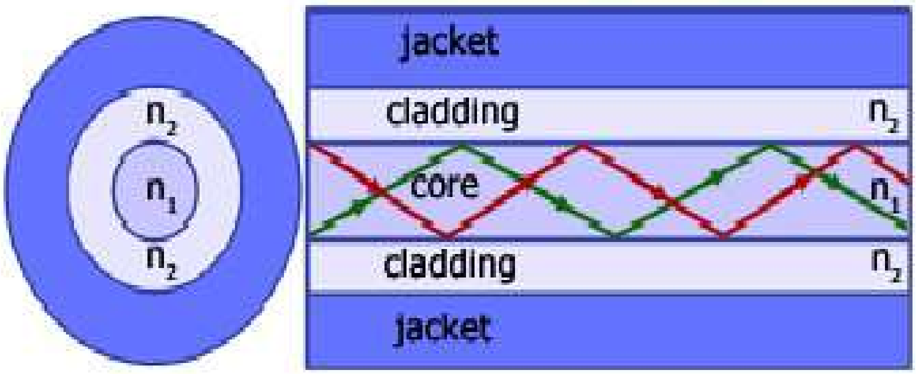
Optical Fibers

Optical fiber typically consists of a **core** of high refractive index surrounded by **cladding** with a lower refractive index. Light is totally internally reflected down the fiber at the boundary of the two media



Optical fiber has a number of advantages over copper :wire

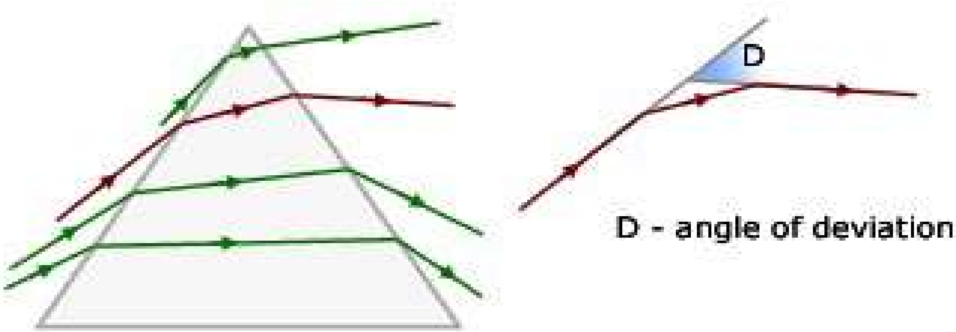
less attenuation.1
can carry more information .2
immune to electrical interference .3
safer - no fire risk as with electric currents .4
wire-tapping more difficult .5

Prisms-3

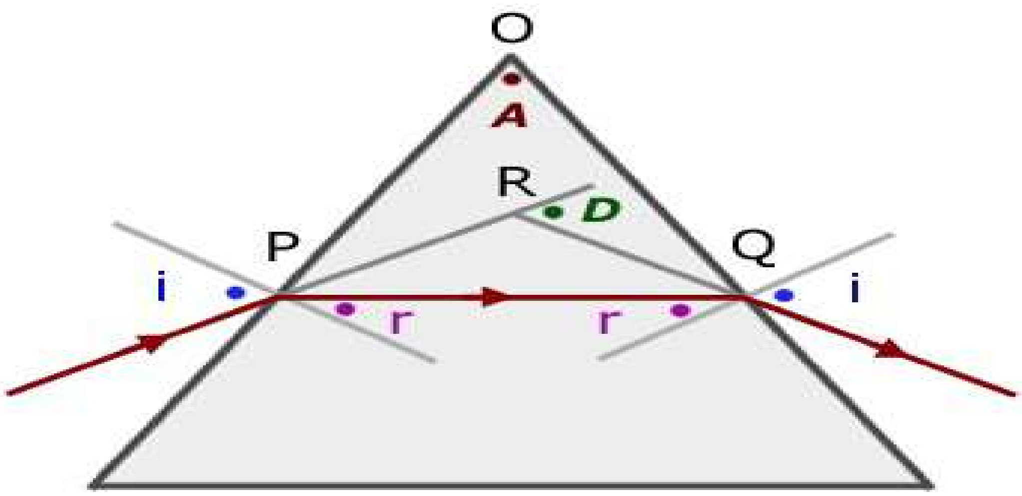
deviation.3-1

Deviation, measured in degrees, is the angle an incident ray is turned through after passing through a prism(or .other optical component)

This deviation is a minimum for a prism when the path .of a light ray is symmetrical about its axis of symmetry

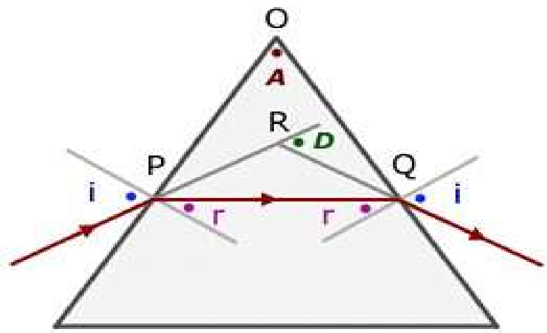


Derivation of Minimum Deviation.3-2
D



$\triangle PQR$

Derivation of Minimum Deviation *D*



In $\triangle PQR$

$$D = \angle RPQ + \angle PQR \qquad \text{(i}$$

(D external angle of $\triangle PQR$)

