Keratometry:

Step 1: FOCUS THE EYEPIECE
- Lower occluder, focus the keratometer light source on the occluder.
- Turn the eyepiece counter-clockwise until blurry, then rotate clockwise JUST until clear, no further. If you rotate too much clockwise, you will over-minus yourself and be out of focus.

Step 2: INSTRUCT THE PATIENT
- Keep your forehead and chin in the rests.
- Breathe normally.
- Blink normally.
- Keep both eyes open.
- Keep non-occluded eye fixed on the target in the keratometer.

Step 3: POSITION THE PATIENT

Step 4: POSITION THE KERATOMETER
- Rotate the dial that controls up and down movement of the entire keratometer.
- Use keratometer light source (circle of light) to center over the patient’s cornea.
- Use the “dimples” of the keratometer to align with the patient’s canthus.

Step 5: FOCUS THE MIRES
- Focus the reticle and the lower right hand circle.

Step 6: LOCATE THE AXIS
- Rotate the drum until plus signs are aligned, just touching or “kissing.”

Step 7: ALIGN THE PLUS SIGNS & MINUS SIGNS
- Rotate the Horizontal Dial until the plus signs superimpose.
- Rotate the Vertical Dial until the minus signs superimpose.

Step 8: READ/RECORD THE MEASUREMENT
- Record as Flat K x Flat Axis / Steep K x Steep Axis (e.g. 43.50 x15 / 45.25 x105)
- Power: Note that each etching indicates 0.12(5) increments

44.00
43.87
43.75
43.62
43.50
43.37
43.25
43.12
43.00

Vertical Axis

Horizontal Axis

Axis
**Lensometry:**

Also called the lensmeter, focimeter, vertometer, the lensometer can measure the power, axis, prism, and optical center of a lens through a process by which the prescription of an existing pair of glasses is determined.

The four properties that can be measured:

1. Sphere and cylinder power, expressed in dipoters (D)
2. Axis of the lens that has a cylindrical component
3. Presence of prism and its direction, expressed in prism diopters (Δ)
4. Optical center of a lens.

Identify the parts of a lensometer.

**Process for lensometry (Plus cylinder):**

Step 1: **CHECK LENSMETER’S POWER SWITCH**
- Turn on.

Step 2: **FOCUS THE EYEPiece.**
- Rotate counterclockwise until reticle is blurred, then rotate clockwise, just until clear.

Step 3: **POSITION THE SPECTACLES**
- Position glasses on the spectacle table with temples facing away from the operator allowing for measurement of the back surface of the lens.
- Be sure that the glasses are resting evenly on the spectacle table to prevent rotation of the lens and an incorrect reading. This is especially important for axis and prism determination.
- Use the spectacle stage/lever to center mires in the reticle.
- Note 2 sets of lines: a set of triple lines widely spaced and a single set of lines (actually a set of triple lines closely spaced.)

Step 4: **ALIGN THE AXIS**
- If the lines appear broken, rotate the axis wheel until they appear straight.

Step 5: **MEASURE THE SPHERE POWER**
- Turn power drum towards you (Plus Cylinder, always rotates toward yourself) until the first mire comes into focus. *(Note, in minus cylinder, follow same steps, but rotate the power drum away from you.)* If it is the triple lines that come into focus first, rotate the axis wheel by 90°, then try again. *Note, if the single line appears broken, rotate the axis wheel until the line appears straight. Note the axis measurement on the axis wheel. This is the cylinder axis reading in degrees (°).* As the power drum is dialed towards you, the single line mire should come into focus first. *(Note the measurement on the power drum. This “1st reading” is the spherical power in diopters)*
- If the single line and the triple line come into focus simultaneously, the lens is spherical.
If the single line is in focus, but the triple lines are blurred, then the lens is a spherocylindrical lens. Additional steps must be conducted to determine the cylinder power.

Step 6: MEASURE THE CYLINDER POWER (if present)
- Turn the power drum towards you until the triple lines come into focus. (Make note of the measurement on the power drum. This is your “2nd reading,” which you will need to determine the cylinder power.)
- The cylinder power is the difference between the 1st reading (single line in focus) and the 2nd reading (triple lines in focus).

