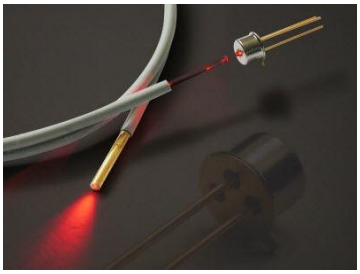
PHY385-H1F Introductory Optics

Class 11 – Outline: Sections 5.5, 5.6

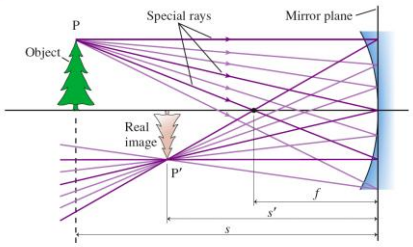
- Convex and Concave Spherical Mirrors
- Prisms – minimum deviation
- Reflecting prisms
- Fibre-Optics



The next 3 weeks . . .

- Next Week: we finish Chapter 5 on Geometrical Optics
- The following week (Oct. 30 and Nov. 1) we discuss Standing waves of light and Lasers (Sections 7.1 and 13.1)
- **Test 2** is on Tuesday Nov. 6 on Chapter 5 and sections 7.1 and 13.1.

FIGURE 23.52 A real image formed by a concave mirror.



The Mirror Equation

For a spherical mirror with negligible thickness, the object and image distances are related by

$$\frac{1}{s_o}+\frac{1}{s_i}=\frac{1}{f} \quad \text{(thin-mirror equation)}$$

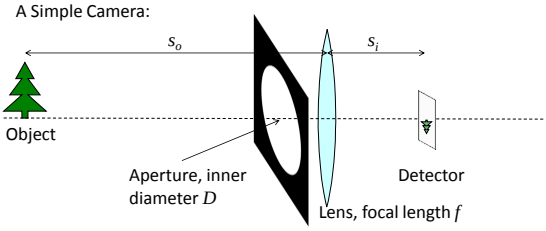
where the focal length f is related to the mirror's radius of curvature by

$$f=\frac{R}{2}$$

Sign convention for spherical mirrors

	Positive	Negative
R and f	Concave toward the object	Convex toward the object
s_i	Real image, same side as object	Virtual image, opposite side from object

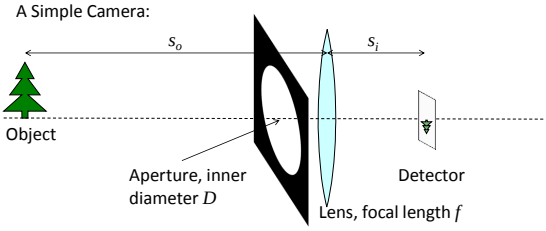
A Simple Camera:



You take a picture of a tree, using an exposure time of Δt. The distance to the tree, s_o, is fixed. If you keep D and f fixed, but increase Δt, what will change about the well-focussed image on the detector?

1. It will get fainter (less energy per pixel).
2. It will get brighter (more energy per pixel).
3. It will have the same exposure level.

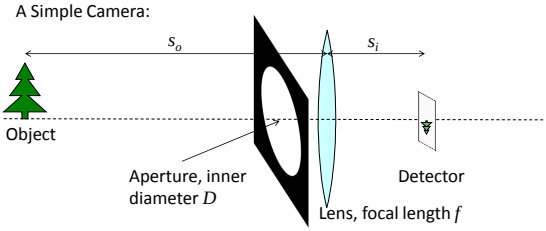
A Simple Camera:



You take a picture of a tree, using an exposure time of Δt. The distance to the tree, s_o, is fixed. If you keep f and Δt fixed, but increase D, what will change about the well-focussed image on the detector?

1. It will get fainter (less energy per pixel).
2. It will get brighter (more energy per pixel).
3. It will have the same exposure level.

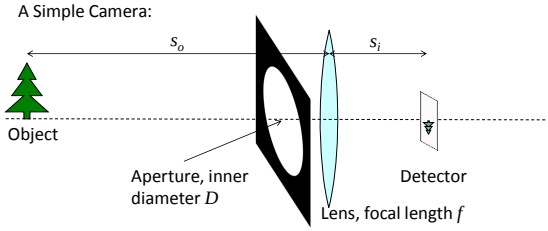
A Simple Camera:



You take a picture of a tree, using an exposure time of Δt. The distance to the tree, s_o, is fixed. If you keep D and Δt fixed, but increase f, what will change about the well-focussed image on the detector?

1. It will get fainter (less energy per pixel).
2. It will get brighter (more energy per pixel).
3. It will have the same exposure level.

A Simple Camera:

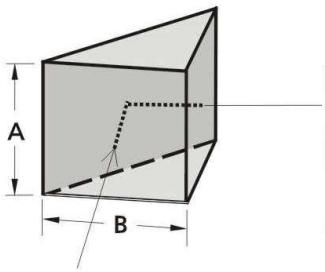


You take a picture of a tree, using an exposure time of Δt. The distance to the tree, s_o, is fixed. If you increase the focal ratio f/D, but wish to keep the same exposure, how should you adjust Δt ?

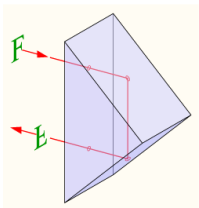
1. Increase Δt
2. Decrease Δt
3. Keep the same exposure time.

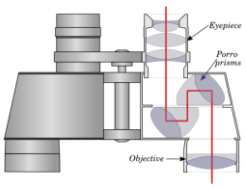
- The total amount of light collected by the lens is proportional to D^2
- The image area of an extended object is proportional to f^2
- So the flux density at the image plane varies as $(D/f)^2$
- D/f is called "relative aperture"
- f/D is called the "f-number" (ie F1.4, F2, F16, etc)
- $(f/D)^2$ is called the "speed". The higher the speed, the shorter an exposure time you need for the same image brightness.
- That's why F-numbers tend to increase by factors of $\sqrt{2}$ on cameras – for each step you have to double the exposure time

Reflecting Right-Angle Prism

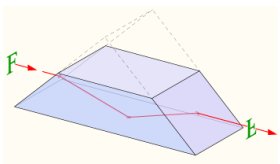


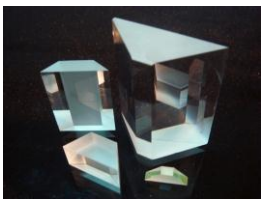
Reflecting Porro-Prism



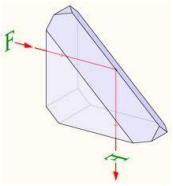


Reflecting Dove-Prism

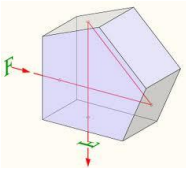


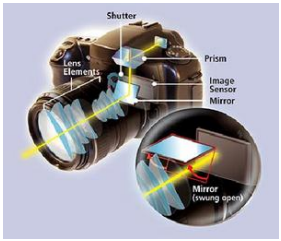


Reflecting Amici Roof-Prism



Reflecting Penta-Prism





Modal Dispersion In Optical Fibres