Optics Quiz 5

This quiz is intended to be taken after completion of Chapters 20-23

Note: Some questions herein may have appeared first in a copyrighted source. If you own the copyright to a question and would like an acknowledgement or to have the question removed, please contact me EyeDentistAAO@gmail.com

No, you can't use a calculator (and you don't need one anyway)

Note that some questions are callbacks from previous quizzes

An ophthalmologist (PD* = 6 cm) performs binocular indirect ophthalmoscopy (BIO) on a phakic child (PD = 3 cm) using a 20D condensing lens. She notes an elevated retinal lesion. If the image has a height of 4.5 mm, what is the height of the lesion itself?

*PD = *Interpupillary distance*

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$$\textit{Image axial mag} = \frac{(\text{Total dioptric power of the pt's eye**}/\text{Condensing lens power})^2}{\text{Examiner's PD in mm}/\text{BIO headpiece PD in mm***}}$$

(Note that the *pt's* PD is irrelevant)

*PD = *Interpupillary distance*
**Always 60D (from the Güllstrand eye) unless otherwise specified
***Always 15 unless otherwise specified

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$$\textit{Image axial mag} = \frac{(\text{Total dioptric power of the pt's eye**}/\text{Condensing lens power})^2}{\text{Examiner's PD in mm/BIO headpiece PD in mm***}}$$

$$= \frac{(60/20)^2}{60/15} = \frac{3^2}{4} = \frac{9}{4} = \boldsymbol{2.25}$$

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$$= \frac{(60/20)^2}{60/15} = \frac{3^2}{4} = \frac{9}{4} = \boldsymbol{2.25}$$

Take careful note of the meaning of the '2.25' result—it indicates the size of the lesion's image is 2.25 times its actual size. It does **not** *mean the lesion is 2.25 mm tall! Answering the question that was asked (*actual lesion height*) requires one more calculation:*

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$$\textbf{\textit{Actual}}\ \textit{lesion height} = \frac{\text{Lesion image height}}{2.25} = \frac{4.5\text{ mm}}{2.25} = \mathbf{2\ mm}$$

*PD = *Interpupillary distance*
**Always 60D (from the Güllstrand eye) unless otherwise specified
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What is the angular magnification of a simple stand magnifier with a 10D lens?

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Knowledge of the following relationships is assessed by this question:

Angular ***magnification*** =

Magnified *retinal angular size*	← θ'/θ →	***Unmagnified*** *retinal angular size*

What is the angular magnification of a simple stand magnifier with a 10D lens?

Knowledge of the following relationships is assessed by this question:

Angular ***magnification*** = θ'/θ

Magnified *retinal angular size*

θ' = Object size x lens power

Unmagnified *retinal angular size*

By convention, a viewing distance of 25 cm (0.25 m) is used in stand-magnifier problems

$$\theta' = \frac{\text{Object size}}{0.25\ \text{m}}$$

What is the angular magnification of a simple stand magnifier with a 10D lens?

Knowledge of the following relationships is assessed by this question:

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Magnified *retinal angular size*

Unmagnified *retinal angular size*

Substituting…

By convention, a viewing distance of 25 cm (0.25 m) is used in stand-magnifier problems

θ' = Object size x lens power

$\theta' = \dfrac{\text{Object size}}{0.25\text{ m}}$

$$\frac{\text{Object size x lens power}}{\left(\dfrac{\text{Object size}}{0.25\text{ m}}\right)}$$

What is the angular magnification of a simple stand magnifier with a 10D lens?

Knowledge of the following relationships is assessed by this question:

Angular ***magnification*** =

$$\theta'/\theta$$

Magnified *retinal angular size*

θ' = Object size x lens power

Unmagnified *retinal angular size*

By convention, a viewing distance of 25 cm (0.25 m) is used in stand-magnifier problems

$$\theta' = \frac{\text{Object size}}{0.25\text{ m}}$$

Substituting…**and simplifying**:

$$\frac{\cancel{\text{Object size}} \times \text{lens power}}{\dfrac{\cancel{\text{Object size}}}{0.25\text{ m}}}$$

What is the angular magnification of a simple stand magnifier with a 10D lens?

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Substituting…**and simplifying**:

$$\frac{\cancel{\text{Object size}} \times \text{lens power}}{\frac{\cancel{\text{Object size}}}{0.25\text{ m}}}$$

Rearranging:

$$= \frac{\textit{lens power}}{4}$$

What you need to know to solve a *simple stand magnifier* problem

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$$\frac{\cancel{\text{Object size}} \times \text{lens power}}{\frac{\cancel{\text{Object size}}}{0.25\text{ m}}}$$

Rearranging:

$$= \frac{\textbf{\textit{lens power}}}{\textbf{\textit{4}}}$$

What you need to know to solve a *simple stand magnifier* problem

So, e.g., a 10D lens is a 10/4 = ***2.5x magnifier***

A friend just purchased an astronomical telescope. She says it has 5x mag, and the objective lens has a power of 10D (but she can't recall whether it has a 'plus' or 'minus' sign in front of it).

a) Is it a +10 or a -10D objective lens?

b) What is the power (and sign) of the eyepiece lens?

c) Absent intervening prisms, will the image be upright or inverted?

d) If it were a Galilean scope, what would be the answers to *a, b* and *c*?

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d) If it were a Galilean scope, what would be the answers to *a, b* and *c*?

a) The objective lens is (+) in both Galilean and astronomical scopes

Don't forget this minus sign! *It keeps the magnification value consistent with our image orientation sign convention*

$$\text{Angular magnification} = -\,\frac{\text{Eyepiece lens}}{\text{Objective lens}} = -\,\frac{\text{Eyepiece lens}}{\mathbf{+10D}}$$

(**Important**! The value '10' is not a constant—
it was given in the stem of the question)

A friend just purchased an astronomical telescope. She says it has 5x mag, and the objective lens has a power of 10D (but she can't recall whether it has a 'plus' or 'minus' sign in front of it).

a) Is it a +10 or a -10D objective lens?

b) What is the power (and sign) of the eyepiece lens?

c) Absent intervening prisms, will the image be upright or inverted?

d) If it were a Galilean scope, what would be the answers to *a, b* and *c*?

a) The objective lens is (+) in both Galilean and astronomical scopes

b) +50D (50D/10D→5x). Astronomical scopes have (+) eyepiece lenses

$$\text{Angular magnification} = -\frac{\text{Eyepiece lens}}{\text{Objective lens}} = -\frac{\text{Eyepiece lens}}{+10\text{D}}$$

$$\text{Angular magnification} = 5 = -\frac{\text{Eyepiece lens}}{\text{Objective lens}} = \underbrace{-\frac{\boldsymbol{+x}}{+10\text{D}} = -\frac{\mathbf{+50D}}{+10\text{D}}}$$

Unlike the value of the objective lens, in this case you had to **solve** for the value of the eyepiece lens

