Handling Prescriptions That Contain Prism

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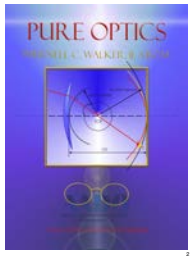
International Speaker & Author
Pure Optics, LLC

Reference:

Pure Optics

by

Phernell Walker, II, MBA, ABOM



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About the Speaker

Phernell Walker, II, MBA, NCLC, ABOM

- Master in Ophthalmic Optics
- Master in Business Administration
- Bachelor of Science in Business
- Associate of Science in Opticianry
- ABO Certified
- NCLE Certified
- Author of text-book, *Pure Optics*
- Joe Bruneni Award in Optics, Association of Schools Colleges of Optometry
- Beverly Meyers Achievement Award in Ophthalmic Optics

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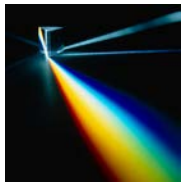
Why is Prism so Important?

Prism is the DNA of every ophthalmic lens design. All lenses are composed of a series of interconnecting prisms.
This Lens Geometry allows us to "MASTER LIGHT".



"These Lens Arrays can focus light, magnify images, demagnify images and even capture light and suspend it within a given material provided that the laws of internal reflection are met.

Phernell Walker, II, ABOM
Master Optician

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Ophthalmic Prism

Prism is defined as a transparent, wedge shaped material with two flat surfaces inclined at a given angle that connect at a point called the *apex*.

The two connected surfaces are resting on the *base* of the prism.

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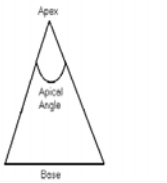
Prism Angles

The angle created between the two surfaces are called the *apical angle* or *refractive angle.*



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Prism & Light

When light travels through a prism three phenomena's occur.

Light is:

- Refracted
- Dispersed
- Displaced

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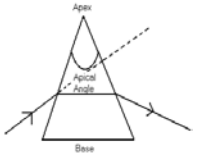
Refraction

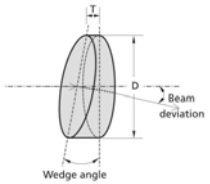
When light travels through a prism it is *refracted* or bent (directional change) toward the prism's base, but the image is displaced toward the apex.



Afocal Magic

A single prim is "afocal". A prism can only refract light, it cannot focus light.

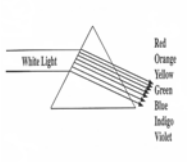
A series of prisms can focus light. This prism array creates an ophthalmic lens.



Dispersion

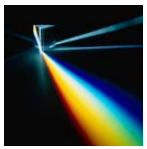
Dispersion is the process of white light separating into it's natural component colors.

Each color has a different velocity through materials, but the same velocity in air.



Dispersion

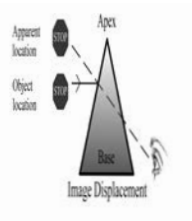
- Red = 656n
- Orange = 610n
- Yellow = 588n
- Green = 510n
- Blue = 486n
- Indigo = 410n
- Violet = 380n



Displacement

Prisms *displace* (change) the apparent location of an object.

When light travels through a prism, light is refracted in the direction of the base. Images are displaced (appear) toward the prism's apex.



Prism Occur's

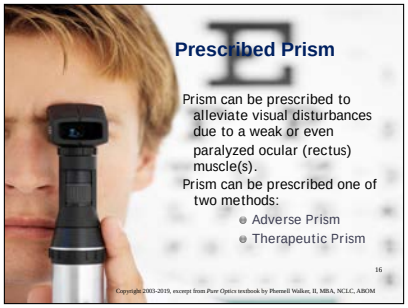
Prism occurs under two conditions:

- Accidental Prism
- Prescribed Prism

Accidental Prism

Accidental Prism occurs when:

- Eyewear P.D. does not match patient's P.D.
- Optical Center does not match O.C. ordered
- Difference between the OD & OS Optical center



Prescribed Prism

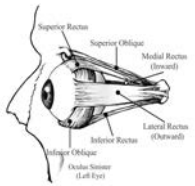
Prism can be prescribed to alleviate visual disturbances due to a weak or even paralyzed ocular (rectus) muscle(s).

