National Academy of Opticianry

Continuing Education Course

Not Your Basic Prism

National Academy of Opticianry
8401 Corporate Drive #605
Landover, MD 20785
800-229-4828 phone
301-577-3880 fax
www.nao.org

Not Your Basic Prism
Advanced Prism

Diane F. Drake, LDO, ABOM, NCLEM, FNAO

First, let's review some of the prism basics. When inspecting a pair of mounted lenses, the optical centers should be located and measured. The distance separating the spotted optical centers should be compared to the patient's actual measured pupillary distance. With the exception of plano powers, if the spotted centers vary from the actual pupillary distance, the patient will experience *prismatic effect.*

Prismatic effect can be described as the visual discomfort which results when the optical center of a lens is not positioned directly in line with the optical axis of the patient's eye. When deviated light, as opposed to undeviated light, passes through the pupil, achieving a clear point focus is difficult if not impossible. This optical problem may be better understood by referring to a basic knowledge of prisms. If an object is viewed through a point on a lens other than through the optical center, then the situation becomes analogous to viewing that object through a prism of the same dioptric value as that of the lens in question. In remembering characteristics of lenses, light passing through a prism will be bent toward the base and the image will be displaced toward the apex. Therefore, an object viewed through a prism will appear to be displaced towards the apex. In the case of an object viewed with a single eye, a simple head or eye movement will re-align the object and the optical axis; no visual discomfort would result. However, a problem may result in the case of two eyes viewing a single object which is displaced in varying degrees and directions depending on the strength and type of lens. Under these circumstances, the eyes must utilize additional muscle action to achieve a single focus with both eyes. This additional exertion may result in eye strain. When the muscles are exerted beyond their ability to coordinate the two optical axes, double vision/diplopia and/or discomfort will result.

When verifying the distance PD against the optical center location on a pair of completed eyewear, it is not as simple as accepting or rejecting the eyewear based on the optical center measurement in millimeters when compared to the patient's distance PD. If the power in the lens is very low in the horizontal meridian, a PD that is incorrect may still be optically acceptable for the patient and could meet the ANSI horizontal prism tolerance. However, a lens of much higher power with the same incorrect PD would result in prismatic effect for the patient and would be unacceptable. You may wish to review prism and power in specific meridians.

Prismatic Effect

One particular reason for a patient having difficulty with adapting to new eyewear is unwanted prismatic effect. When someone looks through any point on a lens other than the optical center, they are in effect looking through prism and they may experience some ocular discomfort if prism is not prescribed or needed. Without understanding prismatic effects in lenses, the optician/technician cannot effectively troubleshoot and problem solve. One of the first things that an optician/technician must check before attempting to design new lenses is whether or not prismatic effect exists in the old lenses. If a patient's current eyewear contains prismatic effect and they have adapted to it, and we make new eyewear using their correct PD, they may have difficulty adapting to the new eyewear. This means we need a game plan to help decide what will be best for the patient. A professional optician/technician cannot assume that the previous eyewear didn't have prescribed prism; he/she needs to know. That means communicating with the prescriber. At this point, the optician/technician must decide to remove the prism, reduce the prism, or leave unchanged the unprescribed prism. The final decision should be based upon the discussion with the refractionist/prescribing doctor. If the patient is uncomfortable with the presence of unprescribed prism, then fixing it in the new lenses should bring welcome relief.

Symptoms of excessive prismatic effects are commonly described to the dispenser as unpleasant effects often difficult to describe. An inexperienced optician/technician will tend to write off complaints to an overly sensitive patient. However, these symptoms should not be ignored because they are real, and a solution rests in a clear understanding of prism.

The professional optician/technician will recognize these issues and direct their attention to the most likely cause; excessive unwanted prism.

Prescribed Prism

Sometimes prism is unwanted and sometimes it is prescribed. Some examples of prescribed prism can be:

- Yoked prism
- Diplopia and/or Confusion
    - Phorias/tropias
    - Anisometropia
    - Testing with prism and/or slab-off
- Post Trauma
- Compromises in Visual Field
- Posture and Mobility
    - Head/neck position problems
- Reading – Bed Specs
- Others

In the case of a patient with esophoria or esotropia, base out prism can be prescribed. It may be all in one eye or split between the two eyes. If it is split between both eyes, the orientation for the prism will still be base out for both eyes. An example of "eso" correction in prescription would be:
OD: -2.00 - 0.25 x 180   1.50 D BO
OS: -2.25 - 0.50 x 175   1.50 D BO

In the case of a patient with exophoria or exotropia, base in prism can be prescribed. It may be all in one eye or split between the two eyes. If it is split between both eyes, the orientation for the prism will still be base in for both eyes. An example of "exo" correction in prescription would be:
OD: -2.00 – 0.25 x 180   D1.50 BI
OS: -2.25 -0.50 x 175   D1.50 BI

Visual field loss is sometimes treated with prism. It shifts an image from the blind area into an area of vision. The base is positioned in the blind area, which shifts the image toward the apex and into the seeing area. For example, a 2.0 diopter prism shifts an image approximately 1.0 degree.