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c) Inverted

$$\text{Angular magnification} = -\frac{\text{Eyepiece lens}}{\text{Objective lens}} = -\frac{\text{Eyepiece lens}}{+10D}$$

$$\text{Angular magnification} = 5 = -\frac{\text{Eyepiece lens}}{\text{Objective lens}} = -\frac{\boldsymbol{+x}}{+10D} = -\frac{\mathbf{+50D}}{+10D}$$

The minus sign renders the value negative, indicating the image is inverted

A friend just purchased an astronomical telescope. She says it has 5x mag, and the objective lens has a power of 10D (but she can't recall whether it has a 'plus' or 'minus' sign in front of it).

a) Is it a +10 or a -10D objective lens?

b) What is the power (and sign) of the eyepiece lens?

c) Absent intervening prisms, will the image be upright or inverted?

d) If it were a Galilean scope, what would be the answers to *a, b* and *c*?

a) The objective lens is (+) in both Galilean and astronomical scopes

b) +50D (50D/10D→5x). Astronomical scopes have (+) eyepiece lenses

c) Inverted

d) +10D, -50D, upright

$$\text{Angular magnification} = -\frac{\text{Eyepiece lens}}{\text{Objective lens}} = -\frac{\text{Eyepiece lens}}{+10D}$$

$$\text{Angular magnification} = 5 = -\frac{\text{Eyepiece lens}}{\text{Objective lens}} = -\frac{+x}{+10D} = -\frac{\mathbf{-50D}}{+10D}$$

(Changed to represent the eyepiece sign for a Galilean scope)

Because of the minus value of the eyepiece lens on a **Galilean telescope**…

A friend just purchased an astronomical telescope. She says it has 5x mag, and the objective lens has a power of 10D (but she can't recall whether it has a 'plus' or 'minus' sign in front of it).

a) Is it a +10 or a -10D objective lens?
b) What is the power (and sign) of the eyepiece lens?
c) Absent intervening prisms, will the image be upright or inverted?
d) If it were a Galilean scope, what would be the answers to *a, b* and *c*?

a) The objective lens is (+) in both Galilean and astronomical scopes
b) +50D (50D/10D→5x). Astronomical scopes have (+) eyepiece lenses
c) Inverted
d) +10D, -50D, upright

$$\text{Angular magnification} = -\frac{\text{Eyepiece lens}}{\text{Objective lens}} = -\frac{\text{Eyepiece lens}}{+10D}$$

$$\text{Angular magnification} = 5 = -\frac{\text{Eyepiece lens}}{\text{Objective lens}} = -\frac{+x}{+10D} = -\frac{-50D}{+10D}$$

(Changed to represent the eyepiece sign for a Galilean scope)

Because of the minus value of the eyepiece lens on a **Galilean telescope**…this minus sign renders the value of the fraction **positive**, indicating the image is **upright**

A friend just purchased an astronomical telescope. She says it has 5x mag, and the objective lens has a power of 10D (but she can't recall whether it has a 'plus' or 'minus' sign in front of it).

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d) If it were a Galilean scope, what would be the answers to *a, b* and *c*?

a) The objective lens is (+) in both Galilean and astronomical scopes

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c) Inverted

d) +10D, -50D, upright

$$\textit{Angular mag} = -\frac{\text{Eyepiece lens}}{\text{Objective lens}} = -\frac{\text{Plus}}{\text{Plus}} = (-)$$

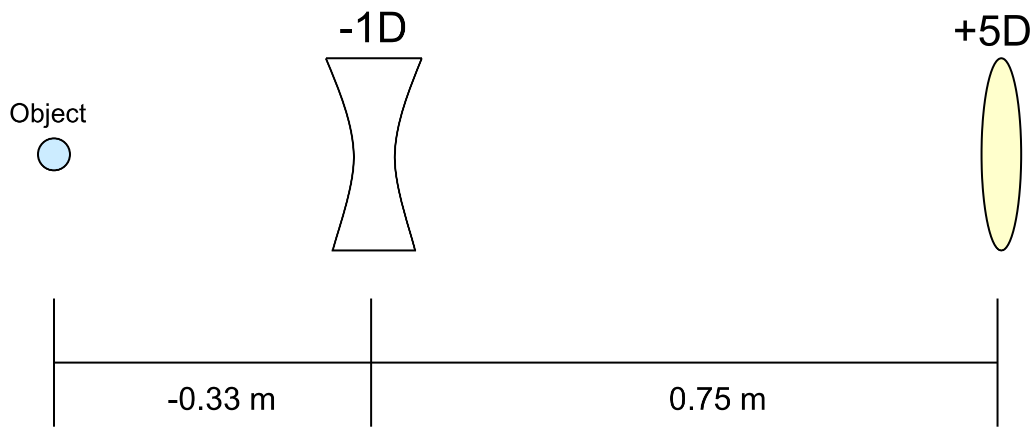
Astronomical telescope
(image is ***inverted***)

$$\textit{Angular mag} = -\frac{\text{Eyepiece lens}}{\text{Objective lens}} = -\frac{\text{Minus}}{\text{Plus}} = (+)$$

Galilean telescope
(image is ***upright***)

Summary slide about scopes—no new info presented

How far apart are the object and the final image?



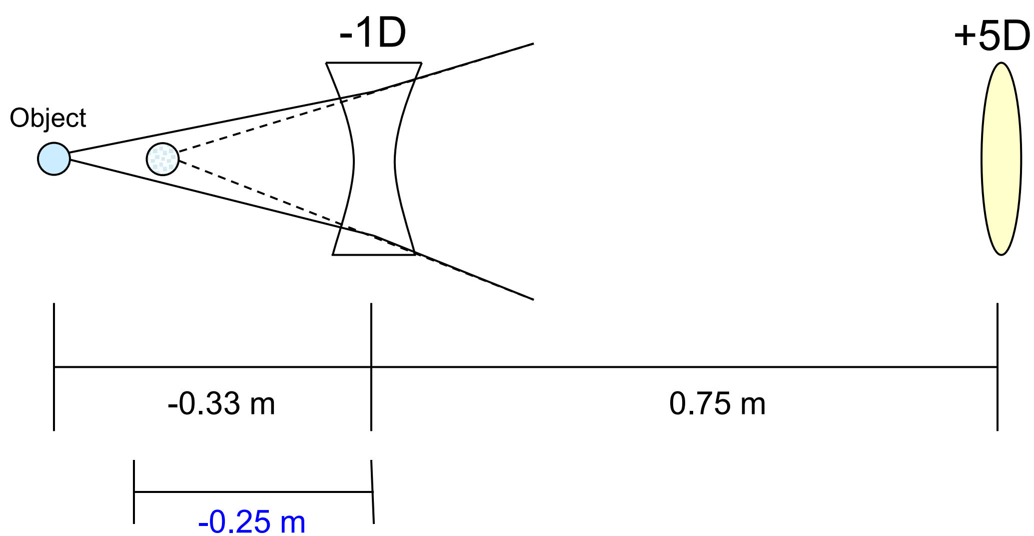
This problem requires a three-step solution:

How far apart are the object and the final image?

