Astronomical Instruments

___ and ________: Everyday Light Sensors

- How does your eye form an image?
- How do we record images?

How does your eye form an image?

- Refraction is the ________ of light
- Eye uses refraction to _____ light

Focusing Light

- Refraction can cause parallel light rays to ________ to a ______

Image Formation

- The ________ is where light from different directions comes into focus
- The image behind a single (convex) lens is actually upside-down!
Focusing Light

- A camera focuses light like an eye and captures the image with a detector
- Detectors in digital cameras are similar to those used in modern telescopes

Telescopes: Giant Eyes

- What are the most important properties of a telescope?
- What are the two basic designs of telescopes?
- What do astronomers do with telescopes?

Three main functions of a telescope

Most important
- __________
  followed by
- __________
  \((\text{called resolution or angular resolution})\)
  and least important,
- __________
  \(\text{magnification } = \frac{\text{objective lens focal length}}{\text{eyepiece lens focal length}}\)

Light Collecting Area

- A telescope’s _______ tells us its light-collecting area: \(\text{Area } = \pi(\text{diameter}/2)^2\)
  - _______
- The largest telescopes currently in use have a diameter of about __ ______

How does the collecting area of a 10-meter telescope compare with that of a 2-meter telescope?

- Area goes like \((\text{diameter})^2\)

_____ _______ or _______ Power

- What is the smallest separation a telescope can detect?
Interference

Angular Resolution or Resolving Power

\[ \alpha = \frac{11.6}{D} \]

- D is diameter of main lens or mirror (in cm)
- \( \alpha \) is resolving power (in arc-seconds)
- _____ lens = _______ angular resolution

Recall: 1 degree = 60 arcmin
1 arcmin = 60 arcsec

Magnification

- Depends on both the _______ _____ and the _______ _____.
- \( M = \frac{\text{focal length}_{\text{obj}}}{\text{focal length}_{\text{eye}}} \)
- A bigger objective lens has a larger area, but not necessarily a larger ______ ______
  - Focal length depends on ______ of the lens

A larger objective lens provides a brighter image

There are two different types of optical telescopes

- A _______ telescope uses a glass lens to concentrate incoming light
- A _______ telescope uses mirrors to concentrate incoming light
A _________ telescope uses a _____ to concentrate incoming light.

If you pass white light through a prism, it separates into its component _______.

Observations at other ________ reveal previously invisible sights

The Sun as seen in visible light from Earth and from space in X-rays by satellites
Why do we put telescopes into space?

Earth's _______ gets in the way!

Image of stars taken with a telescope on the Earth's surface

Same picture taken with Hubble Space Telescope high above Earth's blurring atmosphere

Calm, High, Dark, Dry

- The best observing sites are atop remote mountains

Summit of Mauna Kea, Hawaii

Astronomers use different instruments to look at light of different wavelengths - sometimes, we even have to go above Earth’s atmosphere.

Not all EM radiation can penetrate Earth’s atmosphere.

Hubble Space Telescope
Main Mirror: _______
Telescopes and Earth’s Atmosphere Lecture Tutorial: Page 49-51

- Work with a partner or two
- Read directions and answer all questions carefully. Take time to understand it now!
- Come to a consensus answer you all agree on before moving on to the next question.
- If you get stuck, ask another group for help.
- If you get really stuck, raise your hand and I will come around.

Telescopes & Light

- Telescopes gather information from the entire ___ ________
- Why do some objects glow in IR light? Why do some give off x-rays?
- Interactions between light & ______