\text{ METERS}}$$

NFOS

What is the dioptric power of a lens that has a focal length of -0.25METERS?

We have the focal length – we need the dioptric power.

$$D = \frac{1}{f_{METERS}}$$

$$-4.00\,D = \frac{1}{-0.25\,METERS}$$

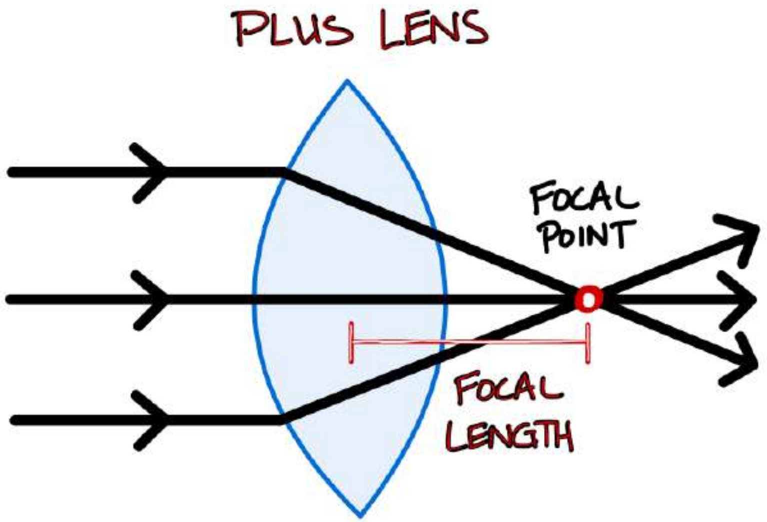
-/+ FOCAL LENGTH
-/+ DIOPTRIC POWER

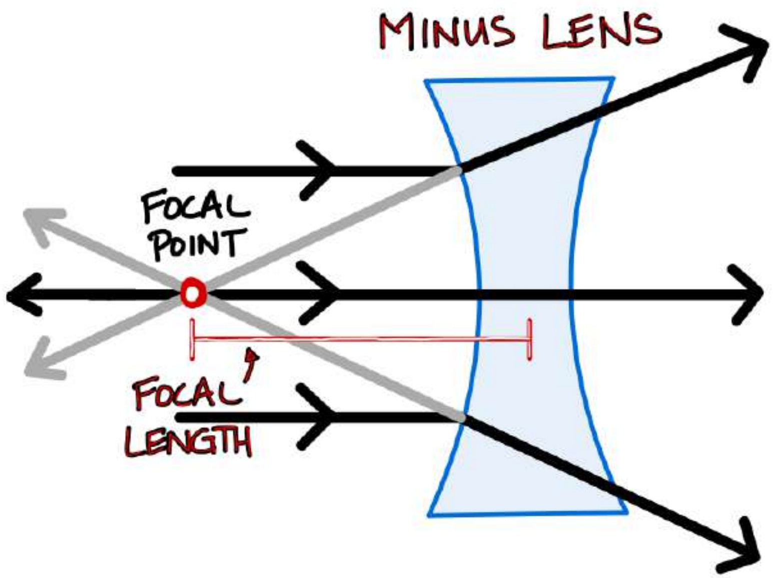
PLUS LENS POWER

- (+) Plus power lens has a **positive** focal length and light rays **converge**.
- Creates a **real** image (really crosses).

MINUS LENS POWER

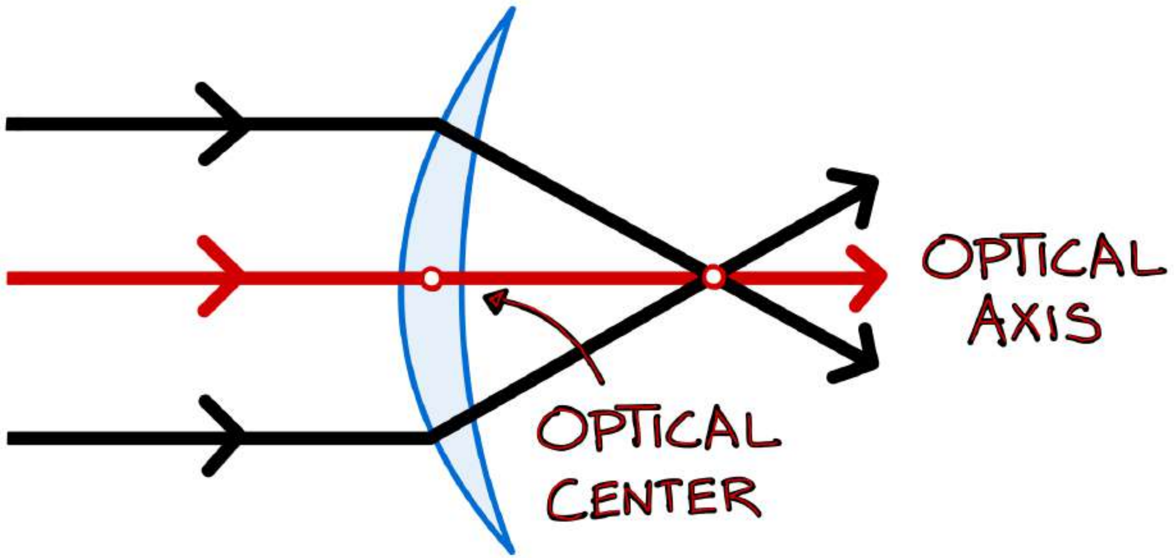
- (-) Minus power lens has a **negative** focal length and light rays **diverge**.
- Create a **virtual** image (doesn’t cross).





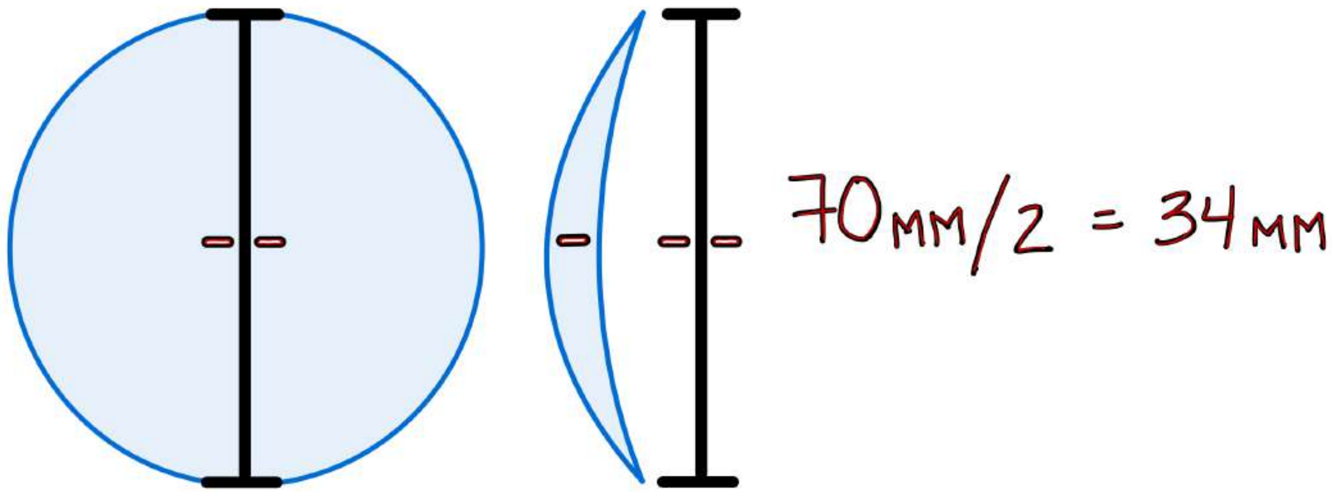
OPTICAL CENTER (OC)

- Single point where ray of light passes through without deviation.
- Point on lens where both sides of the lens are parallel.
- Optical axis should generally be aligned with the wearer’s eye.



GEOMETRIC CENTER (GC)

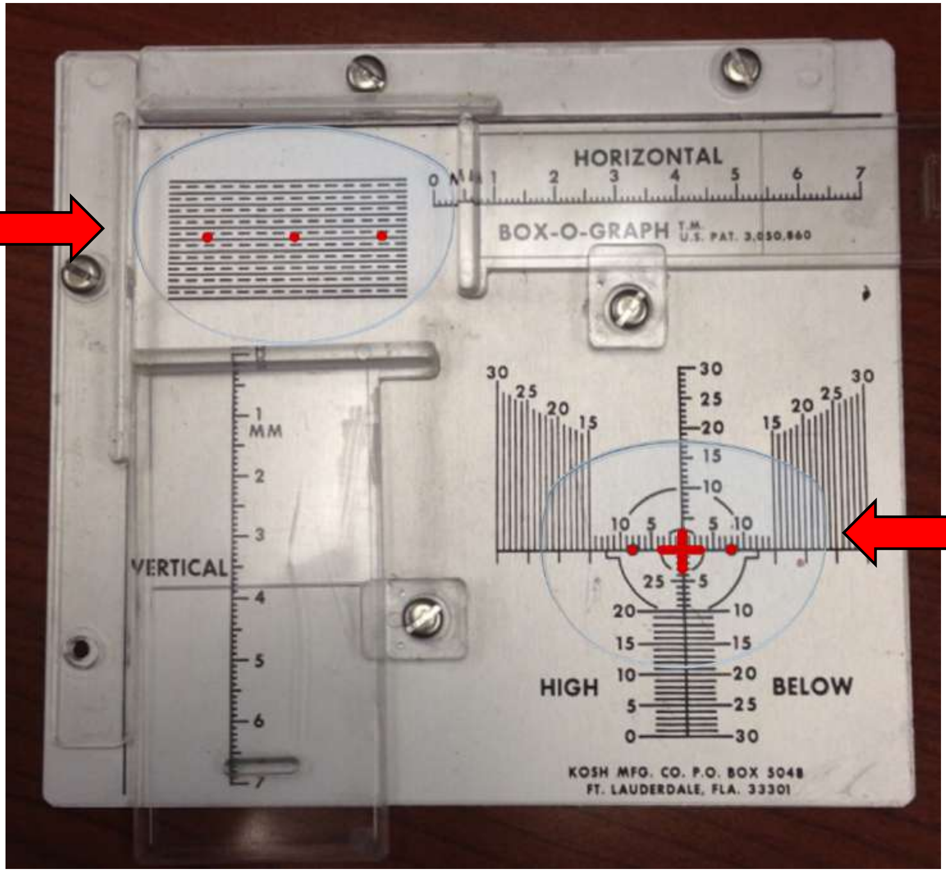
- The exact center point on a lens; equal distance from center to edge.
- Found by dividing the lens diameter by 2.
- Geometric center does ***not*** always correspond to the optical center.
- Lens blanks and edged lenses (all lenses) have a geometric center.



BOX-O-GRAPH

Device used to measure and locate the geometric center of edged lenses.
Popular device when patterned edging was common. Allows exact duplication.

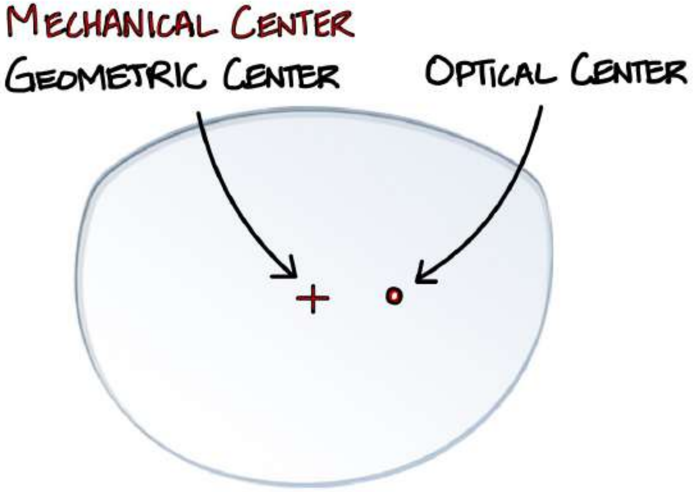
Used to measure vertical & horizontal size of a lens.

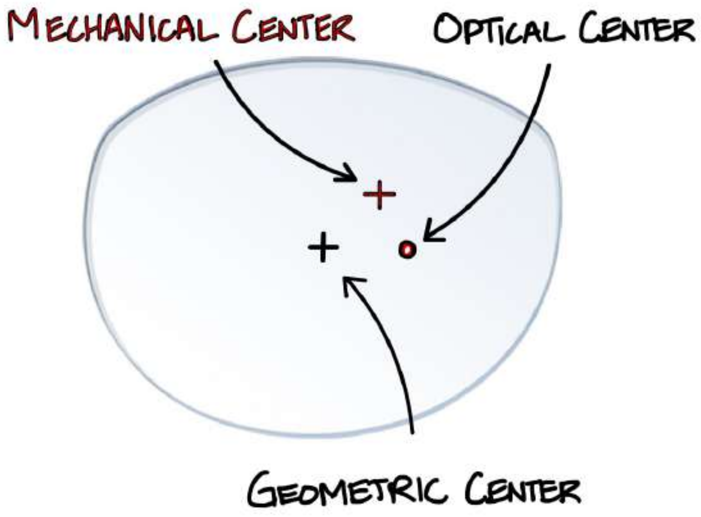


Used to locate the geometric center of a lens.

<u>MECHANICAL CENTER</u> (working center)

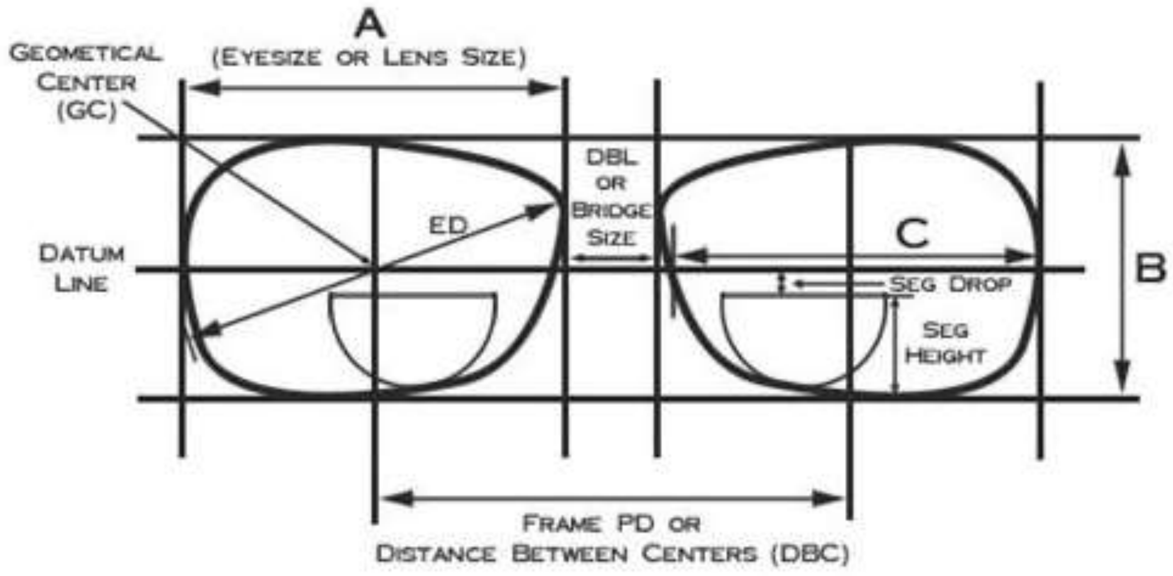
- Any point around which the lens is edged to fit the frame.
- Term used in the finishing lab during edging.
- The mechanical and geometric centers are generally at the same point, but do not *have* to be; they can all be at different points.





Boxing System of Measurement

A method or technique used in the optical industry to ensure precise placement and duplication of lenses that are custom-cut to fit specific prescription frames. This system involves measuring and marking specific reference points on the **lenses and frames** to ensure proper alignment and fit.

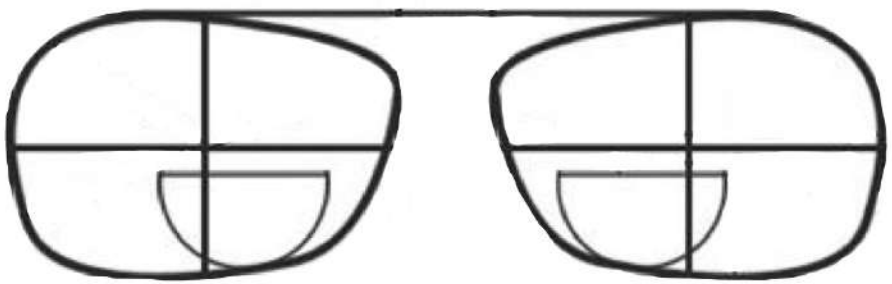


Boxing System of Measurement

IMPORTANT NOTE

When measuring a frame, we're actually measuring the lenses within it to ensure the precise positioning of their optical features. In the boxing system, the focus is more on aligning the lenses within the frame than on the frame itself.

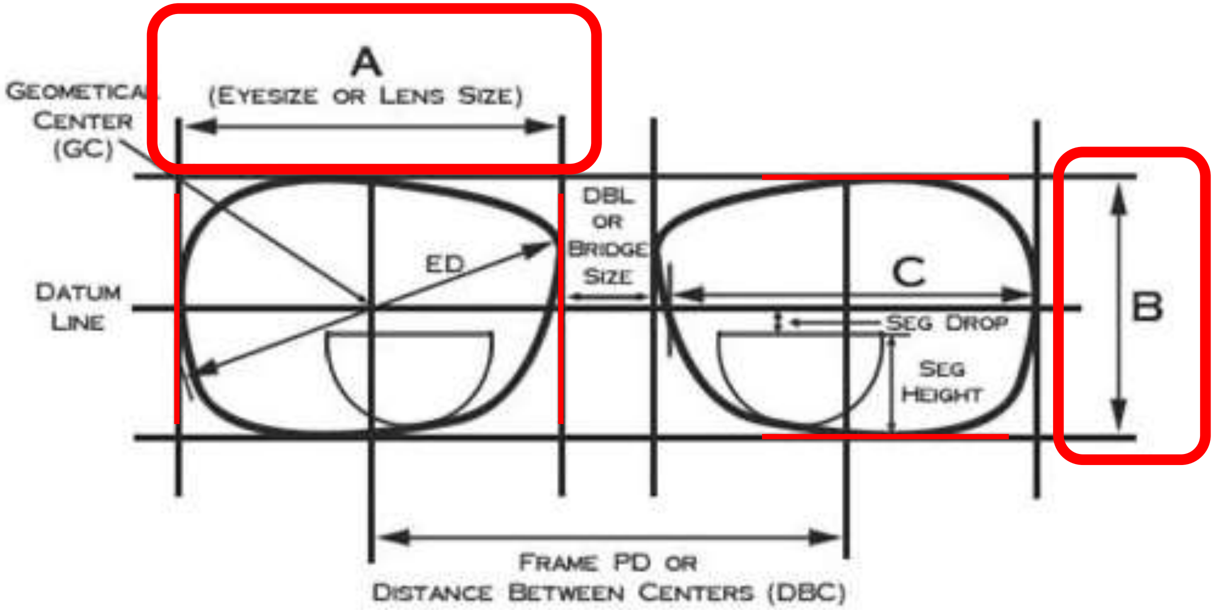
Frame thickness does not impact the measurement.



When measuring thick frames, it is important to remember that the average bevel is 0.5mm. Measure inside to inside and add or subtract 0.5mm for part of lens inside the bezel frame.

Boxing System of Measurement

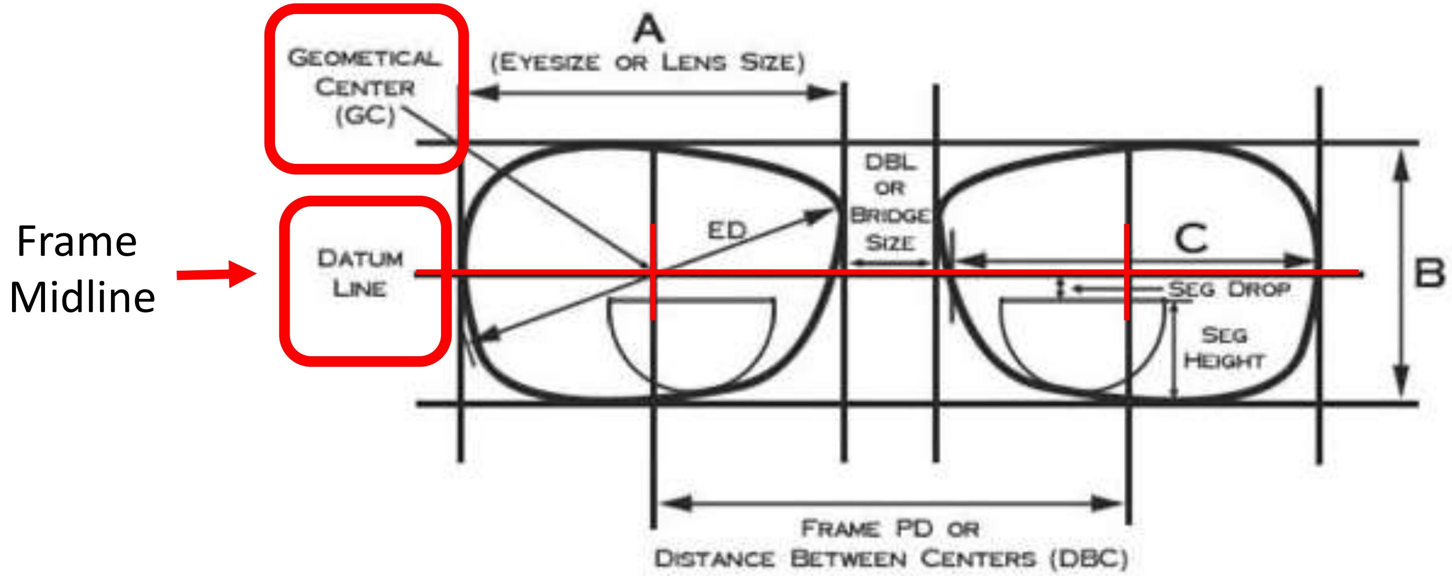
- **"A" Measurement** – the **horizontal distance** between the furthest temporal and nasal edges of the lens shape or the distance between the vertical sides of the box.
- **"B" Measurement** – the **vertical distance** between the furthest top and bottom edges of the lens shape or the distance between the horizontal sides of the box.



Measured from the widest points of the box.

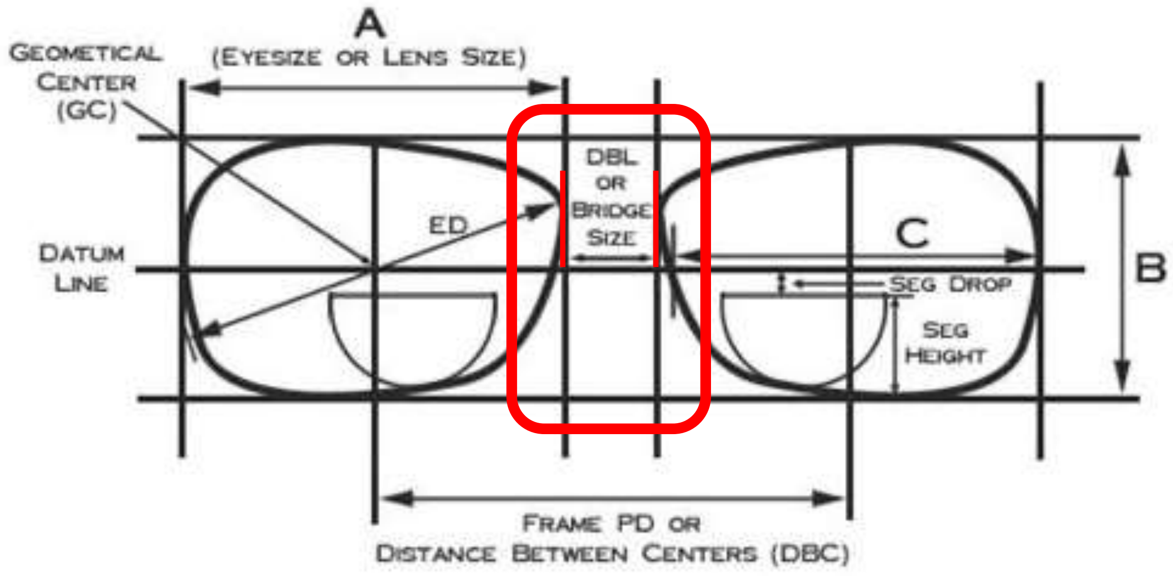
Boxing System of Measurement

- **Datum Line** – The horizontal line that *runs through the geometric center* of the frame (AKA **frame midline**). Found by **dividing the B dimension in half**.
- **Geometric Center (GC)** – The **exact intersection of the A and B dimensions** of the frame or lens.



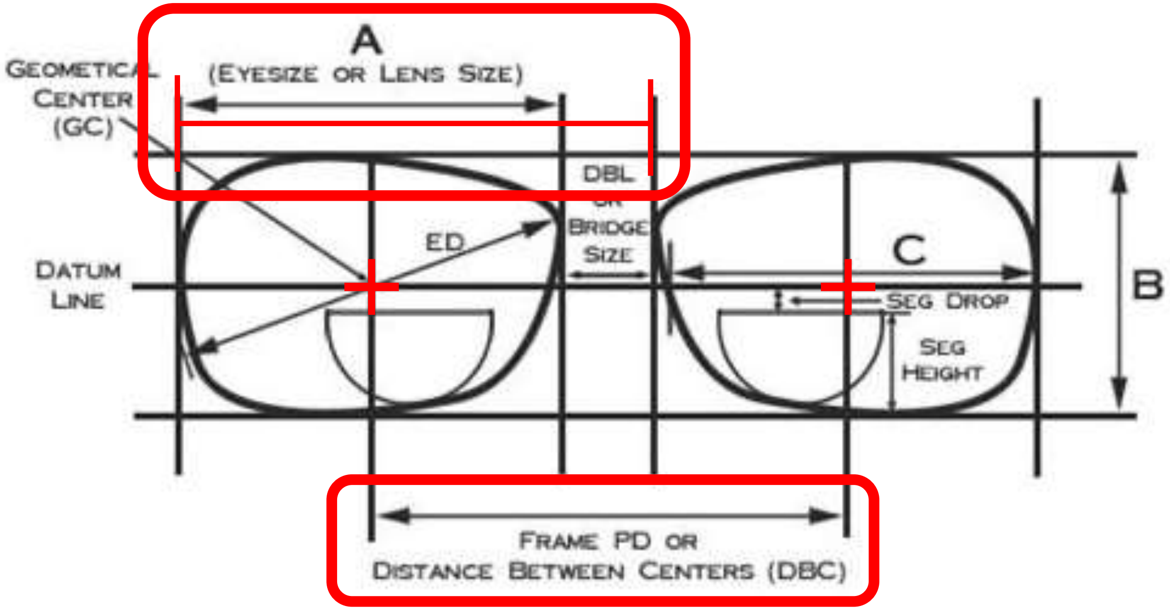
Boxing System of Measurement

- **Distance Between Lenses (DBL)** – The ***shortest distance*** **between the lenses**. (AKA **bridge size**). It is measured at the exact point where the bridge is the narrowest. It is often mis-measured at the location of the nose pads.



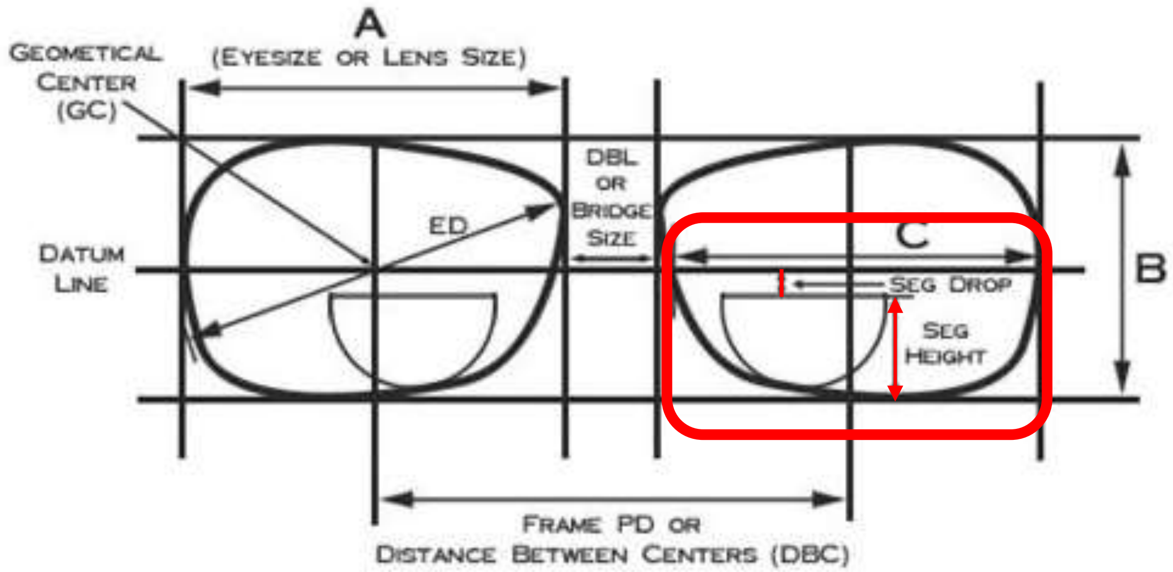
Boxing System of Measurement

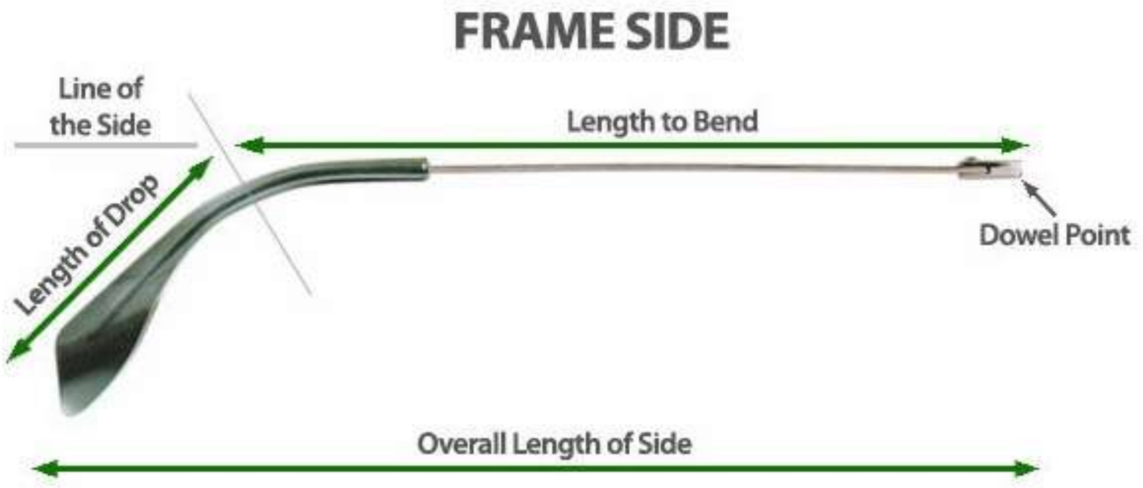
- **Distance Between Centers (DBC)** – The **horizontal distance between the geometric centers** of the lens opening. It can be quickly measured by measuring across the A and DBL dimension of the frame **(A + DBL = DBC)**. DBC is more commonly referred to as the **Frame PD**, but also can be referred to as the **boxing center distance** or **geometric center distance (GCD)**.



Boxing System of Measurement

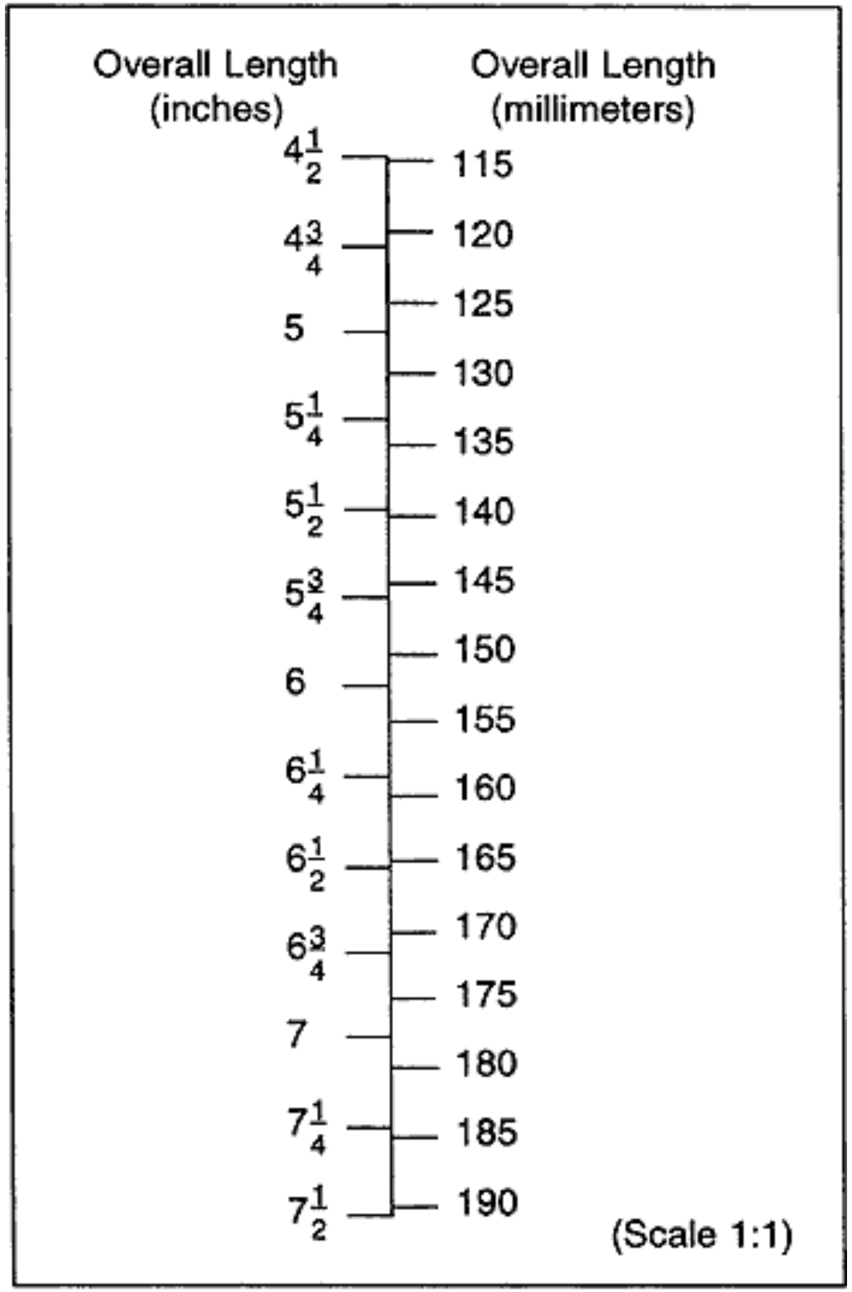
- **Seg height** – vertical distance from the bottom of the frame to the top of the segment. Term often used to refer to any vertical fitting heights (PAL fitting height, MRP height, and OC height).
- **Seg drop** – vertical distance from the frame midline (datum line) to the top of the segment. S**eg drop** when below the midline or **seg raise** when above the midline).





- Temple Length (OTL) - The running distance between the middle of the center barrel screw hole and the end of the temple
- Length to Bend (LTB) – The distance between the center of the barrel and the middle of the temple bend
- Front to Bend (FTB) – The distance between the plane of the front of the frame and the temple bend.

