Clinical Prism Optics: Moving Images, Measurement, Management, and Motion

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1

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2

Pure Optics

by

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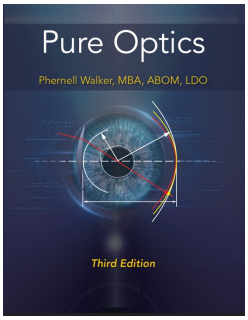
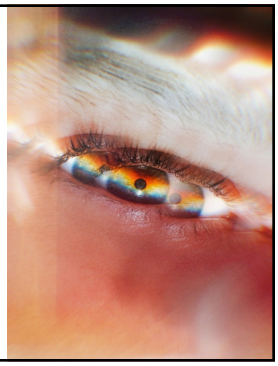


3

Topics

- Theoretical prism
- What are prisms?
- Prism when and why?
- Practical applications of prism
- Q & A



4

Theoretical Prism

5

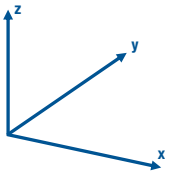
What are Prisms?

- Transparent wedged-shaped materials
- Interconnecting prisms = lenses
- Afocal
- Refract Light
- Move objects in 3D space

6

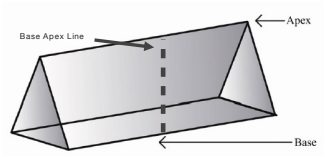
3D Space

- X = Length
- Y = Width
- Z = Height



7

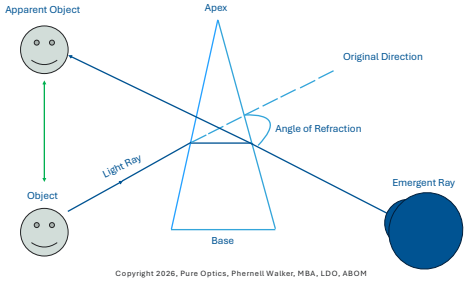
Ophthalmic Prism



- Prism Base - thickest part of the prism
- Prism Apex - thinnest part of the prism

8

Refraction and Deviation



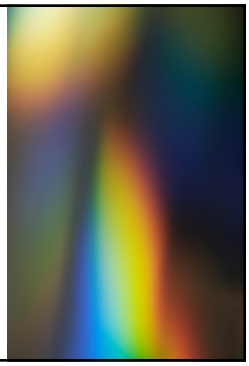
9

Practical Applications of Prism

10

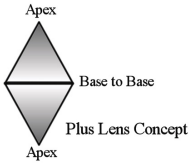
Prism Practical Applications

- Ophthalmic lens creation
- Strabismus (eye turn)
- Vision Therapy
- Neurological Opticianry
- Traumatic Brain Injury (TBI)
- Prism thinning



11

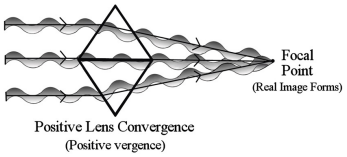
Plus Lens Applications



- + Plus Lenses - used to correct hyperopia and/or presbyopia
- Two prisms connected base to base

12

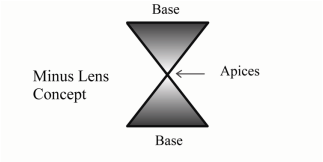
Form Real Images



+ Plus Lenses
- Converge light
- Prism's base is located at the lens center
- Create a real image located behind the lens

13

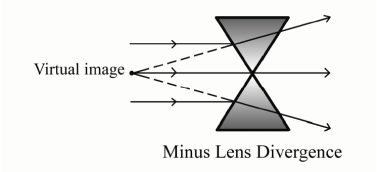
Minus Lens Applications



- - Minus Lenses - used to correct myopia
- Two prisms connected apex to apex

14

Form Virtual / Imaginary Images



- Minus Lenses:
- Diverge light
- Create virtual images located in front of the lens

15

Phernell's Pro Tips to Avoid Prism

- Always measure patient PD's.
- Use a digital measuring device.
- Measure PD of previous eyewear.
- Lenses that require Monocular PD's:
  - Aspheric
  - Atoric
  - Power Compensated
  - Near Variable Focus (NVF)
  - Progressive (PAL)

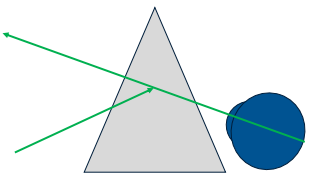
16

Common Prism Symptoms

- My eyes feel like they are pulling.
- Floor is perceived higher.
- Floor is perceived lower.
- I feel like I'm walking up or down hill.
- Horizontal objects appear slanted.

