

Principles of Visual Assessment for Opticians and Technicians

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Introduction

- Introduction
- Definitions
- Patient History/Chief Complaint
- Anatomy & Physiology relative to refractions
- Refractive Errors
- Preliminary Tests
 - Instrumentation used
 - Visual Acuity
 - Reduced Acuity Testing
 - Autorefraction
 - Keratometry/Slitlamp
- The Visual Assessment Instrumentation used
 - Objective Refraction – Retinoscopy
 - Procedures
 - Subjective Refraction
 - Sequence
 - Jackson Cross Cylinder (JCC) Test
 - Refining the Sphere Power
 - Medications used during refraction
 - Cycloplegic Refraction
 - Visual Evaluation
 - Accommodation
 - Convergence
- Other testing Instrumentation used
 - Binocular Balance
 - Muscle Testing
 - Deviations
 - Muscle Imbalances
 - Color Vision
 - Visual Field
- Complications found during visual assessment
- Questions/Answers/Comments/Thank you

Refraction – the Definition – Dictionary of Ophthalmic Optics

The change in direction of light as it passes obliquely from one medium to another of different optical density or refractive index.

The act of determining the focal condition (emmetropia or various ametropias) of the eye and its correction by optical devices, usually spectacles or contact lenses.

Refraction – the Simple Definition

The bending of light

The process of determining/measuring the refractive status of the eye

Refractionist – the Definition – Dictionary of Ophthalmic Optics

Refractionist – One skilled in determining the refractive state of the eyes, the state of binocularity and the proper corrective lenses.

Refraction – Types– Dictionary of Ophthalmic Optics

Cycloplegic refraction – The determination of a patient’s need for refractive correction with the aid of topical drugs to paralyze all accommodative action within the eye.

Manifest refraction – The assessment or development of a refraction formula for an individual patient in prescription form for a specified vertex distance, without the use of cycloplegic eye drops.

Objective refraction – Determination of the spectacle or contact lens formula without utilizing the response of the patient to determine the accuracy. Usually performed with a streak or spot retinoscope or an automatic computerized refraction device. (Autorefractor)

Subjective refraction – Determination of the spectacle or contact lens prescription utilizing the response of the patient to determine the accuracy of the prescription. Usually performed with a phoropter or trial frame in combination with the Snellen chart placed at a predetermined distance, usually 20 feet (6 meters)

Definition

Chief Complaint - CC - Subjective

A subjective statement made by a patient describing the most significant or serious symptoms or signs of illness or dysfunction that caused him or her to seek health care.



Definition

The primary symptom/symptoms that a patient states is the reason for the visit

Short statement from the patient “in their own words” about why they presented for treatment



History

Chief complaint

- Reason for visit

History of present illness

- Detailed information on chief complaint

Medical History

Ocular History

Family History

Social History (age appropriate)

- Alcohol, smoke, occupation, live alone

Terminology – A&P

Anatomy is the branch of biology concerned with the study of the structure of organisms and their parts.

- Anatomy of the eye is the study of the eye structure and parts

Physiology is the study of the function of body parts

- Physiology of the eye is the study of the function/functions of the eye structure and parts
 - In other words how do the parts work?

Four Refractive Mediums of the Eye

Actually, first is the precorneal tear film

The cornea The aqueous humor

The crystalline lens

The vitreous humor

Index of Refraction

Cornea = 1.376

Aqueous humor = 1.336

Crystalline lens = 1.416

- (slightly denser in center than outer layers, 1.406 at the center to about 1.386 in outer layers)
generally accepted as Gullstrand's model of 1.416

Vitreous humor = 1.337

Dioptric Power

Cornea

- +42.00D to +45.00D
 - Gullstrand's model = 43.00D
- Performs about 80% of the refraction or bending of light rays within the eye

Crystalline Lens

- +15.00D - +20.00 D
 - Gullstrand's model = 19.00D
- Depending on textbook

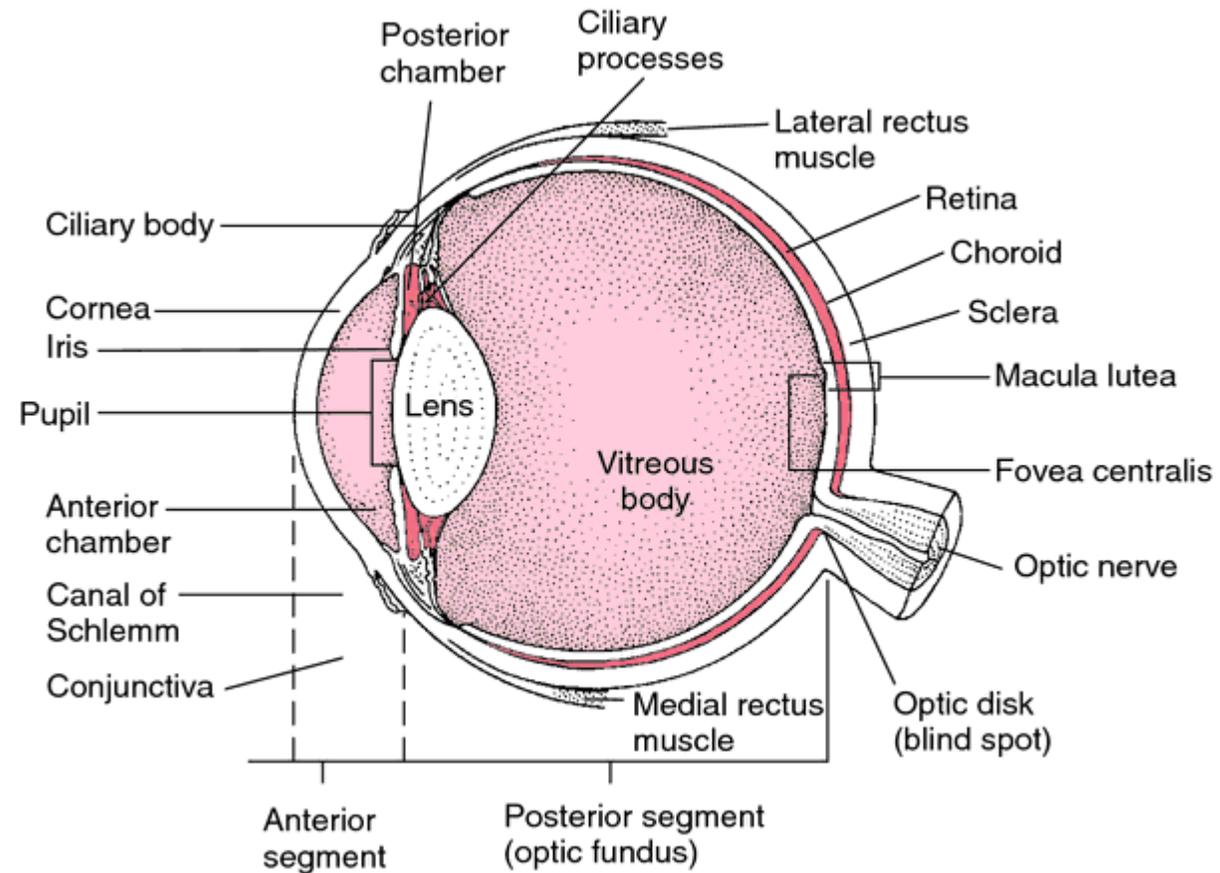
Other Dimensions/Measurements

ABBE value = 45

Average axial length

- 17mm in newborns
- 24mm – 26.5 in adults
 - Gullstrand's model = 24mm
- Measured either by ultrasonography or by partial coherence interferometry (PCI)
 - Changes of 1mm result in approximately 2.50D of refractive error changes in axial myopia or axial hyperopia