Prism can be prescribed one of two methods:

- Adverse Prism
- Therapeutic Prism

Anatomy - Extrinsic Muscles

- Horizontal Rectus
  Medial, Lateral
- Vertical Rectus
  Superior, Inferior
- Oblique
  Superior, Inferior



Prescribed Prism

Prism is prescribed using the prism's dioptric power and the orientation of the base, which can be denoted by four basic or combination(s) of directions:

- Base In (B.I.)
- Base Out (B.O.)
- Base Up (B.U.)
- Base Down (B.D.)
- B.I. & Up, B.I. & DN, B.O. & Up, B.O. & DN

Amblyopia

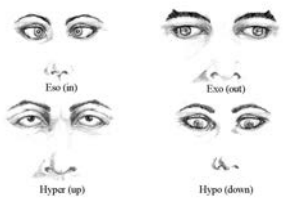
Decreased visual acuity of one eye (uncorrectable with glasses), in the absence of organic eye disease. It is reversible only with a limited time period (children).

Strabismus

Amblyopia is most commonly caused by strabismus.

- Strabismus is a muscle imbalance in which the deviated eye is suppressed to prevent diplopia.
- Clinically, amblyopia exists if vision is 20/30 or worse, or if vision of one eye is significantly less than the other, not correctable to 20/20 with spectacles or contact lenses.

Phoria vs. Tropia



Adverse Prism

Adverse prism is prescribed to strengthen a weak rectus muscle.

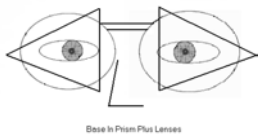
The *apex* is placed over the weak rectus muscle, causing the eye to turn toward the image.

Therapeutic Prism

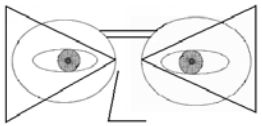
Therapeutic prism is prescribed to relieve the visual disturbance.

The ***base*** of the prism is prescribed over the weak rectus muscle, which displaces the image in the same direction of the eye.

Plus Lens Base In Prism

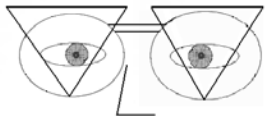


Plus Lens Base Out Prism



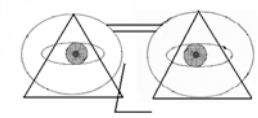
Base Out Prism Plus Lenses

Plus Lens Base Up Prism



Base Up Prism Plus Lenses

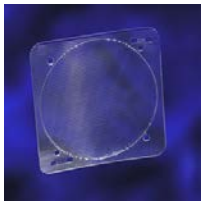
Plus Lens Base Down Prism



Base Down Prism Plus Lenses

Fresnel Press-On Prism

- Temporary Prism
- Used to Determine if Prism will be effective
- Thin Flexible Membrane



Calculate, Quantify and Redistribute Prism

There are several methods to used to calculate and quantify prism:

- **Prism Diopter**
- **Apical Angle**
- **Angle of Deviation**
- **Centrad**

Charles F. Prentice

- Charles F. Prentice, M. E., New York City, N. Y.
- In 1910, Mr. Prentice persuaded Columbia University to establish an optometry program. He devised the curriculum, chose instructors, and lectured frequently
- President, New York State Board of Examiners in Optometry; Special Lecturer
- on Theoretic Optometry, Columbia
- on Ophthalmic Lenses (1886); Dioptric Formulas for Combined Cylindrical
- Lenses (1888); A Metric System of Numbering and Measuring Prisms (the Prism-dioptry) (1890) ; The Iris as Diaphragm and Photostat (1895)

Prism Diopter

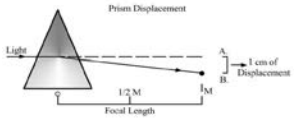
Prism diopter is calculated by the amount of displacement in centimeters divided by the distance in meters.

P = Displacement (cm) / Distance (m)

Prism Dioptric Power

A 1.00 diopter displaces an light 1 centimeter at distance of one meter.

1 Prism Diopter = 1 (cm) / 1 (m)



Prism Occurs

Patients will experience prism if:

- the Major Reference Point (MRP) in the 180th meridian does not coincide with the interpupillary distance (PD)
- a differential in the MRP in the 090th meridian
- their eye rotates excessively behind the lens

Avoiding Prism

- Decentration (move from geometric center) is used by every optical lab to avoid prism.
- Decentration is calculated just before ophthalmic lenses are edged (cut to the desired frames shape).