Conversion Chart (inches to MM)



Practical Application

If a temple is marked 5.0 inches, what mm length temple would be equivalent?

Answer: 25.4 x 5.0 = 127 mm

If a temple is marked 150 mm, what temple length in inches would be equivalent?

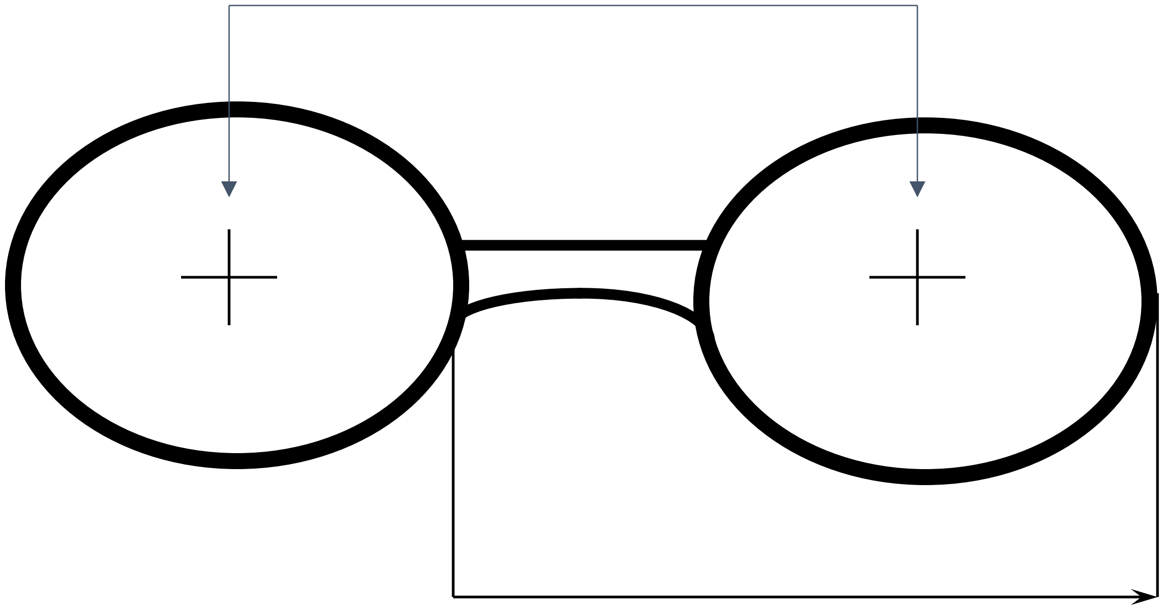
Answer: .0394 x 150 = 5.91 or 6 in

CENTRATION

- Ordinarily, we want the OC'S of the lenses placed directly in front of the patient's pupil. This will only occur if the center of the frame matches the ocular measurement (PD) & it rarely does. Therefore, we DECENTER the lenses to achieve the proper location of the OC's. We need to learn how to measure the FRAMES PD.

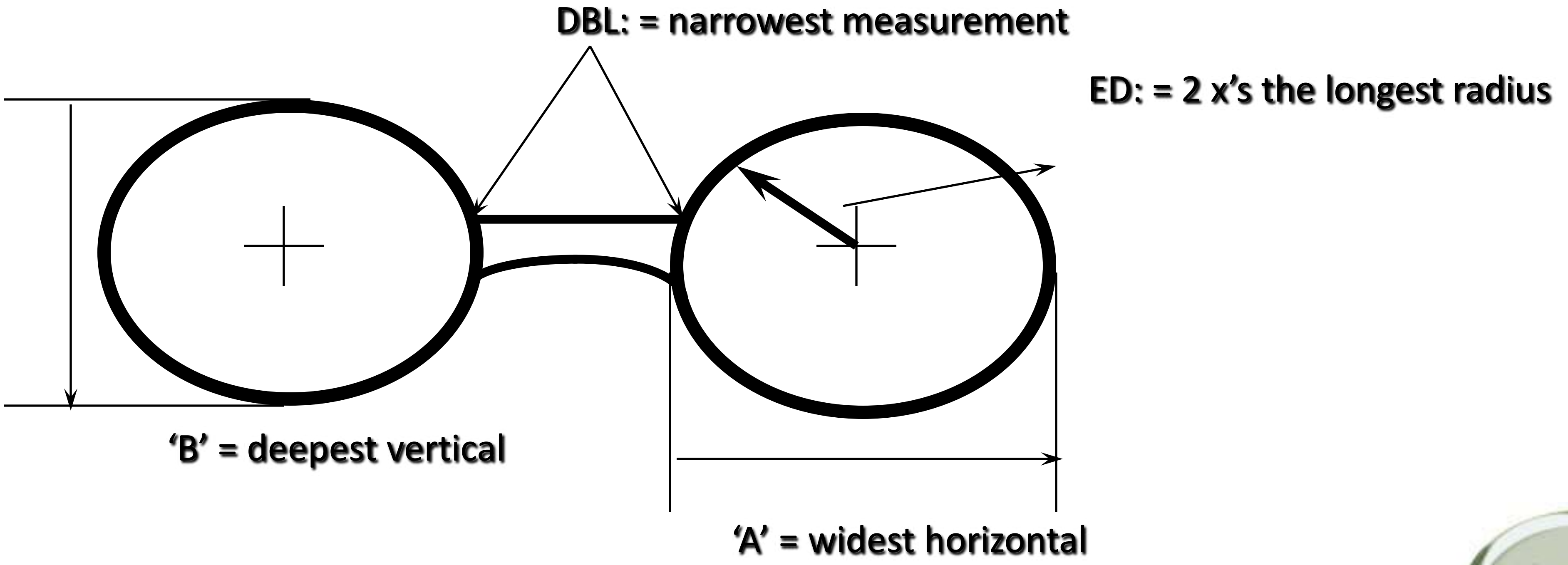
FRAME PD: boxing center to boxing center

We want this measurement…



So we measure this distance.
This is the **Frame PD (boxing center distance)**

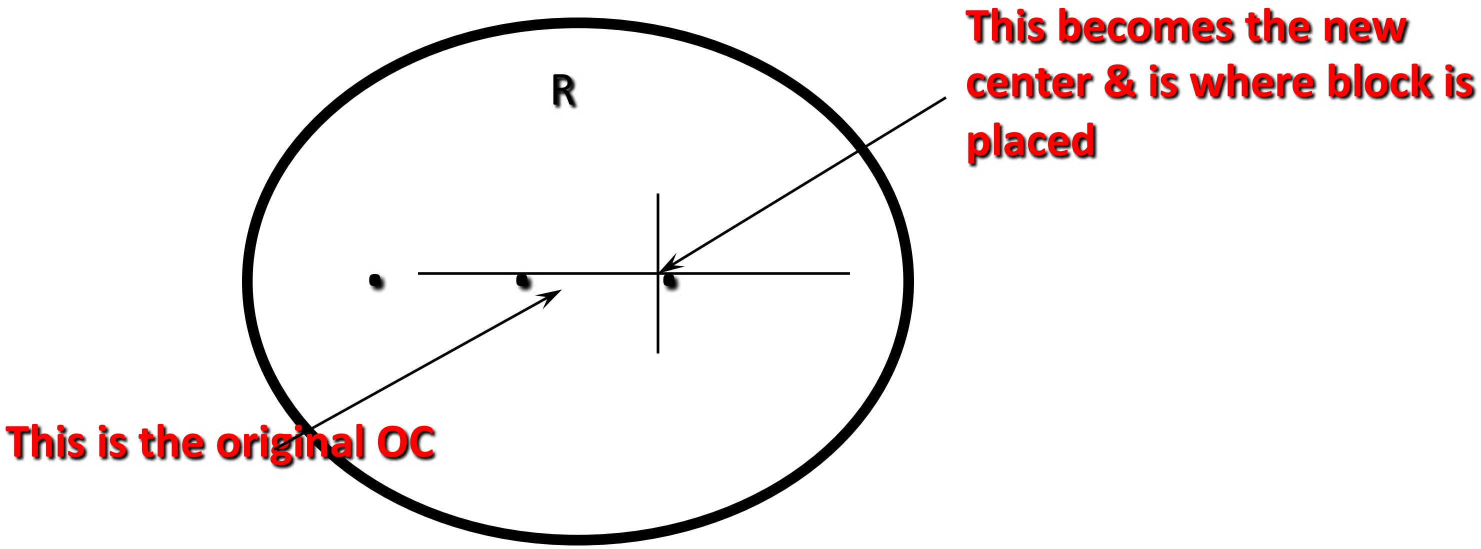
FRAME PD: Boxing System



FPD: = A + DBL

DECENTRATION

A lens decentered will look like this when viewed from the rear or concave side:

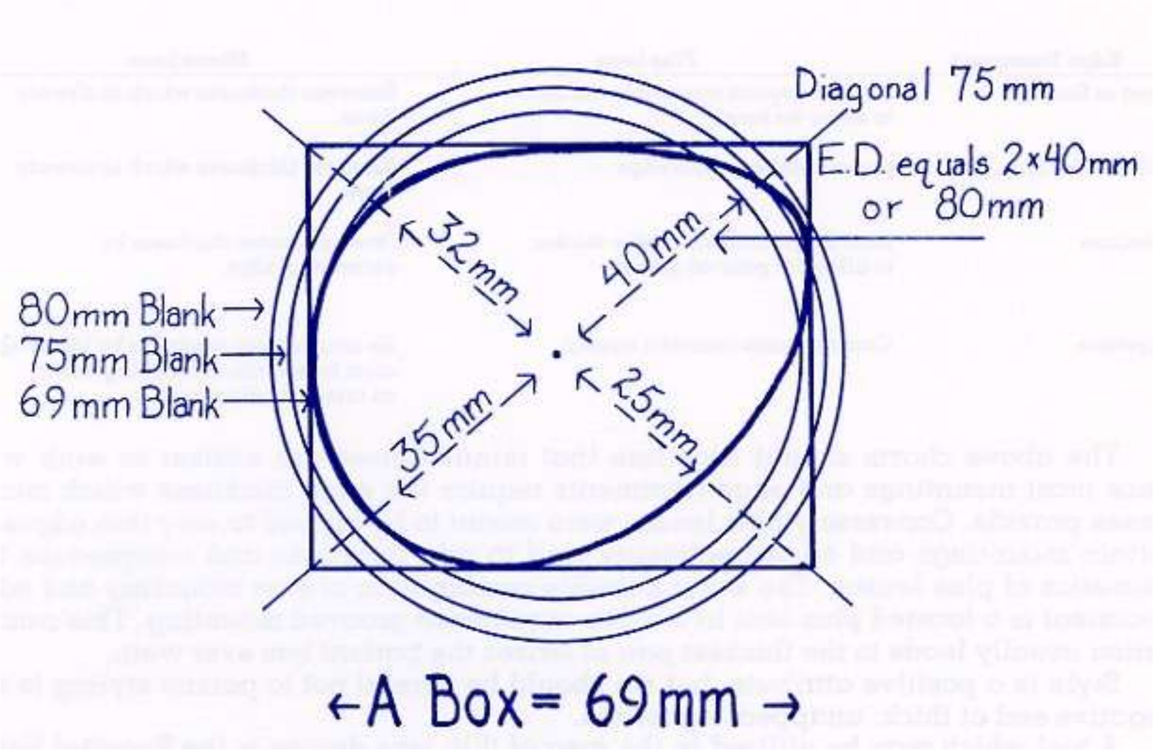


DECENTRATION EXAMPLES

- **FPD 70, PPD 65/ = 2.5 mm in**
- **FPD 73, PPD 62/ = 5.5.mm in**
- **FPD 71, 35.5/35.5 PPD 32/34 = 3.5 mm in; 1.5 mm in**
- **FPD 68, 34/34 PPD 33/35 = 1mm in; 1mm out**
- **Oc's needed at 24 mm; B = 38 = 24 – 19 = 5 mm up**
- **Oc's needed at 21; B = 48 = 21 – 24 = 3mm down**

Effective Diameter (ED)

- Is twice the distance from the geometric center of the lens to the apex of the lens bevel farthest from it.



Effective Diameter - ED

- ED is used in combination with distance decentration to select the minimum lens blank size required to fit a given frame
- MBS = ED + 2 (decentration per lens) or
- MBS = ED + 2 (decentration per lens) + 2 mm
- The addition of the 2 mm is to account for lens imperfections and possible chipping. Add 2mm for chipping if indicated in the question.

Example # 1

- What would the MBS be for a finished, single vision lens that is to be placed in a frame having the following dimensions?
  - “A” = 52 mm, DBL = 18, ED = 57 mm,
    Patient PD = 62 mm

  MBS = 2 (decentration per lens)

  FPD = 70, Patient PD = 62

  Decentration is 4 mm in for each eye or total decentration of 8 mm

  MBS = ED + 2 (decentration per lens)

  MBS = ED + 2 (4) = 8 ED = 57

  57 + 8 = 65 MBS

Example # 2

- What would the MBS be for a finished, single vision lens that is to be placed in a frame having the following dimensions? (Use Brooks Formula)
  - “A” = 52 mm, DBL = 18, ED = 57 mm,
    Patient PD = 62 mm

MBS = 2 (decentration per lens)

FPD = 70, Patient PD = 62

Decentration is 4 mm in for each eye or total decentration of 8 mm

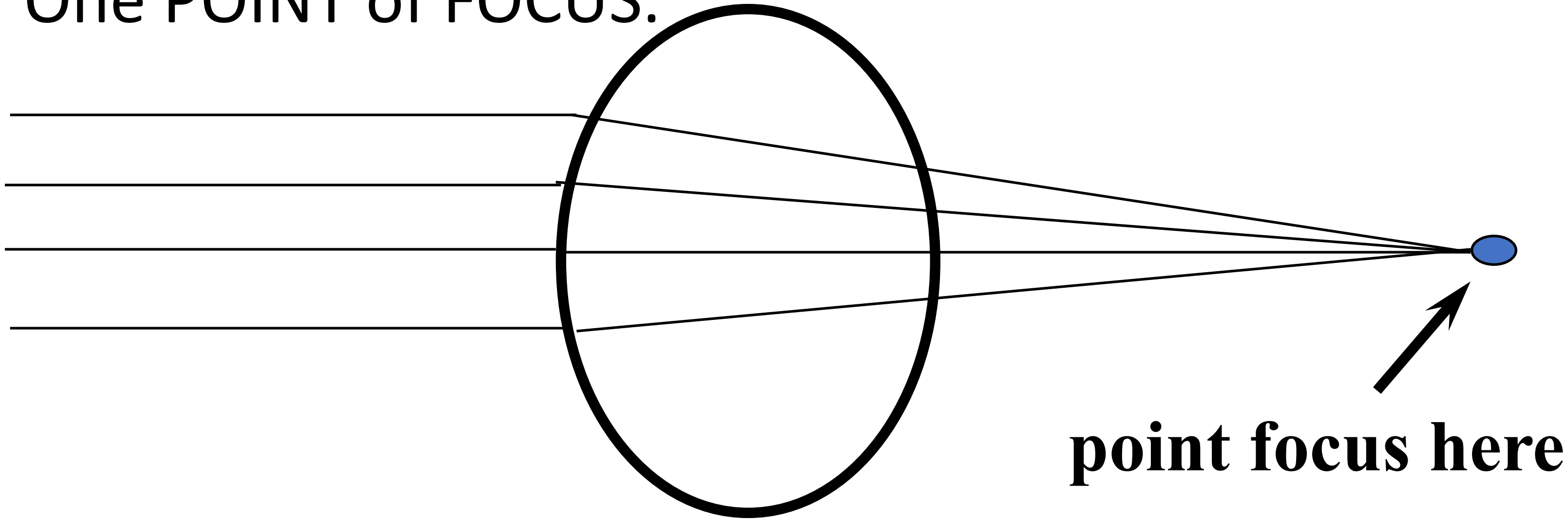
MBS = ED + 2 (decentration per lens) + 2 mm

MBS = ED + 2 (4) = 8 ED = 57

57 + 8 = 65 MBS + 2 mm = 67 mm

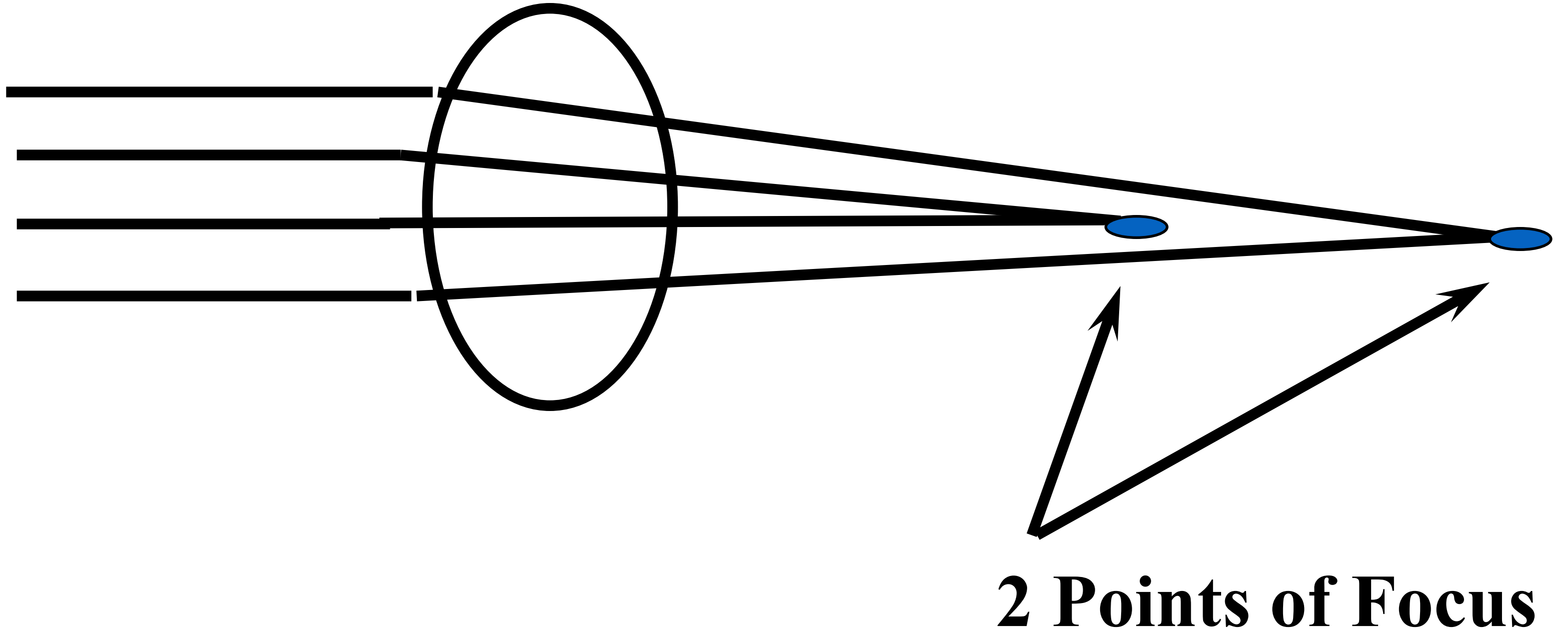
SPHERICAL LENS

- IDENTICAL CURVATURE IN ALL MERIDIANS.
- One POINT of FOCUS.



CYLINDRICAL LENS: + or -

- UNEQUAL CURVATURE IN ALL MERIDIANS
- Two Points of FOCUS.



PRESCRIPTIONS

- Ophthalmic RX's are written by optometrist's and ophthalmologists. They are in a more or less standard format and *may* contain a sphere, cylinder, axis, prism, base direction, and/or an add power and perhaps, special instructions.
- Rx's should have Date of Exam, Dr's Name and Signature, Location, Exp Date

PRESCRIPTION FORMAT

Sph cyl axis prism base

OD Oculus Dexter

OS Oculus Sinister

ADD OD OS Additional power required for near tasks - generally O.U. (oculi uterque)

PRESCRIPTION FORMAT: sphere only

	Sph	cyl	axis	prism	base
OD	-3.00 sphere				
OS	-2.50 sphere				
ADD					
OD					
OS					

The word ‘sphere’ may or not be written. The other spots may be blank or have a line drawn through them.

RX FORMAT: Sphero-cylinder

	Sph	cyl	axis	prism	base
OD	+2.50	+ 0.50	X 90		
OS	+3.00	+0.25	X 95		

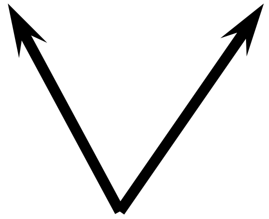
ADD
OD
OS

If the Rx has a cylinder, it must also have an axis. The axis dictates where we put the cylinder power – 90 degrees away from the axis. The sign of the cylinder, like the sphere, can be + or -. OD's tend to write in minus cylinder & MD's tend to write in plus cylinder.

Prescription Format: Prism & Near

	Sph	cyl	axis	prism	base
OD				1Δ	out
OS					

WHEN EYES ARE NOT ALIGNED PROPERLY



ADD
OD
OS **READING POWER**

TRANSPOSITION OF RX

- Expression of the prescription with a plus or a minus cylinder value.
- Does not alter power… just alters its written form.
- Steps:
  - ALGEBRAICALLY ADD SPHERE & CYLINDER
  - CHANGE THE SIGN OF THE CYLINDER
  - CHANGE THE AXIS BY 90 DEGREES (stay within a 0-180 axis)

TRANSPOSITION: Minus Cyl to Plus Cyl

Prescription → OD -2.00 -1.00 x 030

Step 1 – Algebraically add sphere and cylinder

(-2.00) + (-1.00) = <u>-3.00 new sphere power</u>

Step 2 – Change sign of cylinder

-1.00 becomes <u>+1.00 new cylinder power</u>

Step 3 – Change axis by 90 (0-180 range)

30 + 90 = <u>120 new axis meridian</u>

Transposed Rx → OD -3.00 +1.00 x 120

TRANSPOSITION: Plus Cyl to Minus Cyl

Prescription → OD -3.00 +1.00 x 120

Step 1 – Algebraically add sphere and cylinder

(-3.00) + (+1.00) = <u>-2.00 new sphere power</u>

Step 2 – Change sign of cylinder

+1.00 becomes <u>-1.00 new cylinder power</u>

Step 3 – Change axis by 90 (0-180 range)

120 - 90 = <u>30 new axis meridian</u>

Transposed Rx → OD -2.00 -1.00 x 030

NFOS

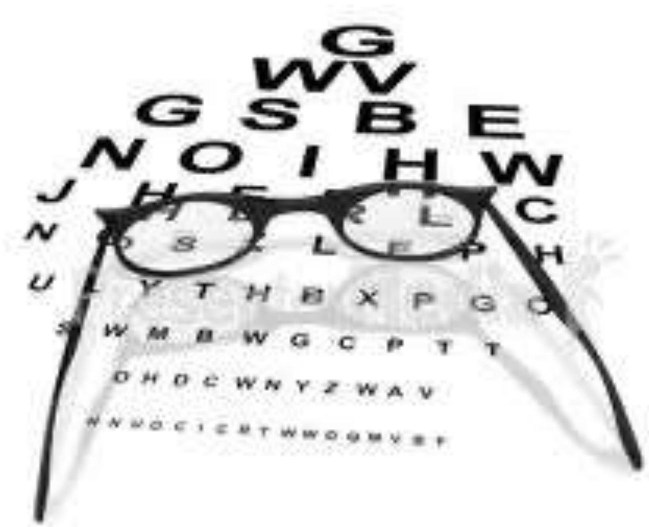
TRANSPOSITION OF RX

- **+3.25 +1.25 X 100 -------- +4.50 -1.25 X 10**
- **-4.75 -1.75 X 75 ----------- -6.50 +1.75 X 165**
- **-1.00 -1.00 X 80 ----------- ???**
- **+2.25 – 1.50 X 170 ------- ???**
- **-3.00 + 1.25 X 110 -------- ???**

TRANSPOSITION OF RX

- +3.25 +1.25 X 100 -------- +4.50 -1.25 X 10
- -4.75 -1.75 X 75 ----------- -6.50 +1.75 X 165
- -1.00 -1.00 X 80 ----------- **-2.00 +1.00 X 170**
- +2.25 – 1.50 X 170 ------- **+0.75 +1.50 X 80**
- -3.00 + 1.25 X 110 -------- **-1.75 -1.25 X 20**

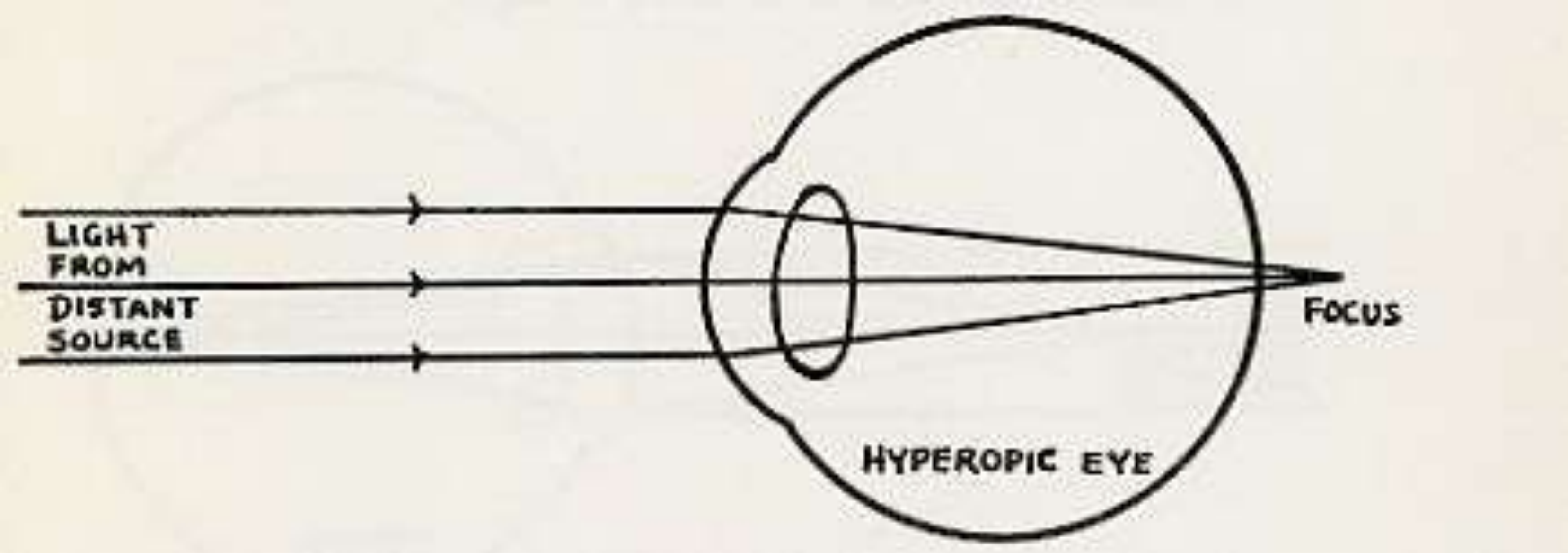
Refractive Errors and Solutions



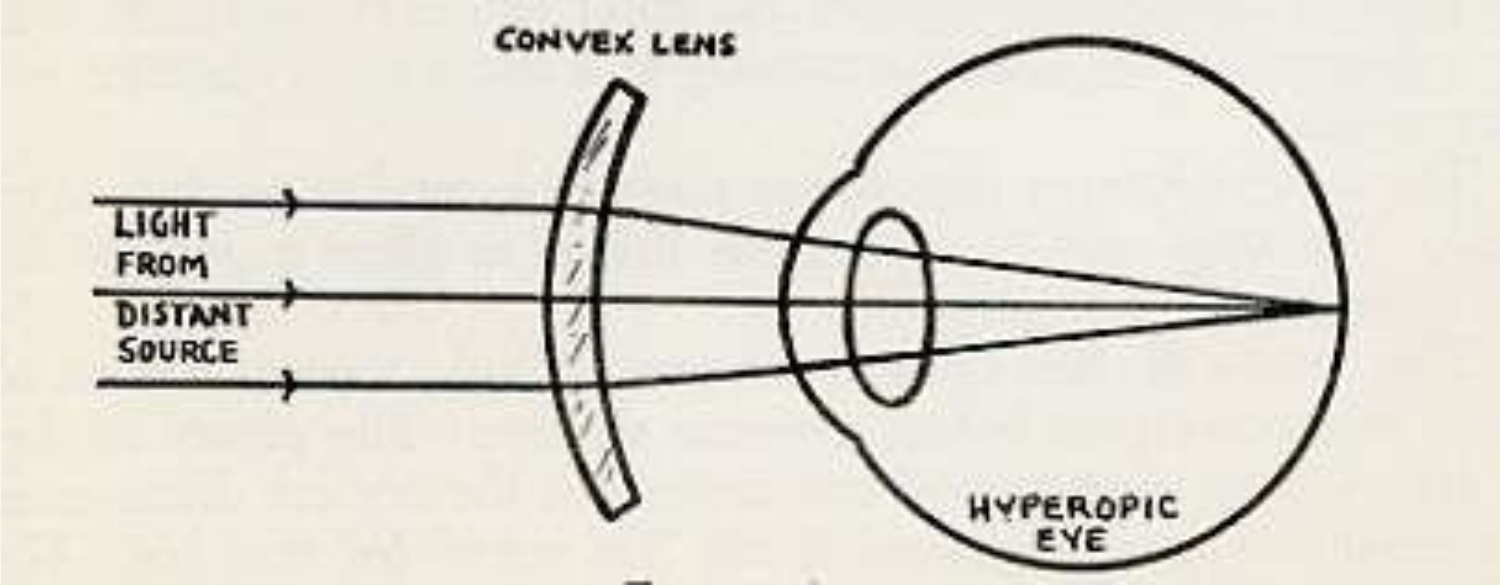
HYPEROPIA Farsightedness

- **THE REFRACTIVE CONDITION OF THE HUMAN EYE THAT WILL NOT ALLOW PARALLEL RAYS OF LIGHT TO FOCUS ON THE RETINA. RATHER, THERE IS A VIRTUAL FOCUS BEHIND THE RETINA.**
- **IN EFFECT, THE EYE IS TOO WEAK ---OR--- THE GLOBE IS TOO SHORT.**

Hyperopia

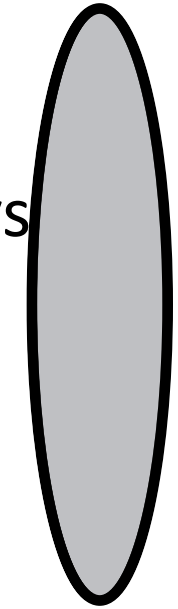


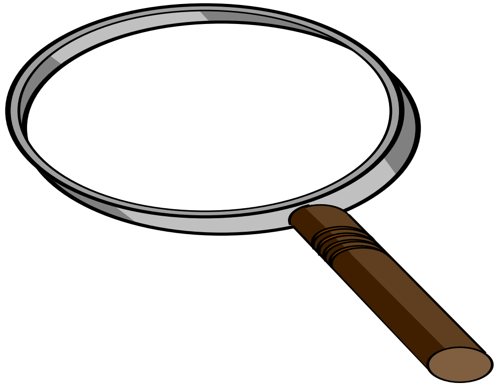
Correction for Hyperopia



PLUS LENSES

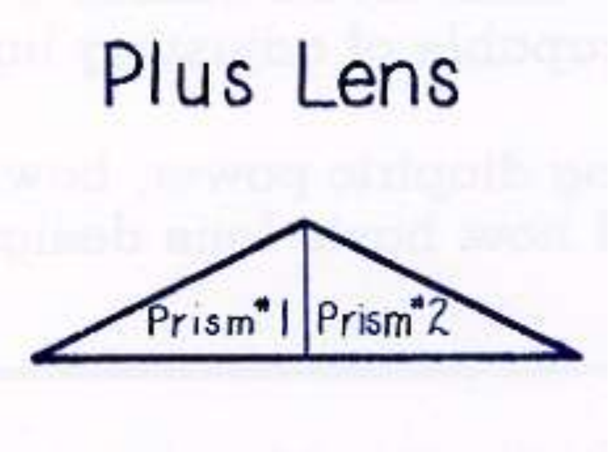
- Thicker at the center
- Magnifies images
- Has AGAINST motion
- Converges incident light rays
- Real Image
- Corrects for hyperopia

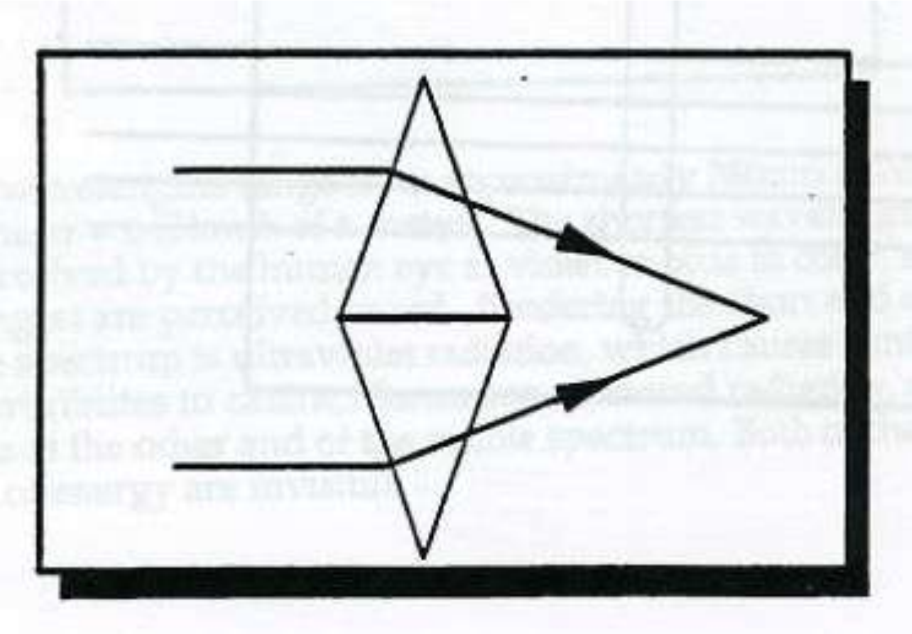




Plus or Converging Lens

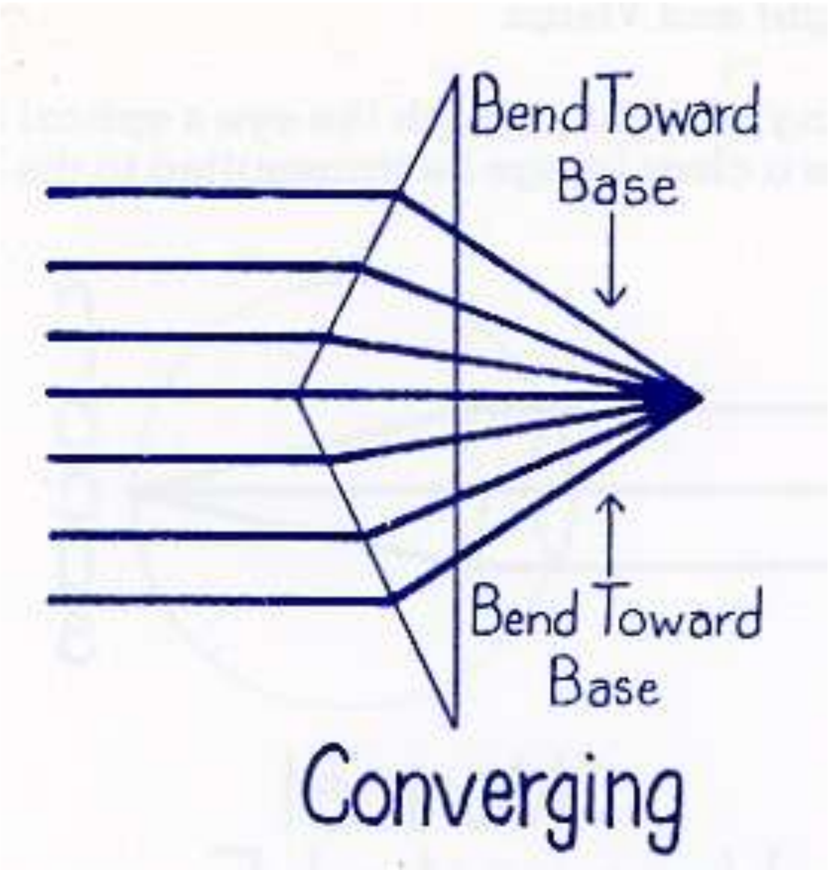
- Prisms placed base to base will converge light passing through them