Prism Notation

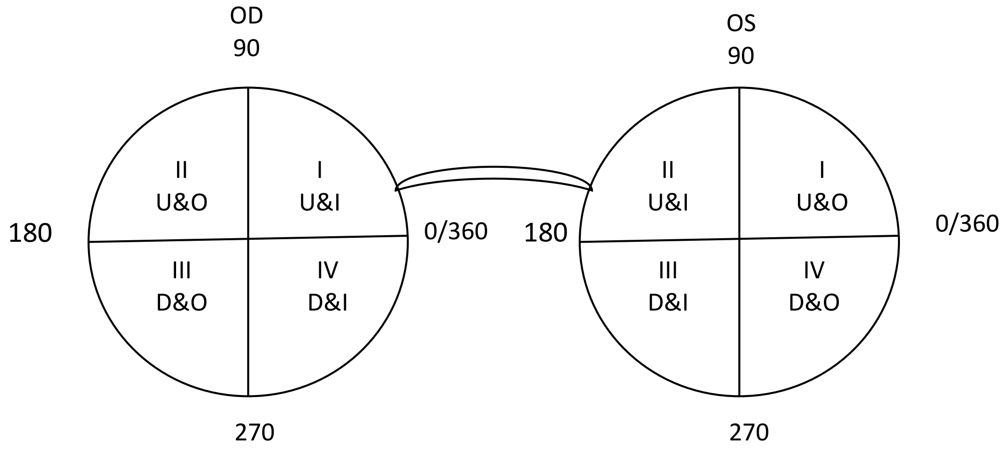
The symbol used to designate prism is the triangle (Greek Delta symbol Δ). Prism notation identifies the amount of the prism and the direction of the base of the prism. Prism notation may be identified in 360 degrees or a combination of ups, downs, ins, and outs.

Prism is not always only in one direction. Simple prism is up, down, in, or out. Horizontal imbalance occurs when the optical centers are either in or out from the patient's correct PD. Oftentimes, a patient will complain about their eyes pulling or eyestrain, and in verifying the eyewear, the dispenser finds that that the Rx checks out, the PD is correct, but the patient is still having problems. Marking the lenses may indicate that the vertical positioning is incorrect creating base up prism or base down prism. If it is approximately the same amount, and in the same direction, the patient may say that if they simply move the eyewear up or down, the vision improves. However, if the centers are unequal, double vision/diplopia will result. It should be noted that a patient has fewer problems with unwanted horizontal prism than with unwanted vertical prism.

The base of the prism is indicated by the Δ combined with the direction:

- Base in would be BI
- Base out would be BO
- Base up would be BU
- Base down would be BD

Compound prism would include two of these vectors. The chart below demonstrates the four vectors. The chart indicates the glasses as you would see them on a patient or read them in a lensmeter:



When you look at the chart, you will notice that the numbers are the same as you look at each side, however, the directions are different based on whether it is the right eye or the left eye. Always remember that up is always up, down is always down, in is always toward the nose and out is always toward the ear/temple. O degrees is always on the right side of the lens when facing the patient or the glasses in the lensometer/lensmeter/vertometer/focimeter with the temples facing away from you.

Examples are:

Excessive base down - complaints from patient can include:

- Floor (horizontal) seems concave
- Standing in bottom of a bowl
- Vertical objects seem taller
- Walking uphill

Exessive base up - complaints from patient can include:

- Floor (horizontal) seems convex
- Standing on top of a hill
- Vertical objects seem shorter
- Walking downhill.

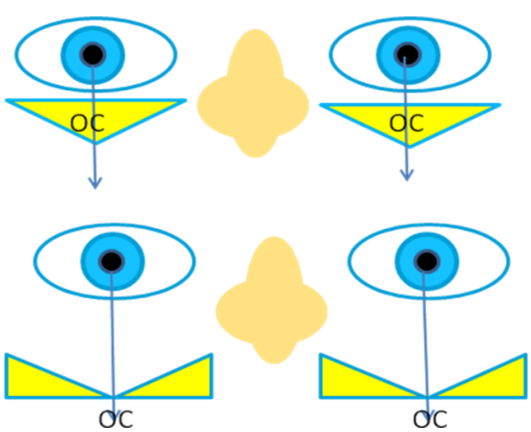
Excessive base in or base out - complaints from patient can include:

- Horizontal seems high towards base
- or/ low towards apex

Canceling and Compounding Prism

Unless prescribed, as previously mentioned, prism can cause dissatisfaction/discomfort for your patient. If there is no double vision or other deviation that needs correction, ideally glasses should create no prismatic effect.

