Anisometropia in the 21st Century

A Primer in Dealing with Prism and Vertical Imbalance

by

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Course Objectives

Upon completing this two-hour, home-study course, the optician should:

- Be more aware of the increasing number of anisometropic prescriptions and be more proficient in providing adequate solutions for the problems relating to it.
- Have a deeper understanding of terms and conditions such as amblyopia, asthenopia, diplopia, strabismus, prism, and vertical imbalance.
- Know the function and limits of slab-offs and reverse slab-offs.
- Be exposed to and competent in the process of "diagramming" to more easily determine the direction of resultant prism.
- Quickly be able to identify "problem Rxs" regarding vertical imbalance.
- Be reminded of Prentice's Rule and consider using a more practical variation of it.
- Know when solutions other than bi-centric grinding must be implemented.
- Avoid certain language when educating your clients regarding anisometropia.
- Be aware of outside resources to continue research on vertical imbalance.
- Have achieved a score of 70% or higher on the 50-question assessment at the end of the course.

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A Primer in Effectively Dealing with Prism and Vertical Imbalance

Anthony D. Record

I Introduction

The problems associated with vertical imbalance are on the rise. One of the most performed procedures today is IOL (intraocular lens) surgery. Thousands of baby boomers become presbyopic every day. As a front-line optician, I am sure you are noticing more frequently patients who require that only one cataract be removed. Sometimes six months or a year or more goes by before the second one must be removed. Due to this ever-increasing phenomenon, an eye care professional must be ready to identify potentially "problem" prescriptions and be adept at suggesting effective solutions for his or her patients.

Consider the following spectacle Rx:

O.D. – 2.50 – 1.75 x 120 / add +2.50
O.S. – 1.00 – 0.50 x 033 / add +2.50

If you were asked to share all your observations about the prescription and the patient to whom it belongs, what are some of the things you might say? You would no doubt say that the patient is myopic (nearsighted); more so in the right eye than the left. The patient is also slightly astigmatic; also more so in the right eye than the left. You might observe that the axis of the cylindrical correction in the right eye is about 90-degrees different than the cylindrical correction of the left eye. You might also note that that is not uncommon. The patient is also presbyopic and requires the same near add in both eyes. You would probably start to think that depending on what frame choice has been made, some consideration should be given to thickness equalization; after all, without some modification the right lens would end up being more than twice the edge thickness of the left, which would probably be unacceptable to a patient, especially if the frame choice happens to be a three-piece, rimless drill mount. Do you have any other observations to share? Do you notice anything else? Did it dawn on you to say that this patient's prescription - while myopic, astigmatic, and presbyopic - is also anisometropic? Probably not.

Consider the following Rx:

O.D. + 2.00 – 1.00 x 090 / add +2.50
O.S. – 0.25 – 1.50 x 090 / add +2.25

Again, if asked to share all of your observations about this Rx and the patient to whom it belongs, what are some of the things you might say? You would no doubt say that, upon first observation, that this prescription is a little unusual. You would also notice that the patient is hyperopic (farsighted) in the right eye, and myopic in the left. You might observe that the axis of the cylindrical correction of the right eye is the same as the axis of the cylindrical correction of

the left eye. This patient is also presbyopic and requires a different near add in each eye. Though not unheard of, this is a bit unusual. Due to the difference in correction in each eye, you might start to think about the cosmetics of the final job. You might also say that you would call the prescriber's office to verify the unlike signs of the sphere, the differing adds, and to perhaps inquire about past eyeglass preferences. Do you have any other observations to share? Do you notice anything else? Did it dawn on you to say that this patient's prescription – while hyperopic, myopic, astigmatic, presbyopic, and unusual - is also antimetropic? Probably not.

The technical definition of *anisometropia* is a condition in which the two eyes have unequal refractive powers, meaning they are in different states of myopia or hyperopia, such as in the first example. In the extreme, the eyes have unequal refractive powers, that is, one eye is myopic, and the other is hyperopic. This condition is called *antimetropia*, as in the second example.

Based on those definitions, consider the following ten, single-vision prescriptions. Place an "x" on the line for each prescription that is anisometropic. Place an "o" on the line for each prescription that is antimetropic. If the prescription is neither anisometropic nor antimetropic leave the line blank.

1.____ O.D. – 2.50 – 2.25 x 010; O.S. – 1.50 sphere

2.____ O.D. – 1.00 – 0.25 x 155; O.S. – 2.00 – 1.00 x 122

3.____ O.D. +.50 sphere; O.S. +1.00 sphere

4.____ O.D. +1.50 – 1.00 x 085; O.S. +.50 + 1.00 x 175

5.____ O.D. – 5.75 – 0.50 x 100; O.S. – 4.00 sphere

6.____ O.D. – 0.75 – 0.50 x 123; O.S. + 0.50 – 0.25 x 005

7.____ O.D. +2.25 – 0.50 x 007; O.S. – 1.25 – 1.25 x 090

8.____ O.D. – 1.25 – 1.25 x 090; O.S. – 1.25 – 1.25 x 090

9.____ O.D. – 10.25 – 1.00 x 077; O.S. – 8.75 sphere

10.____ O.D. +0.75 sphere; O.S. +0.75 sphere

To understand the meaning of these two conditions more fully, one must only dissect the syllables of each word and understand their origins. The words are made up of four Greek elements. "An" means "not;" "iso" means "same;" "metr" means "measure;" and "opia" means "eye." Therefore, anisometropia simply means "not the same measure in each eye." Consider the three Greek elements that together form the word antimetropia. "Anti" means "against" (or differing); "metr" means "measure;" and "opia" means "eye." Therefore, antimetropia simply means "different measure in each eye."

In most cases, left uncorrected, differing rotations caused by significant anisometropia or antimetropia could lead to *diplopia* (double vision) or *asthenopia* (eye strain). Anisometropia can negatively impact the development of functional binocular vision in infants and children, resulting in a condition known as *amblyopia*, more commonly known as lazy eye. It is estimated that 6-8% of American children between the ages of 6-18 have some degree of amblyopia, while 2-3% of the total American population is affected.

II Amblyopia

As stated above, amblyopia is more commonly known as "lazy eye." Although only a relatively small percentage of people are amblyopic, left uncorrected, it can have devastating consequences for the people who are affected. Left uncorrected, central vision will fail to develop in one eye, which is then referred to as the amblyopic (or "lazy") eye. Left untreated, amblyopia can lead to functional blindness in the affected eye. Although the amblyopic eye technically can see, the brain in essence disregards all information sent to it from the lazy eye, because it is "faulty" information. The images sent from the "bad" eye are blurry, so the brain tends to go with the images sent by the "good" or dominant eye. Since this condition usually develops before the age of six, parents, other family members, teachers, or day-care workers are usually the ones who first notice the signs and symptoms of amblyopia. These may include general overall poor visual acuity, eyestrain, headaches, squinting, or even intermittently closing of one eye.

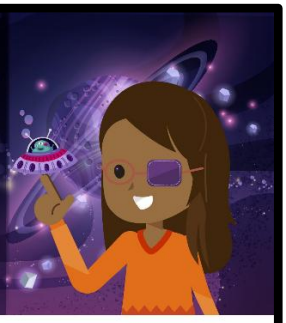
Amblyopic children can be treated with vision therapy (which often includes patching one eye), atropine eye drops, the correct prescription for nearsightedness or farsightedness, or in extreme cases even surgery. The causes of amblyopia include a variety of uncorrected refractive errors (including myopia or hyperopia), ocular trauma, or *strabismus*.