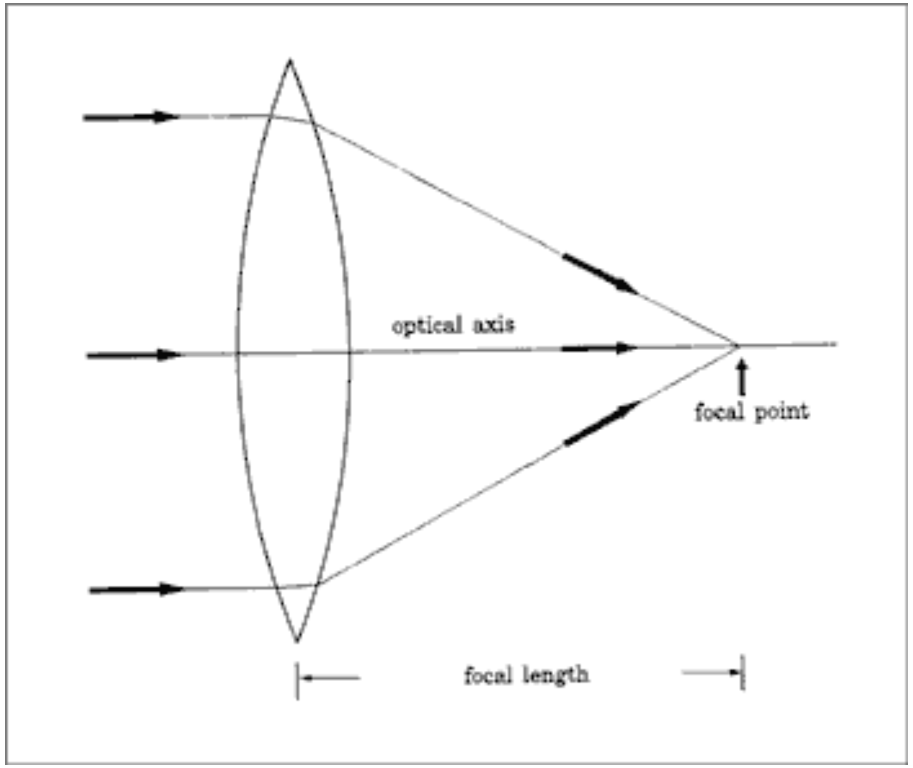
Plus or Converging Lens

- Light is bent toward the base of the prism



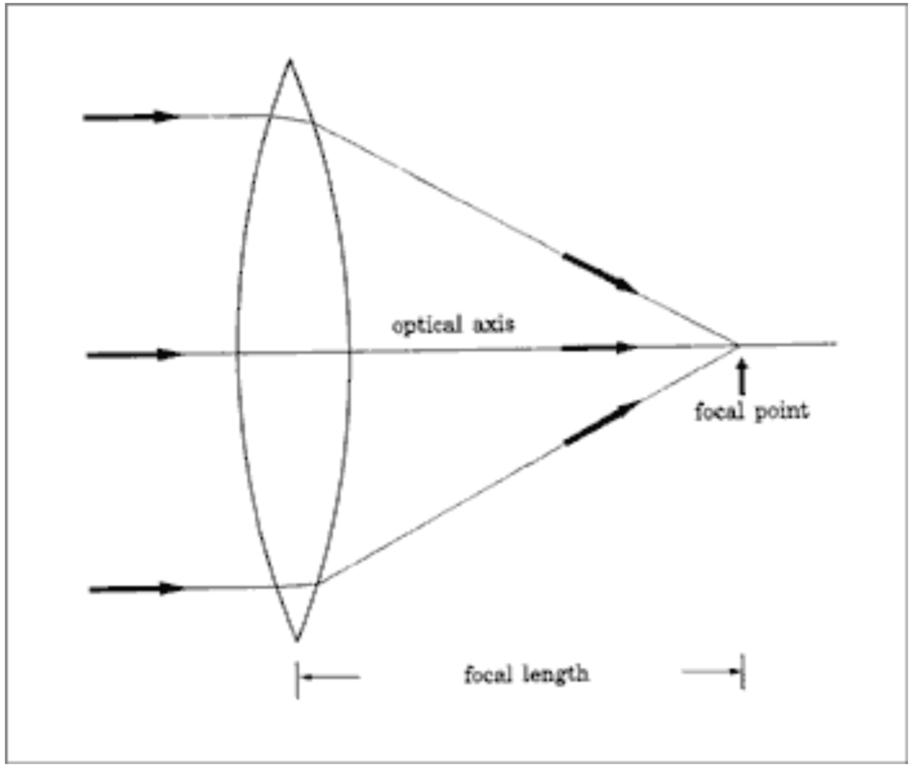
Plus or Converging Lens

- Image formed is a Real Image



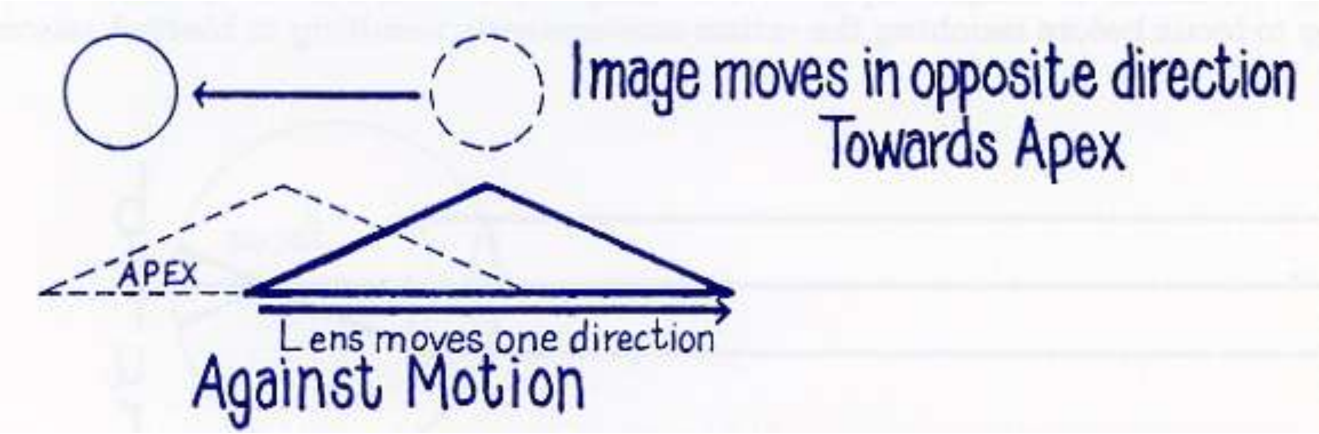
Characteristics of a Plus Lens

- Thicker at the center than at the edges
- Converges light rays
- Has a real focus (Real Image)
- Magnifies objects
- Against Motion



Characteristics of a Plus Lens

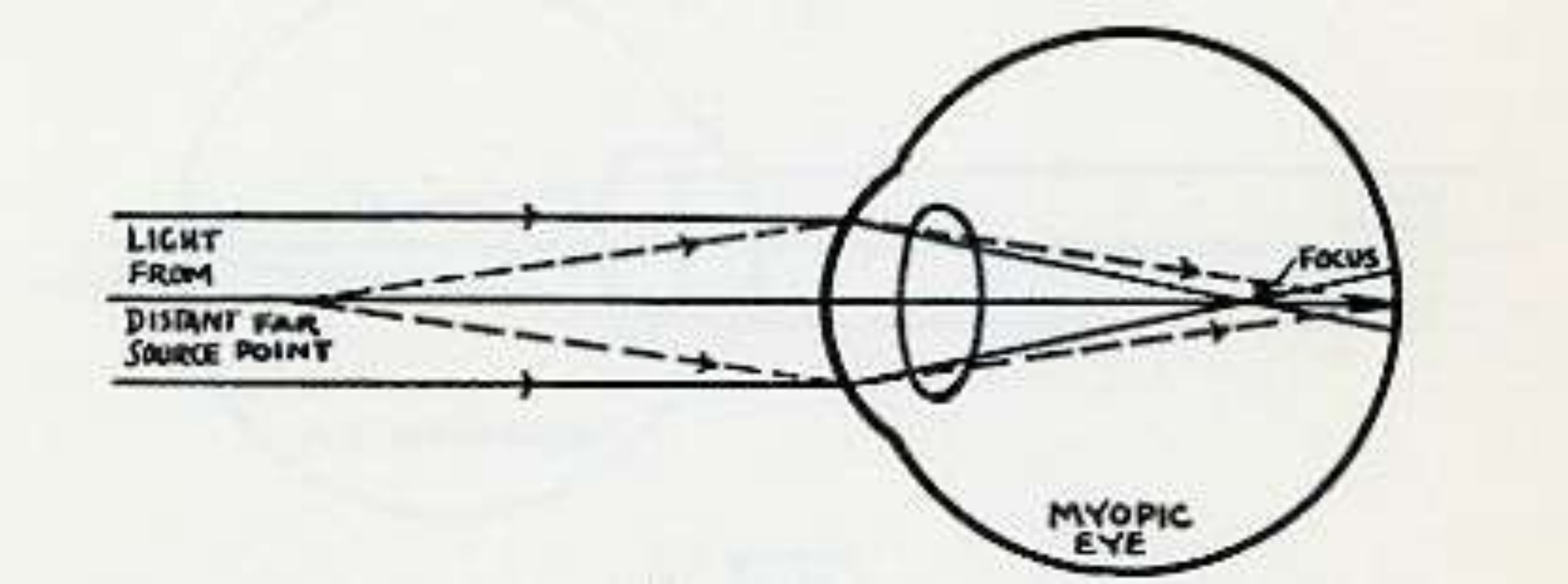
- When and object is viewed through a plus lens, and when the lens is moved, the object moves in the opposite direction



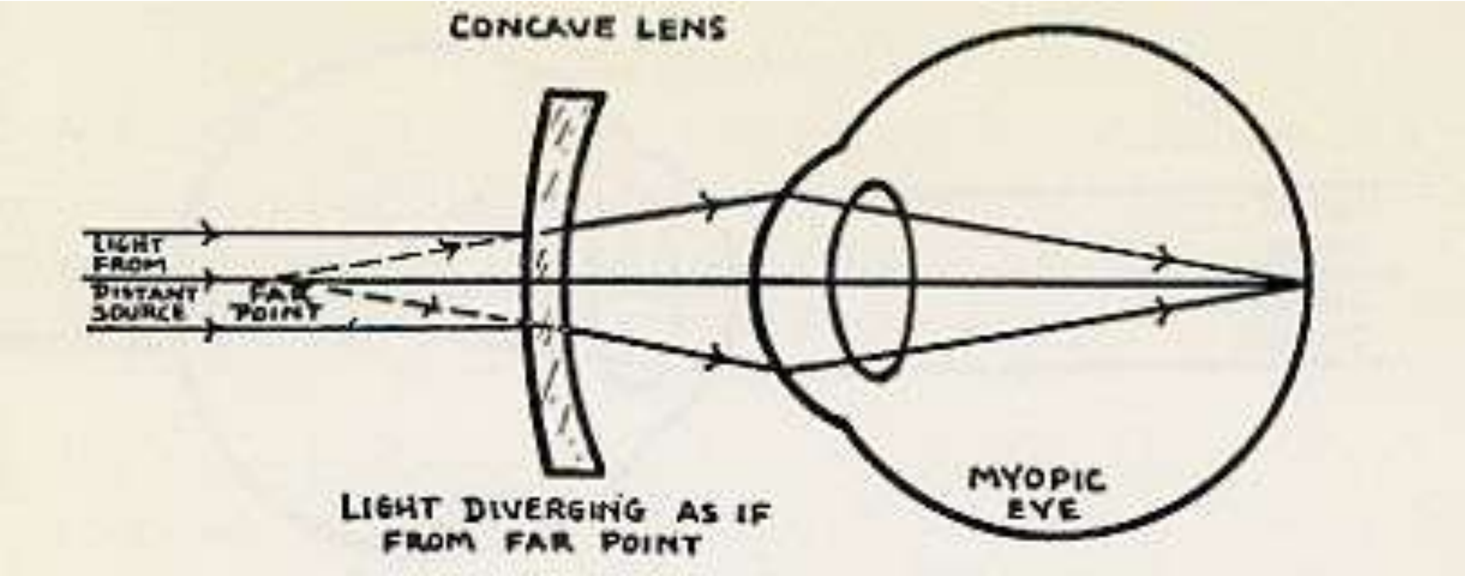
MYOPIA Nearsightedness

- The refractive condition of the human eye where parallel rays of light are focused in front of the retina.
- **In effect, the eye is too strong --- or--- the globe is too long.**

Myopia

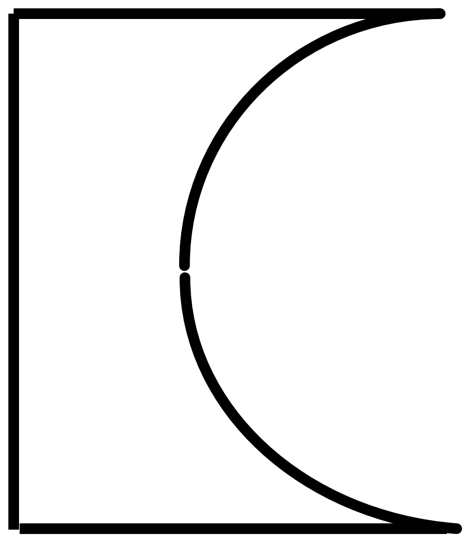


Correction for Myopia



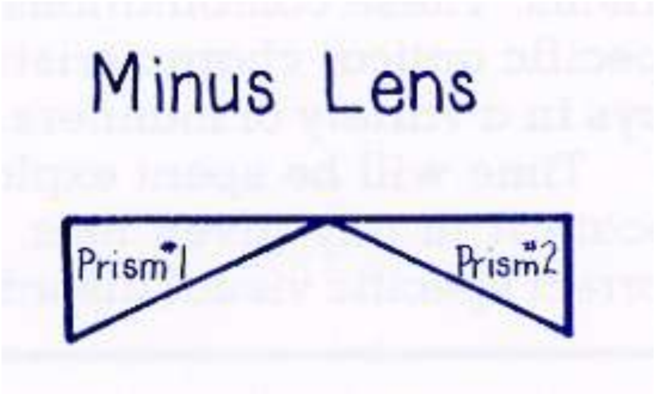
MINUS LENSES

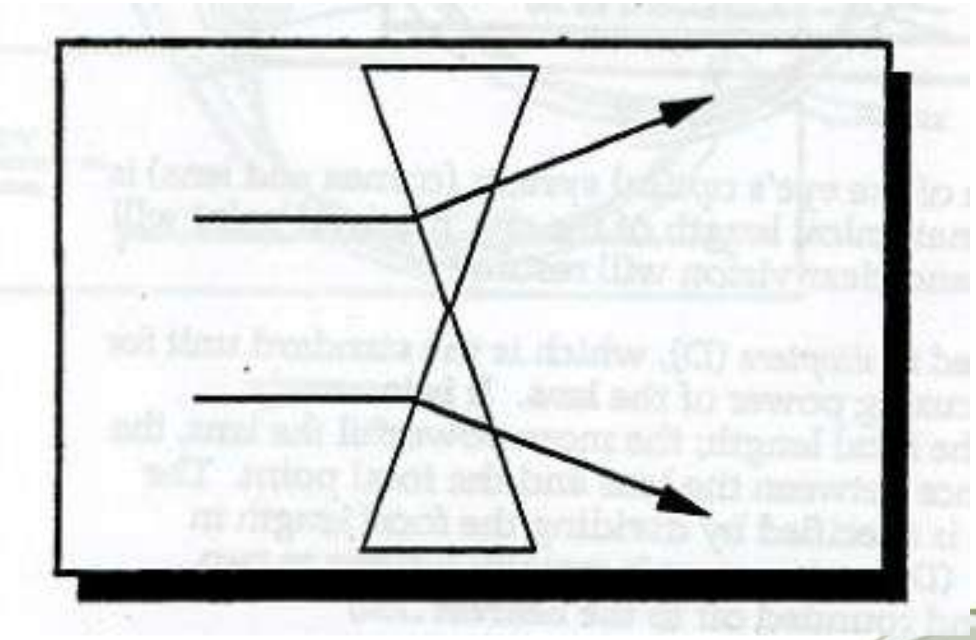
- Thicker at the edge
- Minifies images
- Has WITH motion
- Diverges incident light rays
- Virtual Image
- Corrects for myopia



Minus or Diverging Lens

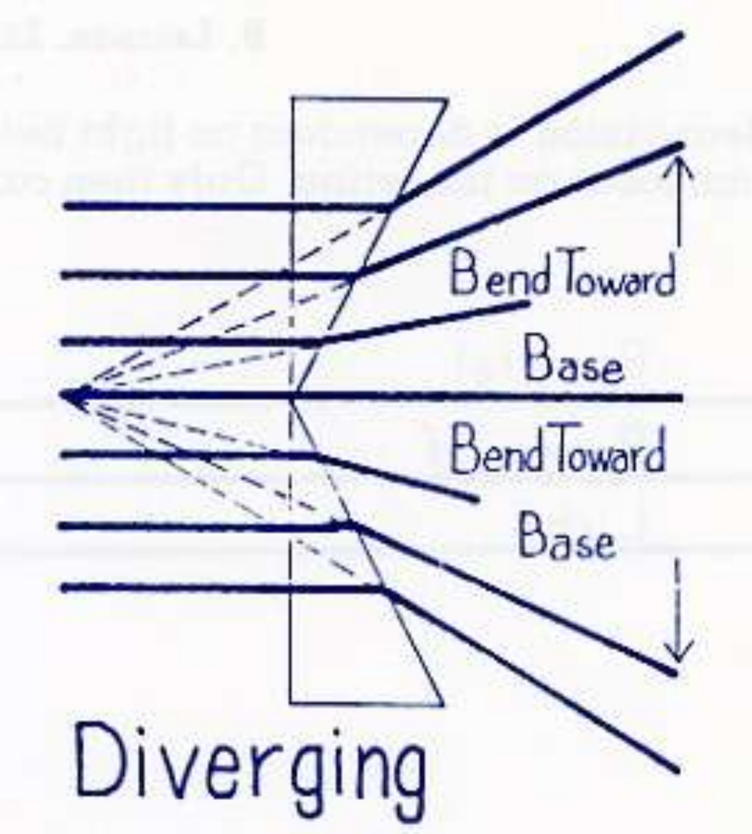
- Prisms placed apex to apex will diverge light rays passing through them





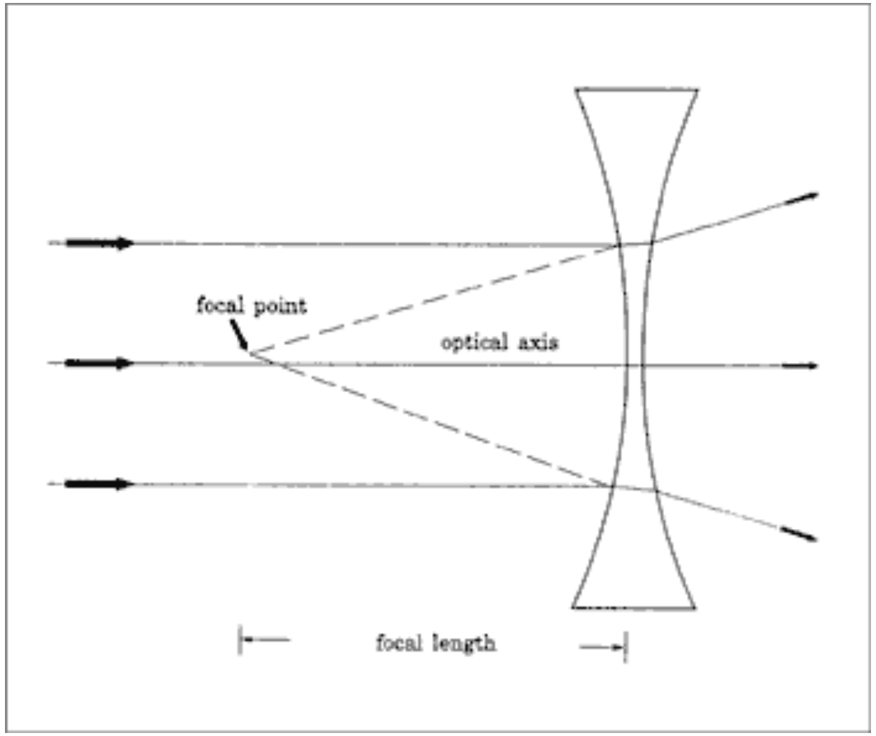
Minus or Diverging Lens

- Prisms placed apex to apex will diverge light rays passing through them



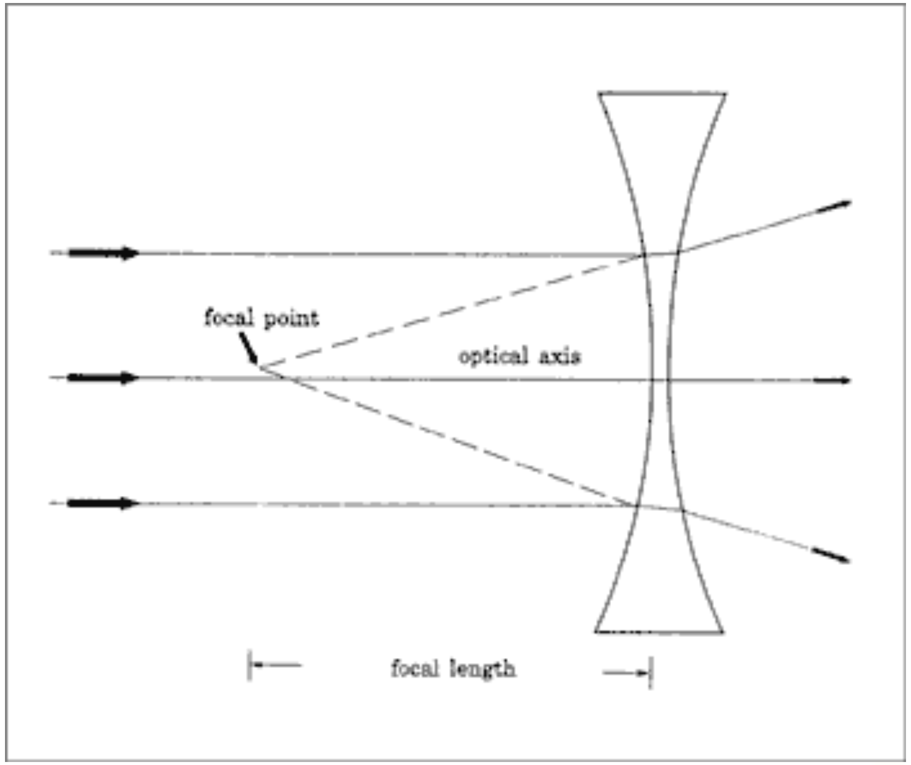
Minus or Diverging Lens

- Image formed is called a Virtual Image



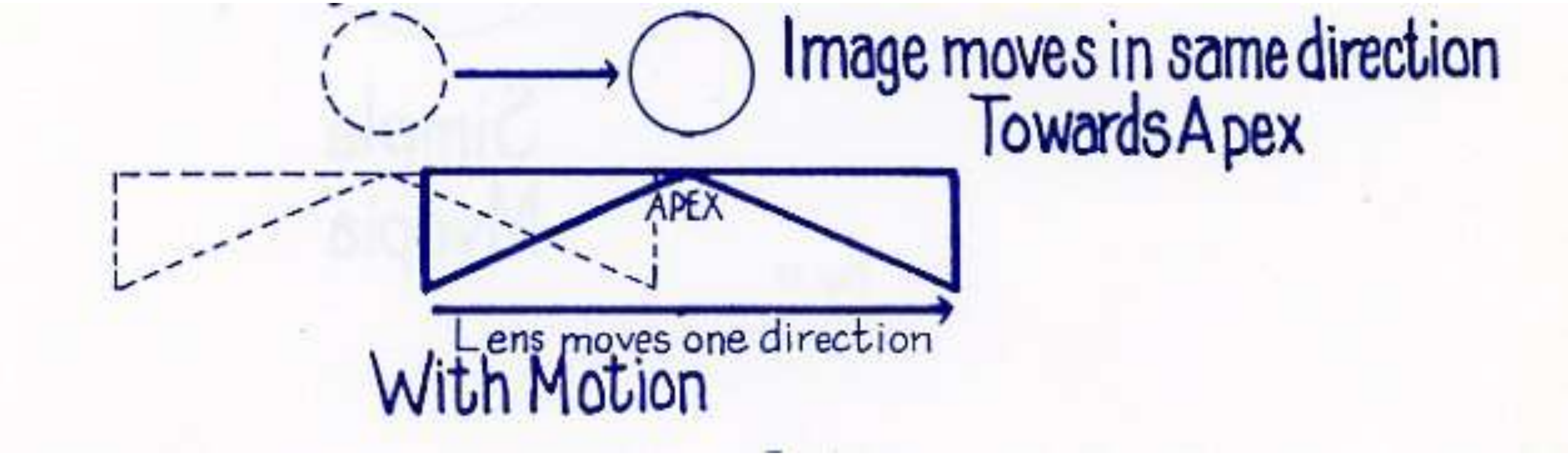
Characteristics of a Minus Lens

- Thinner at the center then at the edge
- Diverges light rays
- Has a virtual focus (Virtual Image)
- Minifies objects
- With Motion

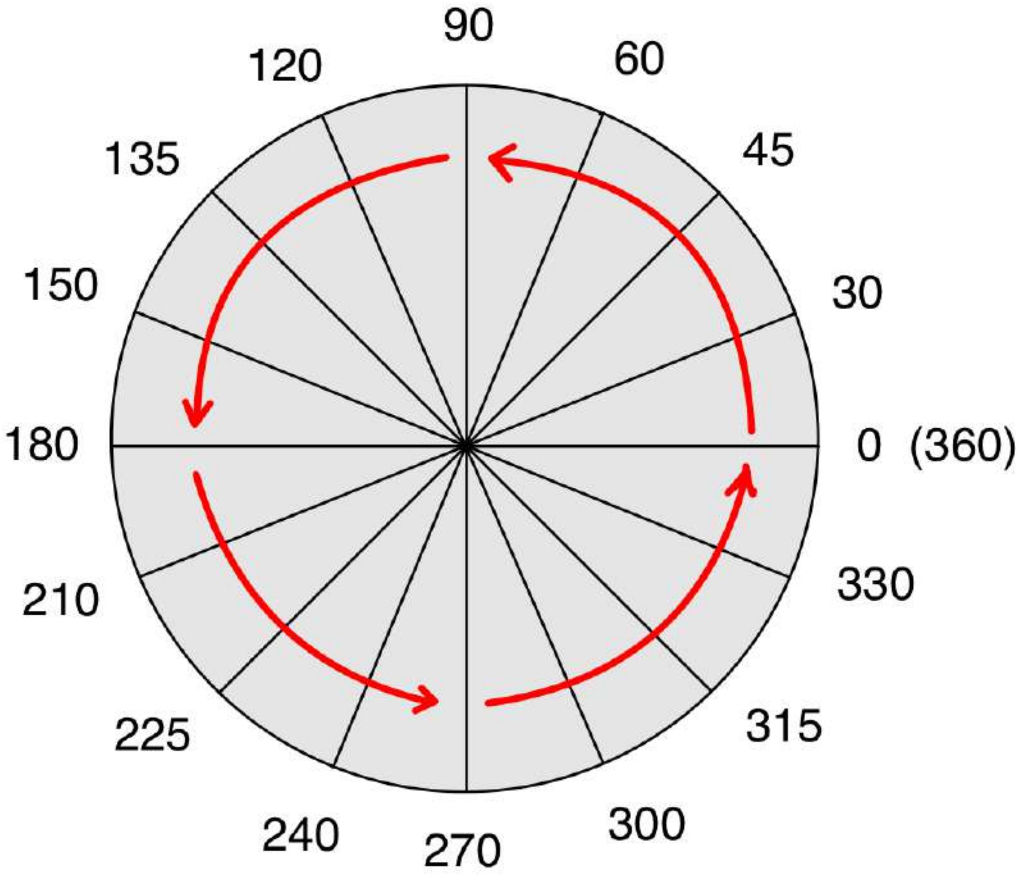


Characteristics of a Minus Lens

- When and object is viewed through a minus lens, and when the lens is moved, the object moves in the same direction



meridian/axis



- Lens meridians are numbered from 0 and go up to 360 degrees.
- Meridian extends across entire surface of lens in every meridian. 0 extends to 180, 90 extends to 270, 135 extends to 315,…
- 0-180 meridians are prescriber's notation
- 180-360 meridians used for lab notation

RX ANALYSIS for Total Power

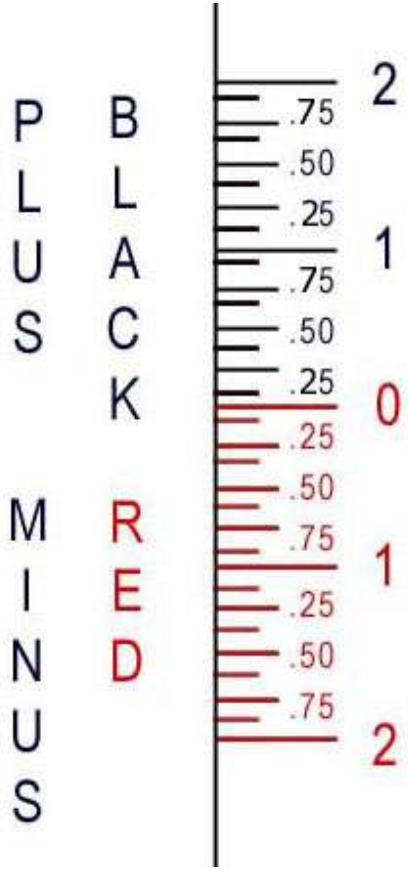
- **OD - 4.00 + 2.25 x 090 Only SPHERE Power at axis**
- **Cylinder Power is always 90 degrees away from the axis**
- **Total Power @ 180 = -4.00 plus + 2.25 = -1.75**

- **OD - 2.00 -1.25 x 180 Only SPHERE Power at axis**
- **Cylinder Power is always 90 degrees away from the axis**
- **Total Power @ 090 = -2.00 plus - 1.25 = -3.25**

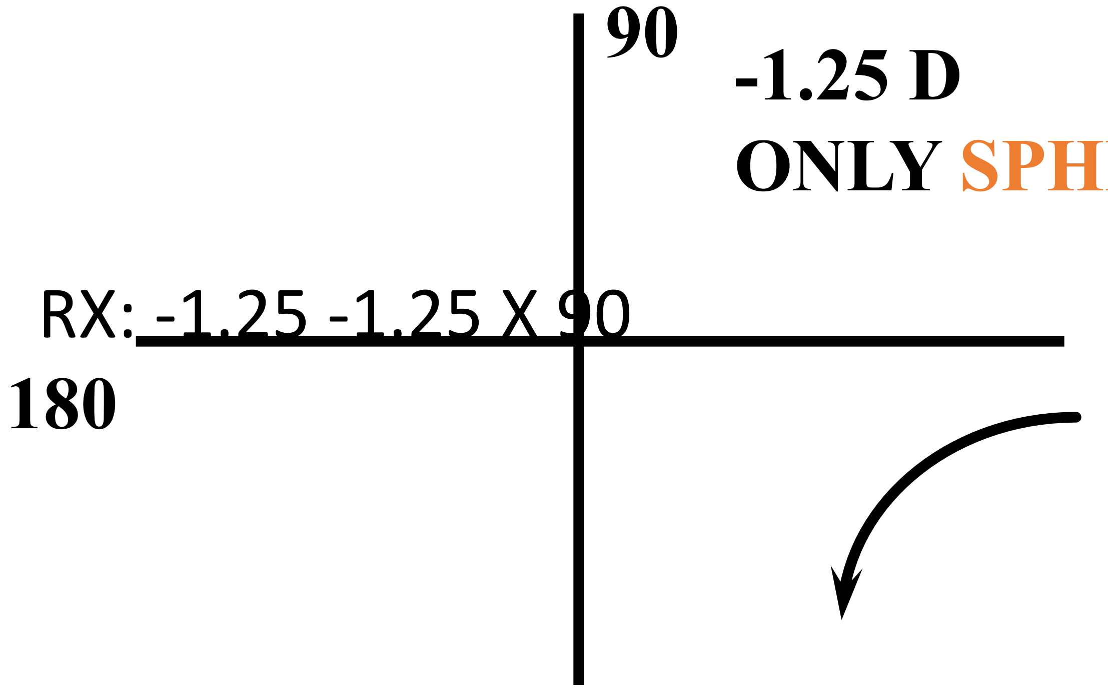
OPTICAL CROSS

- A TECHNIQUE USED TO SHOW THE RX OF AN OPHTHALMIC LENS IN ITS PRIMARY MERIDIANS
- **PRIMARY MERIDIANS:** THE AXIS OF THE RX AND 90 DEGREES AWAY