Ideal Viewing Situation



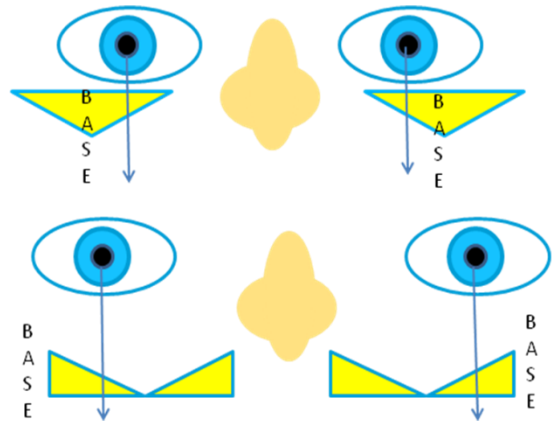
No prismatic effect will result when the optical centers are properly positioned over the patient's optical axis. If prism is not prescribed, this will achieve the best viewing result.

Prism Base out

If the optical centers are offset, visual discomfort may occur because the wearer is no longer looking through a properly positioned lens.

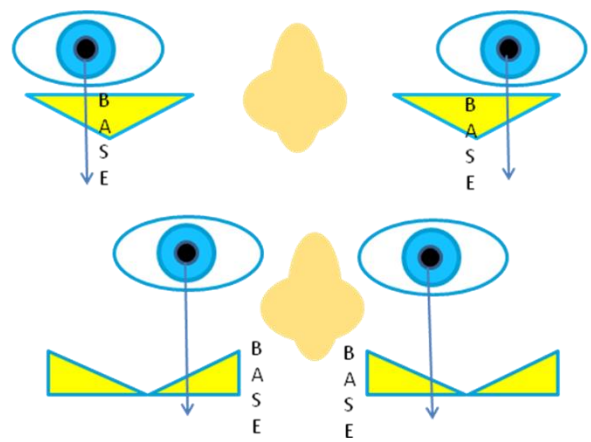
In effect, the wearer will be looking at the world through a prism.

In the example to the right, the base of the prism is positioned out, so the wearer experiences a shift in their vision as the image moves nasally toward the apex of the prism.



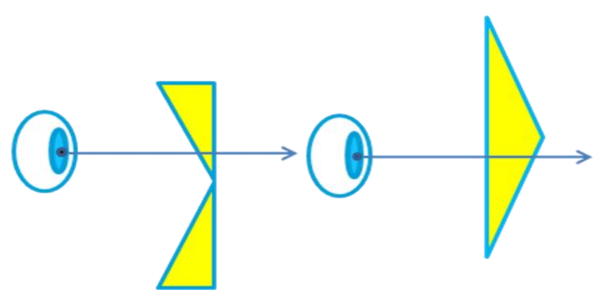
Prism Base In

In the example to the right, the base of the prism is toward the nose and the apex is positioned temporally. Therefore, the image is diverted temporally. The wearer experiences discomfort.



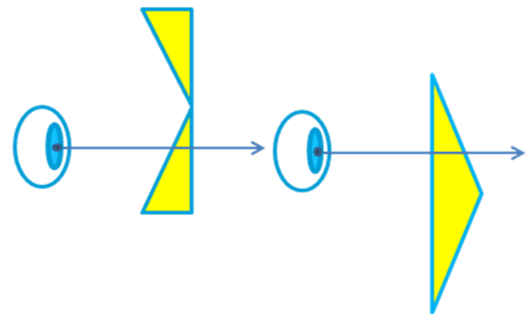
Prism Base Up

When a wearer is looking through the top of a minus lens or through the bottom of a plus lens, base up prism results. The effect to the wearer is that the image moves down. We also refer to this as image jump or image displacement.



Prism Base Down

When a wearer is looking through the top of a plus lens or through the bottom of a minus lens, base down prism results. The effect to the wearer is that the image moves up. We also refer to this as image jump or image displacement.



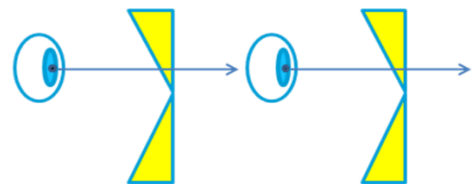
Canceling and Compounding

When viewing through the lens other than the optical center, the patient will experience unwanted prismatic effects. Depending on the power and distance from the optical center, the result may be canceling while others will compound the total result.

