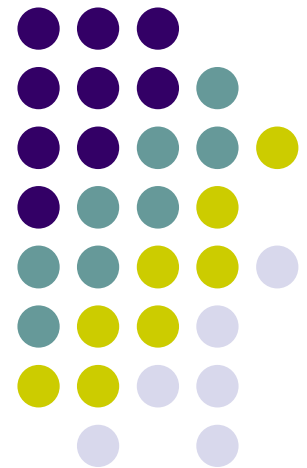
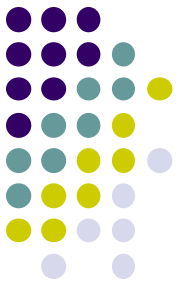


# Optics Quiz 4

This quiz is intended to be taken after completion of Chapters 16-19



*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](mailto:EyeDentistAAO@gmail.com)



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

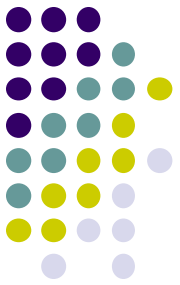
Note that some questions are callbacks from previous quizzes

Define *refractive index* (ie, fill in the fraction)



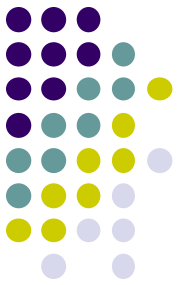
\_\_\_\_\_ = The *refractive index* of the material

Define *refractive index* (ie, fill in the fraction)



Speed of light in vacuum  
Speed of light in material = The *refractive index* of the material

## Fill in the blanks



Changing the direction of light via refraction requires two things:

**a)** The light ray must pass from a substance of \_\_\_\_\_ ; and

**b)** The light ray must encounter the interface between the two substances... \_\_\_\_\_

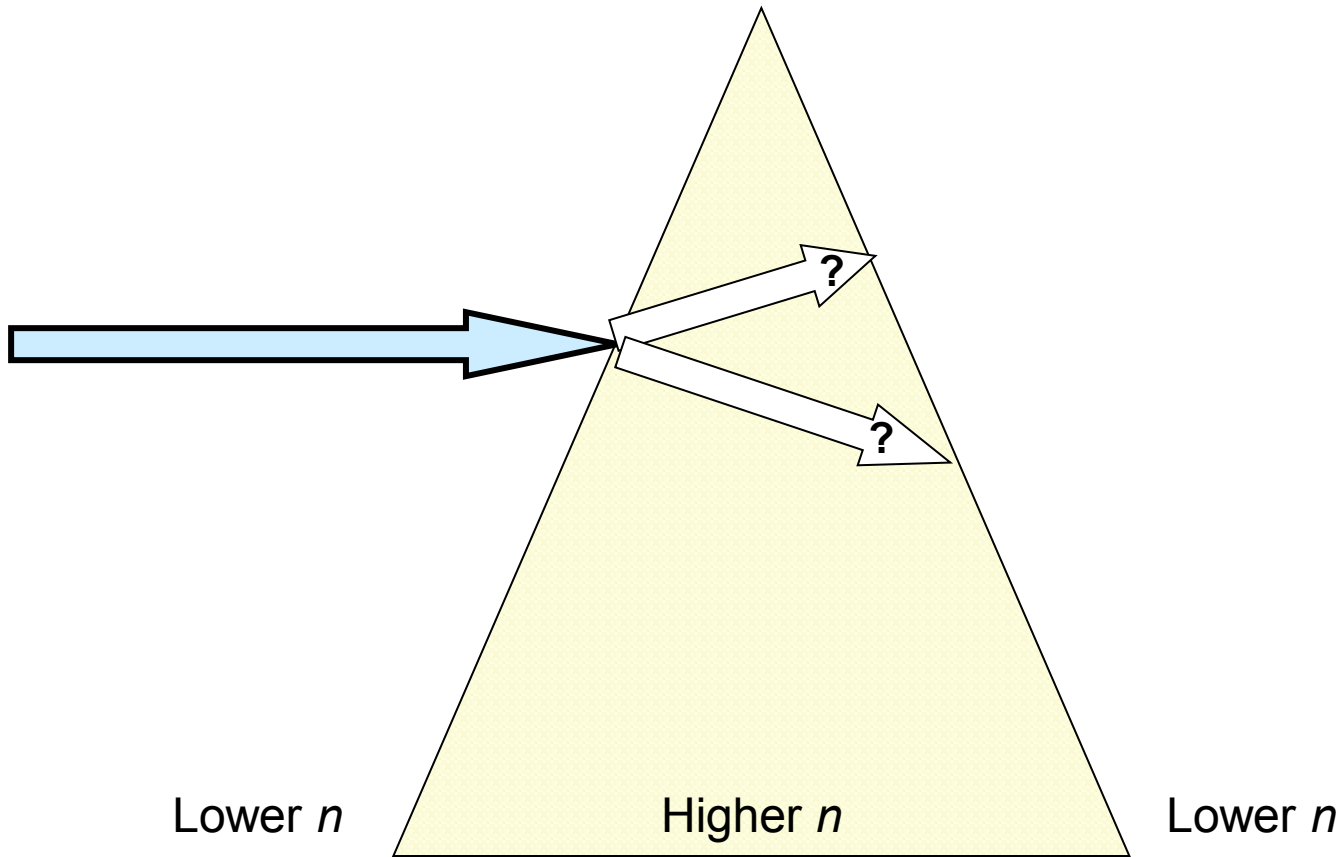
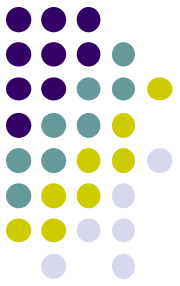
## Fill in the blanks



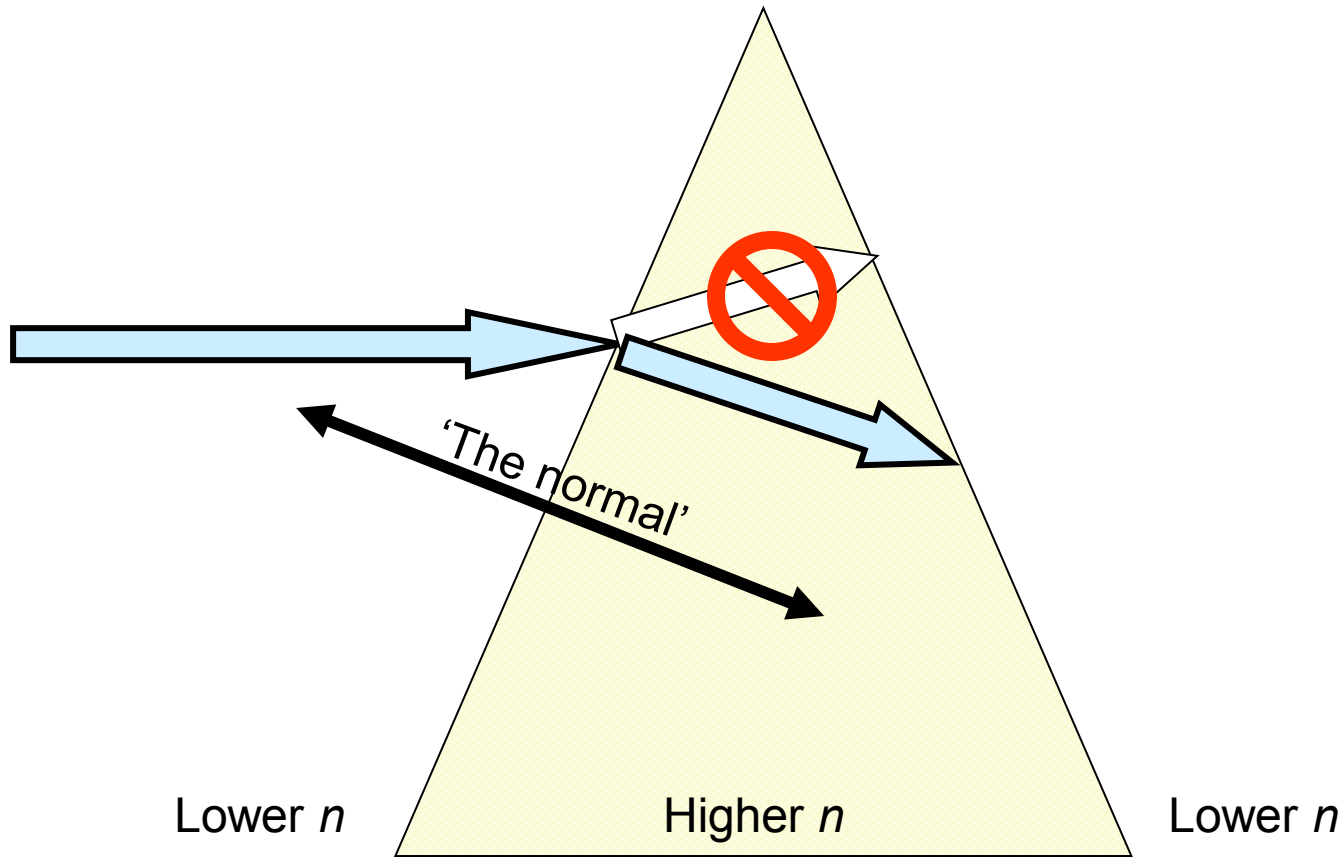
Changing the direction of light via refraction requires two things:

a) The light ray must pass from a substance of **one  $n$  to a substance of a different  $n$** ; and

b) The light ray must encounter the interface between the two substances... **at an angle**