Strabismus is a condition in which the eyes do not look toward an object together. One eye looks at the object normally, while the other eye looks in (esotropia), out (exotropia), up (hypertropia), or down (hypotropia). A patient affected by esotropic strabismus is sometimes said to have crossed eyes. Strabismus is caused by an irregular pulling or paralysis of the ocular muscles. Many infants appear to have crossed eyes. This is simply due to undeveloped vision and is not true strabismus. True strabismus will not disappear as the child matures.

One of the best resources for kids and parents living with amblyopia may be found at the Prevent Blindness America website. Follow the link below which features tips and techniques for promoting compliance, stories from and about children who are patching, and helpful advice from eye care professionals. You may access this free, worthwhile resource using the following link: https://preventblindness.org/why-the-eye-patch/. If you have access to the Internet, take a few minutes right now to familiarize yourself with this resource and perhaps begin to recommend it to your clients. I also recommend you download and print the image below. It is available at the website, and you could easily feature it in a handout, brochure, or poster for your amblyopic, juvenile patients and their caregivers:

Helpful hints for amblyopia and eye patching

Amblyopia treatment can be difficult for children as well as for their parents or caregivers. Showing patience and modeling a positive attitude goes a long way, but these tips can also help.



EXPLAIN!
If your child is old enough, explain how serious her vision problem is and why following the treatment plan matters.

DECORATE PATCHES!
Kids love feeling special. Let them decorate patches with crayons, markers, or stickers. Create fun holiday designs together and enjoy the process!

READ!
There are a number of good children's books on amblyopia. Check your local library.

PLAY!
Patch a favorite doll or stuffed animal.

SOOTHE!
Some children have skin that is sensitive to patch materials or adhesives. Look for patches that do not use the irritating material or consider using a cream beforehand to prevent irritation or after patching to soothe the skin.

PROTECT!
Preventing eye injuries is crucial, especially for kids with weaker eyes. Use polycarbonate lenses and wear eyeguards or faceshields during sports.

INVESTIGATE!
Learn about your child's vision problem using all available resources. Ask your eye doctor, visit the library, or search online.

ENLIST HELP!
Talk to your child's teachers about the vision issue. They can help support your child and explain the situation to classmates, making the classroom more comfortable.

Find out more about amblyopia and tips for eye patching at: PreventBlindness.org/amblyopia

Prevent Blindness | National Center for Children's Vision and Eye Health, Prevent Blindness

III Significant Anisometropia

As the ten prescriptions in the introductory section clearly illustrate, going by the strict definition of anisometropia, most spectacle prescriptions in existence these days could be considered anisometropic. As front-line eye care professionals, dispensing opticians must be able to differentiate between significant anisometropia and insignificant anisometropia. For the purposes of this module, we will define *significant anisometropia* as a prescription that requires something other than a typical solution to correct for it; simple convex (plus lenses), concave (minus lenses), or cylindrical (astigmatism-correcting lenses) will not suffice.

If faced with the following five spectacle prescriptions/scenarios, which one(s) would you think should be considered "significant anisometropia," in that you would suggest a special correction (e.g., a slab-off grind) for your patient? Place an "x" on the line for each that you think do require that kind of special attention; if not, leave the line blank:

1. ____ A 16-year-old girl with the following Rx:
   OD: + 1.75 sphere = 20/20
   OS: - 3.00 -1.00 x 090 = 20/25+

2. ____ A 43-year-old emerging presbyope purchasing his first pair of progressive lenses, with the following Rx:
   OD: + 2.75 - 1.00 x 023; add +1.75 = 20/30-2
   OS: +1.00 sphere; add +1.75 = 20/20-1

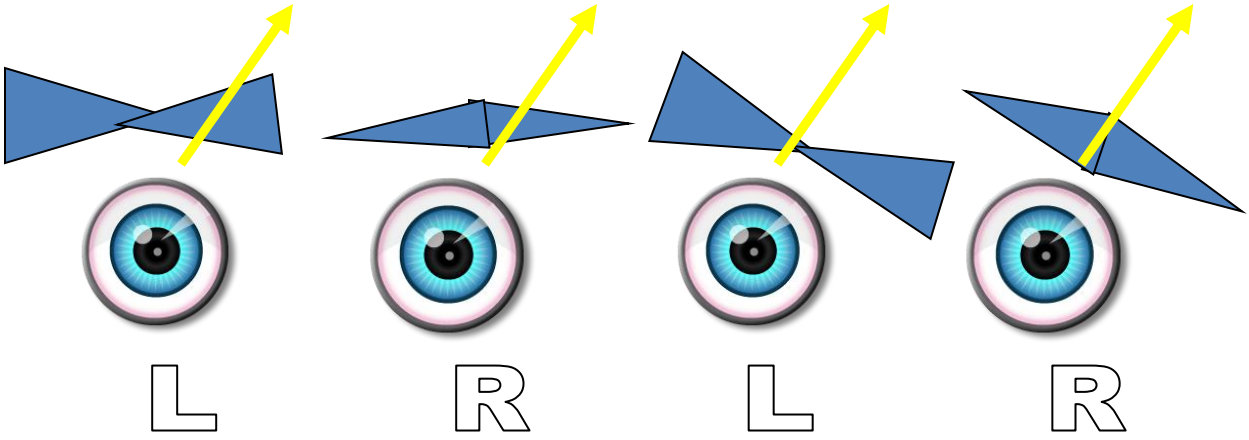
3. ____ A 53-year-old patient who has been successfully wearing the following Rx in Varilux Comfort, polycarbonate lenses with no slab-off prism for the past three years:
   OD: -5.50 - 2.00 x 153; add +2.25 = 20/20
   OS: +2.00 - 1.00 x 005; add +2.25 = 20/25-1; whose prescription has now changed to the following:
   OD: -7.00 -1.00 x 155; add +2.75 = 20/20
   OS: +2.50-1.25 x 069; add +2.75 = 20/20

4. ___ An 8-year-old girl who will soon be wearing her first pair of prescription, single-vision eyeglass lenses. Here is her Rx:
   OD: -2.25 sphere = 20/15
   OS -+3.00 - 1.50 x 090 = 20/20

5. ___ A 61-year-old man who is ordering his first pair of prescription eyeglasses following a successful intraocular lens implant in his right eye. The patient's ophthalmologist has informed him that his left eye only has a "baby cataract," that will probably not be "ripe" for another three years. Here is his prescription:
   OD: -1.00 - 0.50 x 090; add +2.50 = 20/20-2
   OS: +4.50 sphere; add +2.50 = 20/30

The only example above that should have an "x" next to it is number five. Let's look at the other four and figure out why they do not warrant any "special" considerations.

In the first example, a 16-year-old girl who has excellent acuity with her correction has a prescription with significant anisometropia. The disparity in the corrections means that if she glanced 10mm away from optical center, for example, she would experience an imbalance of 3.75 diopters – surely enough that it gets our attention. However, when she does have occasion to glance 10mm away from optical center, she will simply and naturally rotate her head to follow, meaning that she will once again be looking through the optical center of both lenses. Therefore, she should not experience any problem. This phenomenon is illustrated below, in Figure 1.



(Figure 1)

As illustrated and explained above, single-vision prescriptions will rarely require a special correction to deal with anisometropia. The patient merely must turn her head to "correct" the problem. One exception to this would be a patient who is physically unable to turn her head. Perhaps she is immobile due to an accident or disability.

