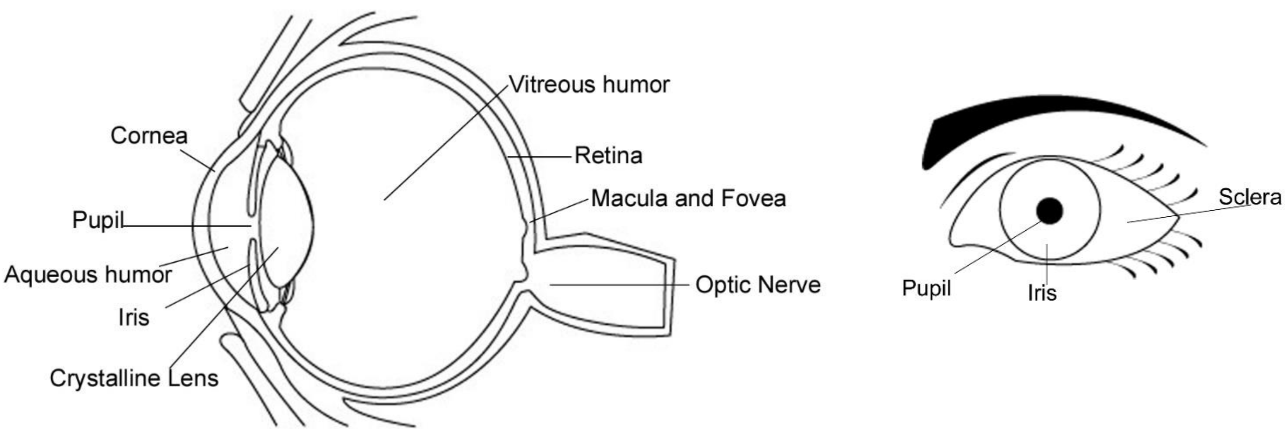
Basic optics and lenses

Video 1 Introduction

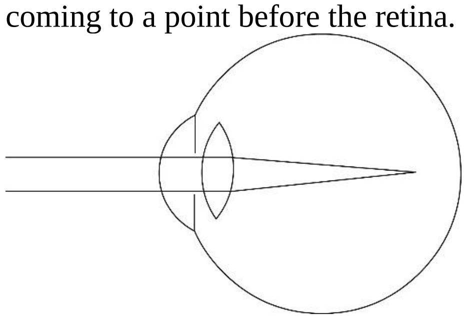
Basic opticianry will cover a number of different subjects. Our first series covers eye anatomy, refractive errors and beginning lenses. We will cover lens styles, materials, and beginning fitting of each lens. I have tried to make it simple for someone that has little or no prior knowledge in the field but also to extend it beyond the basics so everybody should gain something from the video series.

Video 2 Why do we need glasses?

In this video we will cover anatomy and refractive errors.
Here is a front and side view of the eye. The parts are labeled that will be talked about in the video.

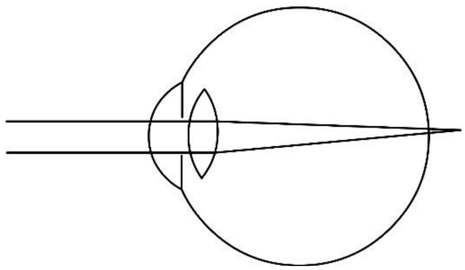


Near sightedness or myopia is a condition where the eye is too long so the patient can't focus on distance objects. If you look at the illustration the light coming into the eye is coming to a point before the retina.



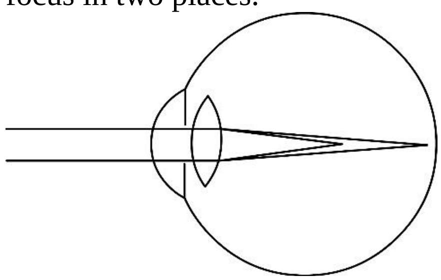
A minus lens will spread the image out slightly (also called diverging) bringing the focus farther back onto the retina. This person will also be able to focus up close without glasses because of his refractive error. This can range from a few inches from their nose to a few feet out, thus the phrase near sighted.

Far sightedness or hyperopia is the condition where the eye is too short so the patient will have trouble focusing up close. The image will come to a point behind the retina.



Now a patient will need a plus lens to help the image to focus on the retina. In many cases this person will have very good distance vision.

Astigmatism means that the cornea does not have a spherical surface and the image will focus in two places.



The patient will need a lens with two separate curves in it to focus the image correctly. This lens is called a compound lens because it has a sphere curve and a cylinder curve. (This is also known as a sphero-cylinder lens if you want to get technical)

The last refractive error that will be in the video is presbyopia. In general, a person about 40 years old will have a problem focusing up close. The condition will start at different times in people but in general it will be come apparent about 40. The crystalline lens will become harder, so the accommodation of a person will be limited. To correct the problem will need single vision readers or multifocal lenses so the distant image and near image can be brought into focus.

One last note that is not brought up in the video is the way the right and left eyes are noted by some doctors. Many will just refer to the right or left eye but the actual medical term for each eye is the OD for the right and OS for the left. OD is short for the Latin Oculus Dexter and OS is Oculus Sinister. If both eyes are referred to then it will be OU.

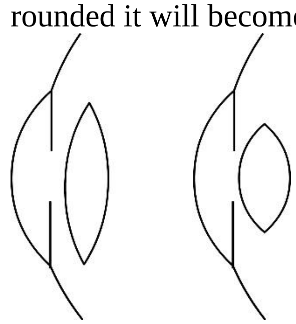
Terms to remember:

Cornea	Clear front 'window' of the eye. It helps to focus the image because it is very refractive. It should have a spherical curve to it. If it does not then the patient will have astigmatism.

Iris — This is the colored part of the eye. It has muscles within it that form the pupil. It will reduce the size of the pupil when there is a lot of light. It will increase the size of the pupil when there are low light conditions.

Pupil — This is the opening in the iris. The light passes through this into the interior of the eye.

Crystalline lens — This is the lens in the interior of the eye that will focus the light or image onto the retina. It will change shape to focus images on the retina. The closer the object is to the person the fatter or more rounded it will become. This is known as accommodation.



Retina — This is the back of the eye that is packed with photosensitive cells that will transmit the image into the brain so the person can actually see. There are two types of cells in the retina, rods and cones. The rods see lines and shapes while the cones see color.

