

“We all know that the real reason universities have students is to educate the professors. But, in order to be educated by the students, one has to put good questions to them. You try out your questions on the students. If there are questions that the students get interested in, then they start to tell you new things and keep you asking more new questions. Pretty soon you have learned a great deal.”

-- John Archibald Wheeler

1

Last Time

- Reflection
 - Angle of incidence = angle of reflection
 - Images formed by mirrors
- Refraction
 - $n_1 \sin(\theta_1) = n_2 \sin(\theta_2)$
 - Images formed by refraction
- Colour & Dispersion
 - Brief intro to electromagnetic waves from an oscillating charge
 - Spectra
- Light scattering

2

Today

- §23.6 - §23.7 Combined – Lenses
- §23.8 – More about images formed by mirrors

3

At midday the scattered light is mostly blue because molecules preferentially scatter shorter wavelengths.

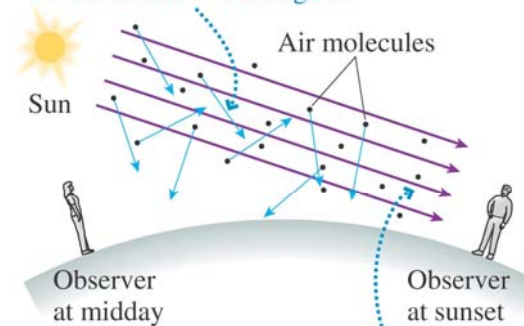


Fig. 23.32

At sunset, when the light has traveled much farther through the atmosphere, the light is mostly red because the shorter wavelengths have been lost to scattering.

4

A Green Flash

The ones I have seen: the colour can be very close to that of a green laser pointer

Enlargement



<http://hea-www.harvard.edu/hrc.ARCHIVE/2006/2006031.000000-2006031.240000/SpaceWeather/swpod2006/31jan06/zinkova.jpg>

5

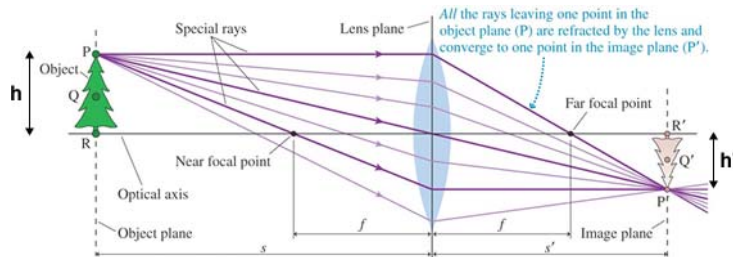
You may have used a magnifying glass to set a dried leaf on fire

Imagine you have two magnifying glasses.
Magnifying glass 1 has a diameter of 5 cm.
Magnifying glass 2 has a diameter of 10 cm.
How does the intensity I of the light at the focus compare for the two lenses?

- A. $I_2 = I_1$
- B. $I_2 = 2 I_1$
- C. $I_2 = \frac{1}{2} I_1$
- D. $I_2 = 4 I_1$
- E. $I_2 = 1.414 I_1$