U + V = P

-3 + (-1) = -4

1/-4 = -0.25 m

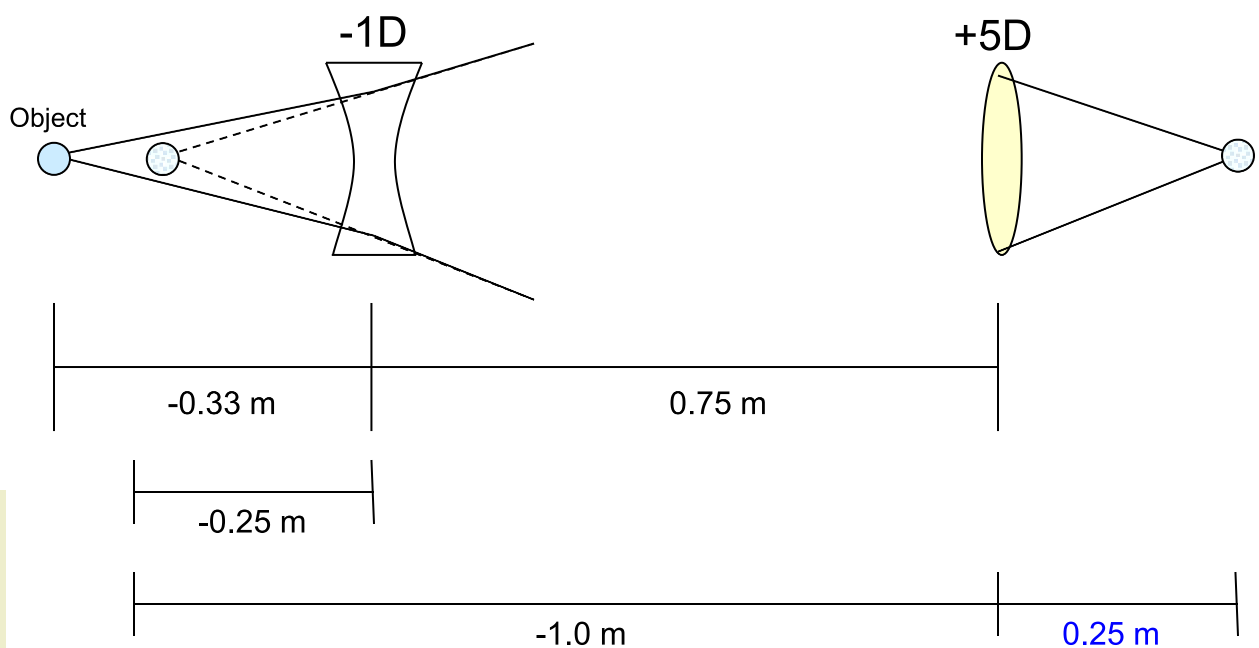


Step 1:
Use the Vergence Formula to determine the location of the image formed by the first lens

How far apart are the object and the final image?

U + V = P
-3 + (-1) = -4
1/-4 = -0.25 m

U + V = P
-1 + (+5) = 4D
1/4 = 0.25 m

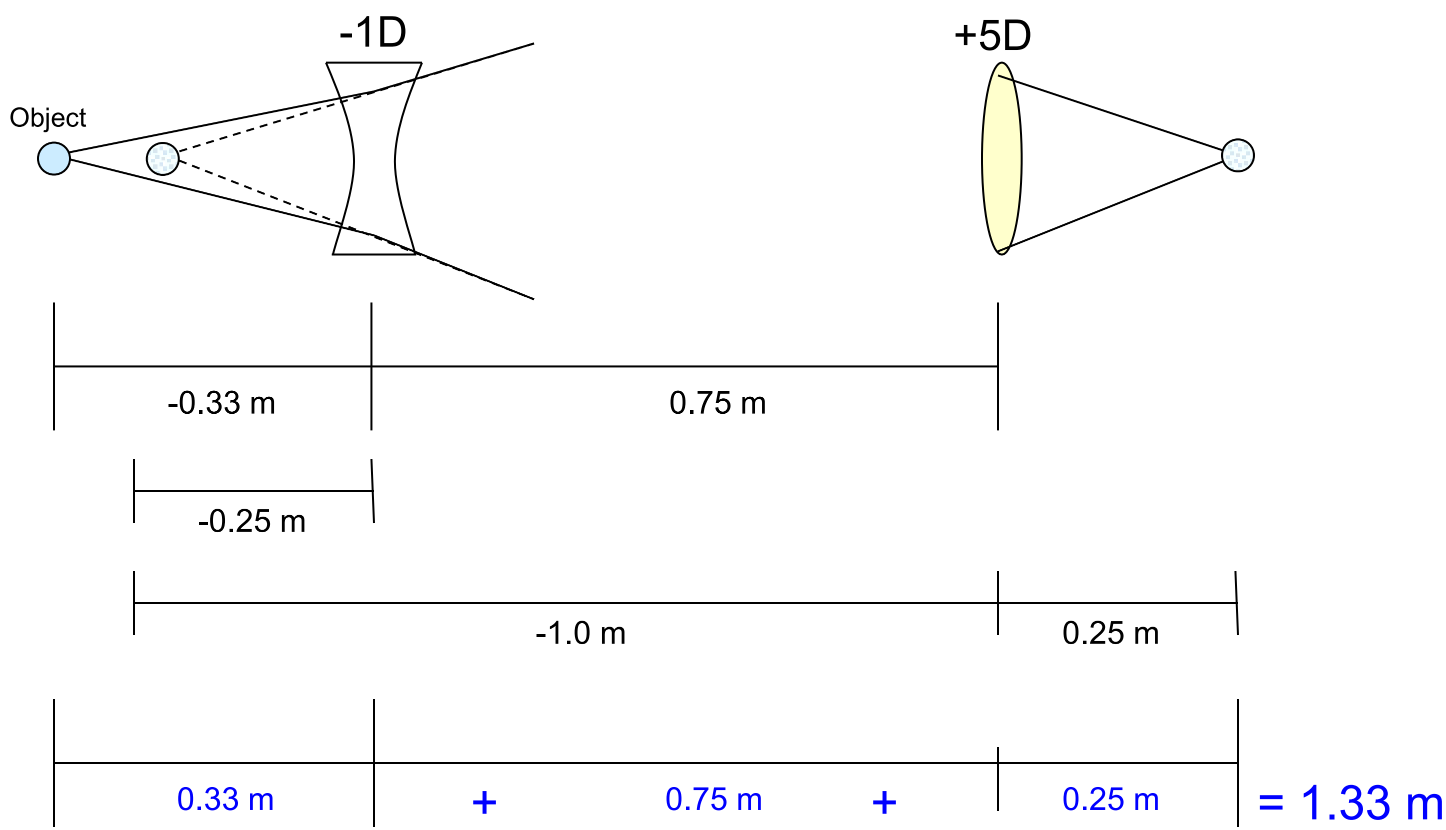


Step 2:
Treat the first image as an object for the second lens

How far apart are the object and the final image?

