Physics 102

Lecture 25

Mon. Nov. 8, 2004.

- Ray-tracing for spherical mirrors.

  — to determine the location, size, orientation of the image of an object.

① . P · ray .

Concave: The parallel ray reflects through the focal point.

② F ray . (for convex mirrors, the extrapolation of the reflected ray goes through F.)

The focal ray reflects parallel to the axis.

③ · C ray .

The centre ray reflects back along its incoming path.

Any two rays will determine the image.

We can use the third as a check.

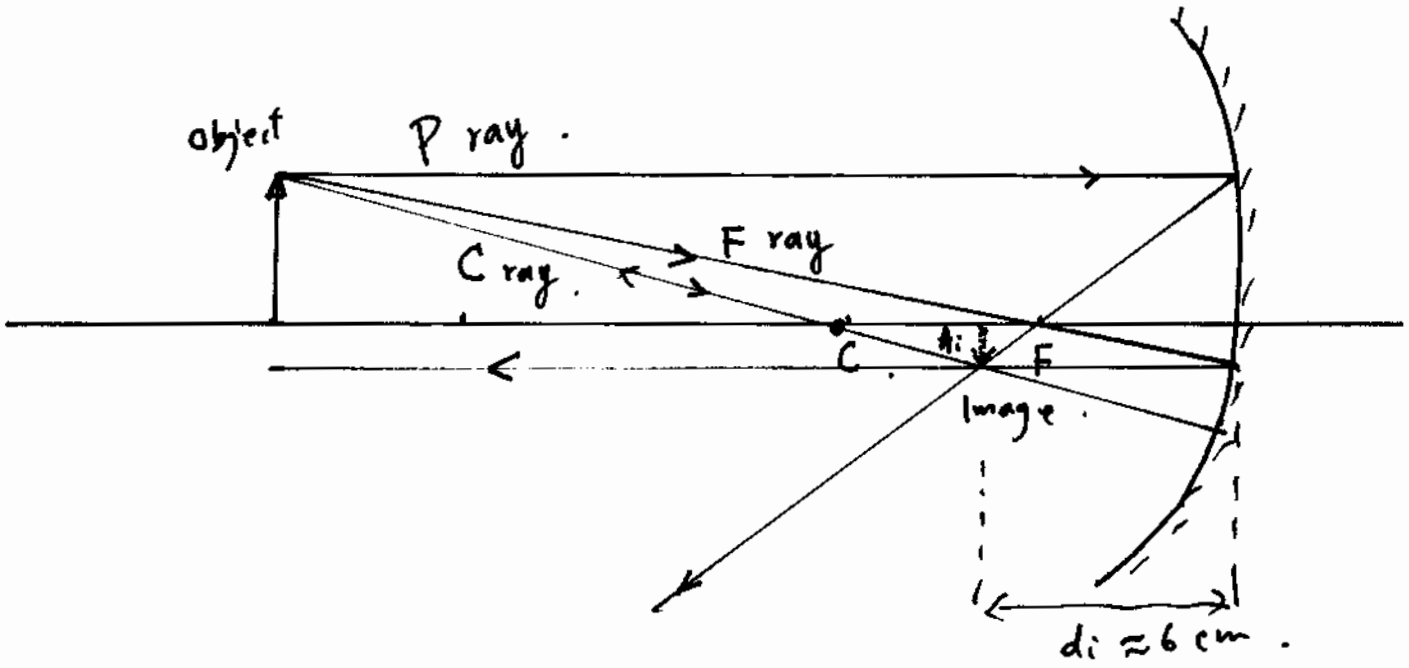
- Focal Point: $\begin{cases} f = \frac{1}{2}R & \text{— concave. in front of mirror} \\ f = -\frac{1}{2}R & \text{— convex. behind mirror.} \end{cases}$

e.g. A concave mirror. (P.861)

$f = 5.00$ cm ($R = 10$ cm).