around points **P** and **Q** respectively,

$$i = \angle RPQ + r \qquad i = \angle PQR + r$$

$$\angle RPQ = i - r \qquad \angle PQR = i - r$$

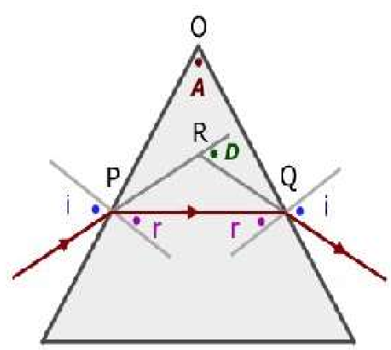
substituting into equation (i

$$\therefore\ \underline{D = 2(i - r)} \qquad \text{(ii}$$

In $\triangle OPQ$

$$A + \angle OPQ + \angle PQO = 180^\circ$$
$$A + (90^\circ - r) + (90^\circ - r) = 180^\circ$$

$$\underline{A = 2r} \qquad \text{(iii}$$



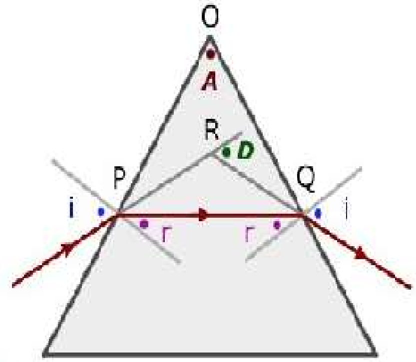
adding together equations (ii & (iii,

$$A + D = 2r + 2(i - r)$$
$$= 2r + 2i - 2r$$
$$= 2i$$

$$\underline{i = \frac{A + D}{2}} \qquad \text{(iv}$$

rearranging equation (iii,

$$r = \frac{A}{2} \qquad \text{(v}$$



Using Snell's Law equation,

$$n_1 \sin(i) = n_2 \sin(r)$$

and substituting for i and r from equations (iv & (v above,

$$n_1 \sin\left(\frac{A+D}{2}\right) = n_2 \sin\left(\frac{A}{2}\right)$$

n_1 is the refractive index of air which approximates to 1. Hence the equation becomes:

$$\sin\left(\frac{A+D}{2}\right) = n_2 \sin\left(\frac{A}{2}\right)$$

Example •

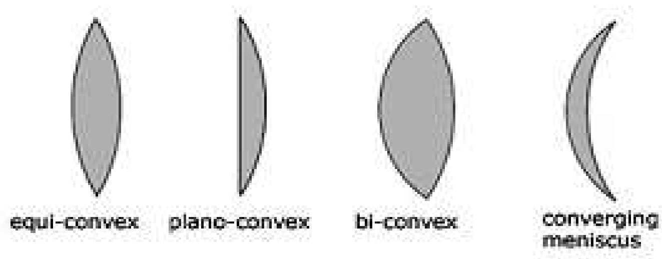
So for a 60^{o} equilateral prism made of glass(n = 1.5 • approx.), the minimum deviation angle ***D*** is given :by

Chromatic dispersion 3-4

The term **Chromatic dispersion** describes how refractive index changes with wavelength for a particular medium

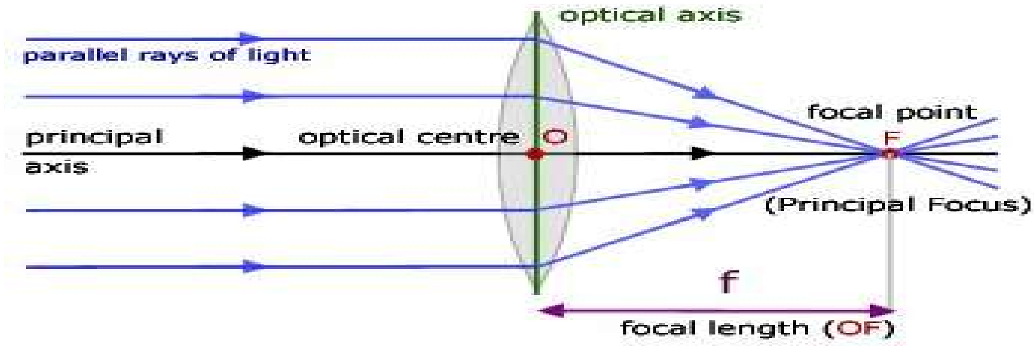
Convex Lenses -4

Types of lens



All four types of convex lens are converging lenses. That is, they bring parallel rays of light to a focus, producing a real image.

<u>Basic ray diagram</u> .4-2



The basic ray diagram for a convex lens introduces a number of important terms
principal axis - the line passing through the centers of curvature of the lens
focal length - the horizontal distance between the principal focus and the optical center of the lens
optical center - an imaginary point inside a lens through which a light ray is able to travel without being deviated
center of curvature - the center of the sphere of which the lens surface is part

<u>Power of a lens</u> 4-3
The power *P* of a lens is the inverse of its focal length *f*. Since *f* is measured in meters 'm' the units of lens power .are m^{-1}

$$P = \frac{1}{f}$$

The power also depends on the type of lens. **Convex** lenses have **positive** powers, while **concave** lenses all have **negative** powers

To understand ray diagrams it is important to know something
: about images. Images come in two categories
real images - are produced from actual rays of light coming to a focus (eg a film projected onto a screen)
virtual images - are produced from where rays of light appear to be coming from (eg a magnifying glass image)
note - the lens is considered to be so thin as to be represented by the axis of the lens(green)