Module 13

Geometric Optics

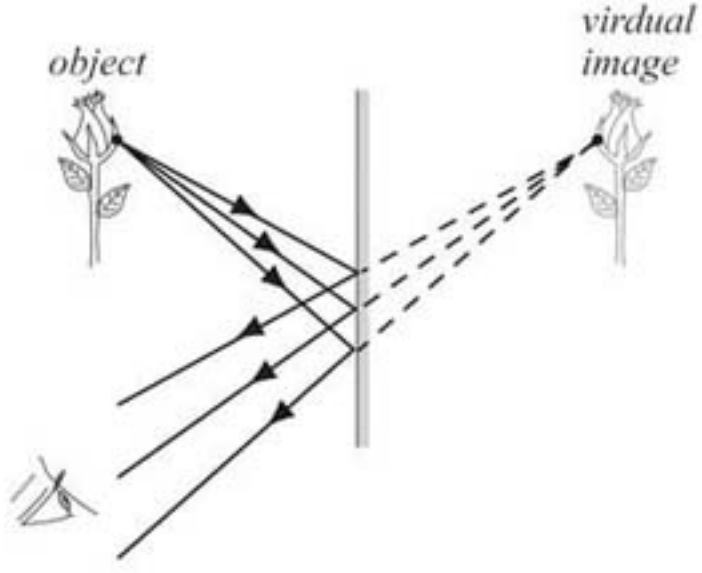
Session Slides with Notes

Geometric Optics

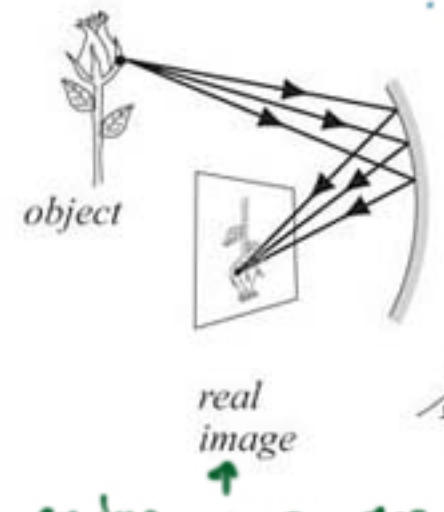
Virtual and Real Images

Optical devices where the ray approach to light is sufficient.

$$\frac{1}{F} = \frac{1}{I} + \frac{1}{O}$$



*A plane mirror creates a **virtual image**, located behind the mirror.*

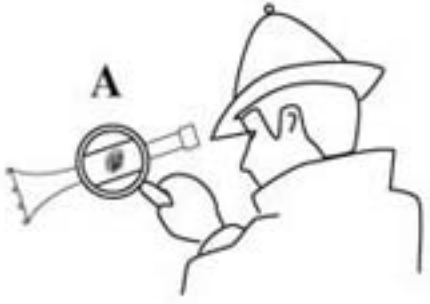


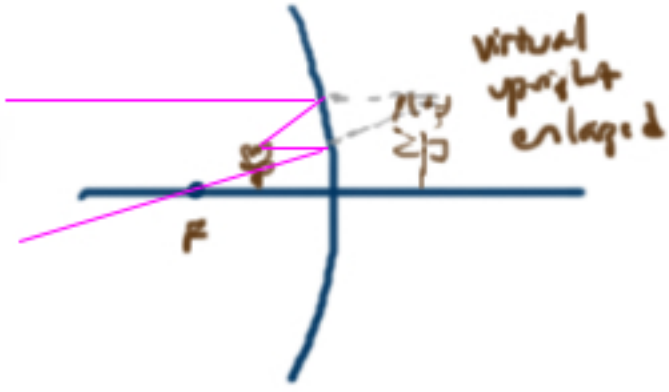
A mirror or a lens changes the path of light so that light emanating from an object point converges on an image point or appears to emanate from a image.

an image you can cast on a screen

*A **real image** is created by a concave mirror (at this object distance) which can be visualized on a screen.*

A detective's magnifying glass and a concave make-up mirror are two simple optical devices that can produce enlarged images.





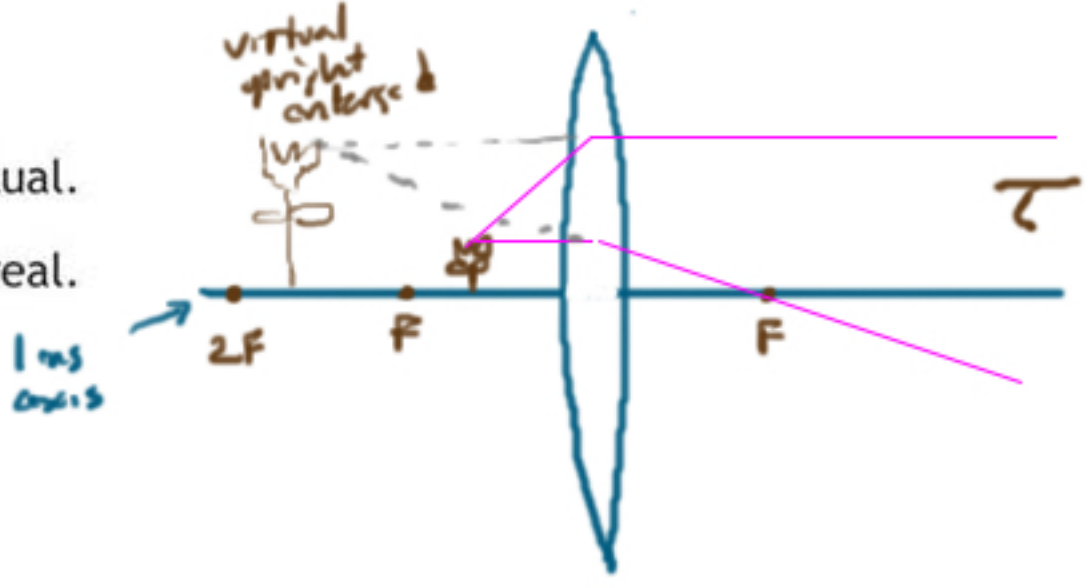
Which of the following statements is true about the images produced above?

a. Image **A** is real and image **B** is virtual.

b. Image **A** is virtual and image **B** is real.

