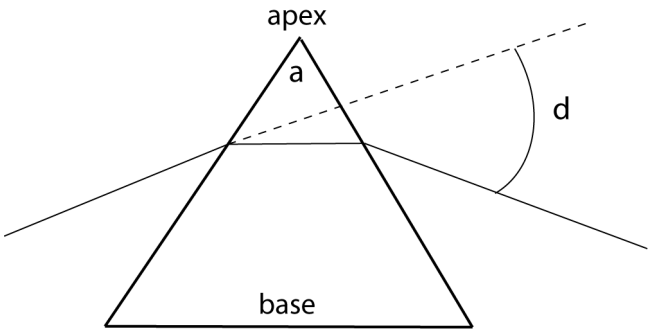
Chapter 3 Summary

Prism Definitions
Refraction Through a Prism
Deviation
Normal Incidence & Emergence
Minimum Deviation
Ophthalmic Prisms
Prism Diopter
Uses of Prisms for Functional & Cosmetic Correction

Prism Basics

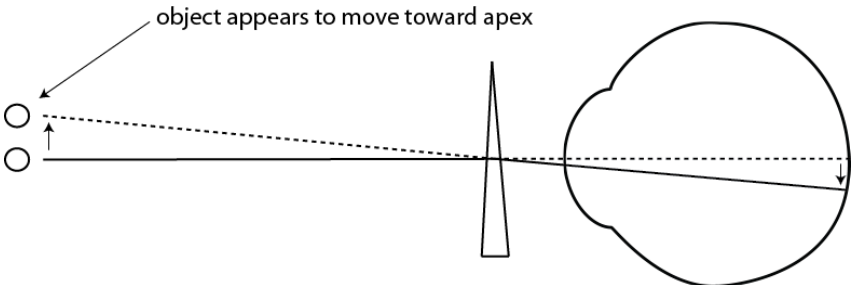
Apical angle (refracting angle) is (a)

Angle of deviation is (d)



a = apical angle d = angle of deviation

Light is deviated toward the base of a prism, but object viewed through the prism appear to move toward the apex



Deviation of a Prism

$$\delta = \delta_1 + \delta_2$$

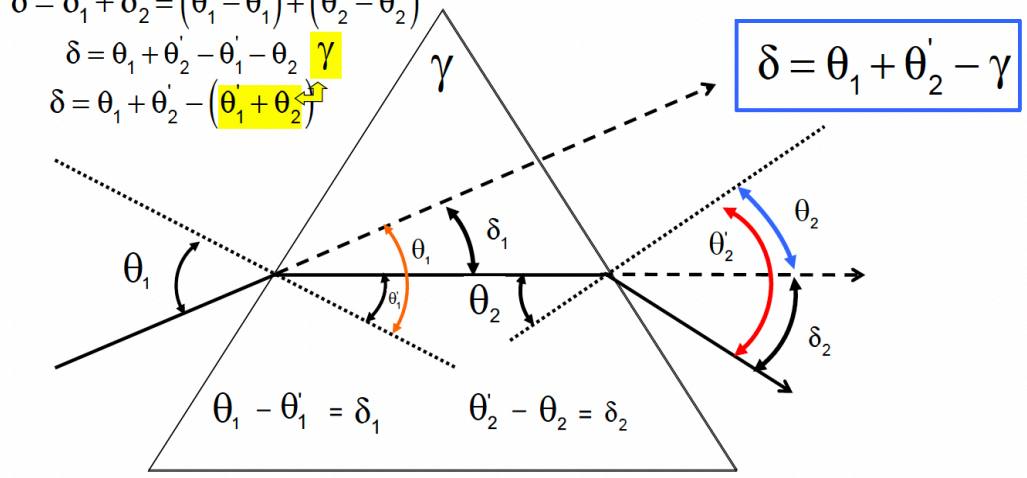
$$\delta_1 = \theta_1 - \theta_1' \qquad \delta_2 = \theta_2' - \theta_2$$

$$\delta = \delta_1 + \delta_2 = (\theta_1 - \theta_1') + (\theta_2' - \theta_2)$$