Myopia — This is also known as near sightedness. A patient cannot see in the distance due to the length of the eye. A minus lens will correct this problem

Hyperopia — This is known as far sightedness. A patient cannot see near. A plus lens will correct this problem.

Astigmatism — The cornea is not a sphere shape so the image will focus in two places. A compound lens with sphere and cylinder curves will correct this problem.

Emmetropia — This is perfect vision. The patient can see near and far with out corrective eyewear.

Presbyopia — This translates into ‘old eyes’. A person around the age of 40 has a problem focusing up close because the lens has become less flexible.

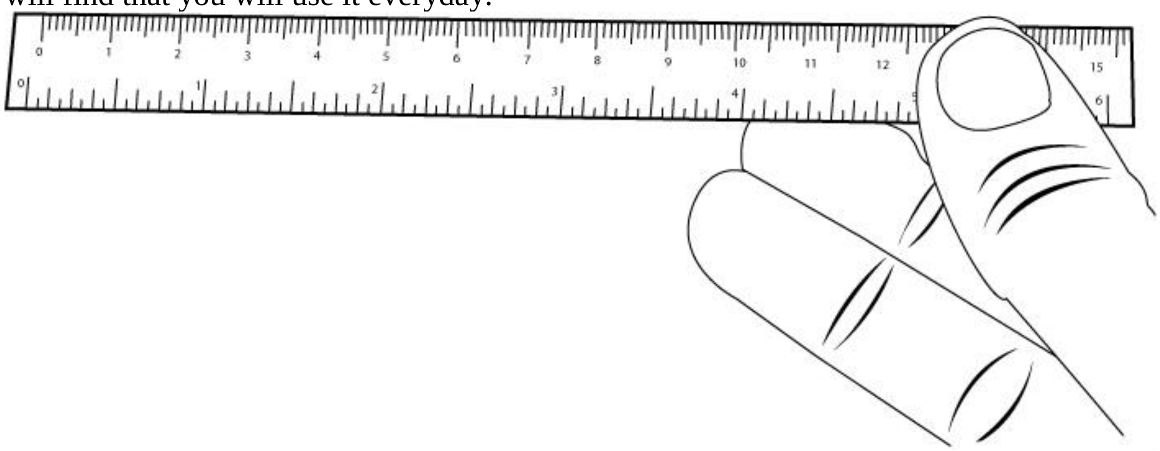
Accommodation — The ability to focus at different points.

Video 3   Metrics and Light

This video covers the basic of the metric system and some fundamental light theory

The metric system is based on the meter. The other unique thing about metrics is that it is based on decimals. This means everything is divisible by 10. If we look at the American measurement system, we have the foot and it is divided by 12 or the yard which has 3 feet in it. So, the system is based on fractions rather than decimals.

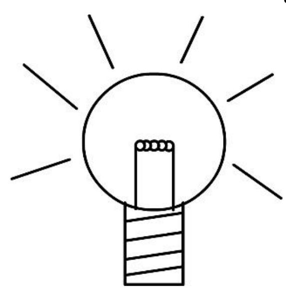
The main metric measurement we use is the millimeter. This is 1/1000 of a meter and is slightly smaller than a $1/16^{th}$ of an inch. Here is a drawing of a millimeter rule and you will find that you will use it everyday.



This has also become known as a ‘PD Stick’ since it can be used to measure the PD of a person. The PD is the distance between the pupils of a patient.

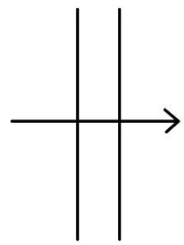
Light

Light is one of the constants of the universe. It travels at 186,000 miles per second. Since it is a form of energy it travels in waves and in a straight line. Once it leaves its source it will diverge from it.

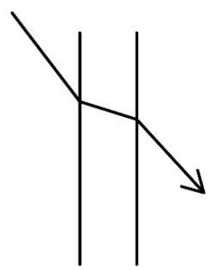


Since we are concerned with light and vision we need to understand how to control light in certain ways. One of the properties of light is when it enters a transparent material it will slow down and in most cases it will bend depending on the two surfaces of the material. This bending of light is called refraction and the basis for all optical lenses.

If light enters a material straight (perpendicular) into a surface it will slow down but not bend.



If the light comes in at an angle, then the light will bend at predictable angles and a lens can be produced to correct refractive errors.



Another aspect of refraction comes into play when the transparent material has different densities. The denser a material the more the light will slow down and the more it will bend. This is called the index of refraction and it is a single number that ranges from about 1.498 to about 1.90 in optical lenses. This number is actually a ratio of the speed of light divided by the speed of light in the material. As an example, the speed of light though basic plastic is 124,165 miles per second. If we divide this into 186,000 (from the speed of light) then we get 1.498 which is the index of refraction for plastic. Most of the indices that are used in the industry will range from 1.498 to 1.74 and there are really only about 6 that are in common use. To the optician this will mean that, in general, the higher the index of refraction the thinner the lens.

Terms to remember:

Index of refraction

> The ratio of the speed of light and the speed of light though a material. This will usually range from 1.498 to 1.74.

Video 4 Basic Frames

Frame come in 4 styles plastic(zyl), metal, grooves rimless, and drilled rimless. All frames have most of the same parts. The front and temples. A plastic frame is usually one piece and the lenses are popped into the frame. Metal frames come apart at the eyewire to mount the lenses. Grooved rimless frame have a nylon line or thin metal piece, the lens is grooves to fit the nylon line or flat metal front into. Drilled rimless frames are held together by the lenses themselves that have been drilled to fit the pins of the temples and bridge into as well. The frames are held together by screws and nuts or plastic bushings.

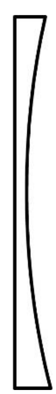
Video 5   Beginning lenses

This brief video introduces lenses and a short part about the materials. We have basic glass that has been used for hundreds of years and the introduction of resin or plastic materials for lenses from the 1970's.

Video 6 Lens power

Here we introduce the power of a lens. Correcting the basic refractive error for myopia and hyperopia takes two different types of lenses. The power is noted in diopters.

A myopic patient will need a minus lens to see in the distance well. This type of lens will minify an image as a person looks through it. It will be thinner in the middle and thicker on the edges. Here is a side view of a typical minus lens.