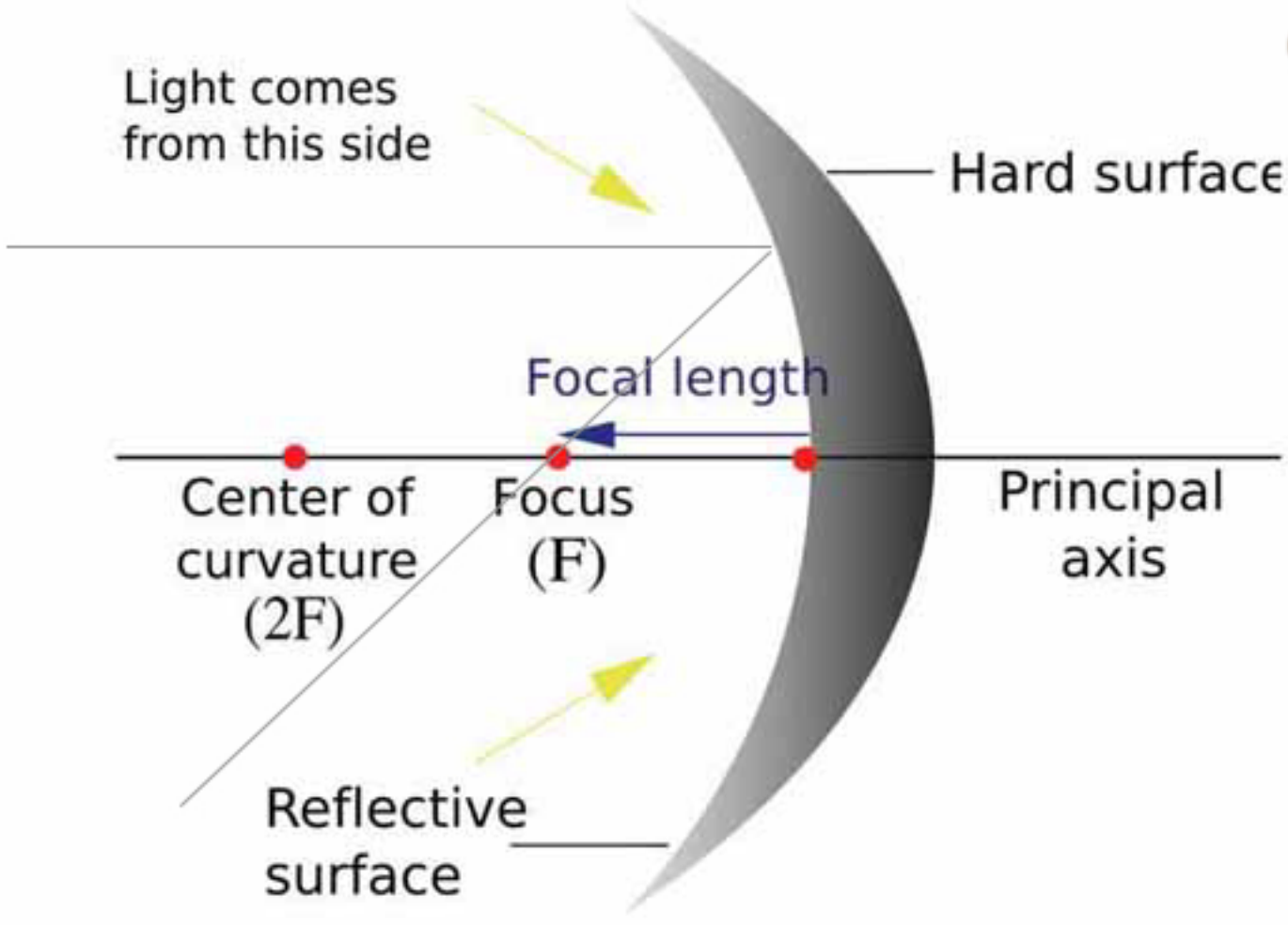
c. Both images are real.

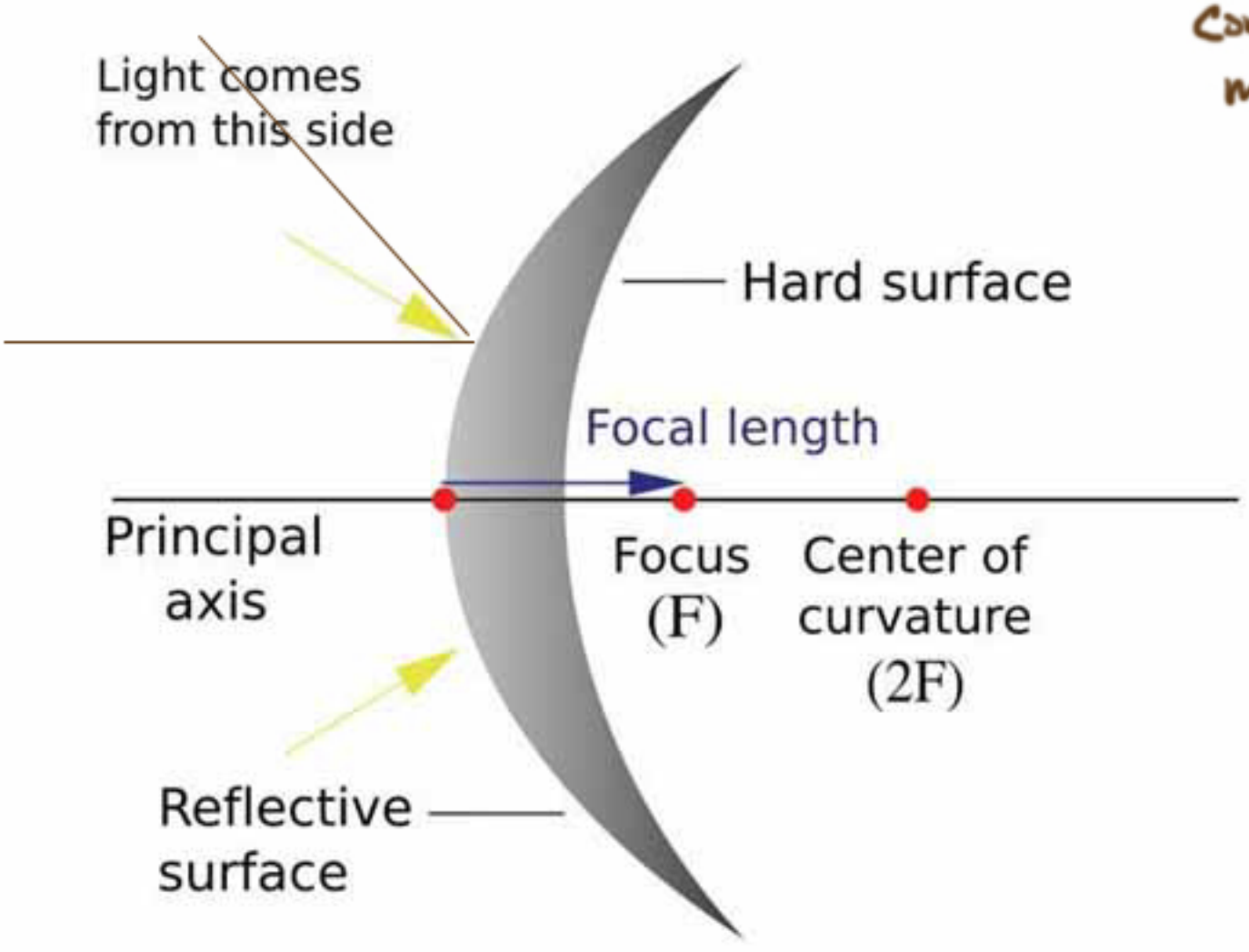
(d.) Both images are virtual.