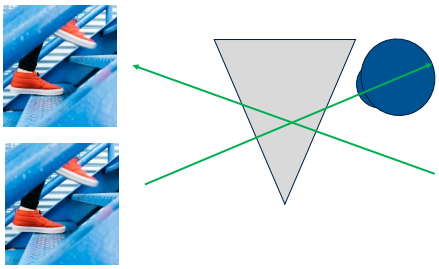
17

Base Down Prism = Objects Appears Higher



18

Base Up Prism = Objects Appears Lower



19

Applications of Prism Calculation

20

Tilted Lenses

Induced prism given by

$$\Delta = (100 \tan\theta)\ c\ D_1$$

Key:

θ = tilt angle

t = reduced thickness

D_1 = base curve

Base direction is direction of tilt: e.g., positive pantoscopic tilt → BD, positive face form (wrap) → BO

26

Example

SV lenses, -6.00 D OU. Lenses are CR-39 with 2.2 mm center thickness, 3 D base curve, and 12 degrees of pantoscopic. In addition to any decentration effects, what is the induced prism of each lens?

$$\Delta = (100 \tan\theta)\, t\, D_1$$

$$\Delta = (100 \tan 12)\frac{0.0022}{1.498}(3) = 0.09 \text{ BD}$$

27

Example

SV glasses, +2.50 D OU. Lenses are CR-39 with 4.4 mm center thickness, 7 D base curve, and 10 deg wrap. In addition to any decentration effects, what is the induced prism of each lens?

$$\Delta = (100 \tan\theta)\, t\, D_1$$

$$\Delta = (100 \tan 10)\frac{0.0044}{1.498}(7) = 0.36 \text{ BO}$$

Total prism > 0.67 Prism D

28

Example

Plano sunglass lenses are polycarbonate with 1.5 mm center thickness, 8 D base curve, and 20 deg wrap each. What is the induced prism of each lens?

$$\Delta = (100 \tan\theta)\, t\, D_1$$

$$\Delta = (100 \tan 20)\frac{0.0015}{1.586}(8) = 0.275 \text{ BO}$$

Therefore, total prism > 0.50 Prism D

29

Quantifying Prism Power

- Prism power is measured in diopters ($D^{\blacktriangle}$)
- Prism is a product of focal power and optical center positioning

30

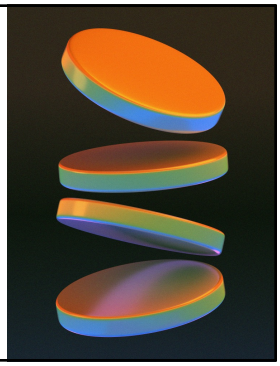
Quantifying Prism Power

- Prism power is measured in diopters ($D^{\blacktriangle}$)
- Prism is a product of focal power and optical center positioning

31

Graphically Map Power

OD -1.50 -1.00 x 090
OS -2.00 -0.75 x 090
Add +1.00
PD: 29/30



32

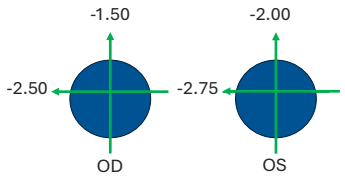
Graphically Map Power

O.C. Off	P.D. Off	Degrees from Axis	% of CYL.
1. Subtract Axis from 090	1. Subtract Axis from 180 or 0	000	0%
2. Find the degrees from Axis	2. Find the degrees from Axis	030	25%
3. Multiply the % x CYL.	3. Multiply the % x CYL.	045	50%
4. Add the product to SPH.	4. Add the product to SPH.	060	75%
		090	100%

33

Power Cross

OD -1.50 -1.00 x 090
OS -2.00 -0.75 x 090
Add +1.00
P.D. 29/30



34

Prentice Rule

$P = h_{cm} \times D$

P = Prism Diopters
h_{cm} = amount off in centimeters
D = lens dioptric power (at axis 180 or 090)

35

Accidental Prism

A new pair of glasses measure PD 68 mm in the focimeter.
Patient's PD is 64 mm

How much prism was induced?

