Lensometry

A lensometer is an optical bench consisting of an illuminated moveable target, a powerful fixed lens, and a telescopic eyepiece focused at infinity. The key element is the field lens that is fixed in place so that its focal point is on the back surface of the lens being analyzed.

The lensometer measures the back vertex power of the spectacle lens. The vertex power is the reciprocal of the distance between the back surface of the lens and its secondary focal point. This is also known as the back focal length. For this reason, a lensometer does not really measure the true focal length of a lens, which is measured from the principal planes, not from the lens surface.

The lensometer works on the Badal principle with the addition of an astronomical telescope for precise detection of parallel rays at neutralization. The Badel principle is Knapp's law applied to lensometers.

Performing Manual Lensometry

Focusing the Eyepiece

The focus of the lensometer eyepiece must be verified each time the instrument is used, to avoid erroneous readings.

1. With no lens or a plano lens in place on the lensometer, look through the eyepiece of the instrument. Turn the power drum until the mires (the perpendicular cross lines), viewed through the eyepiece, are grossly out of focus.
2. Turn the eyepiece in the plus direction to fog (blur) the target seen through the eyepiece.
3. Slowly turn the eyepiece in the opposite direction until the target is clear, then stop turning. This procedure focuses the eyepiece.
4. Turn the power drum to focus the mires. The mire should focus clearly at a power-drum reading of zero (plano). If the mires do not focus at plano, repeat the procedure from step 1.
5. If the mires continue to not focus at plano, the lensometer needs to be recalibrated.

Positioning the Eyeglasses

1. Place the eyeglasses on the movable spectacle table with the temples (earpieces) facing away from you. You are now prepared to read the back surface power of the lens, normally the appropriate surface from which to measure the power.
2. While looking through the lensometer eyepiece, align the eyeglass lens so that the mires cross in the center of the target (reticle). By convention, the right lens power is measured first, followed by the left lens power.

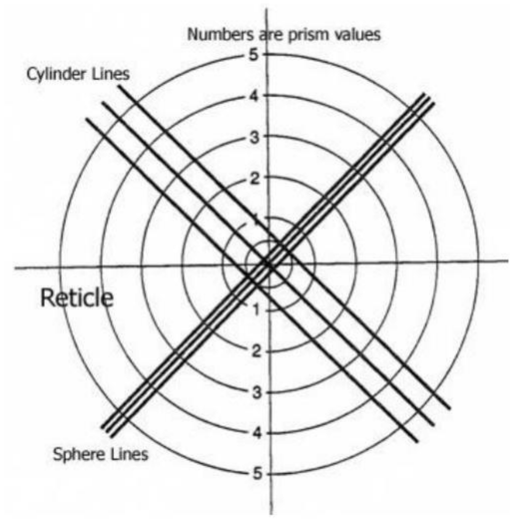


Figure 1: Reticle[1]
Close together lines = single line = sphere power
Wider apart lines = triple lines = cylinder power
Concentric circle = 1 prism diopter

Measuring Sphere and Cylinder Power – Plus Cylinder

1. The two sets of lines may not be distinguishable at first.

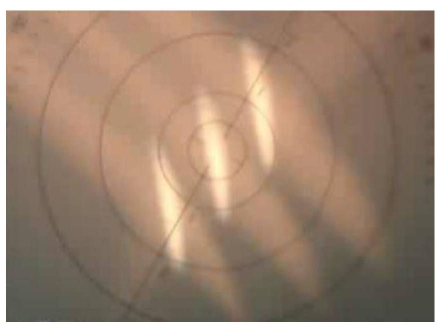


Figure 2[2]

2. Turn the power drum to bring the single lines into sharp focus. At the same time, rotate the cylinder axis wheel to straighten the single line where they cross the perpendicularly oriented triple lines.