Anatomy



Terminology

Emmetropia

Ametropia

- Myopia
- Hyperopia
- Astigmatism
- Presbyopia

Terminology

Astigmatism

Corneal astigmatism

Lenticular astigmatism

Regular astigmatism

Irregular astigmatism

Simple myopic astigmatism

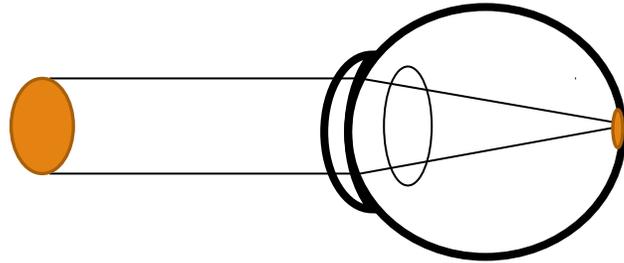
Compound myopic astigmatism

Simple hyperopic astigmatism

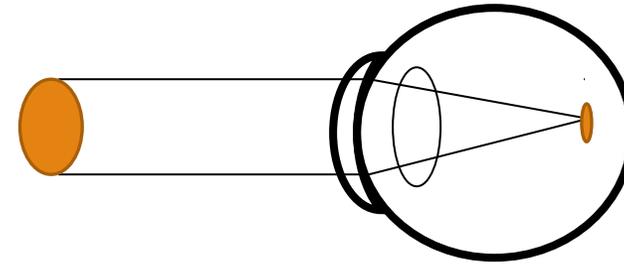
Compound hyperopic astigmatism

Mixed astigmatism

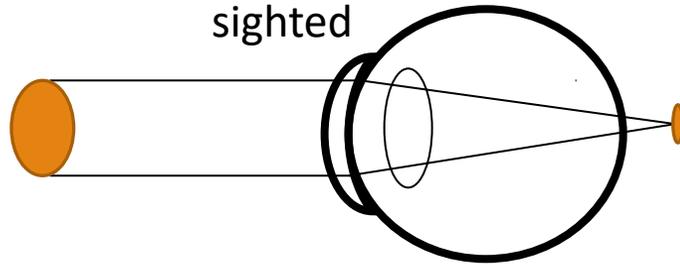
Emmetropia – Normal Focus



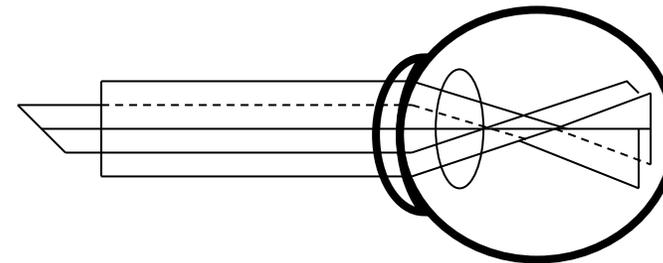
Myopia – Near sighted



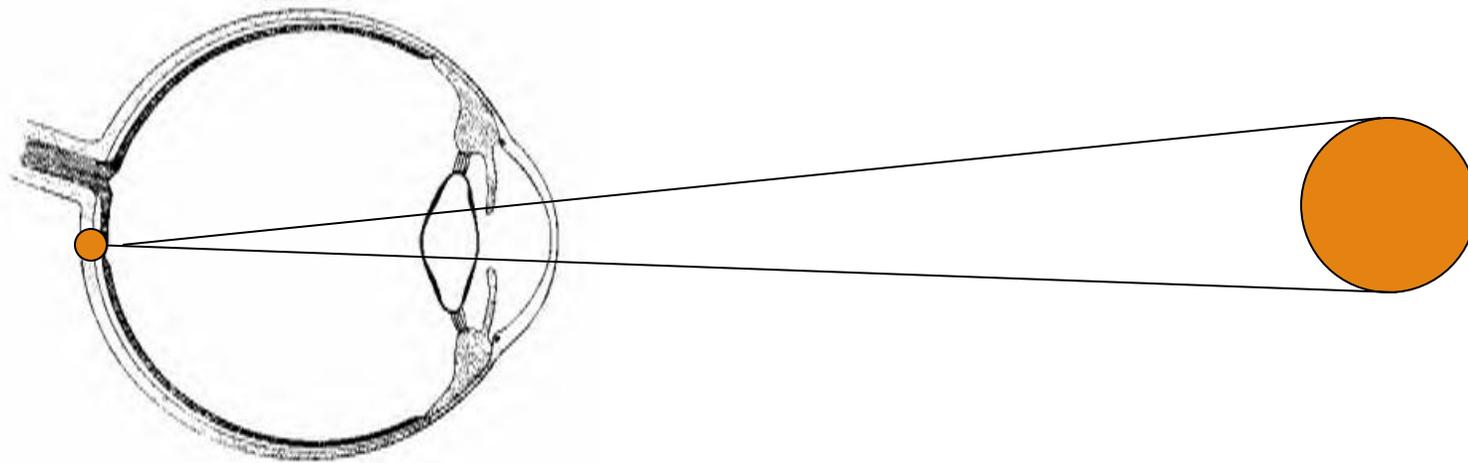
Hyperopia – Far sighted



Astigmatism – Irregular focus – not in one meridian



Emmetropia



Emmetropia

Light from 20ft is focused on the retina

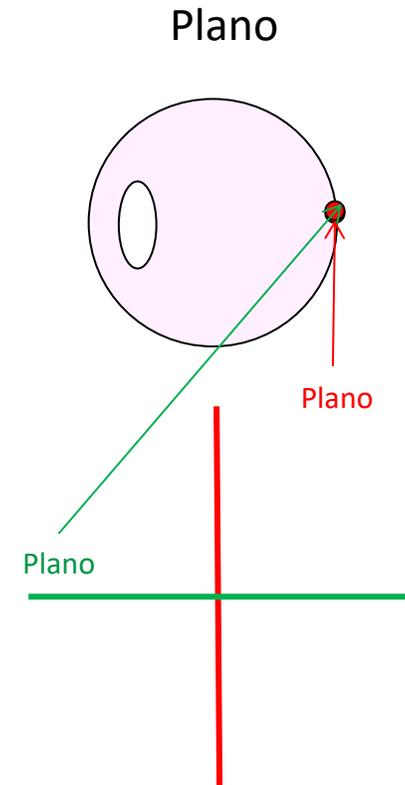
No refractive error – Normal vision

Lens and cornea power is within normal limits

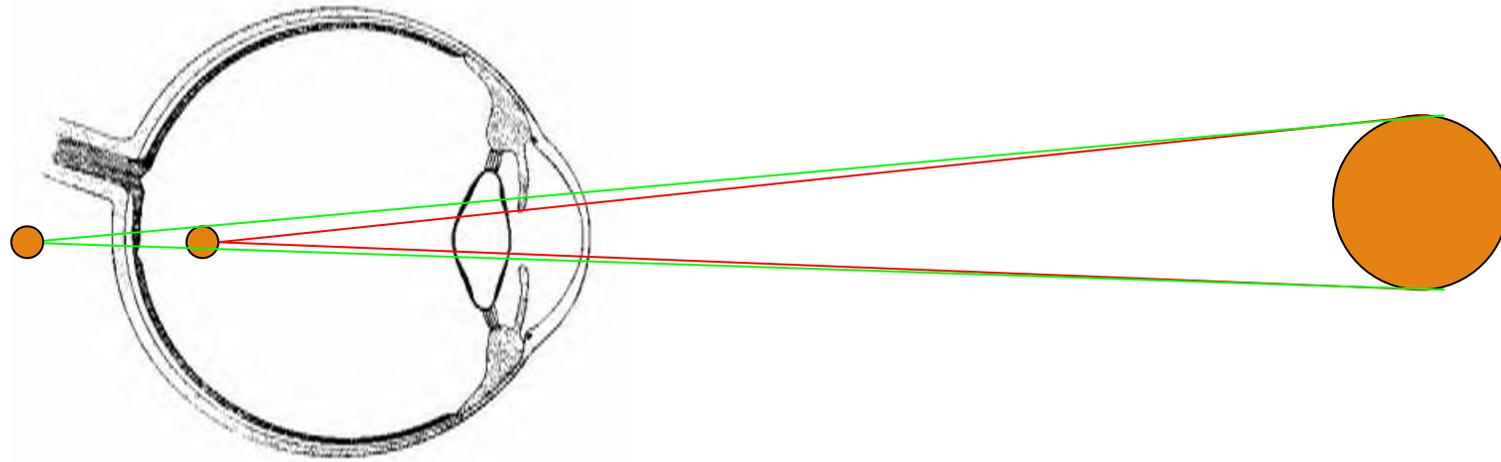
Axial length is within normal limits

Accommodation is sufficient for near viewing

Standard or Non-standard Emmetropia

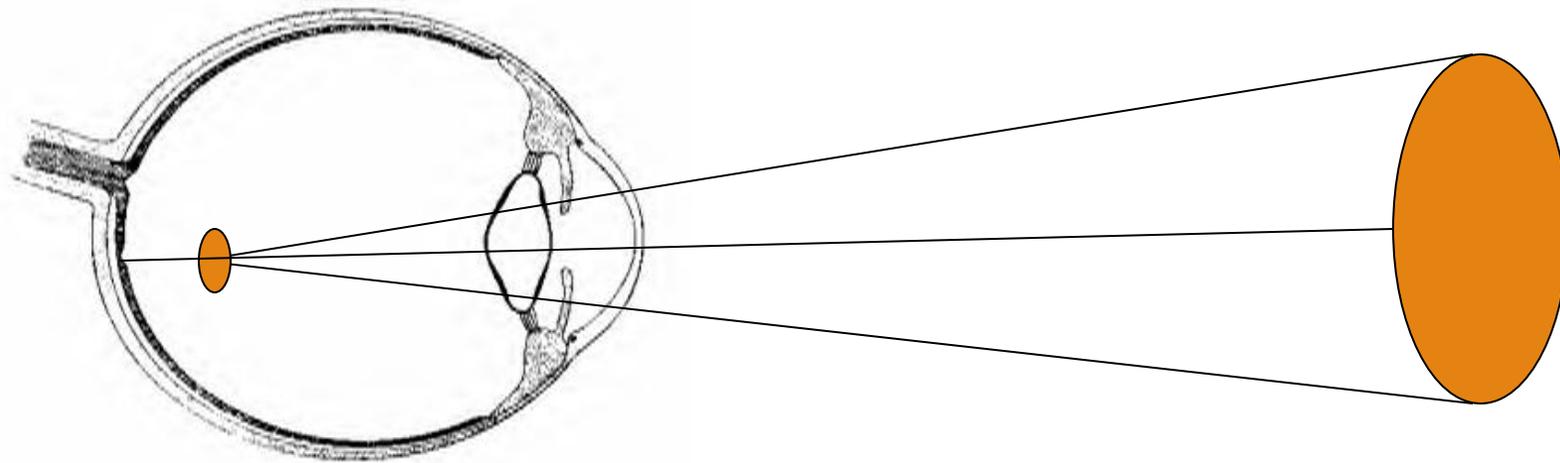


Ametropia



- Myopia
- Hyperopia or Hypermetropia
- Astigmatism

Myopia - Near Sighted - *Short Sight*



Myopia – Nearsighted – Short sight

Axial myopia

- Length is too long

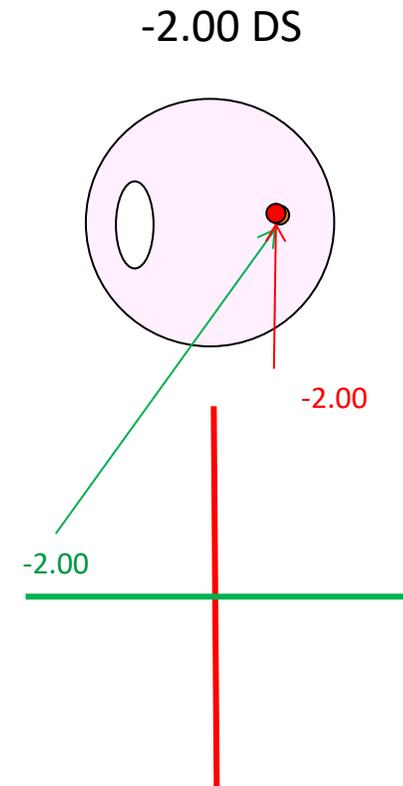
Corneal myopia

- Cornea has too much plus power

Lenticular myopia

- Crystalline lens has too much plus power

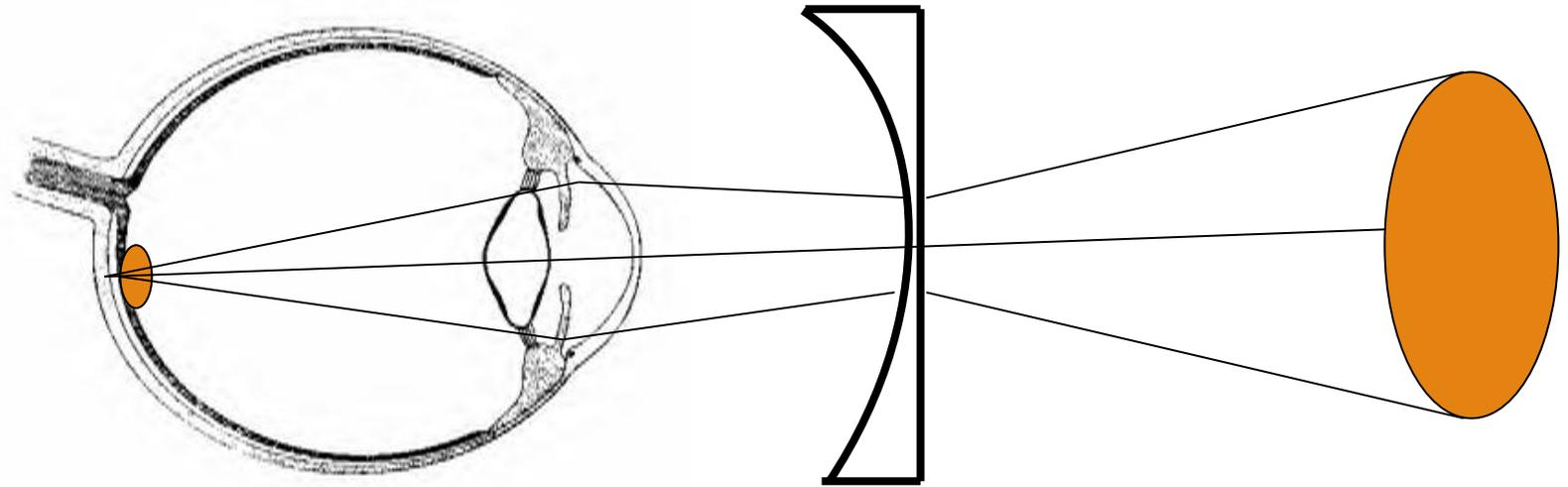
Light comes to a focus in front of the retina



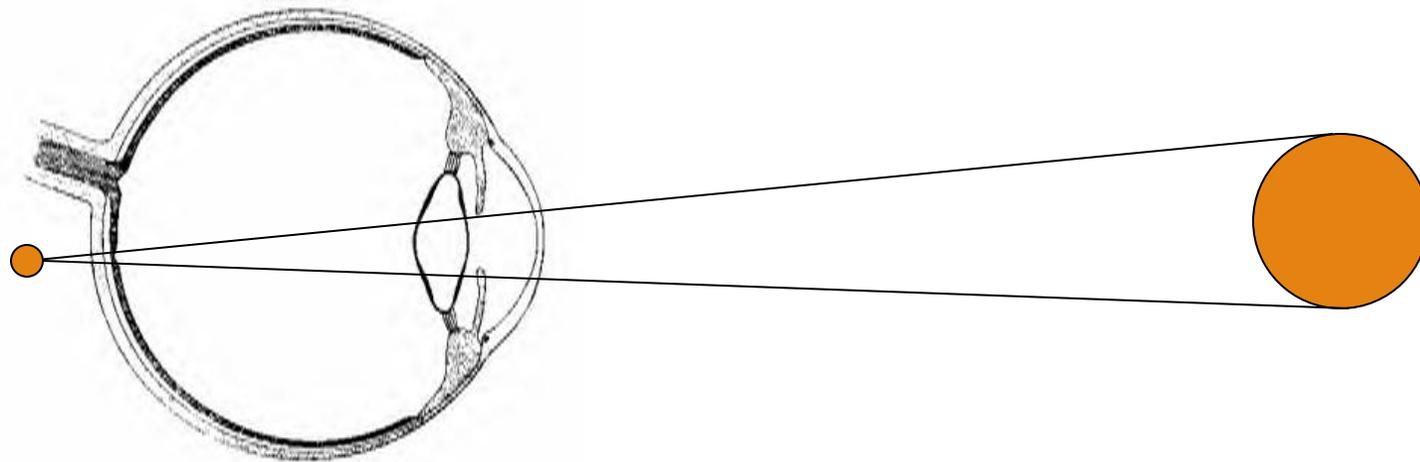
Myopia - Nearsighted - *Short Sight*

A minus (diverging)
lens is use to correct

Minus lenses produce
with motion – to be
discussed more fully
when we cover
retinoscopy



Hyperopia - Farsighted - *Long sight*



Hyperopia

Axial hyperopia

- Length is too short

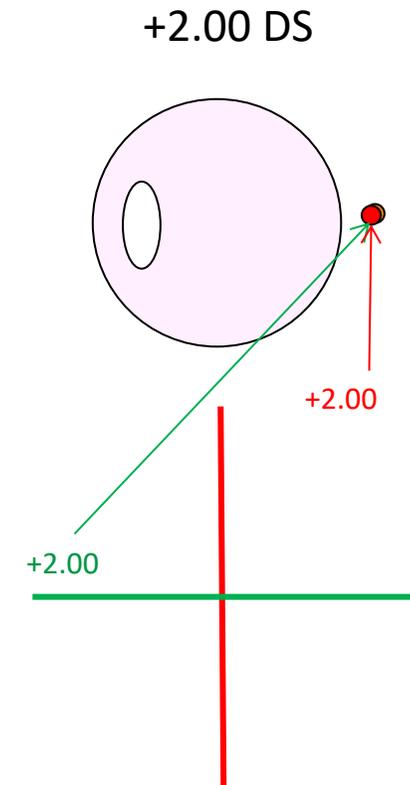
Corneal myopia

- Cornea has too little plus power

Lenticular myopia

- Crystalline lens has too little plus power

Light comes to a focus behind the retina

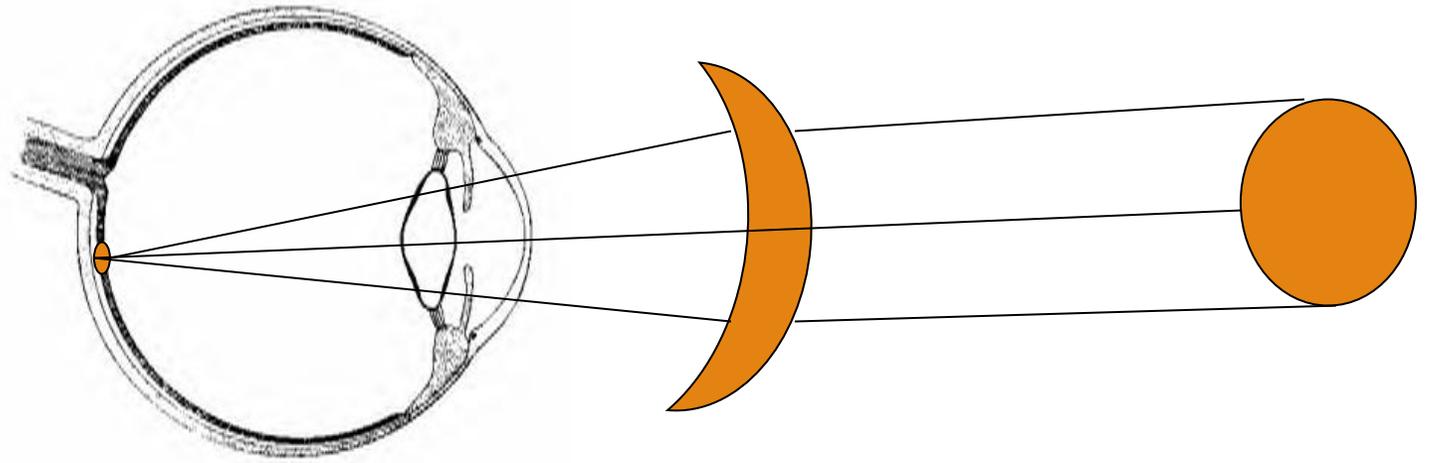


Hyperopia - Farsighted - *Long sight*

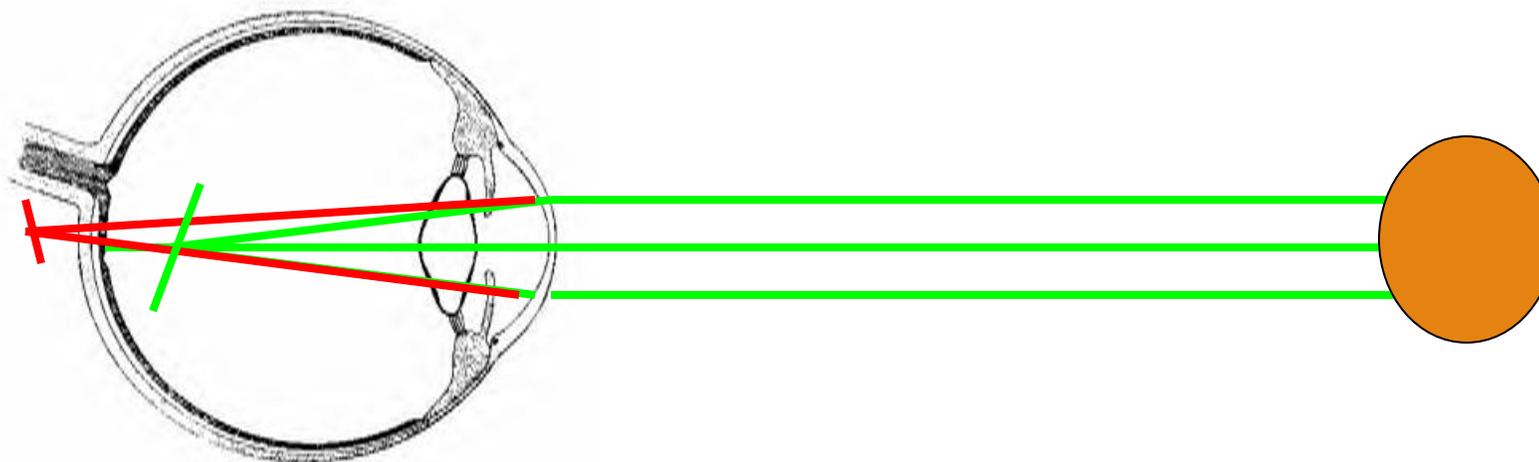
A plus (converging) lens is used to

Correct

Plus lenses produce against motion –
to be discussed more fully when we
cover retinoscopy