U + V = P
-3 + (-1) = -4
1/-4 = -0.25 m

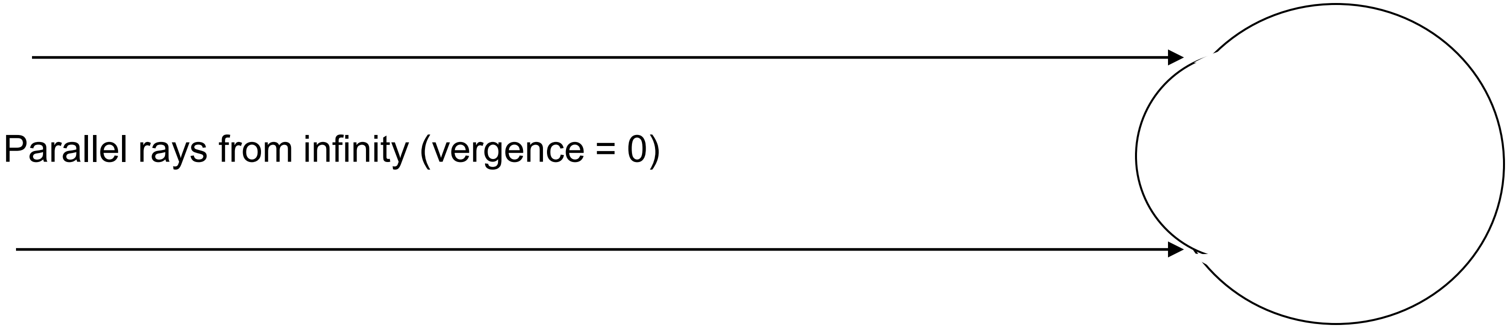
U + V = P
-1 + (+5) = 4D
1/4 = 0.25 m



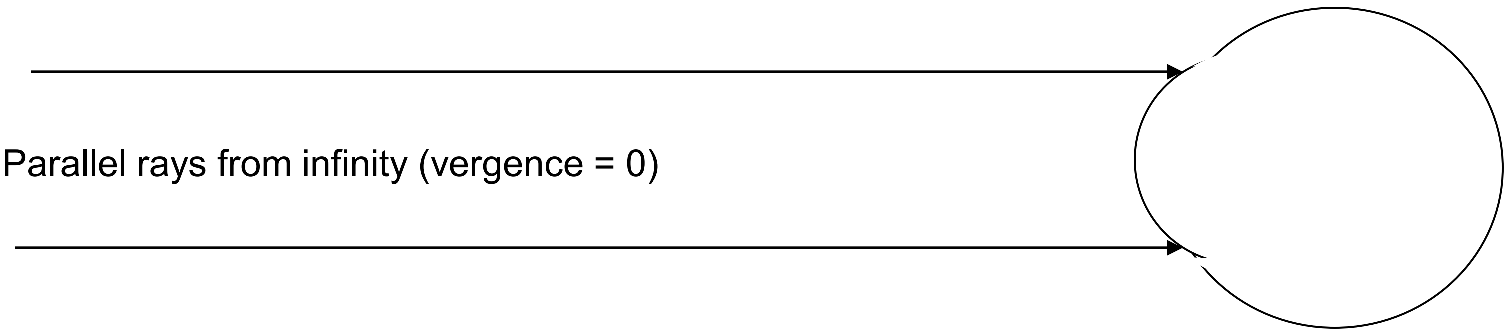
Step 3:
Determine the distance between the initial object and final image

--Indicate where the parallel rays will meet for each refractive status by extending the rays.

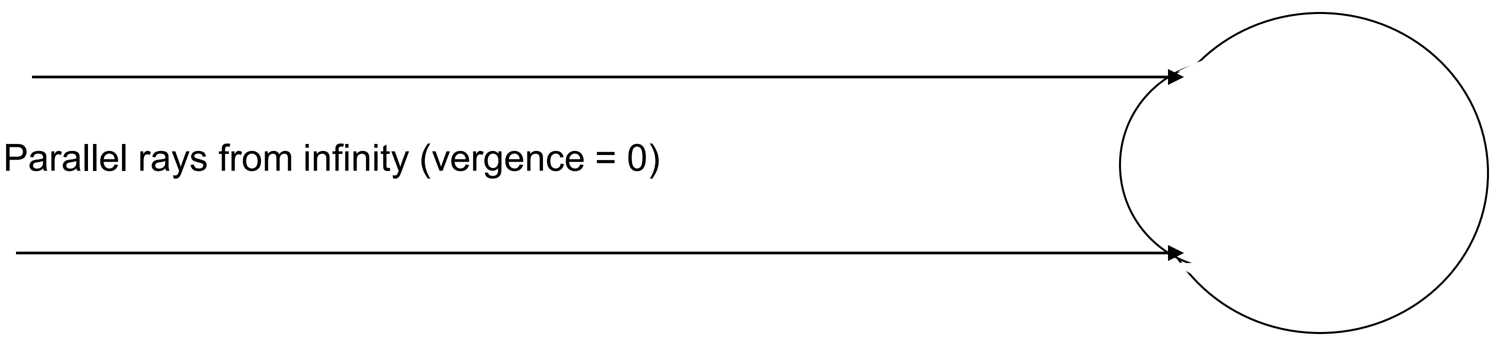
--What is the name for this location?