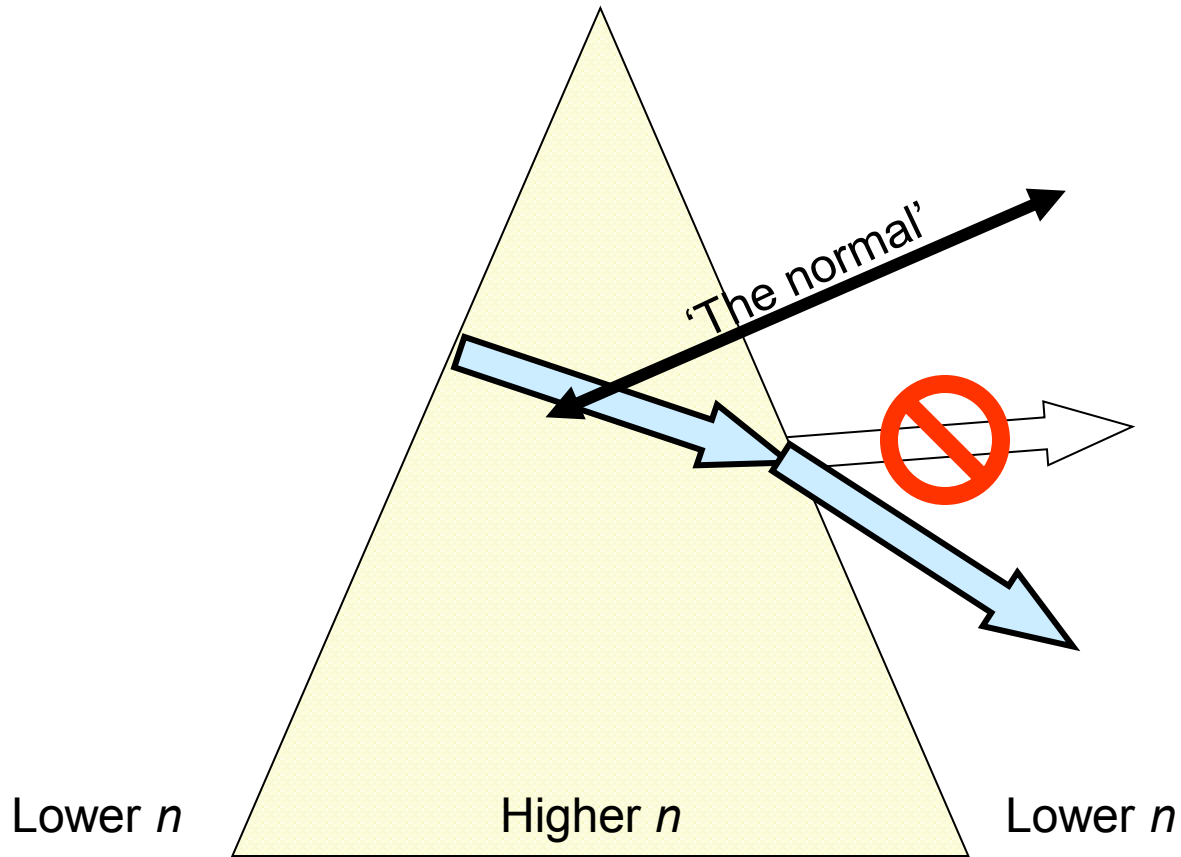


*A light ray is encountering a prism...Which way will the ray be refracted?*



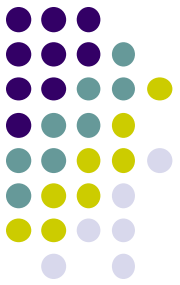
When a ray passes from a material of lower  $n$  to one of higher  $n$ , the ray is deflected **toward** the normal.





When a ray passes from a material of higher  $n$  to one of lower  $n$ , the ray is deflected **away** from the normal.

# Fill in the blanks



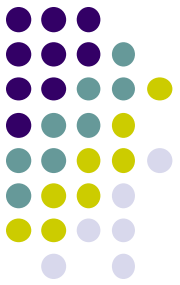
Power (in diopters,  $D$ ) =  $\frac{n' - n}{r}$

a)  $n$  where the rays are... \_\_\_\_\_

b)  $n$  where the rays are... \_\_\_\_\_

c) \_\_\_\_\_ ...of the interface

# Fill in the blanks



Power (in diopters,  $D$ ) =  $\frac{n' - n}{r}$

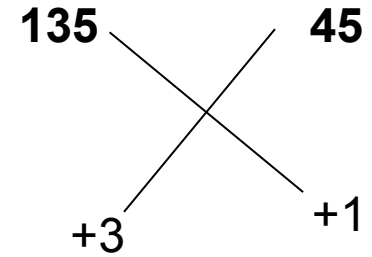
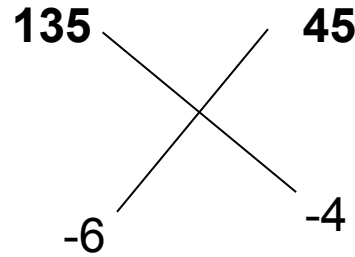
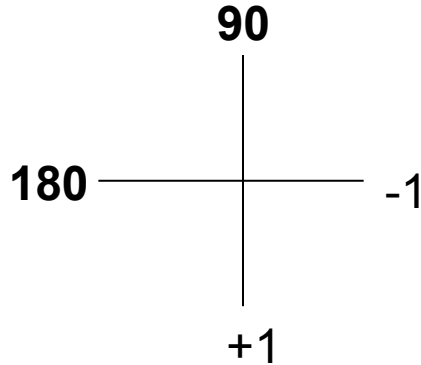
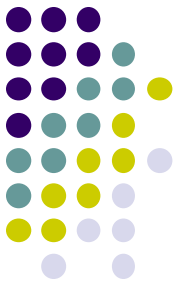
a)  $n$  where the rays are... going \_\_\_\_\_

b)  $n$  where the rays are... coming from \_\_\_\_\_

c) Radius of curvature ...of the interface

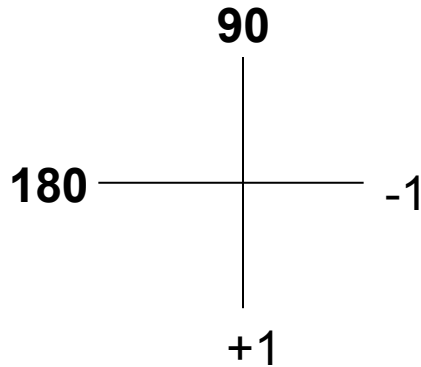
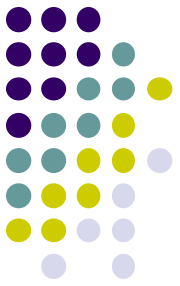
Convert each power cross to its spherocylindrical equivalent in...

- 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) One of these has a special name—which one?

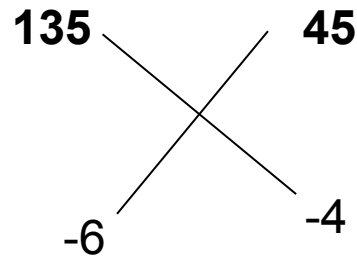


Convert each power cross to its spherocylindrical equivalent in...

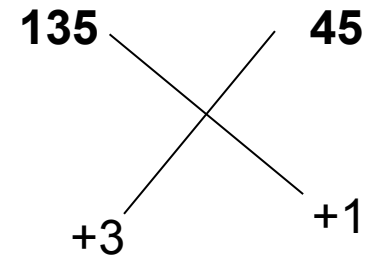
- a) Plus-cylinder format
- b) Minus-cylinder format
- c) Calculate the S.E. for each lens
- d) What type of astigmatism does each represent?
- e) One of these has a special name—which one?



Ⓐ *Plus: -1 +2 x 180*



*Plus: -6 +2 x 045*



*Plus: +1 +2 x 135*

Convert each power cross to its spherocylindrical equivalent in...

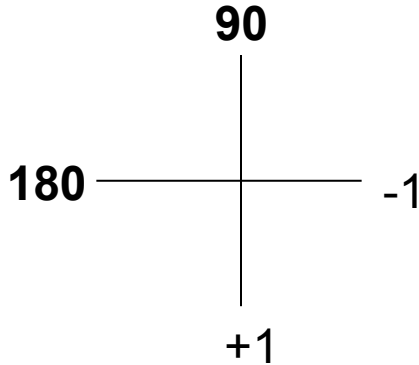
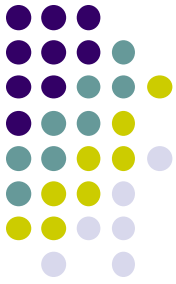
a) Plus-cylinder format

b) Minus-cylinder format

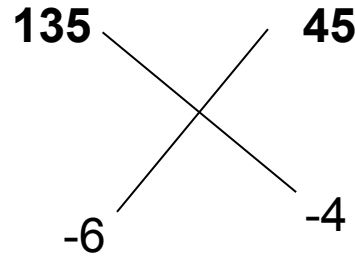
c) Calculate the S.E. for each lens

d) What type of astigmatism does each represent?

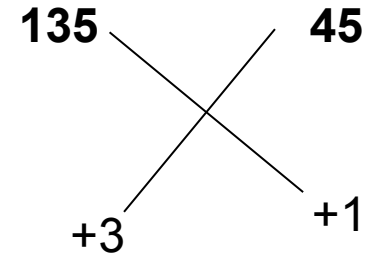
e) One of these has a special name—which one?



**a** *Plus: -1 +2 x 180*  
**b** *Minus: +1 -2 x 090*



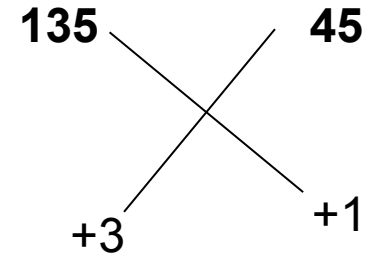
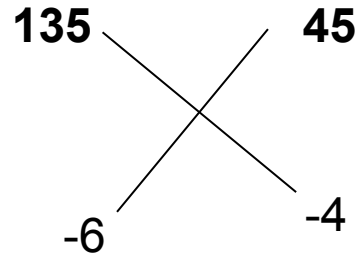
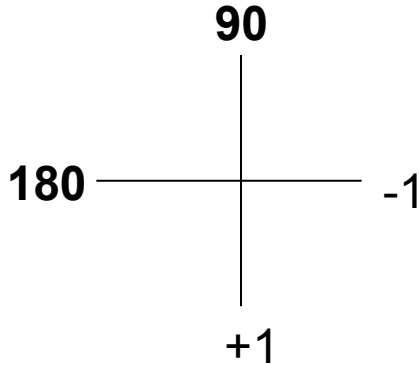
*Plus: -6 +2 x 045*  
*Minus: -4 -2 x 135*



*Plus: +1 +2 x 135*  
*Minus: +3 -2 x 045*

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) One of these has a special name—which one?