OD -4.00 – 0.50 x 180
OS -3.00 – 0.75 x 180

36

Meridian of Dioptric Power

O.C. Off	P.D. Off	Degrees from Axis	% of CYL.
1. Subtract Axis from 090	1. Subtract Axis from 180 or 0	000	0%
2. Find the degrees from Axis	2. Find the degrees from Axis	030	25%
3. Multiply the % x CYL.	3. Multiply the % x CYL.	045	50%
4. Add the product to SPH.	4. Add the product to SPH.	060	75%
		090	100%

37

Horizontal Prism

P = (h_{cm}) (D @ 180th meridian)

P = (.4 cm) (OD -4.00 & OS -3.00)

P = (.4 / 2) (OD -4.00 & OS -3.00)

OD: (.2) (-4.00) = 0.80 ^ D

OS: (.2) (-3.00) = 0.60 ^ D

Total Combined Prism = 1.40 ^ D

Step 1: find Pwr. @ 180

Step 2: subtract lab vs. Patients PD

Step 3: divide / 2 (**note:** horizontal prism only)

Step 4: change mm to cm

Step 5: multiply pwr. X cm off

Step 6: add OD and OS same direction

Step 7: determine base direction

- + plus lenses: Prism **Base is O.C.**
- - minus lenses: Prism **Apex is O.C.**

38

Vertical Prism

The OC of the OD lens was edged at 26 mm and the OS lens was edged at 31 mm.

How much vertical prism was induced with the Rx below?

OD +2.75 – 0.75 x 180

OS +3.00 – 1.00 x 180

OC: 26 mm

39

Meridian of Dioptric Power

O.C. Off	P.D. Off	Degrees from Axis	% of CYL.
1. Subtract Axis from 090	1. Subtract Axis from 180 or 0	000	0%
2. Find the degrees from Axis	2. Find the degrees from Axis	030	25%
3. Multiply the % x CYL.	3. Multiply the % x CYL.	045	50%
4. Add the product to SPH.	4. Add the product to SPH.	060	75%
		090	100%

40

Vertical Prism

Calculate prism for the right lens because the OS lens is correct:

P = (h_{cm}) (D @ 090th meridian)

P = (.5 cm) (+2.00)

P = 1.00 ^ D Base Up

*Is this within ANSI Z80-1 standard?

41

Prism Base Direction

Both Lenses Edged
(same direction)

Plus Lenses

Edged	Result
Too Wide	Base Out
Too Narrow	Base In

Minus Lenses

Edged	Result
Too Wide	Base In
Too Narrow	Base Out

42

Incrementing Prism

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

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

43

Neutralizing Prism

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

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

44

Asymmetrical Prism

- The lab edged lenses at 31/35mm PD.
- How much prism was induced?

OD +3.00 – 0.50 x 090
OS +3.75 – 1.00 x 060

- Patient PD 33/33 mm

45

Mid-line Shift

P = (h_{cm}) (D @ 180th meridian)
P = (OD 31 -33 = 2 mm & OS 35 – 33 = 2 mm) (O.D. +2.50 & O.S. +3.00)
P = (OD .2cm & OS .2cm) (OD +2.50 & O.S. +3.00)
OD Prism = (.2 cm too narrow) (+2.50) & O.S. Prism = (.2 cm too wide) (+3.00)
OD Prism = 0.50 D. B.I. & O.S. Prism = 0.60 D. B.O.
Total Prism = Prism OD + Prism OS
Total Prism = 0.50 D B. I. + 0.60 D. B. O.
Total Prism = 0.10 D ^ B.O. (base out because the stronger prism is Base Out)

46

Prism and Lensometry

47

Mechanical Prism

Mechanical prism – process of creating prescribed prism by manually moving a spectacle lens away from the patient's PD during the layout process before edging the lens.

