Prism Made Easy; Practical Applications

PURE OPTICS

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Renowned National Speaker

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- Master in Ophthalmic Optics
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Financial Disclosure

All content is the original work from Pure Optics, Second Edition by Phernell Walker, MBA, ABOM, LDO.

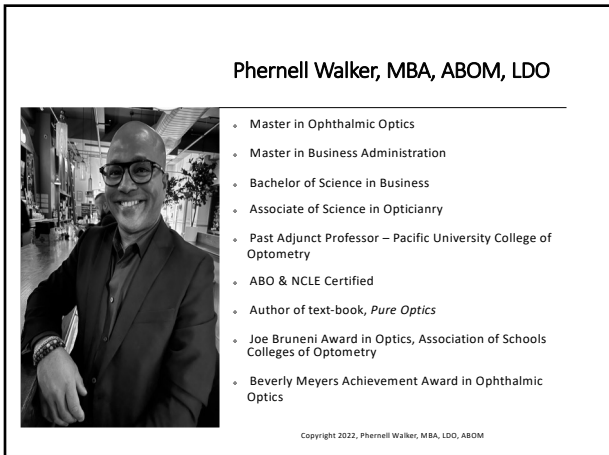There is no financial relationships or support from any company in this presentation.
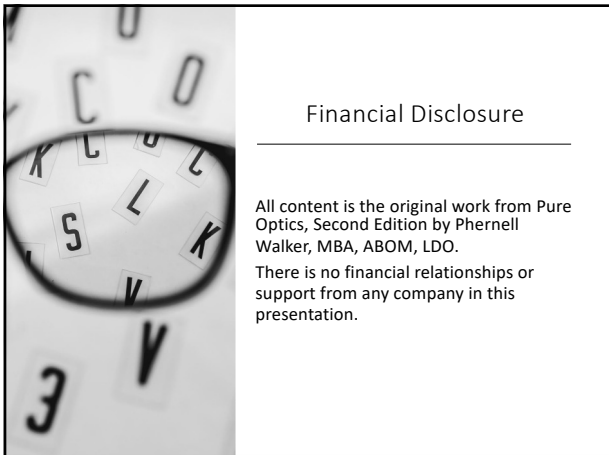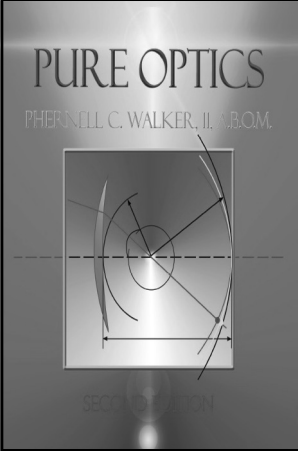
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Content Resource

Pure Optics (2021)
Phernell Walker, MBA, LDO, ABOM

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Refract Light

Ophthalmic Technicians

Opticians

Optometrists

Ophthalmologists

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Using Prism

- **Ametropia** - ophthalmic lenses move image across a plane (1-dimension)

- Move images in 3D space

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Ophthalmic Prism

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

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Refraction and Deviation

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Fundamental Plus Lens Design

Apex

Base to Base

Plus Lens Concept

Apex

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

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Forming Real Images

Focal Point
(Real Image Forms)

Positive Lens Convergence
(Positive vergence)
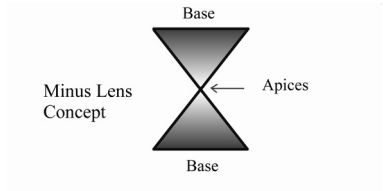
- *+ Plus Lenses* - converge light because the prism's base (thickest part) is located at the lens center
- Plus lenses a create *real image* located behind the lens

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Fundamental Minus Lens Design

- *- Minus Lenses* - used to correct myopia
- Two prisms connected **apex to apex**
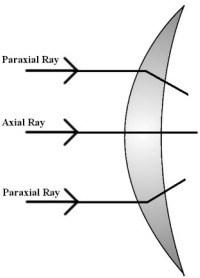
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Forming Virtual / Imaginary Images
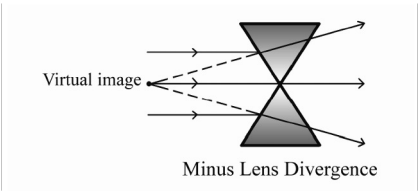
- *- Minus Lenses* - diverge light because the prism's base (thickest part) is located at the lens periphery (edges)
- Minus lenses have a *virtual image* located in front of the lens

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Ray Tracing

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3D Space

- X = Length
- Y = Width
- Z = Height
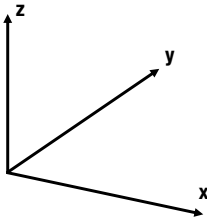
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Lens Evolution Using Prism

Evolution of Lens Design

Bi-Concave Bi-Convex Plano Concave Plano Convex Meniscus Concave Meniscus Convex Aspheric Atoric

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MERIDIAN OF DIOPTRIC POWER

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%

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Power Cross

Rx:
OD: +1.50 -0.50 x 180
OS: -1.00 -0.75 x 180
Add: +2.75
PD: 32/34

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Power Cross

OD: +1.50 -0.50 x 180
OS: -1.00 -0.75 x 180
Add: +2.75
PD: 32/34

```
        +1.00              -1.75

+1.50  ___|___     -1.00  ___|___
          |                  |

        OD                 OS
```

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Prentice Rule

$$P = (h_{cm})(D)$$

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

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Example

$$P = (h_{cm})(D)$$

When verifying a pair of new glasses in the lensometer, you discover that the lenses were edged at a PD of 60 mm.