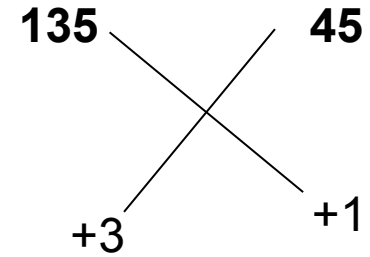
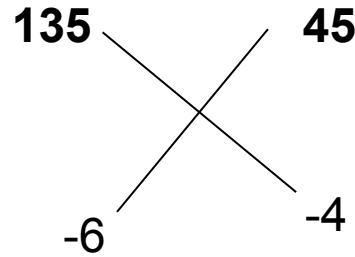
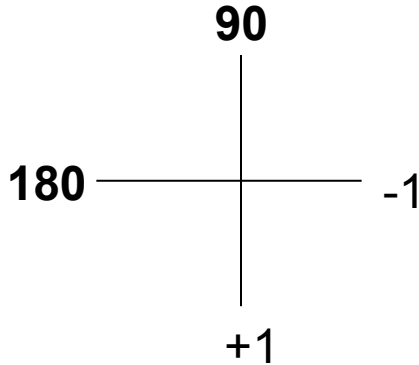
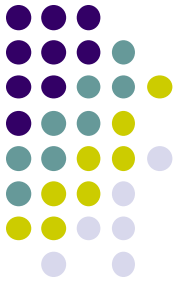
- a) *Plus: -1 +2 x 180*
- b) *Minus: +1 -2 x 090*
- c) *S.E.: Plano*

- Plus: -6 +2 x 045*
- Minus: -4 -2 x 135*
- S.E.: -5*

- Plus: +1 +2 x 135*
- Minus: +3 -2 x 045*
- S.E.: +2*

Convert each power cross to its spherocylindrical equivalent in...

- Plus-cylinder format
- Minus-cylinder format
- Calculate the S.E. for each lens
- What type of astigmatism does each represent?
- One of these has a special name—which one?



- a
- b
- c
- d

*Plus:* -1 +2 x 180  
*Minus:* +1 -2 x 090  
*S.E.:* Plano  
 Mixed astigmatism

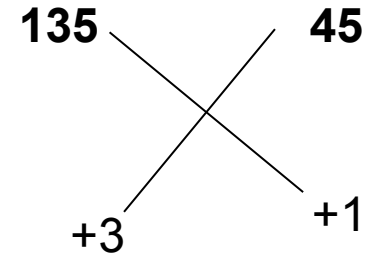
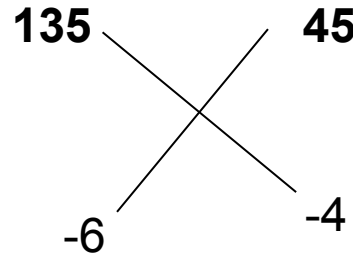
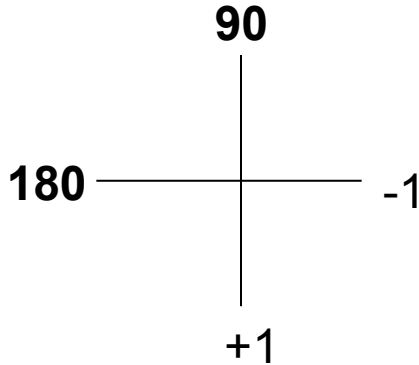
*Plus:* -6 +2 x 045  
*Minus:* -4 -2 x 135  
*S.E.:* -5  
 Compound myopic

*Plus:* +1 +2 x 135  
*Minus:* +3 -2 x 045  
*S.E.:* +2  
 Compound hyperopic

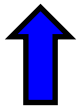


Convert each power cross to its spherocylindrical equivalent in...

- Plus-cylinder format
- Minus-cylinder format
- Calculate the S.E. for each lens
- What type of astigmatism does each represent?
- One of these has a special name—which one?



- (a) *Plus: -1 +2 x 180*
- (b) *Minus: +1 -2 x 090*
- (c) *S.E.: Plano*
- (d) *Mixed astigmatism*



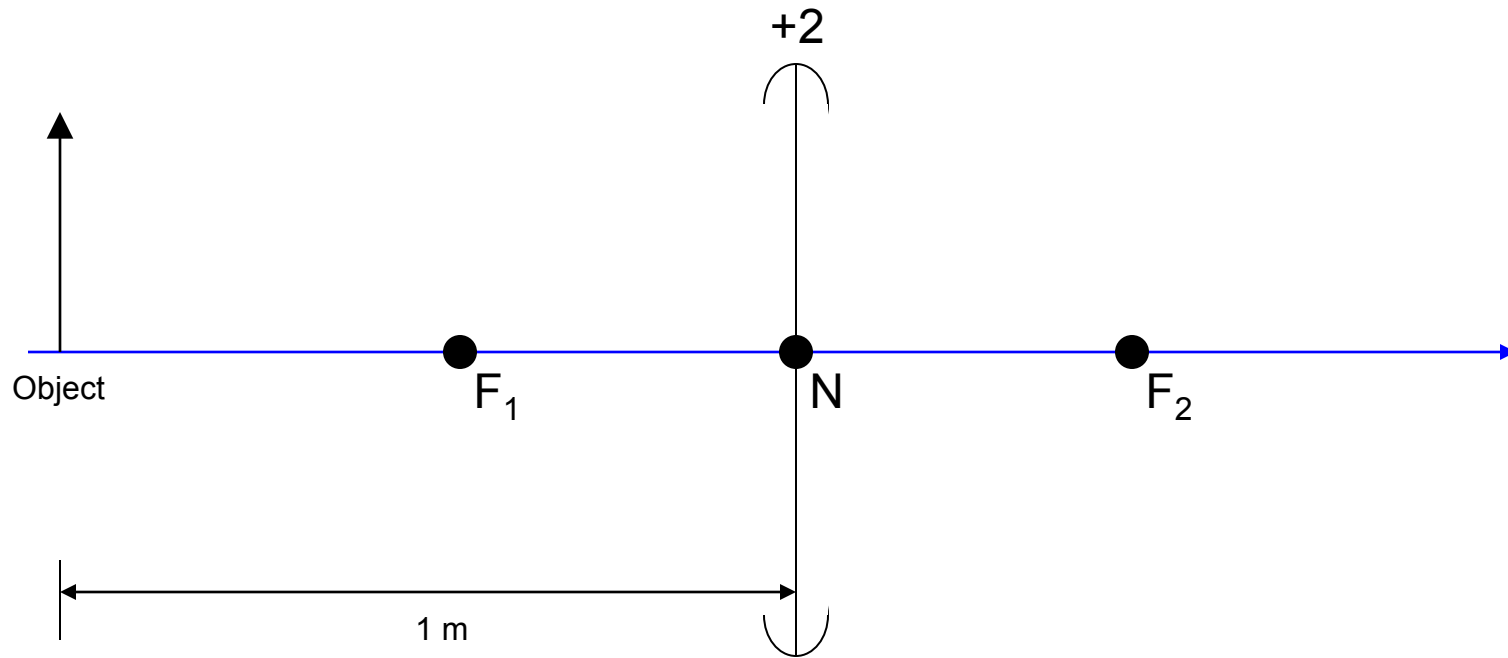
- Plus: -6 +2 x 045*
- Minus: -4 -2 x 135*
- S.E.: -5*
- Compound myopic*

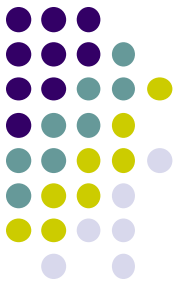
- Plus: +1 +2 x 135*
- Minus: +3 -2 x 045*
- S.E.: +2*
- Compound hyperopic*

- (e) This one is a **Jackson cross** (look at the power cross: Cylinders of equal-but-opposite power oriented 90° from one another)



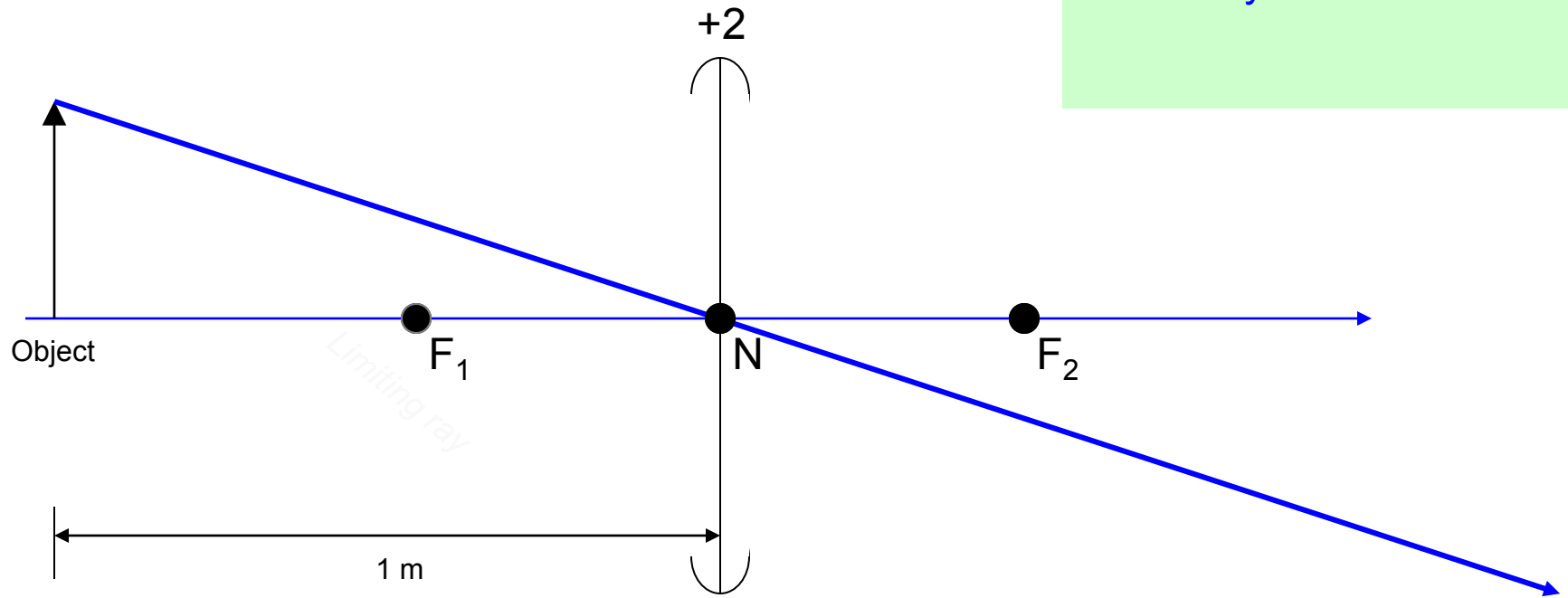
- a) *Where will the image be?*
- b) *Will it be upright or inverted?*
- c) *Are the object and image real or virtual?*





- a) *Where will the image be?*
- b) *Will it be upright or inverted?*
- c) *Are the object and image real or virtual?*