Hyperopic Eye



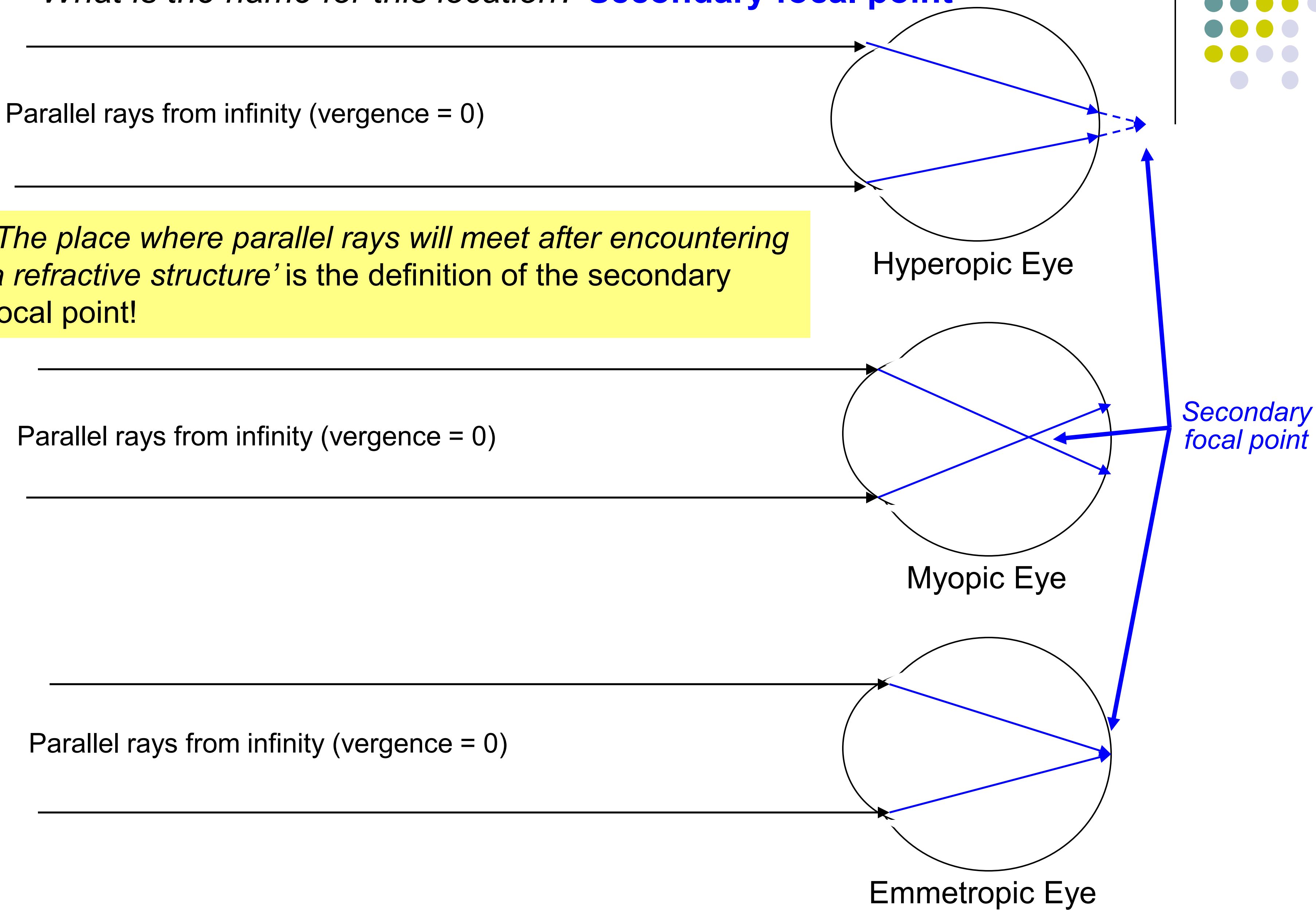
Myopic Eye



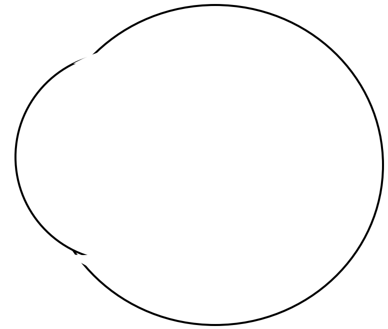
Emmetropic Eye

--Indicate where the parallel rays will meet for each refractive status by extending the rays.
--What is the name for this location? **Secondary focal point**

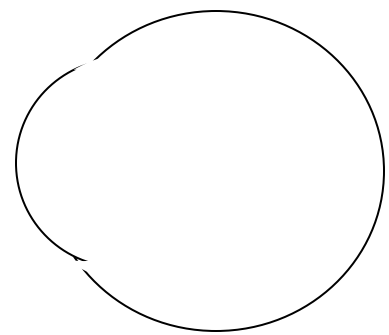
'The place where parallel rays will meet after encountering a refractive structure' is the definition of the secondary focal point!



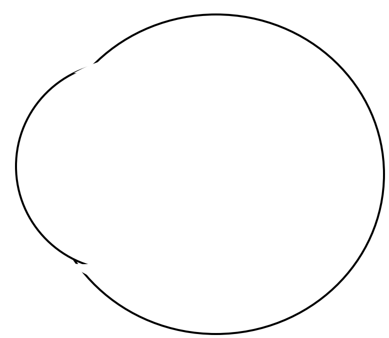
Indicate the location of the far point for each refractive status (ie, draw rays from the far point to where they meet in the eye)