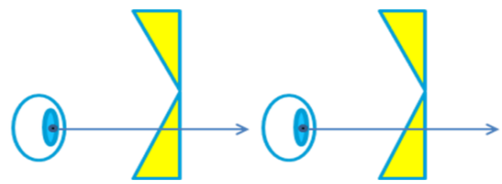
Canceling situations are:

- Base in & base out
- Base up & base up
- Base down & base down

BI & BO



BU & BU



BD & BD

Some canceling prism is used for specific purposes. Yoked prism is canceling prism. It is commonly used for prims thinning in lenses. Yoked prism is also commonly used for patients who misperceive their position in their spatial environment. They may lean forward, backward, or sideways. It can also be used for some patients with nystagmus, helping to bring the null point to a more comfortable position. Yoked prism is always used in both lenses, not just one lens.

Yoked prism can be used for a number of reasons. It would be identified as canceling prism.

An example of horizontally yoked prism would be:

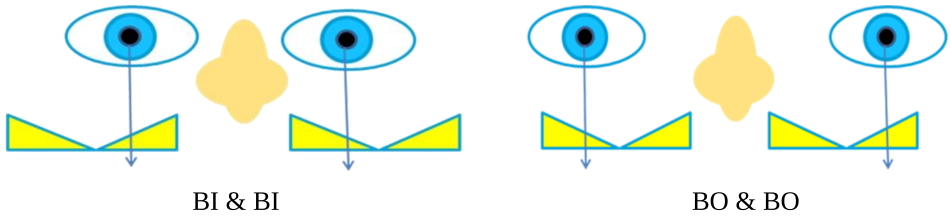
OD: -2.00 - 0.25 x 180   5.00 Δ BI
OS: -2.25 -0.50 x 175   5.00 Δ BO

An example of vertically yoked prism would be:

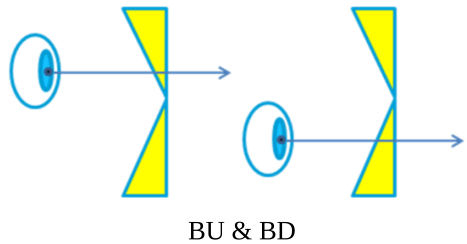
OD: +2.00 - 0.25 x 180   2.50 Δ BU
OS: +2.25 -0.50 x 175   2.50 Δ BU

Compounding situations are:

• Base in & base in
• Base out & base out



• Base up & base down



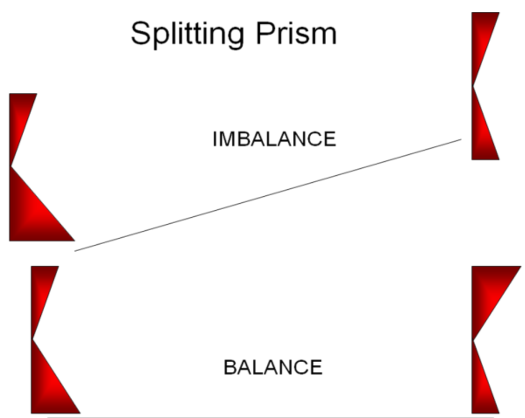
Splitting Prism

Splitting prescribed prism refers to the process whereby the dispenser balances the Rx. This may be done on the occasions that the doctor/refractionist prescribes prism in one eye only. In these prescriptions, the glasses will appear unbalanced in both thickness and weight.

The nature of splitting prescribed prism allows the dispenser to supply the full prismatic effect while balancing the lens by distributing the prescribed prism into both lenses.

For example, look at the following Rx:
O.D. -1.00 -0.25 X 180 10 Diopters Base Down
O.S. -1.00

- The optical alignment of the patient's eyes is not matched and therefore the prescribed prism enables fusion for good binocular vision
- The weight and look of the finished lenses are not balanced
- Splitting the prism allows for a better cosmetic look, as well as better weight balance



The rules are simple:

- Divide the amount of the prescribed prism into 2 parts
- Distribute one part into each eye
- Maintain the prescribed direction the same in the originally prescribed eye. Place the other part into the other eye in an opposite or compounding direction
- Splitting can be done for in, out, up or down prism as long as the rules of prism canceling and compounding are followed
- Always be sure to check with the doctor/refractionist before splitting prism. Most of the time it is fine, but occasionally there is a condition/concern with splitting prism

Splitting prescribed prism is done to balance the weight and cosmetic look of a pair of lenses.

Splitting prism is within the realm of a professional dispenser as long as it is discussed with the doctor/refractionist. If done properly, it maintains the directive of the written Rx and provides the correction without creating an uneven look to the finished lenses. The weight and look of the finished lenses are balanced by spitting the amount of the prism and ordering the lenses with the base direction the same as in the originally prescribed eye and opposite in the other.

