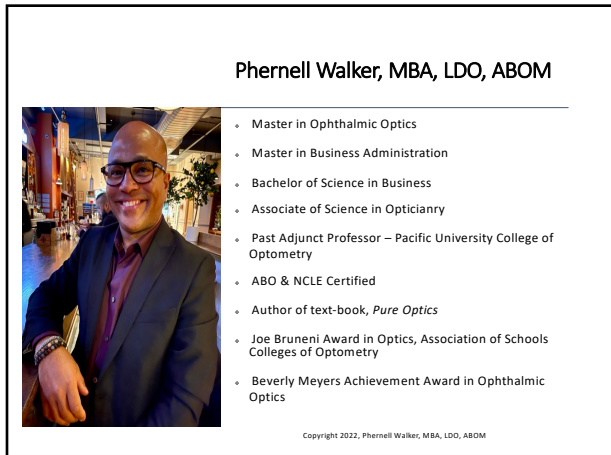
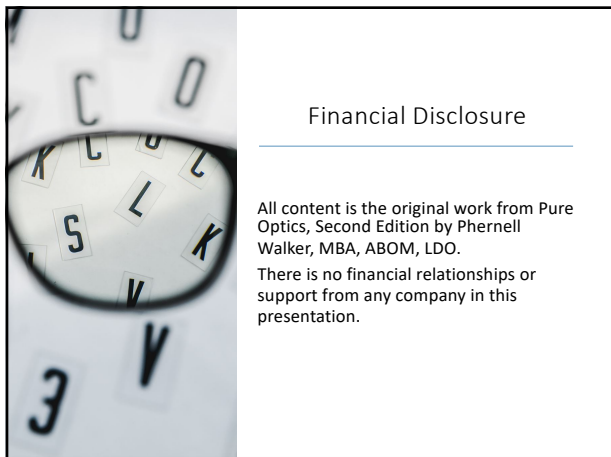





1



2



3



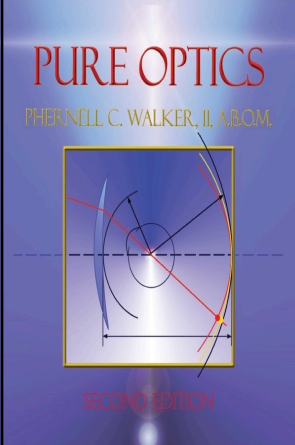
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SECOND EDITION

Content Resource

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Refract Light


Ophthalmic Technicians

Opticians

Optometrists

Ophthalmologists

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6

Using Prism

- **Ametropia** - ophthalmic lenses move image across a plane (1-dimension)
- Move images in 3D space

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Ophthalmic Prism

Base Apex Line

Apex

Base

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

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Refraction and Deviation

Apex

Original Direction

Angle of Refraction

Light Ray

Emergent Ray

Base

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Fundamental Plus Lens Design

The diagram shows two prisms joined at their bases. The top vertex is labeled "Apex" and the bottom vertex is also labeled "Apex". The horizontal line where the two prisms meet is labeled "Base to Base". Below the diagram, the text "Plus Lens Concept" is written.

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

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Forming Real Images

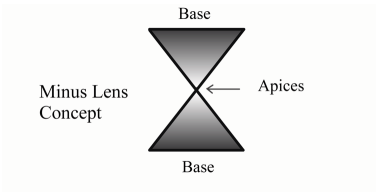
The diagram illustrates light rays entering a plus lens from the left. The rays are shown as wavy lines that converge as they pass through the lens. The point where they meet is labeled "Focal Point (Real Image Forms)". Below the lens, the text "Positive Lens Convergence (Positive vergence)" is written.

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

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Fundamental Minus Lens Design



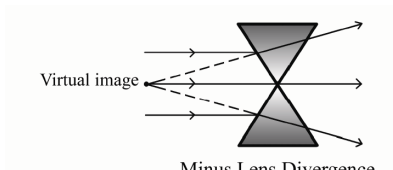
Minus Lens Concept

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

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Forming Virtual / Imaginary Images



Virtual image

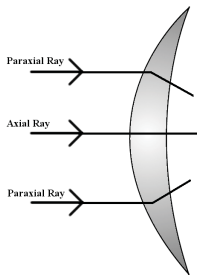
Minus Lens Divergence

- **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



Paraxial Ray

Axial Ray

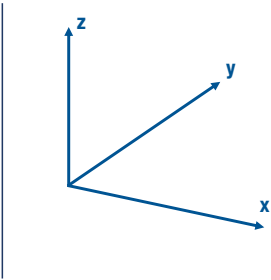
Paraxial Ray

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3D Space

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

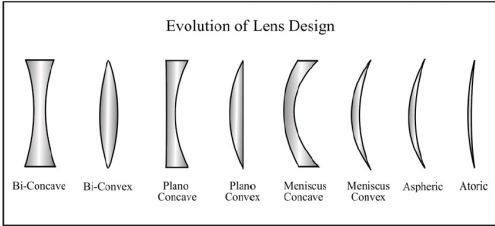


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Lens Evolution Using Prism

Evolution of Lens Design




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MERIDIAN OF DIOPTRIC POWER

Degrees from Axis	Percent of CVL
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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OD: +1.50 -0.50 x 180
OS: -1.00 -0.75 x 180
Add: +2.75
PD: 32/34