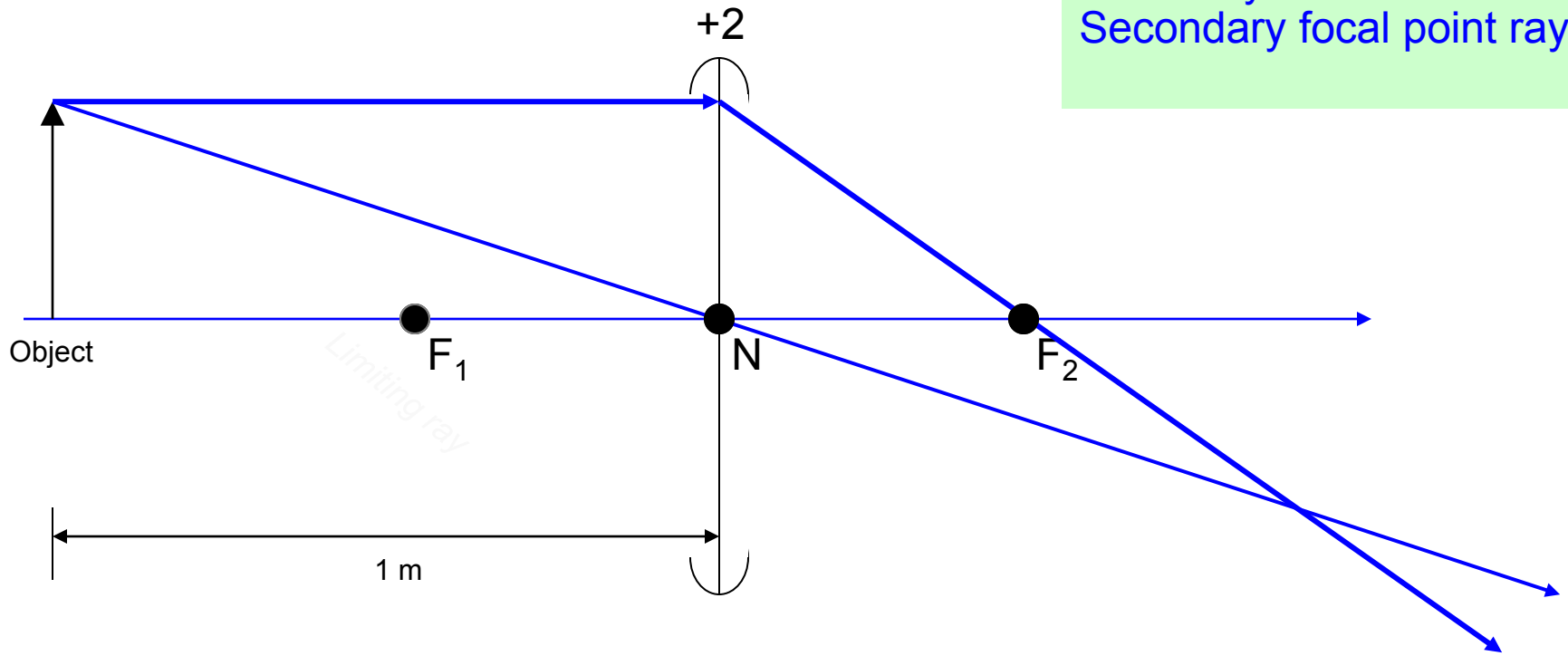
*Trace the:  
Nodal ray*

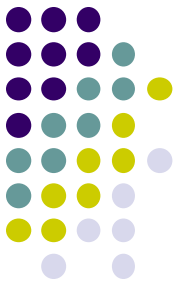




- a) *Where will the image be?*
- b) *Will it be upright or inverted?*
- c) *Are the object and image real or virtual?*

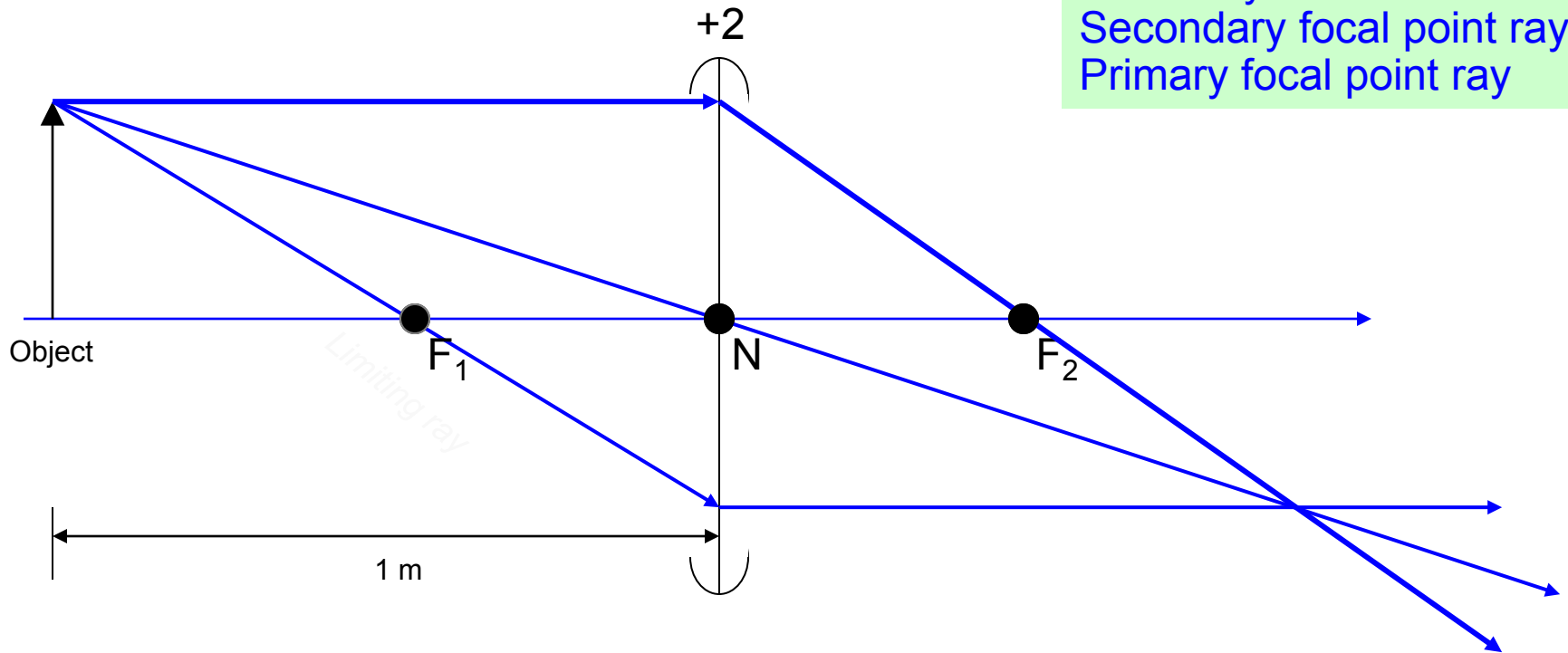
*Trace the:  
Nodal ray  
Secondary focal point ray*

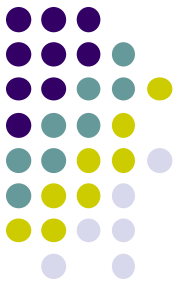




- a) Where will the image be?
- b) Will it be upright or inverted?
- c) Are the object and image real or virtual?

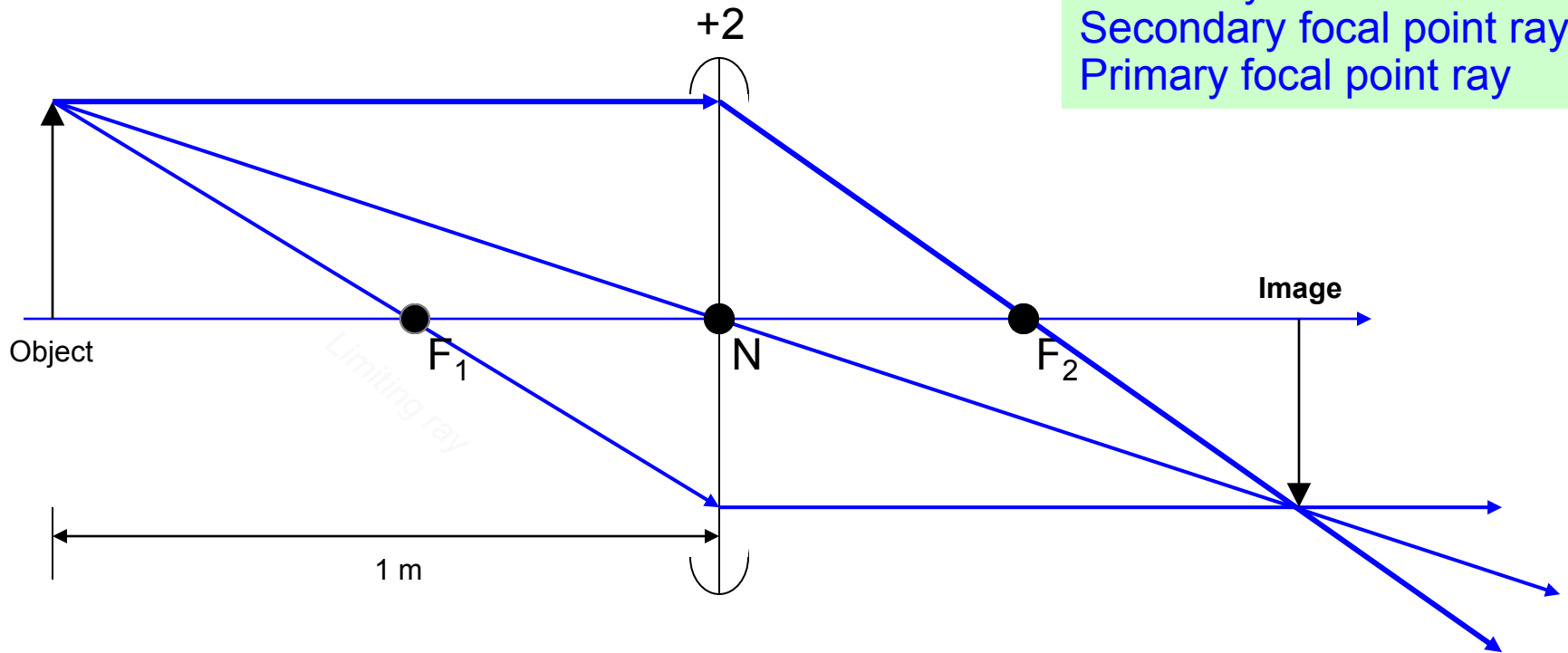
Trace the:  
Nodal ray  
Secondary focal point ray  
Primary focal point ray





- a) Where will the image be? To the **right** of the lens
- b) Will it be upright or inverted?
- c) Are the object and image real or virtual?