$$\delta = \theta_1 + \theta_2' - \theta_1' - \theta_2$$

γ

$$\delta = \theta_1 + \theta_2' - (\theta_1' + \theta_2)$$

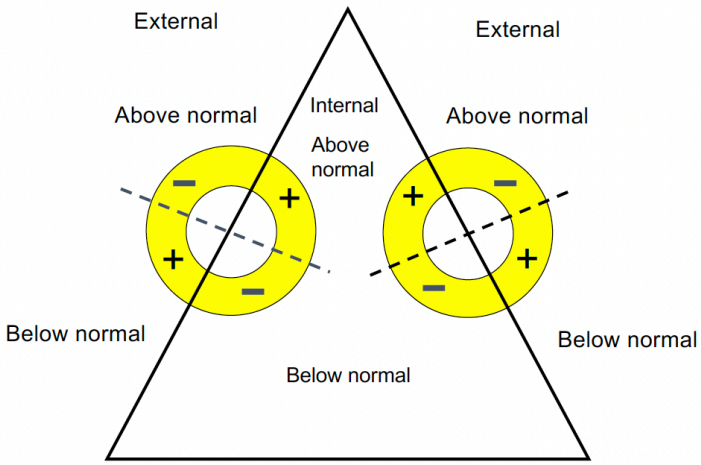


δ_1 = deviation at first refracting surface

δ_2 = deviation at second refracting surface

$\delta_{total} = \delta_1 + \delta_2$

(from Dr. Loshin"s course notes)



Some Useful Formulas

Snell's Law

$$nsin\theta = n'sin\theta'$$

Relationship between Internal Angles and Apical Angle

$$\gamma = \theta_1^{'} + \theta_2$$

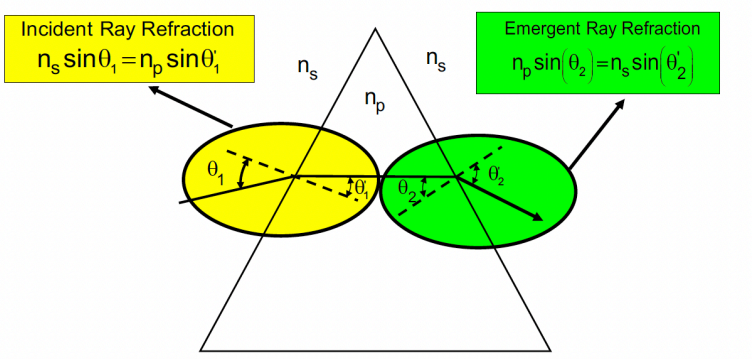
Total Deviation

$$\delta = \delta_1 + \delta_2 \qquad \delta = \theta_1 + \theta_2^{'} - \gamma$$

Types of Prism Problems

Refraction (deviation) at Prism Surfaces
Total Deviation of Prism
Incident Ray Normal to First Refracting Surface
Emergent Ray Normal to Secondary Refracting Surface
Critical Angle & Limiting Ray

Use Snell's Law for Refraction at each Prism Surface

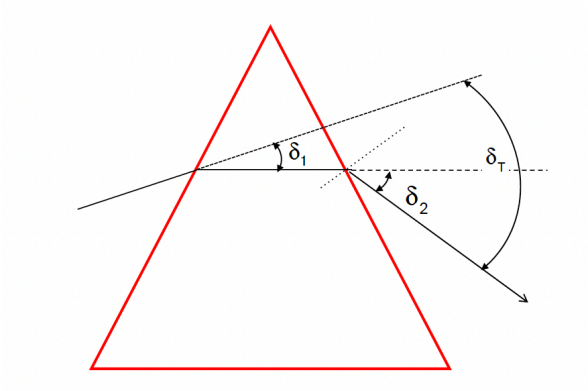


(from Dr. Loshin's course notes)