Concave mirror

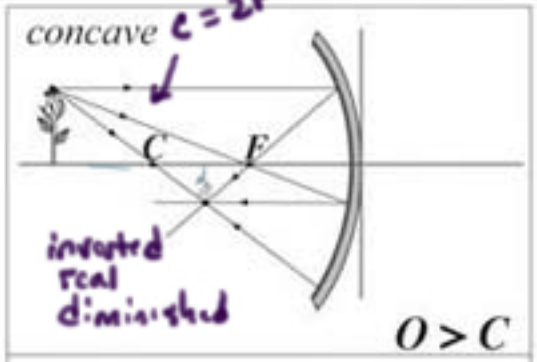
⊕ F




Light comes
from this side
Hard surface
Focal length
Principal
axis
Focus
(F)
Center of
curvature
(2F)
Reflective
surface

Concave and Convex Mirrors

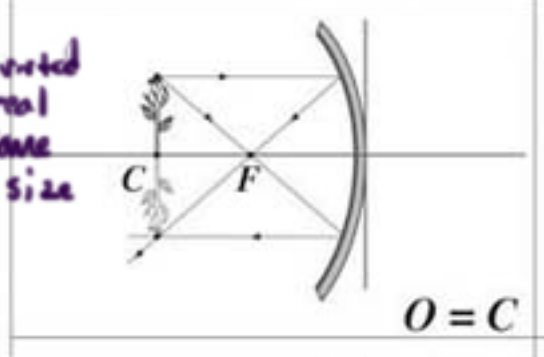
⊖F



C = 2F

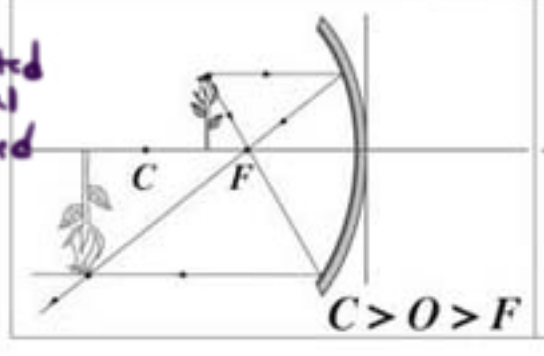
inverted real diminished

$O > C$



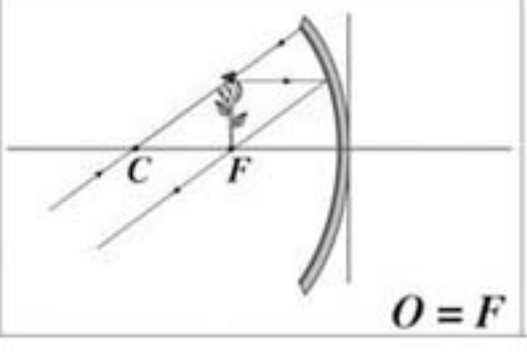
inverted real same size

$O = C$

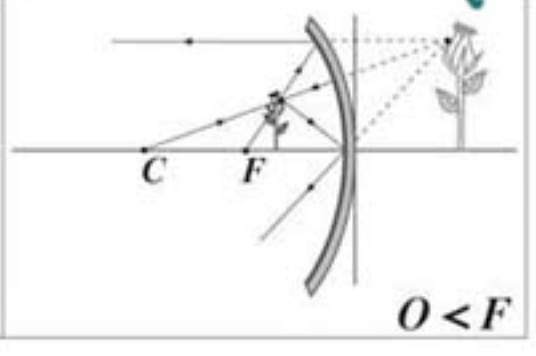


inverted real enlarged

$C > O > F$



$O = F$



$O < F$

virtual upright enlarged

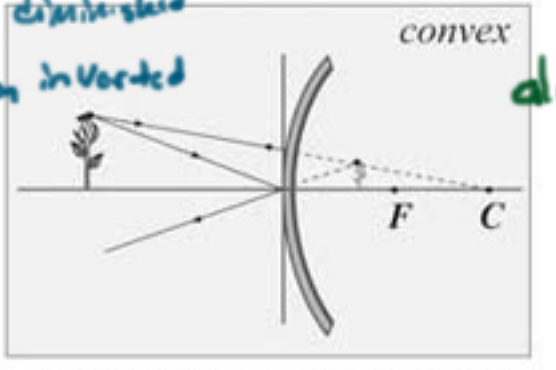
$$\frac{1}{F} = \frac{1}{I} + \frac{1}{O}$$

$$M = \frac{-I}{O}$$

⊖F

|M| < 1 diminished

if ⊖ then inverted



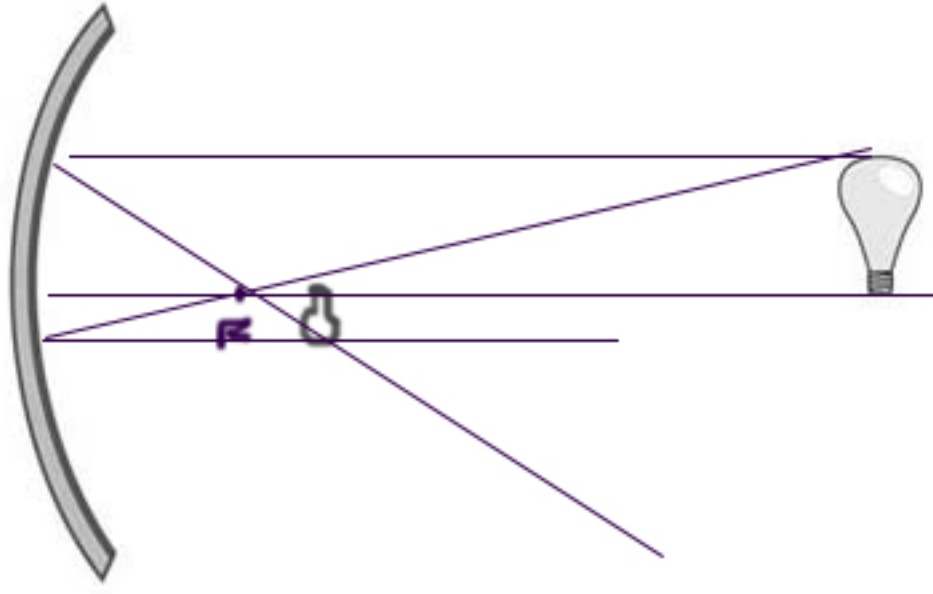
always DUV
diminished
upright
virtual

DEV (diminished, erect, virtual) with a single convex mirror.