**Example:**

First reading (single line in focus) = +1.00D
Second reading (triple line in focus) = +3.50D

So far, our prescription reading is +1.00 +2.50 x 120 (axis determined by axis wheel).

Step 7: CENTER BIFOCAL SEGMENT IN THE LENSMETER
- Reposition THE lens and center the mires of the bifocal in the crosshairs of the reticle.
- Neutralize the power of the bifocal lens.

Step 8: REFOCUS THE SINGLE LINE AND NOTE THE READING FROM THE POWER DRUM
- Rotate the power drum towards you until single line comes into focus. (Note the measurement on the power drum. This “3rd reading” which you will need to determine the bifocal add power.)
- The bifocal add power is the difference between the 1st reading (single line in focus in the upper distance portion of the lens) and the 3rd reading (single line in focus in the bifocal area of the lens).

**Example:**

First reading (single line in focus) = +1.00D
Second reading (triple line in focus) = +3.75D

Now our prescription reading is +1.00 +2.50 x 120, Add +2.75D

**Steps for Transposition:**
1) Add cylinder power to the sphere power. This gives you the NEW sphere power.
2) Change the sign of the cylinder. This gives you the NEW cylinder power.
3) Change axis by 90°, if axis is 90° or less, then add 90°. If the axis is >90°, then subtract 90°.

**Example #1:** +1.00 +1.50 x 170
   - Step 1: +2.50
   - Step 2: -1.50
   - Step 3: x080

**Example #2:** +1.00 -1.75 x 060
   - Step 1: -0.75
   - Step 2: +1.75
   - Step 3: x150
Measure Prism (if present)

- A prism is present when the mires cannot be centered on the central part of the reticles.
- Each black concentric ring represents 1 prism Diopter ($1\Delta$). Count the number of circles from the center of the reticle to the center of the crossed mires.
  - If the mires (point where single/triple lines cross) are displaced towards the nose (nasally), then it is Base In prism (BI).
  - If the mires (point where single/triple lines cross) are displaced towards the temple (temporally), then it is Base Out prism (BO).
  - If the mires are displaced superiorly, then it is Base Up prism (BU).
  - If the mires are displaced inferiorly, then it is Base Down prism (BD).

Determine Optical Center

- Position the lens against the lens stop of the lensmeter.
- Focus the mires and center them within the crosshairs of the reticle.
- If available, use the lens marker (dotting device) to mark the center of the lens. If a lens marker is not available, use a non-permanent marker pen.
Ocular Motility:

Motility Exam
The motility exam determines how one eye moves in conjunction with the other. Several tests provide this information. First the examiner evaluates motility by having the patient follow a moving object to check the nine positions of gaze. As the object is moved, the examiner observes the patient’s eyes to determine function of the extraocular muscles and reveal any manifest deviations.

Hirschberg test
The examiner shines a small light into the patient’s eyes at a distance of 33cm. Note where the light falls. If the patient has no strabismus, the corneal light reflection appears in symmetrical parts of the patient’s pupil.

If strabismus is present, the corneal light reflection appears as asymmetric. An estimate of misalignment can be determined by calculating that for each 1mm of corneal light asymmetry reflection corresponds to 7° (or 15 prism diopters) of ocular deviation of the visual axis.

Krimsky test
The Krimsky test is similar to the Hirschberg test in that it is conducted by observing the corneal light reflection. However, with the Krimsky test, use of prisms is used to determine the specific amount of prism diopters needed to correct the ocular deviation.

Prisms have an apex (the “point”) and a base (the “fat part”). The apex points towards the deviation. The base is points to the direction the eye needs to move to be in “normal” position. The more the eye is turned, the greater the prism power required to correct the deviation.

Cover-uncover Test  [Reveals tropia, or a manifest (obvious) deviation]

Step 1: Have patient fixate on distant target.

Step 2: Use the occluder to COVER one eye at a time.

Step 3: When one eye is covered (keeping the occluder in place), observe the other eye. Only observe the fixation behavior of the non-occluded eye as you slowly COVER, then UNCOVER, the opposite eye.

Step 4: Repeat this procedure several times.