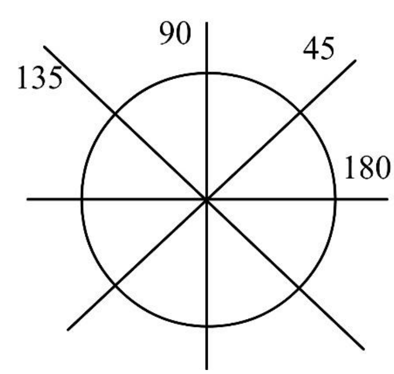
This video covers the very basics of lenses starting with single vision to multifocal.

The first lenses that will be covered are single vision lenses to correct hyperopia and myopia.
A hyperopic patient will need a plus lens to correct the problem. This is just like a magnifier so as a person looks through the lens images will look larger. A plus lens will also be thicker in the middle and thinner on the edge. This is a side view of a basic plus lens.

As you have probably gathered there are plus and minus lenses in the optical industry. The lenses are measured in diopters; the diopter is the basis of measuring a lens, the greater the number, the greater the power, starting at zero and going both in plus powers and minus powers. Minus lenses will be the same except for the sign will be a minus. As an example, the power could be a -5.75 or -2.50. The power in a minus lens could also exceed -25.00. In the plus range the power starts at a +.25 and goes up in quarters to more than +16.00. A typical lens could be a +2.25 or +6.50 as an example.

The next refractive error to go over is astigmatism. The cornea should be a sphere shape like a basketball. If the cornea is misshapen it will be more like a football with a long curve in one direction and a shorter curve perpendicular to the first curve. The lens that corrects this will have two distinct curves and is called a compound lens. The second curve is a cylinder curve combined with the sphere curve. When an RX is written for astigmatism it will have two powers and a third number to indicate axis. As a sample an RX will look like this. -1.00 -1.00 X 42. With this second curve the axis has been introduced and will be from 1 to 180.

The axis is a reference to the sphere power of the lens. The 180 line is the horizontal line across the eye. The axis then starts at 1 on the right of the eye **as if you are looking at a patient**, continuing an arc from right to left. Axis 90 will be the vertical line perpendicular to the 180 and 45 will be on the right side between the 90 and the 180 lines. Axis 135 will be on the left side halfway between the 90 and 180 lines. Please refer to the diagram to see the position of the axis.



The last refractive error covered in the video is presbyopia. This is a condition that happens to all people over 40. The time it happens to a person can vary from late thirties to the late 40's and sometimes the 50's. The crystalline lens in the eye becomes less elastic and a person cannot focus up close without corrective lenses. In most cases a patient will need a multifocal lens to correct the problem, but some people can just use reading glasses. A multifocal lens is a lens with a distance RX and an 'add' at the bottom of the lens to focus up close. This add is a plus power that ranges from a +1.00 to a +3.00 depending on the age of the patient. The add can be as low as a +.50 and be higher than a +3.00 but in most cases, it will have the +1.00 to +3.00 range. The add can be a visible segment of power, called a bifocal or trifocal, or a lens that has the power added gradually across the lens called a progressive.

When a doctor prescribes a multifocal lens and a specific add it will usually focus at a specified reading level such as 16 inches. Depending on the age of the patient the add will change so he or she can read at 16 inches. The older the patient the more power is needed to see at the reading level. A 45-year-old patient may need a 1.50 add and a 55 year old patient may need a 2.50 add. The doctor can also change the power of the add to focus at specific distances like a computer screen or arms length.

Terms to remember

Minus lenses — Lenses made to compensate for near sightedness. This lens will diverge light rays or images. It is thinner in the middle and thicker on the edge.

Plus lenses — Lenses made to compensate for far sightedness. This lens will converge light or an image. It is thicker in the middle and thinner on the edge. This the same as a magnifying glass.

Compound lenses — These lenses have two distinct curves, a sphere and cylinder. This is used to correct astigmatism.

Cylinder curve — The cylinder curve is ground into a lens to correct astigmatism. This curve is just like a side of a can.

Multifocal lenses — These lenses have two or more areas of added plus power for reading up close. Examples include: Bifocals, trifocals and progressive lenses.

The Add — This is the area added to a lens for more plus power. This is for a Presbyopic refractive error.

Video 7 Plus and Minus prescriptions and transposition

Compound lenses have 2 distinct curves in them to correct astigmatism, the sphere and cylinder powers. A typical RX will look like this: -1.00 -1.00 X 142. The first number is the sphere power, the second is the cylinder and the third is the axis. The RX can also be written in two forms called plus cylinder and minus cylinder. The previous example is a minus cylinder form. An example of a plus cylinder would be: -1.00 +1.00 X 142. The obvious difference here, the cylinder is a plus power. In the optical industry there are these two ways to write any prescription. Depending on the doctor and the way he or she was trained they will write their prescriptions either in plus or minus cylinder. In many cases an optometrist will refract in minus cylinder and an ophthalmologist will refract in plus cylinder, but this is not always the case. You will probably run into both forms, so you need to be familiar with them. When the RX is sent to the lab you could send it as is or transpose it to the form you normally use. The lab will always grind in minus cylinder and will transpose any plus cylinder form into minus.

Any optician needs to be able to transpose any prescription in their daily work. This is very simple and works as follows: As our first example an RX reads +1.50 -.50 X 180 First take the sphere and cylinder power and add them together.

  +1.50
+ -.50
  +1.00

Now change the sign of the cylinder, here it will be a +1.00. Then change the axis by 90 degrees. 180 -90 + 90. The new RX is: +1.00 +.50 X 90

Second example given is -4.50 +1.00 X 45 this goes to -3.50 -.1.00 X 135.

Here are two examples not in the video.
The next example is +1.50 +2.25 X 147. So (+1.50) + (+2.25) = +3.75. Change the sign to a -2.25 and the axis is 147 – 90 = 57.
The new RX reads +3.75 – 2.25 X 57.

Here is one a little different. -1.00 + 1.50 X 89. (-1.00) + (+1.50) = +.50. The cyl is now -1.50 and the axis is 89 + 90 = 179.
The RX is now +.50 -1.50 X 179

That is all there is to transposition.

Video 8 Lens Materials

The optical industry has a lot of lens materials available to the optical professional. The first lenses made were out of crown glass. It is still used today but with the advent of lighter plastics, glass is being used less and less and now is usually less than 5% in a typical optical dispensary. In 1946 PPG or Pittsburg Plate Glass Company introduced CR39, a stable plastic for use as a lens material. It is still the most popular lens material used in the world due to the ease of manufacturing, stability and great vision as a lens.