C	=	center of curvature
F	=	focal length (1/2 C)
I	=	image distance
O	=	object distance
M	=	lateral magnification

⊖ image

A concave mirror has a focal length of 20cm. What type of image will the mirror form of a light bulb placed 80cm in front of the mirror?



Data & Eqs

$\frac{1}{f} = \frac{1}{O} + \frac{1}{I}$

$\frac{1}{20} = \frac{1}{80} + \frac{1}{I}$

$\frac{3}{80} = \frac{1}{I}$

$I = 80/3$

≈ 27

$M = \frac{-I}{O}$

$= \frac{-27}{80}$

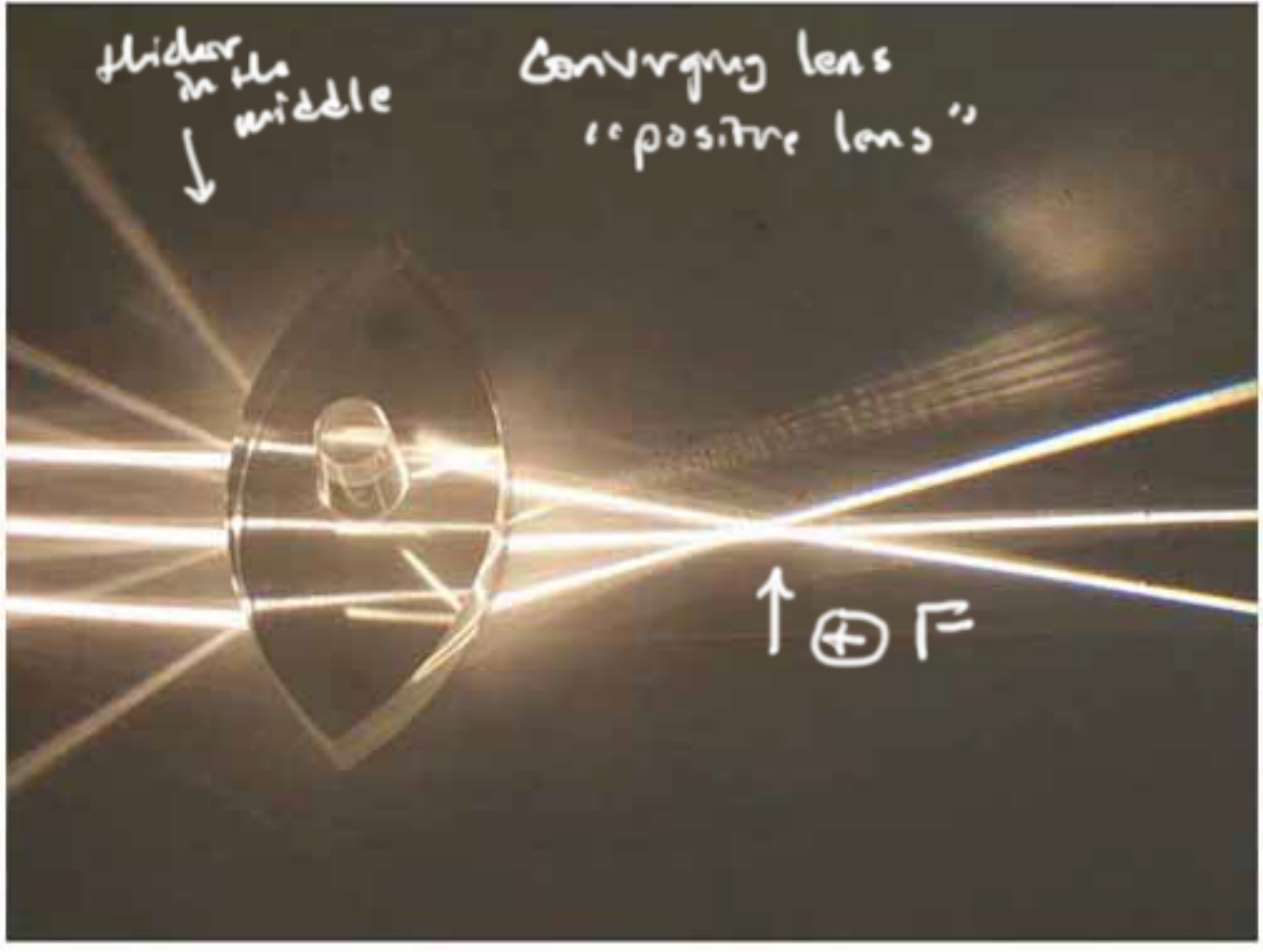
$O > 2F$

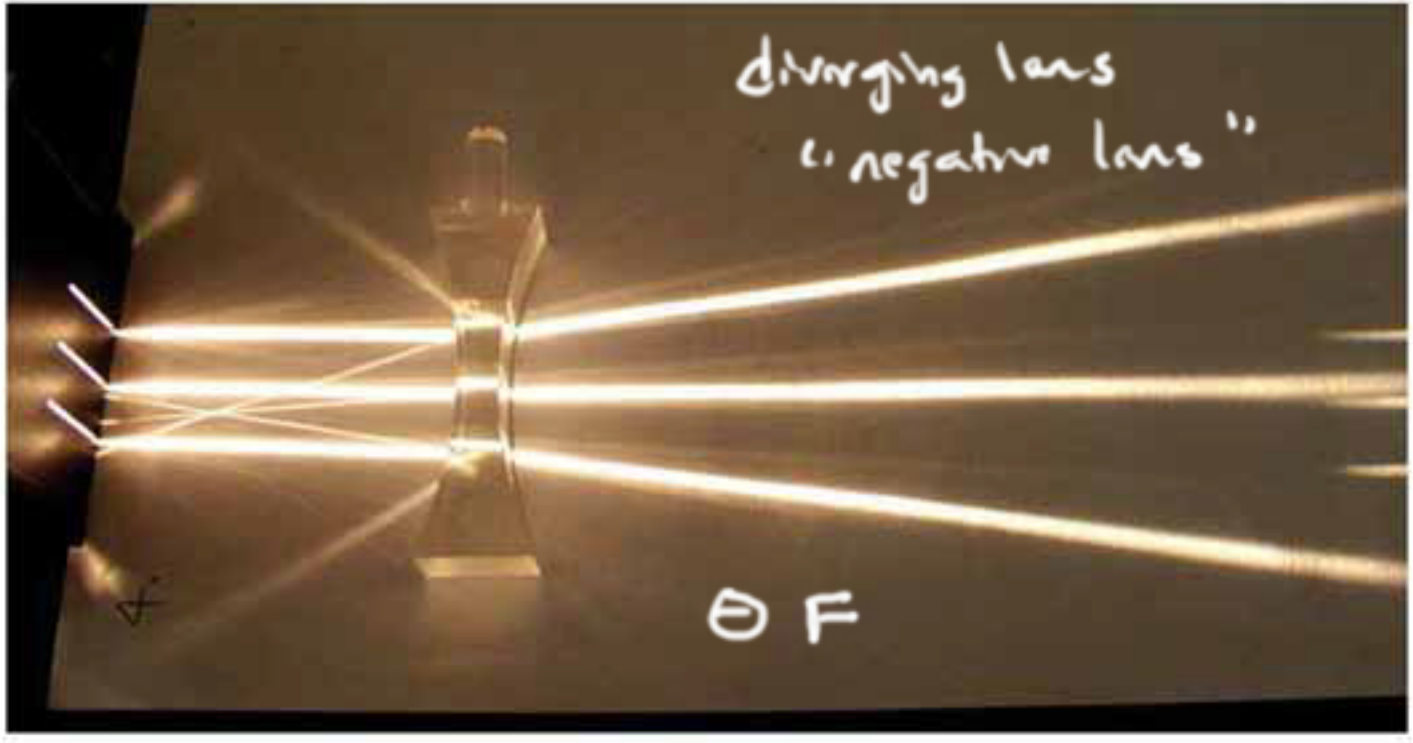
a. virtual, erect, diminished

c. real, inverted, diminished

b. real, erect, enlarged

d. virtual, inverted, enlarged


thicker in the middle
Converging lens