Step 5: Check the opposite eye in the same fashion.

Step 6: If the non-occluded eye moves to fixate on the target, a manifest deviation is present in the form of a tropia. The occluded eye will not move in this case.

Step 7: Tropia should be documented in the patient’s chart.

Or...

Step 6: If the non-occluded eye does not move to fixate on the target, no tropia is present. Then proceed to the cross-cover test.
Cross-cover Test [Reveals phoria, or a latent (hidden) deviation]

Step 1: Have patient fixate on distant target.

Step 2: The occluder is placed over one eye and the fixation behavior of the non-occlude eye is observed.

Step 3: The occluder is moved across the face to cover the opposite eye. When doing so, the re-fixation behavior of the eye being uncovered is observed.

Step 4: The occluder is next moved back across the face to the opposite eye while observing the re-fixation behavior of the eye being uncovered.

Step 5: Repeat this procedure several times.

Step 6: If you observe re-fixation movements, a phoria is present.

Step 7: Phoria should be documented in the patient’s chart.

Or...

Step 6: If you do not observe any re-fixation movements, then no phoria is present.

Step 7: Orthophoria should be documented in the patient’s chart.

Determining the direction of the deviation:

Tropias and phorias are categorized according to the position of the deviated eye. Note: the deviation is where the eye turn starts. So, it is the direction that the eye deviates from normal. (Do not confuse it with which direction the eye has to move in order to find its normal position.)

**Exo- deviation:** deviation is outward, towards the temple.

**Eso- deviation:** deviation is inward, towards the nose.

**Hyper- deviation:** deviation is upwards, toward the forehead.

**Hypo- deviation:** deviation is downwards, towards the chin.
Refinement:

**Step 1: Preparing for Refinement** (1st, record the retinoscopy results and VA with that correction) Be sure that the patient is properly in place behind the phoropter.

**Step 2: Occlude the patient.**
- Occlude one eye.
- Provide a range of letters including the last line the patient was able to read.
- Ensure the patient can see the target.
- Instruct patient that as you offer different lenses, that the patient is to chose the option that provides the sharpest and clearest vision.

**Step 3: Refine the sphere power.**
- Always give plus lenses first
- Ask the patient, “Which makes your vision sharper and clearer?”
- Patient has to “earn” more minus power. If patient does not see more letters, or says that the more minus option is “smaller & darker” they have not “earned” the more minus option.

**Step 4: Put the Jackson Cross Cylinder in place.**

**Step 5: Adjust the Jackson cross Cylinder to assess the axis.**
- Straddle the cylinder axis with the JCC by turning the knurled ring of the lens parallel to the cylinder axis.

**Step 6: Refine the cylinder axis.**
- Offer two choices from which the patient must chose
- Follow the white dot. (go in the direction of the white dot)
- Ask the patient, “Which makes your vision sharper and clearer?”
- More the axis dial by about 5-10° at a time.
- Continue the choice options until both options are equally blurry.

**Step 7: Adjust the Jackson Cross Cylinder to measure power.**
- Now rotate the JCC so that the axis of rotation is 45° away from the cylinder axis and the power (Noted as “P”) is parallel to the cylinder axis.

**Step 8: Refine the cylinder power,**
- Offer the patient two choices by flipping the knurled ring. In one choice the red dots will align with the axis. With the opposite flip, the white dots will aligns with the axis.
- White dots indicate that more plus cylinder would be added. If the red dot is chosen, then plus cylinder power will be taken away.

**Step 9: Remove the Jackson Cross Cylinder**
- Continue offering choices without the JCC until both choices appear equally blurry. (The patient may say they look the “Same” or “No different”

**Step 10: Refine the sphere power.**
• After the cylinder power has been determined, you should go back to finalize the sphere power refinement.
• Always go in the plus direction first.
• OK to add more minus sphere power if the visual acuity improves with the lens change.
• GOAL: Find the best visual acuity using the most plus power (or least minus power).