Decentration to Avoid Prism

The following formula is used to calculate the amount of horizontal decentration required for glazing:

Total Decentration = A + DBL - PD

where:

A = frame's eye size
DBL = distance between lenses
PD = patient's pupillary distance

Direction of Decentration (In or Out)

- If the patient's PD is less than the sum of the "A" and the "DBL" box measurements, the lenses will be decentrated in (nasally).
- If the patient's PD is greater than the sum of the "A" and the "DBL" box measurements, the lenses will be decentrated out (temporally).

Example 1:

A patient has a PD = 60mm and selects a frame with the following measurements:

A = 49mm
B = 40mm
DBL = 17mm
ED = 51mm

How much decentration is required to avoid prism?

Solution:

Total Decentration = A + DBL – PD

? = 49mm + 17mm – 60mm

? = 66mm – 60mm

Total Decentration = 6mm

Since the Total Decentration is 6mm, each lens would need to be decentered 3mm in.

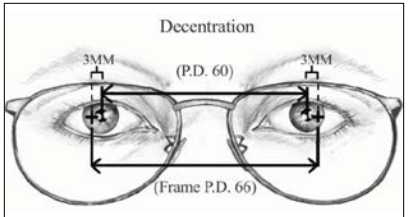


Figure 9-4

Decentration to Create Prism

Achieving Prism by Decentration

Prescribed prism can also be achieved by decentration during the layout process. Prentice Rule can also be used to determine the correct amount of decentration to achieve prescribed prism.

$$(b_{mm}) = (10)\ \frac{P}{D_1}$$

where:

b_{mm} = decentration in millimeters
P = prism
D_1 = dioptric power in the 180° or 090° meridian

Decentration to Create Prism

Example:

How much decentration is needed to create 2 diopters of base out prism with the following prescription?

O.D. –4.00 –1.00 x 045

$$(b_{mm}) = (10)\ \frac{2}{-4.50}$$

$$(b_{mm}) = (10)\ (.44)$$

b_{mm} = 4.40 (about 4.5mm)

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Prentice Rule

The amount of prism experienced by the patient can be calculated using Prentice's Rule:

$$P = (h_{cm})\ (D_e)$$

- P = prism
- h_{cm} = distance expressed in centimeters
- D_e = dioptric power in the specific meridian

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Meridian of Dioptric Power

Calculate the exact amount of prism in a given meridian (i.e. axis 180 and axis 090) requires us to calculate the amount of total power in a given meridian.

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Meridian of Dioptric Power

- Spherocylindrical lenses have only a percentage of the total dioptric power present in each meridian.
- Consequently, each meridian has a different focal length.
- Either a meridian of dioptric power (MDP) chart can be used or it can be calculated using a formula.

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Meridian of Dioptric Power Chart

The MDP chart can be used to determine the total dioptric power of a lens in a specific 5 degree meridian.

Step 1:

Determine the difference from the prescriptions axis and a given meridian.

Step 2:

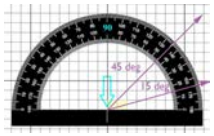
Locate the difference on the MDP chart and multiply the prescriptions cylinder power by the percentage

Step 3:

Algebraically add the amount in Step 2 to the prescriptions sphere power.

Meridian of Dioptric Power Chart

Degrees from Axis	Percent of CYL.
0	0%
5	1%
10	3%
15	7%
20	12%
25	18%
30	25%
35	33%
40	41%
45	50%
50	59%
55	67%
60	75%
65	82%
70	88%
75	93%
80	97%
85	99%
90	100%



Example I:

Determine the dioptric power in the 180th meridian using the following:

Rx: +3.00 – 1.00 X 060

Step 1: *Compute difference in axis*
180 – 060 = 060 (hint: 180 and 0 are on the same plane/meridian)

Step 2: *Multiply cylinder power by percentage on the MDP chart*
-1.00 x 75% = -0.75 D

Step 3: *Add result to sphere power*
+3.00 + -0.75 = +2.25 D

Power Shift Formula

The dioptric power in a specific meridian can also be calculated without the MDP chart with the following formula:

$$D_e = S + [C (\text{sine } a)^2]$$

D_e = dioptric power in the specific meridian
S = sphere power
C = cylinder power
$(\text{sine } a)^2$ = the sine of the angle between the axis and a given meridian

Prentice's Rule: Example #1

The patient's PD is 66mm, but for some unfortunate reason the lab cut the lenses 60mm apart using the following prescription:

OD -2.00 DS
OS -1.50 -0.50 x 060

Calculate Prism Power

P = (hcm) (D_s)
P = ?
(hcm) = (6mm) = (.6cm)