"positive lens"
F


diverging lens
("negative lens")
⊖ F

Lens-Maker's Equation

material

shape

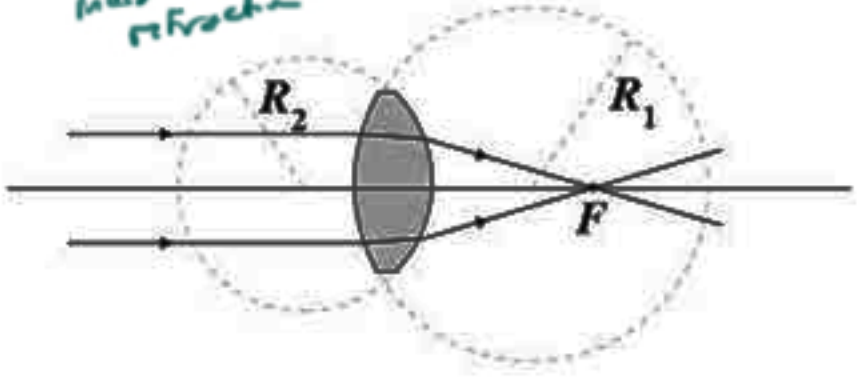
$$\frac{1}{F} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

index of refraction

F = focal length (1/2 C)
n = refractive index
R = radius of curvature

$\frac{1}{F} \leftarrow D$ power in diopters (m^{-1})

$D = \frac{1}{F} + \frac{1}{D}$



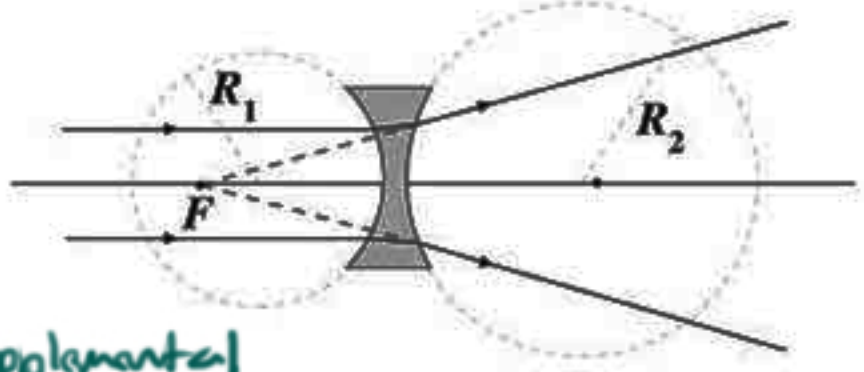
Positive (Converging) Lens

R_1 – positive
R_2 – negative
F – positive

$F_{eye} = 1.5$ cm

What is power in diopter

F .015 m



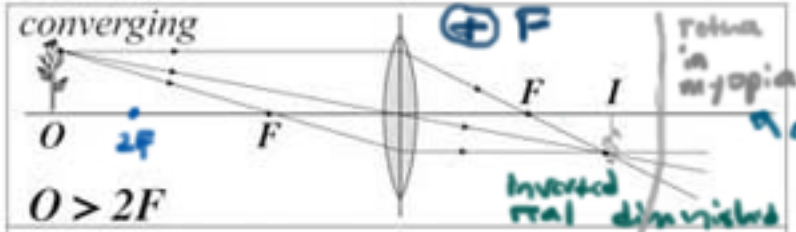
Negative (Diverging) Lens

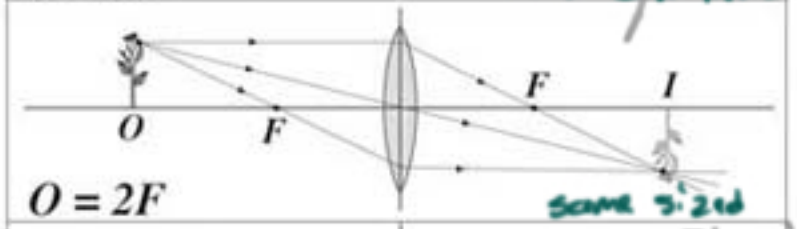
R_1 – negative
R_2 – positive
F – negative