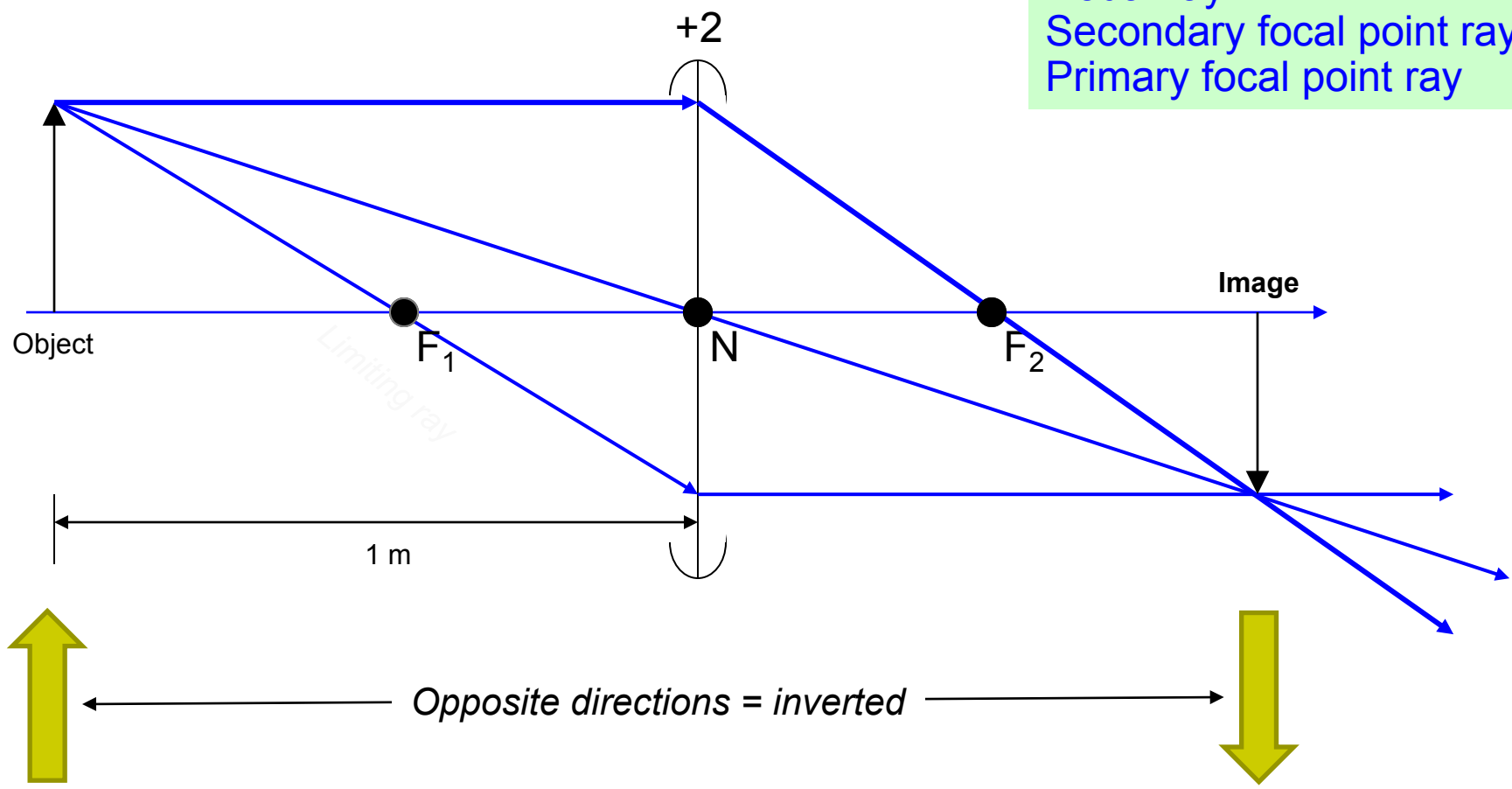
Trace the:  
Nodal ray  
Secondary focal point ray  
Primary focal point ray





- a) Where will the image be? To the **right** of the lens
- b) Will it be upright or inverted? **Inverted**
- c) Are the object and image real or virtual?

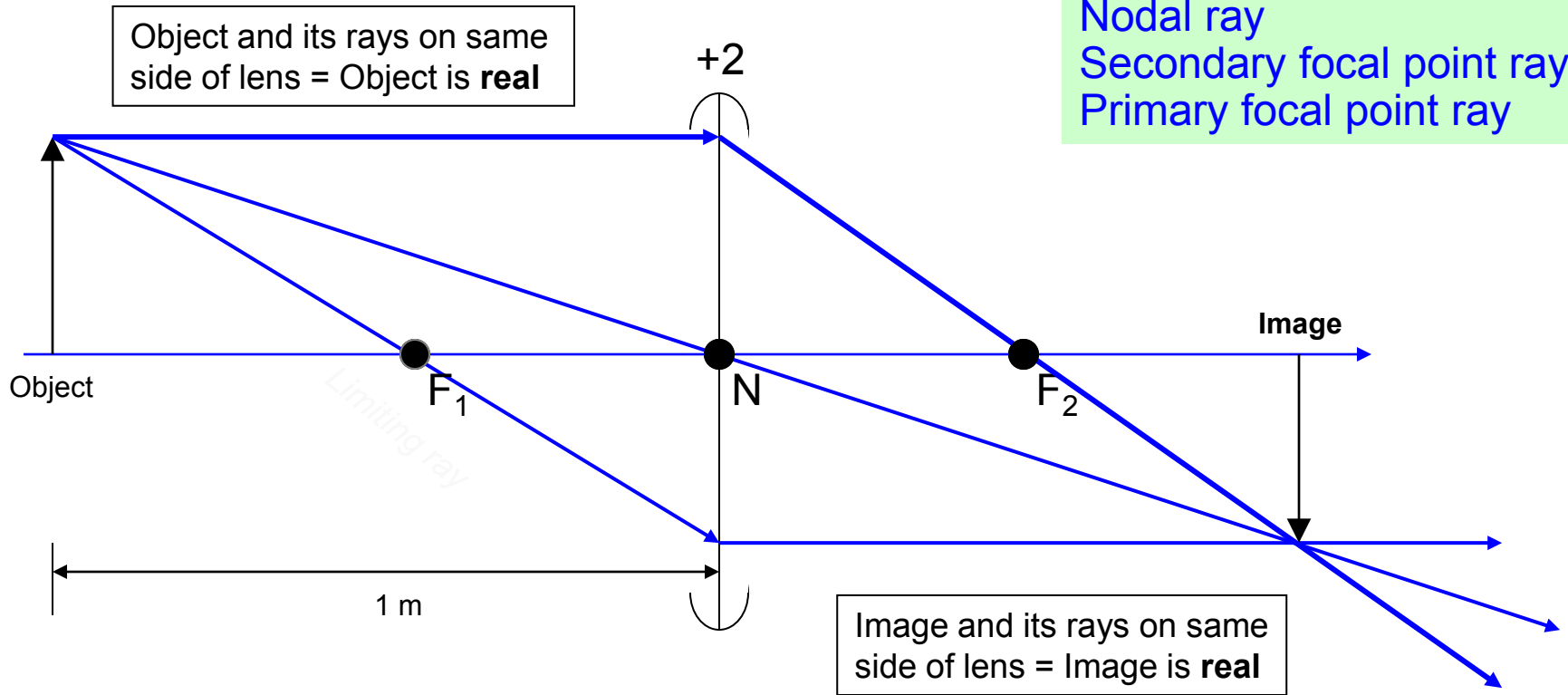
Trace the:  
Nodal ray  
Secondary focal point ray  
Primary focal point ray





- a) Where will the image be? To the **right** of the lens
- b) Will it be upright or inverted? **Inverted**
- c) Are the object and image real or virtual? Both are **real**

Trace the:  
Nodal ray  
Secondary focal point ray  
Primary focal point ray



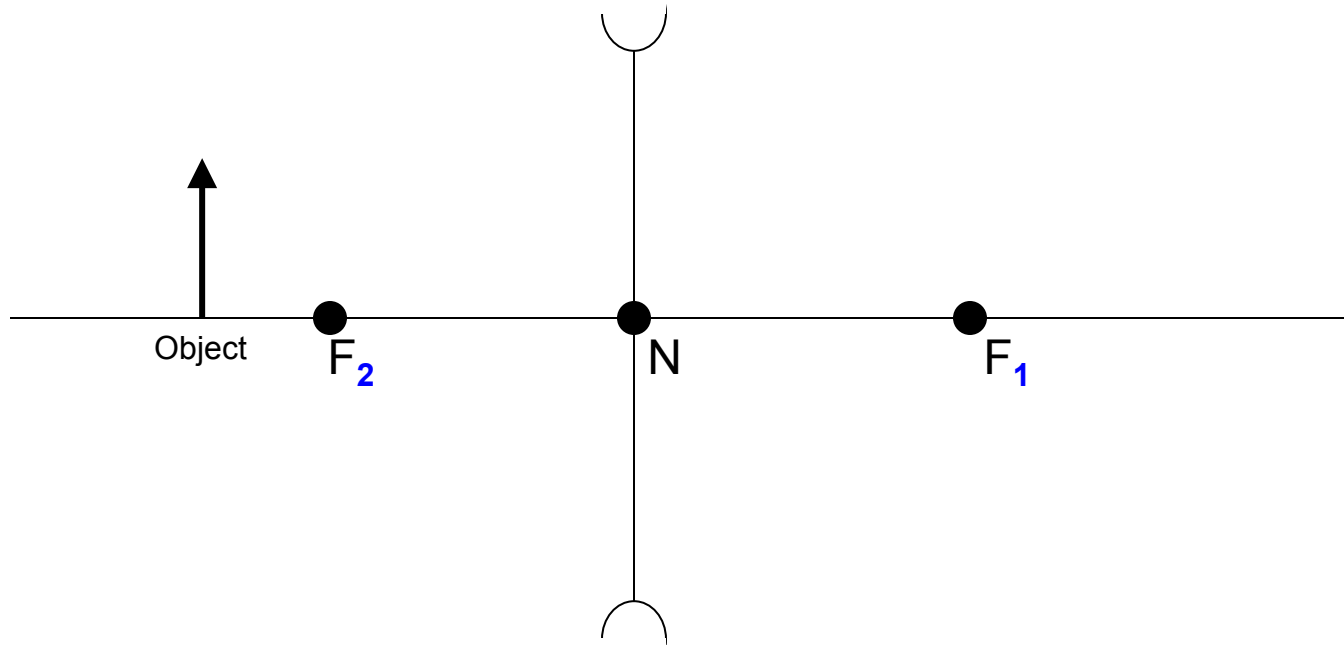




**Note: Minus lens!**

- a) *Where will the image be?*
- b) *Will it be upright or inverted?*
- c) *Are the object and image real or virtual?*
- d) *Is the image magnified or minified?*

