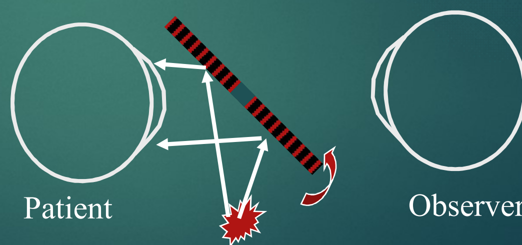
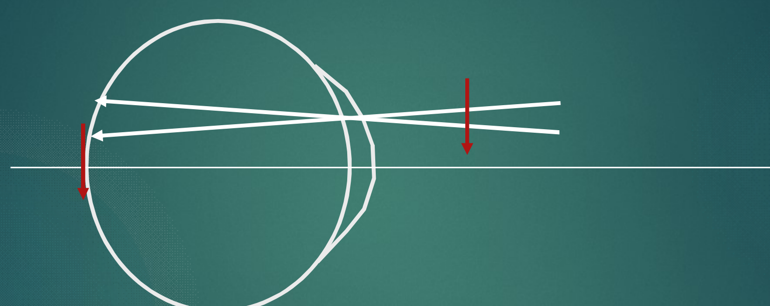
Retinoscopy

Retinoscopy is a means for objectively assessing the refractive error in the eye. A slit of light is projected into the eye and the motion of the returned light is analyzed. Retinoscopy is typically used as a starting point for subjective refractions.

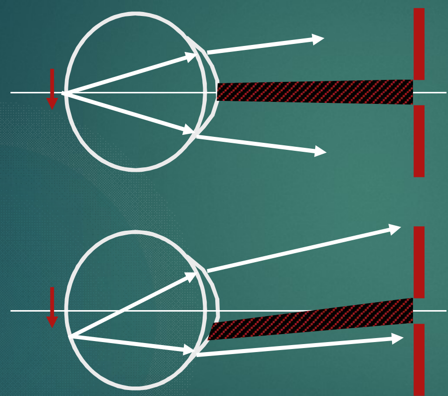


Retinoscopy - Illumination



A slit is imaged into the pupil and scanned across the pupil aperture. The light falling on the retina is an out of focus image of the slit and moves in the same direction as the scan.