Hyperopic Eye



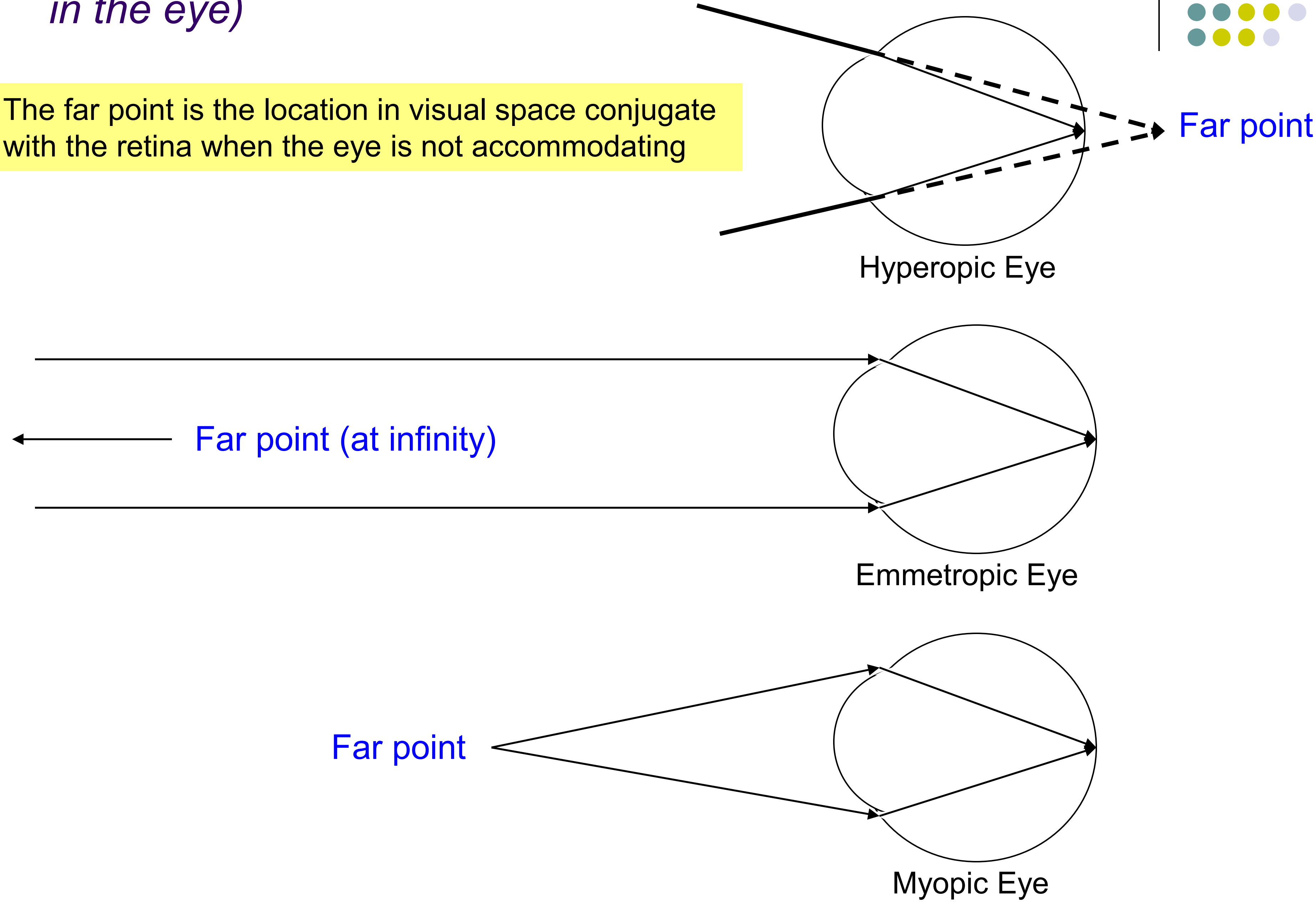
Emmetropic Eye



Myopic Eye

Indicate the location of the far point for each refractive status (ie, draw rays from the far point to where they meet in the eye)

The far point is the location in visual space conjugate with the retina when the eye is not accommodating



A pt is a +5 hyperope. He is capable of a total of 10D of accommodation.
a) Draw the appropriate error lens
b) Indicate the location of his far point (draw and label it)

Absent corrective lenses or surgery:
c) Where is his near point relative to the corneal plane?
d) His range of clear vision is from where to where?

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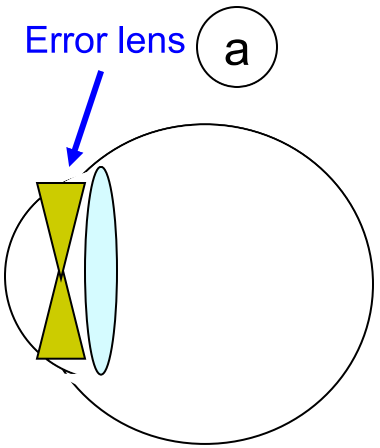

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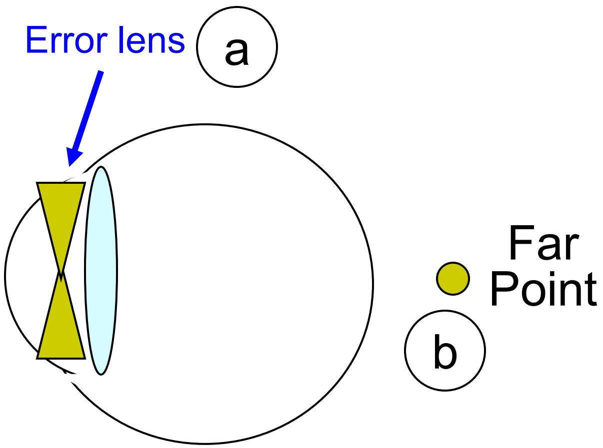
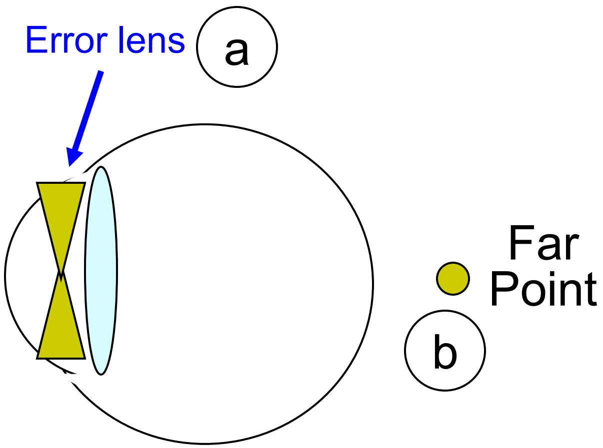


A pt is a +5 hyperope. He is capable of a total of 10D of accommodation.
a) Draw the appropriate error lens
b) Indicate the location of his far point (draw and label it)

Absent corrective lenses or surgery:
c) Where is his near point relative to the corneal plane?
d) His range of clear vision is from where to where?

c) The pt must use 5 of his 10 total diopters of accommodation to see clearly at infinity. This leaves 5D for near. Therefore, his near point is 1/5 = 0.2 m = 20 cm anterior to the corneal plane.

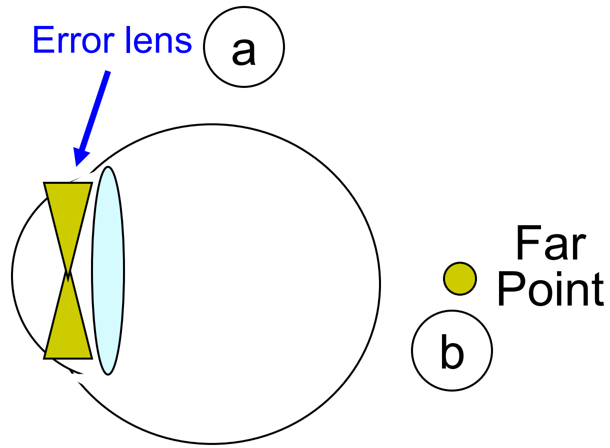


A pt is a +5 hyperope. He is capable of a total of 10D of accommodation.
a) Draw the appropriate error lens
b) Indicate the location of his far point (draw and label it)

Absent corrective lenses or surgery:
c) Where is his near point relative to the corneal plane?
d) His range of clear vision is from where to where?

c) The pt must use 5 of his 10 total diopters of accommodation to see clearly at infinity. This leaves 5D for near. Therefore, his near point is 1/5 = 0.2 m = 20 cm anterior to the corneal plane.

d) His range of clear vision is from 20 cm to infinity.



A pt is a +2 hyperope. He is capable of a total of 6D of accommodation. Absent corrective lenses or surgery:
a) Where is his near point *relative to the corneal plane?*
b) His range of clear vision is from where *to* where?

A pt is a +2 hyperope. He is capable of a total of 6D of accommodation. Absent corrective lenses or surgery:
a) Where is his near point *relative to the corneal plane?*
b) His range of clear vision is from where *to* where?

a) To see clearly at *distance*, this +2 hyperope must first employ 2D of the 6 diopters of accommodation he possesses.