Since the patient's PD is 66 mm, how much prism was induced assuming the patient's Rx is:

O.D. -3.75 D.S.
O.S. -3.00 – 1.00 x 045

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Horizontal Prism

Solution:

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

P = (.6 cm) (O.D. -3.75 & O.S. -3.50)

P = (.6 / 2) (O.D. -3.75 & O.S. -3.50)

O.D. Prism = (.3) (-3.75) & O.S. Prism = (.3) (-3.50)

O.D. Prism = 1.125 D & O.S. Prism = 1.05 D

Total Prism = 1.125 D + 1.05 D

Total Prism = 2.18 D (almost 2.25 prism diopters)

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Vertical Prism

The O.C. of a OD lens was edged at 30mm.

And the OS lens was edged at 26mm.

How much vertical prism was induced with the Rx below?

O.D. +4.25 – 1.00 x 060

O.S. +4.25 – 0.75 x 135

OC: 26mm

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MERIDIAN OF DIOPTRIC POWER

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%

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Vertical Prism

Only calculate prism for the right lens because the OS lens is correct:

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

$P = (.4\ cm)(+4.00)$

P = 1.60 D (a little more than 1.50 prism diopters)

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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

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Compounding Prism

Only calculate prism for the right lens because the OS lens is correct:

P = (h$_{cm}$)   (D @ 090th meridian)

P = (.4 cm) (+4.00)

P = 1.60 D (a little more than 1.50 prism diopters)

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Compounding Prism

Amounting Prism (O.D. & O.S. Lens)
▪ Base In & Base In
▪ Base Out & Base Out
▪ Base Up & Down

- *Amounting prism (compounding prism)* - *when the total prism equals the sum of the right and left lens.*
- It results when either the base direction in the 180th meridian is the same in each lens or if the base is in opposite directions in the 090th meridian

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Neutralizing Prism

Neutralizing Prism (O.D. & O.S. Lens)
▪ Base Down & Down
▪ Base Out & Base In
▪ Base Up & Base Up

- *Neutralizing prism* - opposite of compounding prism. When either the base direction in the 180th meridian of each lens is in opposite directions or if the base is in same direction in the 090th meridian.

- The total prism equals the dioptric difference between each lens and the base orientation is the direction of the strongest prism

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

Monocular Prism

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

Patient PD: 33/33 mm

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Solution

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)
O.D. Prism = (.2 cm too narrow) (+2.50) & O.S. Prism = (.2 cm too wide) (+3.00)
O.D. 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)

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Monocular Prism

What is the total amount of prism if the OC on the right lens was edged 4 mm too high and the left OC was edged 2 mm too low with the following prescription?

OD: -2.00 -1.00 x 180
OS: -2.50 -1.00 x 180

P = (h$_{cm}$) (D @ 090th meridian)
P = (.4 cm OD & .2 cm OS) (-3.00 OD & -3.50 OS)
P = OD 1.20 D B.D. & OS 0.70 D B.U.
P = 1.20 + 0.70
P = 1.90 D

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Cranial Nerves

CN II - vision

CN III - eye motility

CN IV - superior oblique eye muscle

CN VI - lateral rectus eye muscle

CN VII - facial and lacrimal gland

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Locations of the Cranial Nerves

I Olfactory: smell

II Optic: vision

III Oculomotor: eye movements

IV Trochlear: eye movements

V Trigeminal: facial touch, temperature, and pain

VI Abducens: eye movement

VII Facial: chewing, saliva production, taste buds

VIII Vestibulocochlear: maintain equilibrium, hearing

IX Glossopharyngeal: throat and tongue movement, swallowing

X Vagus: heart and lung signals

XI Accessory: neck muscle motor functions

XII Hypoglossal: tongue and chewing movements, speech
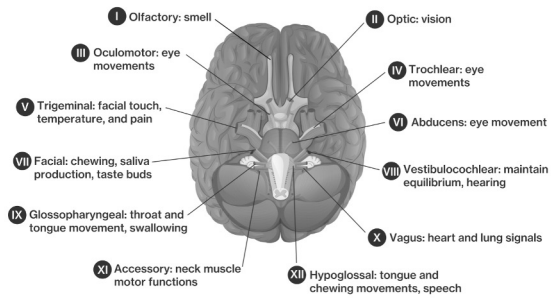
2022