The Relationship between Internal Angles and Apical (Refracting) Angle

$$\gamma = \theta_1^{'} + \theta_2$$

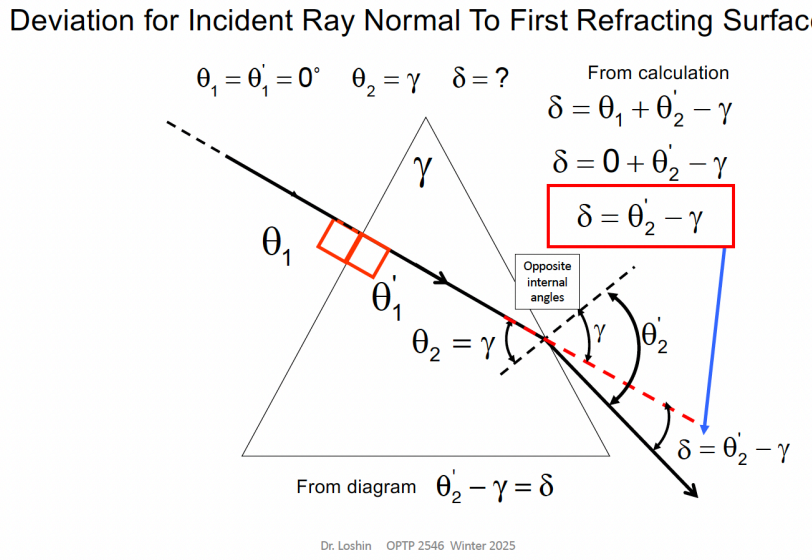
Total Deviation



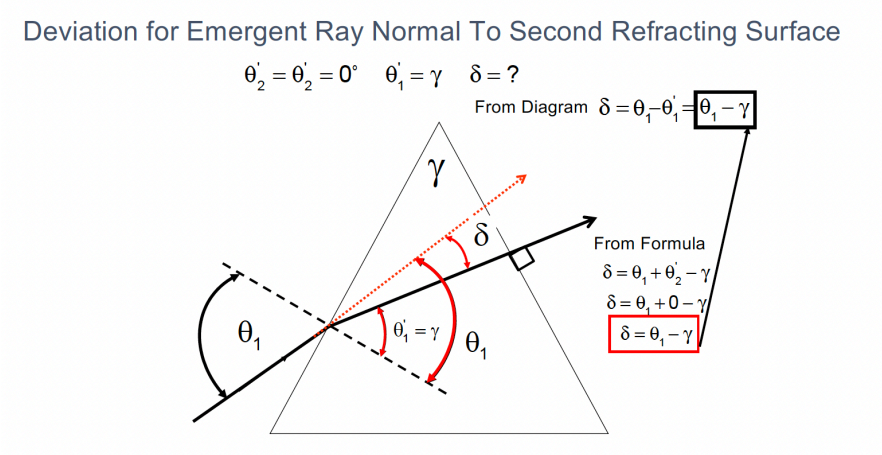
(from Dr. Loshin's course notes)

$$\delta = \delta_1 + \delta_2$$
$$\delta = \theta_1 + \theta_2' - \gamma$$

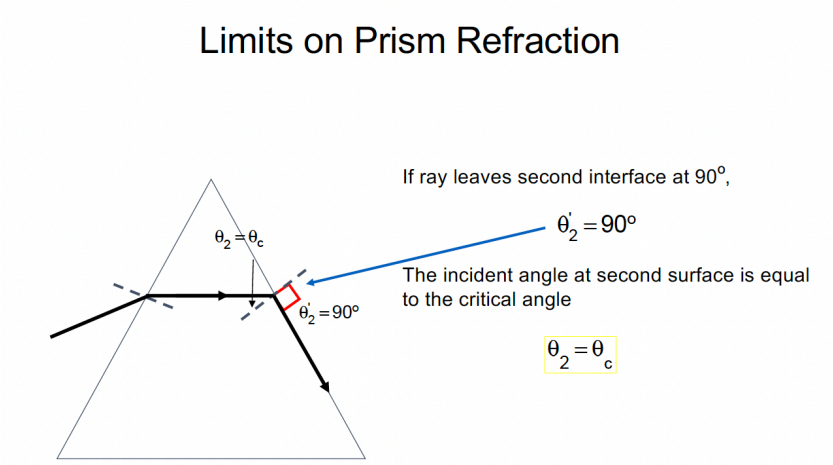
Incident Ray Normal to First Refracting Surface

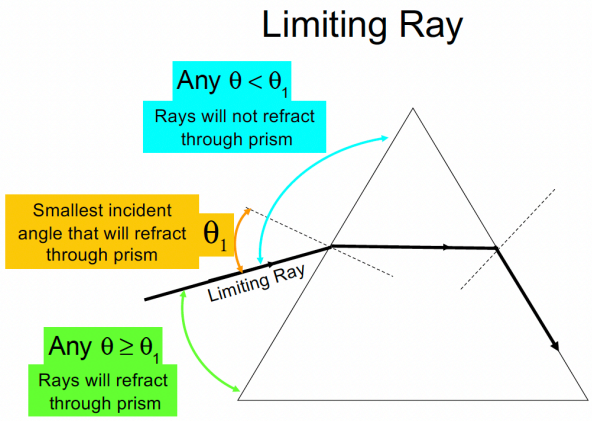


Deviation of Ray Normal to Secondary Refracting Surface



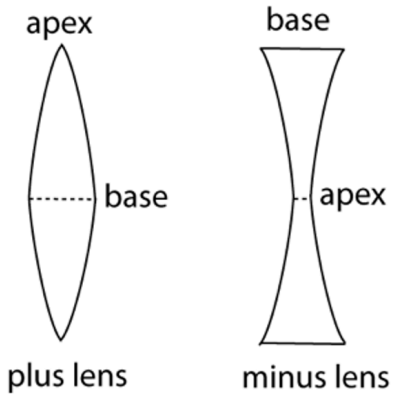
Limits on Prism Refraction





Ophthalmic Prisms

Prisms used for Visual Correction & Testing



For small apical angles (<15 degrees) sin = tan = angle in radians

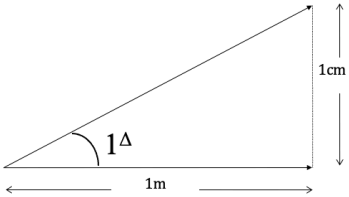
Prism Diopter

Prism used in Optometric Practice are specified in Prism Diopters

1 Prism Diopter creates 1cm of displacement at 1 meter

Prism Diopter

Displacement in centimeters at distance of 1 meter (100cm)