D_s = OD: - 2.00 @ 180
OS: - 1.87 @ 180

OD: P = (.3cm)(-2.00) = .60
OS: P = (.3cm)(-1.87) = .56

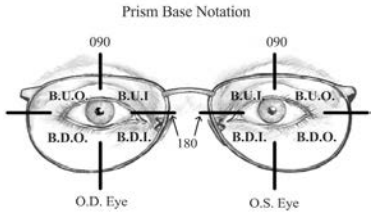
P(OD) + P(OS) = .60 + .56

Total P = 1.16 D

Determine Prism Orientation

The orientation of the prism is easily determined by locating the major reference point in relationship to the patient's pupil and the type of lens (plus or minus) prescribed

- The base of the prism for a plus lens is located at the MRP
- The base of a minus lens is located in the opposite direction of the MRP



Determine Prism Orientation

- **The base of the prism for a plus lens is located at the MRP.**
- **The base of a minus lens is located in the opposite direction of the MRP.**

Example:

The optical center of a pair of plus lenses are edged too narrow. Result is Base In Prism.

The optical center of a pair of minus lenses are edged too narrow. Result is Base Out Prism.

Prism Orientation

Vertical Prism (090th meridian)

- Base Up (B.U.)
- Base Down (B.D.)

Horizontal Prism (180th meridian)

- Base In (B.I.)
- Base Out (B.O.)

Combination Prism (Oblique)

- Base Up & In (B.U. & I.)
- Base Up & Out (B.U. & O.)
- Base Down & In (B.D. & I.)
- Base Down & Out (B.D. & O.)

Compounding vs. Neutralizing Prism

When two prisms are combined, they will have either an increase or decrease in the overall net combined prism.

The "Net Prism" is a result of compounding or neutralizing prism.

Compounding Prism

Amounting Prism
(O.D. & O.S. Lens)

- Base In & Base In
- Base Out & Base Out
- Base Up & Down

Neutralizing

When two prisms cancel each other, we call this net effect "Neutralizing or Canceling Prism".

Neutralizing Prism

Neutralizing Prism
(O.D. & O.S. Lens)

- Base Down & Down
- Base Out & Base In
- Base Up & Base Up

Compounding Vs. Neutralizing Prism

Example I:

Combine the following Prism:

OD: -1.00 -0.50 x 175, 3 Prism D. Base In

OS: -1.50 -0.25 x 005, 3 Prism D. Base In

Answer: Compounding Prism

Example I:

Combine the following Prism:

OD: -1.00 -0.50 x 175, 3 D. Prism Base In

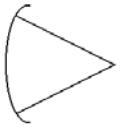
OS: -1.50 -0.25 x 005, 3 D. Prism Base In

Solution I:

3 D Prism B.I. + 3 D. Prism B.I. = 6 D. Prism B.I.

Excessive Base In and Out Prism

Excessive Base In or Out prism will result in the patient seeing objects at a 180 degree slant.



Example:

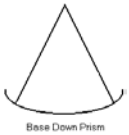
A patient observes your dispensing table at a slant, the side that is too high is the prism's base location.

Excessive Base Up Prism

Excessive Base Up prism will result in the patient noticing that vertical objects appear shorter, the floor slants downward and that horizontal objects appear convex.

Excessive Base Down Prism

Excessive Base Down Prism will result in the patient noticing that vertical objects appear taller, the floor slants upward and that horizontal objects appear concave.



Redistribute Prism

Sometimes prism is prescribed for only one eye.

Large amounts of prescribed prism in one lens can cause:

- asthenopia
- diplopia
- nausea
- increased lens thickness
- asymmetrical lens thickness

Prism can be redistributed evenly in both eyes while achieving the same desired effect.

Steps to Redistribute Prism

- Determine the total amount of prism required
- Divide the total prism required by two
- Keep the same base direction in the original lens. If the prism is Base In or Out, maintain the same direction in each eye
- In the case of **vertical prism** with the bases in the same direction, you must calculate the compounding difference in prism amounts

Redistributing Prism

- Determine the total amount of prism required. (Divide by 2)
- Keep the same base direction in the original lens. If the prism is Base In or Out, maintain the same direction in each eye
- In the case of vertical prism with the bases in the same direction, you must calculate the compounding difference in prism amounts