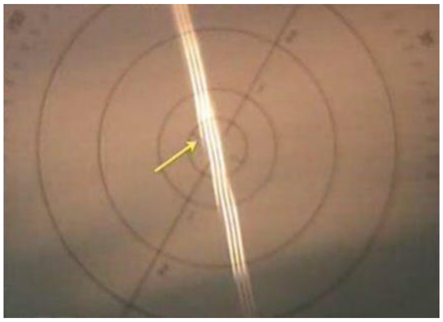


Figure 3: Single lines broken[2]

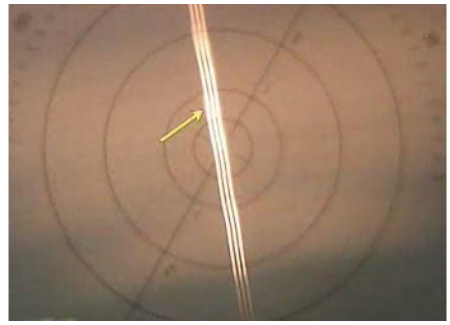


Figure 4: Single lines aligned and focused[2]

3. For plus cylinder measurements, the single line should focus with the least plus or most minus power.

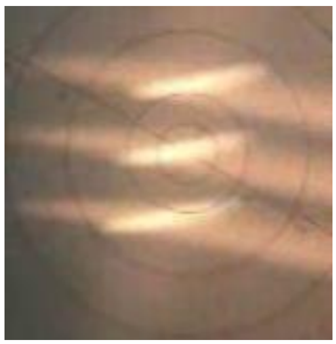


Figure 5: Triple lines broken[2]

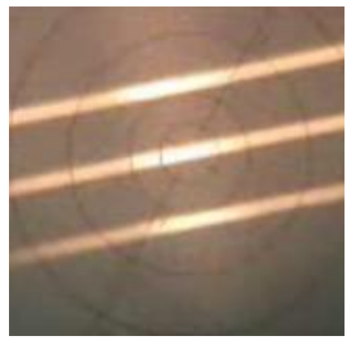


Figure 6: Triple lines aligned and focused[2]

4. If the single lines and triple lines come into focus at the same time, the lens is spherical. If only the single lines focus, you have identified the sphere portion of the spherocylindrical lens. Record the power drum reading at this point as the power of the sphere.

