

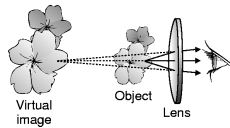
Telescopes and Microscopes

Question:

When you look through the converging eyepiece of a telescope, you see an enlarged image of a distant object. If you replace the eyepiece with one having more curvature and a shorter focal length, will the image you see appear larger or smaller?

Magnifying Glasses

- If the object distance is less than the focal length, no real image forms on the far side of the lens
- The image distance is a negative number!
- There still is an image, a *virtual* image
- The virtual image forms on object-side of lens

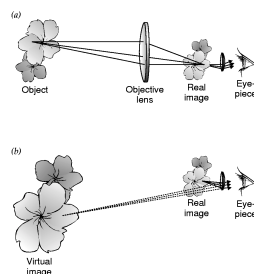


Virtual Images

- Virtual images are
 - upright
 - larger than the object
 - more distant than the object
- Images are magnified
- The shorter the focal length of the lens,
 - the closer the object must be
 - the smaller the region on the object that is viewed
 - the more the magnification of the object

Refracting Telescopes

- One converging lens form a real image
- A second converging lens forms a virtual image of that real image
- Virtual image is highly magnified view of object, but inverted and flipped right-to-left

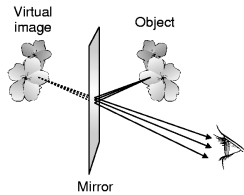


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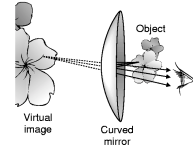
Mirrors 1

- Flat mirror forms virtual image
- Virtual image is similar to the object



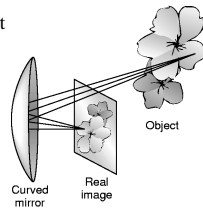
Mirrors 2

- Concave mirror forms virtual image of near object
- Virtual image is
 - upright
 - larger than object
 - more distant than object



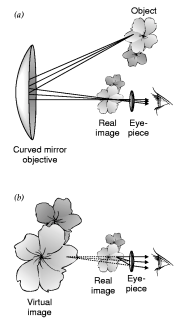
Mirrors 3

- Concave mirror forms real image of distant object
- Real image is
 - Inverted and flipped left-to-right
 - Smaller or larger than object
 - On object side of mirror



Mirror Telescopes

- A concave mirror forms a real image
- A converging lens forms a virtual image of that real image
- Virtual image is highly magnified view of object, but inverted and flipped right-to-left



Comparison

- Refracting telescopes
 - Require clear glass parts
 - Require achromatic multi-element lenses
- Mirror telescopes
 - Require stable but not necessarily transparent parts
 - Do not have any dispersion problems
- Most small telescopes are refractors
- Most large telescopes are reflectors

Why Large Telescopes

- Large aperture yields bright images
- Diffraction limits resolution of telescope
 - Light travels as a wave
 - Passing through an aperture truncates wave
 - Wave spreads following truncation
 - Image points are smeared out
- Larger aperture yields less diffraction

Microscopes

- Just like telescopes, except the object distance is much, much less than the image distance
- First lens projects a real image
- Second lens acts as a magnifying glass to examine the real image