48

Generated Prism

Generated prism – process of creating prescribed prism by creating a wedge across the entire lens during the generating (surfacing) process.

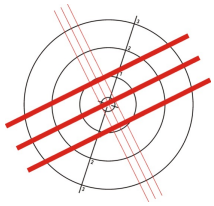
49

Measuring Prism in a Lensometer

50

Measuring Prism in a Lensometer

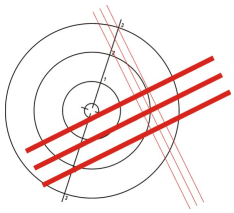
- Sphere power = **thin** mires (S)
- Cylinder power = **thick** mires (C)
- Target = Intersection of S & C
- Prism reticle = concentric rings



51

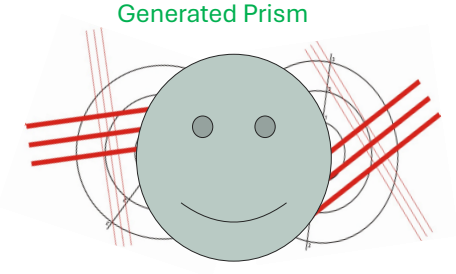
Generated Prism

- Prism power indicated on prism reticle
- Prism base = direction of target



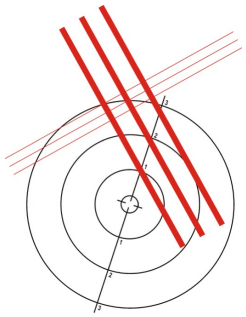
52

Generated Prism



53

Measuring Prism in a Lensometer



54

Measuring Prism in a Lensometer

- Measure the strongest powered lens first.
- **DO NOT** move the table/ stage after measuring each lens.

55

Prism Tolerance

56

Prism Vertically Yoked

- Imbalance = zero (null)
- Prism thinning
- Progressive lenses
- Aspheric lenses
- Atoric lenses

57

Prism and Faceform

- Faceform (wrap)
- Induces prism in opposing directions based on Prentice

58

Convert Degrees to Rectangular Notation

V = D_e (sine a)

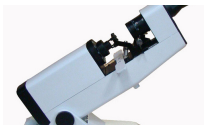
H = D_e (cosine a)

where:

- V = vertical prism
- H = horizontal prism
- D_e = prism dioptric power

59

Convert Degrees to Rectangular Notation



Convert the following prescription neutralized in the lensometer from polar notation to rectangular notation:

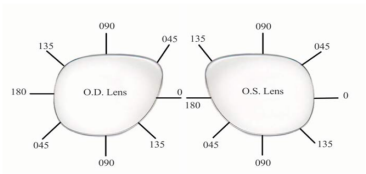
OD +3.25 DS, 4.00$^{\Delta}$ B.I. @ 045

60

OD: -3.25 DS, 4$^{\Delta}$ BI @ 045

V = (4.00) (.707)
H = (4.00) (.707)
V = 2.82
H = 2.82

OD: +3.25, 2.82$^{\Delta}$ B.U., 2.82$^{\Delta}$ B.I.Notice the rectangular coordinates for the right eye directly corresponds with the polar coordinate of 045 degrees (fig. 11-5).

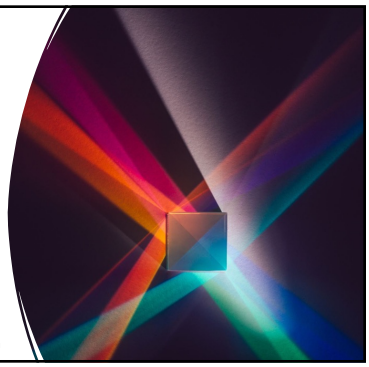


61

Combined Horizontal & Vertical Prism

$\sqrt{P} = V^2 + H^2$

$\tan^{-1} a = v/h$



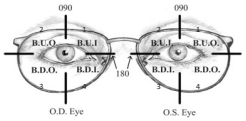
62

What is the Net Result?