The emerging presbyope in the second example has very good corrected visual acuity, and when glancing through the progressive lenses at near he will deviate from the optical center. Unlike someone wearing single-vision lenses, this patient cannot simply "correct" any problems resulting from deviation from optical center by moving his head. So, someone wearing a multifocal with an anisometropic correction needs to have an optician who understands the problems that may arise. The only question with this patient is: Is the anisometropia *significant* enough that it requires supplemental correction? Probably not since there is only about 1 diopter of vertical imbalance.

On paper, the patient in example #3 seems to require some special consideration, in that she has significant vertical imbalance with a multifocal correction, and good corrected visual acuity. However, she has apparently been able to successfully wear a standard correction in the past. Upon further questioning, if the patient has been happy and has not experienced any difficulty in the past: If it ain't broke, don't fix it. She will probably do just fine with a standard correction.

The fourth example is similar to the first.

The fifth and final example should indeed raise the concern of any eye care professional, for many reasons. The patient's corrected visual acuity is good; considering the situation one might say great. There is a vertical imbalance of 5.5 diopters. It is a multifocal correction. Apparently, the patient will have to live with this correction for at least a year. This seems like "the perfect storm." All these characteristics converge to potentially create problems for the patient, unless his eye care professional successfully recommends a supplementary correction. In this case either a slab-off or wearing two separate pairs of eyeglasses (one for reading and one for distance) will effectively solve the problem.

Lately, when I work on the front line of my dispensary, I am seeing more and more patients in the same situation as the hypothetical patient in scenario #5, and I'm sure you do too. Therefore, let's now look more comprehensively at what the problems are, how to identify potentially problem prescriptions, and how to guide our patients to the best solution.

IV Patients Troubled by Anisometropia

Most people with any prismatic imbalance have some trouble or discomfort, but people wearing only single-vision glasses are generally not affected by it. Remember, that regardless of power or disparity of power from lens to lens, when a patient looks through the optical center of a lens, there is zero prismatic effect. As stated earlier, most people wearing single-vision lenses simply turn or rotate their head when looking side to side or up and down, no problem occurs.

Another consideration is that imbalance in the 90th meridian (vertically) is significant. Although some presbyopic patients seem to tolerate significant uncorrected vertical imbalance, from a "textbook" standpoint, more than 1.5 diopters of prismatic imbalance requires special correction and consideration. Uncorrected, visual acuity and clarity at near will be compromised. Why? Remember that prism bends light toward its base, while at the same time it will displace any images viewed through it toward its apex. In considering patient problems in the 90th meridian, the "image" we are concerned with is usually a horizontal line of print, while the patient is reading or working at near, looking through the add portion of the lens. As a patient focuses on a line of print at near, the base up prism of one lens displaces the line of print in a downward direction, while the base down prism of the other lens displaces the line of print in an upward direction. Left uncorrected, the patient will face the challenge of reading horizontally split lines of print in a newspaper or book. This may be perceived as follows:

Patients who have good visual acuity in only one eye are generally not candidates for special correction of vertical imbalance. As discussed earlier, in these cases the brain essentially "turns off" messages sent to it by the weaker eye. In summary, patients who may require a special correction are multifocal wearers with good visual acuity in both eyes, suffering with a vertical prismatic imbalance of more than 1.5 diopters.

V Identifying "Problem" Prescriptions

The first thing an optician should consider in the dispensing process is the relationship between the patient's new prescription and what she has been previously wearing. If the amount of vertical imbalance caused by the new prescription is less than or equal to the old, a special correction will probably not be required. The patient has been wearing single-vision lenses, but now wants to wear only one pair of flat-top 28s. This might cause potential problems. The point being, despite all the formulas and guidelines, the judgment of the eye care professional is paramount in deciding what course of action a patient should take.

To determine whether or not a patient is experiencing 1.5 diopters or more of vertical imbalance, an eye care professional will first have to determine the exact power of the lens in the 90th meridian. The information necessary to determine this is the patient's prescription, reading depth, and the application of optical formulas we learned in school or as apprentices. Since the reading depth is usually identical eye for eye, using a "standard" drop of 10mm in our determination makes sense. Consider the following prescription:

OD: - 1.50 sphere / +2.50 add
OS: + 2.00 sphere / +2.50 add

Using simple math, we determine that the total reading power in the 90th meridian for this patient would be as follows:

OD: + 1.00 sphere
OS: + 4.50 sphere

At this point, do not think addition or subtraction. Rather, think of a number line:

6 5 4 3 2 1 0 1 2 3 4 5 6

←----------→

- (Minus) + (Plus)

Looking at it this way, we see that the "distance" from the point "+1.00" to the point "+4.50" is 3.5. Therefore, left uncorrected, this patient would be experiencing a probably intolerable vertical imbalance of 3.5 diopters. Let's try another one:

OD: - 2.50 sphere / +1.50 add
OS: + 2.50 sphere / +1.50 add

Again, using simple math, we determine that the total reading power in the 90th meridian for this patient would be as follows:

OD: - 1.00 sphere
OS: + 4.00 sphere

Using the number line approach, we see that the "distance" from the point "-1.00" to the point "+4.00" is 5.00. Therefore, left uncorrected, the patient would be experiencing an intolerable vertical imbalance of 5.00 diopters.

Based on what we have just learned, and using the "number line method," determine what (if any) vertical imbalance is present in the following examples, all of which are spherical corrections with the same add in both eyes. (For the purpose of this exercise, assume a corrected acuity of 20/30 or better in each eye.) Additionally, circle "yes" or "no" depending on if you think the patient would or would not require special correction to deal with the imbalance:

Prescription	Imbalance		
1. OD: +1.00; OS: +3.25; +4.00 add	_____	Yes	No
2. OD: +3.75; OS: +2.75; +2.00 add	_____	Yes	No
3. OD: -5.50; OS: Plano; +2.25 add	_____	Yes	No
4. OD: Plano; OS: +1.50; +2.75 add	_____	Yes	No
5. OD: -2.50; OS: +1.75; +2.00 add	_____	Yes	No
6. OD: -2.75; OS: +1.75; +2.50 add	_____	Yes	No
7. OD: -1.50; +2.00; single vision	_____	Yes	No
8. OD: -0.25; +3.25; +1.75 add	_____	Yes	No
9. OD: -2.00; +2.00; single vision	_____	Yes	No
10. OD: +2.00; -2.00; +2.00 add	_____	Yes	No

In all the examples above, the corrections were spherical in both eyes. When the patient's distance prescription is compound (including some correction for astigmatism) instead, the formula is not as straightforward, but still easily determined. Consider the following reference table, that you probably remember from opticianry school or when you were preparing for licensure:

0 degrees away from the axis of the Rx, there is 0 times the cylinder power.
30 degrees away from the axis of the Rx there is .25 times the cylinder power.
45 degrees away from the axis of the Rx there is .50 times the cylinder power.
60 degrees away from the axis of the Rx there is .75 times the cylinder power.
90 degrees away from the axis of the Rx there is 1 times (full) the cylinder power.