Horizontal

Prism that is prescribed horizontally for one eye can be split to achieve balance as long as the other eye carries half of the prism in the same direction as in the prescribed eye. Be sure to check with the doctor/refractionist before doing this.

Vertical

When figuring vertical imbalance, the dispenser must weigh the prism and base direction in each eye in the 90-degree meridian. The total effect is that the combined effect is the amount that must be compensated.

When prism is prescribed in one eye only, the dispenser can split the amount in order to balance lens weight and thickness as long as the half that remains in the originally prescribed eye remains in the prescribed direction in that eye. Again, be sure to check with the doctor/refractionist before doing this. This approach will improve the overall cosmetic appearance.

Examples:

Original Prescribed Prism	*Split Prism*
OD 10 $^{\Delta}$BU	OD 5$^{\Delta}$BU
OS No prism	OS 5$^{\Delta}$BD

This example represents 10 total prism diopters. Since the original prescribed prism was <u>up</u> in the right eye, we keep the direction <u>up</u> in that eye and split the amount of 10 in half resulting in 5. Since we placed 5 in the left eye, it must be in the compounding position of base down.

Original Prescribed Prism	*Split Prism*
OD 10 $^{\Delta}$BD	OD 5$^{\Delta}$BD
OS No prism	OS 5$^{\Delta}$BU

This example represents 10 total prism diopters. However, in this example, since the original prescribed prism was <u>down</u> in the right eye, we keep the direction <u>down</u> in that eye and split the amount of 10 in half resulting in 5. Since we placed 5 in the left eye, it must be in the compounding position of base up.

More Examples of Splitting Prism

Sometimes there is prescribed prism in both lenses, one lens vertical and one lens horizontal. If the prism is fairly strong we can split the prism for the same reasons as previously discussed: weight, thickness, and appearance. The example below will demonstrate how the use of compounding prism will balance the two lenses:

Example:

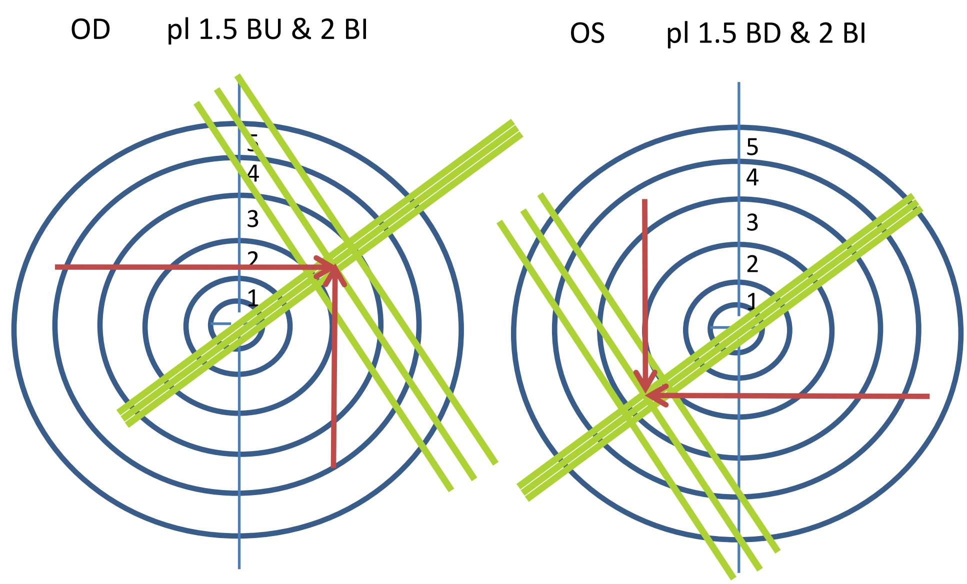
OD pl 3$^{\Delta}$BU
OS pl 4$^{\Delta}$BI

The best result would be the following:

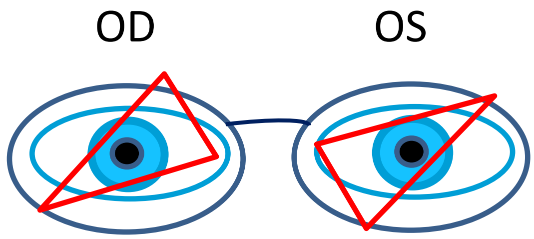
OD pl 1.5$^{\Delta}$BU & 2$^{\Delta}$BI
OS pl 1.5$^{\Delta}$BD & 2$^{\Delta}$BI

The example has vertical prism ordered in the right lens and none in the left, so you would split the 3 and give 1.5$^{\Delta}$ BU to the right lens and 1.5$^{\Delta}$ BD to the left lens Next, there is horizontal prism ordered in the left lens and none in the right. So again, split the 4, giving you 2$^{\Delta}$ BI in each lens.