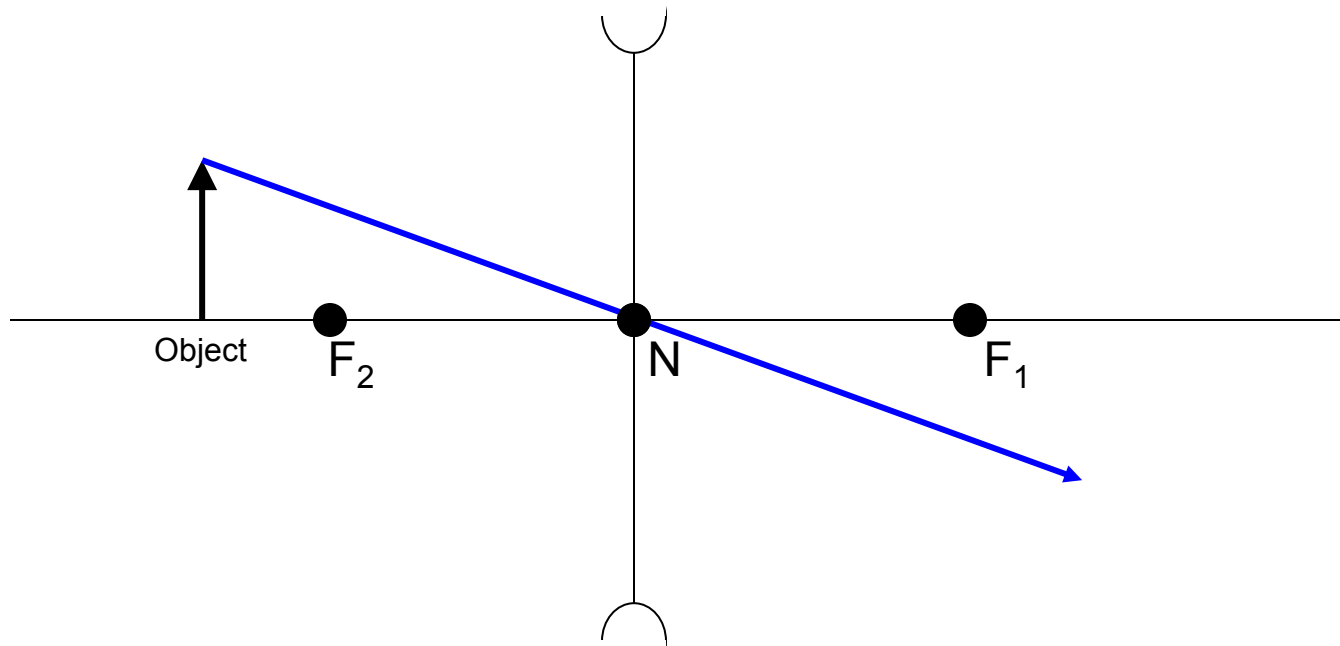
Thin *minus* lens



Trace the:  
Nodal ray

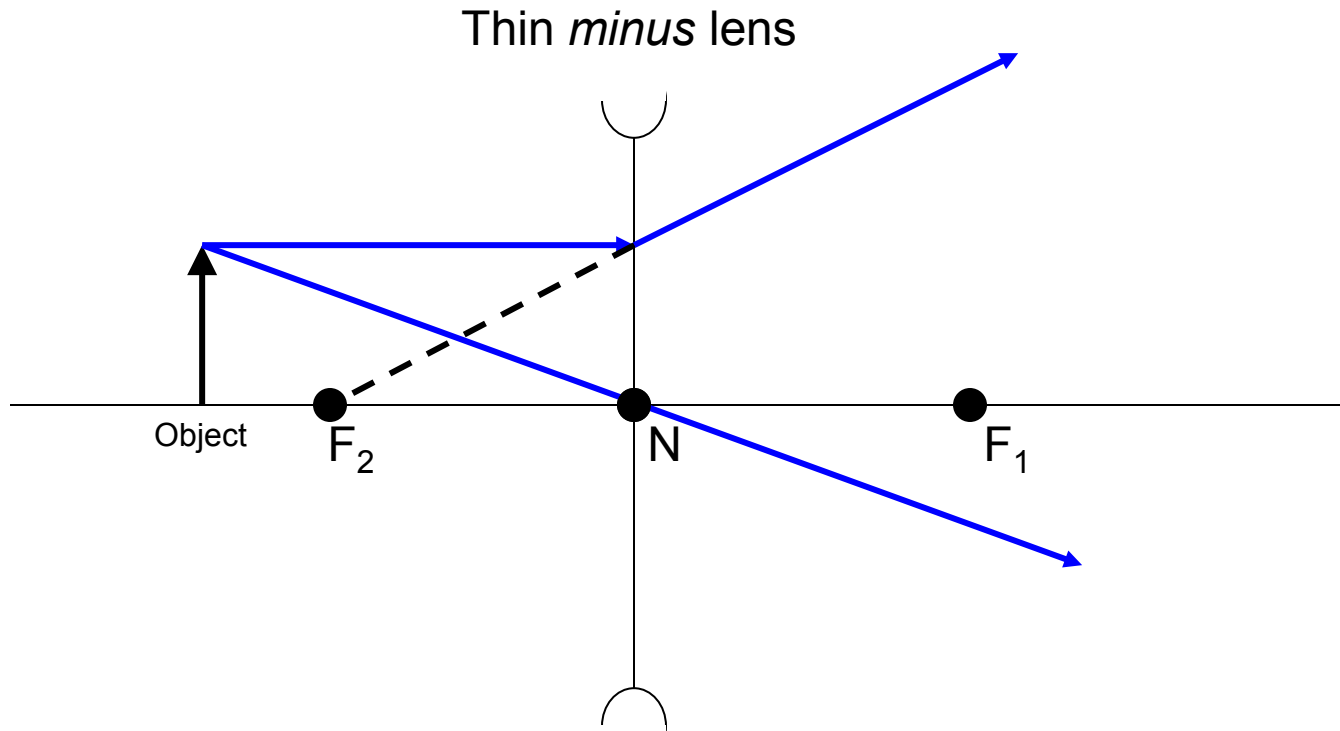
- a) Where will the image be?
- b) Will it be upright or inverted?
- c) Are the object and image real or virtual?
- d) Is the image magnified or minified?

Thin *minus* lens



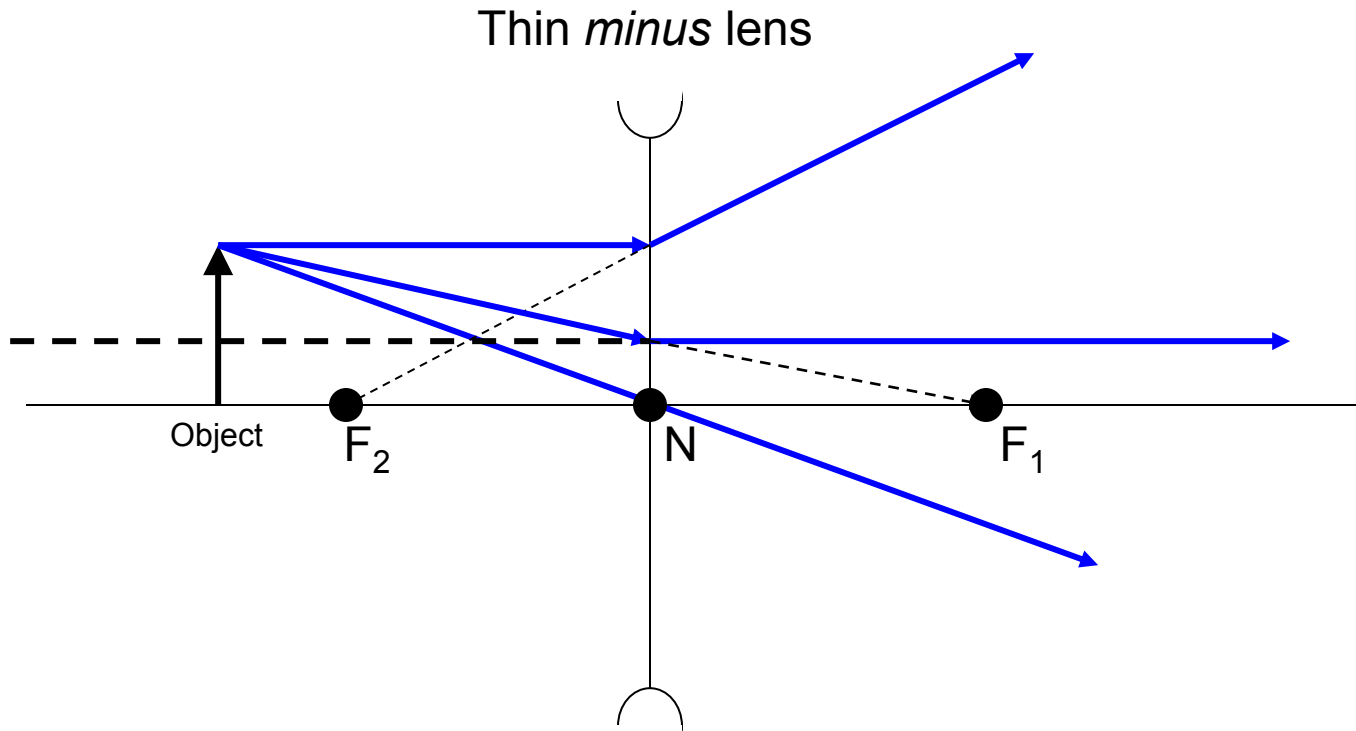
Trace the:  
Nodal ray  
Secondary focal point ray

- a) *Where will the image be?*
- b) *Will it be upright or inverted?*
- c) *Are the object and image real or virtual?*
- d) *Is the image magnified or minified?*