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Traumatic Brain Injury (TBI)

Causes include stroke, automobile accidents, concussions, whiplash, post neurosurgical (e.g., tumor excision, aneurism repair)

80% of TBI patients suffer vision issues

We can use prism to widen a patient's field of view

$1.00^{\triangle}$ diopter is equal to 0.573 degrees

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Diplopia

Diplopia can result in difficulty:

- stereopsis
- walking
- balance
- reading
- visual field loss

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Prism Therapy

- **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)
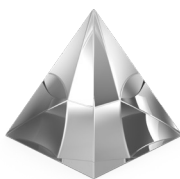
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Prism Therapy

Divergence - bilateral Base In (B.I.)
- Advantage - promotes bifocal stimulation
- Disadvantage - reduces (P.F.R.) prism fusional vergence amplitude

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Amplitude of Convergence

Fusional Convergence amplitudes - focus on a accommodative target at near while holding a base out prism bar in front of one eye

Increasing the prism power gradually while maintaining a single image looking through Base Out Prism (B.O.)
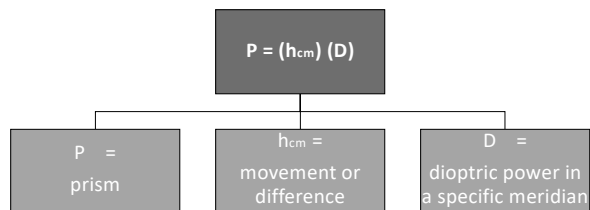
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Creating Prism

- **Decentration (Mechanical)** - optical center edged in a different location than in conjugate with the patient's pupil (180th, 090th or combination)
- **Generated** - prism is created across the entire lens

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Calculating Prism

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

P = prism	h_{cm} = movement or difference	D = dioptric power in a specific meridian

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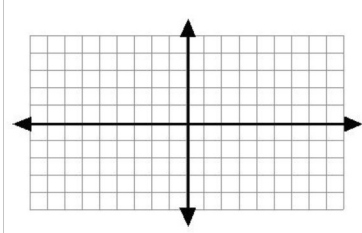
Combined Horizontal & Vertical Prism

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Convert Degrees to Rectangular Notation

$V = D_e (\text{sine } a)$

$H = D_e (\text{cosine } a)$

where:

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

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Convert Degrees to Rectangular Notation

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

O.D. +3.25 DS, 4.00 ▲ B.I. @ 045

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Convert Degrees to Rectangular Notation
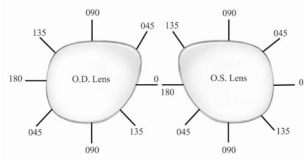
OD: -3.25 DS, 4$^\Delta$ BI @ 045

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).

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Combined Horizontal & Vertical Prism

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

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

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What is the net result?

Rx

OD: -2.00 DS, 1.00$^\Delta$ B.U. & 3.00$^\Delta$ B.I.

OS: -2.50 DS, 1.00$^\Delta$ B.U. & 3.00$^\Delta$ B.I.

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y

Quadrant II
$(-,+)$

Quadrant I
$(+,+)$

x

$(-,-)$
Quadrant III

$(+,-)$
Quadrant IV

50
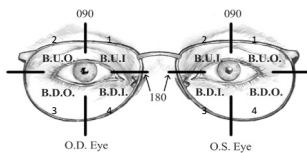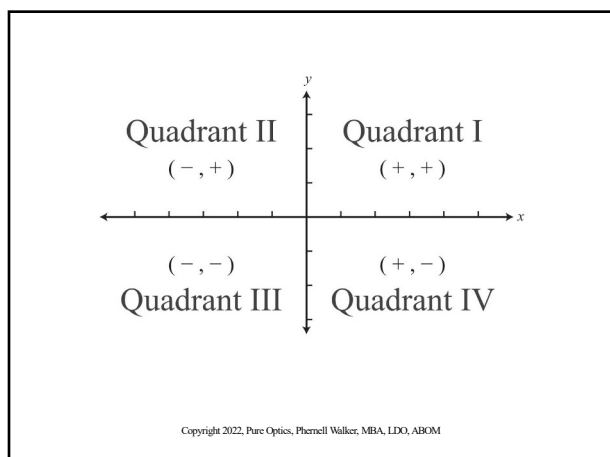
OD:

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

$\sqrt{P} = 1^2 + 3^2$

$\sqrt{P} = 1 + 9$

$\sqrt{P} = 10$

$\sqrt{P} = 3.16$

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

$\tan^{-1} a = 1/3$

$\tan^{-1} a = 18.43$

$\tan^{-1} a = 18$ degrees

OS:

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

$\sqrt{P} = 1^2 + 3^2$

$\sqrt{P} = 1 + 9$

$\sqrt{P} = 10$

$\sqrt{P} = 3.16$

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

$\tan^{-1} a = 1/3$

$\tan^{-1} a = 18.43$

$\tan^{-1} a = 162$ 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	$360 - a_1 = a$

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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

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