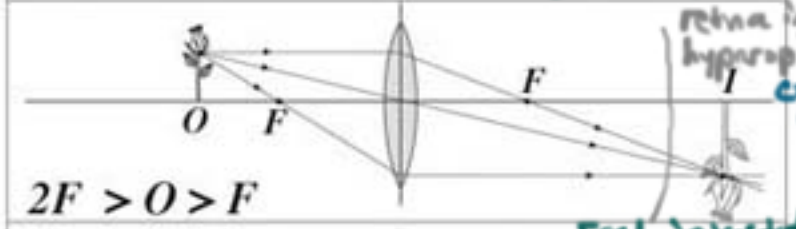
$D = \frac{1}{.015} \sim 65$

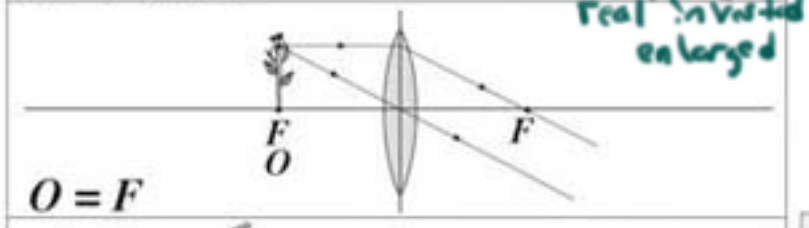
Supplemental

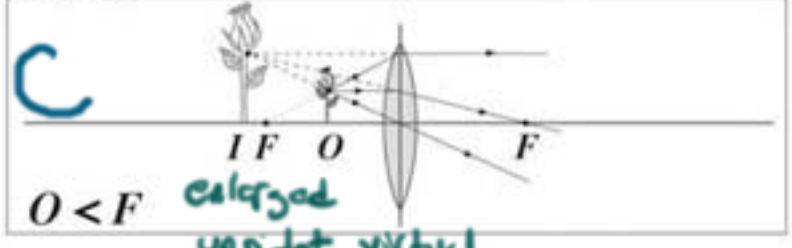
Converging and Diverging Lenses











$$\frac{1}{F} = \frac{1}{I} + \frac{1}{O}$$

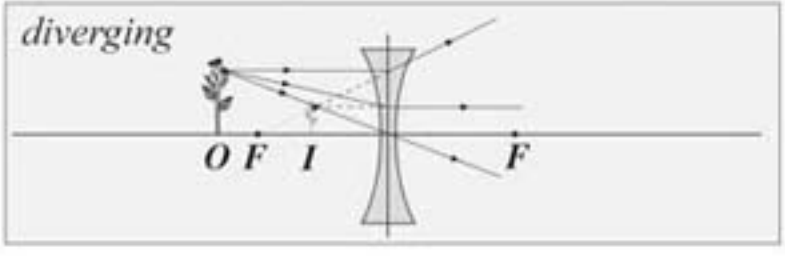
$$M = \frac{-I}{O}$$

F = focal length

I = image distance

O = object distance

M = lateral magnification



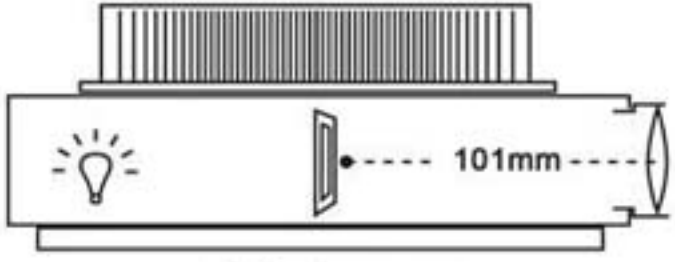
A slide projector has a 100mm projection lens. When the focus knob is adjusted so that the distance between the slide and the lens is 101mm, the projector creates a focused image on a screen 10m in front of the projector. What is the magnification of the image?

$F = 0.1\,m$

$d = .101\,m$

$I = 10\,m$

$M = \frac{-I}{O}$



Slide Projector

a. −99

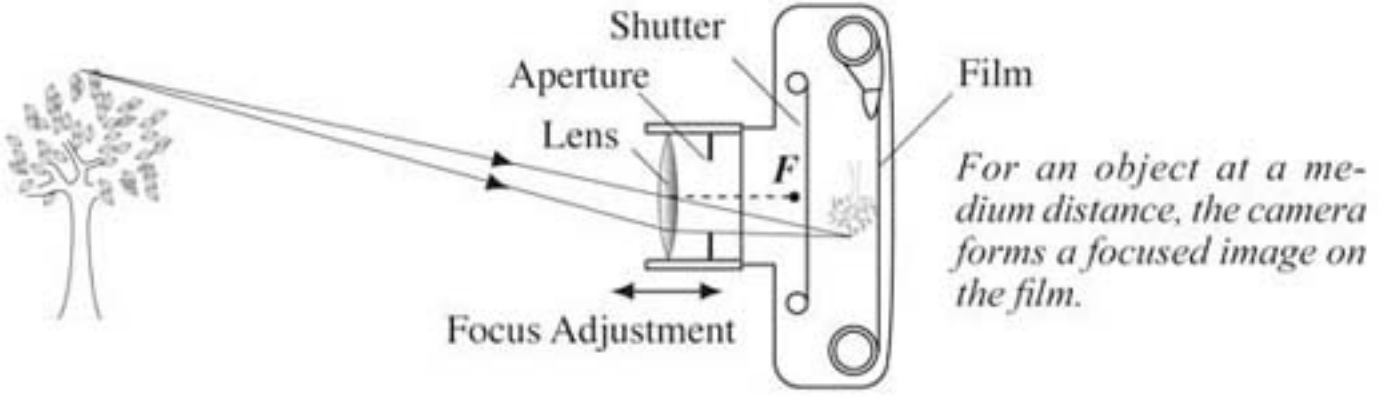
b. 99

c. 100

d. 990

The first prototype of a new camera design can't produce a focused image of an object near the camera. Which of the following might improve the focusing on near objects?

This camera has hyperopia



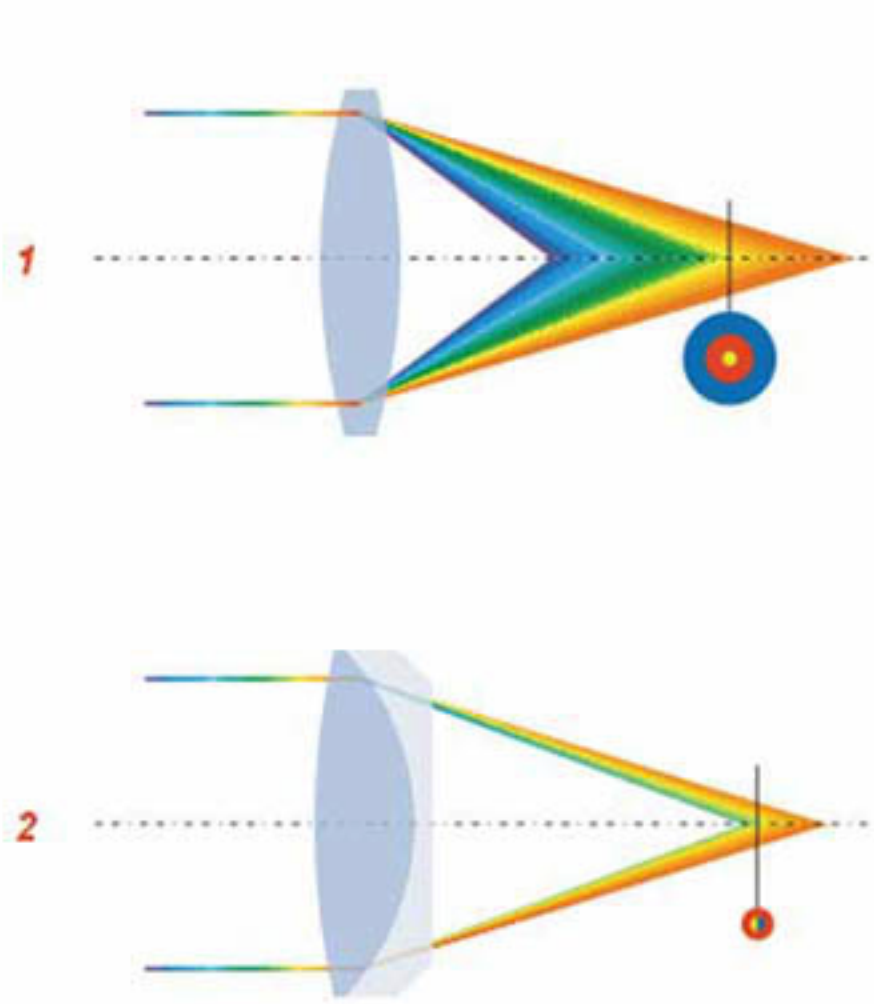
For an object at a medium distance, the camera forms a focused image on the film.