Vertometer Readings



OPTICAL CROSS



-1.25 D

ONLY SPHERE AT AXIS

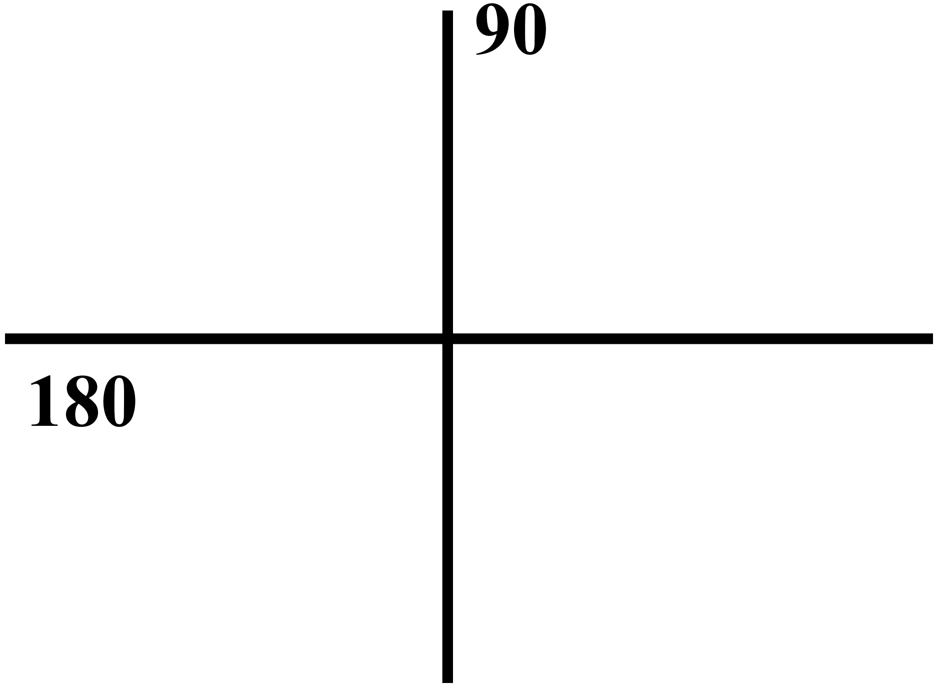
-1.25 D SPHERE

<u>-1.25 D CYL</u>

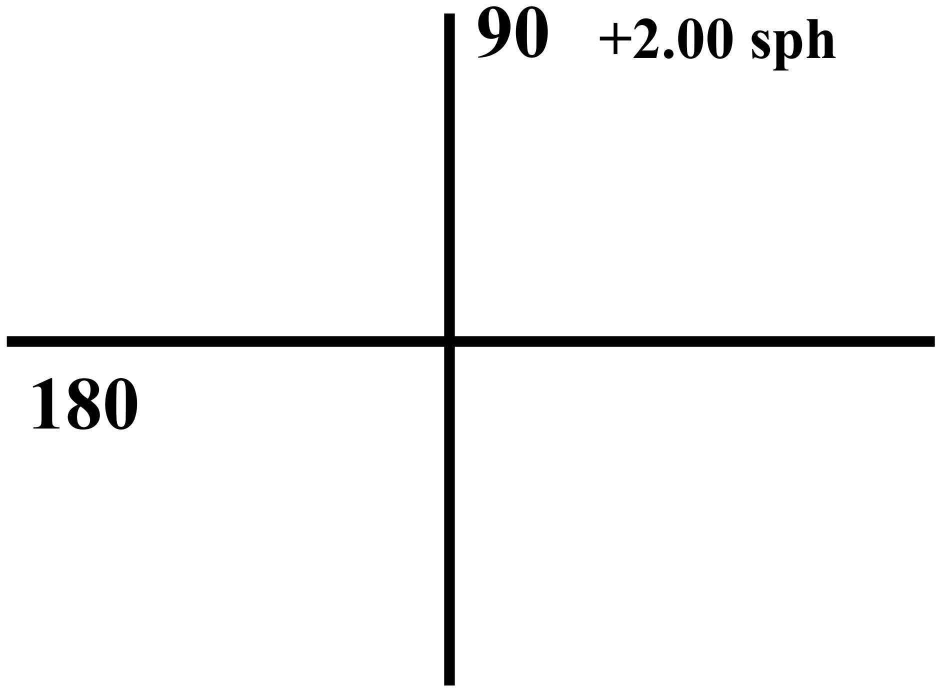
-2.50 TOTAL D

FULL CYLINDER 90 DEGREES AWAY from axis

RX: +2.00 -.75 X 90

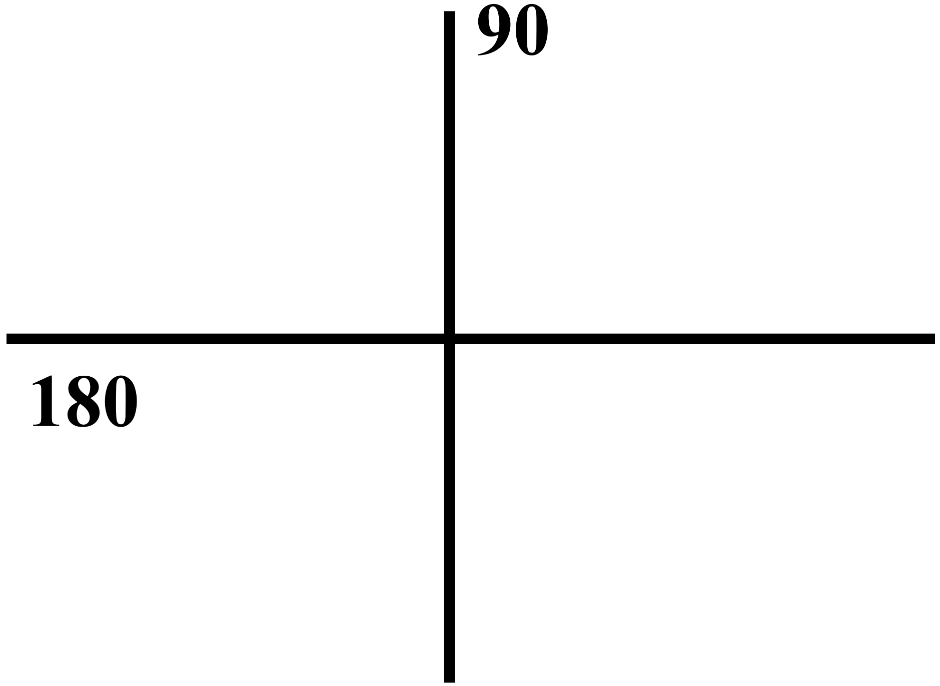


RX: +2.00 -.75 X 90

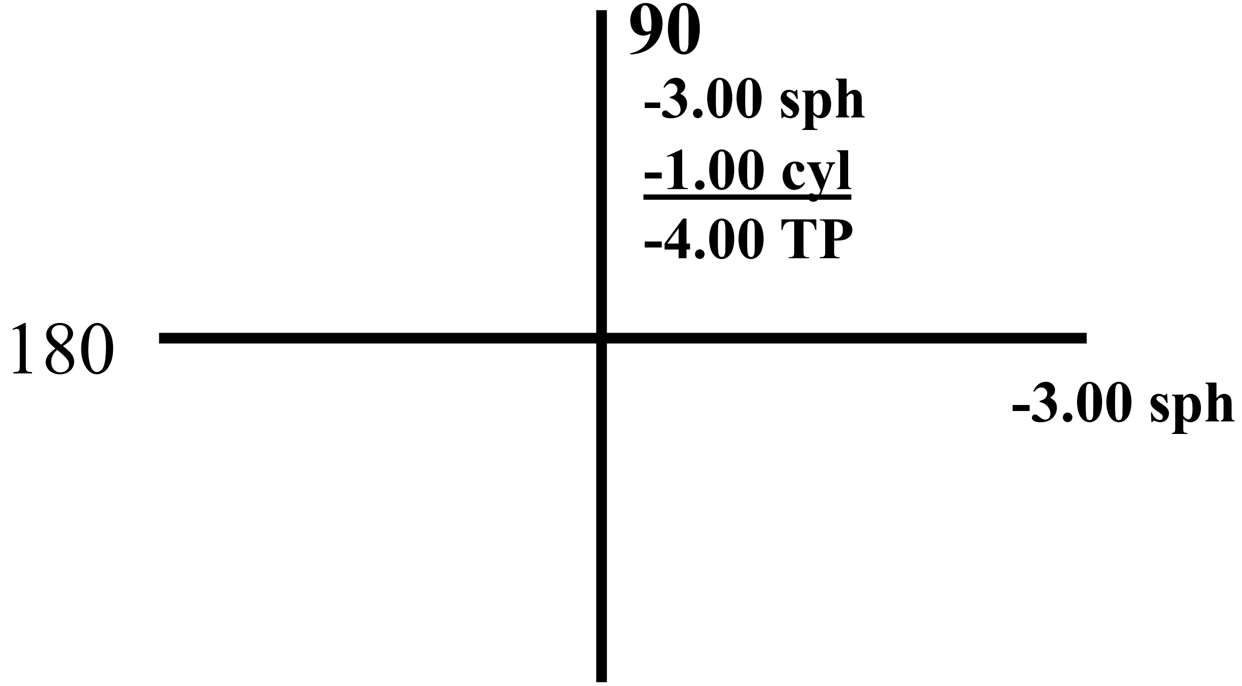


+2.00 sph
-.75 cyl
+1.25 TP

RX: -3.00 -1.00 X 180



RX: -3.00 -1.00 X 180



BASE CURVES

- **THAT CURVE FROM WHICH ALL OTHER CURVES ARE DETERMINED**
- **FOR A CYLINDRICAL SURFACE, THE FLATEST (LOWEST) CURVE ON THAT SURFACE**
- **IN A SINGLE VISION LENS, THE FLATEST CURVE ON THE FRONT SURFACE**
- **IN BIFOCALS, THE ONLY CURVE ON THE SAME SIDE AS THE SEGMENT (ALWAYS A SPHERE)**

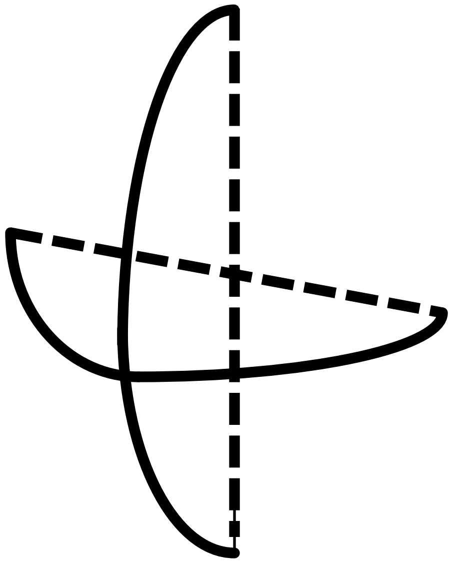
LENS GRAPH

- **USED TO SHOW THE CURVATURE OF AN OPHTHALMIC LENS NEEDED TO ARRIVE AT THE RX**
- **For our purposes now, we will simply subtract the front power from the back power to get the RX**

LENS GRAPH

FRONT

PLUS SIDE

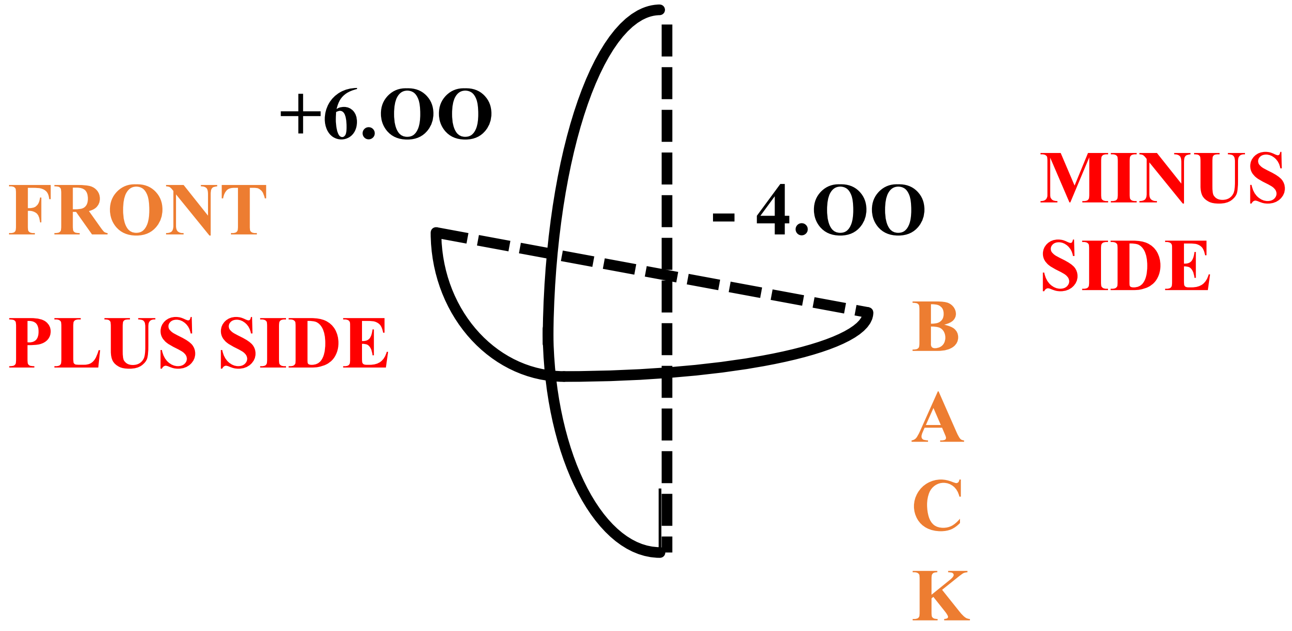


B
A
C
K

MINUS

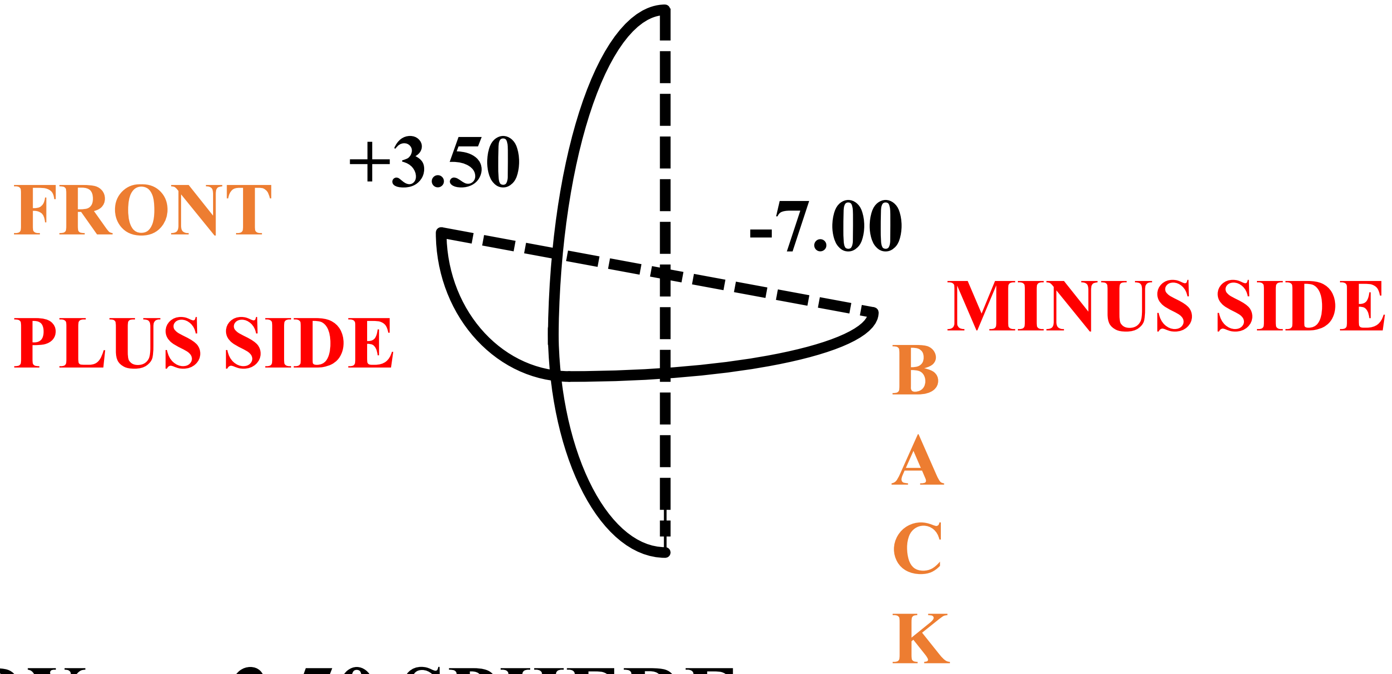
SIDE

LENS GRAPH



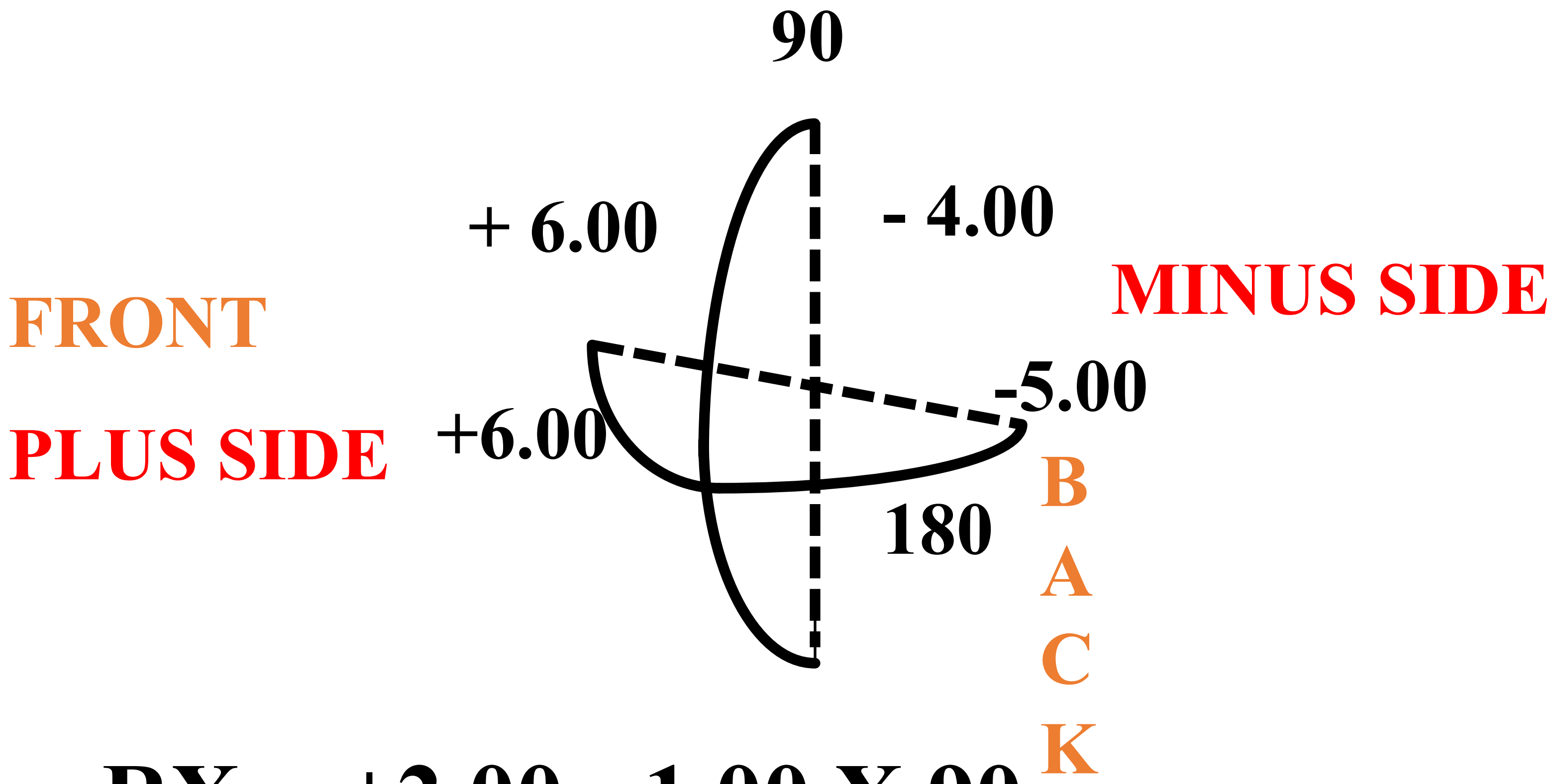
rx = +2.OO SPHERE

LENS GRAPH



RX = - 3.50 SPHERE

LENS GRAPH



RX = +2.00 - 1.00 X 90

Optical Cross

90

+13.00

-10.00

+3.00

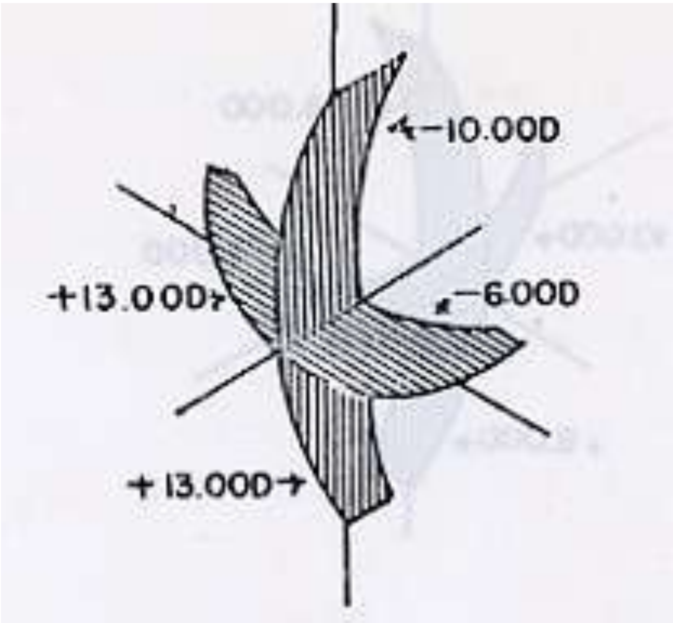
180

+13.00

-6.00

+7.00

axis



Rx = +7.00 – 4.00 x 180

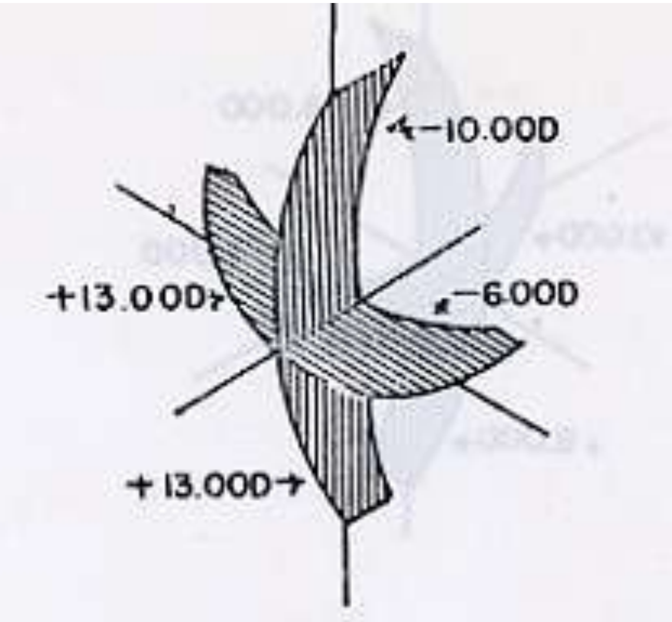
This concave toric surface will have the

horizontal meridian because the curve in that meridian is weaker

Curve Illustration

+13.00

-6.00 – 10.00



Rx +7.00 - 4.00 x 180

Axis is located at meridian of least power or lowest curve

on toric surface

Optical Cross

90

+4.00

-10.00

-6.00

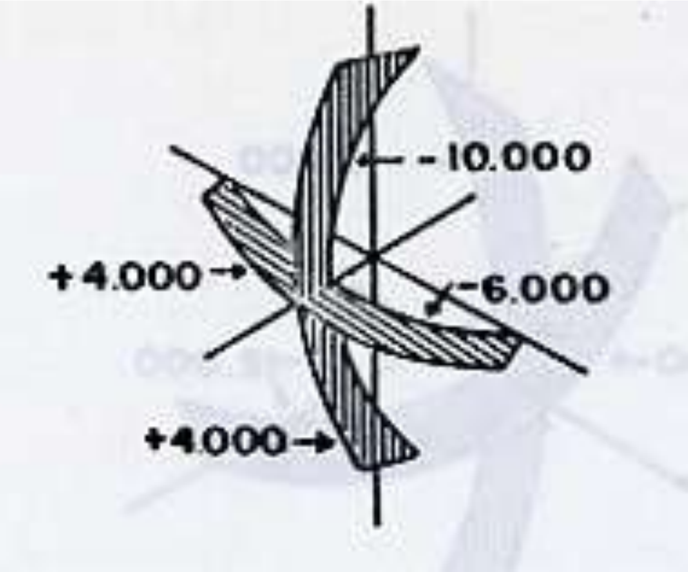
180

+4.00

-6.00

-2.00

Rx = -2.00 – 4.00 x 180

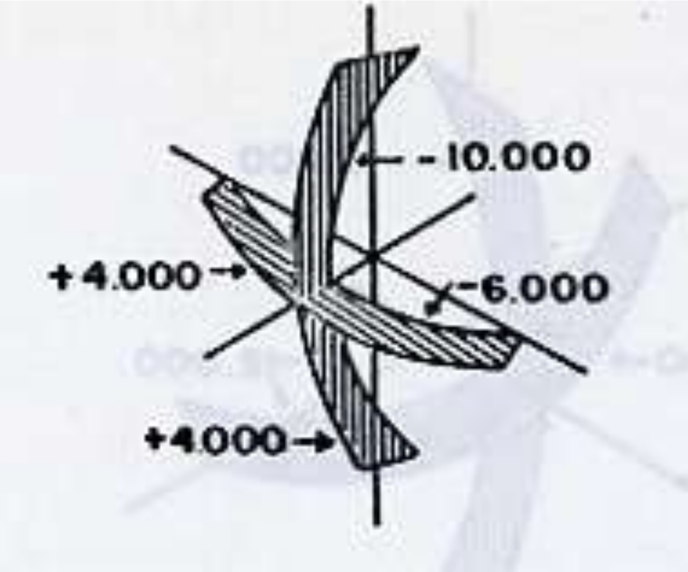


This concave toric surface will have the axis in the horizontal meridian because the curve in that meridian is weaker

Curve Illustration

+4.00

-6.00 – 10.00

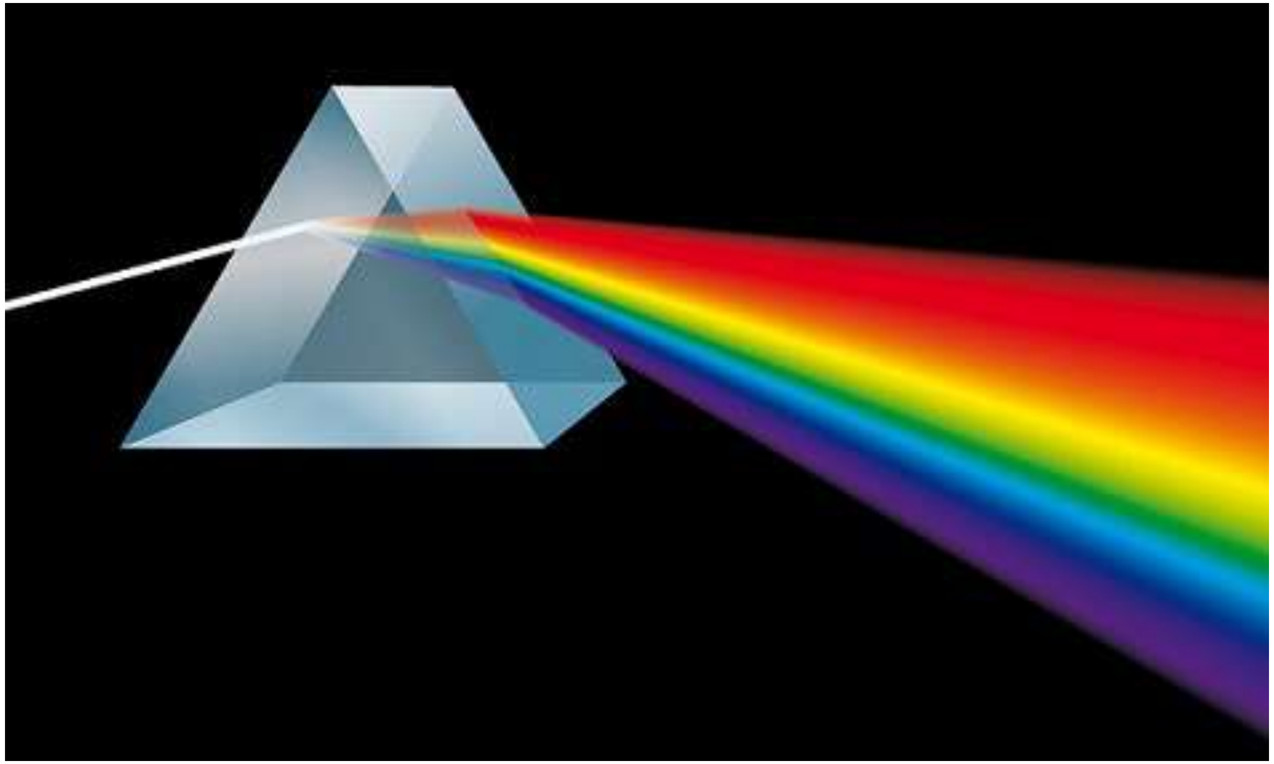


Rx -2.00 - 4.00 x 180

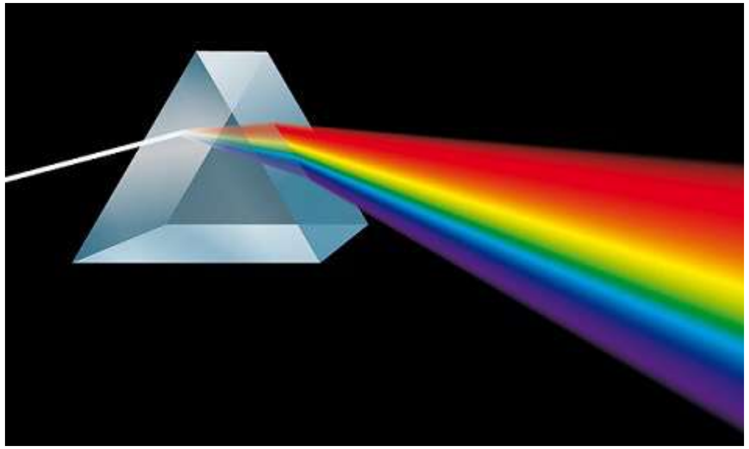
Axis is located at meridian of least power or lowest curve

on toric surface

Dispersion Through a Prism



DISPERSION



Newton's experiment

- **The breaking up of white light into its component colors --- roy g. biv**
- All lenses have dispersion; crown glass, at 58.6, is the best so far.
- **The lower the number the more the dispersion.**
- Patient complaint of seeing "rainbows".
- **Polycarbonate, at 30, is the worst offender so far.**
- Dispersion is a function of MATERIAL, not Index "N"

Abbe Value

- White light is composed of the visible spectrum of wavelengths each corresponding to a different color. When light enters a prism it is bent toward the base of the prism
- Shorter wavelengths (e.g., violet) are bent at a greater angle than longer wavelengths (e.g., red)
- Since a lens is like to two prisms (apex to apex for a minus lens and base to base for a plus lens), light passing through a lens has a tendency to **disperse** into its respective colors as its varying wavelengths are focused at differing points.

Abbe Value

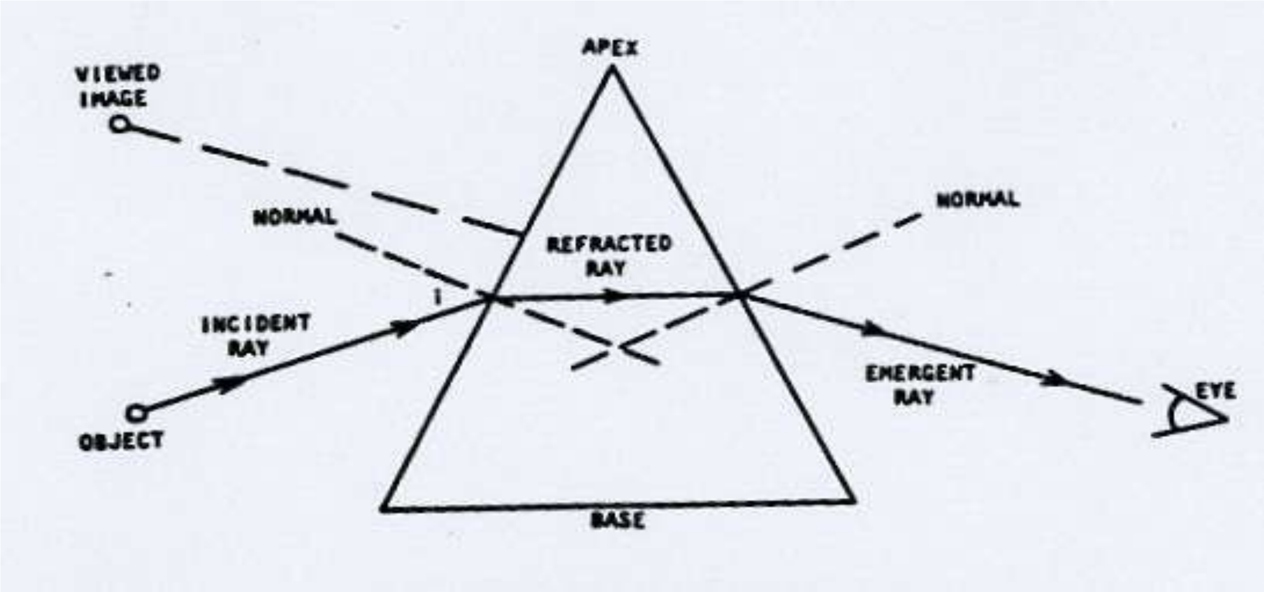
- The tendency to of a material to separate light in this manner is called **chromatic aberration** and is measured by its **Abbe value**.
- The Abbe value of a material is inversely proportional to the chromatic aberration induced as light passes through it.
- In other words, the higher the abbe value, the lower the amount of chromatic aberration.
- Inn general, the **higher the index** of a lens material, the **higher the chromatic aberration**, and the **lower the Abbe value**.

REFRACTION

- **DEFINITION: The bending of light as it passes obliquely from one medium to another of a different index of refraction (N).**
- **The amount of refraction depends on the incident angle & the index of the media.**
- **SNELL'S LAW**
- **DENSE TO DENSER = TOWARD THE NORMAL**
- **DENSE TO LESS DENSE = AWAY FROM THE NORMAL**
- **DENSER MATERIAL (n) = GREATER REFRACTION**

REFRACTION

- **SNELL'S LAW**
- **DENSE TO DENSER = TOWARD THE NORMAL**
- **DENSE TO LESS DENSE = AWAY FROM THE NORMAL**
- **DENSER MATERIAL (n) = GREATER REFRACTION**



Refractive Index

- Refractive index: indicates how much the material will refract or bend light as it enters the material from air
- Compares the speed of light in a given material to the speed of light in air (186,000 mps)
- The higher the index number of a given material, the more the light will refract as it enters the material
- If a material has a greater ability to refract light, less of a curve is required to obtain a specific power, resulting in a thinner lens.
- Plastic (CR-39) and Crown Glass are considered base index with indices of 1.498 and 1.52 respectively.
- Materials with an index between 1.53 and 1.57 are considered mid-index
- Materials with an index of 1.58 and greater are considered high-index
- More frequently, however, anything over 1.53 is called high-index.

REFRACTION

N = <u>SPEED OF LIGHT IN AIR</u> **(186,000 mps)**
SPEED OF LIGHT IN MEDIUM

- **THE MORE LIGHT SLOWS DOWN IN A MEDIUM, THE GREATER THE REFRACTION**

- **Example: IF LIGHT TRAVELS AT 124,000 MILES/SECOND IN A MEDIUM, FIND N.**
- **186,000/124,000 = N = 1.50 Cr-39**
- **Example: IF LIGHT TRAVELS AT 121,569 MILES/SECOND IN A MEDIUM, FIND N.**
- **186,000/121,569 = N = 1.53 Trivex**

Specific Gravity

- Specific gravity describes the density of a lens material by comparing its density to the density of water
- The higher the specific gravity of a lens material, the higher the density, and consequently, the heavier a lens of that material will be for a given power and size.