Redistributing Prism

Rx I:
OD: -5.00 DS, 3.50 BI
OS: -5.25 DS
OD: -5.00 DS, 1.75 BI
OS: -5.25 DS, 1.75 BI

Rx II:
OD: +2.50 DS, 4 BU
OS: +2.25 DS
OD: +2.50 DS, 2 BU
OS: +2.25 DS, 2 BD

Redistributing Prism

Practice #1:
OD: -2.00 -0.75 x 085, 3 Prism B.U.
OS: -2.50 -0.50 x 094

Practice #2:
OD: +3.00 -1.25 x 010, 1.50 Prism B.O.
OS: +3.00 -1.00 x 165,

Practice #3:
OD: -5.25 -0.25 x 093, 2.00 Prism B.I., 0.50 Prism B.D
OS: -5.50 -0.50 x 082,

Answers: Redistributing Prism

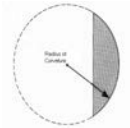
Practice #1:
OD: -2.00 -0.75 x 085, 1.50 Prism B.U.
OS: -2.50 -0.50 x 094, 1.50 Prism B.D.

Practice #2:
OD: +3.00 -1.25 x 010, 0.75 Prism B.O.
OS: +3.00 -1.00 x 165, 0.75 Prism B.O.

Practice #3:
OD: -5.25 -0.25 x 093, 1.00 Prism B.I, 0.25 Prism B.D
OS: -5.50 -0.50 x 082, 1.00 Prism B.I, 0.25 Prism B.U

Prism Thinning

- Process of grinding base down prism in executive bifocals and progressive lenses.
- Manipulates the radius of curvature in the distance portion.



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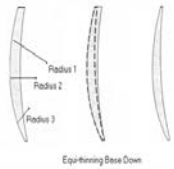
Prism Thinning



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Quantify Prism Thinning

Each manufacturer uses their specific formula to determine the amount of base down prism.

$P = (D_{e\text{-}Add})\ (0.60)$

Example:

OD: +4.50 DS

OS: +4.25 DS

Add +2.50 OU

$P = (D_{e\text{-}Add})\ (0.60)$

P = (2.50) (0.60)

P = 1.50 BD, OU

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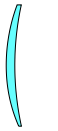
Dynamics of the Add Power

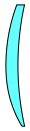
The additional plus power creates

+1.00 DS, +0.75 add



Center Thickness 4.2 mm

+1.00 DS, +3.50 add



Center Thickness 6.2 mm

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Prism Thinning

Prism thinning can be calculated by the surfacing lab using one of the following:

- ~60% of the add power is used
- Computer generated based on lens dimensions
- Lens type used (i.e. dynamic lens designed based on morphing technology)

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Prism Thickness

The reduction in thickness as a result of prism thinning can be calculated using the following formula:

(A) (P) (.02) = Thickness Reduction

Key:
A = Lens Diameter (eyesize)
P = Amount of Prism Used (.60 of add pwr.)
.02 = Constant

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Thickness Threshold

Example:

Rx:

OD: +1.50 -1.00 x 090

OS: +1.75 -1.25 x 090

Add +2.00

Frame = 52 x 17, Temple 140

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Thickness Threshold

Example:
Rx:
OD: +1.50 -1.00 x 090
OS: +1.75 -1.25 x 090
Add +2.00
Frame = 52 x 17
Temple 140

Answer:
(A) (P) (.02) = T
A = 52mm
P = (2.00) (.60)
P = 1.20 prism diopters

(A) (P) (.02) = T
(52) (1.20) (.02) = 1.24mm

80

How Much Prism is Too Much?

The majority of prescription will have an Add Power of +3.00 diopters or less. (Max: 1.80$^{\Delta}$ diopters)

Therefore, prism thinning is typically not an issue for 80% of patients.

Most patients can tolerate up to 3.00$^{\Delta}$ diopters of yoked prism thinning.

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Prism Verification

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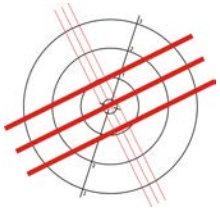
No Prism



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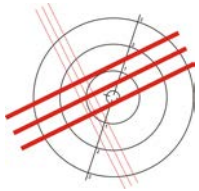
O.S. Lens: Base In Prism



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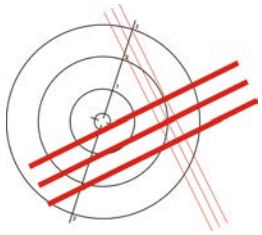
O.S. Lens: Base Out Prism



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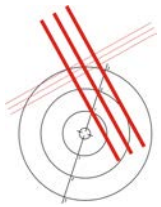
Base Up Prism



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Base Down Prism

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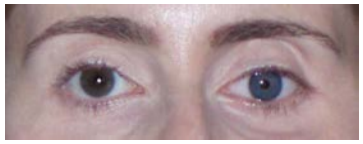
Prosthetic Eye



Ocular Sinister = Prosthetic Eye

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Calculate Amount of Prism Needed for a Prosthetic Eye

Example:

OD: -4.00 DS OC 27
OS: Balance (Prosthetic Eye) OC 21

$P = (hcm) / (1 / D_e)$

? = (.6cm) / (1 / 4.00)
? = (.6cm) / (0.25)

P = 2.40 D Base Down would be ordered in the OS lens
Why would we use BD prism in the OS lens?