To really understand the lens materials now being produced we need to talk about two separate properties of materials used in lenses. The first is the index of refraction and the second is the abbe value of each material.

The index of refraction was brought up in the third video and it is a number to indicate the density of the material in reference to light. It is a ratio of the speed of light in air to the speed of light through a material. The resulting number will range from 1.498 to about 1.90. The lenses we use will only go up to 1.74. The higher numbers refer to some specialty glass that is not normally used in America. The higher the number the more the light will be refracted through a lens which means the lens can be thinner.

The Abbe value is another ratio that is related to the dispersion of light. Basic white light is composed of all the colors and when it is refracted it can start to disperse into the separate colors or a rainbow. When a lens is made of higher index materials it can cause some dispersion and a patient may see an image that looks slightly blurry around the edges. The abbe value is a number between 60 and 30. The higher the number the less dispersion and usually better vision and the lower the number the more dispersion and sometimes (not always) less clear vision.

In this video we will cover the materials in general and in later videos we will cover them more extensively.

The first one is the oldest and that is glass. Also called crown glass, it will be the heaviest of all the materials but has the best abbe value at 60 and an index of refraction of 1.523. The vision through this lens is usually very good. This is very popular with people that want a very durable lens, it will not scratch unless it is abused, and don’t mind the weight of this material. It can be very heavy in higher prescriptions. As mentioned before, glass has been in a steady decline for quite a few years but will have a small market in certain areas of the country.

CR39 or basic plastic is a very popular type of lens material. It is very inexpensive, half the weight of glass, has an index of refraction of 1.498 and an abbe value of about 60 so the lens is a great product for expense and great vision. This material will be the thickest of all the materials discussed. Almost all styles of lenses will be available in CR39.

The rest of the materials are resin, different type of plastics, and they will be noted by their index of refraction or specific material. We won’t discuss high index glass since it is not used consistently in America although many glass progressives are made in 1.60 high index. I don’t believe this is for thinness but the manufacturers, for some reason, only made them in high index.

We have both mid index and high index materials and then polycarbonate. All of these materials have UV protection as well as basic scratch coat included. Mid index is from 1.52 to1.56 index of refraction. These materials will be thinner than basic plastic by about 15%. Many of them have been named by their manufacturers such as Trivex, Phoenix, Aris, Ormex, High X, Spectralite and others. There are a number of lens styles available in these materials but not as many as CR39. If you want to know more about which lenses are made in theses materials please contact your optical lab. The vision through theses lenses will usually be pretty good; the abbe value will be in the 42 to 45 range.

High index 1.60 is a great material. It is about 15% thinner than basic plastic and has a great abbe value at 43. This is a great compromise for thinness and pretty good vision. It will be thinner than mid index and somewhat better vision than the higher index or polycarbonate materials. Again you should contact your lab about lens style availability.

High index 1.66 or 1.67 is basically the same material. This is going to be about 25 % to 30% thinner than basic plastic and the abbe value is going down to 33 to 35. There many progressives, some bifocals, a trifocal and single vision.

1.70 and 1.74 high index materials are the thinnest lenses made in America. These can be 40% thinner than CR39 and in some cases if the lens is aspheric (this will be covered in a later video) they can be almost 50% thinner. The abbe value will be about 33. Another property of high index materials is that they become more reflective as the index of refraction goes up. These lenses should only be sold with anti reflective coats.

The last material is polycarbonate. This has an index of refraction of 1.589 so it is similar in thickness to 1.60 high index. This has always been a difficult material to manufacture as a lens but some of the inherent properties make it harder to see through. The abbe value, at 30, is part of this but there are some other issues about the manufacturing process that leave it with a lot of stress in the lens that may affect the vision for some people. This is a great material for safety since it is 10 times stronger than basic plastic. This is also the lens of choice for children for impact resistance and some liability issues. This can work for many people but you should be aware that some people just can’t wear it. As you dispense more of this material you will find how to fit it into your style of dispensing.

Video 9 The PD or interpupillary Distance

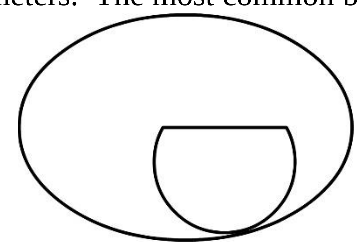
The PD is the most important measurement used in making glasses. This is the distance between the pupils of a patient. It can be measured from one pupil to the other, which is the binocular PD. This will usually range from about 50 to 74 for adults and in the 40’s for children. It can also be measured from the middle of the nose out to each pupil. This is the monocular PD. In general, it will from about 25 to 36 for each eye and will usually be different than the other eye, such as 30 for the right and 33 for the left. Each patient will have two PDs also, the distance PD and the near PD. When a patient looks into the distance the PD will be the widest and when they are looking at reading material or up close the eyes naturally more inward and the PD will be narrower. The measurement can be taken in a couple of ways but the best way is with the pupilometer. This device will take the PD with great accuracy. The other way is to use a millimeter rule and manually measure the distance between the pupils. You just hold the PD stick up to their eyes and measure from the center of one pupil to the other. This will get the near PD because the patient is usually looking at you as you measure. Then you can add 3 or 4 millimeters to the measurement to get the distance PD.

The binocular PD should be used for single vision, bifocal and trifocal lenses. Progressive lenses should always be made using the monocular PDs.

Video 10 Lens Style Overview

There are a huge number of lenses in the optical industry; single vision, bifocals, trifocals, progressive, occupational and computer lenses. Single vision is made in every material available and will focus at one point for the patient. That could be distance or near or even something in between. Different materials will be used for various reasons such as safety, thinness, color, durability and many other reasons.

Bifocal and trifocal lenses are made for the presbyopic patient, so they can have the distance and near vision corrected. The bifocal will have a definite area where the add is placed for reading. This 'segment' can vary in size and shape and is usually placed in the lower part of the lens so when the patient looks down the reading area is in the most appropriate spot. The size of the segment is determined by the width of the add. This is in millimeters and can range from 22 to 45 millimeters. The most common bifocal is the straight top or flat top. This is a round segment with a section cut off the top of the circle. Here is a diagram of what it looks like.