A pt is a +2 hyperope. He is capable of a total of 6D of accommodation. Absent corrective lenses or surgery:
a) Where is his near point *relative to the corneal plane?*
b) His range of clear vision is from where *to* where?

a) To see clearly at *distance*, this +2 hyperope must first employ 2D of the 6 diopters of accommodation he possesses.
To focus at his near point, he will crank in the remaining 4D of accommodation. Thus he will be focused at 1/4 = .25m (25 cm) anterior to the corneal plane.

A pt is a +2 hyperope. He is capable of a total of 6D of accommodation. Absent corrective lenses or surgery:
a) Where is his near point *relative to the corneal plane?*
b) His range of clear vision is from where *to* where?

a) To see clearly at *distance*, this +2 hyperope must first employ 2D of the 6 diopters of accommodation he possesses.
To focus at his near point, he will crank in the remaining 4D of accommodation.
Thus he will be focused at 1/4 = .25m (25 cm) anterior to the corneal plane.
b) His range of clear vision is from infinity to 25 cm anterior to the corneal plane.

A pt is a -2 myope. She is capable of a total of 3D of accommodation. Absent corrective lenses or surgery:
a) Where is her near point *relative to the corneal plane?*
b) Her range of clear vision is from where *to* where*?*

A pt is a -2 myope. She is capable of a total of 3D of accommodation. Absent corrective lenses or surgery:
a) Where is her near point *relative to the corneal plane?*
b) Her range of clear vision is from where *to* where?

a) This pt has a +2 error lens. When she cranks in her 3D of accommodative ability, she has a total of +5D in play. This puts her near point at 1/5 = 0.20m (20 cm) anterior to the corneal plane.

A pt is a -2 myope. She is capable of a total of 3D of accommodation. Absent corrective lenses or surgery:

a) Where is her near point *relative to the corneal plane?*

b) Her range of clear vision is from where *to* where?

a) This pt has a +2 error lens. When she cranks in her 3D of accommodative ability, she has a total of +5D in play. This puts her near point at 1/5 = 0.20m (20 cm) anterior to the corneal plane.

b) Because of her error lens, this pt cannot see clearly at distance. The farthest point at which she can see clearly is her far point, which is located at 1/2 = 0.50m (50 cm) anterior to the corneal plane.

A pt is a -2 myope. She is capable of a total of 3D of accommodation. Absent corrective lenses or surgery:
a) Where is her near point *relative to the corneal plane?*
b) Her range of clear vision is from where *to* where?

a) This pt has a +2 error lens. When she cranks in her 3D of accommodative ability, she has a total of +5D in play. This puts her near point at 1/5 = 0.20m (20 cm) anterior to the corneal plane.
b) Because of her error lens, this pt cannot see clearly at distance. The farthest point at which she can see clearly is her far point, which is located at 1/2 = 0.50m (50 cm) anterior to the corneal plane. As noted above, her near point is at 20 cm. Therefore, her range of clear vision is from 50 to 20 cm anterior to the corneal plane.

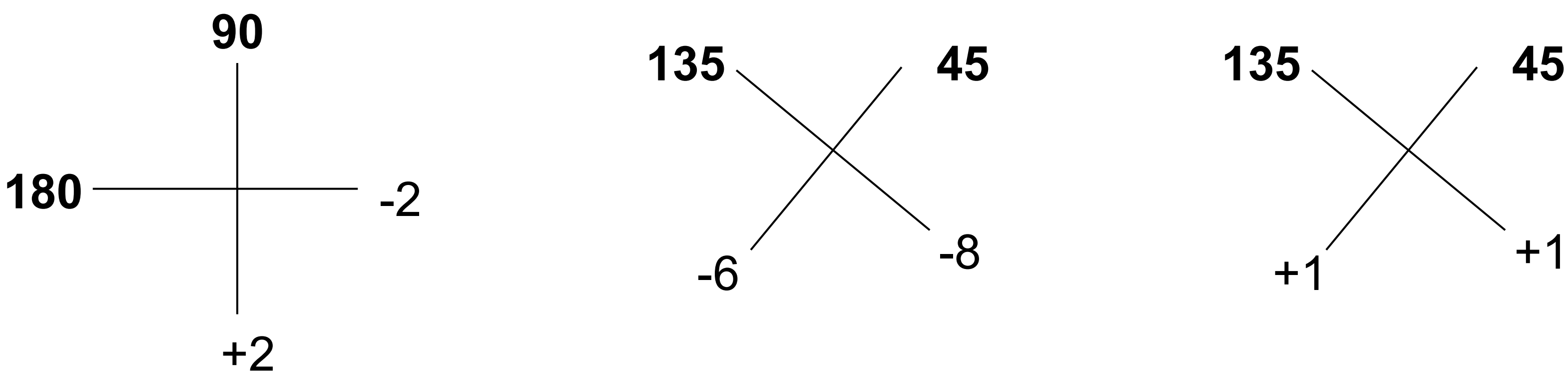
Convert each power cross to its spherocylindrical equivalent in… a) Plus-cylinder format

b) Minus-cylinder format

c) Calculate the S.E. for each lens

d) What type of astigmatism does each represent?

e) Which one is a Jackson cross?



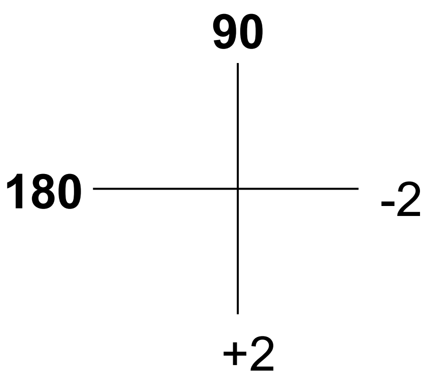
Convert each power cross to its spherocylindrical equivalent in… a) Plus-cylinder format

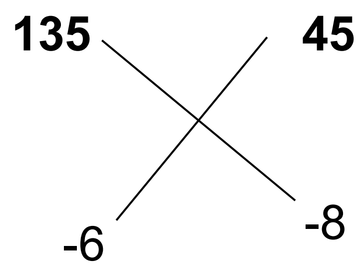
b) Minus-cylinder format

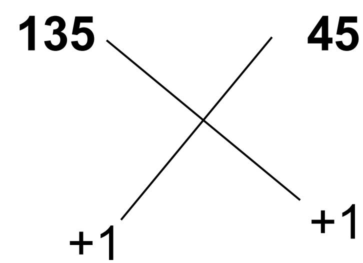
c) Calculate the S.E. for each lens

d) What type of astigmatism does each represent?

e) Which one is a Jackson cross?