The illustration below would demonstrate how the lenses should view in the lensometer:



The following illustration represents how the lenses will actually appear in the finished eyewear. Remember that the prism base location represents the thickest portion of the lens and the apex represents the thinnest portion of the lens. Another reason that this is done is to help avoid potential adjustment problems in the finished eyewear. As a professional dispenser, you should be able to visualize the finished product. This is a prime example of analysis and interpretation of a prescription before frame selection.



The important thing to remember in splitting prism, after discussion with the doctor/refractionist, is to ensure that if prism is prescribed in one direction in a specific eye, it must remain in the same direction in that eye and the opposite direction in the fellow eye. The combined amount must equal the originally prescribed prism.

Vertical Imbalance

In the presence of vertical imbalance as a result of anisometropia (unequal refractive errors), the patient will experience unequal amounts of base up or base down prism, depending upon the prescription. The eyes converge (move inward) when moving from distance to near viewing. When referring to unwanted prism, reference simply up or down for vertical or in or out for horizontal prism. For prescribed prism, the prism base could be up, down, in, out, or any combination thereof, which will be discussed shortly.

One method of showing prism base direction looks like cylinder power with a twist. It will show the total amount of prism and give a meridian for the base direction. The doctor/refractionist may prescribe prism that has both a vertical and horizontal component in the same lens. Rather than having prism ordered as up and in or down and out, it may be identified by how much prism is located at a particular meridian. Please refer back to the prism quadrants previously discussed in this section.

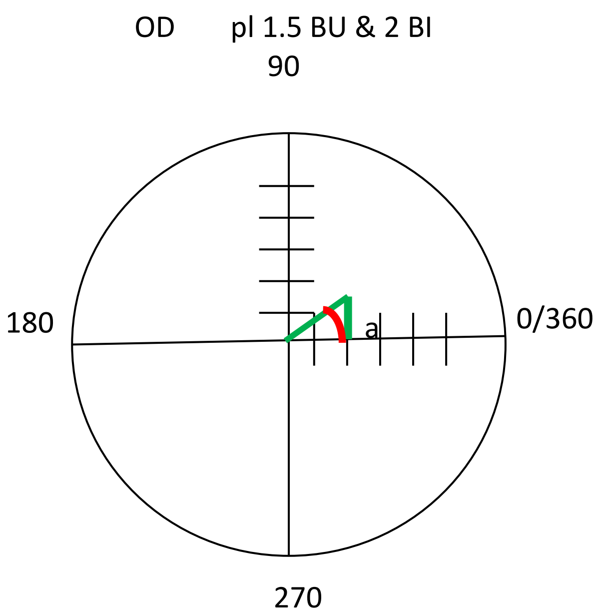
The doctor/refractionist may write the prescribed prism as follows:

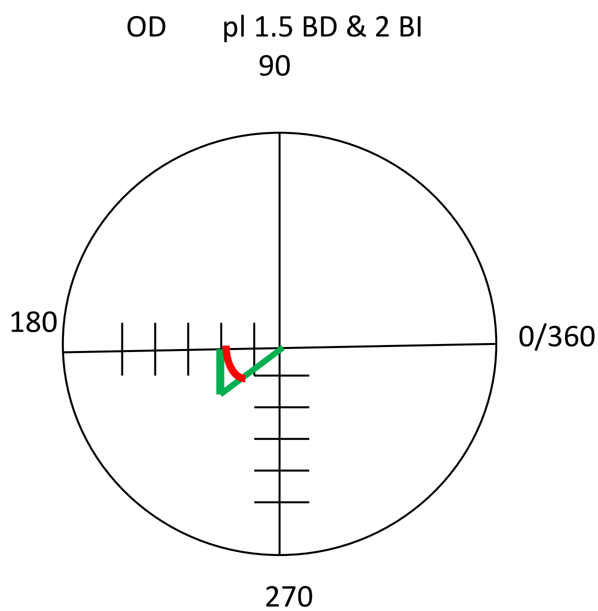
OD Pl 2.5$^{\Delta}$ @ 037
OS Pl 2.5$^{\Delta}$ @ 217

Or, some eyecare professionals like to write it like this:

OD Pl 2.5$^{\Delta}$ BU&I @ 037
OS Pl 2.5$^{\Delta}$ BD&I @ 217

How is the meridian location of the base determined? You may be able to chart it on a graph, and it would look similar to the illustration below. When you look in the lensometer, you may notice the degrees in the periphery of the reticle and that will work, but you need to be able to calculate it as well.