While there is a specific, complex mathematical formula for determining power at every axis, the table shown above should be enough for an optician to closely estimate power in the 90th meridian of a lens. Remember, the axis of the cylindrical correction must be added to or subtracted from axis 90 (the vertical meridian). Consider the following example:

OD: +2.50 – 1.00 x 028; +2.00 add
OS: Plano – 1.50 x 043; +2.00 add

By using simple math, information from the chart just introduced, and the "number line method" we used in the spherical examples, we can determine whether the patient needs special correction or not. Let's do the work: In the right eye, the spherical power is +2.50. The cylindrical power is -1.00 at axis 30 (more or less), which is 60 degrees away from the vertical, or 90th meridian. Remember, we are always concerned with the power at axis 90. So, according to the chart, 60 degrees away from the axis of the cylinder power there is .75 times (three fourths) the power present, or -.75 in this case. Algebraically add +2.50 and -.75 and we determine in this lens the power in the 90th meridian is +1.75 diopters in the right eye. In the left eye the spherical power is plano, or zero. The cylindrical power is -1.50 at axis 45 (more or less), which is 45 degrees away from the vertical, or 90th meridian. So, according to the chart, 45 degrees away from the axis of the cylinder power there is .50 (half) the power present, or -0.75 diopters. Algebraically add zero and -.75 and we determine that the power in the 90th meridian of the left eye is -0.75. Using the number line method, we determine that the "distance" from point "+1.75" to point "-0.75" is 2.50. Therefore, left uncorrected, this patient will experience 1.00 diopter more vertical imbalance than the textbook tolerance of 1.5 diopters of imbalance. Since the add powers are the same, we did not need to include them in the equation. (Had we included them in the equation, the answer would have been the same.) Let's do one more. Consider the following Rx:

OD: +2.00 – 4.50 x 180; +2.50 add
OS: -1.50 – 2.75 x 090; +2.50 add

In the right eye, the spherical power is +2.00. The cylindrical power is -4.50 at axis 180, which is 90 degrees away from the vertical, or 90th meridian. So, according to the chart, that means the entire cylindrical power must be taken into consideration. Algebraically add +2.00 and -4.50, and we determine the power in the 90th meridian in the right eye is -2.50. In the left eye, the spherical power is -1.50. The cylindrical power is -2.75 at axis 90, which is zero degrees away from the 90th meridian, meaning that none of the cylindrical power needs to be considered. Therefore, in the left eye the power in the vertical meridian is -1.50. Using the number line method, we determine that the "distance" from point "-2.50" to point "-1.50" is 1.00 diopter of vertical imbalance, which would not require any special attention. Once again, you will notice that it is not necessary to consider the add power, since it is the same in both eyes. If the add power is different, then it should become part of the calculation.

Determine the vertical imbalance (if any) of the following compound prescriptions and determine whether special correction will likely be necessary. Note the imbalance and circle yes or no. In determining this, assume that each patient has corrected acuities at or near 20/20:

	Prescription	Imbalance		
1.	OD: +2.00 – 1.50 x 088 / +2.50 add OS: -1.00 – 1.00 x 090 / +2.50 add	_____	Yes	No
2.	OD: +6.75 sphere / +2.50 add OS: +1.00 – 1.50 x 135 / +2.50 add	_____	Yes	No
3.	OD: +3.00 – 2.50 x 175 / +3.00 add OS: - 1.25 – 1.00 x 090 / +2.50 add	_____	Yes	No
4.	OD: -1.75 – 2.00 x 045 / +1.25 add OS: - 8.50 sphere / +1.25 add	_____	Yes	No
5.	OD: Plano -5.00 x 180 / +3.00 add OS: -5.00 +2.50 x 090 / +3.00 add	_____	Yes	No
6.	OD: +6.25 – 1.50 x 135 / +2.50 add OS: +2.50 – 1.00 x 090 / +2.50 add	_____	Yes	No
7.	OD: -7.50 -1.00 x 045 / +1.75 add OS: -12.50 – 3.25 x 090 / +1.75 add	_____	Yes	No
8.	OD: Plano / +3.00 add OS: +3.00 – 1.00 x 180 / +3.00 add	_____	Yes	No
9.	OD: +2.75 – 1.00 x 090 / +1.00 add OS: +3.00 sphere / +1.00 add	_____	Yes	No
10.	OD: +8.00 – 4.75 x 180 / +3.00 add OS: +10.50 -3.00 x 150 / +3.00 add	_____	Yes	No

Even though we have not called it by its name yet, in determining whether we should consider special corrections, we have been using one of the first optical formulas we learned – Prentice's Rule. This is the formula that gives us a close approximation of the amount of prism present at any point on a lens based on the dioptric power of the lens and the distance away from its optical center. Although there are some variations, Prentice's Rule is most commonly written as: P = cf; where "P" is the amount of prism, "c" is the decentration (in centimeters), and "f" is the lens power in diopters. The one unusual component of the traditional rule is, of course, centimeters. As opticians, we more commonly work in millimeters. So, a more practical Prentice's Rule for opticians might be expressed as: P = dD/10; where P = prism; d = distance from optical center; D = dioptric power; divided by ten.

To further understand the appropriate direction of prism on a lens, some opticians also find "diagramming" it to be extremely helpful. To appreciate what is meant by diagramming, it may help to remember that at the optical center of any given lens, there is no prismatic effect at all. At points a short distance from the optical center there is a slight prismatic effect. At points farther away from the optical center there is a greater prismatic effect. Therefore, we could say that the curved surface of a lens is made up of a series of very short straight sides angled a bit more than the side adjacent to it, all coming together at the optical center of the lens. Since a prism is symbolized as a triangle, and a lens that corrects hyperopia (a plus, convex lens) is thickest at its center and thinner toward its periphery, we can deduce that a plus lens is made up of a series of prisms with their bases oriented toward the center of the lens (figure 2).

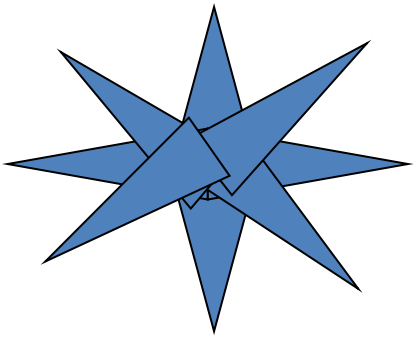


Figure 2

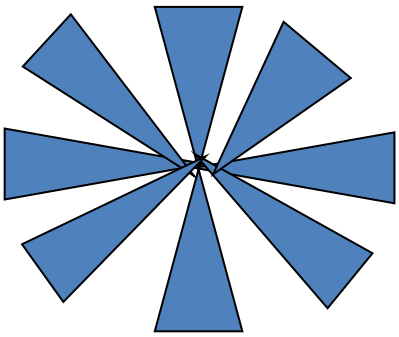


Figure 3

.

Likewise, since a lens that corrects for myopia (a minus, concave lens) is thinnest at its center and thicker toward its periphery, we can deduce that a minus lens is made up of a series of prisms with their apices oriented toward the center of the lens (figure 3).

In most cases, prism is prescribed either up or down (vertical), or in or out (horizontal). So when diagramming to determine the direction of prism, an optician needs to use a template as shown in figure 4 for a plus lens, and a template as illustrated in figure 5 for a minus lens.

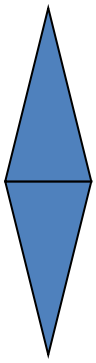


Figure 4

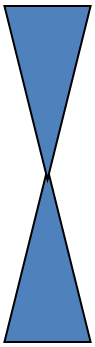


Figure 5

Consider the following question and diagram. (In the diagrams, “x” represents the optical center of the lens, and “o” represents the point on the lens where we are attempting to determine the amount of prism that is present.)

How much prism is present 5mm below the optical center of on a +4.50 lens?