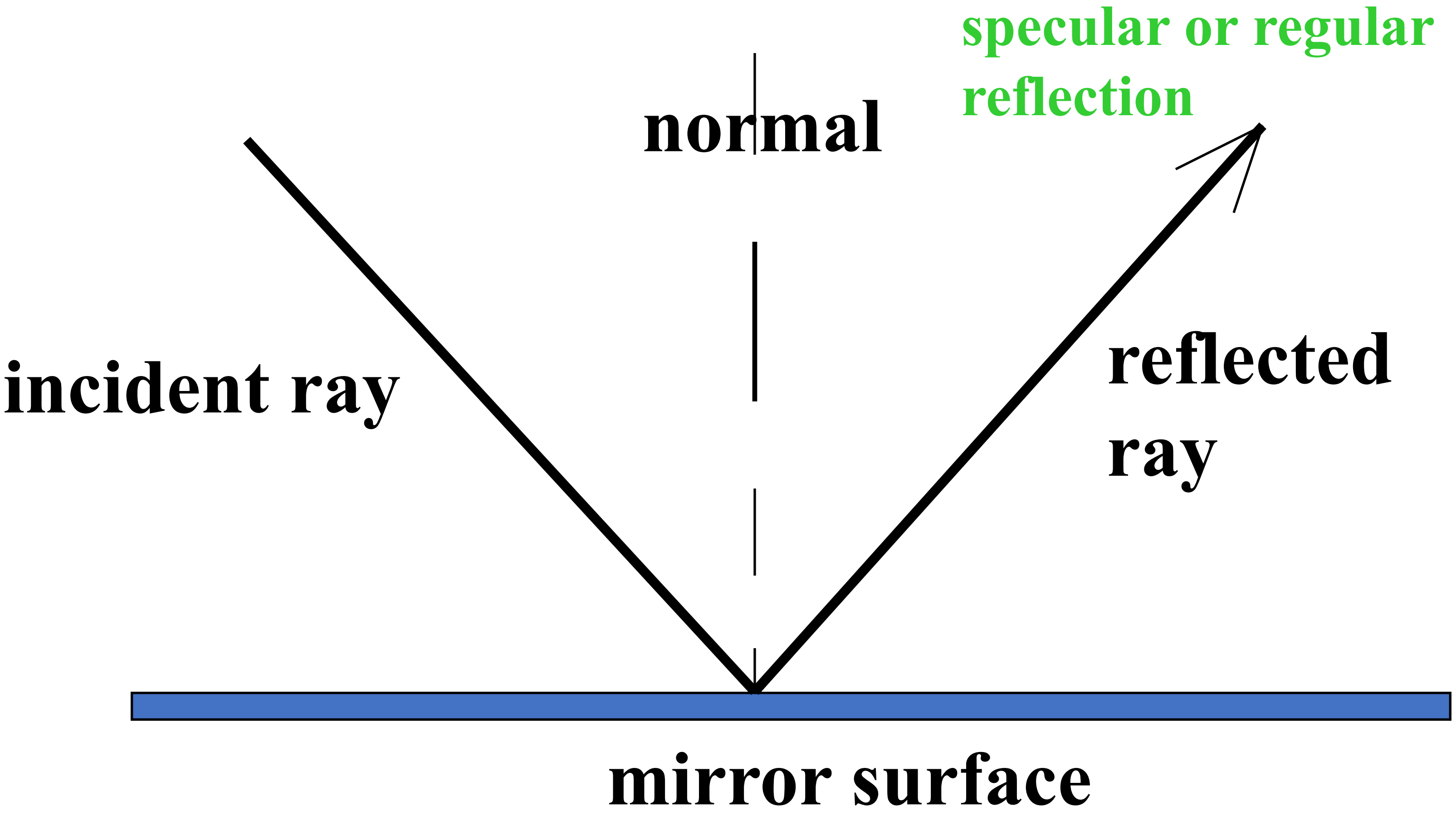
Lens Materials

Index	Material	Clarity	Density
1.49	Cr-39 Plastic	Abbe V 58	SG 1.32
1.523	Crown Glass	Abbe V 59	SG 2.54
1.53	Trivex	Abbe V 43	SG 1.11
1.58	Poly	Abbe V 30	SG 1.21
1.60	High Index	Abbe V 36	SG 1.30
1.67	High Index	Abbe V 32	SG 1.32
1.71	High Index	Abbe V 36	SG 1.35
1.74	High Index	Abbe V 33	SG 1.40

LIGHT PROPERTIES

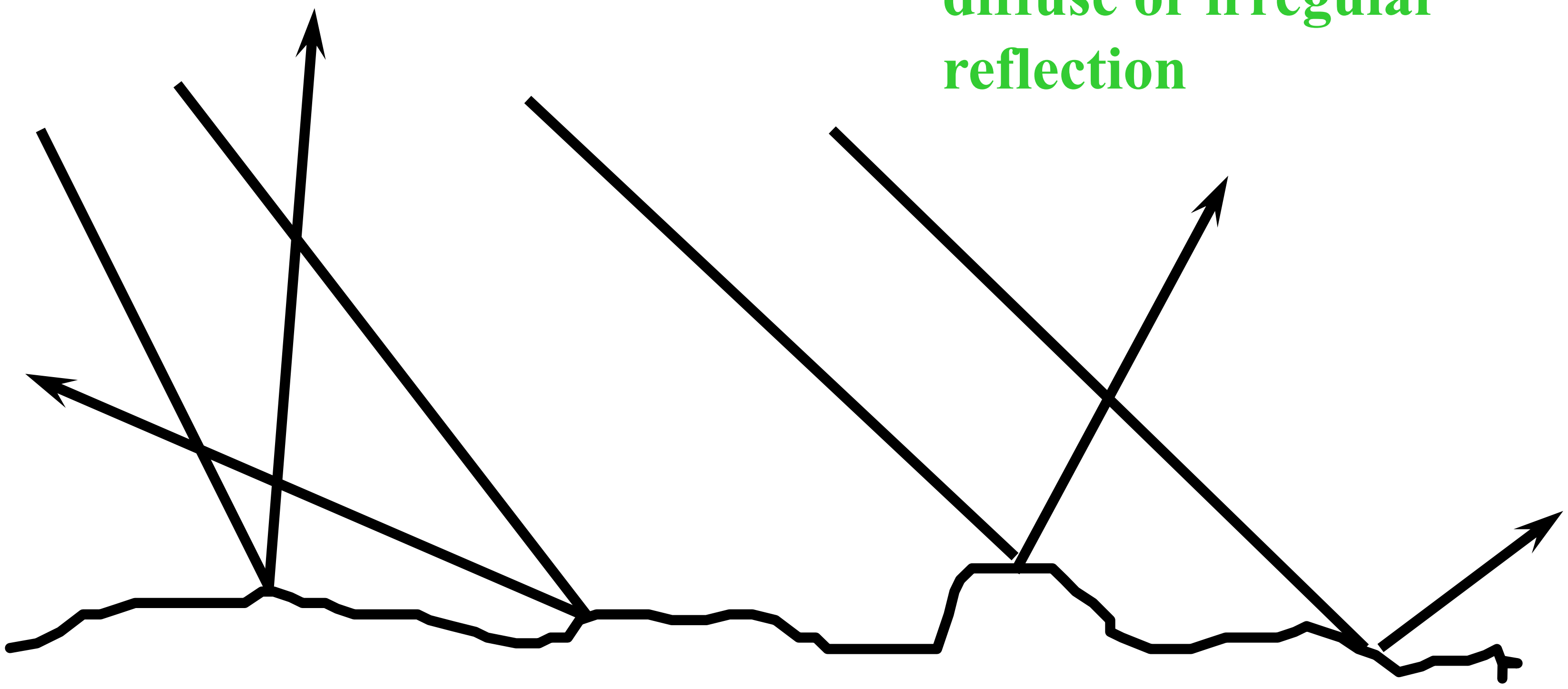
- **LIGHT STRIKING A TRANSPARENT MEDIUM WILL BE:**
  - **ABSORBED**
  - **REFLECTED**
  - **REFRACTED**
- **ABSORPTION VARIES WITH LENS MATERIAL**
- **REFLECTION: 3.5% TO 4% of a LENS SURFACE**
  - **also varies with Index “N”**

LAW OF REFLECTION



LAW OF REFLECTION

diffuse or irregular reflection

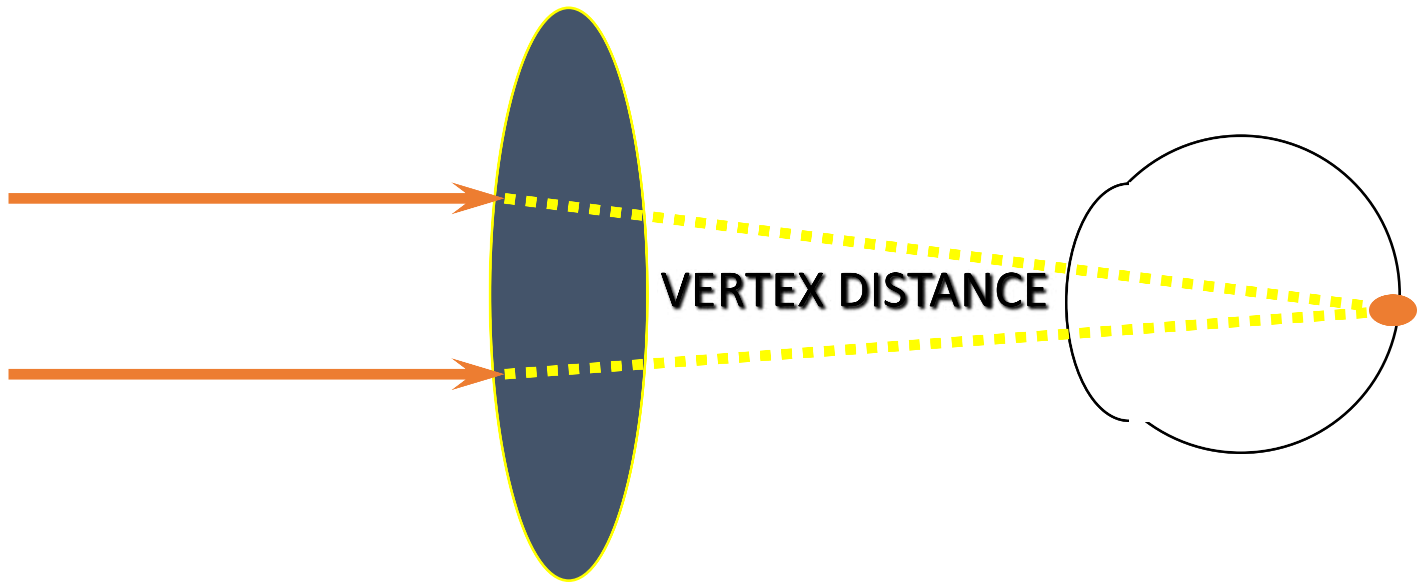


VERTEX COMPENSATION

- WHEN THE FRAME DOES NOT SIT AT THE SAME VERTEX DISTANCE AS THE PHOROPTER/TRIAL FRAME DID DURING THE EXAMINATION
- RULES
  - + MOVED AWAY GETS STRONGER
  - + MOVED CLOSER GETS WEAKER
  - MINUS MOVED AWAY GETS WEAKER
  - MINUS MOVED CLOSER GETS STRONGER

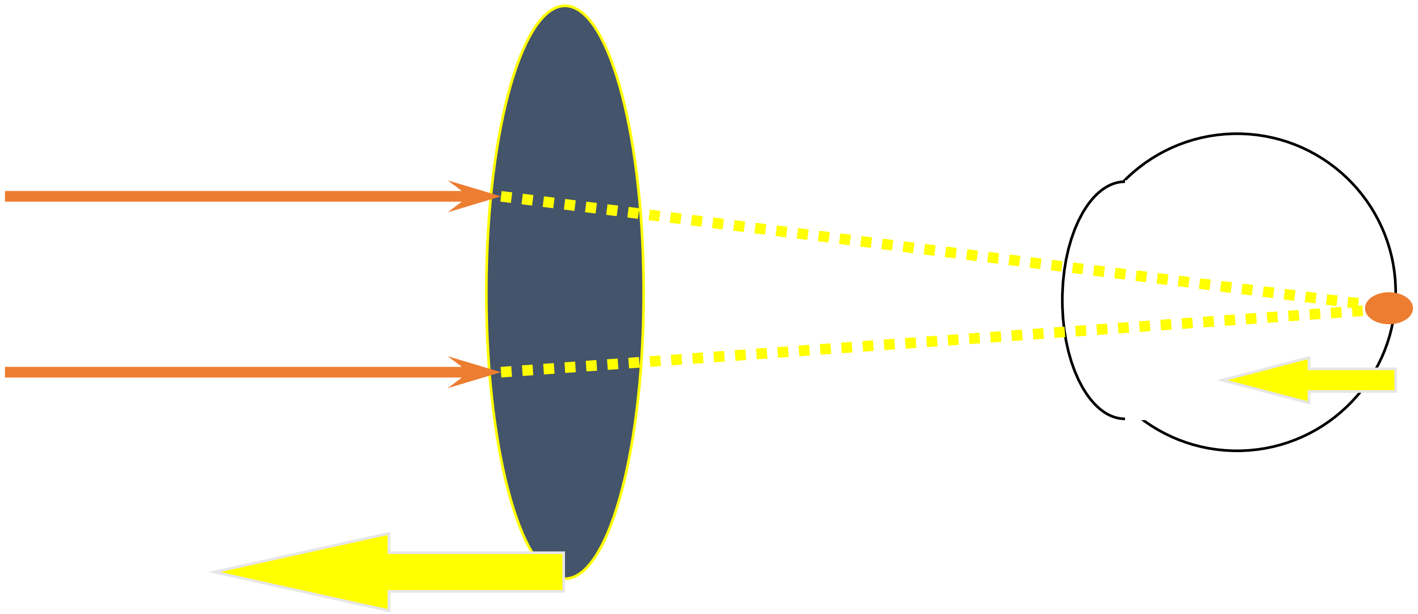
VERTEX COMPENSATION

MANIPULATION of FOCAL LENGTH



VERTEX COMPENSATION

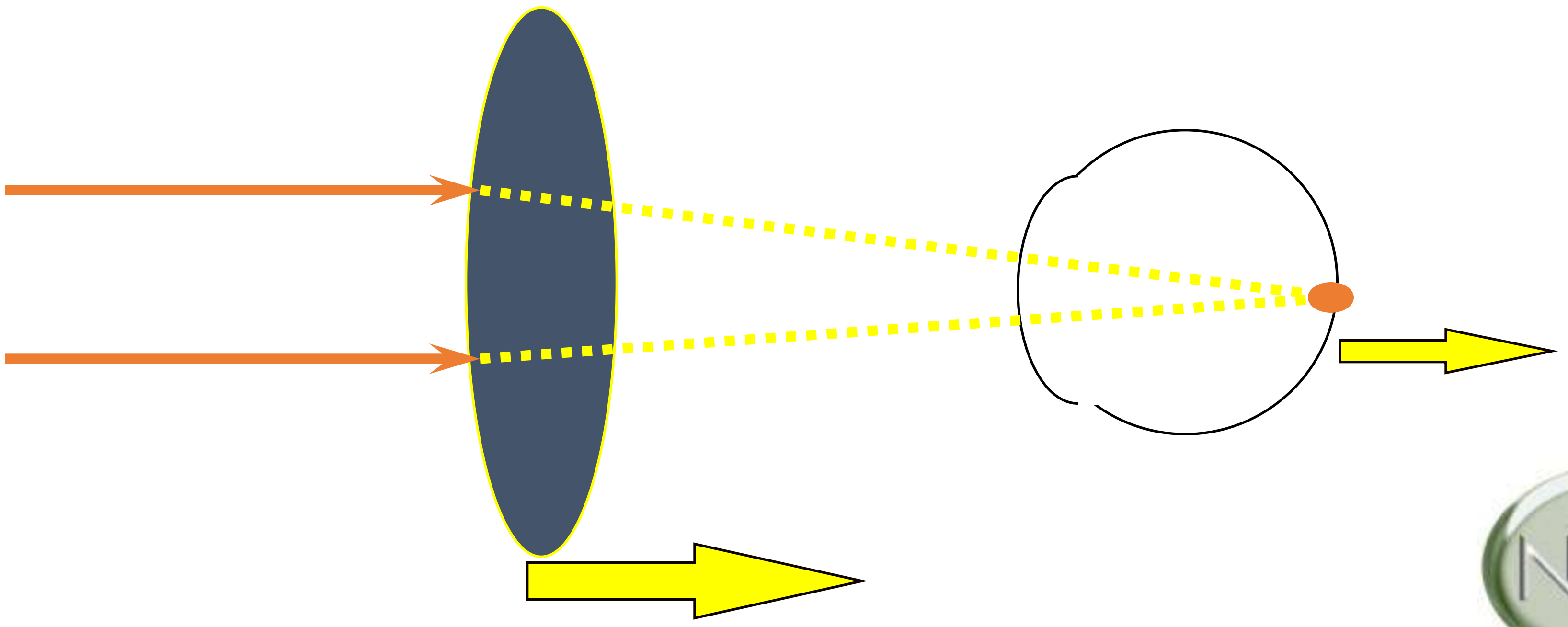
MANIPULATION of FOCAL LENGTH



IF LENS IS MOVED, FOCAL POINT FOLLOWS...

VERTEX COMPENSATION

MANIPULATION of FOCAL LENGTH

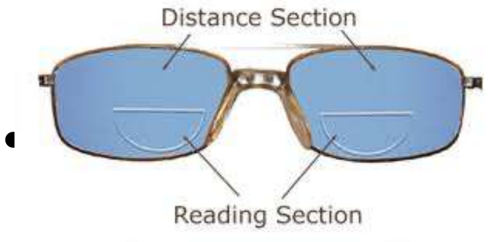


Lens May be moved in EITHER DIRECTION

MULTI-FOCALS

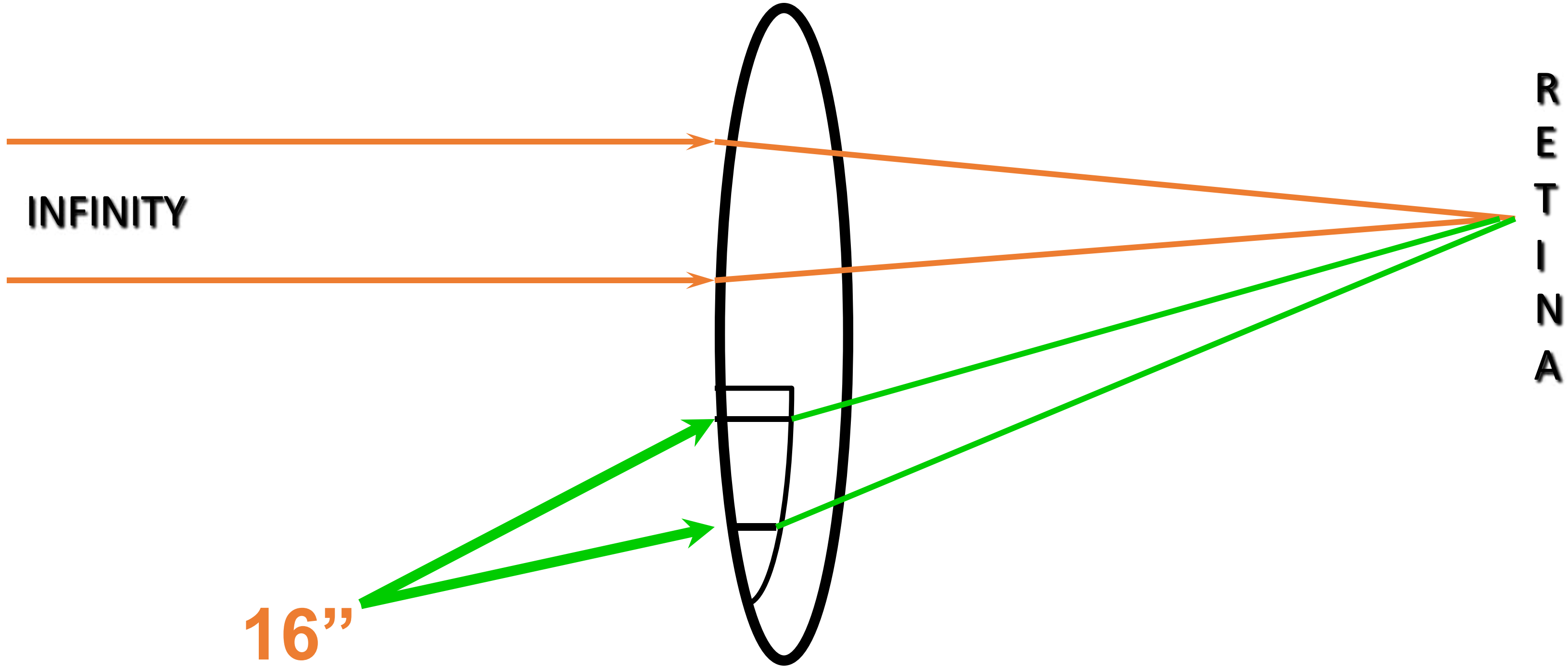
LENS SELECTION

- THE NEAR DESIGN SHOULD REFLECT THE AM
  T SPENDS AT NEAR TASKS

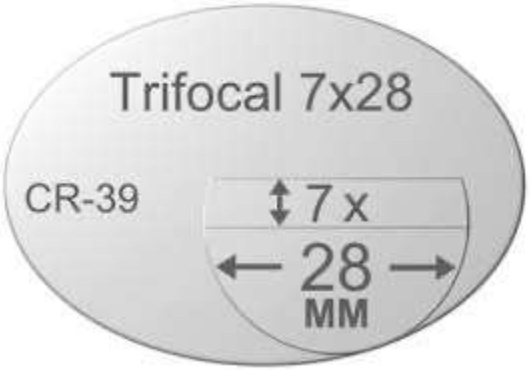


- ID, EXECUTIVE - AKA FRANKLIN; ULTEX A
  LENDED; PROGRESSIVE

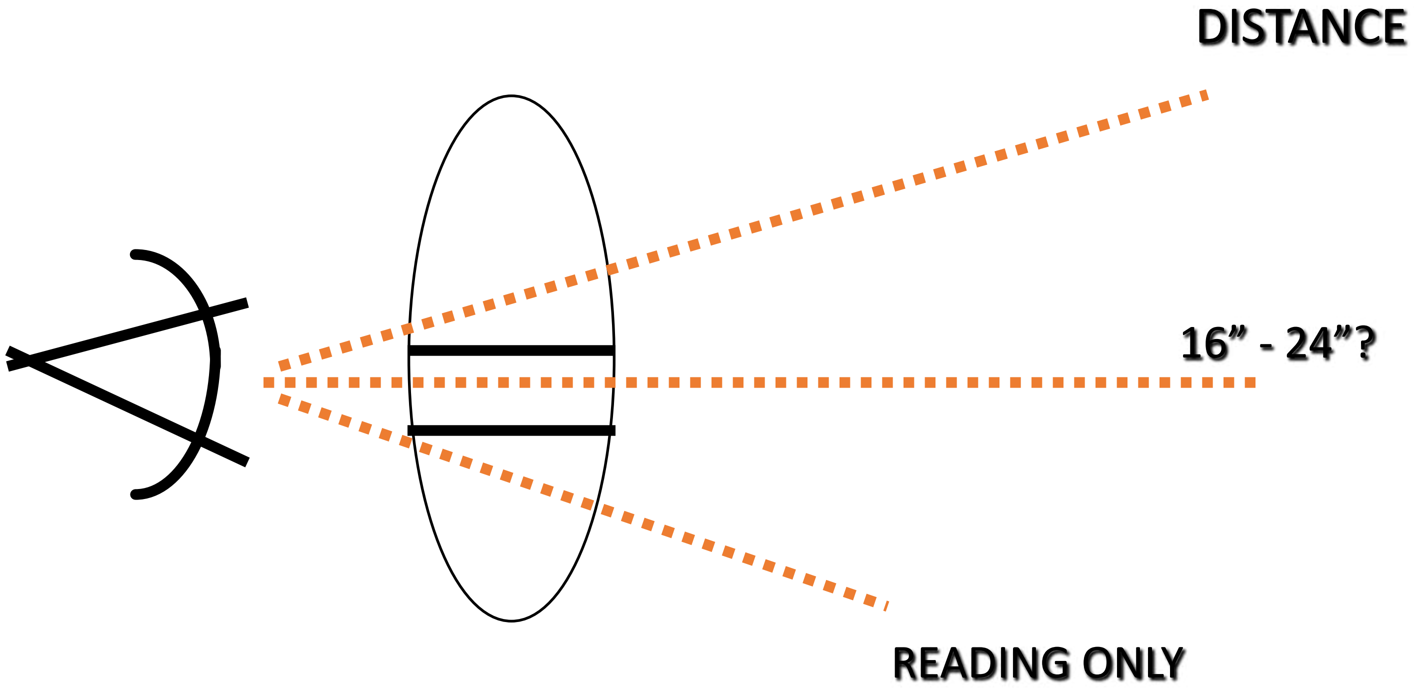
BIFOCAL FUNCTION



INTERMEDIATE VISION

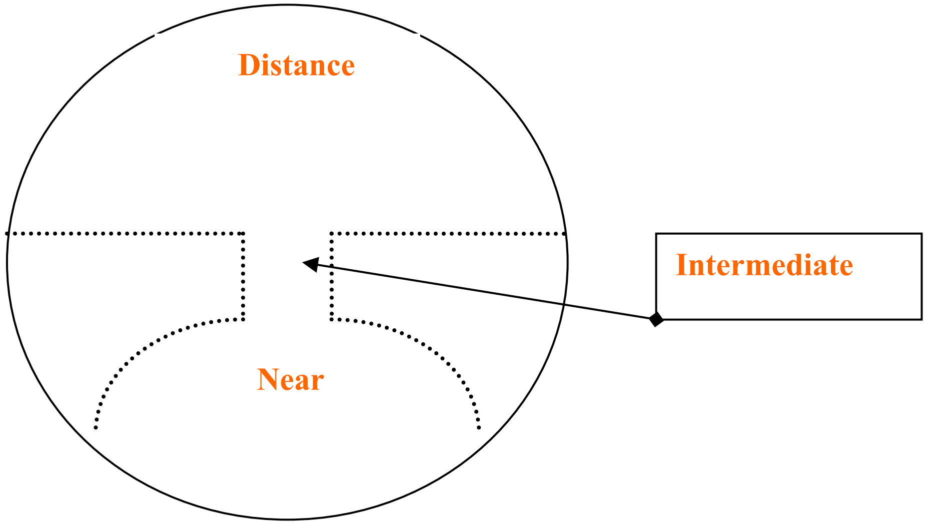


TRIFOCAL



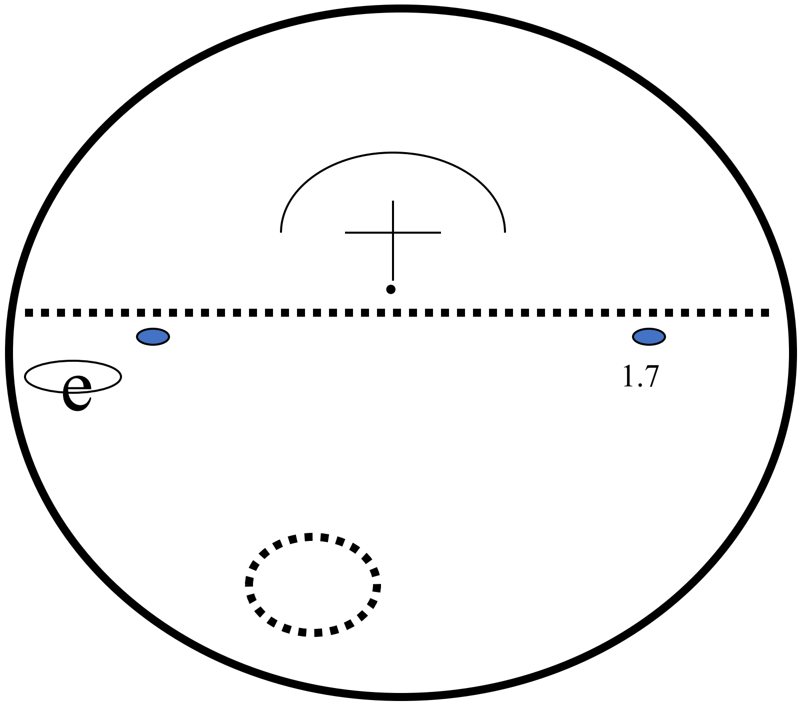
PROGRESSIVE DESIGN

- **Generic progressive design**



- **Basic Marking Layout of a progressive design**

PROGRESSIVE DESIGN



OD –
rear view
minimum heights 13 mm to 24 mm – most insets 2.5

OBLIQUE CYLINDER POWER

- **TO DETERMINE THE PORTION OF CYLINDER POWER AWAY FROM THE AXIS**
- **90 DEGREES = FULL CYLINDER POWER**
- **60 DEGREES = 75%**
- **45 DEGREES = 50%**
- **30 DEGREES = 25%**
- **0 DEGREES (at axis) = 0%**
- **Works in either direction**

Alternate Method

- -1.00 – 2.00 x 60. What is approximate power in 90th meridian?

  90 – 60 = 30 degrees

  30 degrees is 25% of cylinder power

  25% x -2.00 = -.50

  The 90th meridian is 30 degrees away from the axis of the cylinder, thus the power in the 90th meridian is 25% of the cylinder power only!

  Add algebraically this percentage of the cylinder power (-.50) to the sphere power to obtain the total power in the 90th meridian

  (-.50) + (-1.00) = -1.50

Rule of Thumb

5°	.01	50°	.09
	.02		.08
	.04		.08
	.05		.07
	.06		.06
	.07		.05
	.08		.04
	.08		.02
45°	.09	90°	.01

What is approximate total power along the vertical meridian (90) for the Rx -1.00 -2.00 x 60

- 30 degrees away from the axis

.01	Power of cylinder = -2.00 (.25)
.02	= -.50 D
.04	-.50 + -1.00 = -1.50 D
.05	
.06	
<u>.07</u>	
.25	

Example #1

- Rx of +2.50 – 100 x 10
- What is the approximate power at 0 meridian?
- Remember Rule of Thumb?
- The difference between 0° & 10° = 10°
- Rule of Thumb 5 °=.01 &10°= .02
- .01 + .02 = .03
- Power of the cylinder = - 1.00 (.03)

  = -.03

-.03 + +2.50 = +2.47

Example #2

- Rx of +2.50 – 100 x 10
- What is the approximate power at 180 meridian?
- Remember Rule of Thumb?
- The difference between180° & 10° = 10°
- Rule of Thumb 5 °=.01 &10°= .02
- .01 + .02 = .03
- Power of the cylinder = - 1.00 (.03)

  = -.03

-.03 + +2.50 = +2.47

Example #3

- Rx is -5.50 -2.25 x 130
- What is the power at 180 meridian?
- Remember Rule of Thumb?
- 180° – 130° = 50° = .59
- Power of the cylinder = - 2.25 (.59)

  = -1.32

-1.32 + -5.50 = -6.82

Rule of Thumb

5°	.01	50°	.09
	.02		.08
	.04		.08
	.05		.07
	.06		.06
	.07		.05
	.08		.04
	.08		.02
45°	.09	90°	.01

Example #4

- Rx is -3.00 -2.00 x 30 What is the power at 90 meridian?
- Remember Rule of Thumb?
- 90° – 30° = 60° = 75% of the cylinder power
- Power of the cylinder = - 2.00 (75%)

  = - 1.50

  -1.50 + -3.00 = -4.50

Example # 5

- Rx +1.50 +2.00 x 30. What is the power at 180 meridian?
- Remember Rule of Thumb?
- 30° = 25% of the cylinder power
- Power of the cylinder = + 2.00 (25%)

  = +.50

+1.50 + .50 = +2.00

Example # 6

- OD – 1.00 – 1.00 x 45 What is the power at 90 meridian?
- Remember Rule of Thumb?
- 45° = 50% of the cylinder power in OD

  OD -1.00 -1.00 x 45

  OD - Power of the cylinder = - 1.00 (50%) = -.50

  -1.00 + -.50 = -1.50

PRISM

- **CHARACTERISTICS**
  - **SHAPE / DEFINITION**
  - **LIGHT DEVIATION**
- **WANTED AND UNWANTED**
- **BASE DIRECTION & RULES**

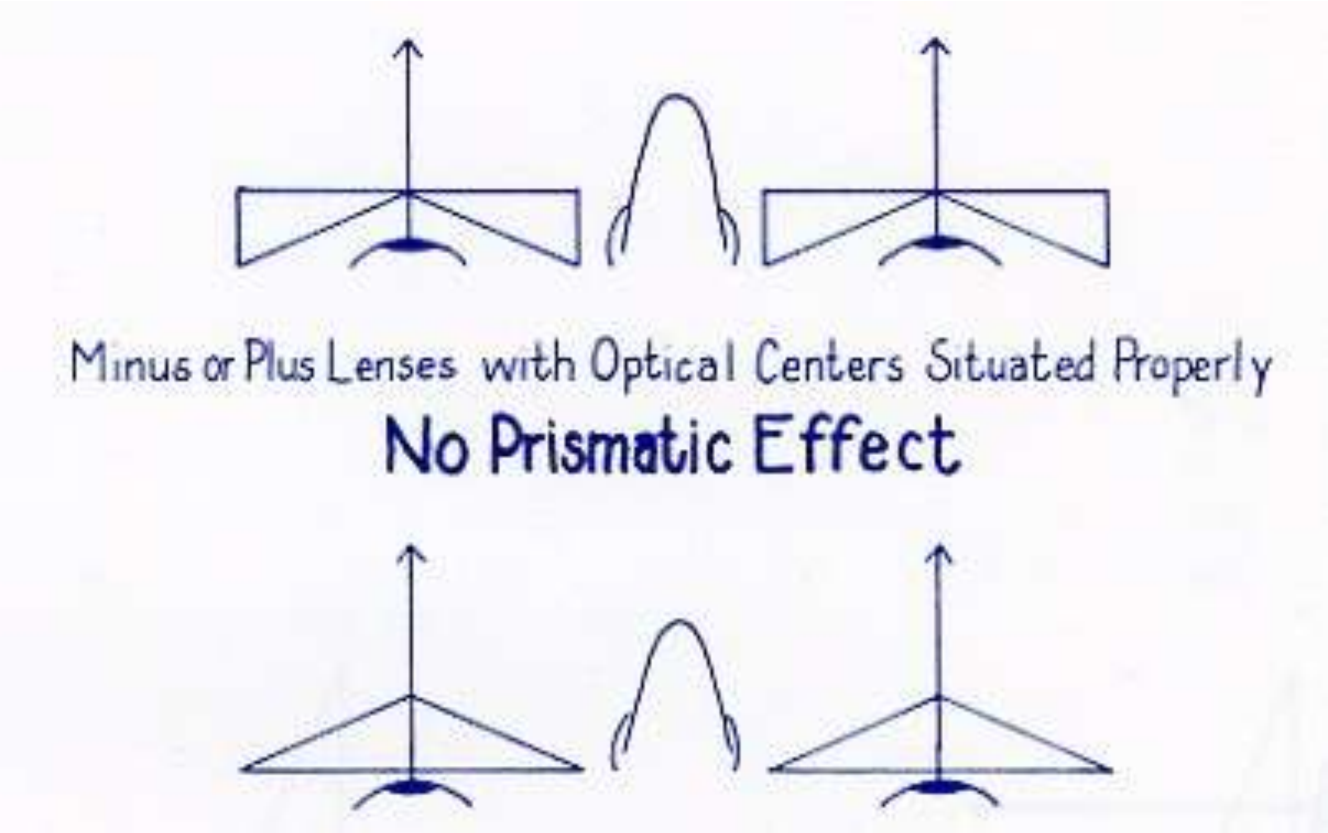
Prism Diopter Δ

- Prisms were first measured to the degree of the apical angle
- Prism diopter is denoted by the Greek letter delta Δ
- C.F. Prentice in 1890, advocated a metric system of numbering prisms
- A 1 prism diopter lens will deviate a ray of light exactly one cm, 10 mm or .1 m on a screen one meter away