Bi-Centric Grinding (Slab-off)

Slab-off is the process of changing the amount of prism in the reading area of a lens without affecting the prism in the distance portion of a lens.

Methods of Slab-off:

- Traditional Slab-off
- Reverse Slab-off

Traditional Slab-off

- Rx Imbalance = > 1.50 Diopters x 090th Meridian
- Lens Selection = Weakest Plus Power
- Lens Selection = Stronger Minus Power
- Ground (Surfaced) = Base Up Prism x 090th Meridian

Reverse Slab-off

- Rx Imbalance = > 1.50 Diopters x 090th Meridian
- Lens Selection = Strongest Plus Power
- Lens Selection = Weaker Minus Power
- Ground (Surfaced) = Base Down Prism x 090th Meridian

Example of Slab-off, FT28

Using the following prescription, how much slab-off should be ordered?

OD -2.25 -1.50 x 135
OS -1.00 - 2.00 x 090
Add +1.75, OU, FT 28

Steps to Calculate Bi-centric Grinding

- Calculate the dioptric power in the 090th meridian of each lens

$$D_e = S + [\ C (\text{sine } a)^2\ ]$$

Calculate the amount of prism 10mm (reading level - FT28) or 8mm (reading level - FT35) below the distance optical center per lens

$$P = (1.0\text{cm})\ (D_e)$$

- The dioptric difference between each lens is the amount of prism required

Calculating Slab-off, FT28

- Calculate the dioptric power in the 090th meridian of each lens
- Calculate the amount of prism use 1 cm (10mm)
- The dioptric difference between each lens is the amount of prism required

Example:
OD: -2.25 -1.50 x 135
OS: -1.00 - 2.00 x 090
Add +1.75, OU

OD: -3.00, OS: -1.00
(3) (1.0) , (1) (1.0)
OD: 3D , OS: 1D
3 - 1 = 2

OD = 2 Diopters, BU

Calculating Slab-off, FT 35

- Calculate the dioptric power in the 090th meridian of each lens
- Calculate the amount of prism use .8 cm (8mm)
- The dioptric difference between each lens is the amount of prism required

Example:
OD: -2.25 -1.50 x 135
OS: -1.00 - 2.00 x 090
Add +1.75, OU

OD: -3.00, OS: -1.00
(3) (0.8) , (1) (0.8)
OD: 2.40 D , OS: 0.80 D
2.40 - 0.80 = 1.60 Diopters

OD = 1.60 Diopters BU

Verify Bi-centric Grinding

Verification of bi-centric grinding requires the use of a lens clock.

- Measure the base curve in the 090th meridian (distance portion only)
- Measure the base curve with the center pin on the slab-off line, one pin on the distance portion and one pin on the near portion
- The difference is equal to the Base Up prism

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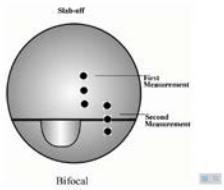
Verification of Bi-Centric Grinding



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Verification of Bi-centric Grinding

- **Measure the base curve in the 090th meridian (distance portion only)**
- **Measure the base curve with the center pin on the slab-off line, one pin on the distance portion and one pin on the near portion**
- **The difference is equal to the Base Up prism**

The distance base curve measures +6.25 diopters

The dual curve measures +8.25

Distance = +6.25D
Dual curve = +8.25D

Base Up Prism = 2.00D

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Conclusion

Prism is the DNA of every ophthalmic lens design. All lenses are composed of a series of interconnecting prisms.

This Lens Geometry allows us to "MASTER LIGHT".

"These Lens Arrays can focus light, magnify images, demagnify images and even capture light and suspend it within a given material provided that the laws of internal reflection are met.

Phernell Walker, II, ABOM
Master Optician

Handling Prescriptions That Contain Prism

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International Speaker & Author
Pure Optics, LLC