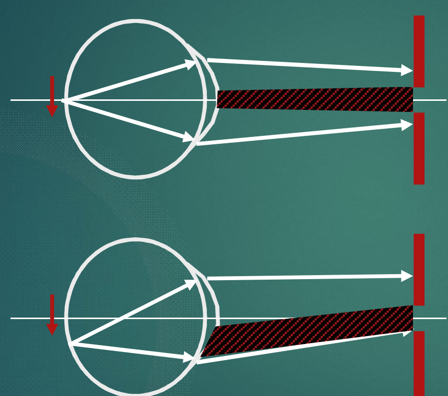
Retinoscopy - Hyperopia



Far Point is Behind Patient - With Motion

http://www.mrcophth.com/eyeclipartchua/retinoscopy.html

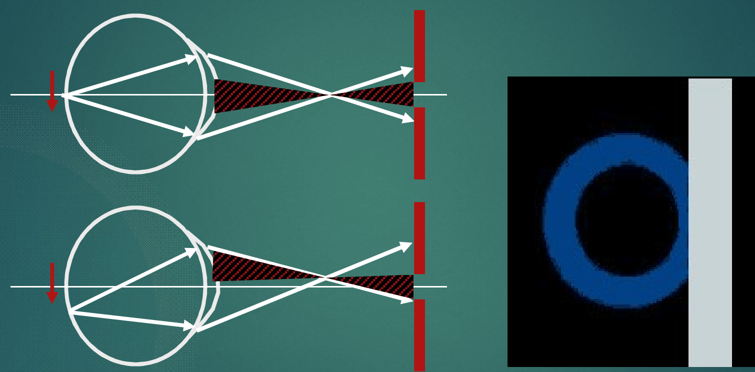
Retinoscopy - Low Myopia



Far Point is Behind Observer - With Motion

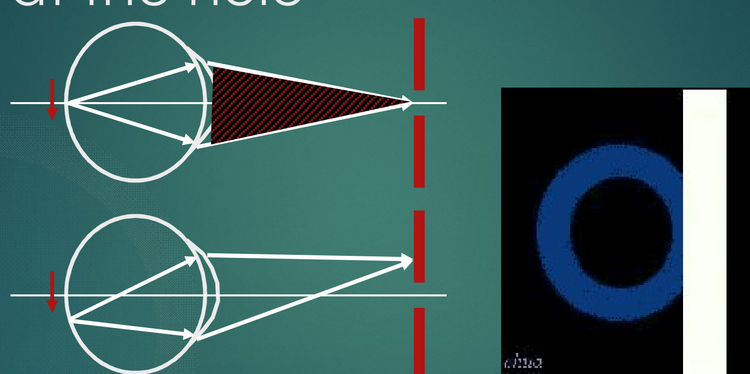
http://www.mrcophth.com/eyeclipartchua/retinoscopy.html

Retinoscopy - High Myopia



Far Point is Between Observer and Patient - Against Motion

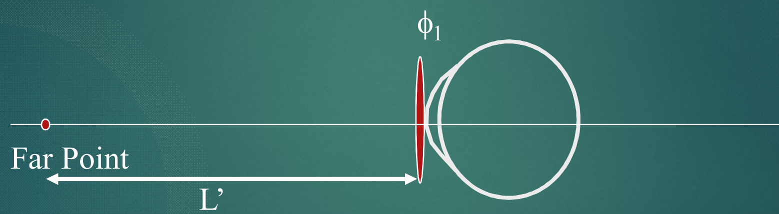
Retinoscopy – Myopia with Far point at the hole



Far Point is at Observer

Spherical Refractive Error

To correct for spherical refractive error, place lens in front of eye to map distant point to the far point.

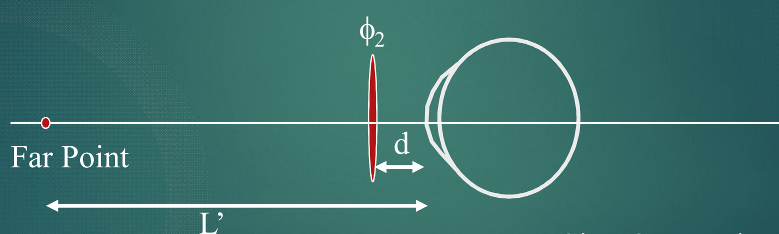


$$\frac{1}{L'} + \frac{1}{\infty} = \phi_1$$

Sign Convention:
L’<0

Spherical Refractive Error

Moving the lens away from the eye changes the required power.



$$\frac{1}{L'+d} + \frac{1}{\infty} = \phi_2$$

Sign Convention:
L’<0

Vertex Adjustment

$$\phi_2 = \frac{\phi_1}{\phi_1 d + 1}$$

Spectacle Lens Power given contact lens prescription

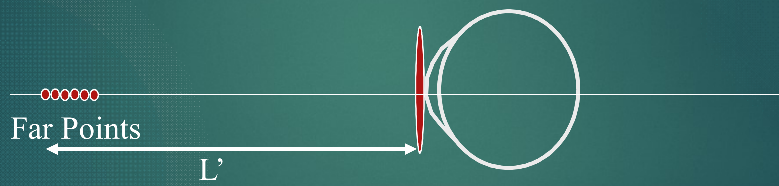
$$\phi_1 = \frac{\phi_2}{1 - \phi_2 d}$$