Use the amended Prentice’s Rule learned above and the appropriate diagram (figure 6) to determine the amount and direction of prism. 4.50 x 5 = 22.5. 22.5 divided by 10 = 2.25 diopters of prism. By simply noting the point on the lens relative to the base of the prism, we now know that at the point of the lens in question has 2.25 diopters of prism, base up.

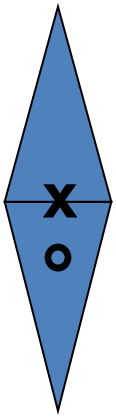
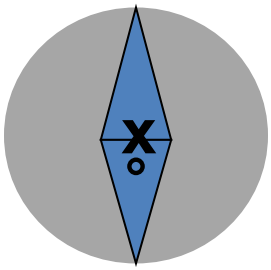


Figure 6

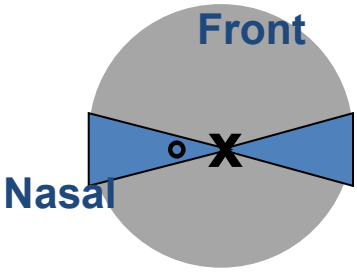
To develop a better understanding of the methods discussed in determining the prismatic effect, take a few minutes to answer the following six questions using both Prentice’s Rule and the diagramming method. Place your answer on the line to the right of the diagramming triangle and show your work.

1. What amount of prism is present 2 mm below the optical center of a +8.50 D lens?



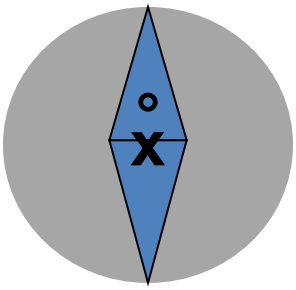
_____ Base _____

2. What amount of prism is the patient experiencing if the optical center is moved 5 mm out toward the temple on a -3.25 lens?



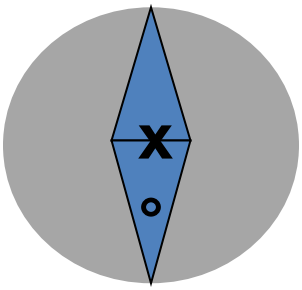
_____ Base _____

3. The optical center is 4 mm below the pupil on a +7.75 lens. What, if any, prism is the patient experiencing?



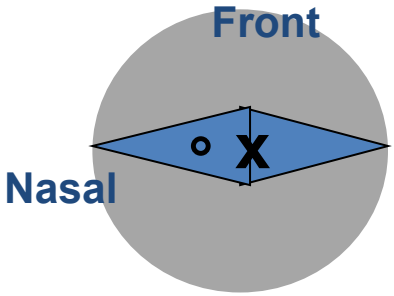
_____ Base _____

4. The Rx is +5.00 – 1.50 x 090. What amount of prism is present 8 mm below the optical center of the lens?



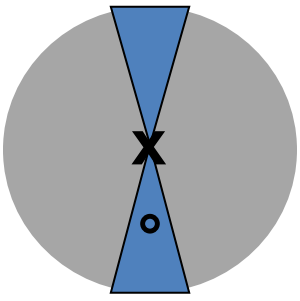
_____ Base _____

5. The Rx is +5.00 – 1.50 x 090. If the optical center is decentered out 5 mm from the patient's pupil, what amount of prism is present?



_____ Base _____

6. The Rx is -10.00 -2.75 x 045. What prism is present if the wearer looks down through the lens at a point 6 mm below the optical center?



_____ Base _____

7 Steps to Identify a Problem Rx:

1. Make sure both lenses are either in plus or minus cylinder form.
2. Determine lens power in the 90th (vertical) meridian.
3. If reading depth is the same, use 10mm as a constant.
4. Using Prentice's Rule, determine prismatic effect on each lens.
5. Use prism diagramming to identify the direction of the prism.
6. Consult with the prescriber and/or the patient to determine previous correction.
7. As an eye care professional, make your decision as to the best course of action.

Ironically, perhaps the most overlooked step by eye care practitioners is number 7. Your knowledge, experience, and communication with the prescriber and the patient are of paramount importance. Additionally, when educating patients, be sure to avoid technical language and jargon like "bi-centric grinding," "prismatic effect," and "anisometropia." Describe the problem and its possible solutions in simple, easy-to-understand, laymen's terms when speaking with your patients.

6 Contraindications for Correcting Vertical Imbalance

1. Single-vision wearers.
2. Contact lens wearers.
3. Patients with one eye.
4. Patients with good acuity in one eye only.
5. Patients who have tolerated high degrees of uncorrected vertical imbalance in the past without special correction.
6. Patients with less than 1.5 diopters of vertical imbalance

Patients who fall into any one of those six categories would not require any special attention; for all others…

VI Methods of Correcting Vertical Imbalance

There are several methods of correcting vertical imbalance. Let's delve into a few different methods and consider their applicability and viability in the 21st century, in terms of their basic advantages and disadvantages.

1. **Dissimilar Segments.** The method of using dissimilar segment styles is usually implemented by placing an executive lens in front of the eye that has the most minus correction. An executive-style bifocal will naturally generate base-up prism in the reading portion of the lens by since the optical center of the lens is located on the segment line. When that is used in conjunction with the naturally generated base-down prism in the upper or distance portion of the lens, a cancelling effect occurs, thereby reducing the prismatic difference between the patient's distance and near correction. The other lens accomplishes the same thing by using an Ultex lens in the most plus lens. Since the optical center of an Ultex is at the very

bottom of the lens (far below an average person's reading gaze) the base down prism of the segment reduces some of the base up of the distance portion. This "dissimilar segments" method mechanically manipulates the prism to make the lenses more compatible with one another – making reading more tolerable for the anisometropic patient. The advantage of using the dissimilar segments solution is that it is inexpensive and requires no special surfacing or edging. However, this method has one, hard-to-overcome disadvantage: While this method used to be implemented quite successfully in decades past, these days it is impractical at best. Why? Nearly 75% of multifocal wearers in America prefer progressive, no-line multifocals. Additionally, with more of an emphasis on style these days, dissimilar segments are unacceptable to most of our clientele. They would not accept the cosmetics, or more accurately the lack thereof, using dissimilar, lined bifocals.

2. **Single-Vision Eyeglasses.** One thing many opticians are unaware of is that bi-centric grinding (more commonly referred to as slab-off and discussed in the next two paragraphs) usually will not correct for a vertical imbalance that exceeds five or six diopters. In cases with severe vertical imbalance, single-vision glasses are the only viable solution to the problem. When choosing this method to correct vertical imbalance, an optician must always remember to instruct the patient that she will have to direct her gaze by physically moving her head to bring it into alignment with the reading material or object being viewed at near. When this occurs, in essence the patient will be using the distance optical centers of the eyeglasses when focusing at near, thus avoiding any prismatic effect. If the optician fails to properly instruct the patient about moving her head instead of her eyes, the patient may not be happy with the correction. The obvious advantages of the single-vision method are that it can easily and effectively correct high levels of vertical imbalance, and that it is inexpensive. This method has a few disadvantages to be sure. First, the patient will have to constantly switch between distance and reading glasses. If the patient chooses full-size reading glasses, she will have to drop her head, and if she chooses half-eyes she will require some other distance correction – for example, contact lenses.

3. **Slab-Off.** The most frequent solution to vertical imbalance is slab-off, or bi-centric grinding. For cases of vertical imbalance six diopters or less, some type of slabbing off the lens is the most exacting way to correct it. There are many ways of slabbing off a lens, and while the process is quite complex, the optical theory that makes it work is beautifully simple. As we have already learned, a given amount of base up prism in the right eye, when used in conjunction with the same amount of base down prism in the left eye, will have a *compounding* effect, resulting in an imbalance with which the patient would have to cope.

