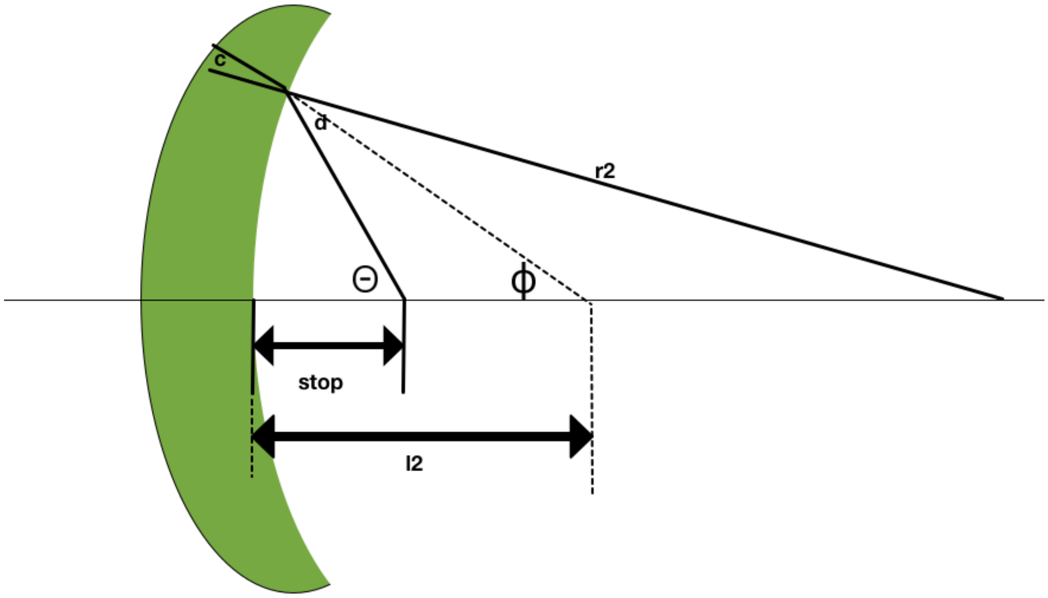


- *Please note that angle a, b, c, and d are used instead of i for incident and r for refraction.* From the image we will start the ray trace by finding the angle of deviation. This is done using the law of sines where the side opposite angle d (angle of refraction from the back surface) is the stop distance minus radius of the back surface. This is equal to $\frac{stop - r_2}{sin\theta}$. We will rearrange to solve for d.

$$\frac{(stop - r_2)}{sin\ (d)} = \frac{r_2}{sin\theta}$$

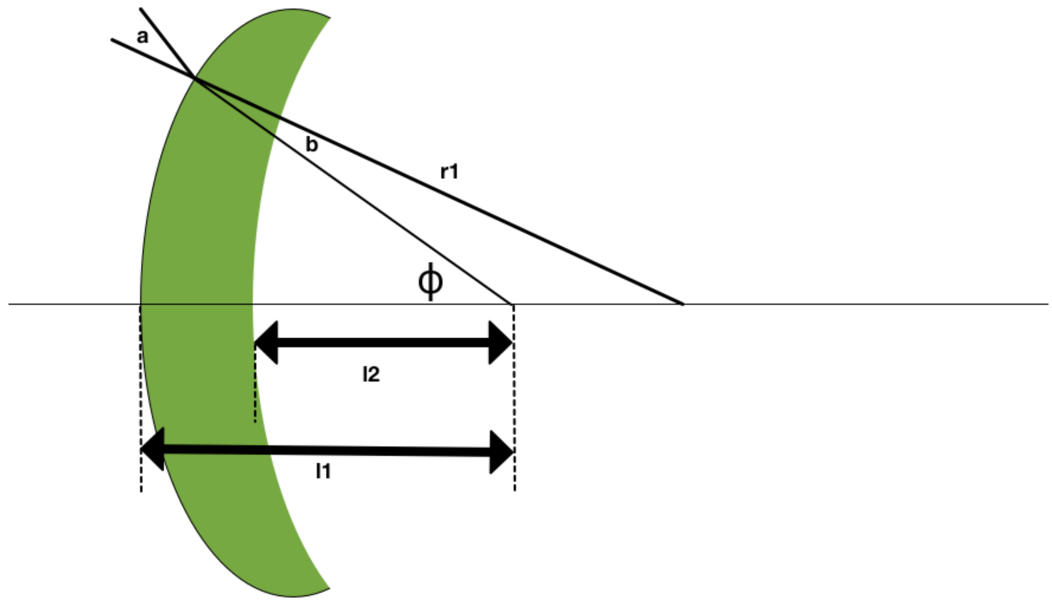
$$sin\ d = \frac{(stop - r_2) sin\theta}{r_2}$$