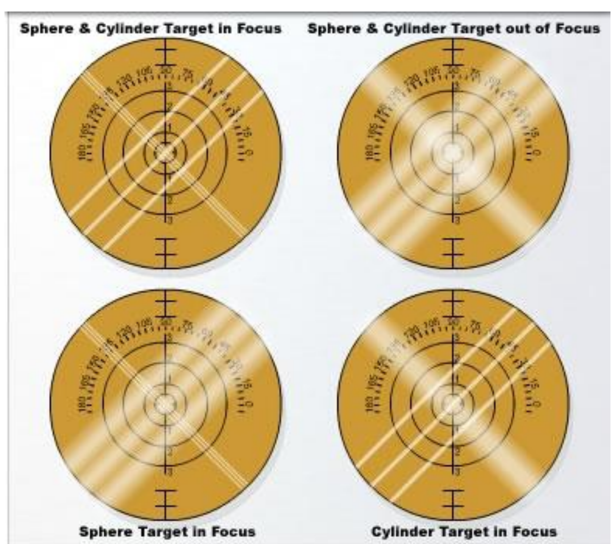


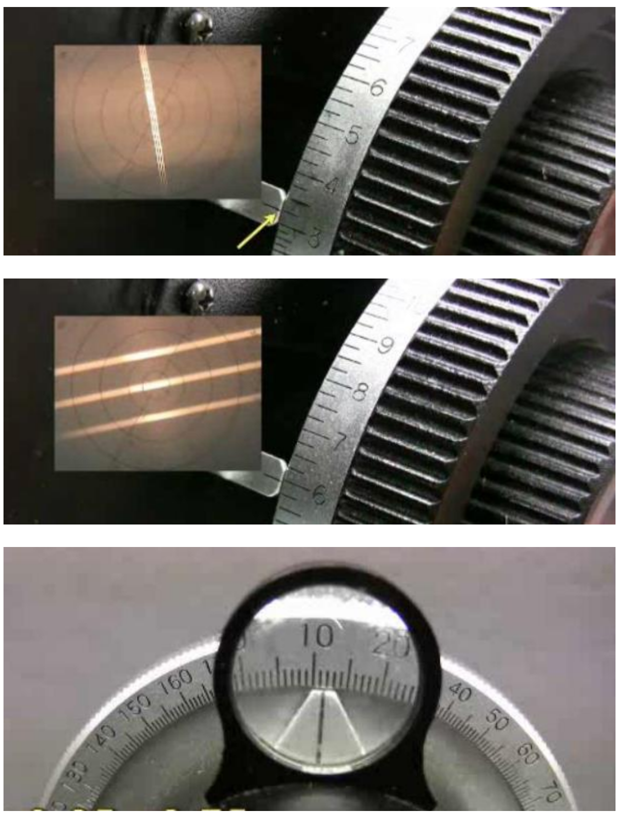
Figure 7[3]

5. If cylinder power is present, after noting the power drum reading for the sphere, measure cylinder power by moving the power drum in a more plus (less minus) direction to bring the triple lines into sharp focus.

   NOTE: If you have to move the power drum in the less plus direction to focus the triple lines, turn the cylinder axis wheel 90° and start over.

6. Calculate the difference between the first power reading for the single line and the second power reading for the triple lines. Record this figure as the plus-cylinder power of the lens.
7. Read and record the axis of the cylinder off the axis wheel.

Figure 8[2]:



Single lines: +3.25

Triple lines: +6.00

Axis: 012

Remember: plus cylinder power is additive: +6.00 – (+3.25) = +2.75

Rx: +3.25 + 2.75 x 012

To convert to minus cylinder format, add the cylinder power to the sphere power, change the cylinder power sign from + to – and change the axis by 90 degrees. In this case, the minus cylinder RX is +6.00 -2.75 x 102.

TIP: Once you find the axis at which the sphere lines are aligned, not broken, you do not need to adjust the axis wheel again while finding the cylinder power.

Measuring Reading Correction

1. After measuring the sphere and cylinder distance portion of a multifocal lens, center the reading portion of the lens in the lensometer gimbal (the ring like frame) and refocus on the single line.
2. The add, or reading correction, is the algebraic difference between the distance reading of the sphere power and the reading portion of sphere power.

   TIP: The reading power is the difference between the distance sphere power and the near sphere power. To determine the difference in power, you only need to focus/read the power of the single line in the reading/bottom part of the lens.

   Example:

   Distance Rx: +3.25 + 2.75 x 012

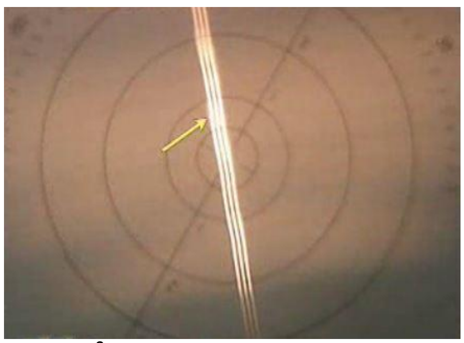


Figure 9[2]

Reading power reading: +5.25

[+5.25 – (+3.25) = +2.00]

Rx: +3.25 + 2.75 x 012 /+2.00 add

3. When measuring a multifocal reading correction greater than +2.50D, the spectacles must be turned around in the lensometer so that the front vertex power is measured. To do this, you will need to flip the frame around so that the temples face towards you. This is because the add/reading power of the lens is on the front surface of the lens. Remember, the distance portion of the spectacle lenses is designed to deal with essentially parallel light. However, the reading correction is designed to work on diverging light, originating from a standard working distance of 40 centimeters. The diverging light from the near object is made parallel by the reading correction portion of the lens. The parallel light then enters the distance lens where it is refracted again. In this way, the reading correction exerts its effect on the light from the nearer object before it passes through the rest of the lens. For stronger reading corrections, there would be a significant difference in the reading correction strength measurement when using the front versus back vertex measurement. Higher reading correction powers will measure more powerful than they actually are when using the back vertex measurement instead of the front vertex measurement.