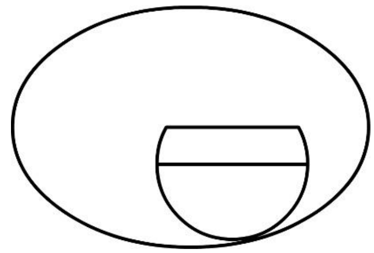


The most popular style is the ST 28. The width is 28 millimeters, but it can also come in several different sizes like the 22, 25, 28, 35, and 45. Sometimes this will also be referred to as a D28 because the segment can look like a D lying on its side. These lenses will be made in glass and plastic and a few are made in mid index, high index and polycarbonate.

Another style of bifocal that is used is the round style. This is a perfectly round segment and can be 22, 24, 25, 28, 30, 35 and 40 millimeters in diameter. All of these are made in plastic, only the 22 is made in glass and there is a lab manufacturing a round in polycarbonate, but it is only available from them.

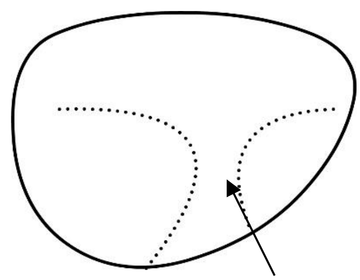
The executive bifocal is also known as a Franklin style. It has a line across the entire lens so the upper part is the distance and the lower part is the near. This can get very heavy for the patient and is now only available in plastic. There are other types of bifocals like curve top, blended and ribbon segs but these are very unusual for the American market.

Trifocals are a variation of the bifocal with an added segment for intermediate vision. Here is a diagram of a typical trifocal.



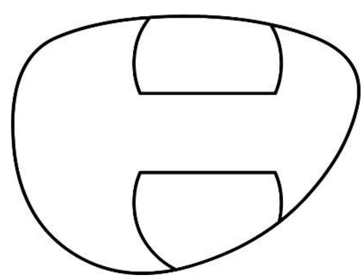
These come in similar widths as the bifocal and are noted as 7X25, 7X28, 7X35 and 8X35. The first number is the depth of the intermediate segment and the second number is the width of the main segment. Styles and materials are much more limited in the trifocal. You will usually only see the straight top style and the executive. Although the round trifocals are made, this is not usually presented to the customer. Trifocals are all made in plastic and glass materials. 7X28 and 8X35 are made in mid index, high index and poly only. A couple of unusual types are made in plastic such as the 9X35, 10X35, 12X35 and 14X35. These are usually used for computer use (but there are better options now for computer lenses). Call your lab for availability.

The progressive lens was introduced into the American market in the late 60's and has become one of the best selling multifocal lenses ever made. This lens is made to achieve more natural vision by allowing the add to change from the distant to the near power through a channel without any lines in the lens. The patient can then look through the lens at specific places to focus at any spot from distance to near. This allows them to have more than just 2 or 3 distinct areas of vision.



Progressive channel

Occupational lenses are made with 2 bifocals, one below as a normal bifocal then one above to see closer, above a patient's head. These are made in flat top and round segments and in glass and plastic only. As the name implies these are mainly for people in occupations that require close vision above their head such as plumbers and electricians.



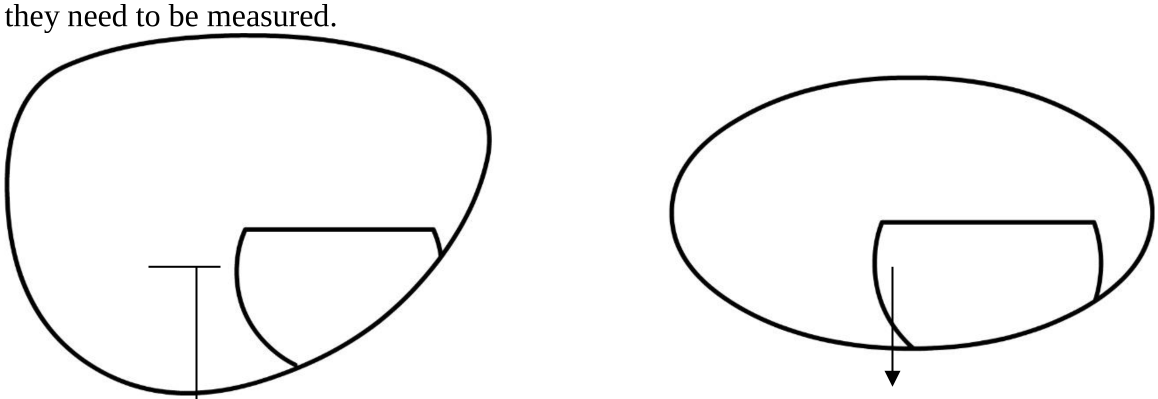
Computer lenses are probably the fastest growing lens now. These are made for people using computers for long times during the day. They come in a couple of distinct styles that have either 2 or 3 areas for viewing. They do not have lines, but they are not true progressives.

Later videos will cover each of the above styles in depth on how they work and how to fit each one.

Video11 Bifocals and Trifocals

Bifocals are made in several different styles and indicated by the width of the segment. Straight top or flat top bifocals that are made in glass are 22, 25, 28 and 35. Plastic bifocals are made in 22, 25, 28, 35 and 45 plus the executive style which is a line across the entire lens. Mid index and poly have the ST 28 and 35 styles. High index 1.60 and 1.66/1.67 are made in ST 28 only.

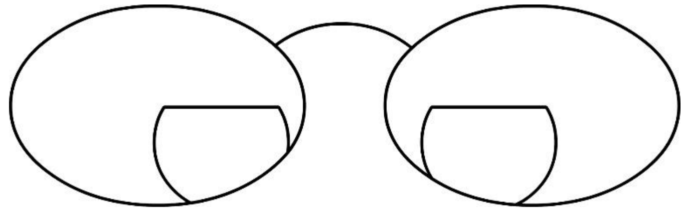
Bifocals give the patient a definite area to see through. This allows them to see at distance and near, which is about 16 inches. If they need to see any other distance, such as intermediate then they will have to adjust their position. This can be a disadvantage to a bifocal wearer. The segment is usually placed about the lower lid. In general, this seems to work but the video has gone into greater depth about fitting specifics. Another thing about segment fitting is how it is measured on the lens. The seg is always measured from the lowest point of a lens. Here are two different lenses that give you an idea how they need to be measured.



Measure from the top of the seg to the lowest part of the **lens.**
In any case this is the way all segments in multifocal lenses are measured.