An object with a height of 4.0 cm ~~$h_o = 1.0$ cm~~ is located 25 cm in front of the mirror. ($d_o = 25.0$ cm)

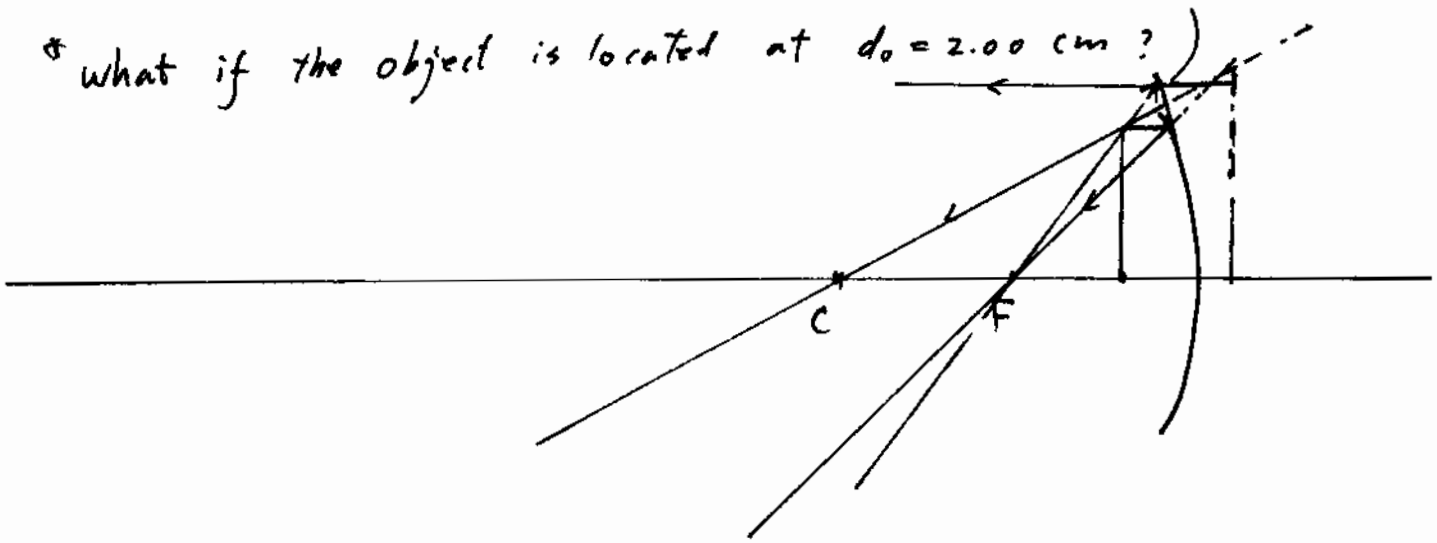
Where is the image?



$d_i \approx 6$ cm

h_i ~~$\approx$~~ -1.0 cm. (−): inverted.

* what if the object is located at $d_o = 2.00$ cm?



The Mirror Equation (p.859)

d_o — Mirror-object distance.

d_i — Mirror-image distance.

$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}.$$

$$f = \frac{1}{2}R.$$

f: (+) concave; (−) convex.