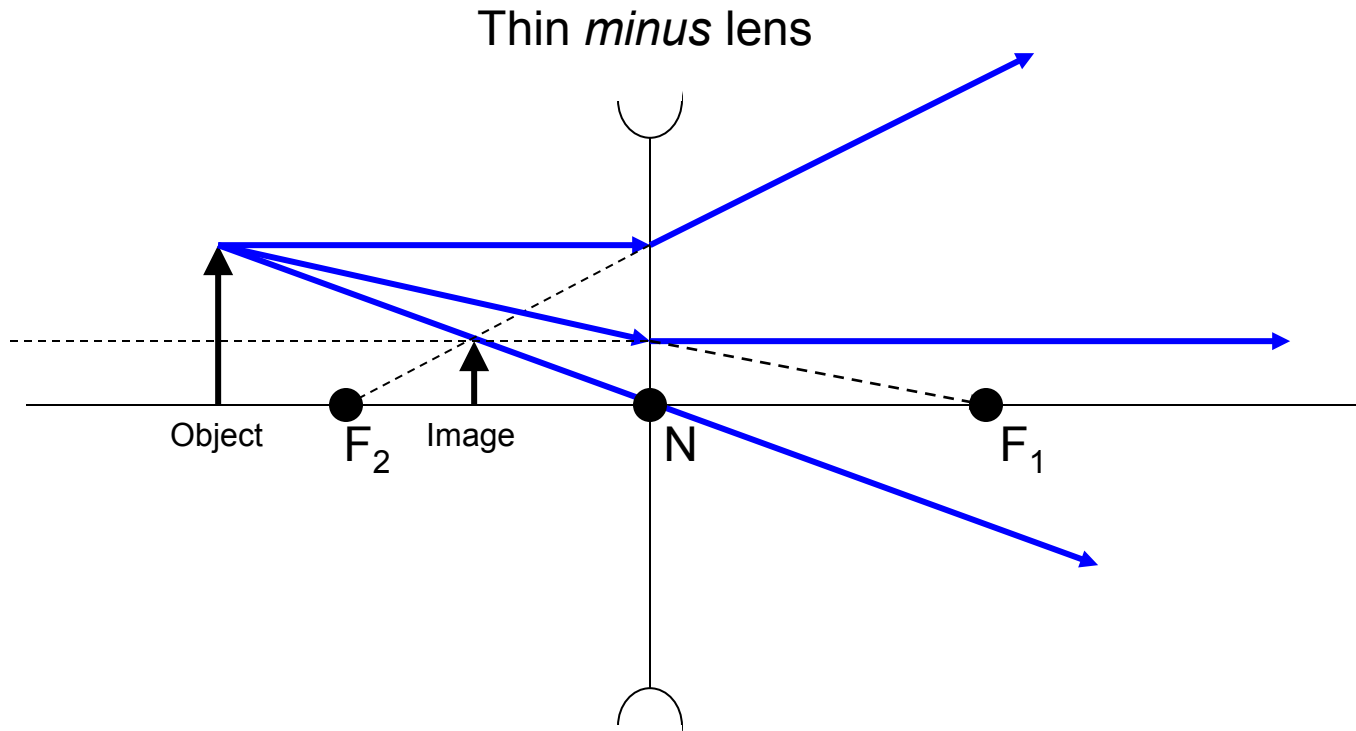
Trace the:  
Nodal ray  
Secondary focal point ray  
Primary focal point ray

- a) *Where will the image be?*
- b) *Will it be upright or inverted?*
- c) *Are the object and image real or virtual?*
- d) *Is the image magnified or minified?*



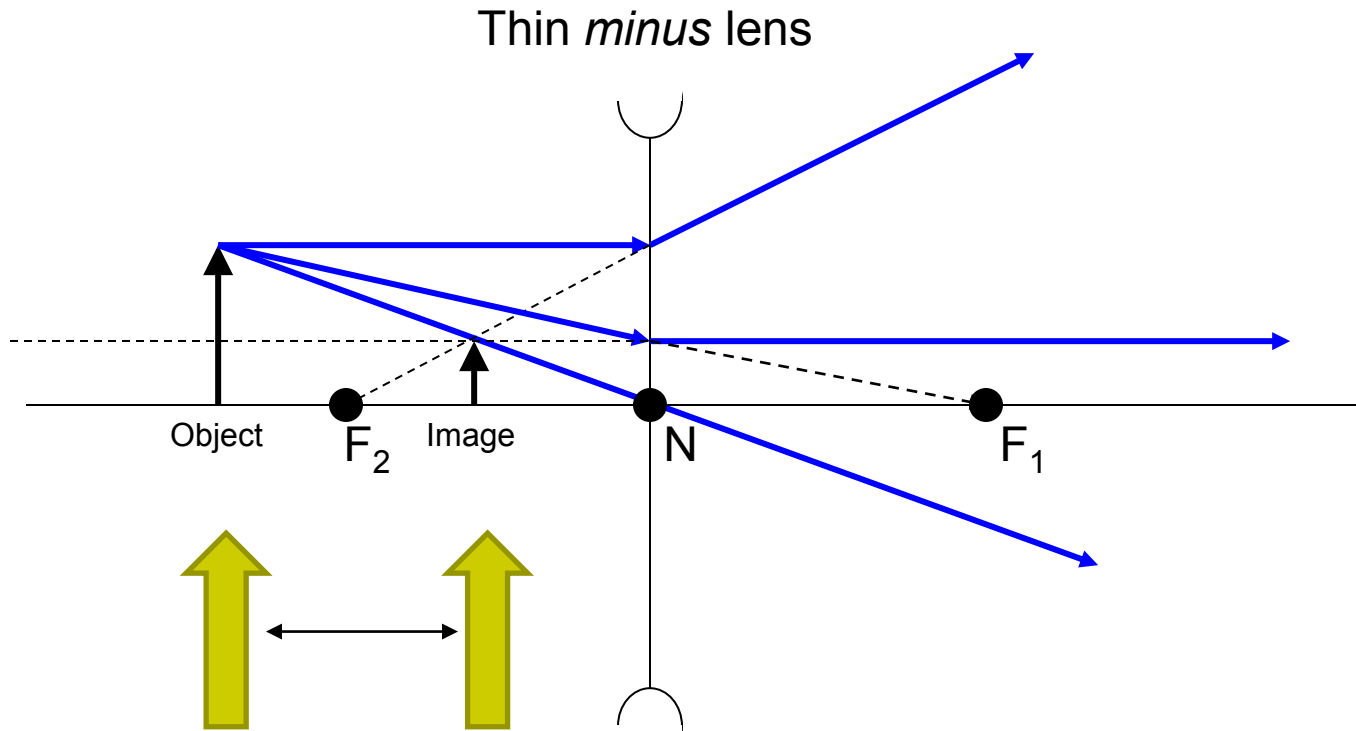
Trace the:  
Nodal ray  
Secondary focal point ray  
Primary focal point ray

- a) *Where will the image be? To the **left** of the lens*
- b) *Will it be upright or inverted?*
- c) *Are the object and image real or virtual?*
- d) *Is the image magnified or minified?*



Trace the:  
Nodal ray  
Secondary focal point ray  
Primary focal point ray

- a) Where will the image be? To the **left** of the lens
- b) Will it be upright or inverted? **Upright**
- c) Are the object and image real or virtual?
- d) Is the image magnified or minified?



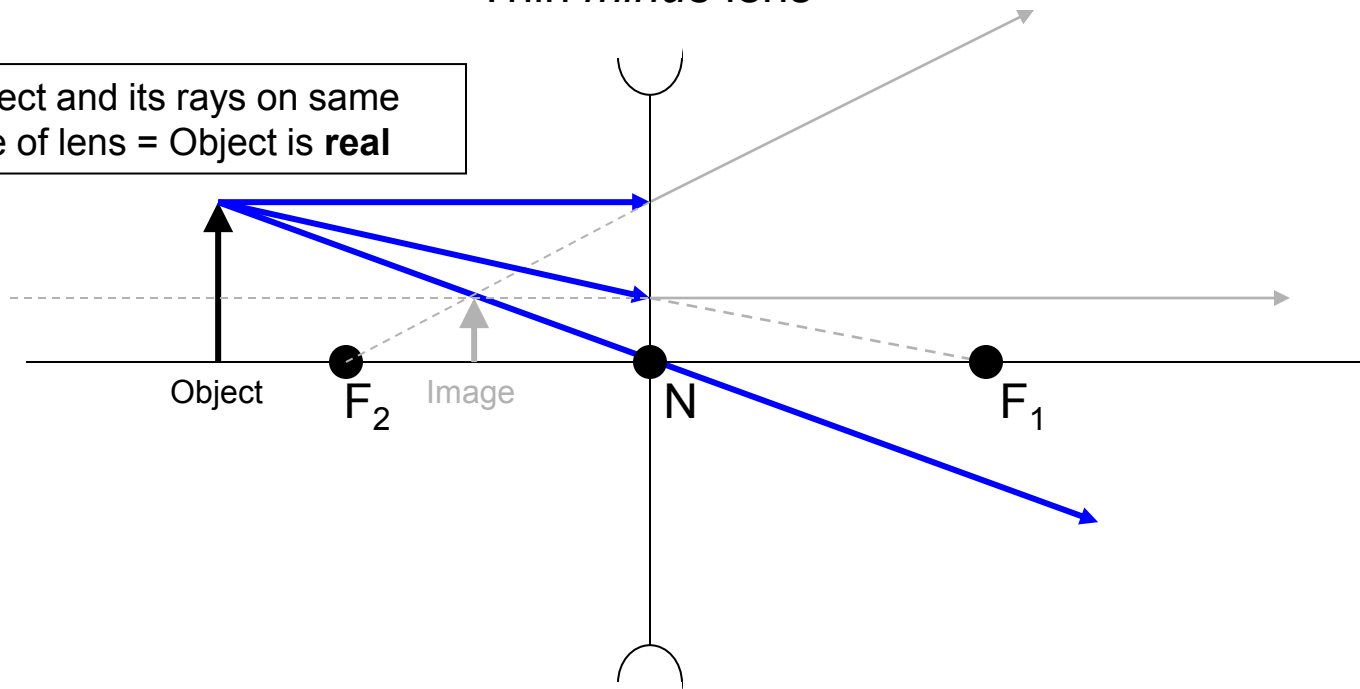
Same direction = Upright

Trace the:  
Nodal ray  
Secondary focal point ray  
Primary focal point ray

- a) Where will the image be? To the **left** of the lens
- b) Will it be upright or inverted? **Upright**
- c) Are the object and image **real or virtual**? Object is **real**
- d) Is the image magnified or minified?