Use of Prisms

- Prisms are commonly prescribed by eye doctors in conjunction with lens prescriptions to alleviate the symptoms which occur in muscle imbalance
- Prisms are routinely used during eye examinations to dissociate the eyes in order to temporarily interrupt fusion

Ophthalmic Prism Visualizations
Patient View



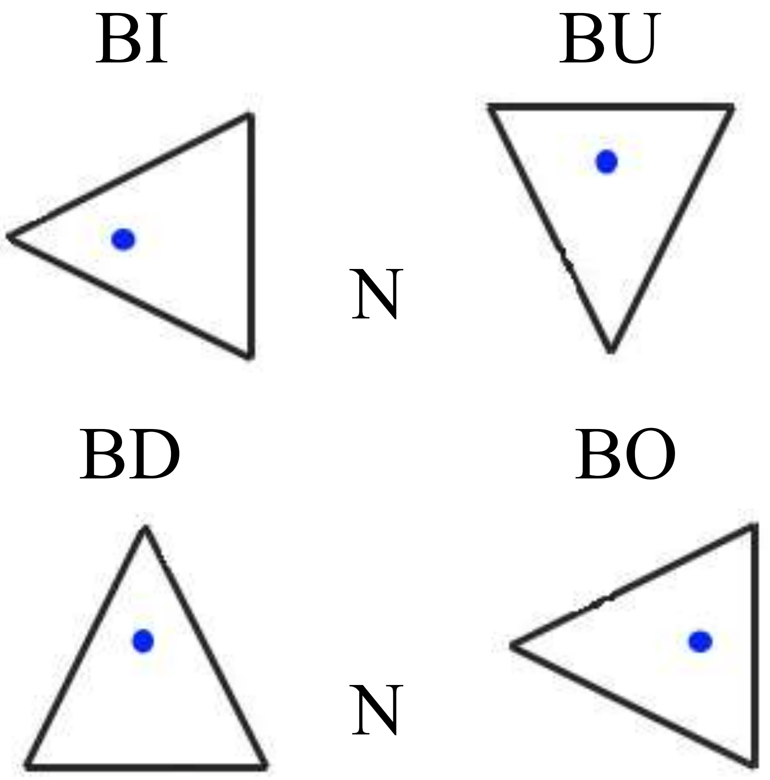
Ophthalmic Prism Base Directions

- A prism is placed before the eye with reference to the base.
- Ex. Base In – BI

  Base Up – BU

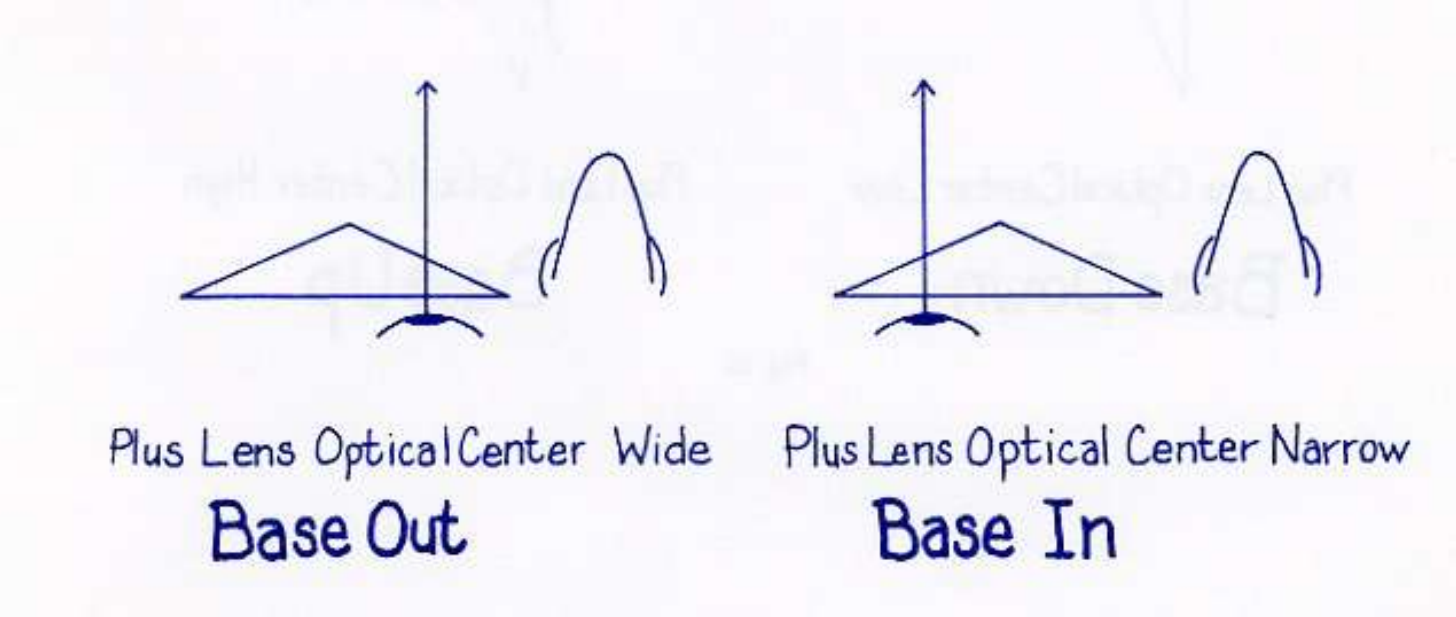
  Base Out – BO

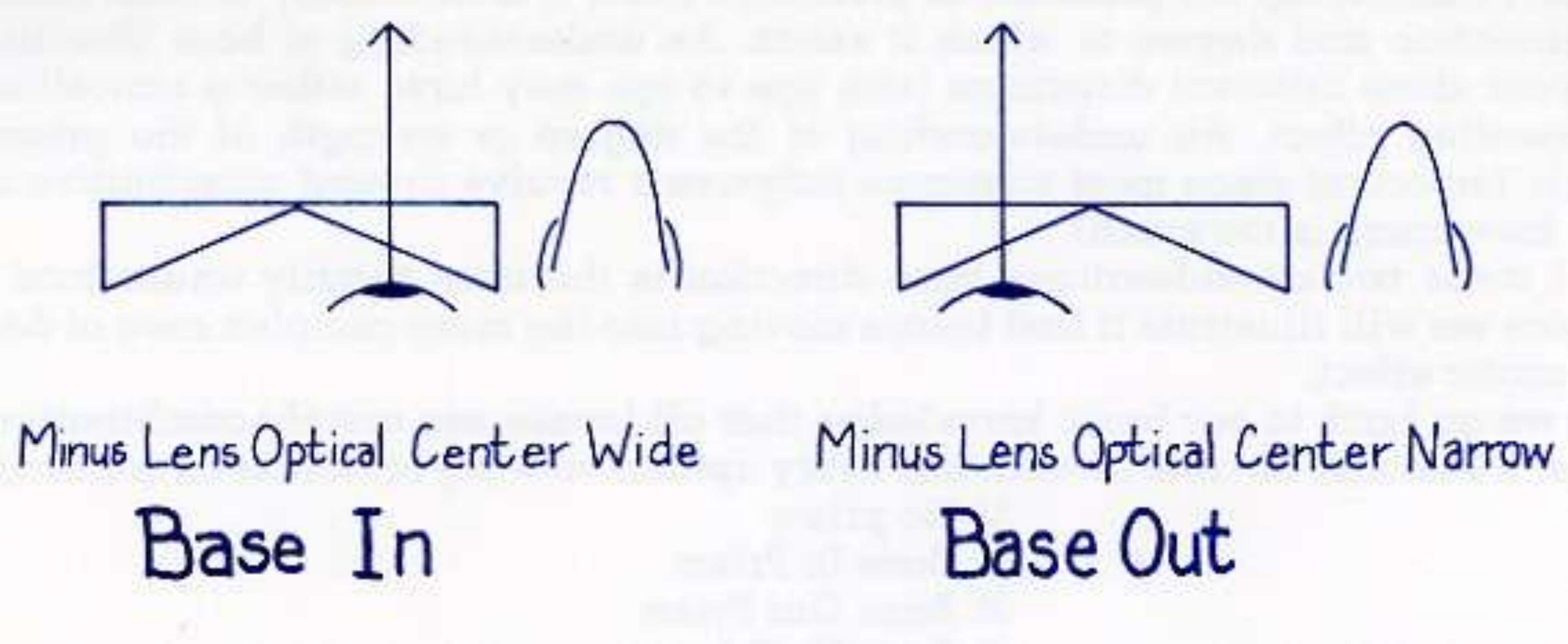
  Base Down - BD

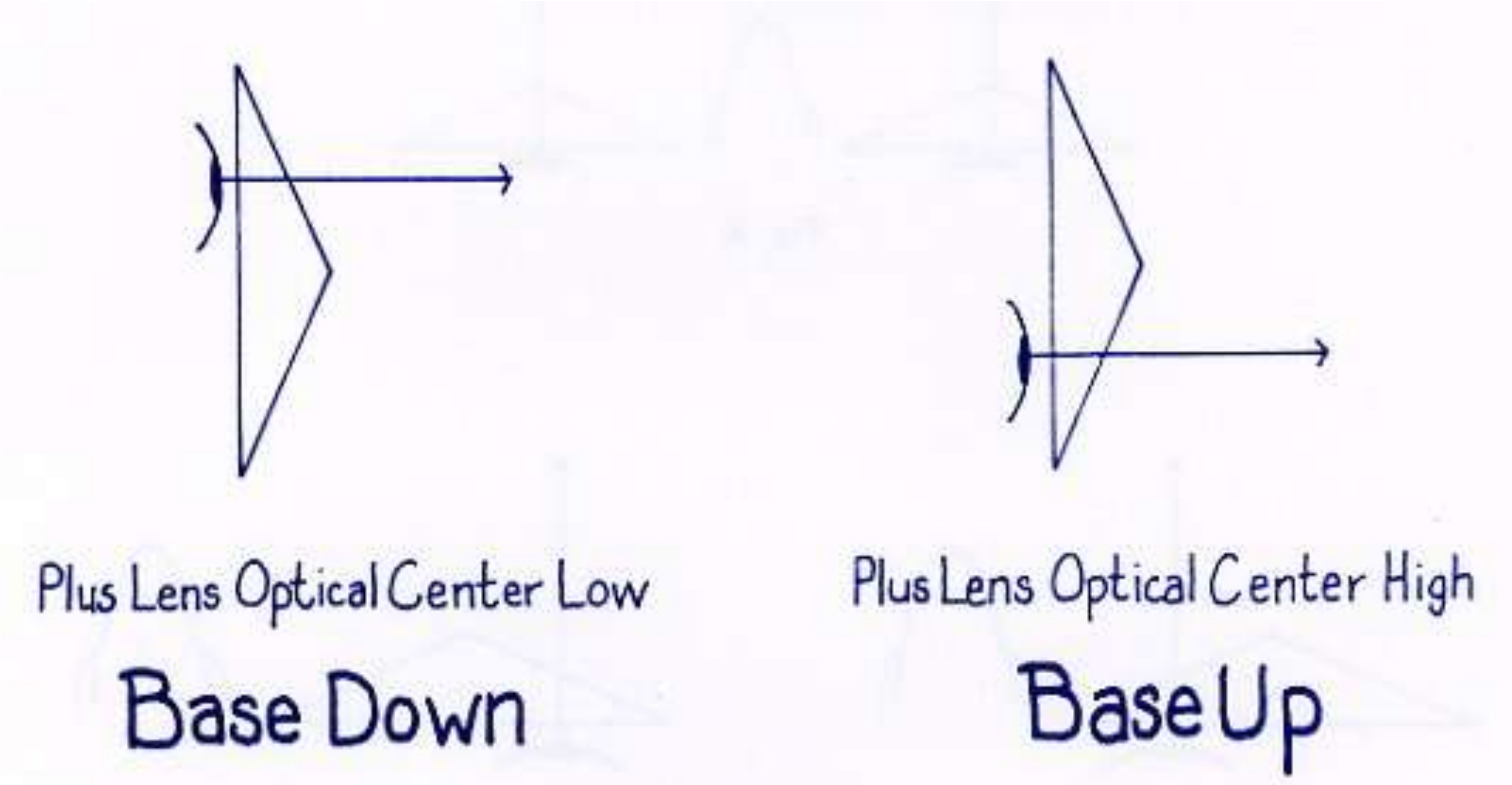


Point to Remember!

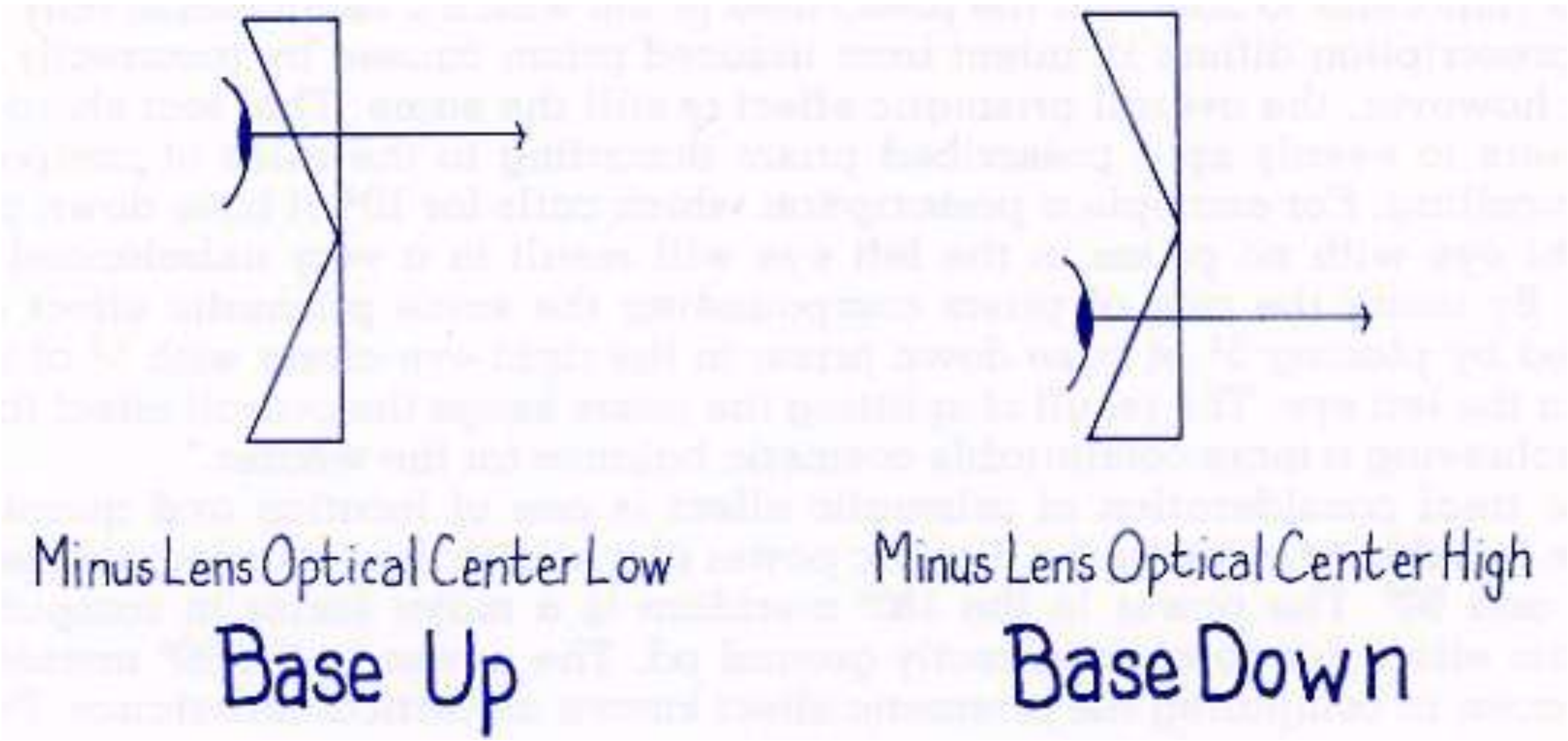
- BI and BO Prism are referenced in relation to the nose of the patient, regardless of minus or plus power




Minus Lens Optical Center Wide
Base In
Minus Lens Optical Center Narrow
Base Out

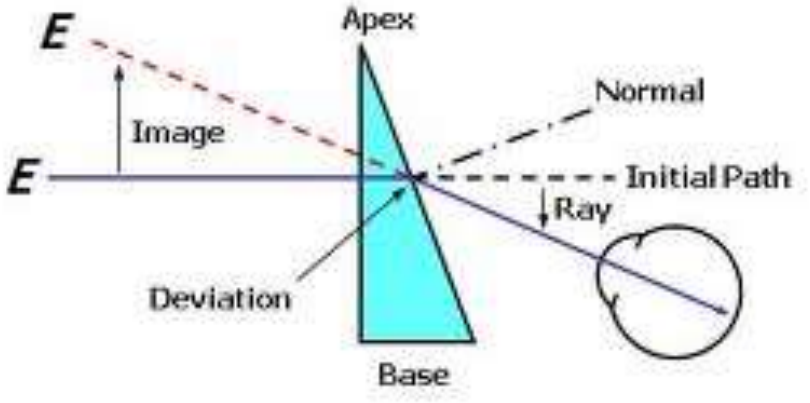


Plus Lens Optical Center Low
Base Down
Plus Lens Optical Center High
Base Up


Minus Lens Optical Center Low
Base Up
Minus Lens Optical Center High
Base Down

Effect of Prism on Light

- A prism deviates light toward its ***base*** but the apparent displacement of objects is toward the ***apex***
- Objects seen through a prism are d



Ray of Light Deviated Towards Prism Base

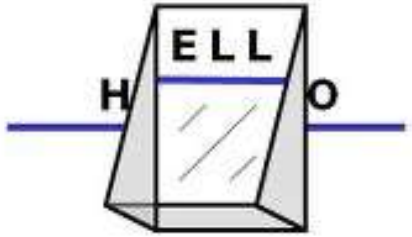
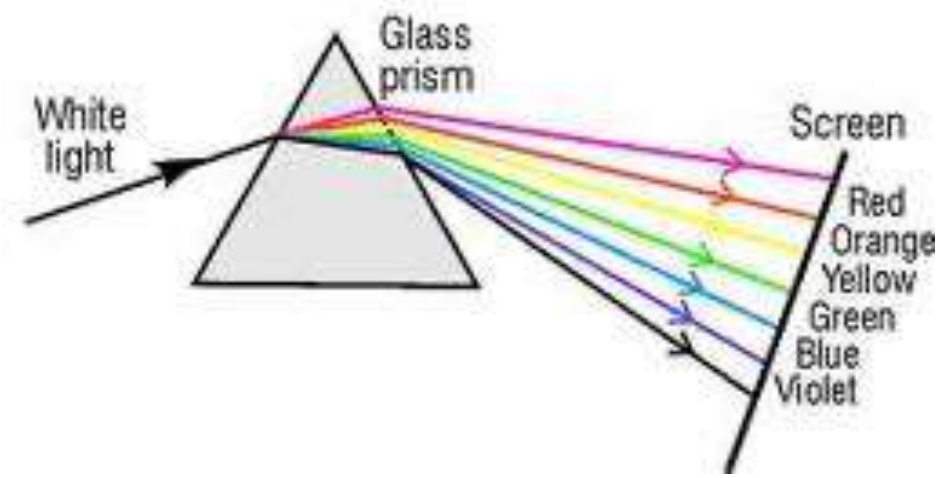


Image Displacement Towards Prism Apex

Effect of Prism on Light

- A prism separates light into its “rainbow” spectrum
- Dispersion – breaking up of light into its component colors
- ROYGBIV or ROY G. BI\

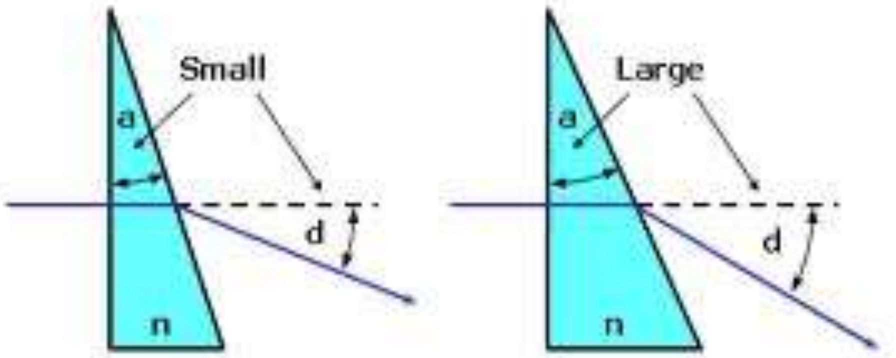


Effect of Light on Prism

- A prism has no focal length
- A prism deviates light toward the base
- An object viewed through a prism will appear to be in a different place than viewed without a prism
- The ***greater*** the angle of the apex (Apical Angle), the ***thicker*** the prism and therefore, the greater the dioptric power. The **stronger** the prism, the **more** it will bend light.

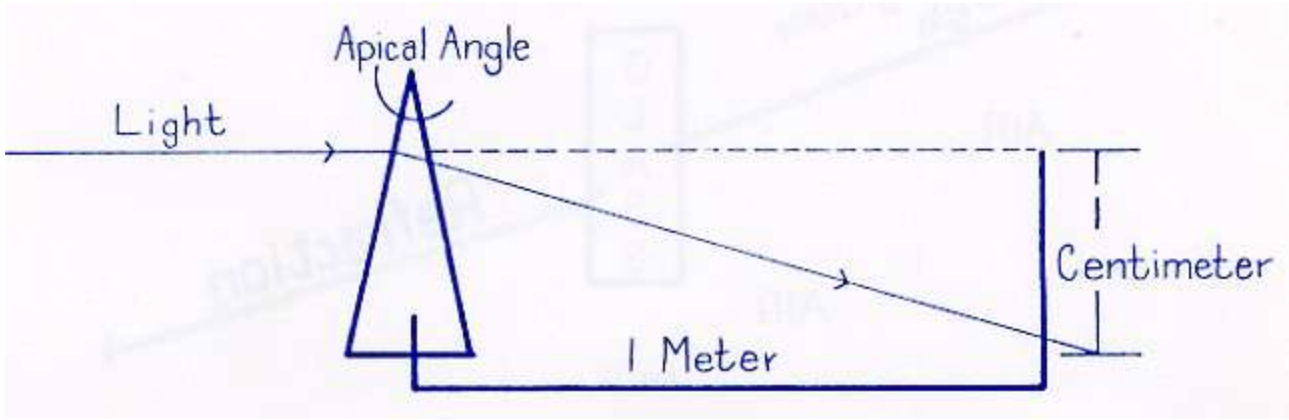
Deviation vs. Displacement

- Deviation in prism is similar to angle of deviation as discussed in refraction.
- The ***<u>stronger</u>*** the prism the ***<u>more</u>*** the light will ***<u>deviate</u>*** and the ***<u>more</u>*** the image will be ***<u>displaced</u>***



Deviation by Weak and Strong Prisms

Prism Diopter Δ



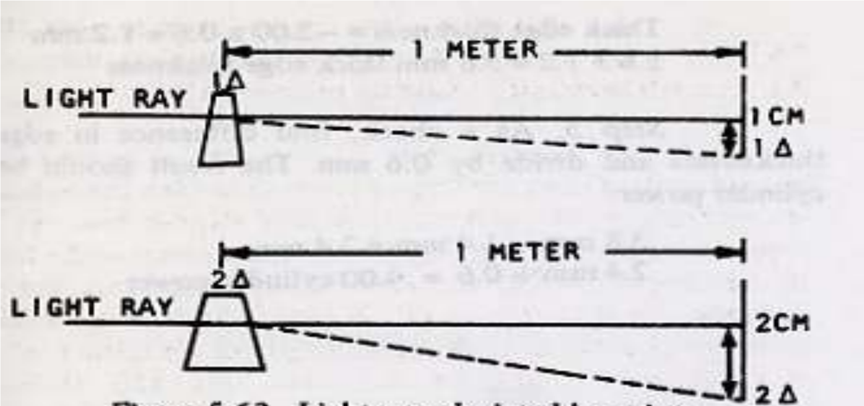


Figure 5-63. Light rays deviated by prism.

Strabismus (Heterotropia)

- Is when one eye is not aligned with the other eye causing the other eye to look in a different direction.
- Result: Diplopia or Double Vision – since two objects are imaged onto the maculas of both eyes.
- In order to see, the person's brain learns to "suppress" the image in the turned eye.

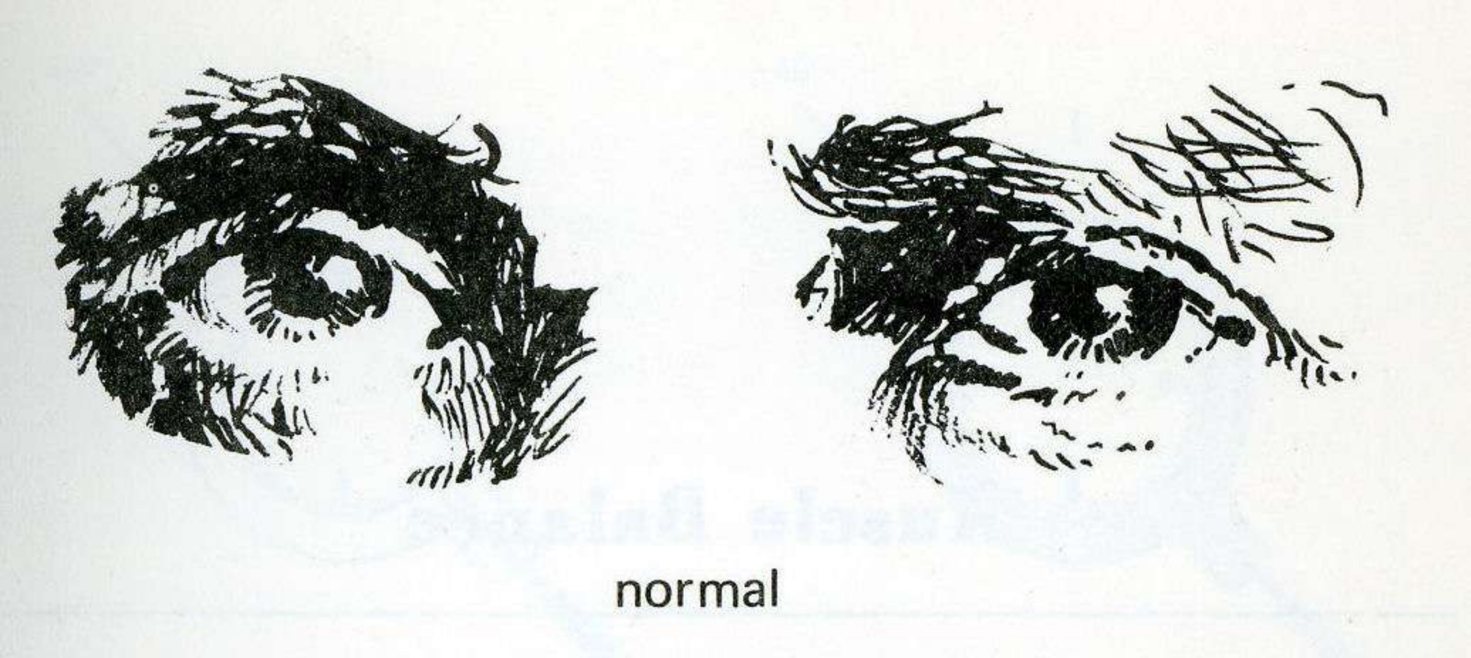
Amblyopia (Lazy Eye)

- When an eye is suppressed (turned off) for too long, the visual acuity in the “Lazy eye” is no longer good. Due to the lack of use, the lazy eye shuts down and decreases the patient vision in that eye.
- The Angle of Deviation of strabismus is measured in “prism diopters”
- Strabismus occurs in about 2% of children
- Esophoria or Exophoria – tendency for the eye to turn
- Esotropia or Exotropia – a fixed turning of the eye

Most common type of Strabismus

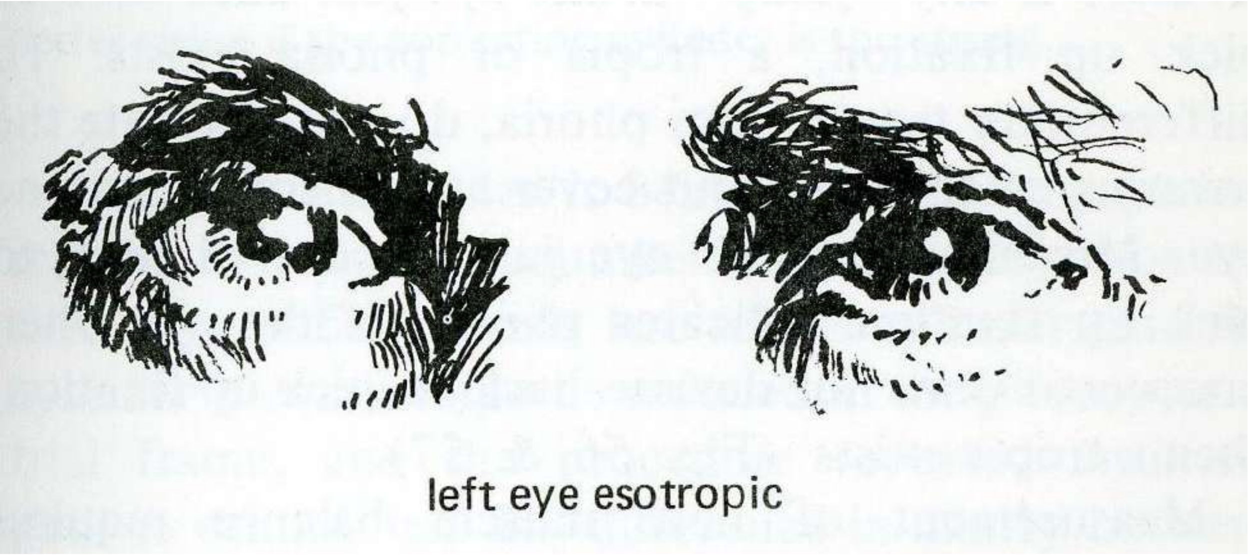
- Esotropia
- Exotropia
- Vision Therapy maybe indicated where complete suppression has not occurred. (Use of prism and eye patching)
- Surgical Correction is the other alternative
- Surgery corrects the deviation, however binocular vision will not usually result

Normal Eye Alignment



Left Eye Esotropia

- The left eye is turned in so the macula in the left eye is turned outward

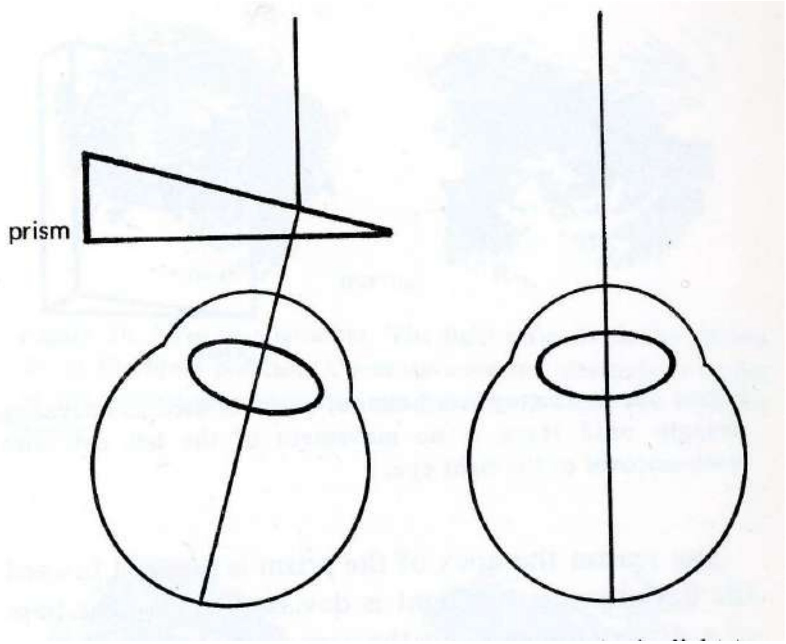


Relieving Prism

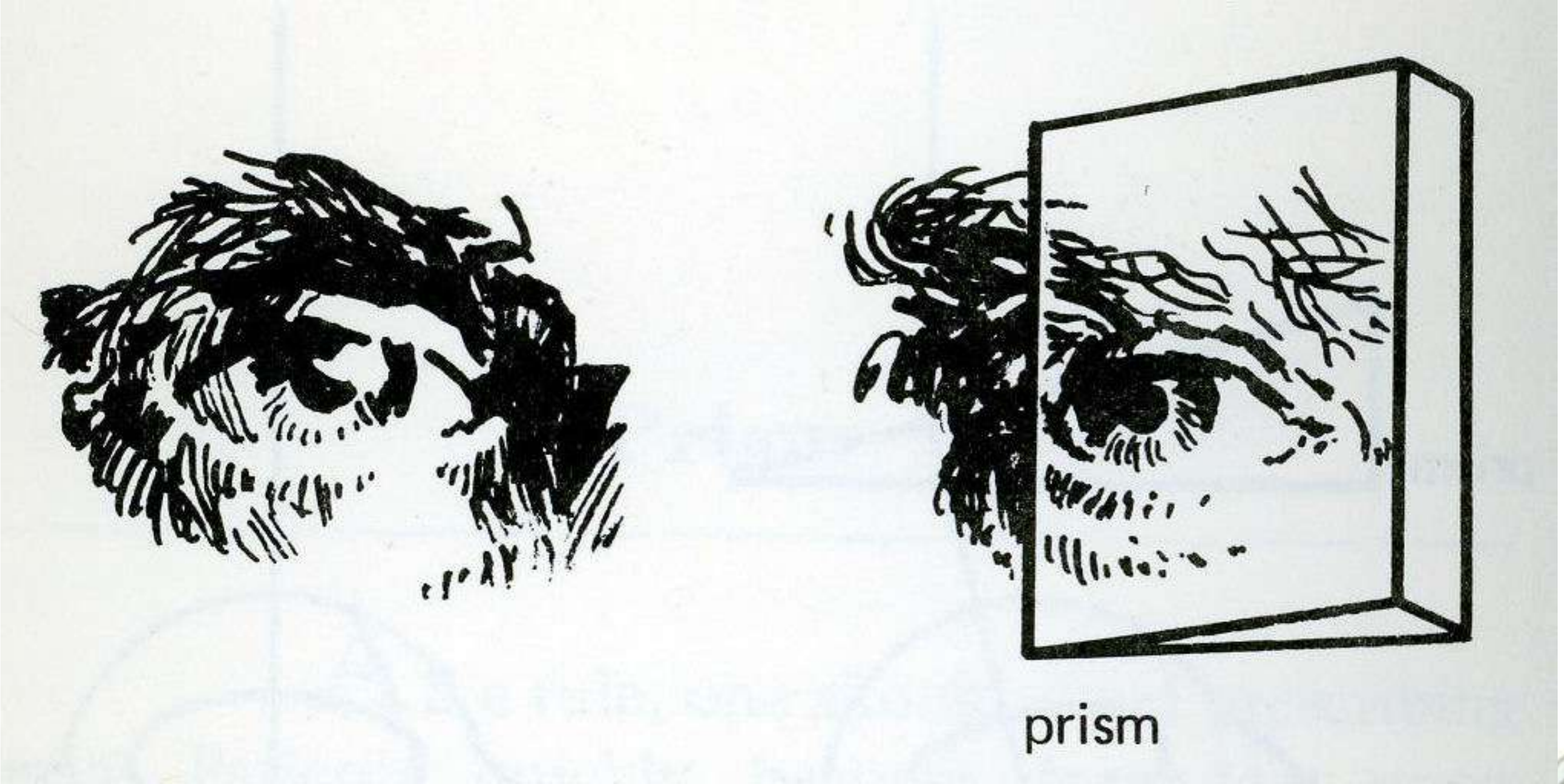
- Is placed in front of the eye with a weak or paralyzed muscle to displace the image in the same direction that the eye turns
- It reduces the distance the muscles have to turn the eye to aim it correctly
- Rule: Point prism in the direction of the tropia (Exotropia – out, Esotropia – in)

Relieving Prism – Esotropia O.S.