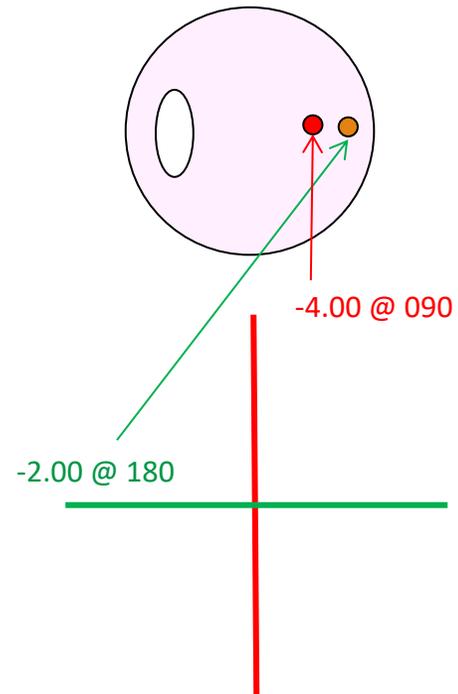


Astigmatism

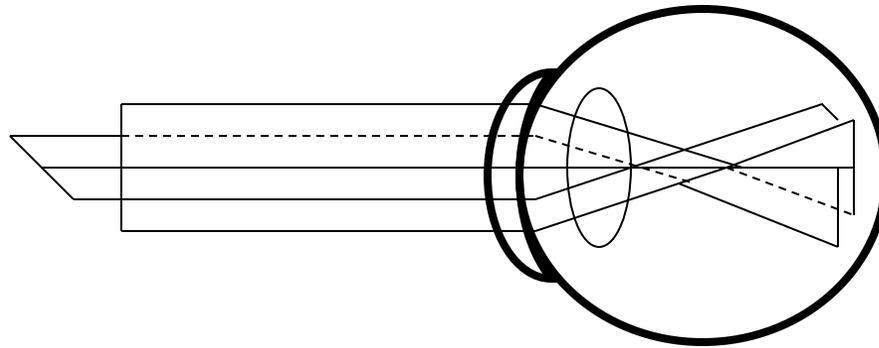


Astigmatism

-2.00 - 2.00 x 180



Astigmatism



Astigmatism

Corneal astigmatism

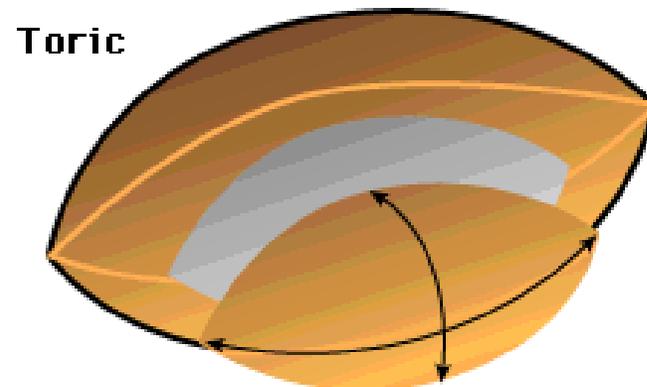
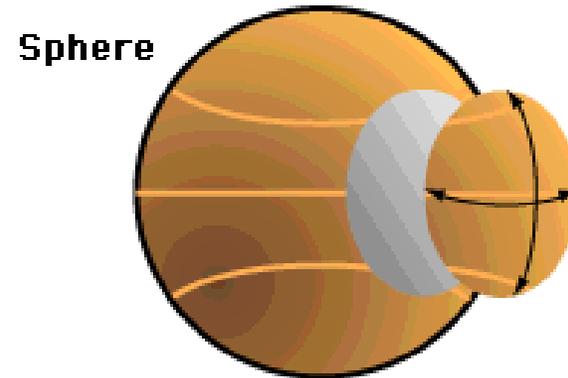
Lenticular astigmatism

Regular astigmatism

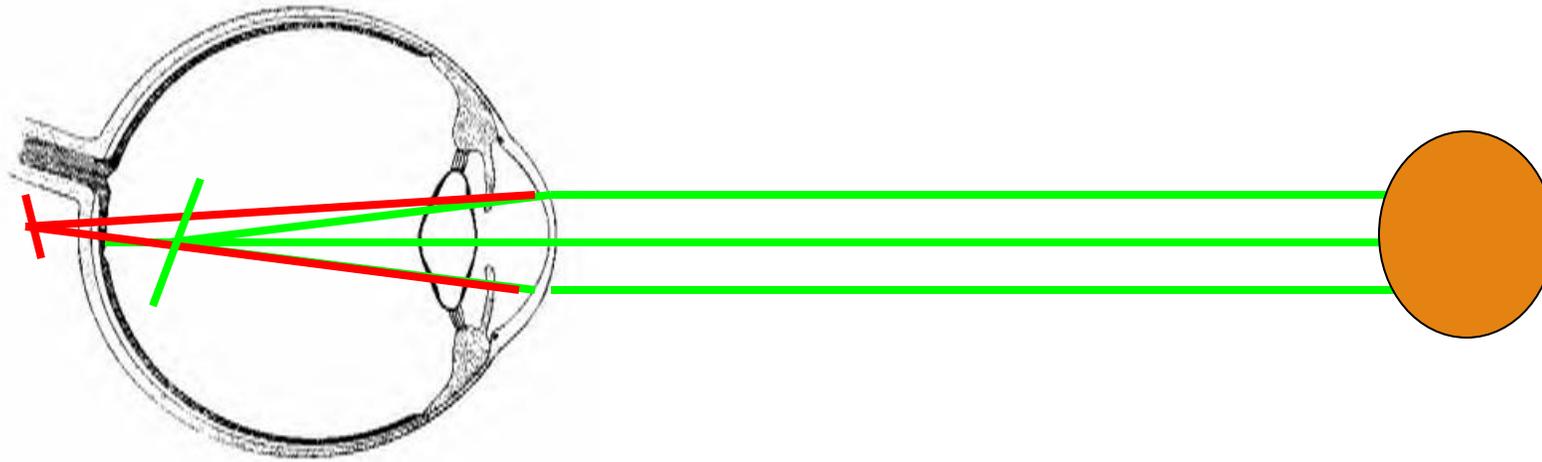
Irregular astigmatism

Residual

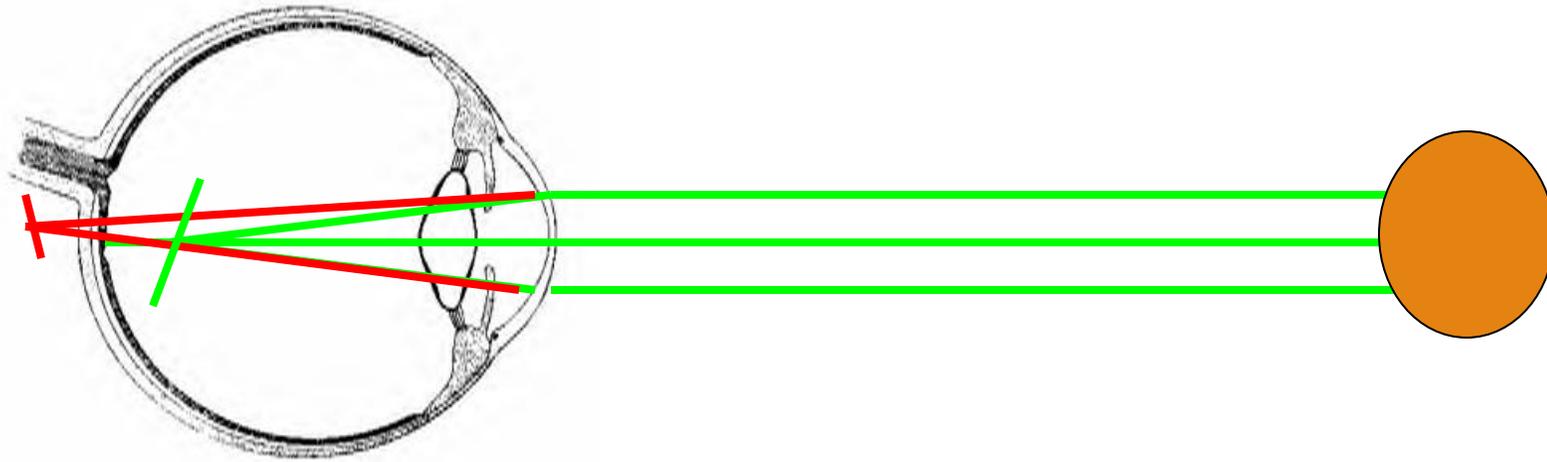
Corneal Astigmatism



Lenticular Astigmatism



Regular Astigmatism



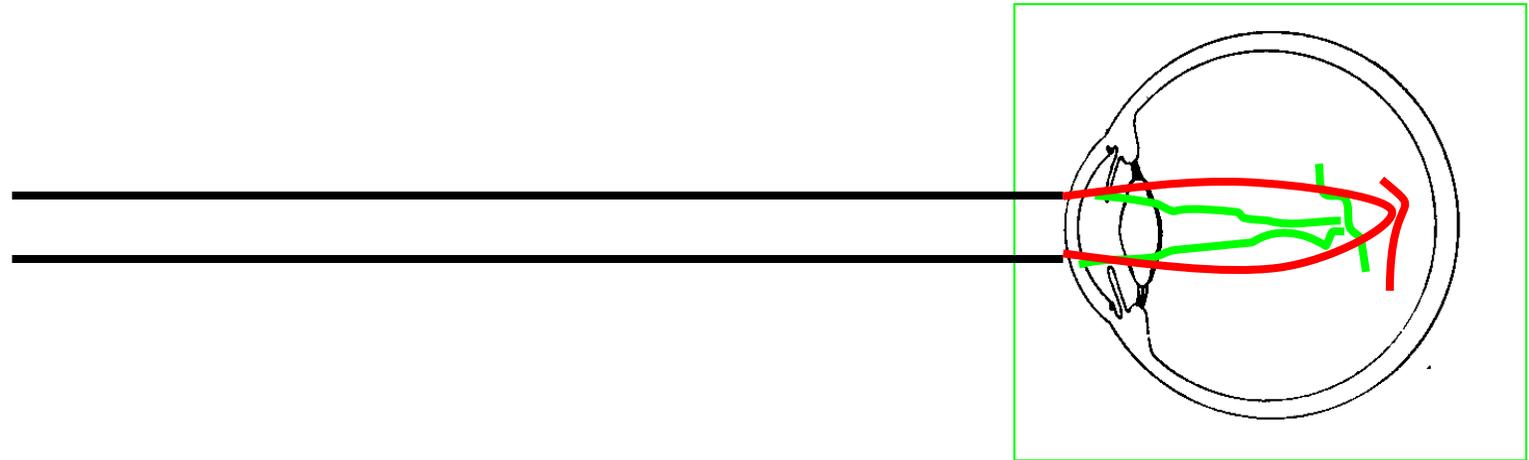
Types of Regular Astigmatism

- Simple myopic astigmatism
- Compound myopic astigmatism
- Simple hyperopic astigmatism
- Compound hyperopic astigmatism
- Mixed astigmatism

Irregular Astigmatism

Principal meridians
are not 90 degrees
apart

Generally best
corrected with
contact lenses



Preliminary Tests

Visual Acuity

Pupil Measurement

Pupillary Reflexes

Ocular motility test (broad H, etc.)

Accommodation

Convergence

Cover tests

Stereopsis

Ocular Muscle Deviations

Color Vision

Visual Fields

Neutralize Glasses

Slit Lamp - Keratometry

Terminology

Visual acuity test

Standardized charts

- Snellen chart
- LogMAR chart

Specialized charts

- Low vision

Visual Acuity

The normal eye can distinguish two points separated by an angle of one minute. Each letter on an acuity chart subtends a five minute angle to the eye independent of distance.

The numerator denotes the distance the patient is from the chart.

The denominator denotes the distance from the chart that a person with normal vision can see the letters.

Visual Acuity

First check the patient's acuity with their current prescription. If the patient correctly identifies half of the letters on the line, record the acuity minus the number of letters missed. For example 20/30 -2.

If it is less than 20/20, you use the pinhole test to see if a new refraction may improve their acuity. The patient looks through a pinhole in an occluder. The pinhole screens out the out-of-focus light rays and allows the in-focus or axial rays to strike the retina. This reduces the diameter of the blur circle improving visual acuity. If the pinhole acuity shows improvement, a change in prescription should help. If there is no improvement with the pinhole, it may be a medical problem causing the reduction in acuity.

The Snellen Fraction

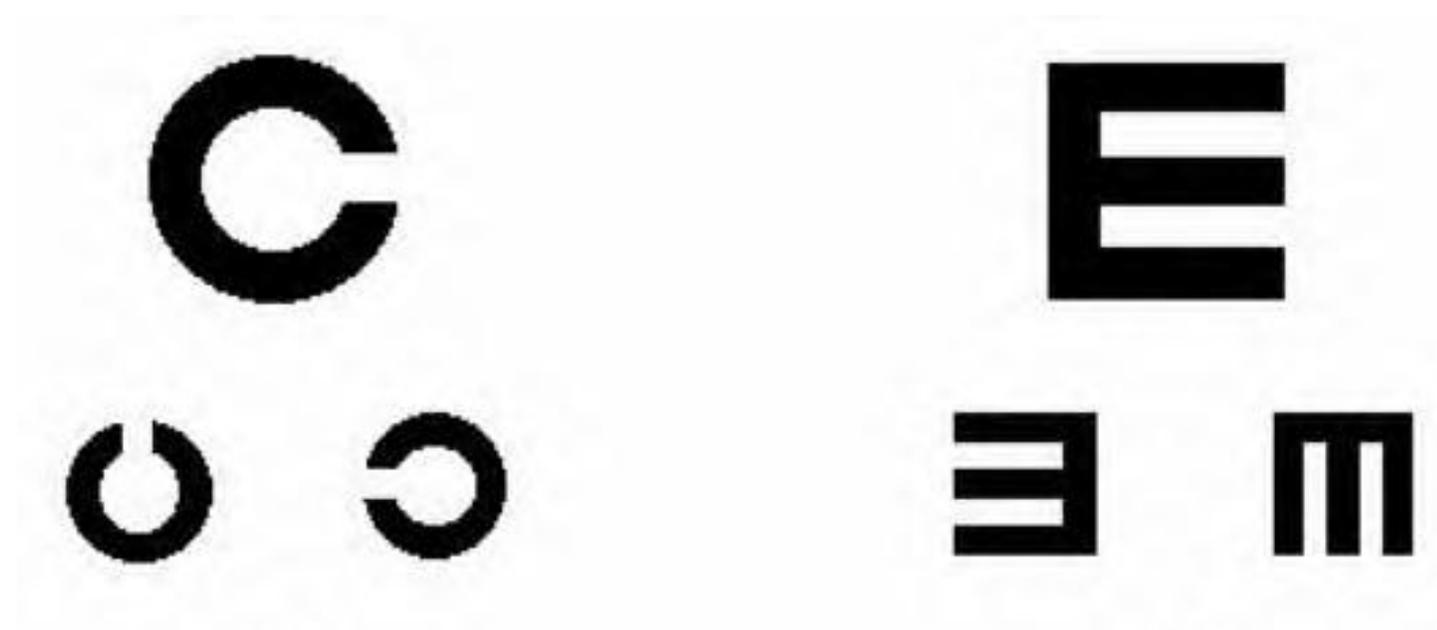
The distance at which the test is made divided by the distance at which the smallest letter read subtends an angle of 5 minutes

The numerator is the testing distance and the denominator is the relative distance at which a specific line can be read.

20/50 means that the test was done at 20 feet and the 50 indicates that the letters on that line subtend an angle of 5 minutes of arc

It also indicates that the patient sees at 20 feet what should be seen at 50 feet

Landolt Ring (C) and the Tumbling E



Jäger Near Chart

No. 7.
1.50M

able treaty, the restitution of the standards and prisoners which had been taken in the defeat of Crassus. His generals, in the early part of his reign, attempted the reduction of Ethiopia and Arabia Felix. They marched near a thou-

No. 8.
1.75M

sand miles to the south of the tropic, but the heat of the climate soon repelled the invaders, and protected the unwelcome natives of those sequestered regions

No. 9.
2.00M

The northern countries of Europe scarcely deserved the expense and labor of conquest. The forests and morasses of Germany were

No. 10.
2.25M

filled with a hardy race of barbarians who despised life when it was separated from freedom; and though, on the first

No. 11.
2.50M

attack, they seemed to yield to the weight of the Roman power, they soon, by a signal

No. 1.
.37M

In the second century of the Christian era, the empire of Rome comprehended the largest part of the earth, and the most advanced portion of mankind. The frontiers of that extensive monarchy were guarded by ancient renown and disciplined valor. The gentle but powerful influence of laws and manners had gradually consolidated the genius of the government. Their gradual subsistence enjoyed and shared the advantages of wealth.