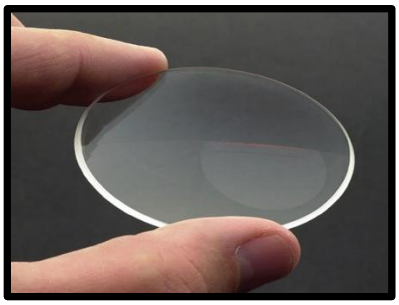
   Likewise, a given amount of prism base up or down when added to an equal amount of prism in the same direction in the other eye will have a *cancelling* effect. For example, two diopters of base-up prism in the right eye used in conjunction with two diopters of base-up prism in the left eye will have a

cancelling effect. Thus, in this example, the patient will experience no vertical imbalance. In summary, when prisms that are opposite in both eyes are combined, they will compound; but if those same opposite prisms are combined in the same eye, they will have a cancelling effect.

So, slab-off uses the cancelling effect of opposite prisms to eliminate the problems associated with vertical imbalance for the patient. First, figure out the total amount of vertical imbalance. Second, we use base-up prism equal to the total imbalance of the prescription in the more minus or base-down component of the prescription. The base-up prism that is ground in the minus, base-down lens has a superimposing or cancelling effect on the imbalance in that eye. Third, the base-up prism ground in the minus, base-down lens places the opposing directions on top of one another, having a cancelling effect in that eye. Fourth, the remaining base-up prism in that eye is equal to the base-up prism in the other eye and therefore has a cancelling effect on it. That means all imbalance has been cancelled and the patient can read without any optical distractions at near.

The advantages of using a slab-off are that it can neutralize up to 5 diopters of vertical imbalance, it can be ground on any type of multifocal and lens material and is not too cosmetically unappealing. (Although the process produces a horizontal line across the lens, it is relatively faint.) The disadvantages are that it usually takes a little longer to process the patient's order because it has to be sent to a specialty lab; additionally, it is fairly costly, usually adding more than $100 to the total cost of eyeglasses.

4. **Reverse Slab-Off.** Some labs that specialize in correcting vertical imbalance prefer to use what is called a reverse slab-off. It achieves the same goal of a ground slab-off (neutralizing all vertical imbalance), but it does so by simply molding base-down prism in the more plus lens, which is why it is called a *reverse* slab-off. The molded, base-down lens superimposes and cancels the base-up component of the imbalance with the base-down prism, matching and cancelling the base down prism in the opposite eye. The advantage of a reverse slab-off is that the molded nature of the lens blank means that no special surfacing is necessary. Additionally, a reverse slab-off can neutralize up to 6 diopters of imbalance, and cosmetically it is no less appealing than a standard slab-off. Just like the slab-off, cost is an issue here. Finally, another disadvantage to a reverse slab-off is that it can only be applied to multifocals that use a straight-top design.



(*Reverse slab-off lens*)

VII Case Studies

For the following 10 case studies, determine first, the amount (if any) of vertical imbalance present. Then circle "yes" or "no" in answer to the question: Should this patient consider a slab-off to correct the imbalance? Finally, in the space provided, briefly detail why, or why not.

Case Study #1: A middle-aged patient who has lost his old eyeglasses. You have no access to his optical history, but he informs you that he has never been able to see "anything other than shadows" out of his left eye.

OD: +3.00 -1.00 x 090 = 20/20-1
OS: -1.50 sphere = 20/200
Add: +2.00 OU; FT-28

Vertical Imbalance: _____
Slab-Off: Yes No
Explanation: _____

Case Study #2: A teenager who wants single-vision, polarized, Gray-C sunglasses.

OD: -1.00 sphere = 20/20
OS: +3.00 sphere = 20/20
PD = 63

Vertical Imbalance: _____
Slab-Off: Yes No
Explanation: _____

Case Study #3: A 69-year-old man who has just had IOL surgery in his left eye only. He is planning to have the cataract in his right eye removed in 12-14 months.

OD: -2.50 -1.00 x 121 = 20/40+
OS: +1.00 -1.00 x 180 = 20/20
Add: +2.50 OU

Vertical Imbalance: _____
Slab-Off: Yes No
Explanation: _____

Case Study #4: A 96-year-old female patient who is wearing aphakic, lenticular, curve-top 25 lenses for the past 30 years. She has a slab-off OD. Her present Rx is:
OD: +14.00 sphere
OS: +18.00 -1.00 x 026
Add: +3.00 OU

Her new Rx is:

OD: +15.00 -0.50 x 005 = 20/40-
OS: +19.00 -1.00 x 030 = 20/40+
Add: +3.50 OU

Vertical Imbalance: _____
Slab-Off: Yes No
Explanation: _____

Case Study #5: A 41-year-old emerging presbyope who has been wearing single-vision, high-index lenses for distance correction only. His previous Rx is:
OD: +4.75 sphere
OS: +1.00 sphere

His new Rx is:

OD: +5.00 -0.50 x 090
OS: +1.25 -0.50 x 090
Add: +1.75 OU

Vertical Imbalance: _____
Slab-Off: Yes No
Explanation: _____

Case Study #6: The first spectacle prescription post IOL surgery for a 70-year-old patient. She had an implant in the right eye and will have the left eye done @ 18 months. Here is her new prescription:

OD: Plano = 20/20+
OS: -5.00 +1.75 X 180 = 20/30-
Add: +2.50 OU

Vertical Imbalance: _____
Slab-Off: Yes No
Explanation:_____

Case Study #7: The first pair of spectacles for a bilateral, post IOL patient. The Rx:
OD: -2.00 -1.00 x 180 = 20/20
OS: Plano -2.00 x 090 = 20/20+
Add: +2.50 OU

Vertical Imbalance: _____
Slab-Off: Yes No
Explanation:_____

Case Study #8: A 44-year-old tour guide who has been happily wearing FT-28s with no slab-off for several years. He has decided to try progressive lenses for the first time. His old Rx is:

OD: -4.25 sphere
OS: +6.25 -1.00 x 180
Add: +2.25 OU

Her new Rx:

OD: -3.75 sphere
OS: +5.00 -1.00 x 180
Add: +3.00 OU

Vertical Imbalance: _____
Slab-Off: Yes No
Explanation:_____

Case Study #9: First Rx, post IOL surgery OU:

OD: -0.50 -0.50 x 090 = 20/15
OS: -1.00 sphere = 20/20+2
Add: +2.75 OU

Vertical Imbalance: _____
Slab-Off: Yes No
Explanation:_____

Case Study #10: A middle-aged patient who complains of strain and occasional double-vision when reading. He is currently wearing FT-35s with no slab-off. His old Rx reads:
OD: -5.00 sphere = 20/20
OS: -4.50 -3.50 x 180 = 20/40
Add: +2.00 OU

His new Rx reads:

OD: -5.25 sphere = 20/20+
OS: -5.00 -4.00 x 178 = 20/30+
Add: =2.25 OU

Vertical Imbalance: _____
Slab-Off: Yes No
Explanation:_____

In conclusion, an eye care professional who realizes that he or she is going to be encountering more and more prescriptions that cause vertical imbalance in the coming years and takes steps to brush up on how best to deal with it will have the upper hand. You will be seen as more knowledgeable and professional by your patients and be more valuable for your boss and your practice. Before answering the questions in the final assessment, review the answers to all the exercises and problems that were presented throughout this module. You will find them in Section VIII below.