- The reason the apex of the pirsm is pointed toward the deviation is that the light is deviated toward the base of the prism. In the case of esotropia, the eye is turned in. The macula is turned out. A prism with the apex toward the nose will bend light outward to strike the macula which in this case is positioned outward

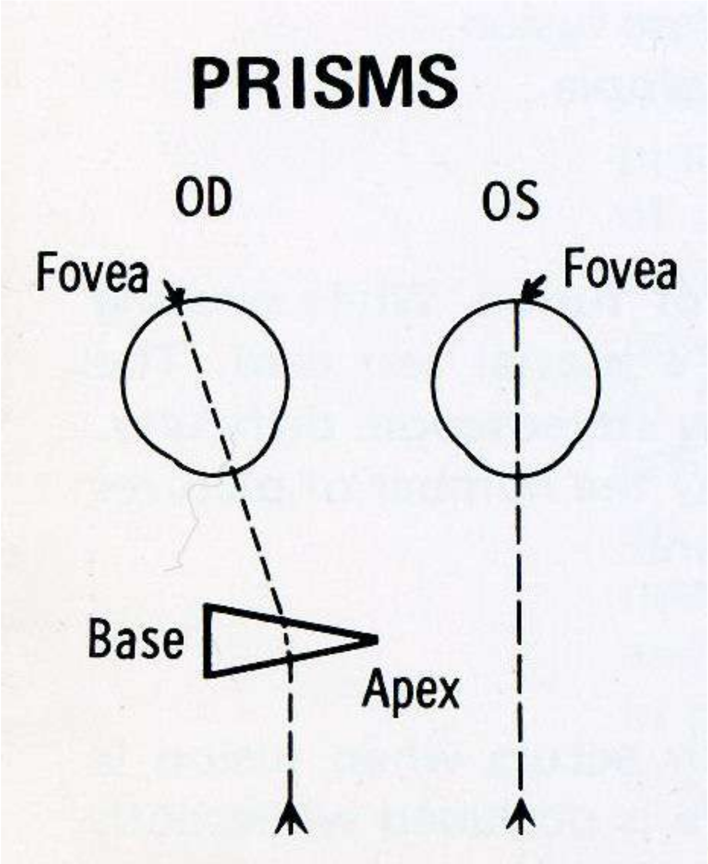


Relieving Prism – Esotropia O.S.



Relieving Prism – Esotropia O.D.

- In a person with a right esotropia, the right fovea is turned temporally. To focus light on the right fovea, a prism base (apex in) is placed in front of the right eye



Adverse Prism

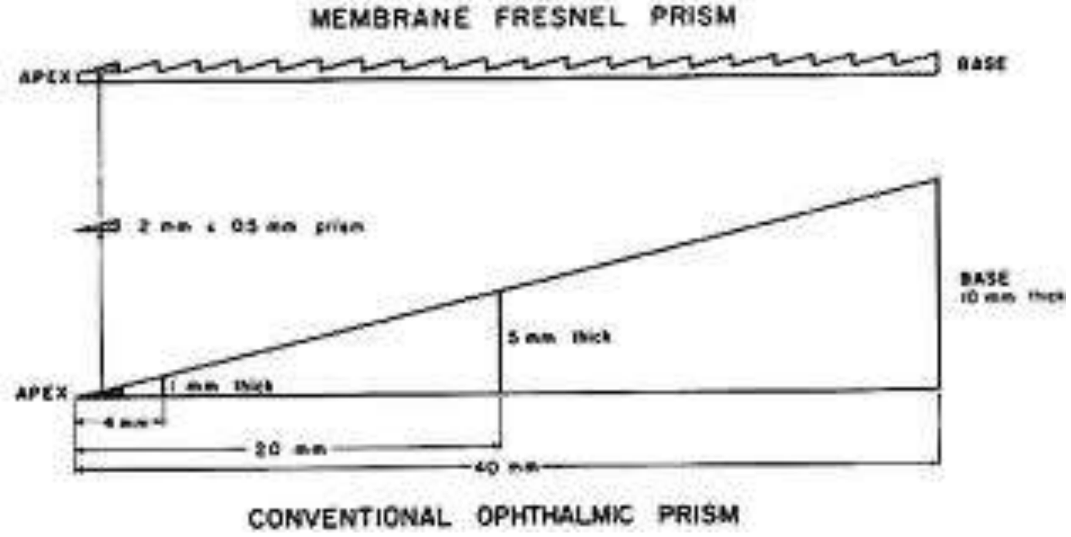
- Is prescribed to stimulate an eye muscle and to make it work harder.
- The technique may be used during eye exercises designed to strengthen the weak muscle

Fresnel Prism

- The French physicist, Augusti-Jean Fresnel is credited with the invention of the concept of this form of lens. Their initial use was primarily to replace the very thick lenses used in lighthouses. To obtain lenses powerful enough for lighthouses, massive heavy lenses were required. By designing the lens as a series of small segments, rather than one large lens, the great weight could be removed.
- The first Fresnel lens was placed in the Cordouan Lighthouse at the mouth of the Gironde estuary in 1823.

Fresnel Prisms

- The Fresnel Press-on lenses used in ophthalmic care today are wafer thin lenses. They are manufactured by the 3M company. 3M Press-on Optics are fabricated from flexible static vinyl which allows them to be easily cut to fit on ophthalmic eyewear lenses. They are available in both lenses and prisms, and available in prism powers up to 40 prism diopters.



Fresnel
Press-On
Prism
Applied to OS

Advantages and Disadvantages

- The main advantage of 3M Press-ons Optics is that they are wafer thin compared to a normal ophthalmic prism.
- The disadvantage is that the flexible static vinyl material that gives these lenses the ability to be easily cut to custom shapes, unfortunately, reduces the contrast of objects viewed through the lens.

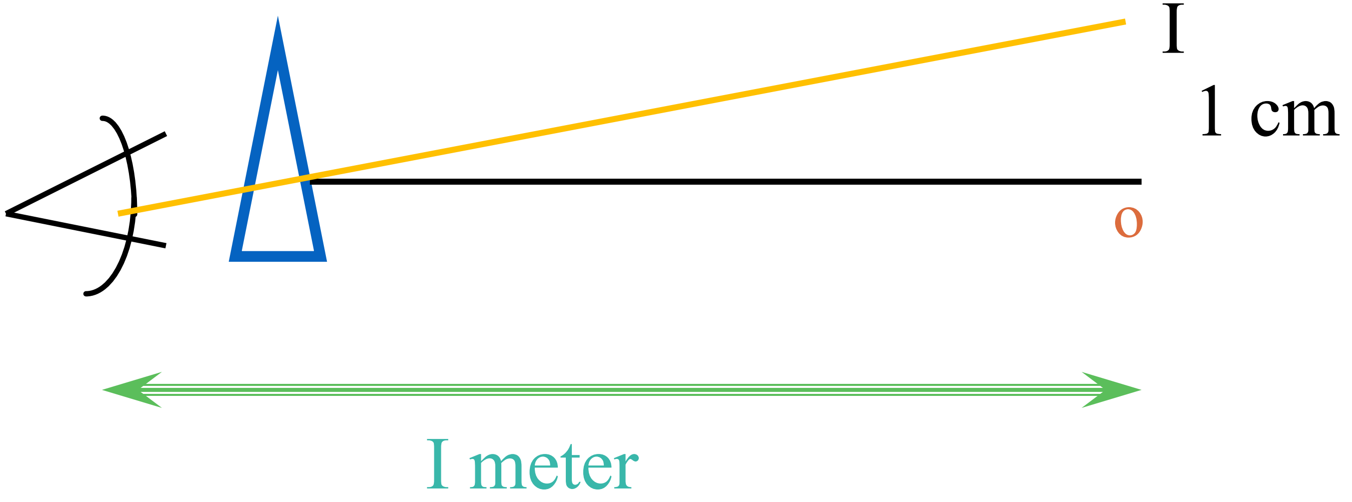
Prismatic Effect and Eyeglasses

- When inspecting a pair of eyeglasses, the optical centers should be located and measured prior to dispensing
- After fabrication, the dotted PD's from the lensometer should be the same as the patient PD given? YES or NO?

- Patient PD should match the dotted PD’s after markup on the lensometer

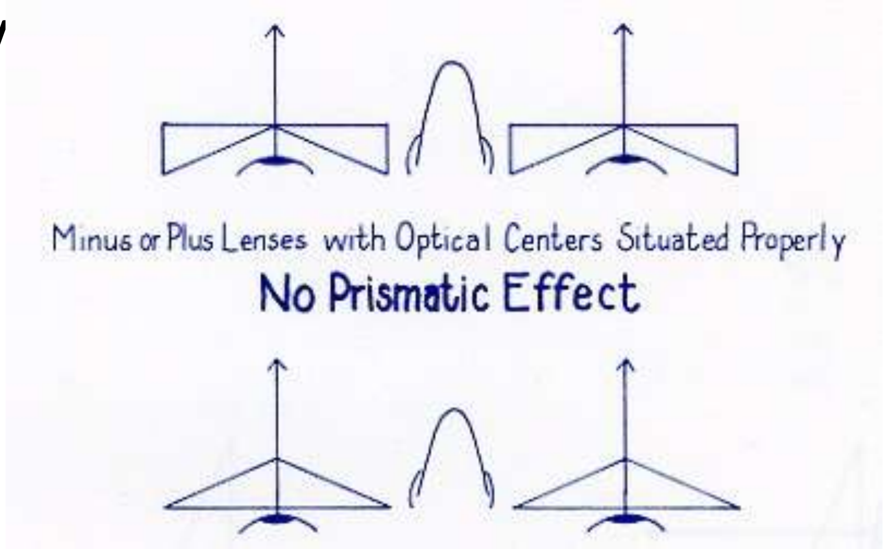
PRISM

- **Thin Edge = Apex**
- **Thick Edge = Base**
- **Prism Diopters = 1cm deviation / 1 M Distance**
- **Light directed toward the BASE**
- **Image directed toward the APEX**



Prismatic Effect

- The visual center of a lens is the point through which the patient actually sees through the lens. Also called the optical center
- If prismatic effect is desired, the visual center and optical center of the lens will not coinside



Prentice Formula

$$\Delta = \frac{D \times \text{Decentration (in mm)}}{10}$$

D = Power in the specific meridian

Δ = Prism Diopters or

The formula can be written to find the amount of decentration needed to obtain a given prism value

$$\text{Dec} = \frac{10 \times \Delta}{D}$$

Example #1

- Compute the amount of prism by decentering a -5.00 D lens 5 mm.

$$\Delta = \frac{D \times \text{Decentration (in mm)}}{10}$$

$$\Delta = \frac{5 \times 5}{10} = \frac{25}{10} = 2.5\Delta$$

Example #2

- What is the prismatic effect at a point 2 mm from the optical center of a +3.00 D lens?

  $$\Delta = \frac{D \times \text{Decentration (in mm)}}{10}$$

  $$\Delta = \frac{3 \times 2}{10} = \frac{6}{10} = .6\Delta$$

Example # 3

- Suppose we have a concave lens of

  -3.00 which is to be decentered 7 mm. What is the prism power obtained by doing so?

$$\Delta = \frac{D \times \text{Decentration (in mm)}}{10}$$

$$\Delta = \frac{3 \times 7}{10} = \frac{21}{10} = 2.1\Delta$$

Example # 4

- Compute the amount of decentration needed for a -5.00 D to obtain 2.5Δ.

$$\text{Dec} = \frac{10 \times \Delta}{D}$$

$$\text{Dec} = \frac{10 \times 2.5\Delta}{5} = \frac{25}{5} = 5\text{mm}$$

Example # 5

- Compute the amount of decentration needed for a +4.00 D to obtain 2Δ.

$$\text{Dec} = \frac{10 \times \Delta}{D}$$

$$\text{Dec} = \frac{10 \times 2\Delta}{4} = \frac{20}{4} = 5\text{mm}$$

Example # 6

- Compute the amount of decentration needed for a +3.00 D to obtain .6Δ.

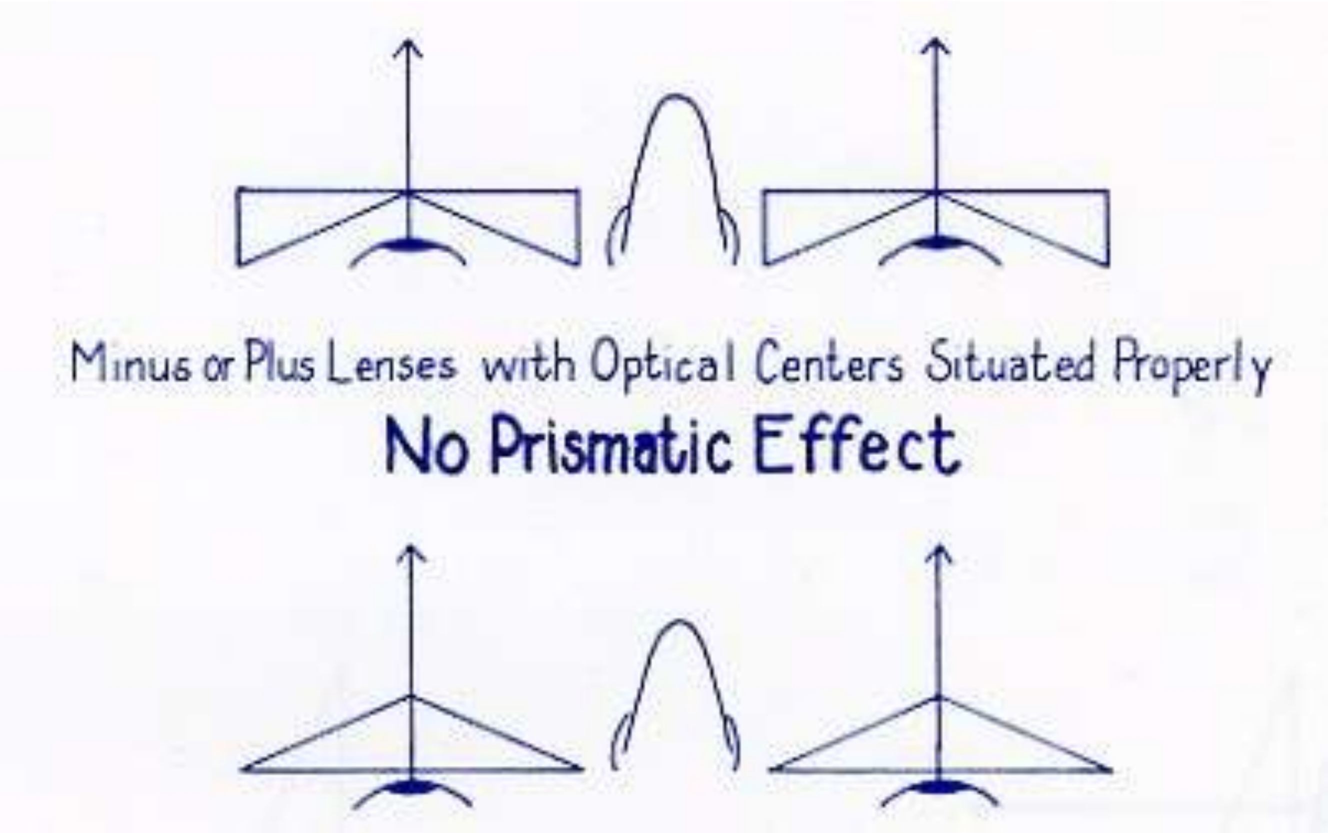
$$\text{Dec} = \frac{10 \times \Delta}{D}$$

$$\text{Dec} = \frac{10 \times .6\Delta}{3} = \frac{6}{3} = 2\text{mm}$$

Base Direction Compared to Where the Patient is looking

- When recording a prism amount, we must also state the direction of the prism relative to the wearer's eye.
- If we go back to our basic knowledge that all lenses are merely combinations of prisms, we should be able to visualize every optical viewing situation.

Ophthalmic Prism Visualizations



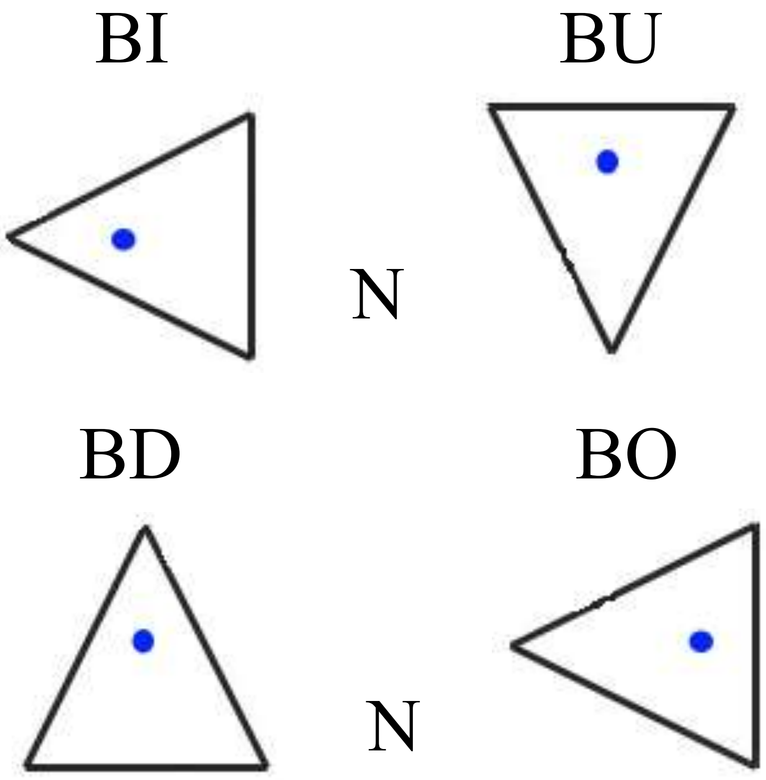
Ophthalmic Prism Base Directions

- A prism is placed before the eye with reference to the base.
- Ex. Base In – BI

  Base Up – BU

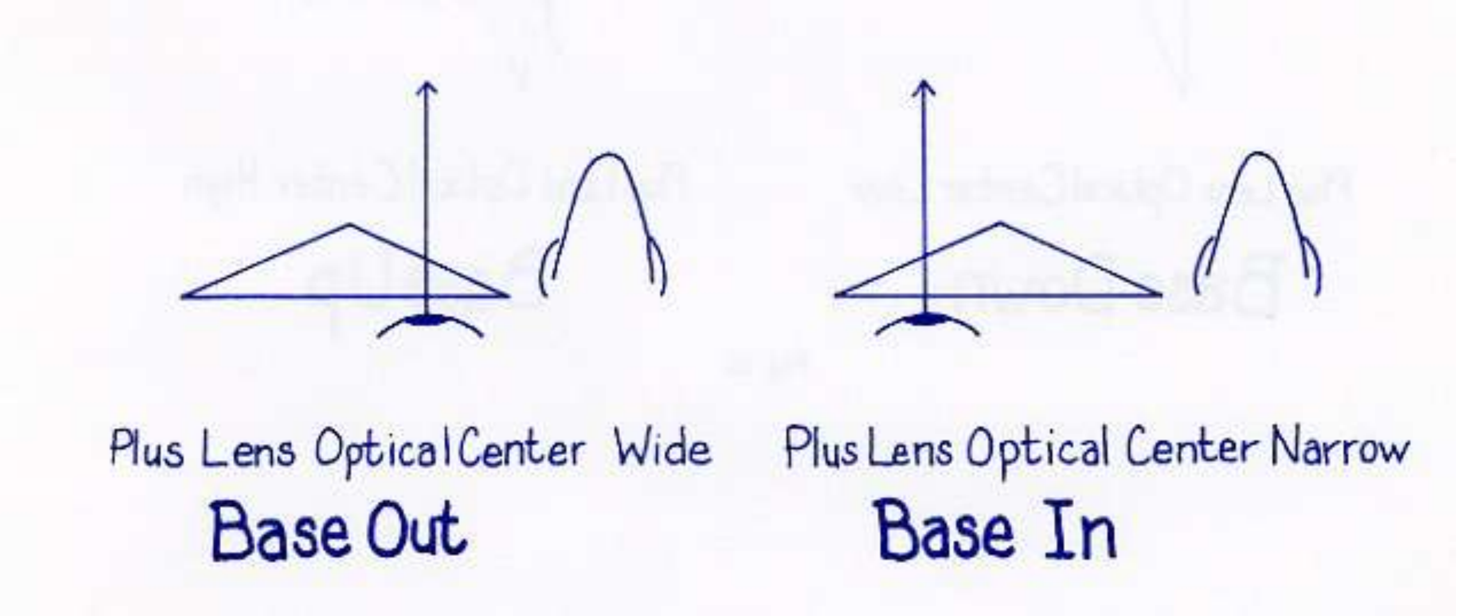
  Base Out – BO

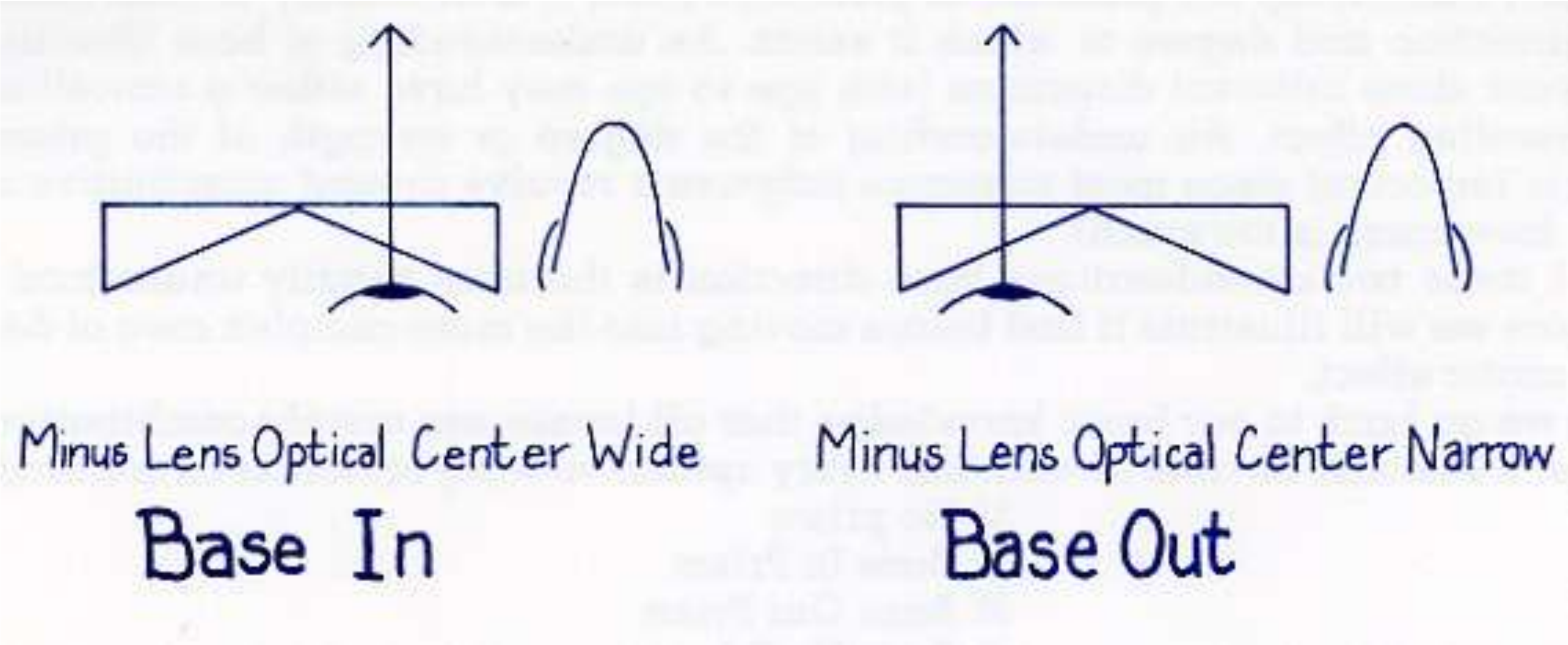
  Base Down - BD

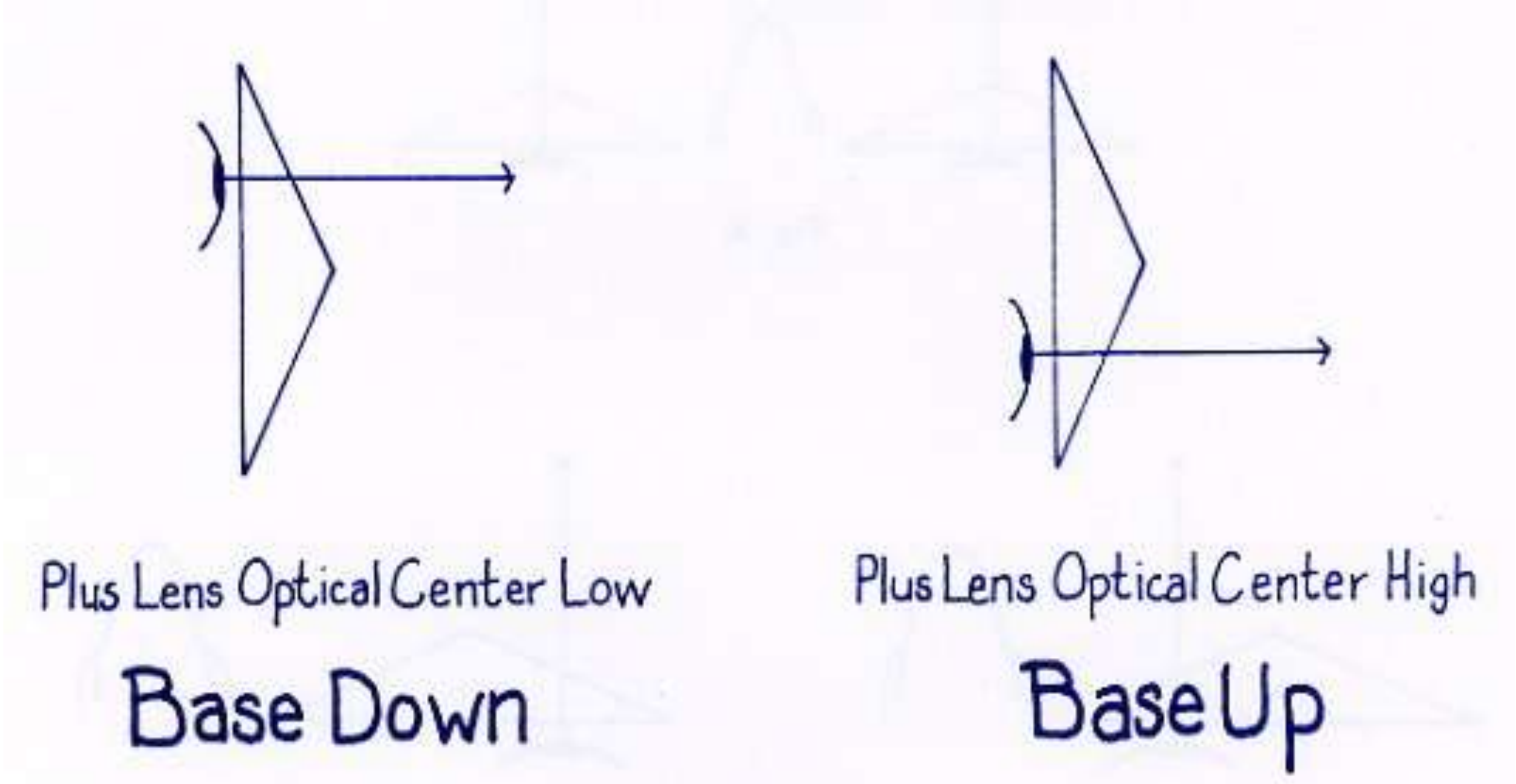


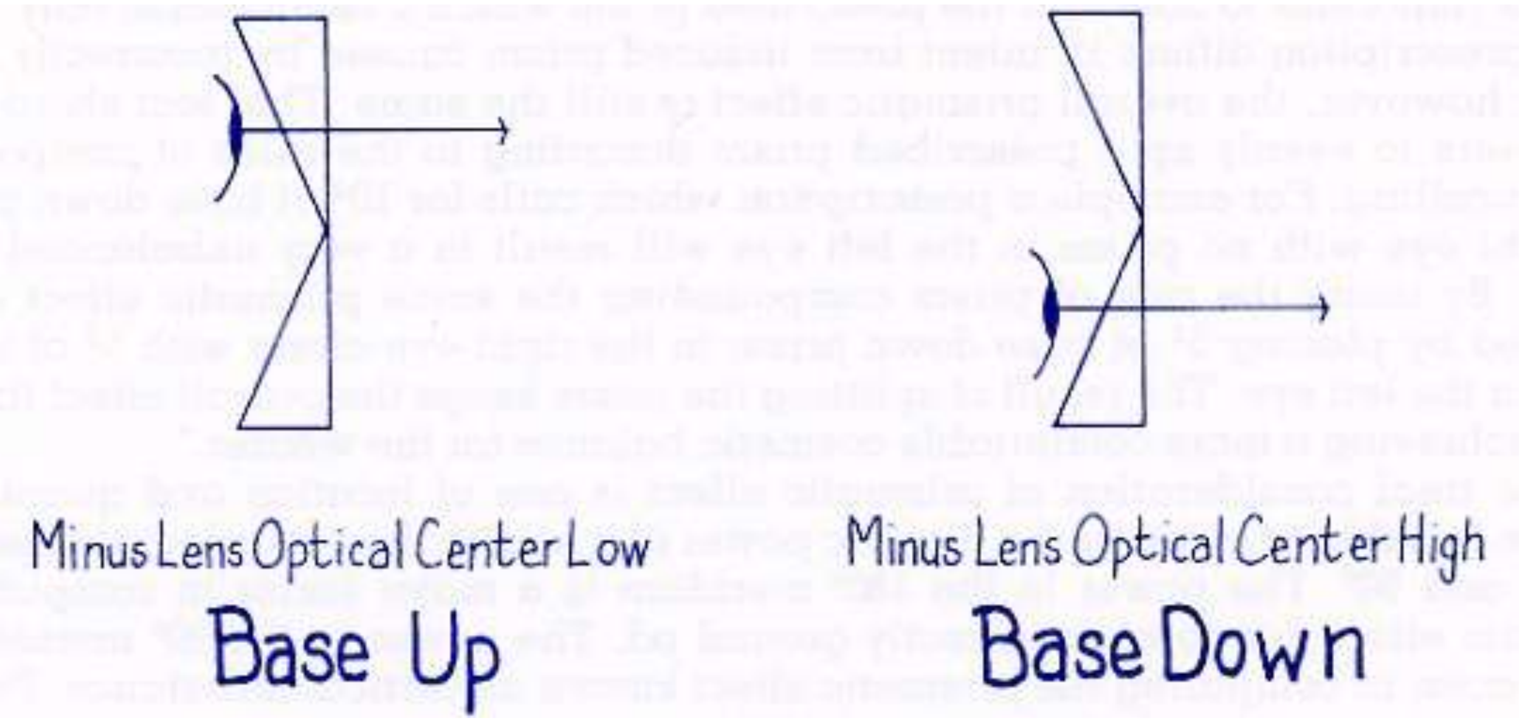
- BI and BO Prism are referenced in relation to the nose of the patient, regardless of minus or plus power

Point to Remember!




Minus Lens Optical Center Wide
Base In
Minus Lens Optical Center Narrow
Base Out


Plus Lens Optical Center Low
Base Down
Plus Lens Optical Center High
Base Up


Minus Lens Optical Center Low
Base Up
Minus Lens Optical Center High
Base Down

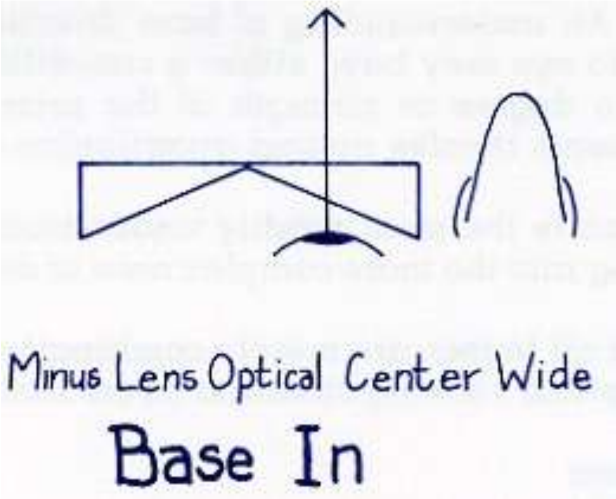
Example #1

- What is the prismatic effect 2 mm nasal from the optical center of a – 5.00 D lens? (The lens is being moved out)

$$\Delta = \frac{D \times \text{Decentration (in mm)}}{10}$$

$$\Delta = \frac{5 \times 2}{10} = \frac{10}{10} = 1\Delta$$

<u>1Δ BI</u>



Example #2

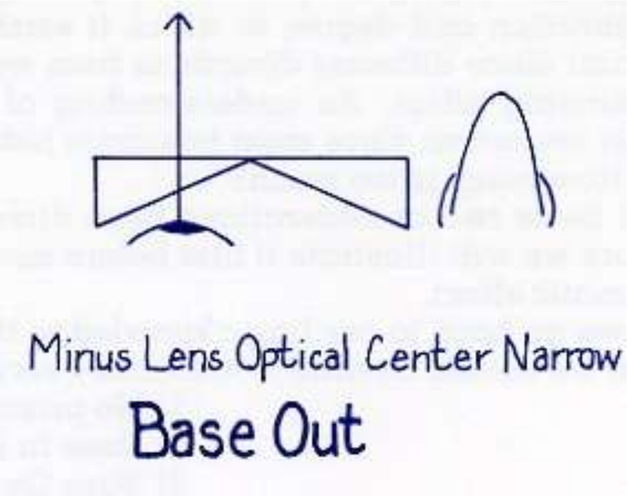
- What is the prismatic effect 2 mm temporal from the optical center of a – 5.00 D lens?