6

Fig 23.36 – heights h and h' added

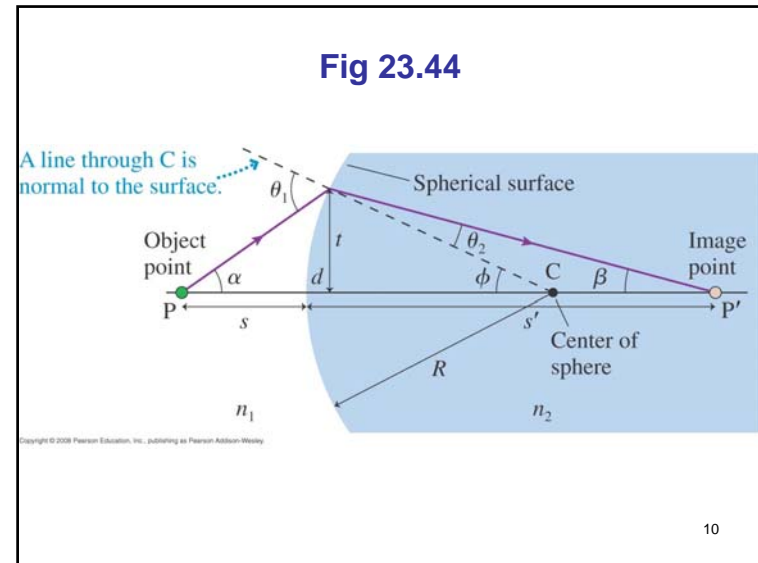
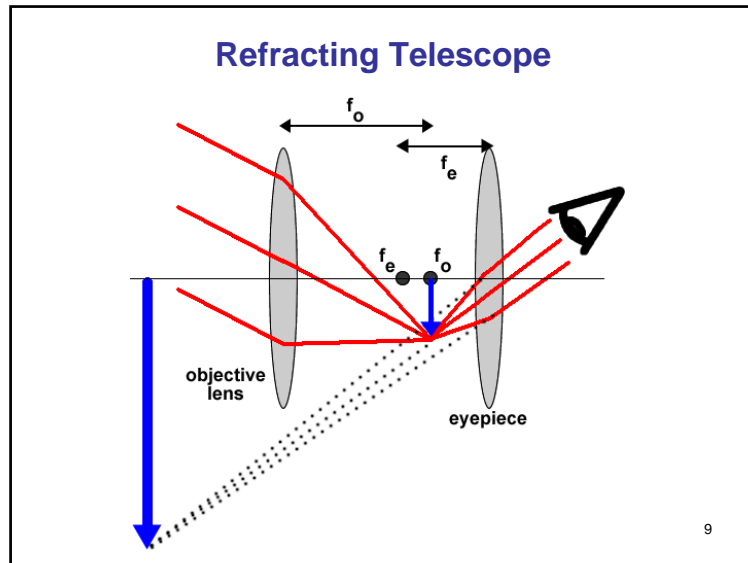


7

A lens is used to form an image on a screen. If the right half of the lens is covered:

- A. the left half of the image disappears
- B. the right half of the image disappears
- C. the entire image disappears
- D. the image becomes blurred
- E. the image becomes dim

8



You have two identical converging lenses, one in air and the other in an aquarium.

For the lens in water, how does the distance to where the light is focused compare to the focus distance for the lens in air?

A. Smaller

B. Same

C. Bigger

$n_{\text{air}} = 1.00$ $n_{\text{water}} = 1.33$ $n_{\text{glass}} = 1.50$ 11

You measure the focal length of a converging lens with red light and again with blue light.

How do the focal lengths compare?

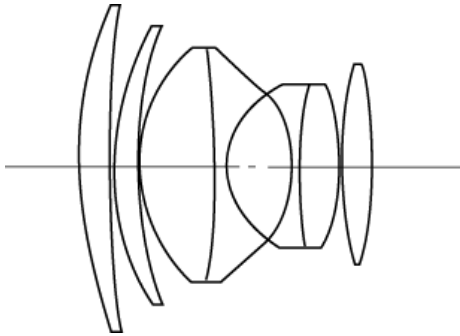
A. $f_{\text{red}} = f_{\text{blue}}$

B. $f_{\text{red}} < f_{\text{blue}}$

C. $f_{\text{red}} > f_{\text{blue}}$

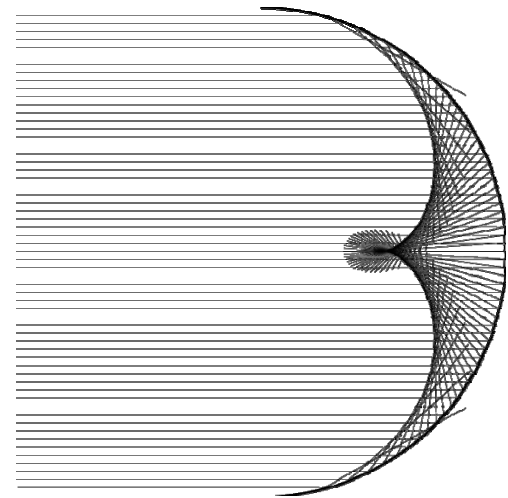
12

Canon 50 mm Lens



http://www.canon.com/camera-museum/camera/lens/s/data/50-85/s_50_095.html

A Spherical Mirror



http://en.wikipedia.org/wiki/Spherical_aberration

14