No. 2.
.50M

However, even the public administration was conducted by the virtue and abilities of Nerva, Trajan, Hadrian, and the two Antonines. It is the design of this part of the five succeeding chapters, to describe the progressive condition of their empire, and afterwards, from the death of Marcus Aurelius, to denote the most important circumstances of its decline and fall, a revolution which will ever be memorable, and is still felt by

No. 3.
.62M

the nations of the earth. The principal conquests of the Romans were achieved under the republic, and the emperors, for the most part, were satisfied with preserving those dominions which had been acquired by the policy of the senate, the active valour of the consuls, and the martial enthusiasm of the people. The seven first centuries were filled with a rapid succession of triumphs, but it was

No. 4.
.75M

reserved for Augustus to relinquish the ambitious design of subduing the whole earth, and to introduce a spirit of moderation into the public councils. Inclined to peace by his temper and situation, it was very easy for him to discern that Rome, in her present exalted situation, had much less to hope than to fear from the chance of arms; and that, in the prosecution of

No. 5.
1.00M

the undertaking became every day more difficult, the event more doubtful, and the possession more precarious, and less beneficial. The experience of Augustus added weight to those salutary reflections, and effectually convinced him that, by the prudent vigor of

No. 6.
1.25M

his councils, it would be easy to secure every concession which the safety or the dignity of Rome might require from the most formidable barbarians. Instead of exposing his person or his legions to the arrows of the Parthians, he obtained, by an honor-

Developed by Austrian ophthalmologist Eduard Jäger in 1854

Pupil

Three responses watched for during exam

- Direct pupil constriction
- Consensual Reflex
- Bilateral constriction when viewing near objects

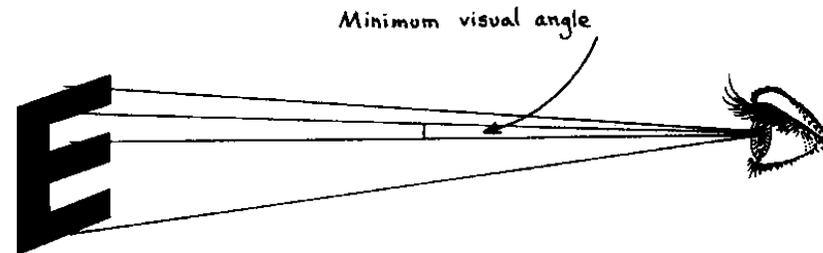
Dilation of pupil performed with mydriatics

Constriction of pupil performed with miotics

Visual Acuity

The measure of the angle subtended by the outer limits of rays of light coming from the minimum detail of an object as they enter the eye

20/20 or 6/6



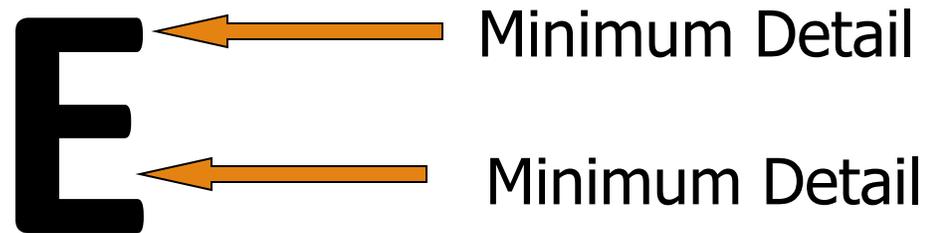
Snellen definition = "normal vision" is the ability of the human eye to recognize an optotype when it subtends 5 minutes of arc and then discriminate a single stroke of the size of 1 arc minute.

Terminology

- Minimum detail
- Resolution
- Visual acuity

Minimum Detail

The detail that must be detected on an object to positively identify or distinguish the object



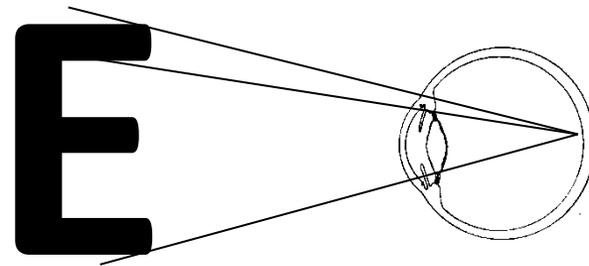
Resolution

The ability to detect minimum detail

The resolving power of the normal eye is a minimum visual angle of 1 minute

The minimum visual angle of the letter is 1 minute

The visual angle of the letter is 5 minutes



Terminology

- Visual Angle
 - Determined by size of object and how far away the object is from the eye
- Minimum visual angle

Refraction 101

General Rules of Refraction

Prior to refraction, baseline visual acuities must be determined.

- OD, OS and OU
- Patients expressing near vision complaints and all presbyopes should have near acuities documented
- For individuals with near vision complaints, and all presbyopes, near acuity should also be documented using M notation, with the testing distance documented if different than 16 inches (40 centimeters).
 - M notation is used to specify size of print by indicating the distance in meters at which the height of smaller letters of the printed materials subtends 5' of arc.
 - Example at 40 cm
 - 1M = Letter size that subtends 5 minutes of arc at one meter (20/20 @ 1 meter)
 - 2M = Letter size that subtends 5 minutes of arc at two meters (20/20 @ 2 meters)
 - 5M = Letter size that subtends 5 minutes of arc at five meters (20/20 @ 5 meters)
 - Etc.....

General Rules of Refraction

Size of Optotype

Metric system – size at exactly 6 meters. the letters that produce 6/6 VA are 8.73mm

- Size of 6/60 are 87.3mm tall

Imperial system (US) – size at exactly 20 feet, the letters that produce 20/20 VA are 8.75mm

- Size of 20/200 are 87.5mm tall

We generally calculate metric 6/6 VA equal to Imperial of 20/20 VA

However, based upon true calculations, 6 meters is actually 19.685 feet. So, the optotype in imperial at 20 feet must be slightly larger to compensate.

- If the testing is done on either metric chart and recorded as metric and the testing done on imperial chart and recorded, that is correct.

General Rules of Refraction

Lights on during retinoscopy

When doing retinoscopy, you will want the **lights lowered**; but, once you start your refraction, you will achieve greater accuracy when you refract with the lights on.

Keeping the lights on during your refraction is important to avoid over-minusing your patients.

When someone is over-minused, the chart will look darker, which can be mistakenly thought of as looking clearer.

Terminology – Eye Exam

Visual Acuity Test is simply one of the tests used during a comprehensive eye exam to determine the smallest letters one can read on a standardized chart. May use special charts or varying distances.

Refraction is one of the tests used during a comprehensive eye exam to determine the refractive error of the eye/eyes

Comprehensive Eye Exam is just that...comprehensive. It includes ocular health examination as well as any pretests needed to determine the refractive errors of the eyes and the health of the eyes.

Objective Refraction- Subjective Refraction- Dictionary of Ophthalmic Optics

Objective refraction – Determination of the spectacle or contact lens formula without utilizing the response of the patient to determine the accuracy. Usually performed with a streak or spot retinoscope or and automatic computerized refraction device.

Subjective refraction – Determination of the spectacle or contact lens prescription utilizing the response of the patient to determine the accuracy of the prescription. Usually performed with a phoropter or trial frame in combination with Snellen chart placed at a predetermined distance, usually 20 feet.

Phoropter – Subjective – Requires Patient Response

The parts of a phoropter include the following:

- Spherical lens Control
- Minus-plano-cylinder Control
- Aperture Control/Strong sphere control
- Jackson Cross Cylinder
- Rislely Prism
- Adjustments
 - PD knob
 - Leveling Knob
- Vertex distance control



Starting Point of Refraction

Autorefractor reading

Retinoscopy

Prior Rx

- Habitual Rx
 - Pre-sight test
 - Optimal is post-refraction

We will be discussing Retinoscopy

Objective Refraction - Autorefractor

Computer-controlled

Patient is positioned on one side and observer on the other.

Starting point for refraction in many offices

Measures how light is changed as it enters a patient's eye. Image moves in and out until the image is focused on the retina. Several are taken and the instrument averages them to create an Rx.

Newer autorefractors are often combined with auto keratometry.



Retinoscopy 101

What is Retinoscopy

It is an objective procedure to estimate a person's refractive error

- Objective means the subject does not need to respond

Retinoscopy allows us to shine a light from the retinoscope into a person's eye.

- We are then able to look at the light as it is reflected back from the retina. This reflected light is called the retinoscopic reflex . We also refer to this as the “Ret Reflex”
 - It is the red reflex we see inside the eye, like when we see red reflex in eye in photos.

Objective Refraction: Retinoscopy

Streak Retinoscope

Retinoscopy Lens

- Working lens
- +1.50D - +2.00D
- Retinoscopy cannot be performed at 20 feet
 - That is how far away the refraction is performed (or calculated for shorter distance)
 - Therefore we must compensate for the distance that we can perform retinoscopy (arm's length is usual)
 - Use the focal length formula to calculate
 - 67 cm would be calculated thusly
 - $D = 1/f$ (focal length in meters)
 - $D = 1/0.67$
 - $D = 1.492537313432836 = 1.50D$
 - 50 cm would be calculated thusly
 - $D = 1/f$ (focal length in meters)
 - $D = 1/0.50$
 - $D = 2.00D$



Objective Refraction: Retinoscopy

With Motion

- Hyperopic – Visual system is under plussed and requires more plus power

Against Motion

- Myopic – Visual system is over plussed and requires more minus power

No motion

- Emmetropia – light reflex is neutral and is seen throughout the pupil
– no power required



Refraction – Estimation of Refractive Status of the Eye

Retinoscopy

- Objective - with use of a retinoscope
 - Static – Refraction with inactive accommodation
 - Dynamic – Refraction with active accommodation
 - Near vision

With much practice, objective refractive status can be performed on infants, mentally infirm, low vision patients, uncooperative or malingering patients.

Observer uses right eye to scope patient's right eye and uses left eye to scope patient's left eye

Must be on same plane



Streak Retinoscope

Has two operating systems:

Projecting system

Observation system



Projecting System

To illuminate the retina

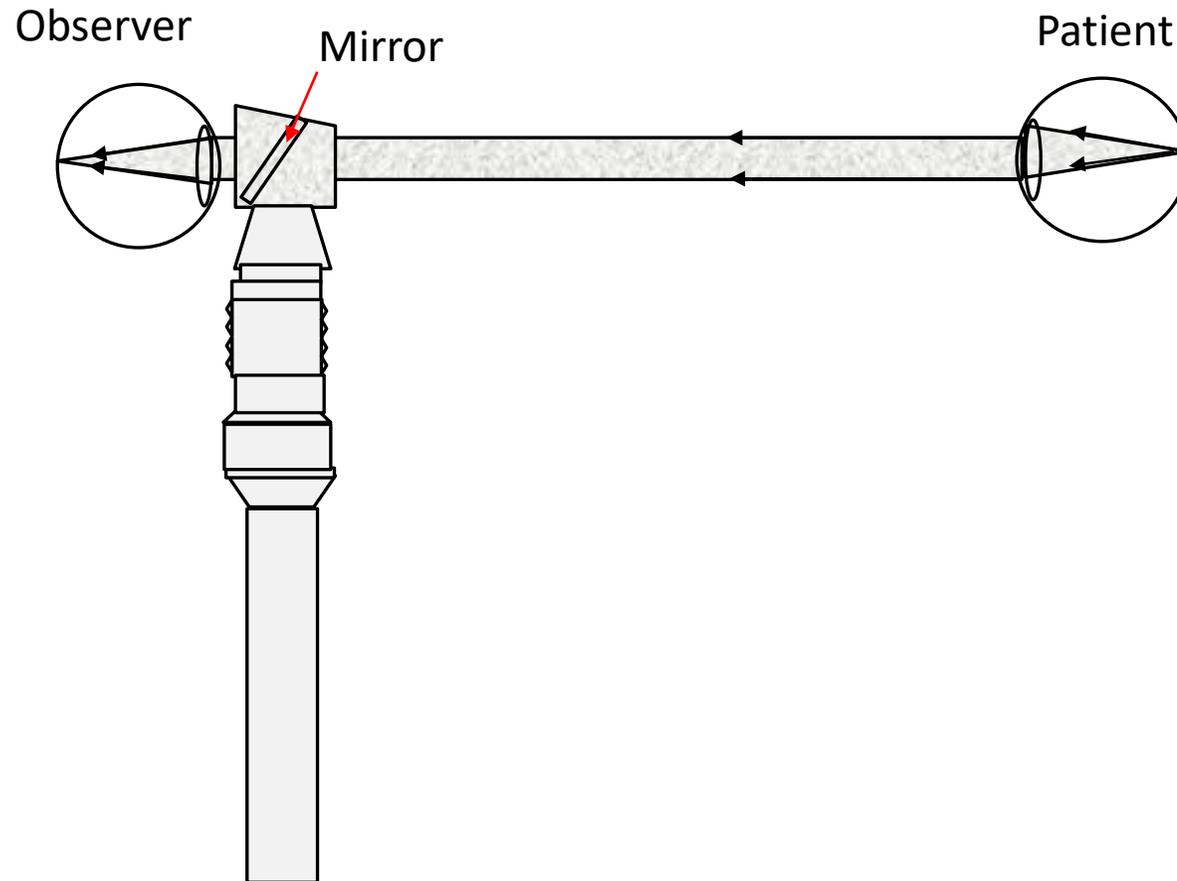
Consists of:

- Light source
- Condensing lens
- Mirror
- Focusing sleeve
- Handle (that contains source of current)

Observation System

Purpose

To allow the observer to see the retinal reflex of the patient



Definition of Far Point

The Far Point of the eye is defined as the point in space that is conjugate with the fovea when accommodation is relaxed

- In other words, it is the farthest distance the eye can see clearly with accommodation at rest

Emmetrope

- Parallel rays of light focus on fovea
- Retina conjugate with infinity
- Far point is at infinity

Myope

- Parallel rays focus in front of the retina
- Far point is between infinity and the eye
- Minus lenses diverge light rays, thus placing the image on the retina and conjugate fovea with infinity

Hyperope

- Parallel rays of light focus behind the retina
- Far point is beyond infinity
- Plus lens converges rays of light thus placing focus on retina and conjugate fovea with infinity

Streak Retinoscopes

Have a light source that produces a line or streak of light.

The streak of light can be changed by moving the slide knob or sleeve

It can be:

- rotated to any axis position (by rotating the sleeve)
- made wider or narrower in width (by moving sleeve up or down)
- changed from convergent to divergent light (by moving the sleeve up or down).

- It is normally used in the 'down' position on Welch-Allyn and up on the Copeland
 - Beam would be wide and out of focus when shown on hand

Steps to Retinoscopy – Minus Cylinder

Select scope and place focusing sleeve in the correct position

- The beam is wide and out of focus
 - Copeland retinoscope –sleeve up
 - Welch/Allen retinoscope –sleeve down

Establish your working distance

- Dial in +1.50D or +2.00D
 - Shorter working distance = higher power

Lights should be on but dim

Position phoropter in front of patient

- Level phoropter
- PD correct (eye centered)
- Both eye holes are open

Start with the retinoscope at plano

Align yourself with the visual axis of the patient's right eye with your right eye

Steps to Retinoscopy – Minus Cylinder

Start with right eye

Fog fellow eye (+1.50D)(may need more + if patient is hyperope)

Have patient look at 20/400 E or light spot (some may use red/green duochrome filter)

- Reinforce that they should be looking at chart and not the retinoscope light, even though it would be blurry

Observe reflex in both meridians – Start with vertical streak to observe horizontal meridian

- You may have to rotate axis

Observe reflex in both meridians

- Find most with motion first (find least against motion first)
- Find least motion second (find most against motion second)
- Neutralize the first meridian by adding plus lenses for “with motion” or minus lenses for “against motion.”