Step 11: Verify balance between two eyes by performing the Duochrome test.
• Using at least 2 lines larger than the smallest the patient can read, move the red-green filter into place.
• Ask patient to chose “which letters are clearer, the letters in red or in green?” if the green letters are clearer, add 0.25D to the plus sphere power.
• If the red letters are clearer, subtract 0.25D of plus power.
• Repeat until the red and green sides appear to be equally blurry.
• Fogging technique(open the occluder in the phoropter and add +3.00 D to the fellow eye.
• Add enough to blur the patient’s vision. Slowly remove the extra plus power on click at a time.
• This result becomes your final refinement.

Step 12: Document the results of the final refraction. (Also record BCVA)
Retinoscopy (Plus Cylinder):

Retinoscopy measures refractive errors by an objective method.

**Step 1: Preparing for retinoscopy:**
- Position patient at phoropter
  - The examiner and patient are eye to eye.
  - Have the patient fixate on a distant target.
- Determine your working distance. (Average working distance is about 67cm (22in)
- If more or less, calculate by using the formula:

\[
\text{Working Distance Lens (D)} = \frac{1}{\text{Distance from examiner’s eye}} - \frac{1}{\text{To the patient’s eye (m)}}
\]

Where D = diopters
And m= meters

- Understand that this working distance will account for a +1.50D adjustment to determine your end result.

**Step 2: Level the phoropter** (adjust until the leveling bubble is between the 2 central vertical lines)

**Step 3: Position the phoropter** (adjust the IPD (interpupillary distance) knob until the center the pupils in the phoropter aperture)

**Step 4: Identify the two meridians.**
- Chose your retinoscope and turn it on to the appropriate brightness.
- NOTE: “intercept” refers to the light from the retinoscope; whereas “Streak” and “reflex” refer to the light from the patient’s eye
- NOTE: if the patient has refractive error, then the reflex from the patient’s eye will align along two meridians.
- Identify these two meridians:
  1. Place sleeve into diffuse light position, using the phoropter lenses (or loose lenses), sweep the streak across the pupil, note whether the streak is “with” or “against” motion.
  2. Once the intercept has been identified, rotate the sleeve 90° and the movement of that streak should be noted.
  3. Convert all streaks to “with” motion by adding minus sphere power.
  4. NOTE:
     - Speed: the reflex moves faster the closer you get to neutrality.
     - Brightness: the reflex gets brighter the closer you get to neutrality.
     - Width: The reflex gets wider the closer you get to neutrality.
  5. If the streak remains the same with rotation of the sleeve, then there is no astigmatism.
  6. If the streaks are different, then there is astigmatism present. The widest streak represents the sphere portion of the refractive error. The narrow streak represents the cylinder portion of the refractive error, which is neutralized with plus cylinder lenses once the axis has been determined.
Step 5: Determine the sphere power.
- Place lenses in front of the eye until neutralization occurs starting with the least plus meridian first- that’s usually the one with the faster and brighter reflex initially)

Step 6: Set the cylinder axis.
- Once the least plus meridian has been neutralized (Step 5), rotate the retinoscope intercept 90° and parallel to the most plus reflex. An intercept properly aligned with the most plus reflex indicates the axis of plus cylinder.

Step 7: Determine the cylinder axis.
- Use break, thickness, intensity/straddling, skew phenomena

Step 8: Determine the cylinder power
- Turn the cylinder power dial adding plus cylinder power lenses while sweep back and forth until neutralization is achieved.
- Once neutralization has been found, rotate the retinoscope sleeve to verify there is no “with” or “against” motion in any meridian.
- Side note: Recognize Spherical aberration and scissors reflex

Step 9: Subtract your working distance from the final retinoscopy results. (Subtract the working distance dioptric value from the sphere power of the distance prescription.

Step 10: Document your results
Tonometry:

Some steps (Steps 1-10) in the applanation procedure may be done in an order. Some steps (Steps 11-18) be done in a specific order.

- Be sure that the tonometer is calibrated regularly.
- Be sure that the tonometer tip is clean and disinfected between patients. (3% H2O2) or 1:10 bleach for 10 minutes. Clean, rinse, dry thoroughly prior to use on a patient’s eye.
- Also, can use alcohol pad or swab.

Step 1: Turn on the slit lamp power.

Step 2: Position the cobalt blue filter.