Contact Lens Power given spectacle lens prescription

The same relationships hold for hyperopic eyes

Axial Astigmatism

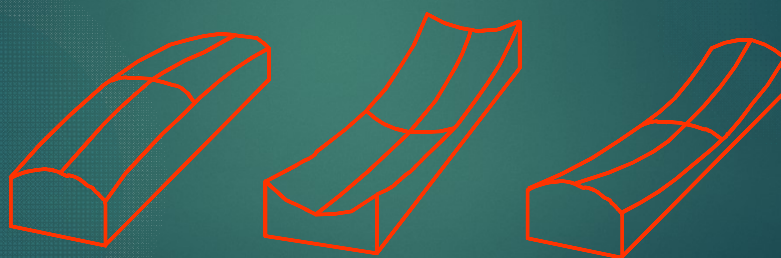
The position of the far point depends on the meridian. Two meridians 90° apart have far points at either end of the line. These meridians can be oriented at any angle.



Axial astigmatism requires a spherocylinder lens for correction.

Toric or Spherocylinder Lenses

Spherocylinder lenses have a given power along one meridian and another power along the meridian 90º away.



Toric or Spherocylinder Lenses

Spherocylinder lenses can be decomposed into a spherical lens and a cylindrical lens. There are two combinations of spheres and cylinders.

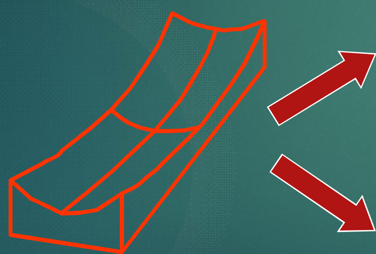
Flat plus sphere with a plus cylinder

or

Steep plus sphere with a minus cylinder

Toric or Spherocylinder Lenses

Spherocylinder lenses can be decomposed into a spherical lens and a cylindrical lens. One combination has a plus cylinder and one has a minus cylinder.



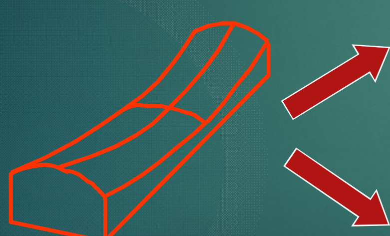
Flat minus sphere with a minus cylinder

or

Steep minus sphere with a plus cylinder

Toric or Spherocylinder Lenses

Power crosses are used to determine the shape of a spherocylinder and to convert between the plus cylinder form and the minus cylinder form.