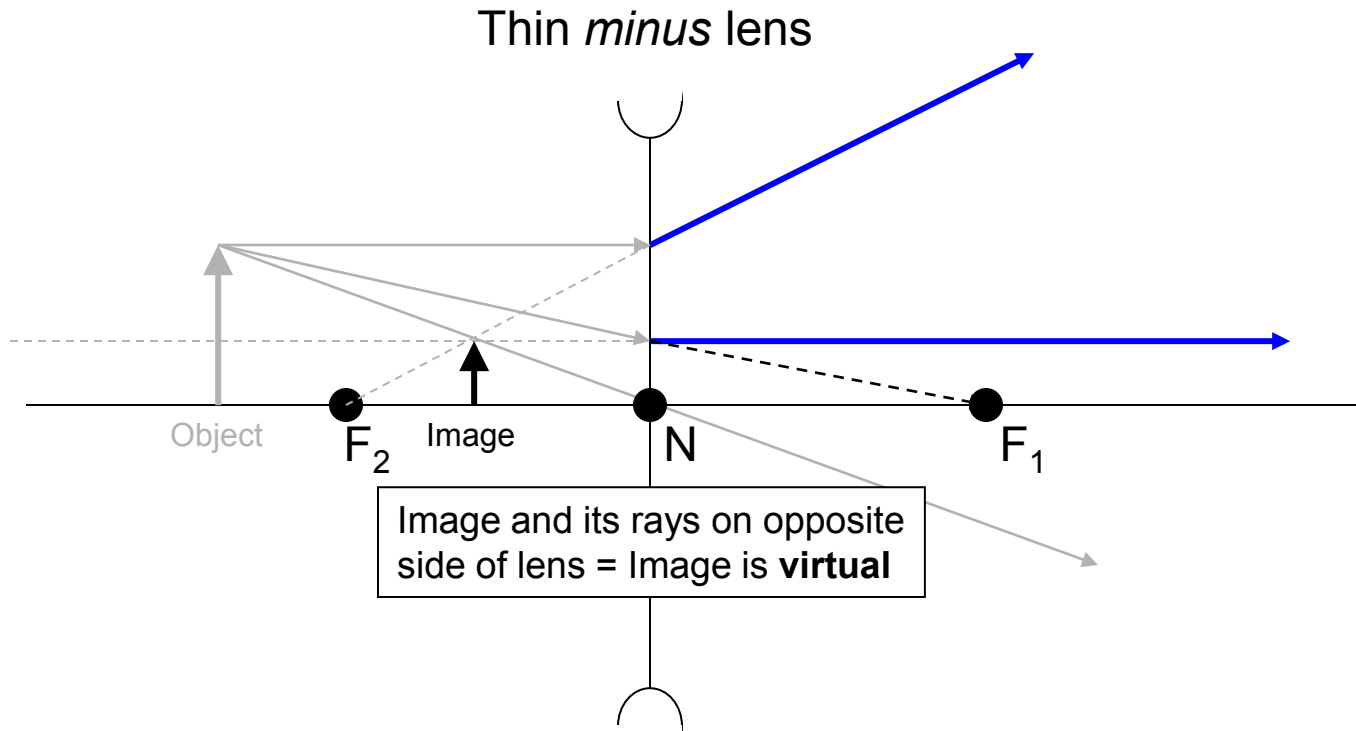
### Thin *minus* lens

Object and its rays on same side of lens = Object is **real**



Trace the:  
Nodal ray  
Secondary focal point ray  
Primary focal point ray

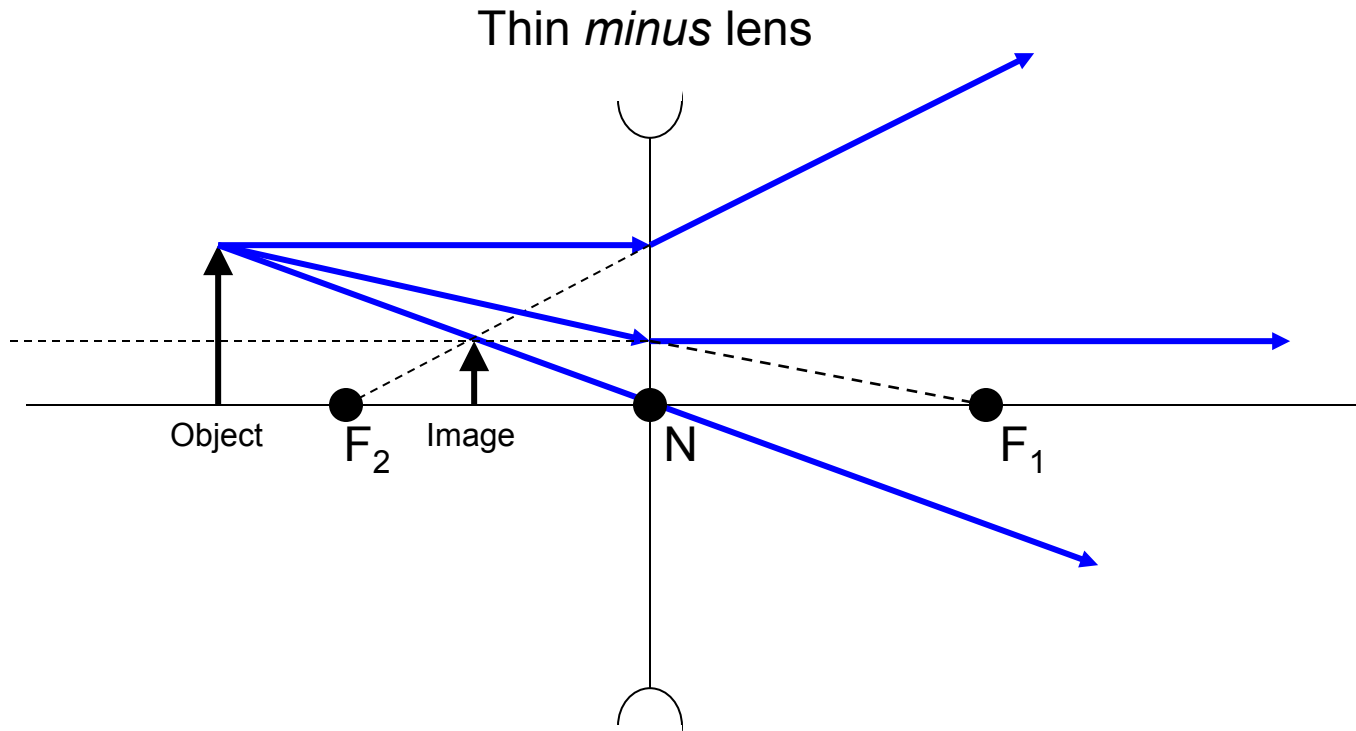
- a) Where will the image be? To the **left** of the lens
- b) Will it be upright or inverted? **Upright**
- c) Are the object and image real or virtual? Image is **virtual**
- d) Is the image magnified or minified?





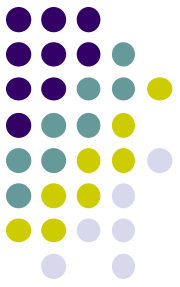
Trace the:  
Nodal ray  
Secondary focal point ray  
Primary focal point ray

- a) Where will the image be? To the **left** of the lens
- b) Will it be upright or inverted? **Upright**
- c) Are the object and image real or virtual?
- d) Is the image magnified or minified? **Minified**



*A pt is a +4 hyperope. He is capable of a total of 4D of accommodation. Absent corrective lenses or surgery:*

- a) Where is his near point relative to the corneal plane?*
- b) Formally, his range of clear vision is from where to where?*
- c) Practically speaking, his range of clear vision is from where to where?*

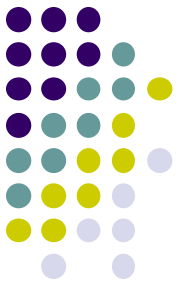


*A pt is a +4 hyperope. He is capable of a total of 4D of accommodation. Absent corrective lenses or surgery:*

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

*b) Formally, his range of clear vision is from where to where?*

*c) Practically speaking, his range of clear vision is from where to where?*



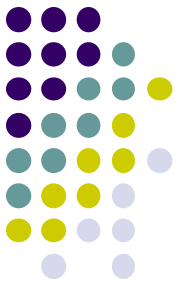
a) To see clearly at distance, this +4 hyperope must first employ 4D of accommodation, which uses up all of his accommodative reserve. Thus, he has no remaining accommodative power with which to focus any closer.

*A pt is a +4 hyperope. He is capable of a total of 4D of accommodation. Absent corrective lenses or surgery:*

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

*b) Formally, his range of clear vision is from where to where?*

*c) Practically speaking, his range of clear vision is from where to where?*

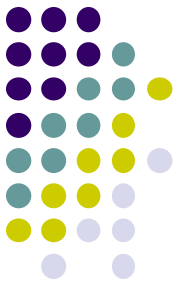


a) To see clearly at distance, this +4 hyperope must first employ 4D of accommodation, which uses up all of his accommodative reserve. Thus, he has no remaining accommodative power with which to focus any closer.

b) His formal range of clear vision is just 'at infinity.'

*A pt is a +4 hyperope. He is capable of a total of 4D of accommodation. Absent corrective lenses or surgery:*

- a) Where is his near point relative to the corneal plane?*
- b) Formally, his range of clear vision is from where to where?*
- c) Practically speaking, his range of clear vision is from where to where?*



- a) To see clearly at distance, this +4 hyperope must first employ 4D of accommodation, which uses up all of his accommodative reserve. Thus, he has no remaining accommodative power with which to focus any closer.
- b) His formal range of clear vision is just 'at infinity.'
- c) In practical terms, from out in the distance to somewhere around the 20 ft/6 m mark.

*A pt is plano uncorrected. She is capable of a total of 8D of accommodation. Absent corrective lenses or surgery:*

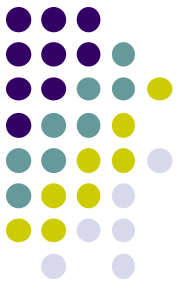
- a) Where is her near point relative to the corneal plane?*
- b) Her range of clear vision is from where to where?*



*A pt is plano uncorrected. She is capable of a total of 8D 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?*

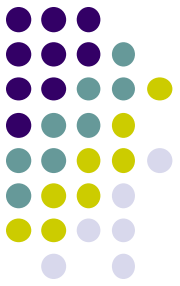


a) This pt has **no** error lens. When she cranks in her 8D of accommodation, she has a total of 8D in play. This puts her near point at  $1/8 = 0.125\text{m}$  (12.5 cm) anterior to the corneal plane.

*A pt is plano uncorrected. She is capable of a total of 8D 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 **no** error lens. When she cranks in her 8D of accommodation, she has a total of 8D in play. This puts her near point at  $1/8 = 0.125\text{m}$  (12.5 cm) anterior to the corneal plane.

b) Because of her lack of an error lens, this pt can see clearly at distance. As noted, her near point is at 12.5 cm. Therefore, her range of clear vision is from infinity to 12.5 cm anterior to the corneal plane.