$+1.50$		$+1.00$		-1.00		-1.75
		—			—	
		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:

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

$$P = (.6 \text{ cm}) (O.D. -3.75 \ \& \ O.S. -3.50)$$

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

$$O.D. \text{ Prism} = (.3)(-3.75) \ \& \ O.S. \text{ Prism} = (.3)(-3.50)$$

$$O.D. \text{ Prism} = 1.125 \text{ D} \ \& \ O.S. \text{ Prism} = 1.05 \text{ D}$$

$$\text{Total Prism} = 1.125 \text{ D} + 1.05 \text{ D}$$

$$\text{Total Prism} = 2.18 \text{ D} \text{ (almost 2.25 prism diopters)}$$

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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?

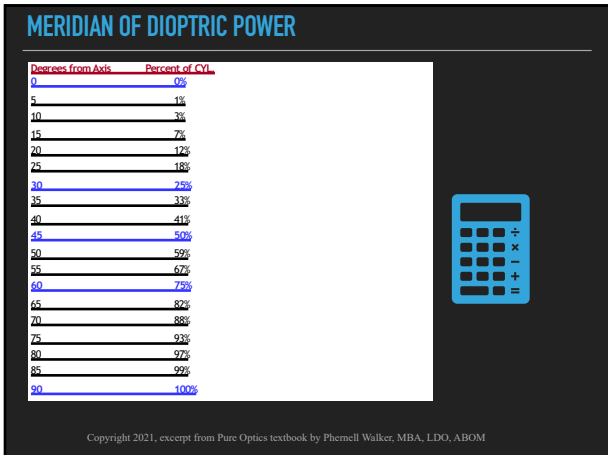
O.D. +4.25 - 1.00 x 060

O.S. +4.25 - 0.75 x 135

OC: 26mm

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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:

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

$P = (.4 \text{ cm}) (+4.00)$

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

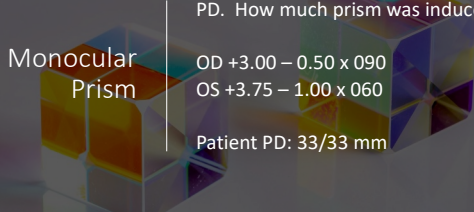
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The lab edged lenses at 31/35mm PD. How much prism was induced?

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

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

$P = (OD \ 31 - 33 = 2 \text{ mm} \ \& \ OS \ 35 - 33 = 2 \text{ mm}) (O.D. \ +2.50 \ \& \ O.S. \ +3.00)$

$P = (OD \ .2cm \ \& \ OS \ .2cm) (OD \ +2.50 \ \& \ O.S. \ +3.00)$

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

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

$P = (.4 \text{ cm OD} \ \& \ .2 \text{ cm OS}) (-3.00 \text{ OD} \ \& \ -3.50 \text{ OS})$

$P = OD \ 1.20 \text{ D B.D.} \ \& \ OS \ 0.70 \text{ D B.U.}$

$P = 1.20 + 0.70$

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

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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^Δ diopter is equal to 0.573 degrees

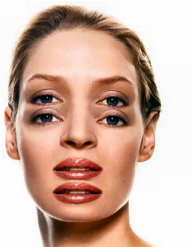
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Diplopia

Diplopia can result in difficulty:

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

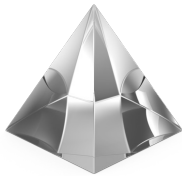


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Prism Therapy

- **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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PRACTICE MAKES PERFECT


- ▶ **Chief Complaint:** Neck pain holding head downward angle. Room appears downward angle.
- ▶ **VA:** 20/20 OU
- ▶ **Onset:** After 2 weeks of continuous wear
- ▶ **Modifying factors:** went to Dr. Crackmebach, chiropractor without relief



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DR. CRACKMEBACH




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DR. CRACKMEBACH

RELEASE THE QUACKIN!



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LAB ORDER


OD: -6.00 -0.75 x 180
OS: -6.50 -1.00 x 180
PD: 61 OC: 26
A = 51
DBL = 18
B = 40
ED = 53
Pantoscopic Tilt: 12 degrees

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NEUTRALIZED GLASSES

OD: -6.00 -0.75 x 180
OS: -6.50 -1.00 x 180
PD: 61
Lab Edged:
PD: 29/31
OC: 20



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PRENTICE RULE

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

- P = prism
- h_{cm} = off in cm
- D_e = meridian specific



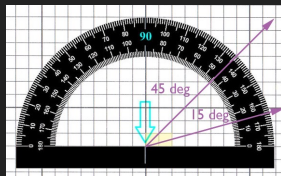
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OPTICAL CROSS

OD: -6.00 -0.75 x 180

OS: -6.50 -1.00 x 180



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MERIDIAN OF DIOPTRIC POWER

Degrees from Axis	Percent of CVL
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%