VIII Answers to Module Questions

- For the 10 questions in Section I, asking whether the Rxs are anisometropic or antimetropic, you should have placed an "x" after numbers 1,2,3,4,5, and 9; you should have placed a "o" after numbers 6 and 7; there should be no mark at all after numbers 8 and 10.

- For the 5 scenarios in Section III, hopefully you placed an "x" after only number 5. The explanations for all five questions appear after the questions in Section III.

- For the first set of 10 questions in Section V, the answers are as follows:

1.	2.25	Yes
2.	1.00	No
3.	5.50	Yes
4.	1.50	Yes
5.	4.25	Yes
6.	4.50	Yes
7.	3.50	No
8.	3.50	Yes
9.	4.00	No
10.	4.00	Yes

- For the second set of 10 questions in Section V, the answers are as follows:

1.	3.00	Yes
2.	6.50	Yes
3.	2.75	Yes
4.	4.75	Yes
5.	0.00	No
6.	3.00	Yes
7.	4.50	Yes
8.	2.00	Yes
9.	0.25	No
10.	5.00	Yes

- For the third set of 6 questions in Section V, the answers are as follows:

1.	1.7	Base Up
2.	1.6	Base In
3.	3.1	Base Down
4.	4.0	Base Up
5.	1.75	Base Out
6.	6.80	Base Down

- For the 10 Case Studies in Section VII, here are the answers and *suggested* explanations:

1. Vertical Imbalance: 4.5; Slab-off: No; Explanation: The poor visual acuity in the left eye means the vertical imbalance is not problematic.
2. Vertical Imbalance: 4.0; Slab-off: No; Explanation: It is a single-vision correction.
3. Vertical Imbalance: 2.75; Slab-off: Yes; Explanation: Acuities are good, and the patient would probably find it intolerable to function for a year without some special accommodation.
4. Vertical Imbalance: 4.25; Slab-off: Yes; Explanation: The new prescription contains more imbalance than the previous Rx, and the patient is already wearing a slab-off.
5. Vertical Imbalance: 3.75; Slab-off: Yes; Explanation: Since this is the patient's first multifocal correction, he will surely need some special correction due to nearly 4 diopters of imbalance.
6. Vertical Imbalance: 3.25; Slab-off: Yes; Explanation: Same as #3.
7. Vertical Imbalance: 3.00; Slab-off: Yes; Explanation: With nearly 3 diopters of imbalance, this post-IOL patient would probably not tolerate a standard correction.

8. Vertical Imbalance: 7.75; Slab-off: No; Explanation: Despite the extreme imbalance, the patient has happily "tolerated" even more imbalance without any apparent problems.
9. Vertical Imbalance: 0.50; Slab-off: No; Explanation: Imbalance is under 1.5 diopters.
10. Vertical Imbalance: 3.75; Slab-off: Yes; Explanation: He is already complaining of problems that are probably a result of uncorrected vertical imbalance. The new Rx improves acuity and increases the imbalance. Uncorrected, his previous problems will only be compounded.

Author's Note: If you are happy with the results you achieved with these questions – great! If not, perhaps you might want to re-read this module, do some review and/or further studying. Though it's been around forever, one of the best resources is still *System for Ophthalmic Dispensing* by Clifford W. Brooks and Irvin M. Borish, particularly chapter 20: "Prism and Accommodating at Near." On the Internet just do a Google search using terms like "vertical imbalance in lenses," "Prentice's Rule," etc. If you have any questions, comments, or concerns about this CE module, I would love to hear from you, and (short of giving you the answers to the final assessment) I will help you any way I can. I also value your constructive feedback. My e-mail address anthony@opticalseminars.com . My cell phone is (352) 848-4222. My mailing address is PO Box 5445, Spring Hill, FL 34611-5445. Good luck with the final assessment.

IX Final Assessment

1. Which of the following corrections for vertical imbalance would require a patient to consciously drop her head when reading, to appreciate the design of the correction?

    a. Dissimilar segments
    b. Single-vision reading glasses
    c. Slab-off
    d. Reverse slab-off
    e. None of the above

2. Base-down prism in a lens will displace a line of newspaper copy being viewed through that lens:
    a. Upward
    b. Downward
    c. Toward the O.C. of the lens
    d. Toward the periphery of the lens

3. Which of the following corrections would be best to correct 8 diopters of vertical imbalance?
    a. Dissimilar segments
    b. Two pairs of SV glasses – one for distance; one for near-
    c. Slab-off
    d. Reverse slab-off
    e. None of the above

4. Which of the following spherical Rxs is antimetropic?
    a. OD: +1.50 sphere OS: -1.50 sphere
    b. OD +0.25 sphere OS: +3.75 sphere
    c. OD: -2.50 sphere OS: -2.25 sphere
    d. OD: -10.00 sphere OS: -7.75 sphere
    e. All are antimetropic
    f. None are antimetropic

5. How many diopters of vertical imbalance should an eye care professional consider significant enough to consider providing special correction for?
    a. 0.50
    b. 1.50
    c. 2.50
    d. 3.50
    e. 6.00

6. Which of the following spherical Rxs are anisometropic?
    a. OD: +1.50 sphere OS: -1.50 sphere
    b. OD: +0.25 sphere OS: +3.75 sphere
    c. OD: -2.50 sphere OS: -2.25 sphere
    d. OD: -10.00 sphere OS: -7.75 sphere
    e. All are anisometropic
    f. None are anisometropic

7. How many diopters (if any) of vertical imbalance is present in the following Rx at near?
   OD: +5.00 -1.00 x 180
   OS +7.00 sphere
   Add: +3.00 OU
    a. 0
    b. 1
    c. 2
    d. 3
    e. 4

8. Since it is usually the same in both eyes, what is not included in determining vertical imbalance?
    a. PDs
    b. Spherical powers
    c. Cylindrical powers
    d. Add power
    e. Axis of correction

9. Which of the following corrections come molded on the front surface of the lens?
    a. Slab-off
    b. Reverse slab-off
    c. Dissimilar segments
    d. Executive lenses
    e. None of the above

10. Which if the following lens materials will accept a slab-off?
    a. Crown glass
    b. CR-39
    c. Polycarbonate
    d. Trivex
    e. All of the above
    f. None of the above

11. Slab-off corrects for prismatic imbalance in which meridian of the lens?
    a. 45-degrees
    b. 60-degrees
    c. 90-degrees
    d. 180-degrees

12. How much cylinder power is present 90-degrees away from the axis of the prescription?
    a. 25 %
    b. 50 %
    c. 75 %
    d. 100 %
    e. None

13. Vertical imbalance most often adversely affects vision at:
    a. Night
    b. The periphery
    c. Distance
    d. Near
    e. None of the above

14. Which if the following corrections would be the most exacting and convenient method of correcting for 4.5 diopters of vertical imbalance at near?
    a. Dissimilar segments
    b. Slab-off
    c. Contacts for distance; readers for near
    d. Two separate pairs of eyeglasses: one for distance; one for near

15. Which if the following would best correct for 6 diopters of vertical imbalance at near?
    a. Reverse slab-off
    b. Slab-off
    c. Ultex/Executive combination
    d. Lenticular lenses

16. The formula used to determine prismatic imbalance is:
    a. Bowman's Rule of Thumb
    b. Prentice's Rule
    c. Vertex Compensation
    d. Slab-Off Equations