4. When measuring the add power in progressive addition lenses, take care to select the area with the least distortion in both the distance and the reading portions of the lenses before doing your measurements. Be sure to measure the reading add, as close to the bottom of the lens as possible.

TIP: Progressive lenses have the power of the add etched finely on the surface.

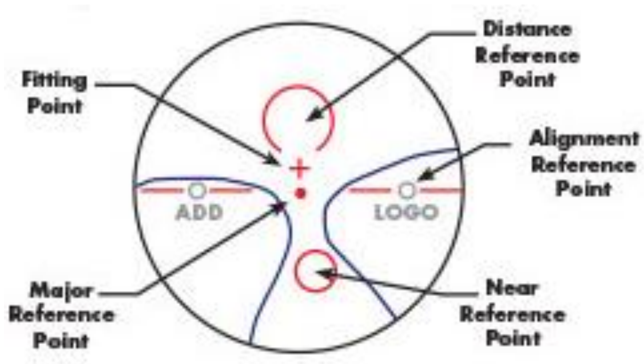


Figure 10[4]

Detecting Prism

Prismatic correction can be incorporated into a lens in 2 ways.

1. Ground-in prism – this involves grinding the surface of the lens at an angle during surfacing.

   Ground-in prism is revealed when the lensometer mires cannot be centered within the target when reading the lens in the usual place.

2. Induced prism – this involves decentering the optical center away from the patient's visual axis to utilize the prismatic properties of spherocylindrical lenses.

   This method is based on Prentice's rule, wherein prismatic effect (P), measured in prism diopters, is equal to the power of the lens (D) times the displacement of the optical axis (d) in centimeters.

   $$P = D \times d(cm)$$

   Induced prism is revealed when the mires can only be centered when the lens is decentered. For this reason, it is very easy to miss the presence of induced prism if you do not pay close attention to the optical center in relation to the patient's visual axis.

   The easiest and most accurate way to detect induced prism is to mark the patient's visual axis on the lens.

Marking the pupillary center/visual axis

1. While wearing the glasses, ask your patient to fixate a distance target.
2. Occlude the left eye.
3. Use a wax pencil or washable marker to mark the center of the right pupil on the surface of the lens.

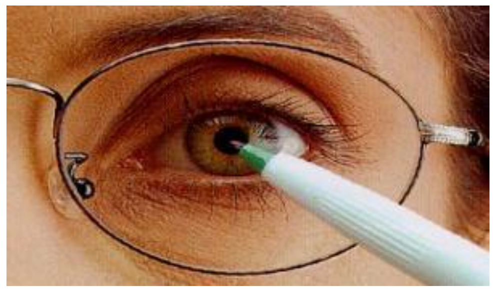


Figure 11[5]

4. Occlude the right eye and mark the center of the left pupil on the surface of the lens.
5. When reading the lenses on the lensometer, center the pupil mark in the lensometer gimbal.

If the mires are centered, then the optical axis corresponds to the patient's visual axis and there is no prism in the lens. If they are decentered, prism is present and you can now accurately quantify how much prism is present and in which direction the prism is oriented.

Measuring Prism Power and Orientation

There are 3 ways to measure prism power and orientation on a manual lensometer.

1. If there are less than 5 prism diopters in the lens, simply count the number of black concentric circles from the central cross of the lensometer target to the center of the vertical and/or horizontal crossed mires. Each circle represents one prism diopter.

   Record the base direction of the prism by determining the direction of the displacement of the mires. For example, if the mires are displaced upward, the prism base is up; downward displacement indicates base down; displacement towards the nose, base in; and displacement towards the temple, base out.

Example: The mires are decentered toward the temple of this right lens and fall on the 3rd concentric circle labeled with a “3”.