a *Plus*: -2 +4 x 180

Plus: -8 +2 x 135

Plus: +1 sph

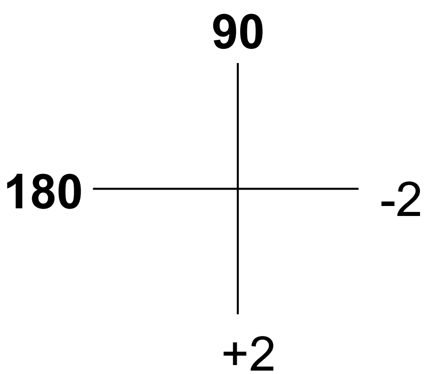
Convert each power cross to its spherocylindrical equivalent in… a) Plus-cylinder format

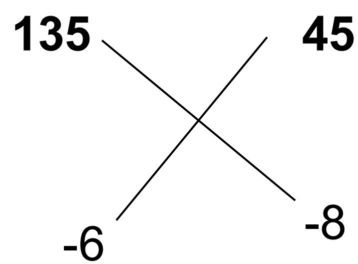
b) Minus-cylinder format

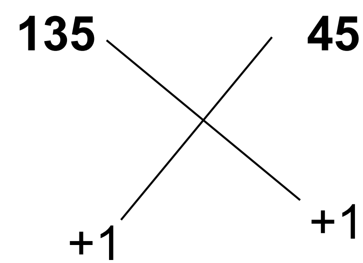
c) Calculate the S.E. for each lens

d) What type of astigmatism does each represent?

e) Which one is a Jackson cross?







a *Plus*: -2 +4 x 180
b *Minus*: +2 -4 x 090

Plus: -8 +2 x 135
Minus: -6 -2 x 045

Plus: +1 sph
Minus: +1 sph

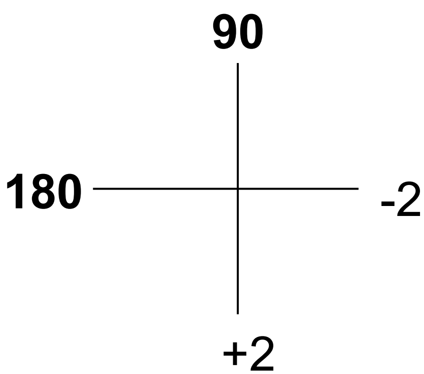
Convert each power cross to its spherocylindrical equivalent in… a) Plus-cylinder format

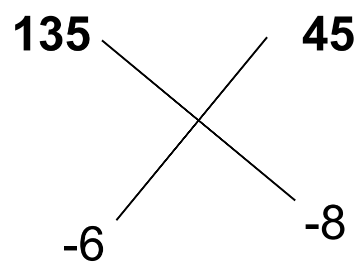
b) Minus-cylinder format

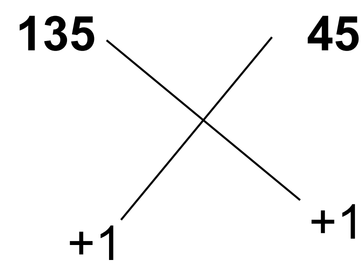
c) Calculate the S.E. for each lens

d) What type of astigmatism does each represent?

e) Which one is a Jackson cross?







a *Plus*: -2 +4 x 180
b *Minus*: +2 -4 x 090
c *S.E.*: Plano

Plus: -8 +2 x 135
Minus: -6 -2 x 045
S.E.: -7

Plus: +1 sph
Minus: +1 sph
S.E.: +1

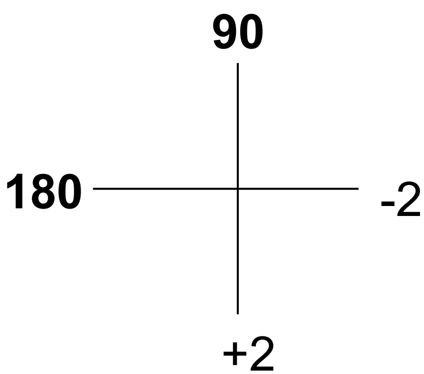
Convert each power cross to its spherocylindrical equivalent in… a) Plus-cylinder format

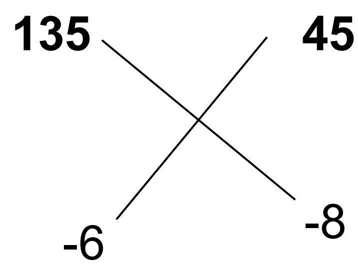
b) Minus-cylinder format

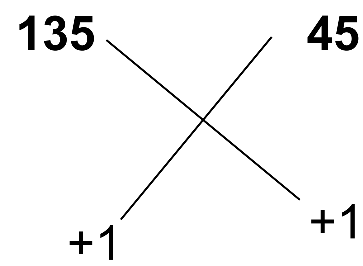
c) Calculate the S.E. for each lens

d) What type of astigmatism does each represent?

e) Which one is a Jackson cross?







a *Plus*: -2 +4 x 180

b *Minus*: +2 -4 x 090

c *S.E.*: Plano

d Mixed astigmatism

Plus: -8 +2 x 135

Minus: -6 -2 x 045

S.E.: -7

Compound myopic

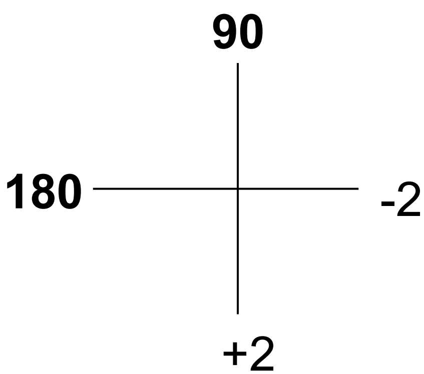
Plus: +1 sph

Minus: +1 sph

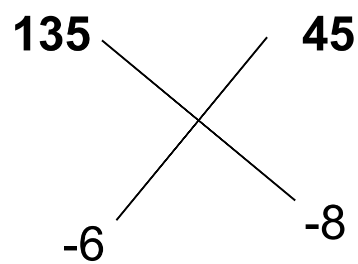
S.E.: +1

Not astigmatic, ie, is a spherical lens

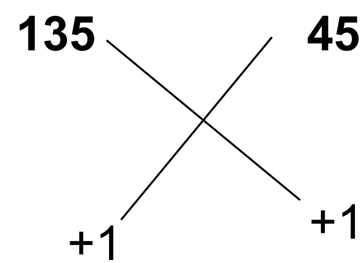
Convert each power cross to its spherocylindrical equivalent in… a) Plus-cylinder format
b) Minus-cylinder format
c) Calculate the S.E. for each lens
d) What type of astigmatism does each represent?
e) Which one is a Jackson cross?



a *Plus*: -2 +4 x 180
b *Minus*: +2 -4 x 090
c *S.E.*: Plano
d Mixed astigmatism
e **Jackson cross**



Plus: -8 +2 x 135
Minus: -6 -2 x 045
S.E.: -7
Compound myopic



Plus: +1 sph
Minus: +1 sph
S.E.: +1
Not astigmatic, ie, is a spherical lens