The next thing that needs to be emphasized is the adaptation for any type multifocal including bifocals, trifocals and progressives. Any lens that is new to a patient will have some sort of trial period where the patient needs to get used to the lens and learn how to use it, so patient education is necessary for each pair of glasses dispensed. If the patient is going to wear a bifocal or trifocal for the first time, then there could be issues with the line and the new add area that will magnify images. A bifocal wearer could look down and think things are closer or they may be blurry. The patient will need to be aware of these possible issues and some time with the patient should be devoted to having them try them out in the office as they sit or walk around.

The other issue that needs to be brought up here is the use of the appropriate PD for bifocals and trifocals. The binocular PD is better for the patient in this style of lens. If you use unequal monocular PDs, such as 30/34, then the segments will be positioned differently in the frame in relation to the nasal edge.



The patient may notice this and may request that they be redone because they are not equidistant in the frame. I have always used binocular PDs and have never had to redo a pair of lenses because the patient needed mono PDs. The video has a little more detailed explanation of this.

Trifocals are made as a logical extension of the bifocal by adding another segment with half the power of the bifocal, so the patient can now see at an intermediate distance. This is usually about arms length or somewhere around 30 inches out. The size is indicated by the intermediate depth and the width of the seg. 7X25, 7X28, 7X35 and 8X35 are the most common styles. The first number is the depth of the top seg and the second number is the width of the segment itself. Glass comes in 7X25, 7X28 and 7X35. Plastic comes in 7X25, 7X28, 8X35 and executive. Mid index and poly offer 7X28 and 8X35 styles and there is now a 7/28 in 1.67 high index.

When fitting a trifocal, it will be slightly higher than a bifocal so both areas are usable to the patient.

Video 9 Progressives

Progressive lenses were first introduced to America in the late 1960's and have had a steady growth since. The progressive uses a design that makes a channel or corridor of increasing plus power down the lens to the full reading add close to the bottom. This allows more natural vision and the patient can focus at any distance depending on which part of the corridor he is looking through. This is a huge change from a bifocal or trifocal where there are only two or three areas to use. The areas around the corridor may also have some blurry spots that are not as clear as the top and this may cause some concern from the patient, but these areas will generally clear up as the patient wears the lenses. The video goes into more detail on how these lenses work and more personal experience on some aspects of wearing the lens. As mentioned before, any lens will have some adaptation time so patient education and selling the better progressives will give you great results. The newest type of progressive lenses are using advanced digital surfacing which has taken this lens to the next level of comfort and is easier to wear. The surface and curves of the lens are now being more closely analyzed with better techniques then ever before and allowing the manufacturers to produce better and clearer vision across much of the lens.

This lens is fit at the pupil for the seg height and there may be slightly more adaptation times to this type of lens but in the long run it will serve the patient better by more natural vision. Also, when fitting this type of lens, the use of monocular PDs is necessary. Be knowledgeable about the lenses that you are fitting. There are minimum seg heights for each style and only certain materials available. Contact your lab or sales rep if you need educational materials for the patient and spec sheets for yourself.

Video 13 Occupational lenses

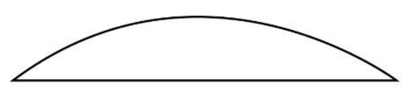
Occupational lenses are lenses made with two separate bifocals, one below in the normal position and one above for seeing up close at something above your head. These lenses are also called double D bifocals. They are made in glass and plastic only. The position of the bifocal below will determine the position of the bifocal above because there is a standard separation of 14 millimeters between the lenses. This separation is standard and cannot be changed. The video goes into the fitting details and you need to make sure you double check your heights because you don't want to make a mistake on one of these.

Video 14 Computer lenses

Computer lenses in general are lenses ground for the intermediate and near powers and they have no lines. Another style has three areas of vision, the near, intermediate and slightly farther, usually about 4 to 6 feet but these are not true progressives either. This lens can work great for many computer users that have an add in their regular glasses of about 1.50 or more. Although younger presbyopes can benefit from these if they are fit correctly.
All these lenses are now fit at the pupil, just like a progressive. When the lens is made the lens is converted to near power. The invoice from the lab may have the near power noted on the bill and this is what is checked on the lens. It will be checked at the neat point only. If you try and read the intermediate it will not work and will not look correct. Some lenses will have the distance noted but the near needs to be read to make sure the RX is correct.

Video 15 Aspheric Lenses

Aspheric lenses are very popular in the industry today. To understand aspheric curves, we have to have an understanding of the front curves of lenses. In most cases the front curve on a lens in spherical. This means that the front curve is shaped like the curves of a basketball, the curve is the same in all directions. As an example, the measured curve could be +6.25 on all portions of the lens.



An aspheric curve is obviously a curve that is not spherical. This means the curve will change from the middle out; as an example, the front curve could be a +10.00 then it changes to a +9.00 then it changes to a +8.00 farther out. This is concentric change so from the top it could look like a target. The center or bulls eye

will be a higher base curve like a +10.00. The next ring out would be a +9.00 and the next would be a plus 8.00. If we were to have an exaggerated view of the side it would look like this:

The curves are very gradual so the asphericity is not visible, but you could see the changes if you were to use a lens clock on the front surface. This type of lens is great in plus lenses because the vision will be better for the patient and the lens can be thinner and flatter. This lens is recommended for plus lenses from about a +2.00 to a +9.00. It is available in many materials and so the lens could even be thinner in a mid or high index product. Aspheric lenses are made in single vision, some bifocals and possibly a plastic trifocal. Progressive lenses are not made aspheric in this manner.

Many high index lenses are now made in aspheric and lots of time you can get aspheric minus lenses. Aspherics work very well in plus lenses but are not as effective in minus lenses. They will be thinner, but it will not be as noticeable as in a plus lens.

Progressive lenses have aspheric curves, but this is to make them progressive not the thinner or flatter style.

Video 16 Tints and Polarized lenses

Tints can be added to almost any lens made. Tints in resin lenses can be made in almost any color imaginable but tints in glass lenses are only made in specific colors. Since glass lenses are only a small part of an optical business we'll briefly cover them first.