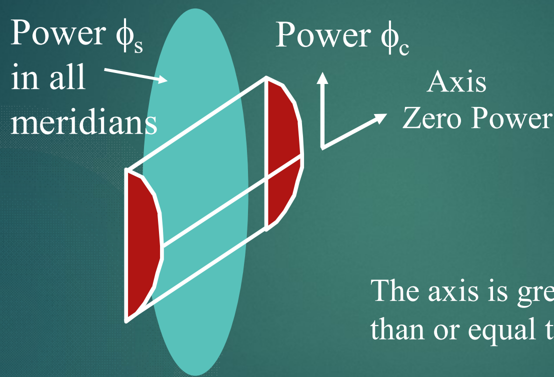


Flat minus sphere with a plus cylinder

or

Steep plus sphere with a minus cylinder

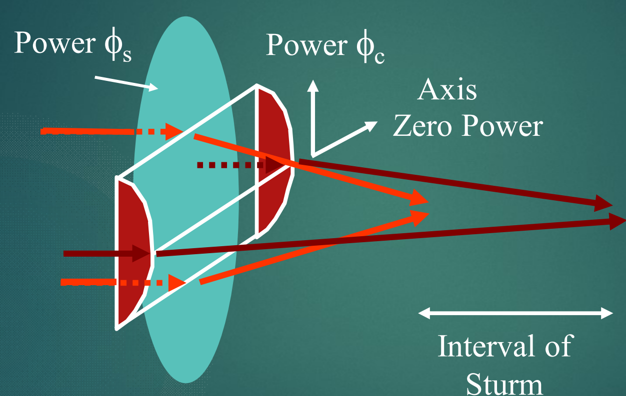
Toric or Spherocylinder Lenses



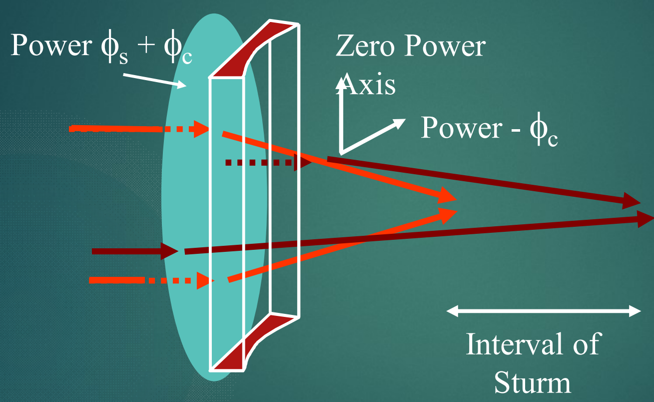
The axis is greater than 0° and less than or equal to 180° due to redundancy.

ϕ_s / ϕ_c x Zero Power Axis

Imaging with Spherocylinder Lenses



Imaging with Spherocylinder Lenses



Cylinder Forms

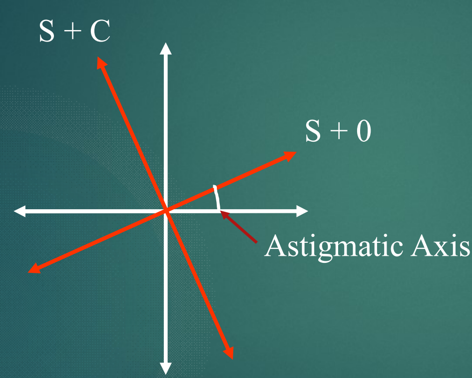
If the power of the cylinder is positive, the prescription is in plus cylinder form.

If the power of the cylinder is negative, the prescription is in minus cylinder form.

To convert between forms:

1. New spherical lens has power $\phi_s + \phi_c$
2. New cylindrical lens has power $-\phi_c$
3. New axis is rotated 90°.

Power Crosses

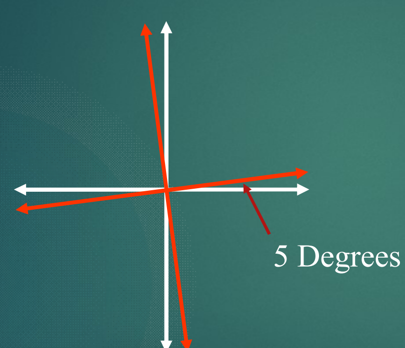


1. Draw a cross with one axis along the astigmatic axis and the other perpendicular to it.

2. Write the sphere power on both axes.

3. Write zero on the astigmatic axis and the cylinder power on the other axis.

Power Crosses

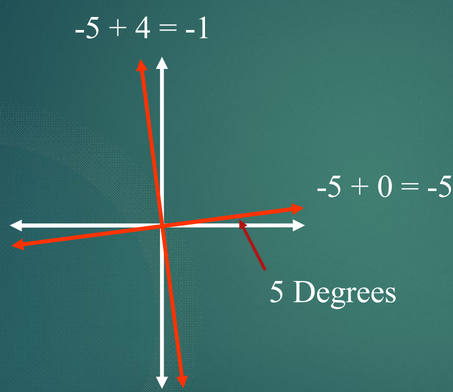


You have a lens with the prescription

-5.00 +4.00 x 5º

What is the power cross?