Step 3: Adjust the brightness of the filter. (Adjust to brightest position)

Step 4: Adjust the slit lamp bean intensity to its widest setting.

Step 5: Adjust the slit lamp beam angle. (Adjust to a wide angle, about 45-60°)

Step 6: Adjust for more than 3D of corneal astigmatism by rotating the prism tip so that the minus cylinder axis aligns with the red line on the prism tip.

Step 7: Administer anesthetic to the patient. (anesthetic with fluorescein)

Step 8: Instruct the patient.
Ask the patient to:
- Fixate the non-applanated eye on the target that you designate
- Breathe normally
- Keep the chin and the forehead against the rests
- Keep the teeth together and tem ought closed during ht entire procedure
- Keep both eyes wide open
- Assist with keeping the eye open as needed, using finger and thumb, being sure to press only against the orbital bones NOT the eye ball.

Step 9: Set the force adjustment dial (starting around 10mmHg)

Step 10: Set the ocular magnification (lowest magnifying power)

Step 11: Adjust the tonometer to the patient. (Chin rest adjusted so that patient’s eye is level with the line on the head rest bar, then also align the patient’s with the applanating prism.

Step 12: Position the angle of the slit lamp at ~ 45°.

Step 13: Position the prism. Using slit lamp’s joystick, move the prism until it is centered on the cornea and nearly touching it.

Step 14: Applanate the cornea.
(use the joystick to gently move the prism forward until it touches the cornea. Look through the oculars to confirm the tip is touching the cornea. Use care in this step to avoid abrading the cornea.

**Step 15: Position the mires.**
- Use the joystick to position the mires so that there are 2 equal-sized semi-circles centered on the oculars.
- Note: Be cognizant of too much or too little fluorescein and if you are compressing to hard on the cornea.

**Step 16: Take the pressure.**
- Slowly move the force adjustment control to adjust the mires.
- Position the mires until the inside edge of each semi-circle are just touching.... NOT overlapping.

**Step 17: Observe the pressure reading.**
- Gently remove the tonometer from the patient’s eye.
- The force adjustment is calibrated in grams. (1g = 10mmHg)
- Each hash mark represents 2/10ths of a gram (or 2mmHg)
  - Example: if the indicator arrow is on the 2 hash mark, that is 20mmHg
  - Example: if the indicator arrow is on the first hash mark past 1, it is 12mmHg.

**Step 18: Record the reading.**
Visual Fields:

Automated VF

Step 1: Program the patient information into the machine.

Step 2: Set up the perimeter.

Step 3: Prepare the patient.
- Tell the patient you are going to patch the fellow eye.
- Place the corrective lenses into the lens holder (if applicable).
- Ask the patient to place their head in the rest and keep the forehead against the bar.
- Ask the patient to fixate on the center target at all times.
- Ask the patient to fixate on the center light at all times.
- Instruct the patient to click the response button any time a target is seen of any intensity inside the bowl.
- Instruct the patient that the test can be paused at any time to allow resting. Tests may be resumed by the operator.
- Encourage the patient to blink normally.

Step 4: Select the corrective lenses.
- Use the current refraction.
- If the patient is presbyopic, a reading add must be calculated, using the age-add table.
- If the patient has more than 1.0D of cylinder, it is used as well.
- If the patient has 1.00D or less of cylinder, than the spherical equivalent is used.

Step 5: Position the corrective lenses. (sphere lens nearest the patient)

Step 6: Adjust the cylinder lens axis.

Step 7: Position the lens holder.

Step 8: Select test and verify patient information. (24-2, 30-2, which eye, etc.)

Step 9: Center the image of the patient’s eye.

Step 10: Monitor the patient during the test. (Encourage fixation, center patient’s eye as needed)

Step 11: Complete the test. (Save results, go to the other eye if ordered)

Step 12: Print the test.

Step 13: Validating the reliability of the test.
- False positives- patient clicked when they shouldn’t have been able to see the stimulus.
- False negatives- patient didn’t click when they should have been able to see the stimulus.
- Fixation losses- machine can roughly analyze based on the blind spot testing.
- Fluctuation- machine retests same spots with same intensity for consistency.