Steps to Retinoscopy – Minus Cylinder

- Once first meridian is neutralized, rotate retinoscope's streak 90 degrees from where neutrality was found
- Streak will be horizontal to neutralize vertically meridian. Neutralize this meridian.
 - If your patient has *no astigmatism*, there will be no motion.

- Repeat with left eye

Refine Axis

Confirm Neutrality

Repeat with left eye

Remove Working Distance

- If using +1.50 working distance power, adjust -1.50D
- If using +2.00 working distance power, adjust -2.00D

Steps to Retinoscopy – Minus Cylinder

- Once neutralized, rotate your retinoscope's streak 90 degrees from where your streak was previously aligned with the retinal reflex.
- Now, with this streak more horizontally oriented, streak the more vertically-oriented meridian.
 - If your patient has *no astigmatism*, there will be no motion. Retinoscopy is completed for this eye.
 - If your patient has *with-the-rule* astigmatism, you will see “against motion,” which you will neutralize by adding minus cylinder axis 90 degrees away from the initial meridian you neutralized.
 - If your patient has *against-the-rule* astigmatism, you will see “with motion.” If this is noted, neutralize it by adding plus spherical power.
 - For against-the-rule astigmatism, after neutralizing this second meridian with sphere power, rotate the cylinder axis 90 degrees, back to the initial meridian.
 - Next, rotate your retinoscope's streak back to this more vertically-oriented position. You should now see “against motion” in the more horizontal meridian, which you will neutralize by adding minus cylinder.
- Once you have neutralized the right eye, do the same for the left eye.
- When you have neutralized both eyes by retinoscopy, remove your working distance lens from each eye (1.50D for a 67cm working distance or 2.00D for a 50cm working distance).

Refine Axis

Confirm Neutrality

Remove Working Distance

- If using +1.50 working distance power, adjust -1.50D
- If using +2.00 working distance power, adjust -2.00D

Repeat with left eye

Verifying Reflex

Moving backward will cause the far point to be between you and the patient

- Against motion would be seen

Moving forward will cause the far point to be beyond

- With motion would be seen

If reflex is “With Motion”, add plus power

If reflex is “Against Motion”, add minus power

Compensating for Working Distance

Determine the lens power that gives neutrality

Subtract 1.50D or 2.00D from the power of the trial lenses (depending upon working distance)

For example:

Lens power found for neutrality is +3.00D, a working distance lens (power) of +1.50D was used

- $+3.00 - 1.50 = +1.50D$

Lens power found for neutrality is -3.00D, a working distance lens (power) of +2.00D was used

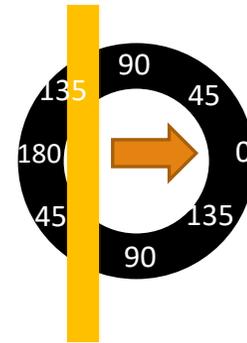
- $-3.00 - 2.00 = -5.00D$

Steps to Retinoscopy – Minus Cylinder

- Chase the most plus first or least minus
- Sphere power and axis are found together
- For the Rx, scan first meridian to neutrality
 - This will be the spherical power.
 - The other meridian will have against motion
 - (indicating minus, which will be your cylinder power).
 - Starting point in retinoscopy in minus cylinder will be most plus/least minus

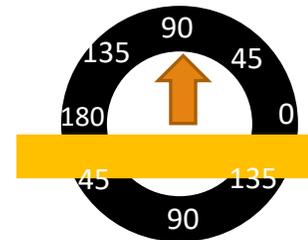
The Streak – the intercept

Streak (intercept) is oriented with the 90 degree line on the optical protractor, but the streak is being moved along the 180 degree meridian. This is called “streaking 180”.

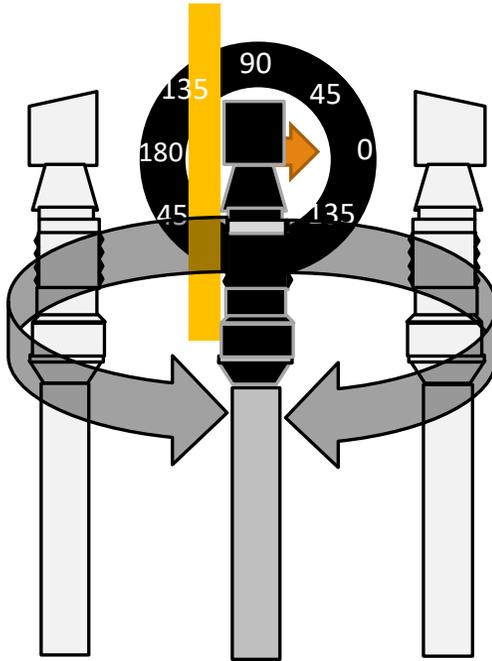


The Streak – the intercept

Streak (intercept) is oriented with the 180 degree line on the optical protractor, but the streak is being moved along the 90 degree meridian. This is called “streaking 90”.

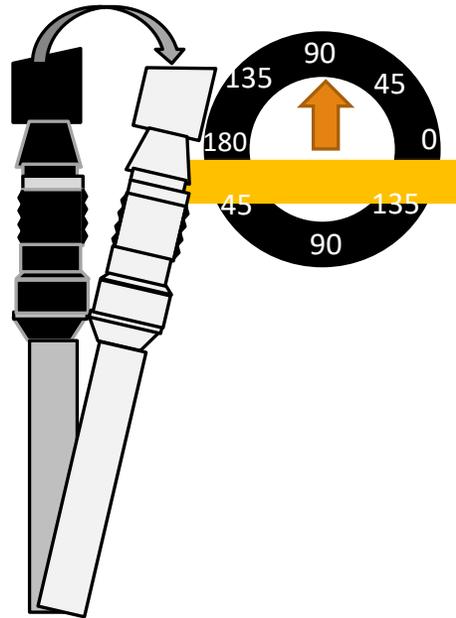


Directions of “Streaking”



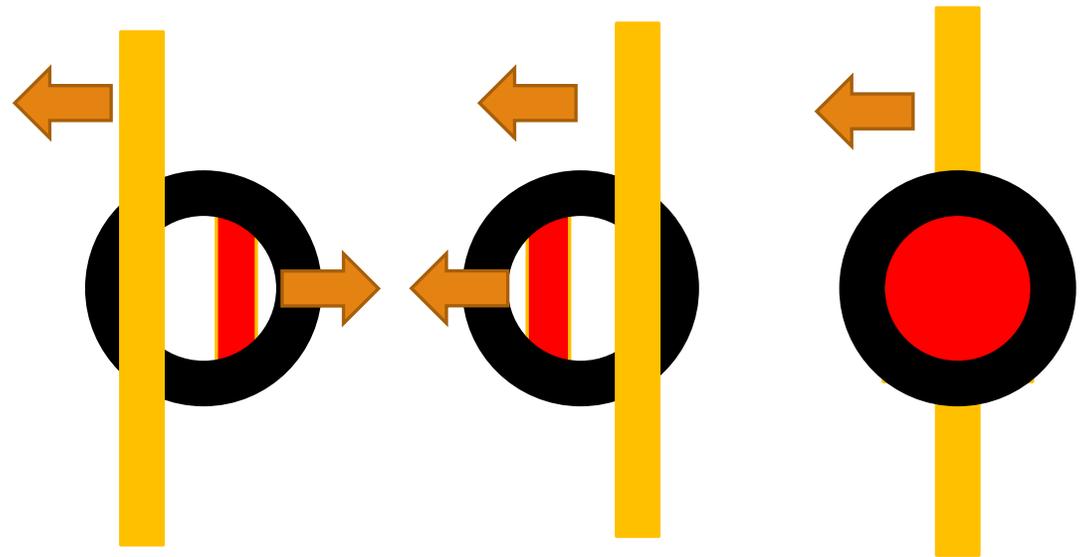
Be sure to hold retinoscope perpendicular to floor and rotate your wrist.
Use right hand to hold retinoscope when checking patient's right eye.
Use left hand to hold retinoscope when checking patient's left eye.

Directions of “Streaking”



Be sure to hold retinoscope perpendicular to tilt downward. Do not move side to side.
Use right hand to hold retinoscope when checking patient's right eye.
Use left hand to hold retinoscope when checking patient's left eye.

Retinoscopy

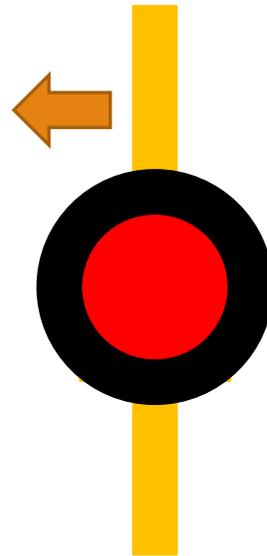


Against
motion
Myopic
meridian

With
motion
Hyperopic
meridian

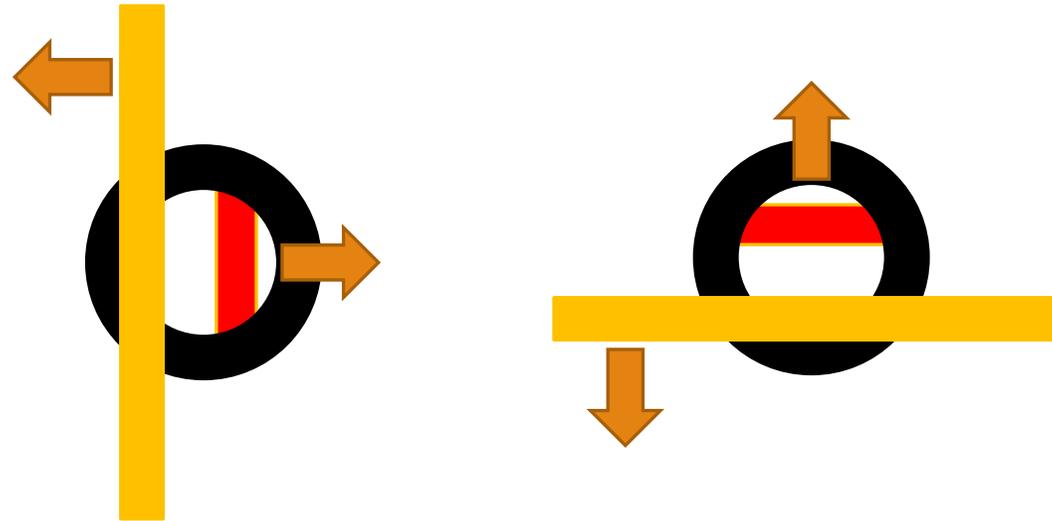
Neutrality

Emmetropia



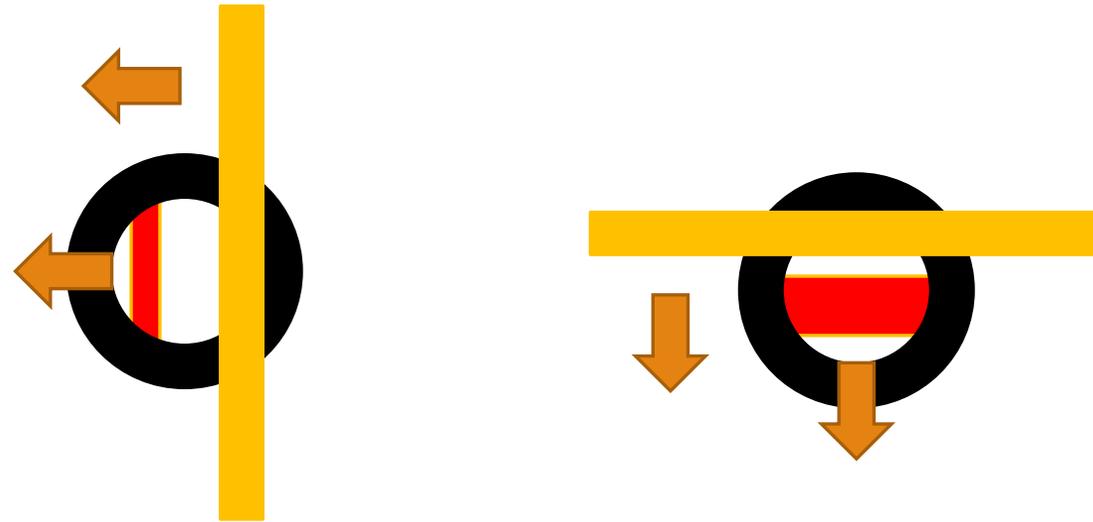
Neutrality

Spherical



Reflex is the same width, intensity and speed
in all meridians
Could be “With” or “Against” motion

Cylinder in Rx



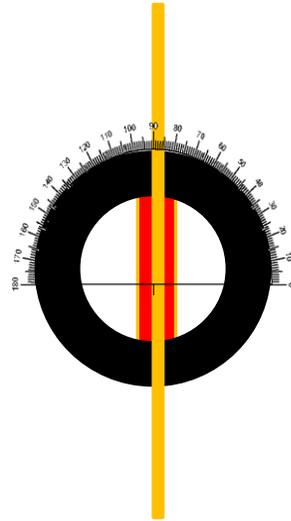
Reflex width is different widths, intensity and speed in each principal meridian

Could be “With” motion in both meridians

Could be “Against” motion in both meridians

Could be “With” motion in one meridian and “Against” motion in opposite meridian

Cylinder Axis in Rx



Cylinder axis is determined by the thinnest reflex
Lower sleeve to enhance intercept

Straddling

Axis can be confirmed by straddling

Use estimated correcting cylinder

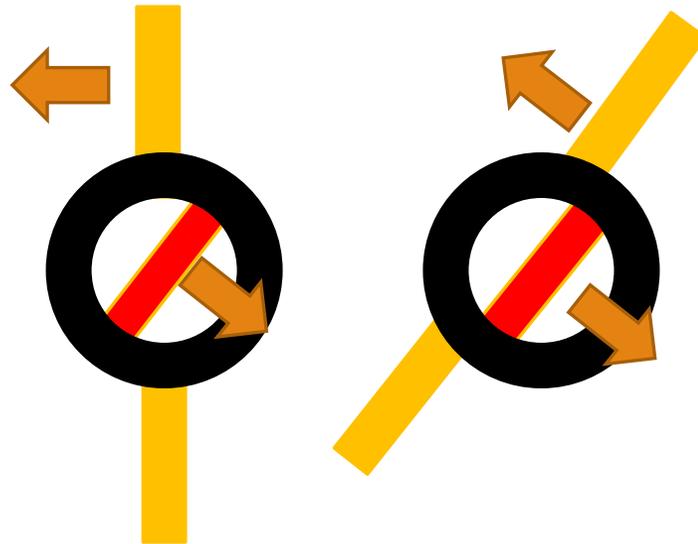
Rotate retinoscope intercept 45° off-axis in both directions

- Width of reflex should be equal in both off-axis positions

If the axis is incorrect, the widths will be unequal in the 2 positions

The axis of the correcting cylinder should be moved toward the narrower reflex and the straddling performed again until the width is equal

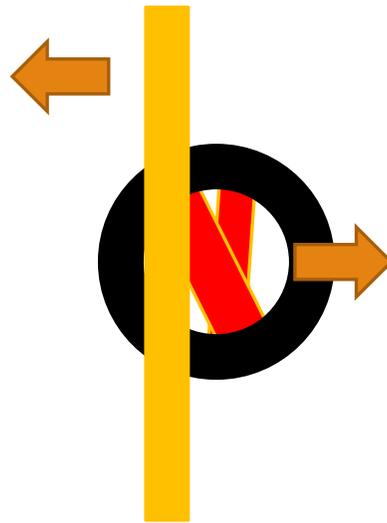
Retinoscopy



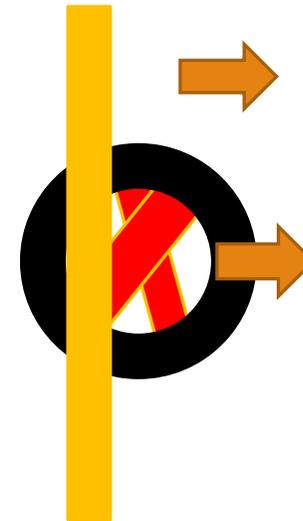
Reflex and intercept are not aligned. Off axis with oblique motion "Break"

On axis with intercept parallel to motion

Irregular Astigmatism -Keratoconus



Scissor
motion



Scissor
motion

Special Notes on Retinoscopy

Don't forget to remove the power of the "working" lens upon completion of retinoscopy prior to determining Rx

Brightness – bright or dull?