Power Crosses

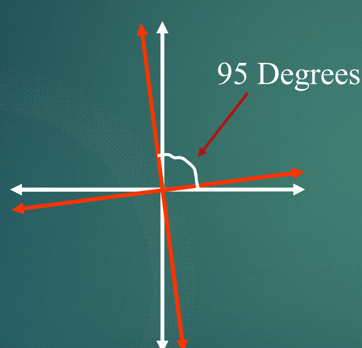


You have a lens with the prescription

-5.00 +4.00 x 5º

What is the power cross?

Power Crosses

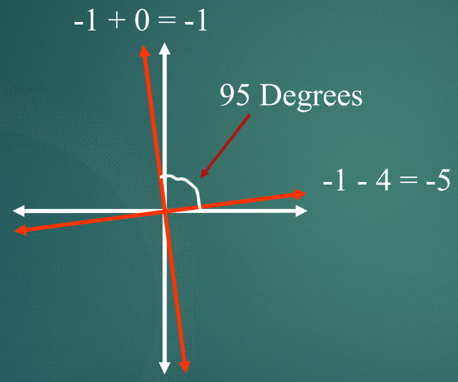


You have a lens with the prescription

-1.00 -4.00 x 95º

What is the power cross?

Power Crosses

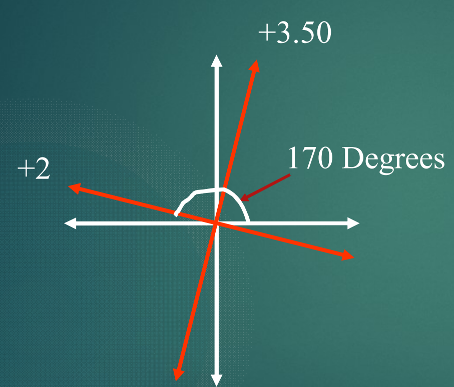


You have a lens with the prescription

-1.00 -4.00 x 95º

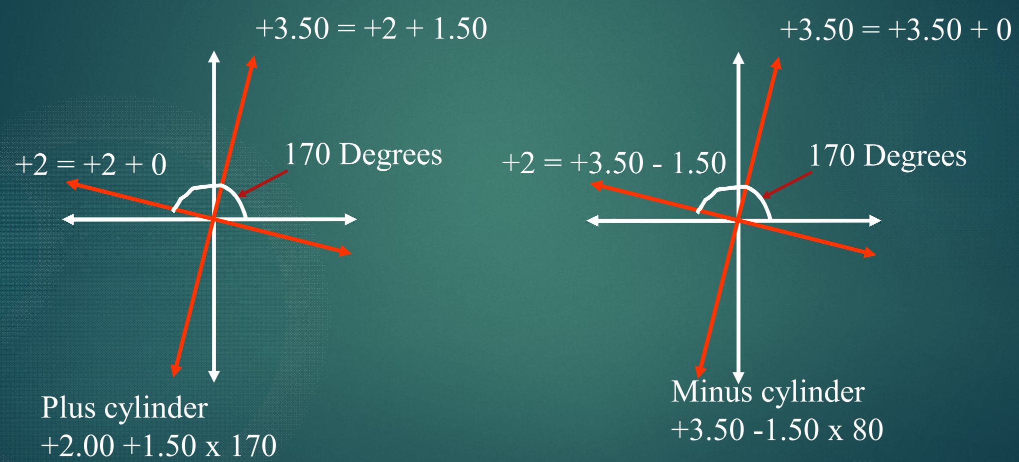
What is the power cross?

Power Crosses



You have a lens with power +2.00 D along the 170 º and +3.50 D along the 80º meridian. What is the lens prescription in plus cylinder form? What is the lens prescription in minus cylinder form?

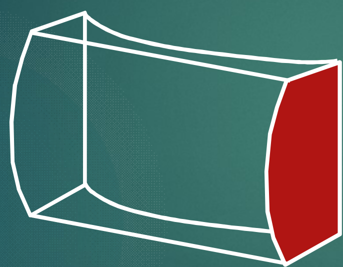
Power Crosses



Spherical Equivalent Power

- Average power of a spherocylinder lens
- SEP = $\phi_S + 0.5 \times \phi_C$
- This is the lens that would put the circle of least confusion on the retina.