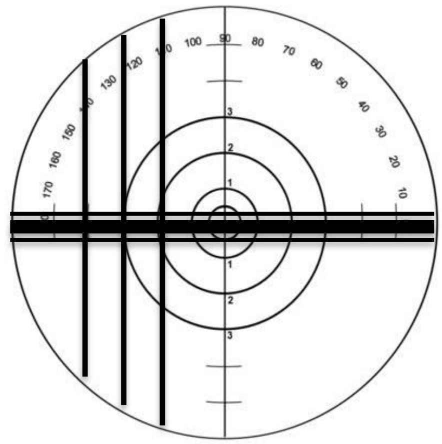


Figure 12: Right lens[1]

This lens has 3^{Δ} Base OUT prism

2. Auxiliary prisms may be needed to assist in measuring glasses with prism power greater than 5^{Δ}.

   By holding loose optical prisms over the lens, you can bring the mires back to the center of the reticle. Remember that the orientation of the prisms in the glasses will be opposite of the orientation of the prism needed to offset it.

Figure 13: Because the single sphere line is not visible, this right lens has more than 5^{Δ} of horizontal prism ground in.

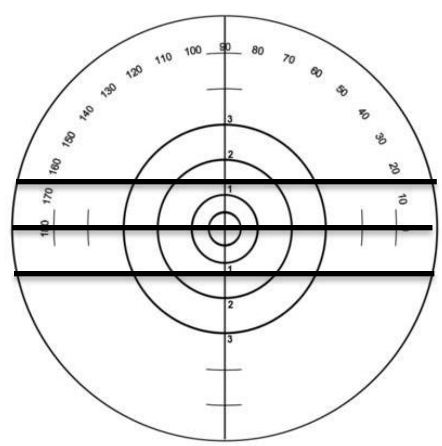
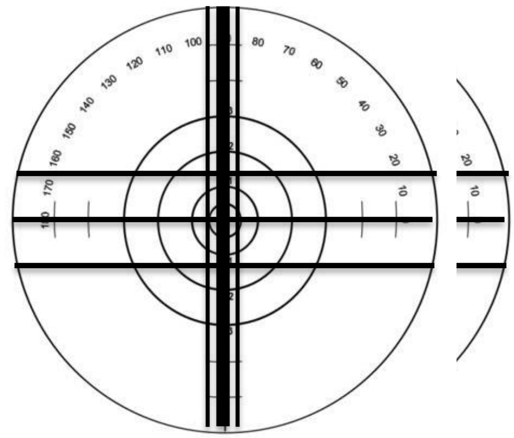


Figure 14: With a 5$^{\Delta}$ base out prism held over the lens, the mires are closer to the center but not centered completely.[1]

Figure 15: With a 7$^{\Delta}$ base out prism held over the lens the mires are centered.[1]



This lens has 7$^{\Delta}$ Base IN prism

3. Prism compensating device (PCD) – present on many newer manual lensometers.

Figure 16[6]

To read horizontal prism, rotate the silver knob into the 180° position and then turn the knob until the mires are centered horizontally.

To read vertical prism, rotate the knob into the 90° position and then turn the knob until the mires are centered vertically. Read the amount of prism from the scale.

Additional Comments

1. If you feel the RX is reading different than prescribed on an automated lensometer, check the RX on a manual lensometer to be sure.

2. Automated lensometers can detect prism but often do not measure it accurately, especially when there are greater than 5^{Δ} in the lens.
3. Digital lenses, particularly digital progressive lenses, will not measure exactly to the power prescribed. This is because digital lenses are designed to adjust for the different vertex distances the patient will have when viewing through different parts of the lens.
4. Prism is measured from the distance portion of multifocal lenses in most cases. If the reading correction of a multifocal lens is decentered vertically, you can use vertical auxiliary or PCD prism offset to bring the mires to the center for more accurate reading. This usually does not mean that there is prism ground into the reading portion of a multifocal lens. With the exception of slab off prism, it is unusual to have prism ground into the reading portion of a multifocal lens that is not also present in the top portion of the lens.

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