Optics Review
01/27/2026

Topics

Angular magnification
Difference between objective and eyepiece
Telescope absolutes
Defining Aperture stops based on different positions (we are only doing 2 lens systems right now, but one 3-lens system was given and confused us)
Determining/setting up the entrance pupil and exit pupil before plugging in any numbers in (we only did one mathematical example for each but the set up was already provided and element placements were not explained)

Angular Magnification
It is important to distinguish between lateral and angular magnification.

Lateral Magnification:
The ratio of image height to object height
$LM = \frac{h_{image}}{h_{object}}$
Need to have image and object distances

Angular Magnification:
The magnification of the final image relative to unaided viewing at the Near Point (NP)
NP is 25cm (the least distance of distinct vision)
We use Angular Magnification when the virtual image is at infinity (rays emergent from system are parallel)

Example: Simple Magnifier
If object is at F then the Angular Magnification is:
AM = NP/f = F/4
If object is closer than F then:
AM = (NP/f) + 1 = F/4 + 1

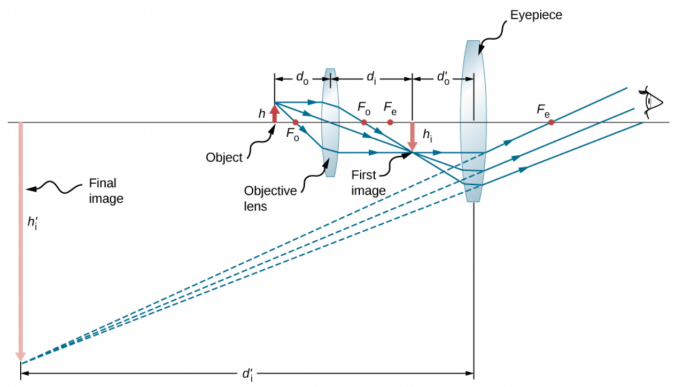
Objective and Eyepiece Lenses

The Objective lens is closer to the Object
The Eyepiece is closer to the Eye

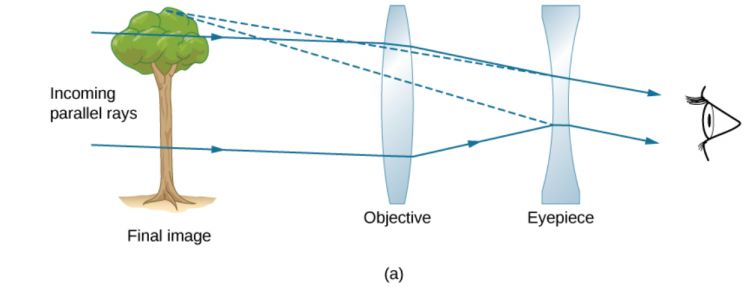
For Telescope
Objective lens is always Positive Power and lower power than Eyepiece
Eyepiece can be either Positive (Astronomical or Keplerian) or Negative (Galilean or Terrestrial)
Magnification is -Fe/Fo

For Microscope
Objective lens and Eyepiece Lenses are both Positive Power
Objective Lens has higher power than Eyepiece Lens
The overall magnification of a compound microscope is the product of:
The linear magnification of the objective lens
The angular magnification of the eyepiece
M_{TOTAL} = LMo x AMe (LMo = Lateral Mag from Objective Lens and AMe = Angular Mag from Eyepiece)
LMo = l'/l (l' = image distance, l = object distance)
AMe = F/4 (F = eyepiece power)

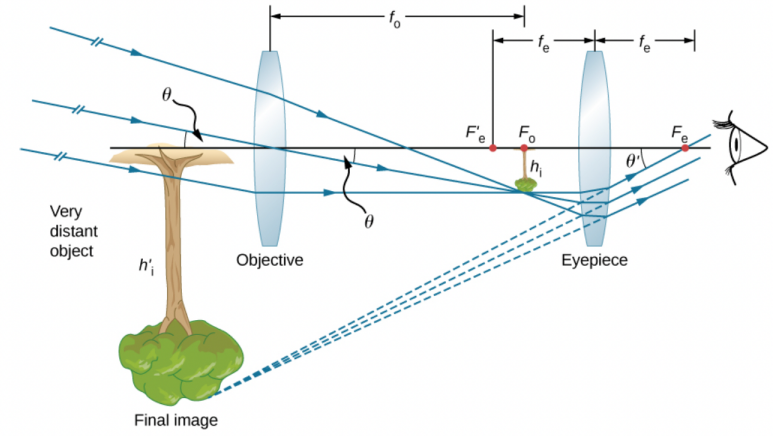
Compound Microscope Optics



Telescope Optics



(a)



(b)

Telescope Magnification with Uncorrected Refractive Error

Refractive Error	Galilean TS	Keplerian TS
Myopia	Reduced	Increased
Hyperopia	Increased	Reduced

Aperture & Field Stops, Pupils & Windows

Aperture Stop (AS)

The aperture stop is the physical component that limits the amount of light reaching the image and therefore controls the illuminance (brightness) of the image. It can be located in front of, behind, or within the lens system. One of the lenses may serve as the aperture stop. The aperture stop depends on the location of the object.

Field Stop (FS)

The field stop determines the extent of the object that will be represented in the image (the field of view).

Entrance Pupil: the image of the aperture stop as seen from the object
Exit Pupil: the image of the aperture stop as seen from image space

Entrance Window: the image of the field stop as seen from the object space
Exit Window: the image of the field stop as seen from the image space

Example: Telescope Optics

For a simple telescope (afocal) with 2 lenses and no internal apertures, consider the following:

The Objective Lens is always the Aperture Stop and Entrance Pupil
The Ocular (Eyepiece) Lens is always the Field Stop and Exit Window

Therefore:
Find Exit Pupil by looking at AS through the Eyepiece Lens
Find the Entrance Window by looking at the FS through the Objective Lens*

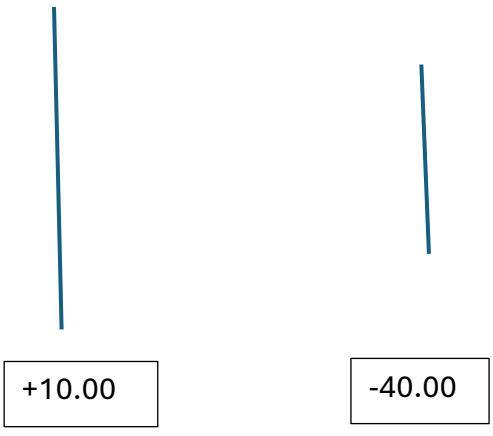
*When finding the Entrance Widow, object and image space are reversed

For other Optical Systems, you must be given AS and FS
If there are 2 or more elements, AS and FS are different elements

Finding Exit Pupil for an Afocal Telescope

What is the location of the exit pupil of a Galilean telescope with a +10.00D objective and a -40.00D eyepiece?

Remember:



Objective Lens Aperture is always Aperture Stop (AS)
Exit Pupil is image of AS from behind the lens system (through Eyepiece)
Telescope length is $f'_{objective} + f'_{eyepiece}$

1. Determine telescope length to determine object distance of AS from Eyepiece

2. Find image length of AS through Eyepiece