Once drawn, a protractor is needed to determine the meridian and the location of the resultant prism. Or you may use the resultant prism formula.

Resultant Prism

The formula is:

$$R = \sqrt{\text{Vertical Prism}^2 + \text{Horizontal Prism}^2}$$

Resultant prism is a term that refers to the resolved prism which results in a lens where two separate amounts of prism are prescribed in different directions in the same eye.

A prism diopter out and a prism diopter down in the same eye will actually be ground as a given amount ground between the axis of the originally prescribed prisms. The resolved amount of prism is determined by using the above formula. That amount of prism is then ground at the axis that is arrived at by drawing the diagonal of the parallelogram graphed using the prescribed prisms.

- First, identify how much prism. The resolved amount of prism is determined by using the above formula. That amount of prism is then ground at the axis that is arrived at by drawing the diagonal of the parallelogram graphed using the prescribed prisms
- For the right lens we have 1.5 diopters up and 2 diopters in in the right eye

Although we show the entire process, let's go through the steps using your scientific calculator. Begin by simply looking at the formula and plugging in the known values to the formula.

The resolved amount of prism is determined by using the above formula. That amount of prism is then ground at the axis that is arrived at by drawing the diagonal of the parallelogram graphed using the prescribed prisms.

The next level is straight forward. Look for your squared button with is x^{2}. Next, do the math. 1.5 squared is 2.25 and 2 squared is 4. Added together they are 6.25.

$$R = \sqrt{\text{Vertical Prism}^2 + \text{Horizontal Prism}^2}$$

Example 3 diopters in and 2 diopters up

$$R = \sqrt{1.5^2 + 2^2}$$

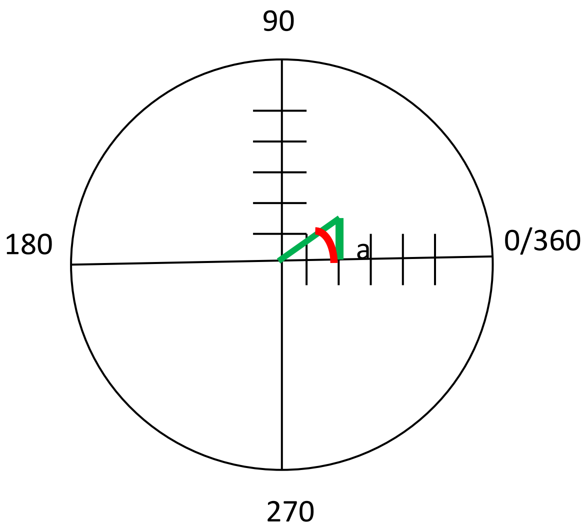
$$R = \sqrt{2.25 + 4}$$

$$R = \sqrt{6.25}$$

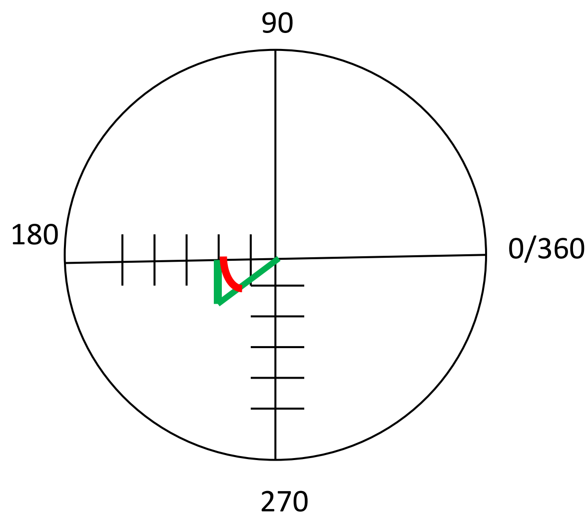
R = 2.5 diopters

Leaving 6.25 on your calculator, hit the square root symbol. The result will be 2.5 diopters. So now we know how much prism, but we don't know the degree.

OD pl 1.5 BU & 2 BI



OD pl 1.5 BD & 2 BI



The picture above shows it drawn on the lens again. However, this time please note the location of the resultant prism meridian, labeled above. The lines represent the resultant prism and form a right triangle. The resultant prism is the length of the longest line in the right triangle. This would also equate to the hypotenuse of a right triangle. The resultant formula shows that there are 2.5 prism diopters, but we need to know the degree of the axis, which is represented by the angle.

To find the meridian location, we use another formula: tan a = V/H. The first formula gave us the amount of the resultant prism; this one will give us the location of the resultant prism.