1 prism diopter = displacement of 1cm at 1 m

Converting to Prism Diopters

$$\delta^{\Delta} = 100\ tan\delta^{\circ}$$

$$1^{\Delta} = 1.75^{\circ}$$

Deviation of Prism in Prism Diopters (when γ is in degrees)

$$\delta^{\Delta} = 100(n_p - 1)tan\gamma^{\circ}$$

Chapter 3 Additional Problems

Types of Prism Problems

Refraction (deviation) at Prism Surfaces
Total Deviation of Prism
Incident Ray Normal to First Refracting Surface
Emergent Ray Normal to Secondary Refracting Surface
Critical Angle & Limiting Ray

Refraction (deviation) at Prism Surfaces

1. What is the angle of emergence of a prism with an apical angle of 40 degrees made of an optical material with an index of 1.580 if the angle of incidence is 50 degrees?

Total Deviation of Prism

2. What is the total deviation of the prism in problem 1?

Incident Ray Normal to First Refracting Surface

3. What is the deviation for a prism with an apical angle of 35 degrees and an index of refraction of 1.50 for a ray incident normal to the first surface?

Emergent Ray Normal to Secondary Refracting Surface

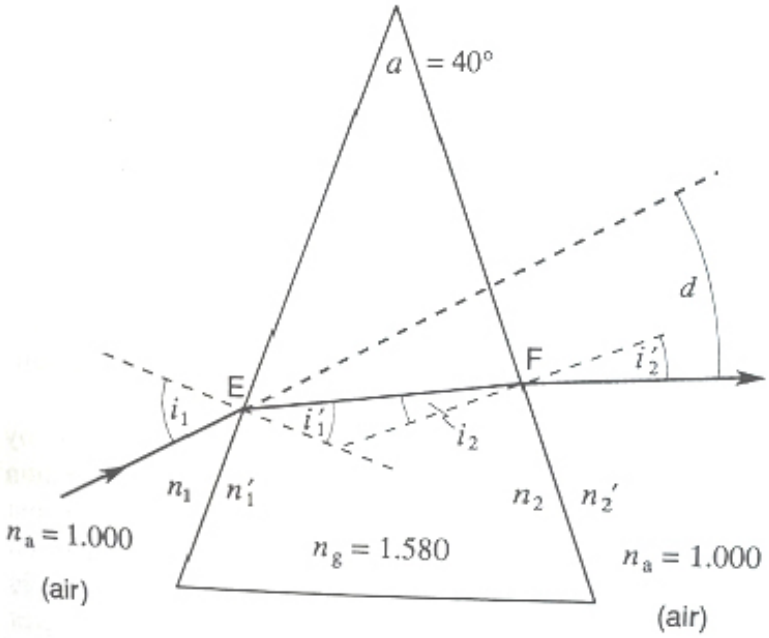
4. What is the incident angle (at first refracting surface) of a ray that emerges from a prism normal to the secondary refracting surface if the prism has an apical angle of 25 degrees and an index of refraction of 1.50?

Critical Angle & Limiting Ray

5. What is the limiting angle (incident angle at first surface) for a prism that has an apical angle of 60 degrees and an index of refraction of 1.50?

Refraction (deviation) at Prism Surfaces (Problems 1 & 2)

1. What is the (1) angle of emergence and (2) total deviation of a prism with an apical angle of 40 degrees made of an optical material with an index of 1.580 if the angle of incidence is 50 degrees?



Given:
apical angle = 40°
$n_p = 1.580$
$i_1 = 50°$

Find:
i_2' and d

Incident Ray Normal to First Refracting Surface

3. What is the deviation for a prism with an apical angle of 35 degrees and an index of refraction of 1.50 for a ray incident normal to the first surface?

Emergent Ray Normal to Secondary Refracting Surface

4. What is the incident angle (at first refracting surface) of a ray that emerges from a prism normal to the secondary refracting surface if the prism has an apical angle of 25 degrees and an index of refraction of 1.50?

Critical Angle & Limiting Ray

5. What is the limiting angle (incident angle at first surface) for a prism that has an apical angle of 60 degrees and an index of refraction of 1.50?