- Reflex gets brighter as you get closer to neutrality

Direction

- With – Corrected with plus lenses
- Against – Corrected with minus lenses

Speed – fast or slow?

- Reflex speed gets faster closer to neutrality

Thickness – Thin or wide

- Thickness is wider as it gets closer to neutrality

Special Notes on Retinoscopy

Retinoscopy takes time

Ensure patient can see “target” letter or spot

- Your head could get in the way...ask
- Shift slightly to ensure they see target

Practice, Practice, Practice

Retinoscopy may be challenging on some patients. (However, on some of these it is the answer.)

- Examples:
- Cataracts
- Patients with corneal opacities
- Young patient with spherical aberration in periphery
- Irregular corneas
- Monocular patients
- Uncooperative patients – some mentally challenged, some children

Other “Notes”

AXIS

- On average, in patients with cylinder, the axis should mirror
 - WTR, ARA, Oblique (opposite meridians)
- In addition when adding the axis on the right and the axis on the left, they generally equal 180 or 360
- Example: if the axis on the right is 090, the axis on the left should be close to 090. Sum would be 180
- Example: if the axis on the right is 180, the axis on the left should be close to 180. Sum would be 360
- Example: Oblique axis...if the axis on the right is 135, the axis on the left should be close to 045. Sum would be 180

There may be exceptions, however, this would be within normal

Difficulties in Retinoscopy

Accommodation

- Purpose of working lens
- Cycloplegic exam

High refractive errors

- High Plus
- High Minus
- Start with high trial lens power (+7.00) or (-7.00) or even higher

Opaque cornea

- Corneal scars

Opacities in crystalline lens

- Cataracts

Patients with strabismus

Accommodative fluctuations

Small pupils

- Move closer and try to see reflex then move back

Large pupils

- Concentrate on center of reflex to avoid spherical aberration in periphery

Spherical aberration in periphery of pupil

- Concentrate on center of reflex

Irregular corneas

Common Errors

Using the wrong working distance

- Therefore:
 - Measure where you will be working and calculate your working distance

Performing retinoscopy off-axis

- Therefore:
 - Look at your angle and make sure you are in line with patient's eye
 - Hold retinoscope in right hand using right eye on patient's right eye
 - Hold retinoscope in left hand using left eye on patient's left eye

Getting in the way of the patient

- So:
 - They will focus on you instead of the target and may stimulate accommodation
- Therefore:
 - Speak to them periodically to ensure they see the target instead of you

Discussion on “With” and “Against”

“With motion” retinoscopy will be corrected by “Against motion” lenses

- Visual system is under plussed and will be corrected by plus lenses

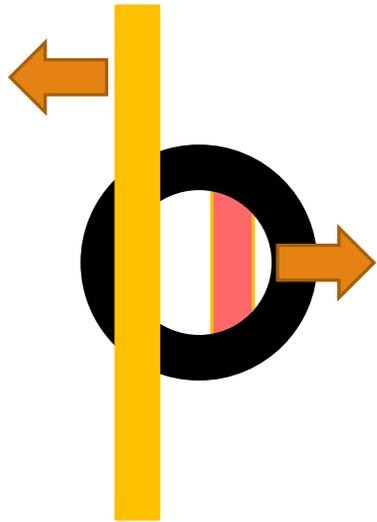
“Against motion” retinoscopy will be corrected by “With motion” lenses

- Visual system is over plussed and will be corrected by minus lenses

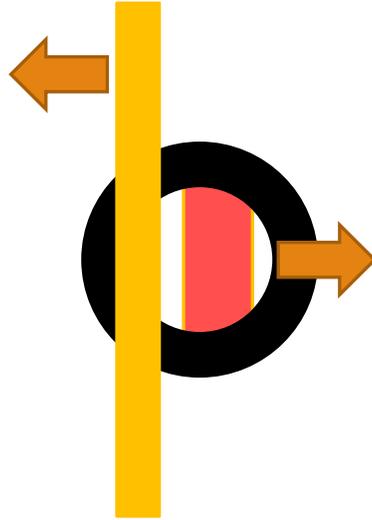
When Scoping patient and you reach “neutrality”, continue until you see the first “reversal” of motion and go back one step.

- That way, you know you are at true “neutrality”

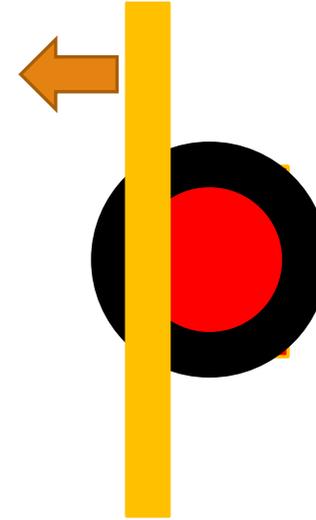
Some Examples – Streaking 180 Meridian



Start at plano
Vertical meridian is against
motion
Reflex is fairly narrow fairly dull
Movement is fairly slow

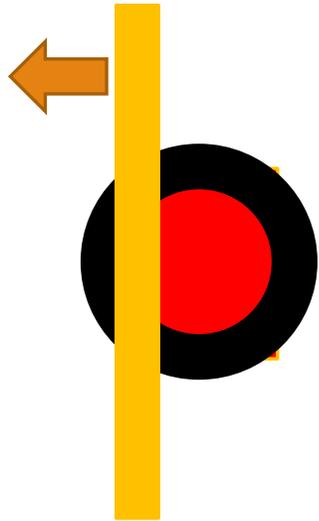


Add -2.00D
Vertical meridian is against
motion
Reflex is somewhat wider and a
little brighter
Movement is a little faster



Add -3.00D
No motion
Reflex is full and bright
Neutrality has been reached

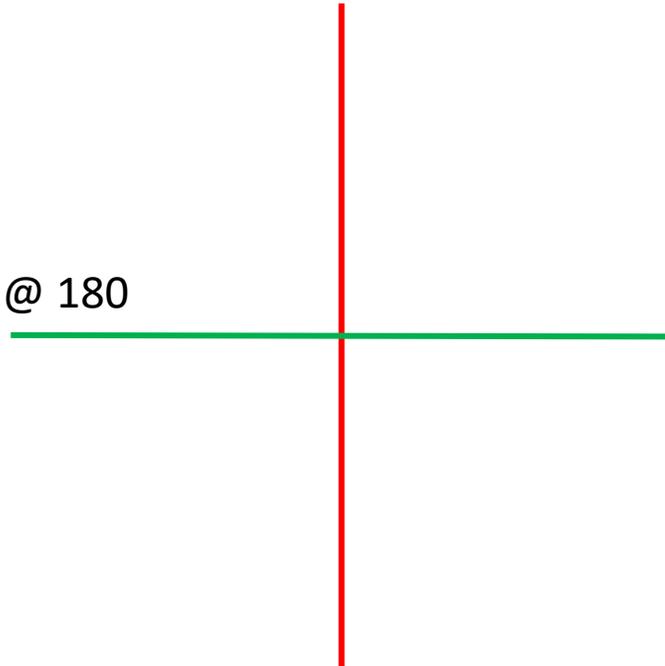
Some Examples



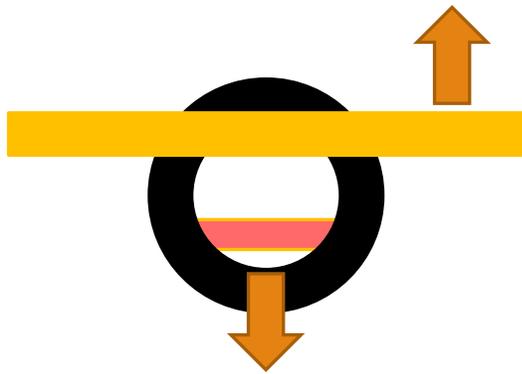
-3.00D

Neutrality has been reached
Put -3.00D on the lens cross

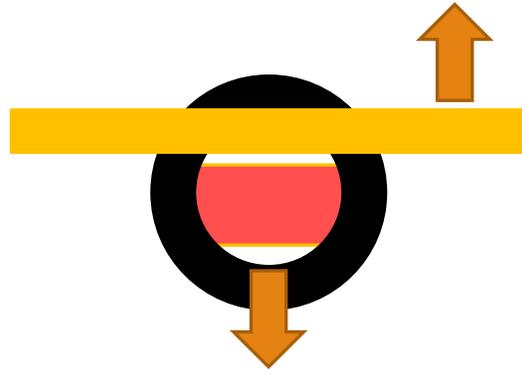
-3.00 @ 180



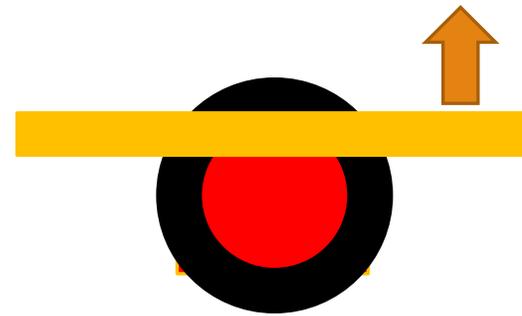
Some Examples – Streaking 90 Meridian



Start at plano
Horizontal meridian is against motion
Reflex is fairly narrow fairly dull (it is thinner than in the 180 meridian, so we know it will require more minus)
Movement is fairly slow

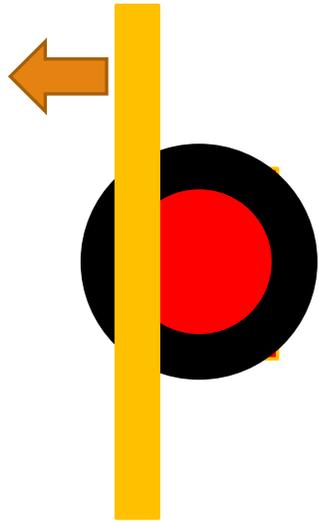


Add -3.50D
Vertical meridian is against motion
Reflex is somewhat wider and a little brighter
Movement is a little faster



Add -5.00D
No motion
Reflex is full and bright
Neutrality has been reached

Some Examples

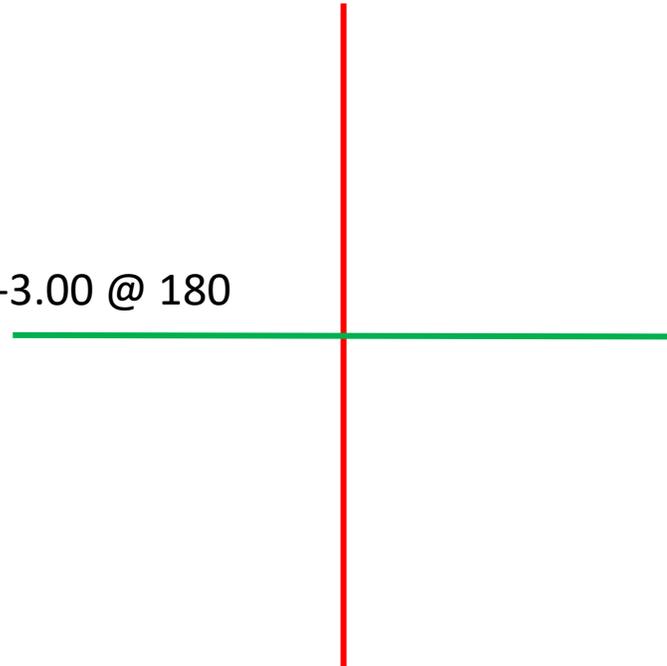


-5.00D

Neutrality has been reached
Put -5.00D on the lens cross

-5.00 @ 090

-3.00 @ 180

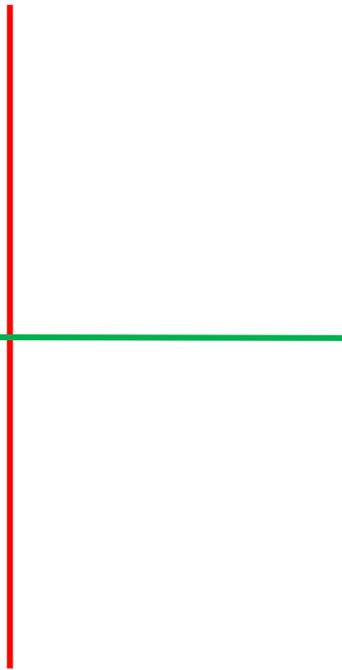


Some Examples

-5.00 @ 090
-6.50 @ 090

-3.00 @ 180

C -4.50 @ 180



If using a 67cm working distance, you used a +1.50D lens,
Therefore, you must adjust the powers

Sphere relates to axis (use weakest minus power)

Difference between the two meridians is 2.00D

Therefore:

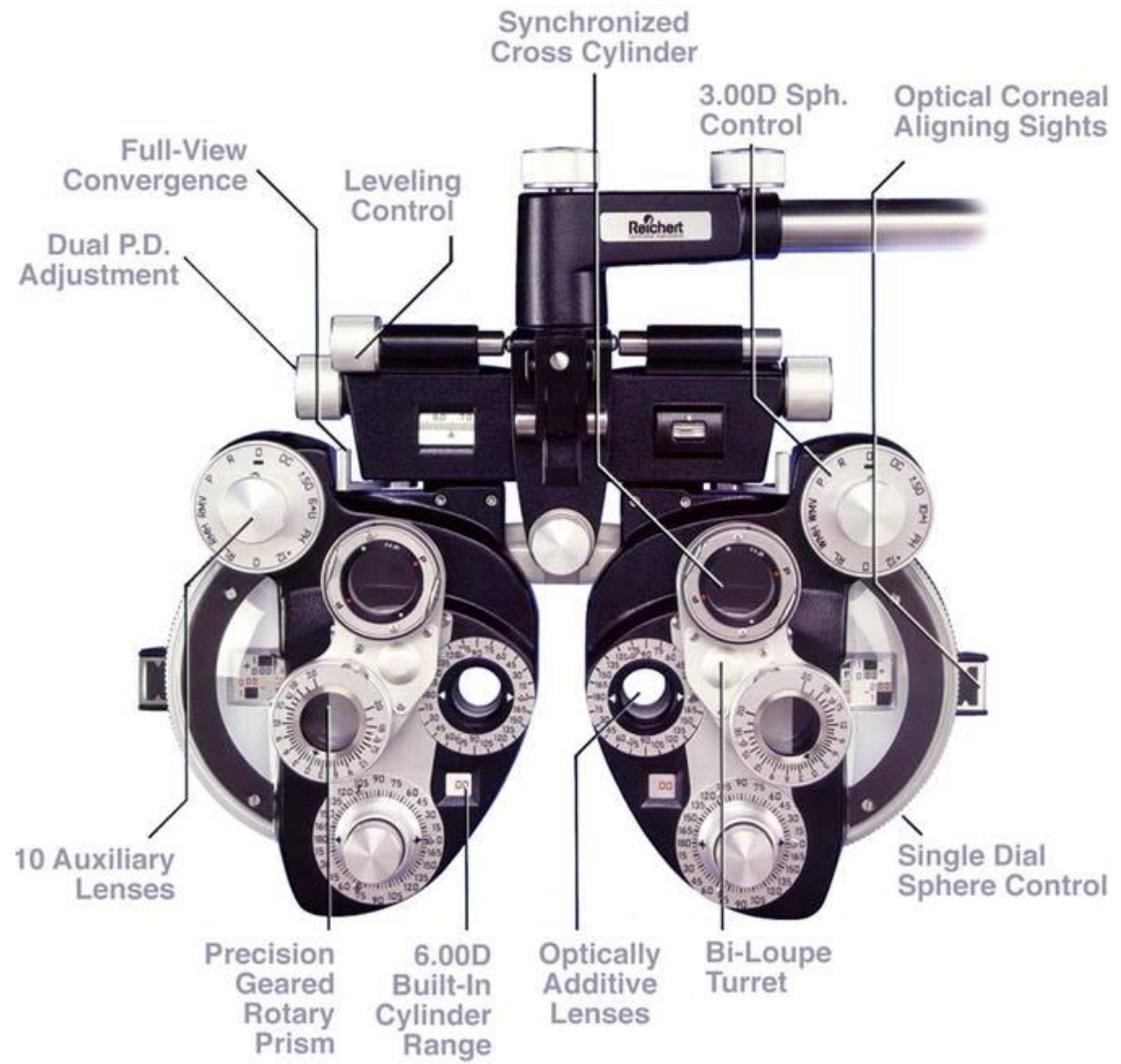
-4.50 -2.00 x 180

By using the lens cross, you can easily calculate the final Rx

Subjective Refraction

Subjective refraction – Determination of the spectacle or contact lens prescription utilizing the response of the patient to determine the accuracy of the prescription. Usually performed with a phoropter or trial frame in combination with the Snellen chart placed at a predetermined distance, usually 20 feet (6 meters)