  (The lens is being moved in)

  $$\Delta = \frac{D \times \text{Decentration (in mm)}}{10}$$

  $$\Delta = \frac{5 \times 2}{10} = \frac{10}{10} = 1\Delta$$

  <u>1Δ BO</u>



Example #3

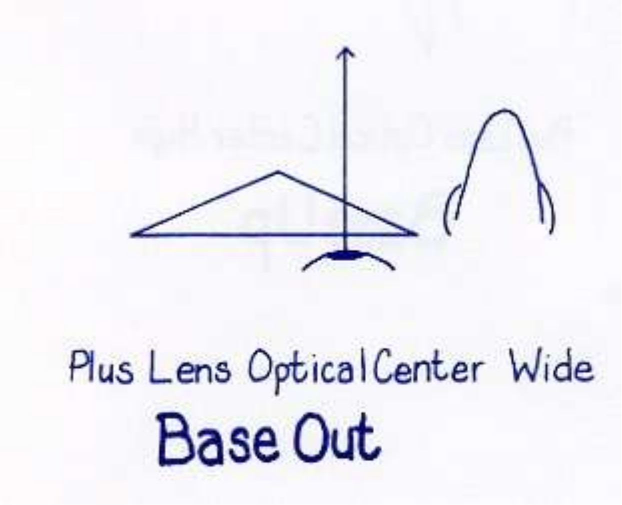
- What is the prismatic effect 2 mm nasal from the optical center of a +3.00 D lens?

(The lens is being moved out)

$$\Delta = \frac{D \times \text{Decentration (in mm)}}{10}$$

$$\Delta = \frac{3 \times 2}{10} = \frac{6}{10} = .6\Delta$$

<u>.6Δ BO</u>



Example #4

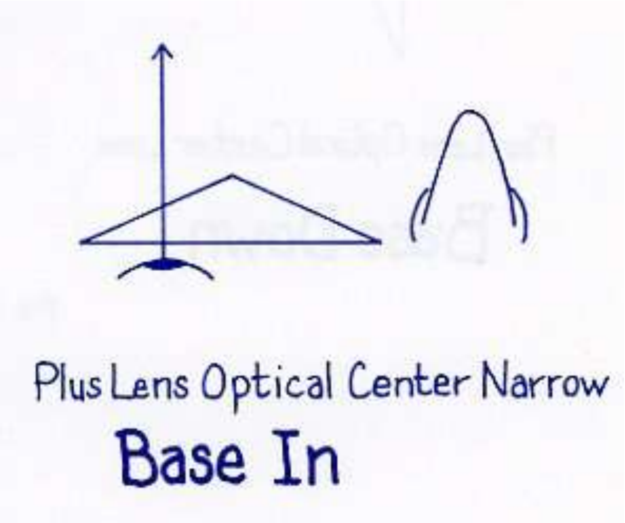
- What is the prismatic effect 2 mm temporal from the optical center of a +3.00 D lens?

(The lens is being moved in)

$$\Delta = \frac{D \times \text{Decentration (in mm)}}{10}$$

$$\Delta = \frac{3 \times 2}{10} = \frac{6}{10} = .6\Delta$$

<u>.6Δ BI</u>



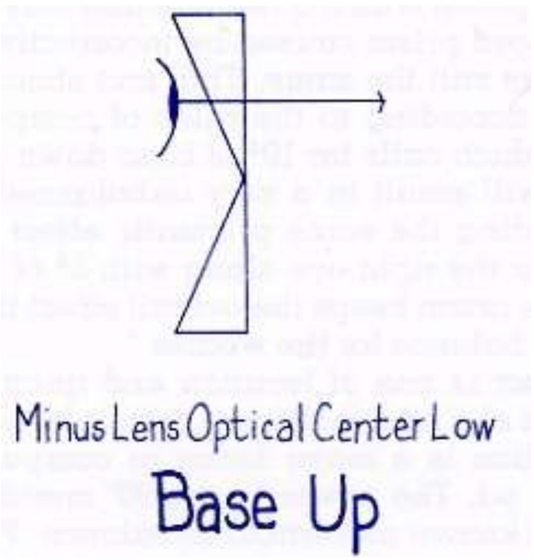
Example #5

- What is the prismatic effect 2 mm above the optical center of a -5.00 D lens?

$$\Delta = \frac{D \times \text{Decentration (in mm)}}{10}$$

$$\Delta = \frac{5 \times 2}{10} = \frac{10}{10} = 1\Delta$$

<u>1Δ BU</u>



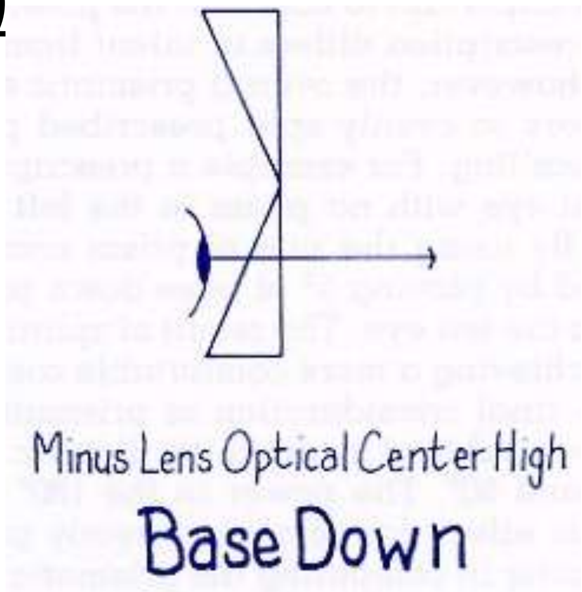
Example #6

- What is the prismatic effect 2 mm below the optical center of a -5.00 D lens?

$$\Delta = \frac{D \times \text{Decentration (in mm)}}{10}$$

$$\Delta = \frac{5 \times 2}{10} = \frac{10}{10} = 1\Delta$$

<u>1Δ BD</u>



Example #7

- What is the prismatic effect 2 mm above the optical center of a +3.00 D lens?

$$\Delta = \frac{D \times \text{Decentration (in mm)}}{10}$$

$$\Delta = \frac{3 \times 2}{10} = \frac{6}{10} = .6\Delta$$

.6Δ BD

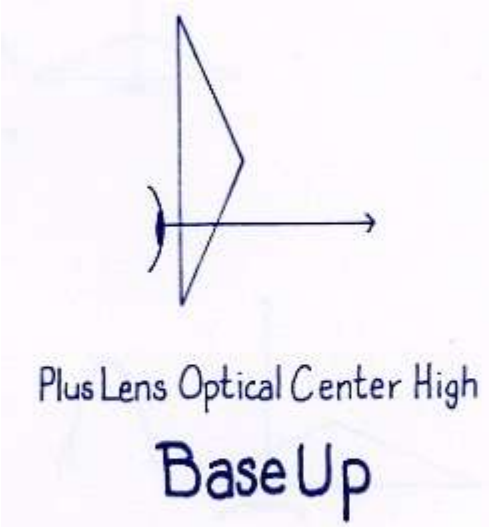
Example #8

- What is the prismatic effect 2 mm below the optical center of a +3.00 D lens?

  $\Delta = \frac{D \times \text{Decentration (in mm)}}{10}$

  $\Delta = \frac{3 \times 2}{10} = \frac{6}{10} = .6\Delta$

  <u>.6Δ BU</u>



Example # 9

- With a prescription of +3.00 -1.50 x 90 what amount of decentration will provide 1 prism diopter, BI?

Answer

$$\text{Dec} = \frac{10 \times 1\,\Delta}{1.50}$$

$$\text{Dec} = \frac{10 \times 1\Delta}{1.50} = \frac{10}{1.50} = 6.67\text{mm}$$

Why the 1.50 Power?

Example #10

- With a prescription of-2.75 + 1.00 x 180 what decentration will produce 4 prism diopters base up?

Answer

$$\text{Dec} = \frac{10 \times 4\,\Delta}{1.75}$$

$$\text{Dec} = \frac{10 \times 4\Delta}{1.75} = \frac{40}{1.75} = 22.8\text{mm dec DN}$$

Why the 1.75 Power?

Approximate Power of Cylinder Power

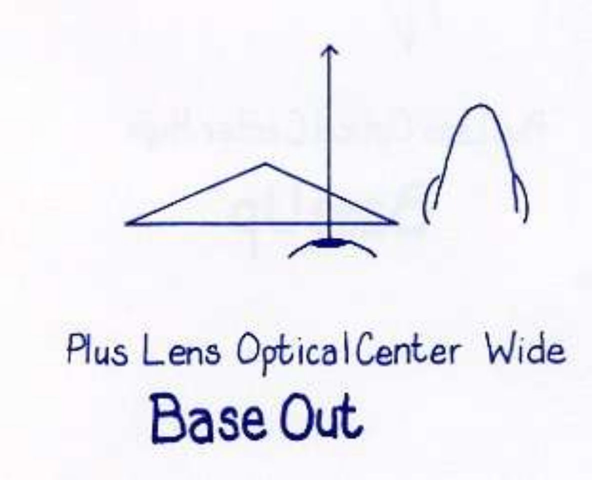
- When cylinder power is incorporated in a prescription, approximate power at 180 or 90 degree is your point a reference.
- This will depend on whether the prismatic effect is Horizontal or Vertical
- We will need to use the Oblique Meridian formula in these cases

Example # 1

- How much prism is present 4 mm on the nasal side of the optical center for the Rx of +2.50 – 100 x 10

  (Optical Center is being moved out)
- Remember Rule of Thumb?
- 180° (0 °) – 10° = 10° = .01 + .02 = .03
- Power of the cylinder = - 1.00 (.

  = -



-.03 + +2.50 = +2.47

$\Delta = \frac{4 \times 2.47}{10} = \frac{9.88}{10} = 1\Delta$

<u>1Δ BO</u>

Rule of Thumb

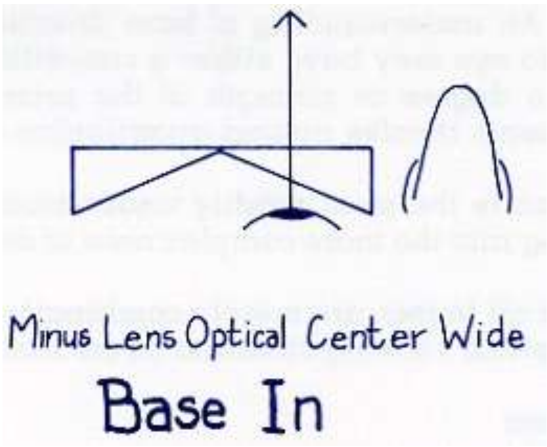
5°	.01	50°	.09
↓	.02	↓	.08
	.04		.08
	.05		.07
	.06		.06
	.07		.05
	.08		.04
	.08		.02
45°	.09	90°	.01

Example # 2

- The Rx is -5.50 -2.25 x 130. If the optical center is moved out 6 mm, what is the prismatic effect?

  (Optical Center is being moved out)
- Remember Rule of Thumb?
- 180° – 130° = 50° = .59
- Power of the cylinder = - 2.25 (.59)

  = -1.32



-1.32 + -5.50 = -6.82

$\Delta = \frac{6 \times 6.82}{10} = \frac{40.92}{10} = 4.1\Delta$

<u>4.1Δ BI</u>

Example # 3

- The Rx is -3.00 -2.00 x 30. What is the prismatic effect looking 3 mm above the optical center of the lens?

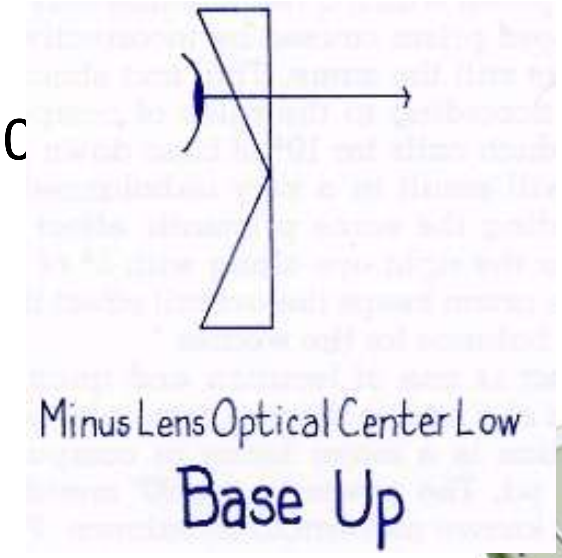
  (Optical Center is being moved down)
- Remember Rule of Thumb?
- 90° – 30° = 60° = 75% of the cylinder power
- Power of the cylinder = - 2.00 (75%)

  = - 1.50

-1.50 + -3.00 = -4.50

$$\Delta = \frac{3 \times 4.50}{10} = \frac{13.50}{10} = 1.4\Delta$$

<u>1.4Δ BU</u>



Determining Overall Prismatic Effect

- When the eyeglass wearer is looking through any point other than the optical centers of the lenses, visual discomfort may occur as well as eye fatigue (Asthenopia)
- When prism is induced in each lens in a pair of glasses, we need to determine whether the prism will cancel each other or compound each other
- Regardless of the amount of prism in any one eye, the wearer only experiences the residual or combined effect of lenses in tandem

Canceling and Compounding Situations

- Base directions are either cancelled or compounded from eye to eye
- In canceling situations, subtract the smaller prism amount from the larger amount. Then assign the prism direction to the lens originally having the large prism amount
- In compounding situations, add the two prism amounts together to give the total effect

Prism Situations

Canceling Situations

- Base Up and Base Up
- Base Down and Base Down
- Base In and Base Out

Compounding Situations

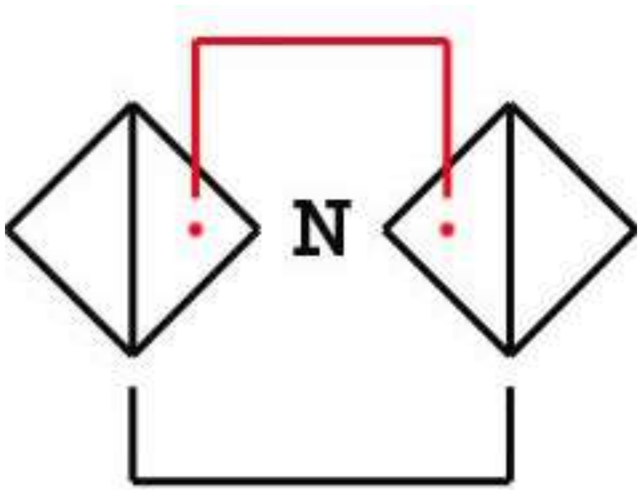
- Base Up and Base Down
- Base In and Base In
- Base Out and Base Out

Sample Chart of Prismatic Effect

- Right Eye Left Eye Situation Resulting Effect
  - 2Δ up 4 Δ up canceling 2 Δ up Left Eye
  - 2 Δ dn 4 Δ dn canceling 2 Δ dn Left Eye
  - 2 Δ up 2 Δ up canceling No effect
  - 2 Δ in 4 Δ out canceling 2 Δ out left eye
  - 2 Δ up 4 Δ down compounding 6 Δ total
  - 2 Δ in 4 Δ in compounding 6 Δ total
  - 2 Δ out 4 Δ out compounding 6 Δ total
  - Point to Remember! Compounding Situations
  - **UP DOWN IN IN OUT OUT – ADD/ Everything else subtract**

Example #1

- Given Rx OD +4.00 OS + 4.00
  - Frame PD = 68, Patient PD = 64
  - What is the amount and direction of prism if the above lenses are not decentered in each eye and what is the total prismatic effect?
  - 68 – 64 = 4 mm ÷ 2 = 2 mm each eye



Answer

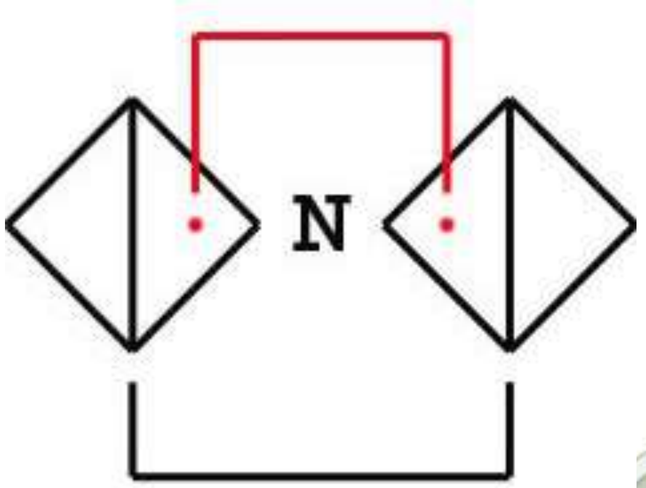
$$\Delta = \frac{d \times D}{10} = \frac{2mm \times 4.00}{10} = 0.8\ \Delta \text{ BO each eye}$$

Visual lines are passing through the inside portion of lenses which is, in effect, base out prism

0.8 Δ BO OD

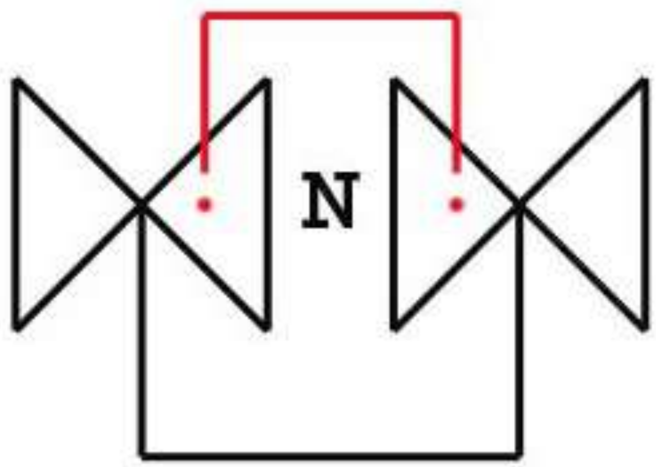
0.8 Δ BO OS

Total = 1.6 Δ BO



Example #3

- Given Rx OD - 4.00 OS - 4.00
  - Frame PD = 68, Patient PD = 64
  - What is the amount and direction of prism if the above lenses are not decentered what is the prismatic effect for each eye and what is the total prismatic effect?
  - 68 – 64 = 4 mm ÷ 2 = 2 mm each eye



Answer

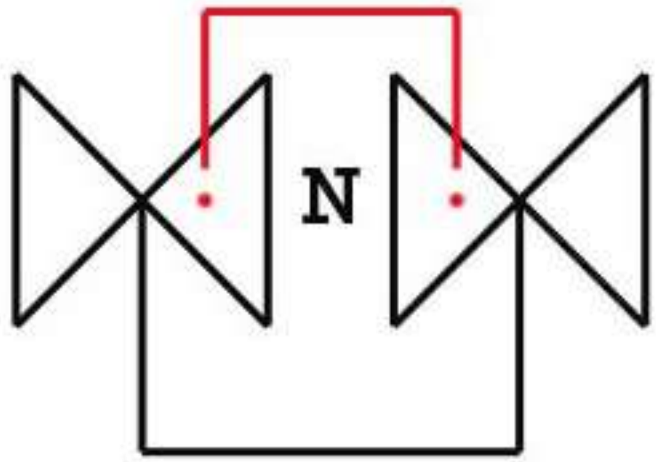
$$\Delta = \frac{d \times D}{10} = \frac{2mm \times 4.00}{10} = 0.8\ \Delta \text{ BI each eye}$$

Visual lines are passing through the inside portion of lenses which is, in effect, base out prism

0.8 Δ BI OD

0.8 Δ BI OS

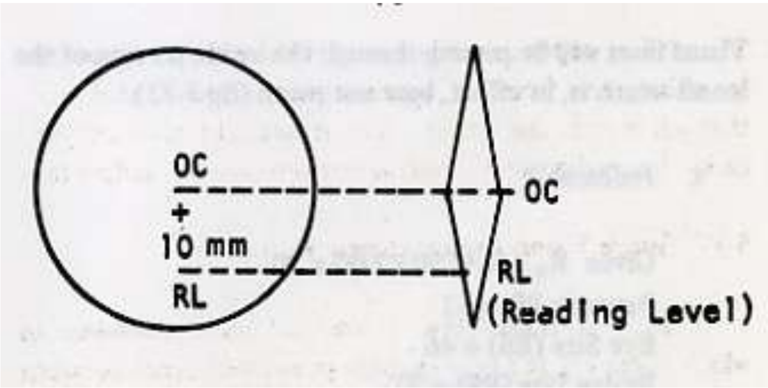
Total = 1.6 Δ BI

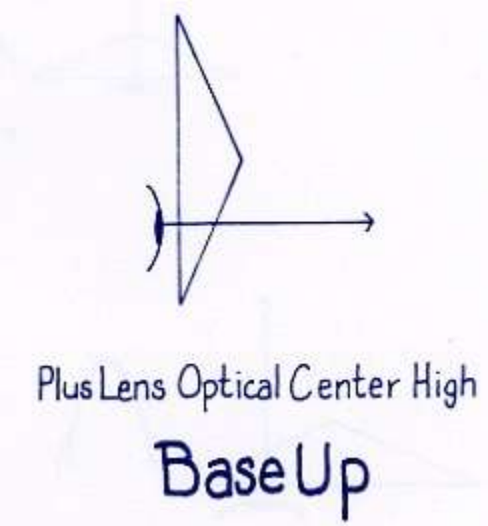


Example #1

- A patient is wearing +4.00 OU. What is the prismatic effect in the vertical meridian 10 mm below the optical center of the lens?

$$\Delta = \frac{10 \times 4.00}{10} = \frac{40}{10} = 4\Delta \text{ BU}$$

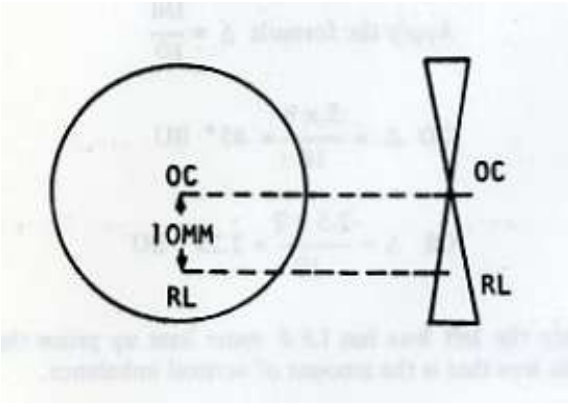


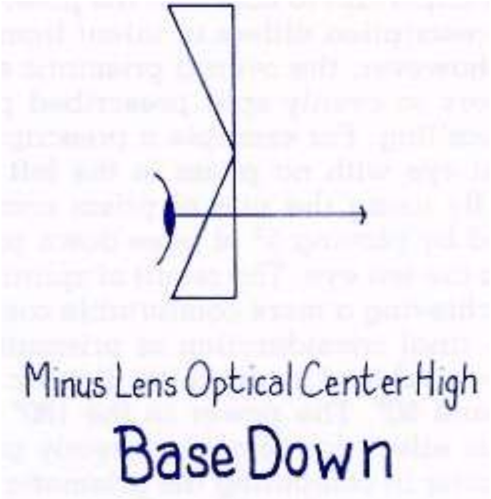


Example #2

- A patient is wearing -5.00 OU. What is the prismatic effect in the vertical meridian 10 mm below the optical center of the lens?

$$\Delta = \frac{10 \times 5.00}{10} = \frac{50}{10} = 5\Delta \text{ BD}$$



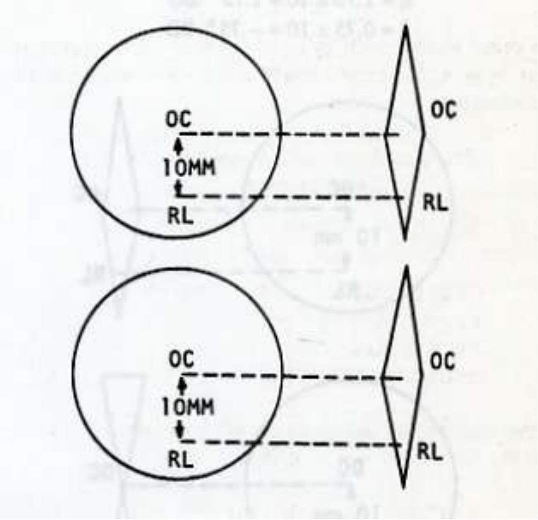


Example #3

- A patient is wearing +1.00 OD and +3.75 OS. What is the prismatic effect in the meridian 10 mm below the optica lens?

$\Delta = \frac{10 \times 1.00}{10} = \frac{10}{10} = 1\Delta$ BU

$\Delta = \frac{10 \times 3.75}{10} = \frac{30.75}{10} = 3.75\Delta$ B



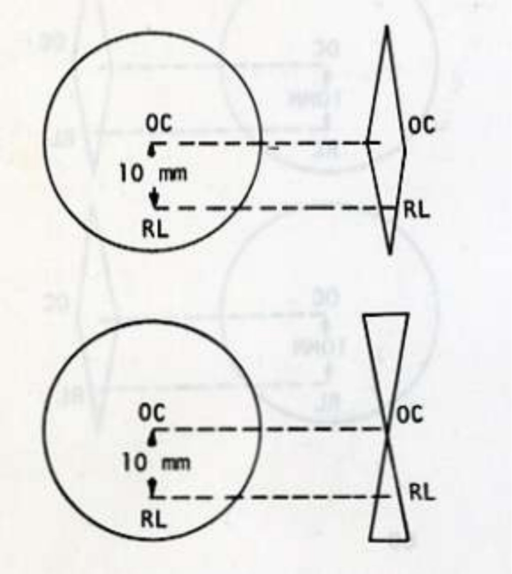
Canceling Situation - The net difference is 2.75 Δ BU

Example #4

- A patient is wearing +1.75 OD and -.75
the prismatic effect in the vertical meri
below the optical center of the lens?

$$\Delta = \frac{10 \times 1.75}{10} = \frac{17.50}{10} = 1.75\Delta \text{ BU}$$

$$\Delta = \frac{10 \times .75}{10} = \frac{7.5}{10} = .75\Delta \text{ BD}$$



Compounding Situation - The net difference is

2.50 Δ BU

VERTICAL IMBALANCE

PRISMATIC TOLERENCE:

- Vertical prism is ***NOT*** tolerated well
- Horizontal will vary with pt.

When to Calculate VI:

- **1.50D of Anisometropia or if symptoms**

- Formula: (Prentice Formula)

VI = (Differ Pwr @ 090° x Reading Level) / 10

WAYS to CORRECT VI

- **Two Pair of Glasses**
- **Prism in Segments Only**
- **Fresnel press-on prisms**
- **Dissimilar Segments**
- **R-Compensated Segments**
- **Slab - Of f Prism**

How to Calculate Slab Off (Bicentric Grinding)

- Determine power of each lens in 90 ° meridian
- Determine distance from optical center of carrier lens to reading level
- Apply Prentice Formula to calculate amount of vertical prism induced in each eye at the reading level
- The difference in amount of vertical prism in each eye is approximately equivalent to amount of prism to be "slabbed off"
- Conventional Slab Off is always ground base up on the lens with the most minus or least plus in the 90^{th} meridian

Reverse Slab Off

- A lens design that is available to the laboratory from the lens manufacturer in which the prism has already been molded into the semi-finished lens. As the name suggests, the prism base is oriented base down or in the reverse direction of the conventional base up orientation. In this case the slab off is placed in the lens **with the least minus or most plus.**

Sample Chart of Prismatic Effect

Right Eye	Left Eye	Situation	Resulting Effect
2Δ up	4 Δ up	canceling	2 Δ up Left Eye
2 Δ dn	4 Δ dn	canceling	2 Δ dn Left Eye
2 Δ up	2 Δ up	canceling	No effect
2 Δ in	4 Δ out	canceling	2 Δ out left eye
2 Δ up	4 Δ down	compounding	6 Δ total
2 Δ in	4 Δ in	compounding	6 Δ total
2 Δ out	4 Δ out	compounding	6 Δ total

- Point to Remember! Compounding Situations
- **UP DOWN IN IN OUT OUT – ADD/ Everything else subtract**

Example # 1

Rx O.D. -1.75 -.50 x 180

O.S. -4.75 -.25 x 180 +2.00 Add OU

Reading Level is 10 mm from distance optical center

1. Determine power in the 90th meridian for each lens
2. R -2.25 L -5.00
3. Distance optical center = 10 mm from reading level

$$\Delta = \frac{D \times \text{Decentration (in mm)}}{10}$$

D = Power in the specific meridian

Δ = Prism Diopters

O.D. $\frac{-2.25 \times 10}{10}$ = 2.25 Δ BD

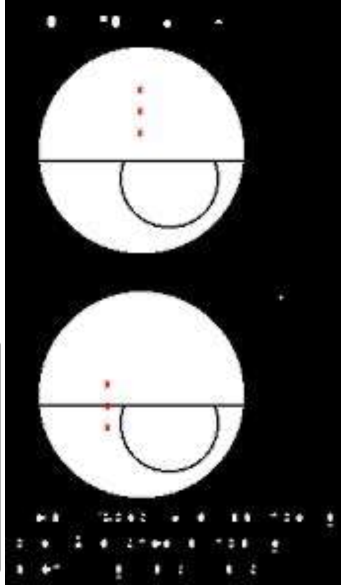
O.S. . $\frac{-5.00 \times 10}{10}$ = 5.00 Δ BD

UP DOWN IN IN OUT OUT – ADD/ Everything else subtract

5.00 – 2.25 = 2.75 Δ

Rule: Slab off the left eye **2.75** Δ base up for conventional lens (Least Plus/Greatest Minus) or **2.75 Δ** BD in Right Eye for reverse slab off.(Greatest Plus/Least Minus)

SLAB-OFF PRISM



Lens Combination	When Using Slab-off	When Using Reverse Slab
Two Minus Lenses	Highest Minus	Lowest Minus
Two Plus Lenses	Lowest Plus	Highest Plus
One Plus, One Minus	The Minus Lens	The Plus Lens

Multi-Focal Style	Slab Placement
Flat Top Bifocal	Slab line should be in line with the top of the bifocal
Trifocals	Slab line should be in line with the bottom of the intermediate portion
Progressives	Slab line should be positioned slightly above the near verification circle

Example # 2

Rx O.D. +1.00 -.25 x 90

O.S. +5.50 -.50 x 90 +3.00 Add OU

Reading Level is 10 mm from distance optical center

1. Determine power in the 90th meridian for each lens
2. R +1.00 +5.50
3. Distance optical center = 10 mm from reading level

$$\Delta = \frac{D \times \text{Decentration (in mm)}}{10}$$

D = Power in the specific meridian

Δ = Prism Diopters

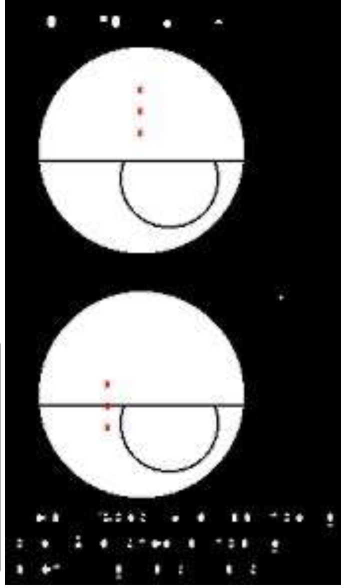
O.D. $\frac{+1.00 \times 10}{10}$ = 1.00 Δ BU

O.S. . $\frac{+5.50 \times 10}{10}$ = 5.50 Δ BU

UP DOWN IN IN OUT OUT – ADD/ Everything else subtract

5.50 – 1.00 = 4.5 Δ

SLAB-OFF PRISM

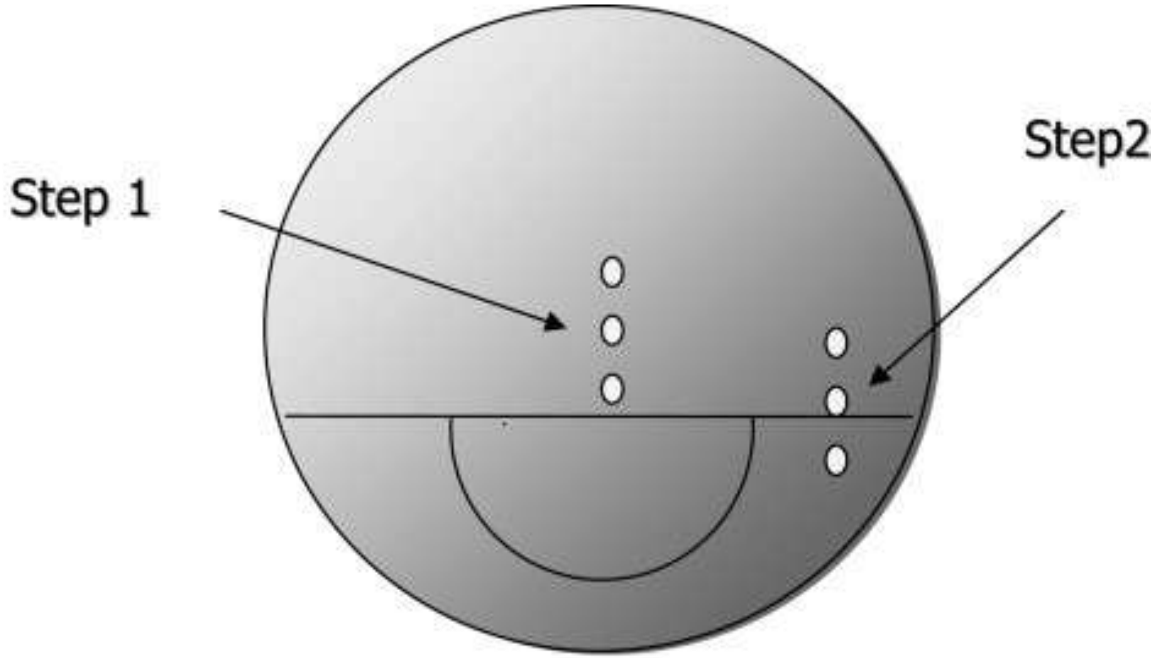


Lens Combination	When Using Slab-off	When Using Reverse Slab
Two Minus Lenses	Highest Minus	Lowest Minus
Two Plus Lenses	Lowest Plus	Highest Plus
One Plus, One Minus	The Minus Lens	The Plus Lens

Multi-Focal Style	Slab Placement
Flat Top Bifocal	Slab line should be in line with the top of the bifocal
Trifocals	Slab line should be in line with the bottom of the intermediate portion
Progressives	Slab line should be positioned slightly above the near verification circle

Checking Slab Off with Lens Clock

Lens Clock



Splitting Prism

- Occasionally, an Rx shows prism in just one lens
- To balance the weight of the lenses and improve cosmetic effect of the prism, opticians may want to ***Split the Prism*** between the two lenses

Rules for Splitting Prism

- Divide the amount of the prism in half
- Assign one half with the base direction requested in the lens where it was prescribed
- Assign the other half of the prism amount to the other lens with the base in the compounding direction
- Before ordering, always request permission from the refractionist

Example # 1

OD Plano 5 Δ BU

OS Plano

Answer: OD 2.5 Δ BU

OS 2.5 Δ BD

Example # 2

OD Plano 5 Δ BU

OS Plano 3 Δ BI

Answer: OD 2.5 Δ BU & 1.5 Δ BI

OS 2.5 Δ BD & 1.5 Δ BI

Example # 3

OD -5.00

OS -5.00 4 Δ BI

Answer: OD -5.00 2 Δ BI

OS -5.00 2 Δ BI

Example # 4

OD -5.00 -1.00 x 180 3 Δ BU

OS -5.00 – 1.00 x 180

Answer: OD -5.00 – 1.00 x 180 1.5 Δ BU

OS -5.00 – 1.00 x 180 1.5 Δ BD

Example # 5

OD +5.00 - .50 x 90

OS +5.00 5 Δ BD

Answer: OD +5.00 – .50 x 90 2.5 Δ BU

OS +5.00 2.5 Δ BD

Thank You

Good Luck on the ABO

- For more information, contact the NFOS or visit our website at www.nfos.org

- Power-point by Professor Robert J. Russo – Email: information@nfos.org