Each scientific calculator is a little different, so read the directions to be able to use your own. These are the steps for a few versions of a Texas Instrument scientific calculator:

tan a = V/H
tan a = 1.5/2
First divide 1.5 by 2 = .75 don't round yet
Then go to 2nd function on your calculator and then tan
The answer is 36.86989765 rounded to 36.87 = 37

Note: You may have a button on the calculator labeled "inv" or "arc" rather than using the 2nd function button.

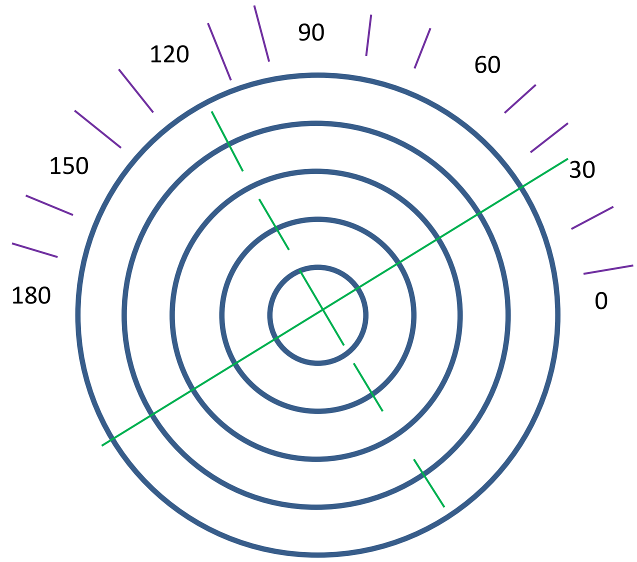
Look at your quadrants. If the answer falls within the quadrant you want, i.e. I, that is your answer. If, however, it is in another quadrant, you will add 90 to your answer for quadrant II, 180 to your answer for quadrant III, and 270 to your answer for quadrant IV.

For the right lens, the resultant prism is 2.5 D at 37°. Since viewing your quadrants from above, you will notice that your resultant prism falls within quadrant I, the degree is simply 37°.

Now work the formula for the left lens. The numbers are the same, so you will end up with 37°. Because the prism for the left lens is found in quadrant III, you will add 180 to 37° and get 217°. So, you will find the answer to be:

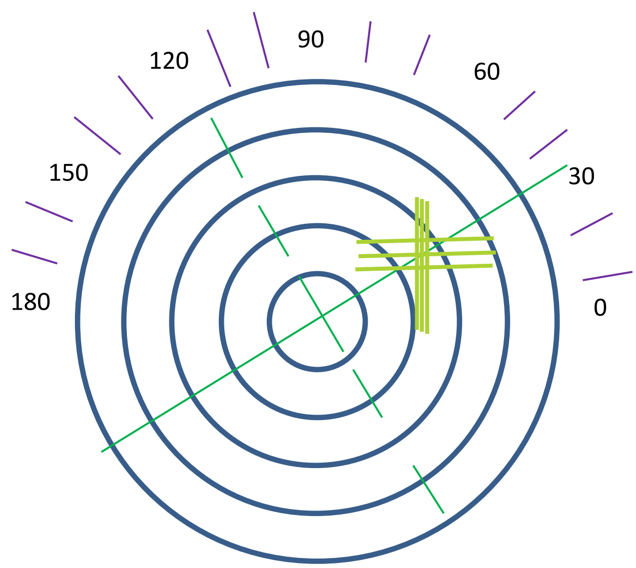
OD Pl 2.5^{Δ} @ 037°
OS Pl 2.5^{Δ} @ 217°

Look in the lensometer at the reticle. First, rotate the straight line around. Notice that there are degree markings around the top of the reticle. They usually go from 0 to 180, which is why one of our notations is based on 0 -180.



Rotate the line until it is at approximately 37 degrees. Depending on the manufacturer of the lensometer, you may be setting it at the second of the four small lines between 35 and 40, or you may be setting it at the seventh small line between 30 and 40. You are reading this scale just as if it were a ruler.

Look at the rings. The smallest ring may be 0.5, then 1, then 2, 3, 4, 5, and so forth, or they may start with 1. There may also be a 1.5 ring between the 1 and the 2. If there are no markings you have to refer to the manual that came with your lensmeter and find out what the rings represent.



Conclusion

As you can see there are a number of things regarding prism that you would need to look for and identify when both analyzing an Rx as well as when inspecting a pair of mounted lenses. In order to maximize your patient's vision, it is incumbent upon you, the optician/technician, to identify all of the concerns and then make recommendations as to how to improve the vision of your patient.

National Academy of Opticianry
8401 Corporate Drive #605
Landover, MD 20785
800-229-4828 phone
301-577-3880 fax
www.nao.org