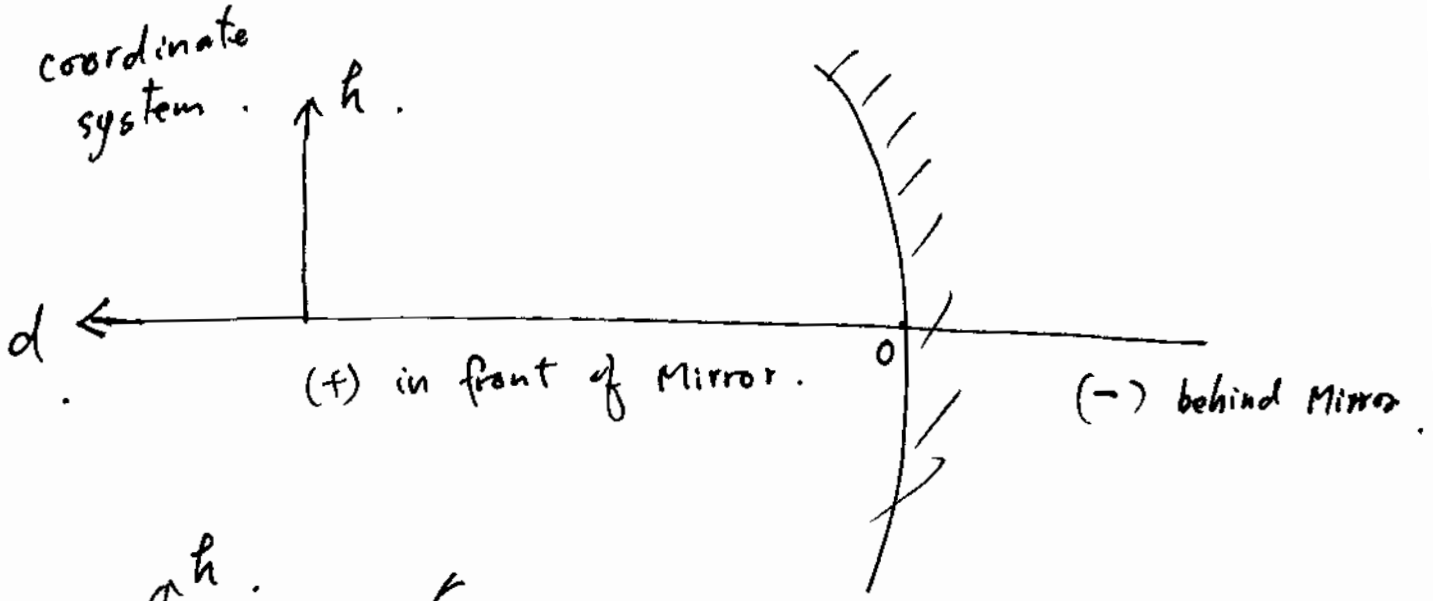
$$\frac{h_o}{-h_i} = \frac{d_o}{d_i}.$$

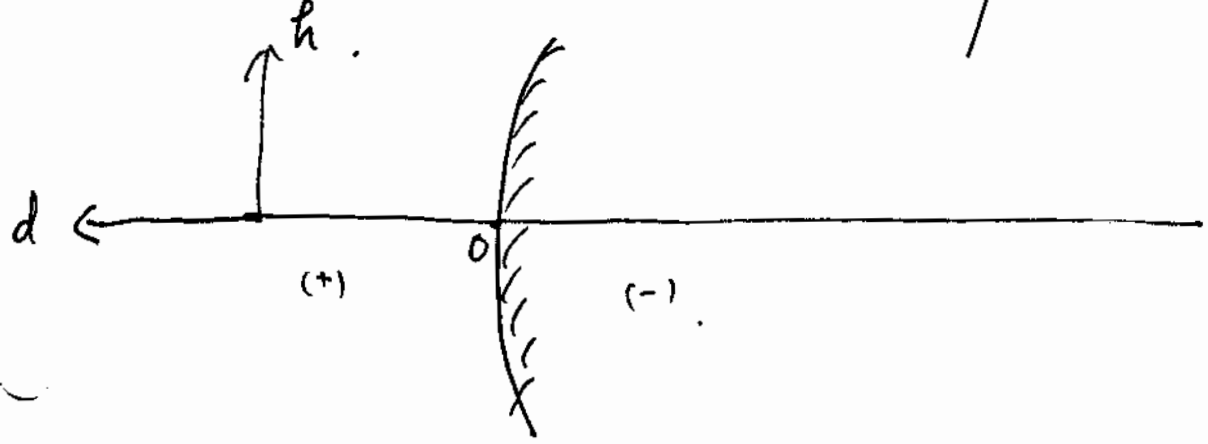
h_o, h_i — (+) upright. (−) inverted. (down word)