Tints in glass lenses are made 'in mass' which means the color of the lens in made in the lens itself, it is not coated on the top of a clear lens. Since the tint is made in the lens material the color can vary with the thickness of a lens. A high minus lens will be thinner in the middle and thicker on the edge, so the tint will be darker on the outer edges of the lens. In a plus lens it will be just the opposite, so the thicker area is in the middle of the lens and will be darker through the center and slightly lighter on the edges. Also, this type of process limits the number of colors available in glass. The glass industry has made the tint colors very consistent so replacing one lens after a few years will mean the tints should match. Tints in glass also do not fade with time and exposure. Although there are a few oddball colors, the colors available are: grey, brown, green, yellow, pink and G15. All the colors are also graded by density by number 1, 2 and 3. One will be the lightest and three will be the darkest. Grey can be made in all three densities, but they are all dark enough to be sunglasses. The #1 is about a 50% density the #2 is about 60% and the #3 is about 75%. Since the tints are made in mass then there cannot be gradient types. Brown tints are only available in the darkest shade, so it is a sunglass of about 75% density. Yellow is in one shade and is a very bright canary yellow and not made for sunglasses but can be used for better contrast such as night driving or skiing on overcast days. This is a very expensive tint and is only made in single vision. Pink is a light color and has a little brown in it so it is not a bright color at all. The #1 is about 10% and the #2 is about a 15% density. The last color is G15 and was created by Bausch and Lomb during World War 2 for pilots. This is a combination of a grey and green color and if you have any Ray Ban sunglasses many times they come with a glass G15 color in them. This makes a great sunglass and is very comfortable to look through. It is made in single vision only.

Tints on resin or plastic lenses can be almost any color or shade, solid, gradient or double gradient. In some cases, this can be good and sometimes not so good. If there are too many choices, then it can be confusing for everybody.

The main colors in tinting are brown and grey and in many cases it's for sunglasses. The density can be anything and a lot of dispensers will indicate the density by the numbers 1, 2 or 3 just as in the glass tints, but this is very subjective. A #1 tint may not be the same #1 that the lab will use or the optician you may work with. Having a tint sample set will help minimize the problems with tints in general (this should be available from your lab). You can show the tints to the patient and send in the sample, so the lab can duplicate it. Many dispensers are also using a percentage for the density, from 5% (which is almost clear) to 90% (which only lets in 10% of the light), to let the lab know how dark the tint should be.

The colors available are only limited by your imagination but I would recommend that there should be a limit on what to show the patient. Again, too many could confuse the issue. When starting to work with a patient you should find out what they are trying to achieve with their glasses. Is it for sunglasses, a fashion tint, something to work with indoors or specific sports? These are just a few things that the patient may be trying to do. Experience will start to guide you on what tints to have available and what is achievable from the lab.

Polarized lenses are made with a filter that blocks light or glare from a certain angle, which is usually below the line of sight, although this is a sunglass (there are no clear polarizing lenses) and will reduce the amount of light that will reach the eye. The light blocked is usually reflected light off of water or smooth surfaces. The main colors available will be grays and browns and slight variations within these two colors and can come in two densities indicated by the letters A and C. The C will be the darker at about 75 to 80% and the A can range from about 40 to 60% depending on the manufacturer. This style of lens is great for any outdoor activity and provides very good vision and comfort to the wearer. Call the lab you use to get a sample set to show your patients.

There are several newer colors coming out in a variety of lens styles in the past few months, so I would call your lab for the most recent list. The newer colors include some very unusual colors like blue, green, red, orange, violet and yellow. These colors are relatively light and will not polarize the light as well as the darker colors do.
One last thing about polarized lenses that make them inconvenient for some people is their effect on LCD screens. This type of screen may come in cars, on watches, cell phones and flat screen monitors. In some cases, the lens will turn the screen being viewed unreadable or even black; this probably will be a minor inconvenience since they are for mainly for sun wear, but you should be aware of the possible problem.

Video 17 Photochromics

Photochromic is a generic term for lenses that turn darker in sunlight. They may change because of the light itself, due to the UV in the light or a combination of both. The first photochromic was introduced in a glass lens and is called Photogray Extra. Photobrown Extra is also available. As the names imply the lenses will turn darker gray or brown when exposed to sunlight. These products have been around since the 1960's and are still popular with a certain clientele. The newest product in glass is called thin and dark which allows the lab to grind a slightly thinner lens and the lens gets darker with more of the photosensitive material in the lens. These lenses are made with the photochromic ingredient, silver halides, throughout the lens, which is called 'in mass'. With the decline of glass in the market place the optical industry has been looking for the same type of changeable lens in the resin materials. Although there have been a couple of companies to try this, the first commercially successfully product was Transitions, introduced in the early 1990's. Since then the industry has been introduced, LifeRx., Sensity, Photofusion and Sunsync. All of these have very similar properties and work well in general.
The lenses are made with different technologies and all work pretty well. Transitions is made with an 'imbibing' process that incorporates the photochromic into the front surface of the lens. LifeRx use a lamination process to adhere the photochromic to the front surface of the lens. Each one of the processes has its own advantages and disadvantages but in general the performance is very similar.
The products are similar but the availability in lens styles could be the determining factor in the ones you choose to use. Sensity is a Hoya product so the lenses will be only from Hoya. LifeRx is a Vision-Ease photochromic and is only available in their lenses. Transitions is the most popular by far, so its availability is huge. For specifics on all these lenses contact your local lab.

Photochromics are a large part of the optical industry now so this should be common product to present to your patients.

Video 18 Coatings

Coatings for lenses are a very large part of what we can do for the patient. The coatings range from UV protection, basic scratch resistance, anti reflective and mirrors. The difference within each one of these categories can also be huge.

Ultra violet protection, called UV coating, is a basic coating to protect the eyes from ultra violet radiation. This is something that should be offered to any one getting just CR39 lenses. Any lens that is mid or high index, poly or photochromic has built in UV protection already. This is just a dipping process done at the lab. This should not be done on glass lenses due to the resulting unattractive color of the coat.

Scratch resistant coatings are made for all resin lenses and vary in cost and effectiveness. Most resin lenses come with a basic scratch coat but can be upgraded to a better more effective product. Each lens manufacturer or lab may have several different coatings offered that will have warranties from one year, one time to possibly a life time warranty. Contact your lab for more information.