Jackson Crossed Cylinder

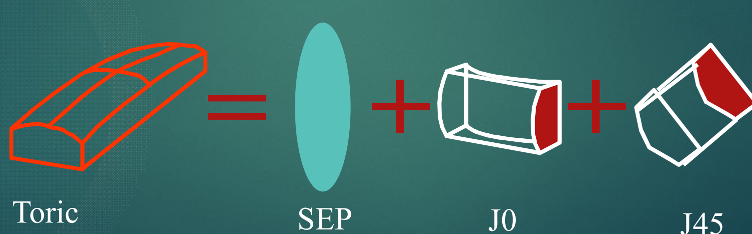


A crossed cylinder has a power ϕ_c along one axis and a power $-\phi_c$ along the other axis.

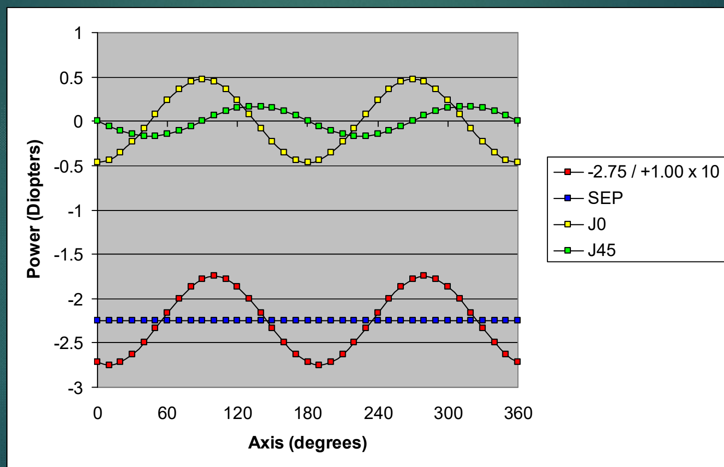
Crossed cylinders also have a spherical equivalent power of zero.

Astigmatic Decomposition

- The result of combining spherocylinder lenses of different axes can be determined using astigmatic decomposition. An example of an application of this technique is determining the resulting prescription in a patient with cylinder error and a toric lens that is oriented improperly.



Astigmatic Decomposition



Astigmatic Decomposition - Example

Find the resultant lens of the combination of
-2.75 D / +1.00 D x 10 and
+4.25 D / -1.50 D x 20

Sphere	Cylinder	Axis	J0	J45	SEP
S	C	θ_o	$-0.5*C\cos 2\theta_o$	$-0.5*C\sin 2\theta_o$	S+C/2
-2.75	1.00	10 →	-0.470	-0.171	-2.25
4.25	-1.50	20 →	0.575	0.482	3.50
			↓	Add	↓
S_R	C_R	θ_R ←	0.105	0.311	1.25

Astigmatic Decomposition

$$S_R = \sum SEP - \sqrt{\left(\sum J_0\right)^2 + \left(\sum J_{45}\right)^2}$$

$$C_R = 2\sqrt{\left(\sum J_0\right)^2 + \left(\sum J_{45}\right)^2}$$

$$\theta_R = -\tan^{-1}\left[\frac{C_R/2 + \sum J_0}{\sum J_{45}}\right] \quad \text{add } 180° \text{ if } \theta_R \le 0°$$

Old Equation

$$\theta_R = \frac{1}{2}tan^{-1}\left(\frac{\Sigma J45}{\Sigma J0}\right) + 90°$$

Change to

$$\theta_R = -tan^{-1}\left(\frac{\frac{C_R}{2}+\Sigma J0}{\Sigma J45}\right)$$

In the example:
S_R = +0.922 D
C_R = +0.656 D
θ_R = 125.7°

Phoropter