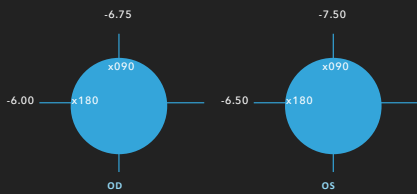
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OPTICAL CROSS

OD: -6.00 -0.75 x 180

OS: -6.50 -1.00 x 180



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DELTA

Patient Rx

OD: -6.00 -0.75 x 180

OS: -6.50 -1.00 x 180

PD: 61

OC: 26

Lab Results:

OD: -6.00 -0.75 x 181

OS: -6.50 -1.00 x 178

PD: 29/31

OC: 20

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PRENTICE RULE

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

• $P = ?$

• $h_{cm} = \text{OD: } 6\text{mm} = 0.6\text{cm}$

OS: $6\text{mm} = 0.6\text{cm}$

• $D_e = \text{OD: } -6.75 \times 090$

OS: -7.50×090




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SOLUTION

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

P = OD: $(0.6cm) (-6.75) = 4.05^{\wedge}$ B.U.
P = OS: $(0.6cm) (-7.50) = 4.50^{\wedge}$ B.U.



Prism Imbalance = 0.45^{\wedge} Imbalance
Total Prism = -4.00^{\wedge}
*images appear downward due to BU prism causing head cape and possible neck pain.
Solution: Base Down Prism should be prescribed to resolve the unwanted prism.

- Prism is neither +/-
- Integer determines: base direction & compounding vs. neutralizing
- Lack of O.C. induces power shift for Sph/Cyl/Axis

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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

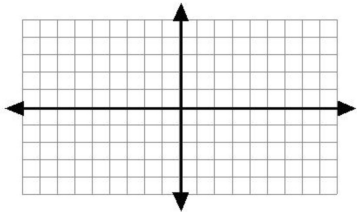
$$P = (h_{cm}) (D)$$

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 dioptic 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 Δ B.I. @ 045

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Convert Degrees to Rectangular Notation

OD: -3.25 DS, 4^Δ BI @ 045

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

OD: +3.25, 2.82^Δ B.U., 2.82^Δ 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

$$VP = V^2 + H^2$$

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

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What is the net result?

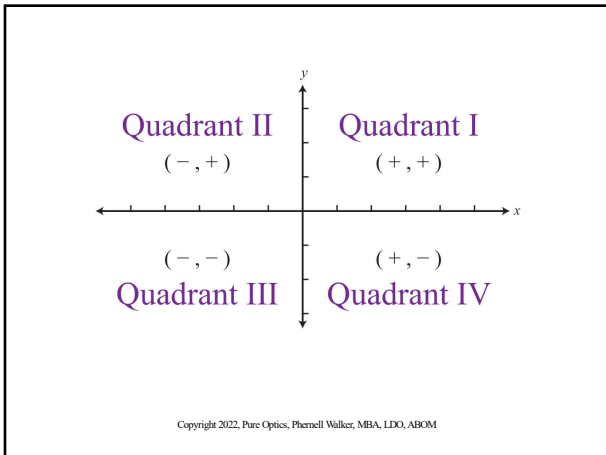
R_x

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

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

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OD:	OS:	<p><u>Determine Tangent Angle</u></p> <table border="0"> <tr> <td>a₁</td> <td>a</td> </tr> <tr> <td>Quadrant I</td> <td>a₁ = a</td> </tr> <tr> <td>Quadrant II</td> <td>180 - a₁ = a</td> </tr> <tr> <td>Quadrant III</td> <td>180 + a₁ = a</td> </tr> <tr> <td>Quadrant IV</td> <td>360 - a₁ = a</td> </tr> </table>	a₁	a	Quadrant I	a ₁ = a	Quadrant II	180 - a ₁ = a	Quadrant III	180 + a ₁ = a	Quadrant IV	360 - a ₁ = a
a₁	a											
Quadrant I	a ₁ = a											
Quadrant II	180 - a ₁ = a											
Quadrant III	180 + a ₁ = a											
Quadrant IV	360 - a ₁ = a											
$\sqrt{P} = \sqrt{V^2 + H^2}$	$\sqrt{P} = \sqrt{V^2 + H^2}$											
$\sqrt{P} = \sqrt{1^2 + 3^2}$	$\sqrt{P} = \sqrt{1^2 + 3^2}$											
$\sqrt{P} = 1 + 9$	$\sqrt{P} = 1 + 9$											
$\sqrt{P} = 10$	$\sqrt{P} = 10$											
$\sqrt{P} = 3.16$	$\sqrt{P} = 3.16$											
$\tan^{-1} a = v/h$	$\tan^{-1} a = v/h$											
$\tan^{-1} a = 1/3$	$\tan^{-1} a = 1/3$											
$\tan^{-1} a = 18.43$	$\tan^{-1} a = 18.43$											
$\tan^{-1} a = 18 \text{ degrees}$	$\tan^{-1} a = 162 \text{ degrees}$											

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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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