a. decrease the maximum distance between lens and film

b. substitute a lens with increased index of refraction material

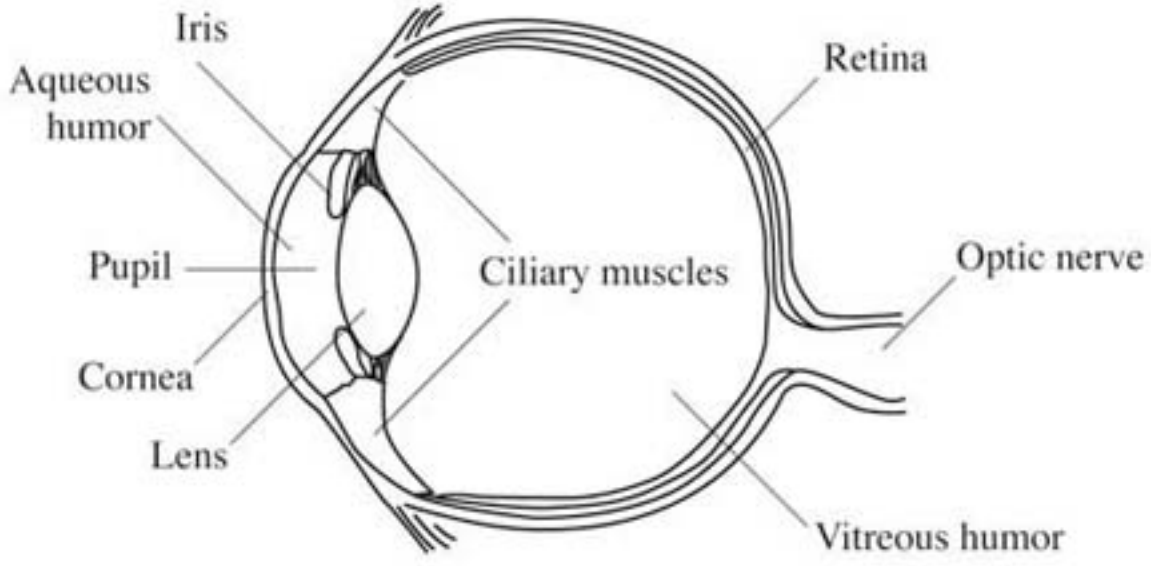
c. increase the radii of curvature of the two lens surfaces