Rx

OD: -2.00 DS, 1.00 ▲ B.U. & 3.00 ▲ B.I.

OS: -2.50 DS, 1.00 ▲ B.U. & 3.00 ▲ B.I.



63

OD	OS
$\sqrt{P} = V^2 + H^2$	$\sqrt{P} = V^2 + H^2$
$\sqrt{P} = 1^2 + 3^2$	$\sqrt{P} = 1^2 + 3^2$
$\sqrt{P} = 1 + 9$	$\sqrt{P} = 1 + 9$
$\sqrt{P} = 10$	$\sqrt{P} = 10$
$\sqrt{P} = 3.16$	**$\sqrt{P} = 3.16$**
$\tan^{-1} a = v/h$	$\tan^{-1} a = v/h$
$\tan^{-1} a = 1/3$	$\tan^{-1} a = 1/3$
$\tan^{-1} a = 18.43$	$\tan^{-1} a = 18.43$
$\tan^{-1} a = 18$ degrees	**$\tan^{-1} a = 162$ degrees**

Determine Tangent Angle

a_1	a
Quadrant I	$a_1 = a$
Quadrant II	$180 - a_1 = a$
Quadrant III	$180 + a_1 = a$
Quadrant IV	$360 - a_1 = a$

64

Rectangular Prism Rx

OD: -2.00 DS, 1.00 ▲ B.U. & 3.00 ▲ B.I.

OS: -2.50 DS, 1.00 ▲ B.U. & 3.00 ▲ B.I.

Combined Prism Rx

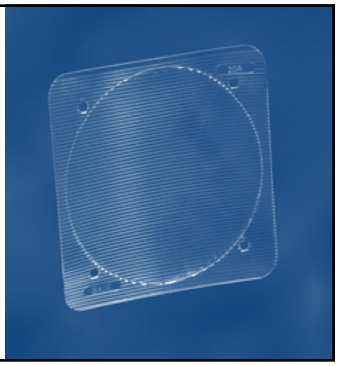
OD: -2.00 DS, 3.16 ▲ @ 018 degrees

OS: -2.50 DS, 3.16 ▲ @ 162 degrees

65

Fresnel Prism

Temporary
Testing Prism



66

Prism Power

- Bilateral prism - splitting prism between both eyes
- Convergence (ESO) - bilateral Base Out (B.O.)
- Divergence (EXO) - bilateral Base In (B.I.)
- Right (Hyper)
  - OD lens = Base Down (B.D.)
  - OS lens = Base Up (B.U)
- Left (Hyper)
  - OD lens = Base Up (B.U.)
  - OS lens = Base Down (B.D)

67

Questions and Answers

68

Take Away #1

Prism and Lensometry – always measure the strongest powered lens first, document your measurements including the prisms base direction. Then measure the opposing lens **without moving the lensometer table/ stage** between each lens.

69

Take Away #2

Prescribed Prism – always measure and record the monocular PD for prescribed prism.

70

Take Away #3

Prescribed Prism - the prisms base is always prescribed in the opposite direction of the eye's deviation.

Deviation	Base Direction
Esophoria/ tropia	Base Out (B.O.)
Exophoria/ tropia	Base In (B.I.)
Hyperphoria/ tropia	Base Down (B.D.)
Hypophoria/ tropia	Base Up (BU)

71

Take Away #4

Accidental Prism (non-prescribed) – patients will perceive objects is the opposite direction of the prism's base looking through spectacle lenses with accidental prism.

Perceived Object	Prism's Base Direction
Floor appears higher	Base Down (B.D.)
Floor appears lower	Base Up (B.U.)
Appear shifted inward (medially)	Base Out (B.O.)
Appear shifted outward (laterally)	Base In (B.I.)

72

Take Away #5

Newly Prescribed Prism - when prescribing prism for the first time, consider using trial frames. This enables patients to experience the new prism in three-dimensional space rather than through a phoropter, allowing for better acclimation.

73