Subjective refraction requires response from the patient (subject)



Phoropter

Review of phoropter

The parts of a phoropter include the following:

- Spherical lens Control
- Minus-plano-cylinder Control
- Aperture Control/Strong sphere control
- Jackson Cross Cylinder
- Risley Prism
- Adjustments
 - PD knob
 - Leveling Knob
- Vertex distance control



Refractometry

You will not be in bright light

You will need to know the dials and knobs

You will also need to know the chart that you will be using, so that you can watch the patient not look at the chart

Minus lenses will be in red and plus lenses will be in either white or black

Minus lenses diverge light

Plus lenses converge light

Refractometry

Sphere power controls

- Rotated downward, adds plus sphere or reduces minus power
- Rotated upward, adds minus power or reduces plus power

Cylinder power controls

- Rotated clockwise adds plus cylinder or reduces minus
- Rotated counterclockwise adds minus cylinder or reduces plus

Cylinder axis knob

- 1 - 180 degrees, 185 degrees would be 005 degrees

Phoropter – Set up

Original set-up would be for retinoscopy

If not using retinoscopy first:

- Set for Patient PD, level, both eye holes open to ensure you can see both

For the refraction, you should start with your starting power dialed into the phoropter

- This is achieved by retinoscopy, autorefractometry or prior (habitual) Rx

Phoropter

Begin with the OD (right eye)

- On the auxiliary knob set the dial to 0
- There are 10 lenses on this knob and you will use most of them

Occlude the OS (left eye)

You will see the occluder (OC) on the auxiliary knob



Steps to a Subjective Refraction

Refraction is best achieved with lights on (possibility of over minusing a patient occurs with lights are too dim or off)

Place the patient in a comfortable sitting position behind the phoropter

Adjust the PD to center the patients eyes on the lenses

Level the phoropter to ensure a perfectly horizontal position

Adjust the back vertex distance to 12 mm

Starting point of refraction is determined by objective refraction in one of the following:

- Retinoscopy
- Autorefraction
- Power of previous eyewear

How to test baseline Visual Acuity

Test VA of each eye independently using Snellen Chart

Determine spherical power

- Occlude one eye
- “Fog” the eye with a plus lens
- Start decreasing the power by 0.25D each time and ask the patient which is better
- Stop when patient does not respond to any improvement
- Use the least minus or most plus power
 - Maximum Plus, Maximum Visual Acuity (MPMVA)

Refraction - Phoropter

Using your chart, put several lines beginning with the 20/20 line up to 20/50 line and ask patient to read the smallest line they can read

If they can read the letters presented, add +0.75D

- This should reduce vision by 2-3 lines
- If no loss of vision, click in an additional +0.75D or until vision is reduced by 2-3 lines

Slowly decrease power in 0.25D steps until patient can see 20/20 or 20/15 line or no further vision improvement is achieved

- Click in less plus or more minus power

Once you have achieved best acuity, move on to cylinder correction refinement

- You will move back to sphere during cylinder refinement

Steps of Subjective Refraction

Ensure patient can communicate with you

Test baseline VA

- Occlude OS while testing OD and then reverse using starting Rx
- If using occluder for VA or while performing refraction, do not use a small diameter pinhole aperture. Use 1.2mm or larger as pinholes smaller will produce a blurring effect of diffraction around the edges of the aperture, increasing the blur circle and cause the vision to be worse.

Establish spherical power

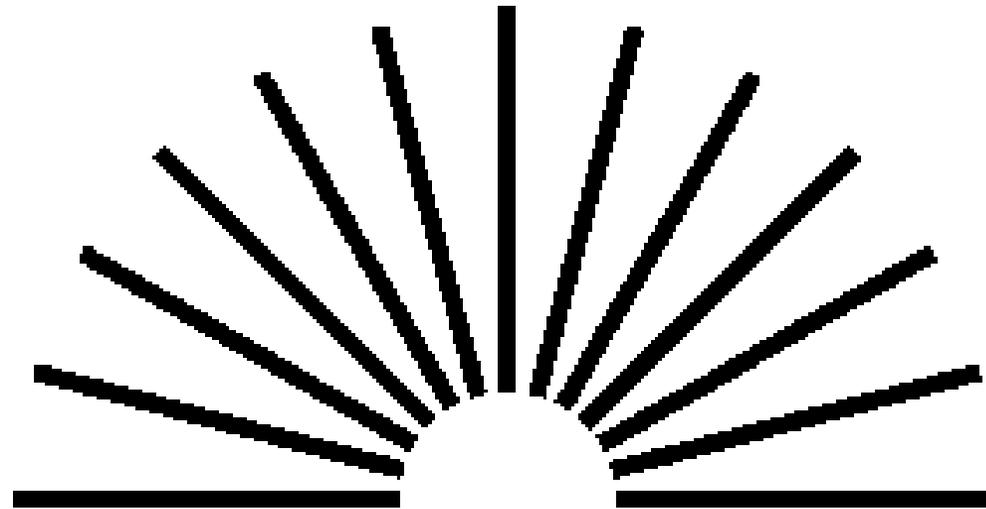
- Best VA to be at 20/30 or better using starting Rx
- After achieving 20/30 VA, reduce 20/30 line to half the line
- Fog patient using plus power to relax accommodation
 - Dial 3 clicks or +0.75 D (4 clicks if using 20/40 line)
- Refine sphere power

Steps of Subjective Refraction

Cylindrical axis refinement

- Astigmatic Fan Test
- Clock dial Test
- JCC

Cylindrical power refinement



Clock Dial

Fog the patient

- Add Plus Power to reduce VA

Ask which lines are clearest

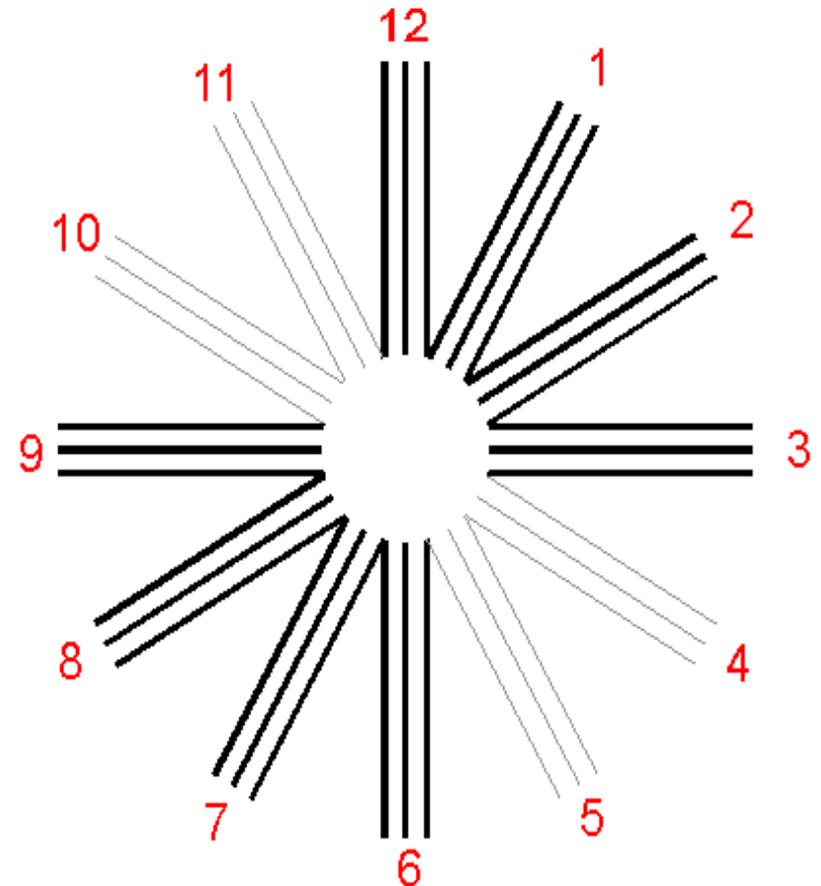
If the patient states no difference, there is no astigmatism

If they say some are clearer, then multiply the lower number x 30 to determine the axis

So:

If 6 and 12 are clear: $6 \times 30 = 180$

Answer: Axis = 180



Jackson Cross Cylinder

Jackson Cross Cylinder is a combination of two cylinders

(minus & plus power) 090 degrees apart

JCC Power = +/- 0.25 or -/+0.50

Red Dots = Minus Power

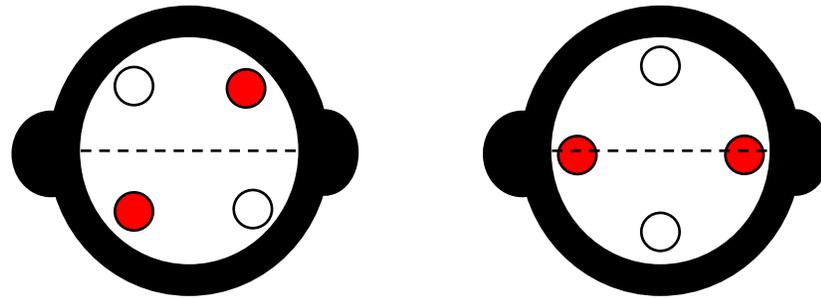
- Minus cylinder follow the red

White Dots = Plus Power

- Plus cylinder follow the white

Start with OD with OS occluded then OS with OD occluded

Jackson Cross Cylinder



Jackson Cross Cylinder

Refining Cylinder/Axis and Power

If patient's refractive error is mostly cylindrical or retinoscopy or autorefraction found 1.00D of cylinder or more, check cylinder axis first.

Otherwise, check cylinder power first and then move on the axis. You may still go back.

- Move the Jackson cross-cylinder (JCC) in front of the patient's eye.
- To check the cylinder axis first, position the JCC so that the white and red dots straddle the cylindrical axis by 45 degrees on either side.

Jackson Cross Cylinder

Have the patient look at either a single line of letters one line larger than their best visual acuity found during the initial MPMVA, or the same grouping of letters you started with.

- Tell the patient, “I am going to give you two choices. Neither will be perfectly clear; however, I want you to tell me which lens choice is clearer: choice one or choice two; choice three or choice four? And so on.”
- Be sure to use fresh choices and new numbers with each pair you present.

Jackson Cross Cylinder

- Move the axis in the direction of the red dot, initially in 15-degree increments, for individuals with 2.00D of cylinder or less. You will decrease the increment size following a reversal by 15-10-5-3-1 degrees as the axis is refined.
- For individuals with more than 2.00D of cylinder, start with 5-degree increments, decreasing the increment size following a reversal by 5-3-1 degrees until the axis is refined.
- To check cylinder power, adjust the position of the JCC so that the white or red dots correspond with the cylinder axis.

Jackson Cross Cylinder

- Ask the patient, “Which is clearer: one or two?”
 - If the patient chooses the *white dot*, subtract -0.50D of cylinder power while remembering to add -0.25D of spherical power to maintain the spherical equivalent.
 - If the patient chooses the *red dot*, add -0.50D of cylinder power and add $+0.25\text{D}$ of spherical power to maintain the spherical equivalent.
 - Once the patient reverses (i.e., chooses the red dot after previously choosing the white or vice-versa) adjust the cylinder power by 0.25D in the opposite direction of your previous change. The spherical power does not need to be adjusted for this 0.25D change.

Jackson Cross Cylinder

- Once more, check the cylindrical power with the JCC to see if the patient wants more or less power. *The goal is to give the least amount of cylindrical power that provides the clearest vision.*
- When the cylindrical power and axis have been refined with the JCC, remove the JCC from in front of the patient's eye and ask the patient to read the smallest line they can.

Jackson Cross Cylinder

Cylinder Power Search

If retinoscopy or autorefraction indicated no cylinder was needed and you suspect otherwise, do a cylinder power search.

- With your JCC oriented for power at 90 and 180 degrees, ask the patient, “Which is better: choice one or two?”
 - If the patient indicates no preference, repeat at 45 and 135 degrees.
 - If the patient indicates a preference, add -0.50 cylinder at the axis where the red dot is oriented, along with $+0.25D$ sphere power to maintain the spherical equivalent.
- Using the standard JCC technique described previously, refine the cylinder power and axis.

Subjective Refraction Goal

Our goal is to give the strongest plus sphere or weakest minus sphere that will achieve the best VA

Be careful:

- Ask “It is clearer? Or just darker and smaller? If VA isn’t improved, you may likely over minus patient
- Particularly myopic patients have a tendency to want darker....if the VA isn’t improved, hold off

Steps of Subjective Refraction

After cylinder and axis is refined, go back to sphere refinement

Fogging patient

Confirmed by:

Binocular balancing

- Duochrome
- Binocular balance (vertical prism) (Dissociation Test)
- Pinhole
 - Pinhole occluder – rarely used for balancing

Fogging

Is done to make the eye artificially myopic

In the state of hyperopia, patients tend to accommodate

Therefore, we put enough plus power in front of the eye so that accommodation is relaxed and the refractive error is stable

Duochrome Test

Based upon principle of chromatic aberration

In the normal eye (emmetropia) yellow light focusses on the retina while red focusses behind and green in front

Emmetrope will see both red side and green side equally clear

If the patient sees red clearer, they are under minused or overplussed

- RAM/GAP

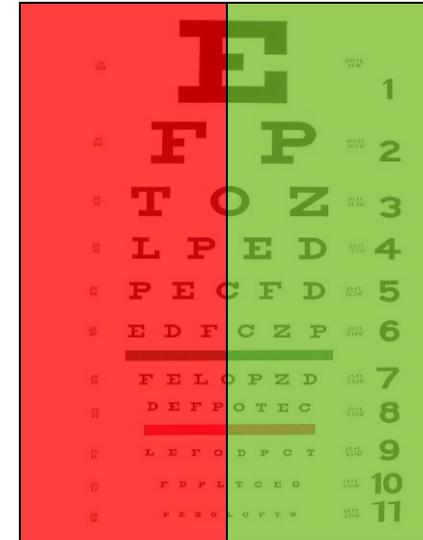
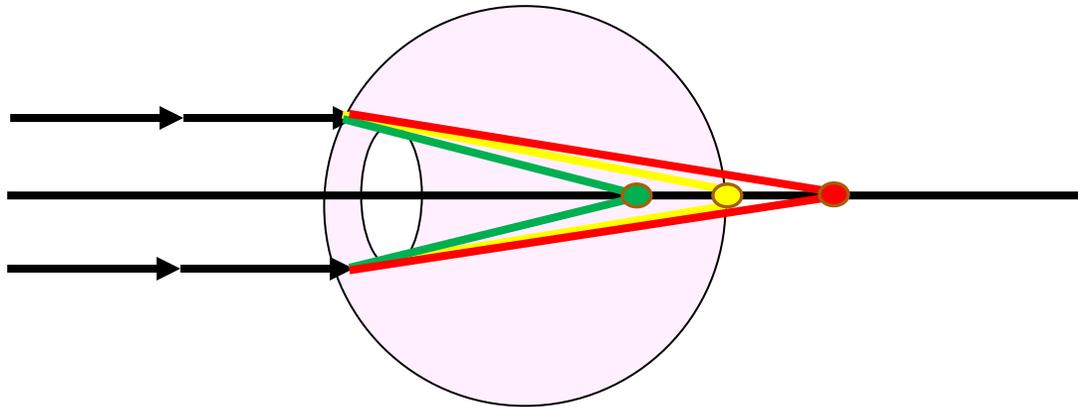
Refining The Sphere Power

Fogging

Add Minus

Duochrome, Bichrome or Red-Green Test

Results



Binocular Balancing

The purpose of Binocular Balancing is to make sure that the accommodation of both eyes is equally relaxed.