$$d = sin^{-1}[\frac{(stop - r_2) sin\theta}{r_2}]$$

- Continuing with the trace we can find the angle of incidence using Snell's Law $n\ sin\ i = n\ sin\ r$, where angle r is angle d in the above equation and we will solve for i using the variable c. We can find c by $c = sin^{-1}(\frac{sin\ d}{n})$
- We now need to determine our angle of refraction from the front surface. You can see, from the image, that angle ϕ is created on the optical axis from the front surface. It also falls on the optical axis at a different point than the stop

distance. $\varphi = \theta + a - c$

- Now we can use the law of sines, similar to what we did for angle d to find l_2 and then l_1. $l_2 = (\frac{r2 \times sin\ c}{sin\phi}) + r2$



- $l_1 = l_2 + thickness$
- Now we will find the front surface angles. We will start by finding the angle of refraction. For the front surface we need to take the center thickness into account. We will add the center thickness to l_2 to get l_1. From here the formula will look the same as above.$b = sin^{-1}[\frac{(l_1 - r_1)sin\phi}{r_1}]$
- Now we use Snell's law again to find the angle of incidence of the front surface, substituting a for i and b for r. $a = sin^{-1}(sin\ b \times n)$
- The angle of incidence minus the angle of refraction is equal to the angle of deviation. We can obtain the angle of deviation for the front and back surfaces and add them together. $deviation = a - b + c - d$
- We can determine the prism power from the angle of deviation by $p = 100(tan(deviation))$
- Chromatic aberration will equal $CA = \frac{p}{v-value}$
- Using a +5.00 on an +8.00 base curve with 4.2 mm of center thickness, 27 mm stop distance, 30\$$^{\text{o}\$}$ viewing angle, a v-value of 36, in a material of 1.6. We need

to determine the radius from the back surface using the back vertex formula.

- $bv = D - (\frac{f_1}{1-(\frac{t_m}{n})f_1})$
- f_1 can be found by $f_1 = \frac{8.00\times(1.6-1)}{0.53} = 9.06$, now we can find the back vertex power and front radius.
- $r_1 = \frac{(1.6-1)}{9.06} = 0.0662\ m = 66.2\ mm$
- $bv = 5.00 - (\frac{9.06}{1-(\frac{0.0042}{1.6})9.06} = -4.28$ from the back vertex power we can get the radius of the back surface by $r_2 = \frac{1-1.6}{-4.28} = 0.1402\ m\ 140.2\ mm$

$$d = sin^{-1}[\frac{(27-140.2)sin(30)}{140.2}]$$

$$= -23.82$$

$$c = sin^{-1}(\frac{sin(-23.82)}{1.6})$$

$$= -14.62$$

$$phi = 30 + (-23.82) - (-14.62)$$

$$= 20.8$$

$$l_2 = \frac{140.2 \times sin(-14.62)}{sin(20.8)}$$

$$= 40.55$$

$$l_1 = 40.55 + 4.2$$

$$= 44.75$$

$$b = sin^{-1}[\frac{(44.75-66.25)sin(20.8)}{66.25}]$$

6.62

$$= -6.62$$

$$a = sin^{-1}(sin(-6.62) \times 1.6)$$

$$= -10.63$$

$$deviation = (-10.63) - (-6.62) + (-14.62) - (-23.82)$$

$$= 5.19$$

$$p = 100tan(5.19)$$

$$= 9.07$$

$$CA = \frac{9.07}{36}$$

$$= 0.25$$

Now we can compare it to a -5.00 on a +2.00 base curve with a 1.5 mm center with

$$d = -19.66$$

$$c = -12.14$$

$$b = -19.06$$

$$a = -31.50$$

everything else remaining the same.

$$deviation = 4.92$$

$$p = 8.6$$

$$CA = -0.23$$