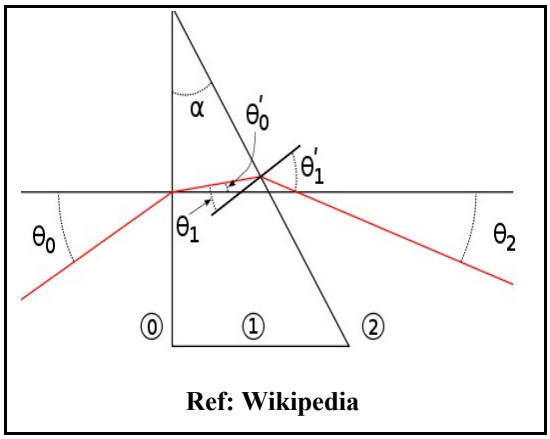
# (eo211) 2. Changes In Angle And Displacement Due To Lens And Prisms

Translation by J D White,

## 1. Purpose

a. To find the smallest angle that a prism will refract a beam of light and determine the prism's refractive index at that wavelength.
b. To determine the path deviation introducted and the index of refraction of a piece of glass placed in a laser beam
c. To understand the path of light through convex and concave lens, understand the differences in focal point between the two lens and final to understand the relationships between objects and images for these lens.

## 2. Theory Summary (see Chinese)



Ref: Wikipedia

### 2.1 Prism

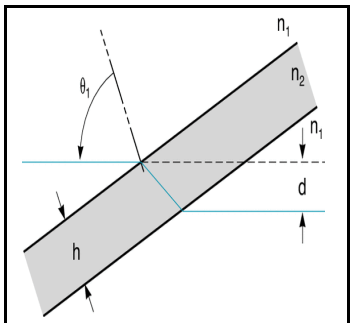
$$n = \frac{\sin\theta_0}{\sin\theta_2} = \frac{\sin\left(0.5\left(\delta_m + \alpha\right)\right)}{\sin\left(0.5\alpha\right)}$$

where n is the refractive index of the prism, $\delta_m$ is the minimum value of the deviation of the light beam from a straight path, I.e, $\delta = \theta_o + \theta_2 - \alpha$. takes on a minimum value. See http://en.wikipedia.org/wiki/Prism_(optics)

### 2.2 Glass

$$d = h \sin\theta \left[1 - \frac{\cos\theta}{\sqrt{\left((n_2/n_1)^2 - \sin^2\theta\right)}}\right]$$

where s is the displacement of the beam, h is the thickness of the media (glass plate), n is the refractive index of the media, and d is the displacement of the diffracted beam and θ is the incident angle on the glass surface



Ref: Newport Catalogue

### 2.3 Lens

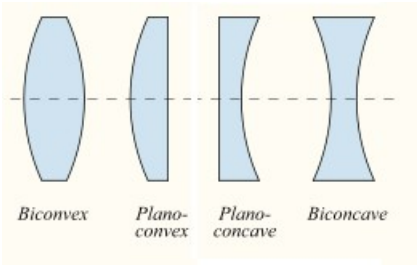
$$\frac{n}{o} + \frac{n}{i} = \frac{n}{f} = \left(n_g - n\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$ in air, n=1.

## 3. Experimental Introduction

a. Find the minimum diffraction/refraction angle and index of refraction of a 60-60-60 prism
b. Using a plate of glass, observe the propagation of light in different medium and calculate the refractive index of glass.
c. Using parallel beams of light, find the focal points of concave and convex lens.

## 4. Equipment

1. Optical Teaching Equipment,
2. Prism,
3. Glass plate,
4. Lens types:
   i. biconvex, USED
   ii. plano-convex, NOT USED
   iii. plano-concave, USED
   iv. biconcave, NOT USED



Fg. Lens Types

## 5. Procedure

a. Prism Work

b. Glass Slide
c. Lens

# 6. Results

## 6.1 Prism

**Table 1: Prism**

| Measured Smallest Angle ($\delta_m$) | | | | | | | | | | $<\delta_m>$ | n |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Try 1** | **Try 2** | **Try 3** | **Try 4** | **Try 5** | **Try 6** | **Try 7** | **Try 8** | **Try 9** | **Try 10** | | |
| | | | | | | | | | | | |

## 6.2 Glass

a. Measure the thickness of the glass using different methods:

Reading with Ruler: _____ Reading with Micrometer: _____

b. Fill in the table 2 to obtain the refractive index of the glass

**Table 2: Glass**

| Try | Entrance Angle (θ) | Displacement (d) | n | average |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |

## 6.3 Convex Lens: Relationship of focal length and image for convex lens

a. Data Set 1: Biconvex

Measured focal length: _____cm

| | o>2f | o > 2f | 2f > o > f | o=f | o<f | Average (cm) |
|---|---|---|---|---|---|---|
| i distance | | | | | | |
| o distance | | | | | | |
| calculated f | | | | | | |
| erect/inverted image? | | | | | | |
| magnification | | | | | | |
| true/virtual image | | | | | | |

b. Data Set 2: Rotate the convex lens 180 degrees and repeat

Measured focal length: _____cm Calculated focal length average: _____cm

| | o>2f | o > 2f | 2f > o > f | o=f | o<f | Average (cm) |
|---|---|---|---|---|---|---|
| i distance | | | | | | |
| o distance | | | | | | |
| calculated f | | | | | | |
| erect/inverted image? | | | | | | |
| magnification | | | | | | |
| true/virtual image | | | | | | |

## 6.4 Concave lens: Replace convex lens with concave lens

a. Data Set 1: concave-plano

Measured focal length: _____cm

| | o>2f | o > 2f | 2f > o > f | o=f | o<f | Average (cm) |
|---|---|---|---|---|---|---|
| i distance | | | | | | |
| o distance | | | | | | |
| calculated f | | | | | | |
| erect/inverted image? | | | | | | |
| magnification | | | | | | |
| true/virtual image | | | | | | |

b. Data Set 2: Rotate the concave lens 180 degress and repeat (plano-concave)

Measured focal length: _____cm

| | o>2f | o > 2f | 2f > o > f | o=f | o<f | Average (cm) |
|---|---|---|---|---|---|---|
| i distance | | | | | | |
| o distance | | | | | | |
| calculated f | | | | | | |
| erect/inverted image? | | | | | | |
| magnification | | | | | | |
| true/virtual image | | | | | | |

## 7. In Class Questions.

1.
2.
3.
4. A candle that is 6 cm tall is standing 10 cm from a thin concave lens whose focal length is -30 cm. Determine the location of the image and describe it in detail.
5. We would like to place an object 45 cm in front of a lens and have its image appear on a screen 90 cm behind the lens. What must be the focal length of the appropriate positive lens?

## 8. Homework Questions