The most common way to accomplish this is to use the six diopter auxiliary vertical prism lens available in most Phoropters.

This causes the patient to see two charts with one above the other.

Binocular Balancing

The patient is again fogged and then asked if the letters on both charts are equally sharp.

If they are equal, the fog is removed simultaneously by reducing plus 0.25 at a time until maximum acuity is achieved.

The duochrome filter can be used with the prism dissociation to help determine which eye should be adjusted.

Vertical Prism Dissociation Test

Eyes will be dissociated by using the Risley prisms in the phoropter

Fog the patient (+1.00D)

Use isolated 20/50 line

Use Equal and opposite prism in OD and OS

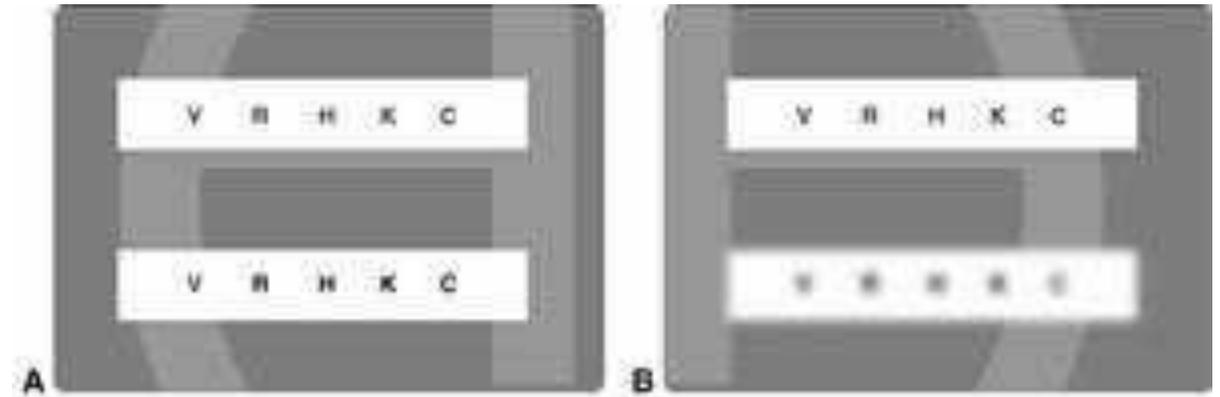
- 3 or 4 BD in OD and 3 or 4 BU in OS



Vertical Prism Dissociation Test

BD prism will cause image to be higher (top)

BU prism will cause image to be lower (bottom)



Vertical Prism Dissociation Test

Tell patient that both images will be blurred. However, look at both top and bottom and tell me which one is clearer or are they equally blurred?

- If the patient says top is clearer, add +0.25D to the OD and repeat the question
- If the patient says bottom is clearer, add +0.25D to the OS and repeat the question
- Now patient says that both eyes are equally blur, we then balance accommodation with +0.25D
- Remove the prism and remove fog.
-

Considerations

Sometimes a patient may present falsely as a myope. They may be hyperopic or even emmetropic.

- The condition is called pseudomyopia:
- It occurs when a spasm of the ciliary muscle prevents the eye from focusing in the distance, sometimes intermittently
- May be organic, through stimulation of the parasympathetic nervous system or functional in origin through eye strain or fatigue of ocular systems.
 - Intense study habits, intense reading, even intense digital device usage.

Management includes plus lenses, base in prism to relieve convergence

Considerations on Subjective Refraction

A change of 0.25D should approximately equal one line of improvement in visual acuity

- If it does not, maybe the change is not necessary

- Example:
- Patient DD
- Habitual Rx and VA
- OD: -3.75 DS 20/30
- New Rx:
- OD: -4.25 DS should produce VA of 20/20

Considerations on Subjective Refraction

Refraction is an art and takes patience for your patients

Go slowly

Don't tire your patient out

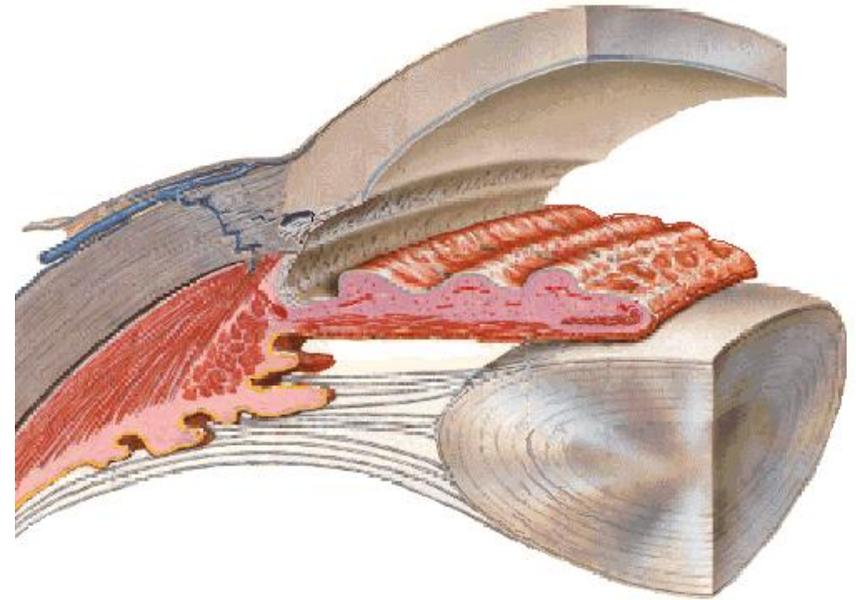
Get used to using phrases such as:

- I will give you choices....
- If they hesitate, say...Let me show you again...
- Which is better...or are they the same
- If patient indicates about the same, give least minus or most plus

Accommodation

Amplitude of Accommodation

- The maximum amount of accommodation the eye can exert
- Age
 - Different charts for estimating the amplitude for a give age
- Push-Up Method
 - Determines the near point of accommodation by moving the chart closer until the vision blurs.



Understanding Presbyopia

Age-Related Vision Changes

As we age, our visual system undergoes major changes

Decline of accommodation

Senile miosis

Loss of visual acuity

Lowered contrast sensitivity

Increased lighting sensitivity

Slower speed of visual processing

Accommodation

Accommodative Facility

- The eye's ability to focus on stimuli at various distances and in different sequences in a given period of time.

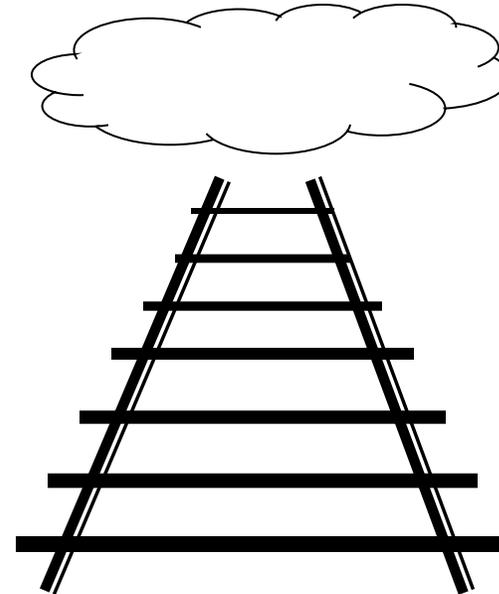
Accommodative Insufficiency

- Patient looks at a small target while a flipper with plus and minus lenses is alternated in front of the eyes.
- Usually +2.00 and -2.00
- Insufficient accommodation below age level may be caused by:
 - Stress
 - Systemic medications
 - Ocular inflammation
 - Thyroid disease
 - Juvenile diabetes mellitus

Convergence

Near Point of Convergence (NPC)

- The nearest point in front of the eyes which the eyes can converge upon a fixation target and maintain single vision; that is, the closest point of fixation just before the image becomes double. (fixation)
- Penlight or transilluminator can be used
 - Patient is to look at light and see how many they see
 - If doubled, move the light further away until it appears single
 - Move it toward the patient until it doubles
 - This distance is known as the break point
 - Break point greater than 7 cm (70mm) is considered abnormal
-



Add Power for Presbyopia

Have patients hold a reading card where they would be comfortable for reading

- May Use chart on rod on phoropter

Determine their accommodation

Use Jaeger Eye Chart

- Notes on chart would be based upon smallest line read...example
 - J1, J2, J3 etc.

Special distances would be calculated based upon Focal length formula

Change in the Mean Amplitude of Accommodation With Age

Age (Years)	Amplitude (Diopters)
10	10.6 - 13.5
15	10.1 - 12.5
20	9.5 - 11.5
30	6.6 - 8.9
35	5.8 - 7.3
40	4.4 - 5.9
45	2.5 - 3.7
50	1.6 - 2.0
55	1.1 - 1.3
60	0.7 - 1.0

Measured by moving the target toward the subject until first blur is reported (Borish 1970; Turner 1958)

Chart Abbreviations

VA	Visual Acuity
Cc	With correction
Sc	Without correction
N	Near
D	Distance
PH	Pinhole
J	Jaeger notation

Other Testing

IOP

Visual Fields

Color Vision

Eye Alignment

Motility

Depth perception (stereopsis)

Slit lamp

Pupil testing

Glare

Contrast Sensitivity

Dilation

Others as needed

Reduced Acuity Testing

Reduce testing distance

Use larger optotype size

Count fingers

Hand motion

Light projection

Light perception

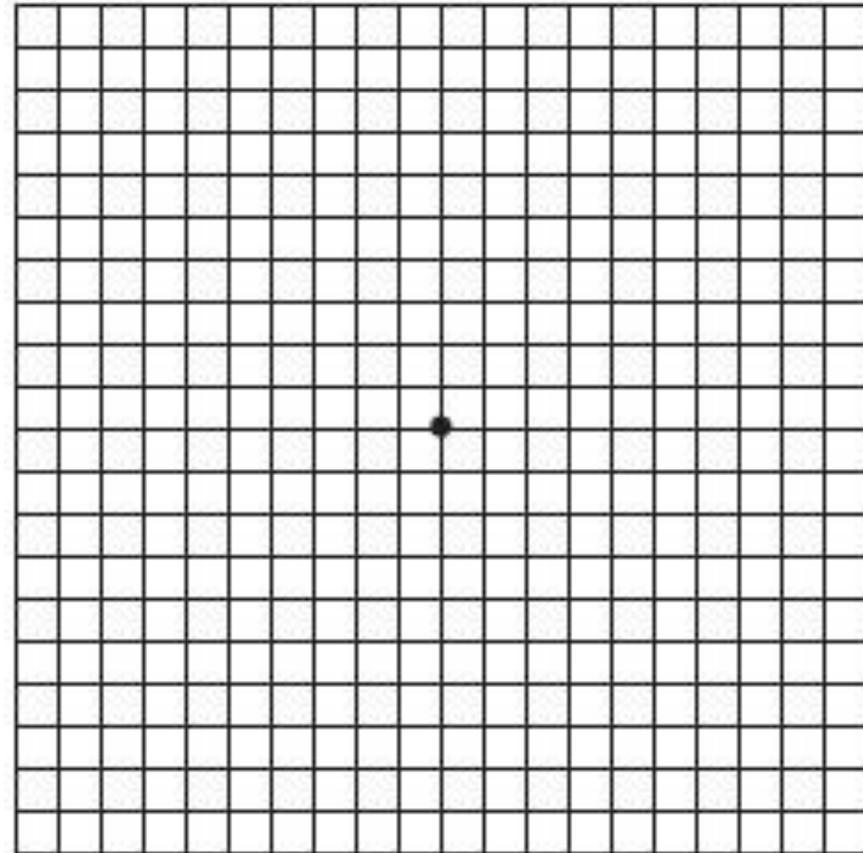
Visual Fields

Normal Monocular: 95 degrees outward, 60 degrees inward, 75 degrees downward, 60 degrees upward.

Scotoma: Blind spot

Testing:

- Perimeters
- Amsler Grids
- Confrontation Test



Low Vision

Legal Categories:

Motor Vehicle: 20/40 at MVD or 20/70 from Doctor. (Florida)

Legally Blind: 20/200 best corrected acuity or 20 degree field or less.

Only 25% of the legally blind are totally blind.

Visual Evaluation Far Point - Distance

May be Able to Use Projection Charts

Probably Will Have to Reduce Test Distance

Low Illumination May Not be Satisfactory

Standard Charts Have no Optotypes Between 20/100 and 20/200

No Optotypes Larger Than 20/200

Converting to 20 Foot Notation

Multiply Top Number by the Integer That Produce an Answer of 20

Multiply the Bottom Number by the Same Integer

Example: $5/100 = 5 \times 4 / 100 \times 4 = 20/400$

Color Vision

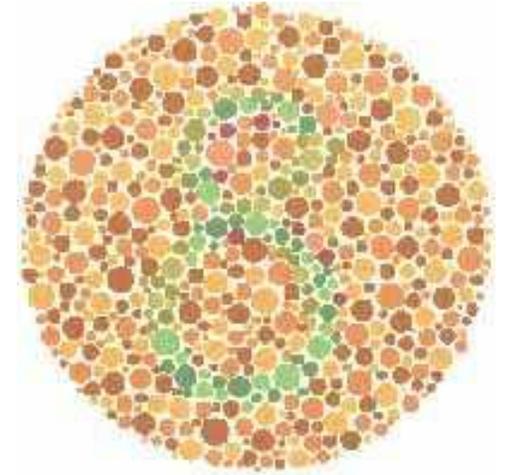
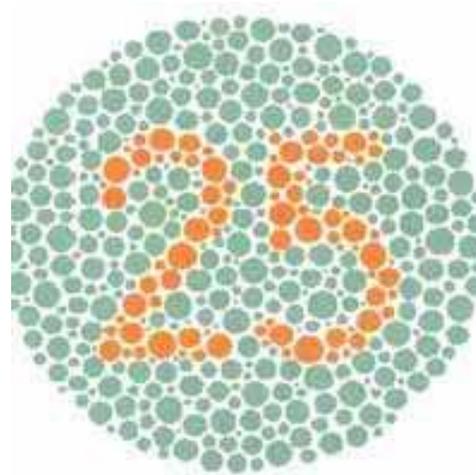
Pseudoisochromatic Plates

- Ishihara

Color vision defects

Congenital color defects occur in 8% -10% of male population and .4% of the female population

Cones are sensitive to blue, red and green



Different anomalous conditions

Protanomaly, which is a reduced sensitivity to red light

Deuteranomaly, which is a reduced sensitivity to green light and is the most common form of color blindness

Tritanomaly, which is a reduced sensitivity to blue light and is extremely rare

Ocular Muscle Deviations

Alternating Cover Test

Cover / Uncover Test

Phoria

Tropia