17. Which of the following patient's acuities would be contraindicative in correcting a vertical imbalance of 3.75 diopters?
    a. OD = 20/20 OS = 20/30
    b. OD = 20/30+ OS = 20/200-
    c. OD = 20/50+ OS = 20/40+
    d. OD = 20/80 OS = 20/80

18. Which is always used on the "most minus" lens?
    a. Slab-off
    b. Reverse slab-off
    c. Dissimilar segments
    d. Press on prisms

19. How much cylinder power is present 45-degrees away from the axis of the Rx?
    a. None
    b. 25 %
    c. 50 %
    d. 75 %
    e. 100 %

20. Amblyopia affects approximately what percent of American children?
    a. 2-4 %
    b. 4-5 %
    c. 6-8 %
    d. 8-10 %
    e. 10-12 %

21. In the word anisometropia, "metr" means:
    a. Different
    b. Same
    c. Measure
    d. Eye
    e. Acuity

22. OD: -1.00 -1.25 x 180 = 20/20
    OS: -4.75 -2.00 x 090 = 20/30-
    Add: +2.50 OU
    In the above Rx, which component does not need to be factored in to determine vertical imbalance?
    a. Add power
    b. Cylinder power OD
    c. Cylinder power OS
    d. Axis
    e. Acuities

23. In order to better "see" the direction of resultant prism on a lens, an optician should use which of the following techniques?
    a. Prentice's Rule
    b. Diagramming
    c. The Cancelling Method
    d. The Compounding Method

24. A prism displaces objects being viewed through it toward its:
    a. Apex
    b. Vertex
    c. Base
    d. 90^{th} Meridian
    e. 180^{th} Meridian

25. OD: +1.00 -1.00 x 180
    OS: -2.50 sphere
    Add: +1.75 OU
    The above Rx is:
    a. Unusual
    b. Antimetropic
    c. Anisometropic
    d. Multifocal
    e. Missing acuities
    f. All of the above
    g. None of the above

26. Assuming acuities of 2/20 OU; +2.50 add OU; reading depth 8mm OU. Which of the following Rxs contain the *most* vertical imbalance?
    a. OD: +2.50 sphere OS: +1.50 -2.00 x 045
    b. OD: -2.75 sphere OS: -4.75 +1.00 x 090
    c. OD: +7.50 sphere OS: +3.50 +2.00 x 180
    d. OD: -1.00 sphere OS: +2.00 sphere
    e. OD: +1.00 sphere OS: +3.00 -3.00 x 044

27. Referring to the same choices in question 26, which one has the *least* vertical imbalance?
    a. A
    b. B
    c. C
    d. D
    e. E

28. One way of thinking of a plus lens is that it is made up of an infinite number of prisms with their _____ oriented toward the optical center of the lens.
    a. Apices
    b. Bases
    c. 180^{th} meridians
    d. 90^{th} meridians

29. One way of thinking of a minus lens is that it is made up of an infinite number of prisms with their _____ oriented toward the optical center of the lens.
    a. Apices
    b. Bases
    c. 180^{th} meridians
    d. 90^{th} meridians

30. The best candidate for a slab-off correction is a patient with:
    a. Good visual acuity in both eyes
    b. Presbyopia
    c. A vertical imbalance greater than 1.5 diopters
    d. All of the above
    e. None of the above

31. Which of the following does not need to be considered when determining vertical imbalance?
    a. Lens power in the 90^{th} meridian
    b. Lens power in the 180^{th} meridian
    c. Acuity
    d. Reading depth
    e. All are important determining factors

32. When speaking to your patient about the potential problems resulting from the vertical imbalance of his or her prescription, which of the following descriptive terms should be avoided?
    a. "Slabbing-off"
    b. "Bi-centric grinding"
    c. "Vertically imbalanced"
    d. "Diplopia"
    e. All of the above
    f. None of the above

33. Asthenopia is a technical, ocular term for:
    a. Eye strain
    b. Double vision
    c. Vertical imbalance
    d. Horizontal imbalance

34. What, if any, is the amount of vertical imbalance in the following prescription, at near?
    OD: +1.00 sphere
    OS: +2.50 -0.50 x 180
    OD Add: +2.00
    OS Add: +2.50
    a. 1.0 diopters
    b. 1.5 diopters
    c. 2.0 diopters
    d. 2.5 diopters
    e. There is no vertical imbalance

35. If a 2.0 base-up prism is superimposed over a 2.0 base-down prism it will result in a vertical imbalance of:
    a. Zero
    b. 1 diopter
    c. 2 diopters
    d. 3 diopters
    e. 4 diopters

36. The effect illustrated in Question #35 is called:
    a. Prentice's Rule
    b. Refractive Theory
    c. Cancelling
    d. Compounding
    e. None of the above

37. If a 2.0 base-up prism is present in the patient's right lens, and a 2.0 base-down prism is ground into the left lens, it will result in a total vertical imbalance of:
    a. Zero
    b. 1 diopter
    c. 2 diopters
    d. 3 diopters
    e. 4 diopters

38. The effect illustrated in Question #37 is called:
    a. Prentice's Rule
    b. Refractive Theory
    c. Cancelling
    d. Compounding
    e. None of the above

39. If the left lens has a total reading power of +3.50 diopters in the 90th meridian, and the right lens has a total reading power of +1.00 in the 90th meridian, a slab-off should be considered.
    a. True
    b. False

40. The number of eyeglass jobs needing a correction for vertical imbalance processed in the coming years is likely to increase due to the number of expanding presbyopes, baby boomers, and IOL procedures
    a. True
    b. False

41. The technical term for lazy eye is:
    a. Diplopia
    b. Strabismus
    c. Amblyopia
    d. Asthenopia
    e. None of the above

42. How much cylinder power is present 27 degrees away from the axis of correction? Approximately:
    a. None
    b. One-fourth
    c. One-half
    d. Three-fourths
    e. All of it

43. Esotropia and hypotropia are manifestations of:
    a. Strabismus
    b. Nystagmus
    c. Amblyopia
    d. Asthenopia
    e. None of the above

44. The Prevent Blindness website is a great on-line resource for children dealing with:
    a. Bullying
    b. Presbyopia
    c. Amblyopia
    d. Exotropia

45. Slabbing-off a single-vision pair of eyeglasses might be considered:
    a. Never. SV lenses never require a slab-off
    b. If the patient is disabled, or if her head is immobile
    c. If the vertical imbalance is greater than 10 diopters
    d. If dissimilar segments did not work

46. Creating an opposing prism in a mold instead of grinding it on the lens is used with:
    a. Plus lenses only
    b. Minus lenses only
    c. Reverse slab-offs
    d. Standard slab-offs

47. Lens power: +3.00 -1.00 x 90; add +2.75. How much power is the patient experiencing when reading through the bifocal portion of this lens?
    a. +2.00 diopters
    b. +3.00 diopters
    c. +4.25 diopters
    d. +5.75 diopters
    e. None of the above

48. Lens power: -3.00 -1.00 x 180; add +2.75. How much power is the patient experiencing when reading through the bifocal portion of the lens?
    a. +0.25 diopters
    b. +1.25 diopters
    c. -0.25 diopters
    d. -1.25 diopters
    e. None of the above

49. Uncorrected vertical imbalance could cause:
    a. Asthenopia
    b. Diplopia
    c. Vision distortion
    d. All of the above

50. How far away from the optical center of a +2.00 spherical lens would the patient experience 1 diopter of prism?
    a. 2 mm
    b. 3 mm
    c. 4 mm
    d. 5 mm
    e. 6 mm