Magnification:

$$M = \frac{h_i}{h_o} = -\frac{d_i}{d_o}.$$

M: (+) upright. (−) inverted.





e.g. #36. of ch.26. (P.883)

A concave mirror with a focal length of 36 cm produces an image whose distance from the mirror is one-third the object distance. Find the object and image distances:

given: $f = 36$ cm. $d_i = \frac{1}{3} d_o$. $d_o = 3 d_i$.

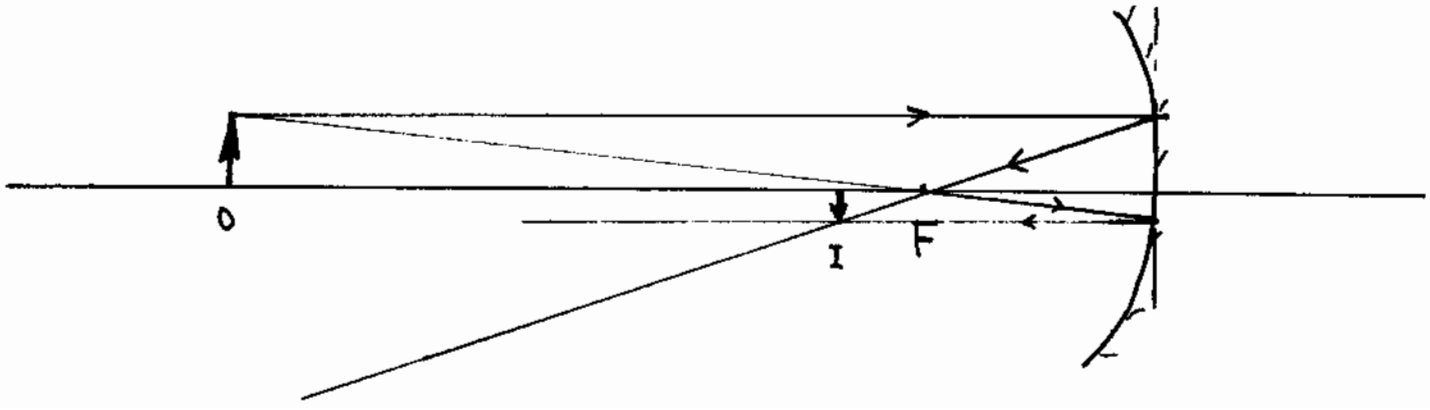
find: $d_i = ?$ $d_o = ?$

$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}. \quad , \quad \frac{1}{3d_i} + \frac{1}{d_i} = \frac{1}{f}.$$

$$\frac{4}{3d_i} = \frac{1}{f}.$$

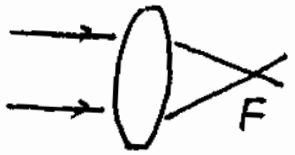
$$d_i = \frac{4}{3} f = \frac{4}{3} \times 36 = 48 \text{ cm}.$$

$$d_o = 3 d_i = 144 \text{ cm}.$$



- Lenses.

Converging : e.g.

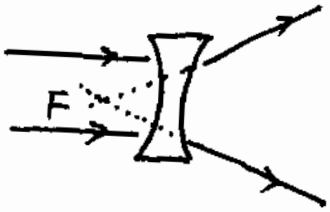


$f > 0$.

double-convex

ray bent toward the axis.

diverging. e.g.



$f < 0$

double-concave. Rays bent away.

- Ray Tracing for thin lenses.
  - lens is thin.
  - Angles are small.

① P-ray : will be bent and through F. (convex)

[concave : extrapolates through F].

② F-ray : bent to parallel

③ M-ray (Midpoint ray) : No bending when a ray goes through the centre of lens.