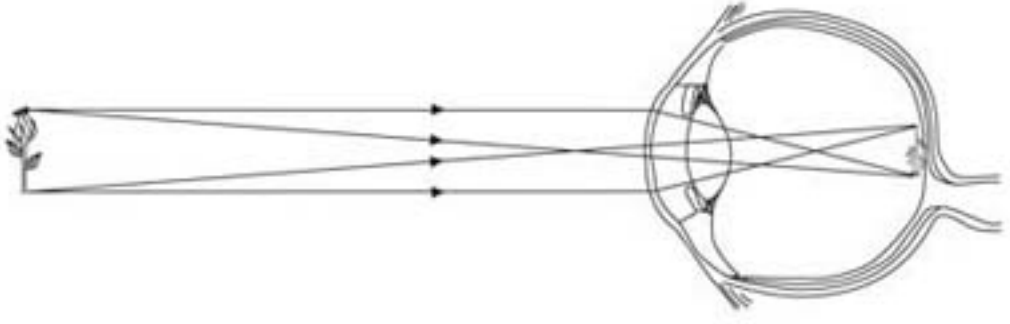
d. decrease the aperture



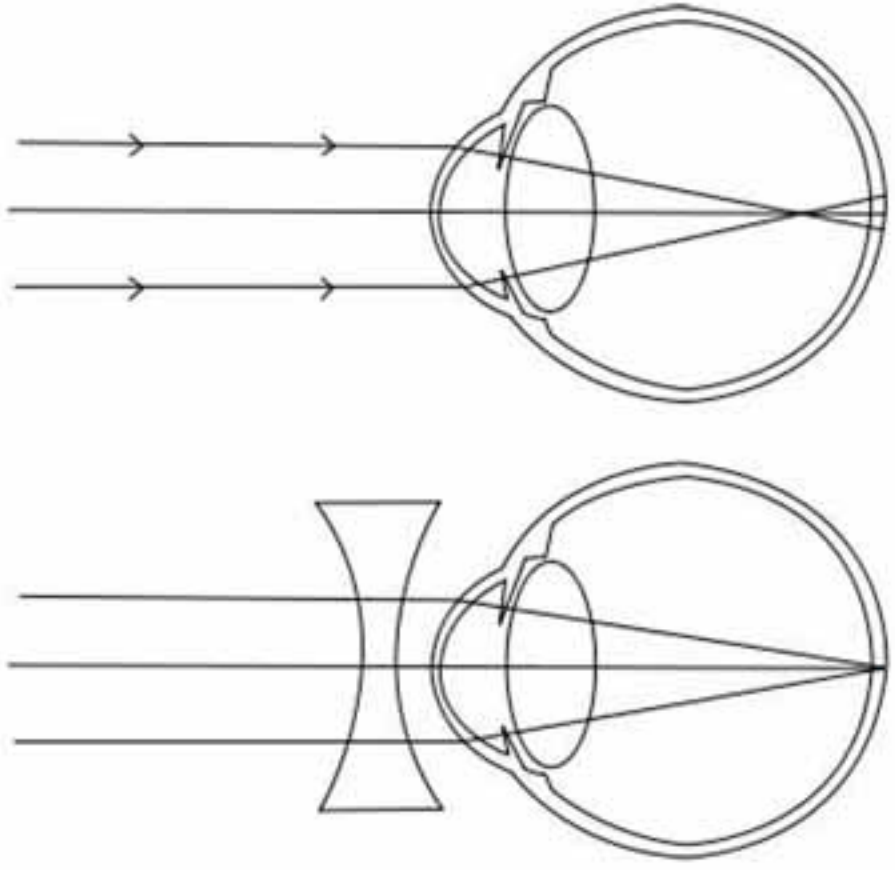
Dispersion causes chromatic aberration

The Human Eye

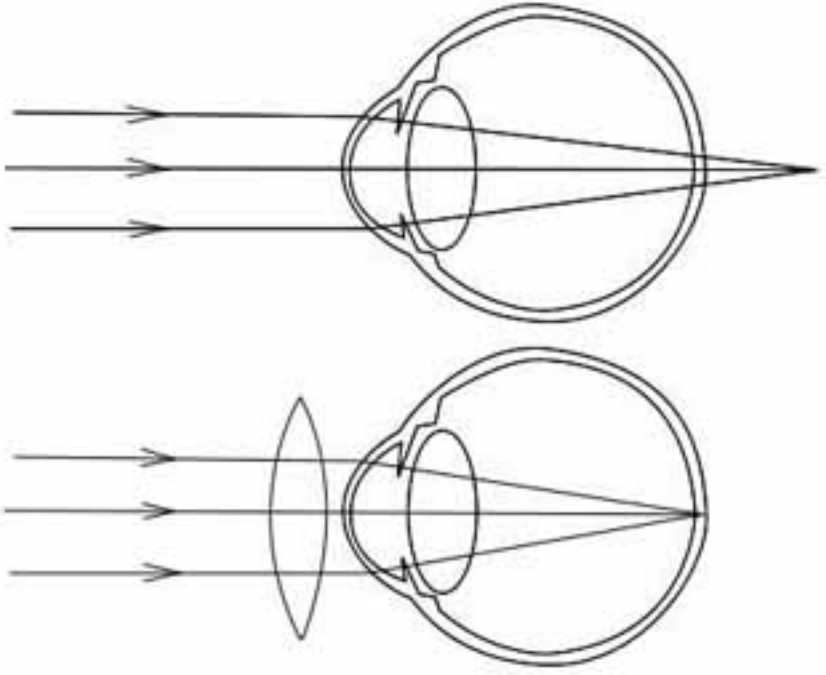




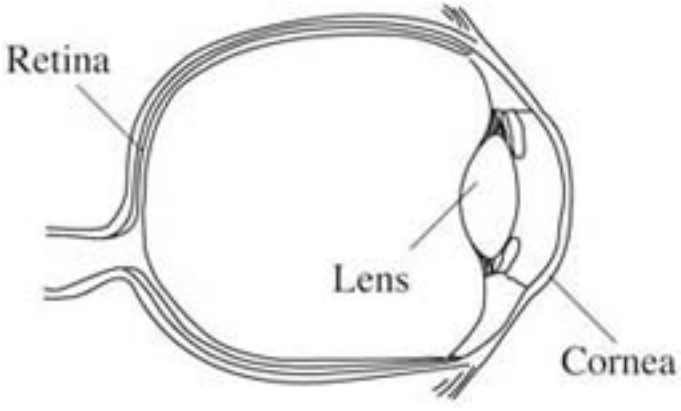
Myopia



Hyperopia



A common vision defect results if the eyeball is too long in relation to lens and corneal structure. Which of the following describes the underlying optical causes of poor vision in such cases?



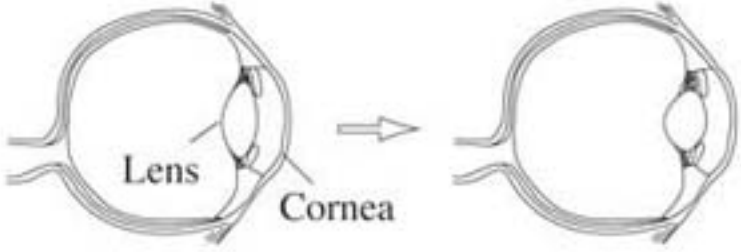
a. An inverted (upside-down) image forms on the retina.

b. Distant objects are focused on the retina, but near objects are focused behind it.

c. The images of far objects focus in front of the retina.

d. The images of near objects focus in front of the retina.

Although most of the diffraction of light entering the eye happens at the air-cornea boundary, adjustments of focal length to distance are made by changes in lens shape, a process called accommodation.



Which of the following happens when the lens becomes less elastic with age and less able to assume a rounded shape?

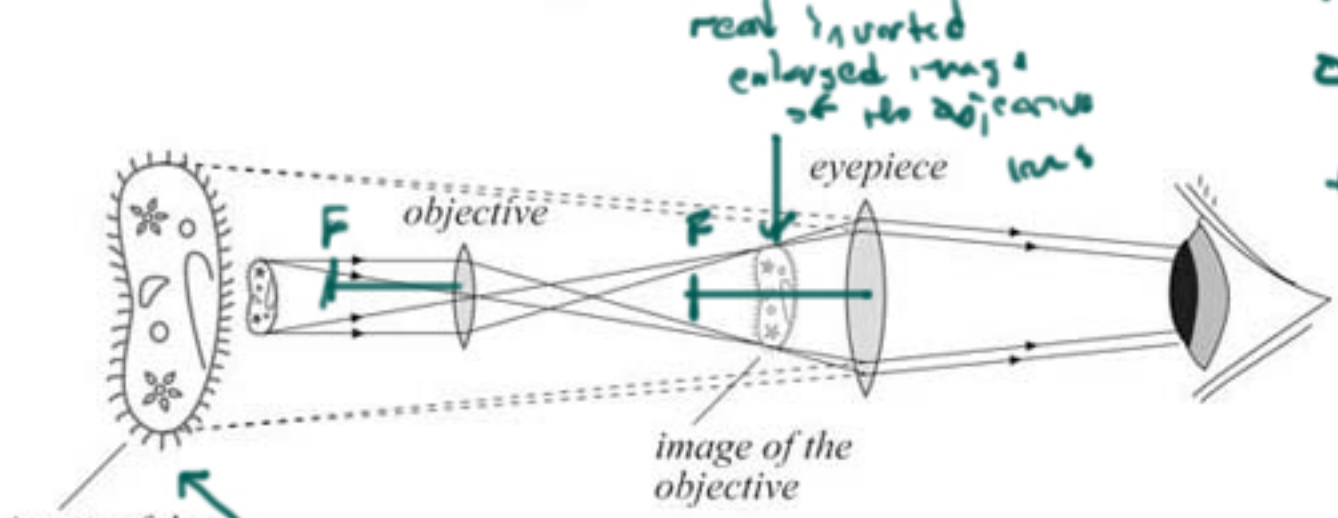
a. The images of near objects focus on the retina.

b. The images of near objects focus in front of the retina.

c. The images of distant objects focus in front of the retina.

d. The value of the near point increases.

Compound Microscope



Take the image of the 1st as the object of the 2nd.