Anti reflective coats were introduced into the optical field several years ago but only within the past 5 to 10 years have become a very viable product that will hold up under day to day use. The AR coat will increase the amount of light that will pass through a lens and this will help the patient to see more clearly. In a non-coated lens only 92% of the light will pass through but with an AR coat this will increase to over 99%. AR coats are multi layered to increase scratch resistance and adhere better to the lens and make them hydrophobic (water repellent) and oleophobic (oil repellent). Manufacturers are also making different quality AR coats, so the dispenser can offer different types to the customer depending on their wants. It would benefit you to get a sample of an AR coated lens and a non-AR coated lens to show patients.

Mirrors are a great addition for mainly sunglasses, but certain types can be added to clear or lightly tinted lenses for more of a fashion look. Mirrors can be solid, gradient, double gradient, multicolored and semi-transparent (also known as a flash). The cool factor is one main benefit, but they will generally add to the density of the tint in the lens. Contact your lab for a sample set of mirrors to show your patients. This can increase your sales of second pairs.

Video 19 Materials and Thickness

This is a subject that will cover a lot of ground for any optician. One of the main concerns of patients can be the thickness of a lens. This can be in both plus and minus lenses. There are four basic areas that influence the thickness of a lens: frame size, patient PD, prescription, and material. If a large frame is used for a patient then the lens will be thicker, either on the edge (for minus lenses) or in the middle (for plus lenses). The interpupillary distance (the PD) also has a big influence on the lens thickness. When a lens is decentered then the optical center of a lens is moved over the pupil of the patient and this will change the thickness of a lens. There is a simple calculation to measure this which involves the patient PD and the frame size.

A frame size is given with two numbers, the A and the DBL. This is usually somewhere on the frame or it can be measured with a PD stick. As an example, a frame can be a 50/20, 56/17 or 46/21. These numbers are the A and DBL. For the calculation take the A and add the DBL together. If the frame is a 50/20 then the result is 70. This is also known as the frame PD. To get the decentration, take the frame PD and subtract the patient PD. In the video we use a frame of 50/20 and the PD of 70. With this example the calculation is 70 – 70 = 0 so the lenses are centered in the frame and there is no decentration. If the patient PD is 60 then the calculation is 70 – 60 = 10. This is the total decentration and so each lens would be moved in 5 millimeters or half the total decentration. The video has some diagrams to show you the change that can happen when there is a lot of power or a lot of decentration.

The video also shows some diagrams that will give you an idea of the changes in a lens as the frame size increases.

The table below is for your reference from the video. The total difference from the CR39 to the 1.74 is noted as 37% in the video but it is only about 33%. Also, these calculations will be from basic lens maker formulas and the center/edge for plastic is 2.0 millimeters and any other material can have a 1.5 center/edge. This ½ millimeter difference has been calculated into the following table.

Material	-5.00 Power	Difference	%
CR39	5.5		
Trivex	4.5	1.0	18.0
Poly/1.60	4.3	1.2	22.0
1.67	4.0	1.5	27.0
1.70	3.8	1.7	31.0
1.74	3.7	1.8	33.0

Video 20 Materials and comparisons

CR39

CR39 has been the main material for the optical industry since the late 70s. It is easy to manufacture, use and tint and the patient will have great vision through it. Almost all lens styles are made in this material and it usually is the least expensive of all lenses. It can be scratch coated, UV coated, AR coated and have mirrors applied to it. This is a great all-around material. The only problem with it can be the thickness compared to higher index materials but in some cases a patient will want the best vision and CR39 is the best for that. This is always a great material between a -2.00 and a +2.00.

There are times we don't want to use CR39, and that will be for safety glasses, drilled rimless frames and children. Although CR39 can be used for each of these, except drilled rimless, different materials will perform better than CR39. Safety glasses can be made in any material made but the real preference is polycarbonate or Trivex since they are the most impact resistant lenses made. This is the same for children's eye wear; the liability issues outweigh the minor clarity problems of poly. Trivex can solve some of the clarity problems because it has a better abbe value. Drilled rimless frames should be made in poly, Trivex, 1.60 or 1.67 materials for the strength/flexibility properties of each.

Sometimes a product may only be made in plastic. If a prescription gets over about +12.00 then the lenses made are usually only in plastic. With the way the industry is headed, introducing new products, this may soon change.

Trivex

Trivex is the newest material to the industry. It is the lightest material and is very impact resistant. The abbe value is 43 and this will work great for drilled rimless, safety eyewear and perfect for children. About 15% thinner than CR39.

Polycarbonate
Polycarbonate is a great product in many cases. It has come out in almost all lens styles and will include many of the photochromics too. Comparatively poly can be about 20 to 25% thinner than plastic and is less expensive than mid or high index plastics. The vision through poly can bother some people because of the low abbe value but it is not always a problem.

- Abbe value is 30
- One of the lightest materials
- 20 to 25% thinner than plastic
- Relatively inexpensive for a thinner material

High Index materials
High index 1.60 is a great all-around material; it can have great vision, it can be as thin as poly and a number of lens styles are available. Even a few photochromics have come out in 1.60. The costs will be higher than polycarbonate.

- Abbe value is 43
- 20 to 23% thinner than CR39
- Aspheric available
- Lots of lens styles

High index 1.66/1.67 is another great material; thinner than poly and 1.60 and pretty good vision even though the abbe value is about 33. The lens styles are more numerous than 1.60 also. Both aspheric and photochromics are available.

- Abbe value of 33
- 25 to 30% thinner than CR39
- Lots of lens styles
- Aspheric and photochromics available

High index 1.70 and 1.74 are the thinnest materials available in America. These will be about 31 to 37% thinner than basic plastic and can be even thinner in aspheric. The abbe value here is 33 but being an ultra-high index material, it needs to be AR coated for best results. Right now, there are only single vision and progressives made in 1.70 and 1.74.

- Abbe value about 33
- 31 to 37% thinner than CR39
- Only in SV and progressive

Video 20 Conclusion

I hope this video series has helped in expanding your knowledge of the optical industry and opticianry. Please email me any questions and comments you have on the series, I truly want it to be a benefit to everyone that uses it. Also take the time to fill out the survey that I have as a link on the website.

Thank you for taking the Basic Optics course.

Addendum

You should know about the boxing system. The boxing system is the standard way to measure a lens and frame. It is derived from a box drawn around a lens shape. The longest horizontal length is the 'A' and the longest vertical is the 'B'. The DBL is the distance between the lenses positioned in a frame and the MRP is the major reference point or center of the lens in the box. A typical frame sized as the A and DBL and then that is inscribed on the frame. It could look like a 50/20 or a 56/17.