Physics 5B

Lecture 14, February 13, 2012

Chapter 32, Spherical Mirrors
Spherical Mirror Focus

Focal Plane

Principal axis

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Spherical Aberration
Parabolic Reflector

- On-axis parallel rays (i.e. from an object very far away) are perfectly focused to the point F, with no spherical aberration.
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• However, objects away from the symmetry axis suffer from a distortion called “coma”.
Mirror Equation

\( f > 0 \) for concave mirror
\( d_o, d_i > 0 \) if on the side of the mirror
where the light is (i.e. real object and image)

\[
\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}
\]

\[ m \equiv \frac{h_i}{h_o} = -\frac{d_i}{d_o} \]
Sign Conventions

- The same mirror equation works for concave and convex mirrors
  - Concave: $f > 0$
  - Convex: $f < 0$
- $m > 0$: non-inverted
- $m < 0$: inverted
- $d_i > 0$: image on the light side of the mirror (real)
- $d_i < 0$: image on the opposite side of mirror (virtual)
- $d_o > 0$: object on the light side of mirror
- $d_o < 0$: object on the other side of the mirror (virtual)

**Note:** virtual images are no less “real” to our perception than real images. After all, the final image on our retina is always real.
What signs apply to the mirror, object, and image of the man shown in this photograph?

A. $d_o > 0$, $d_i > 0$, $f > 0$

B. $d_o > 0$, $d_i < 0$, $f > 0$

C. $d_o > 0$, $d_i < 0$, $f < 0$

D. $d_o < 0$, $d_i > 0$, $f > 0$

E. $d_o > 0$, $d_i > 0$, $f < 0$

The image is magnified, so it must be a concave mirror. The image is upright, so it must be virtual (the man is between the focus and the mirror). Note how the image of the door in the background is inverted, because that object is further away from the mirror than the focus (the door is a real image). That is also characteristic of a concave mirror.
Spherical Mirror Examples

1. \( d_o = 100 \text{ cm} \) and \( f = 40 \text{ cm} \)
2. \( d_o = 20 \text{ cm} \) and \( f = 40 \text{ cm} \)
3. \( d_o = 40 \text{ cm} \) and \( f = -40 \text{ cm} \)
4. Two mirrors separated by 80 cm, with the object halfway between. Mirror 1 has \( f = -40 \text{ cm} \) and mirror 2 has \( f = 40 \text{ cm} \). Find the first two finite-size images.
“Mirage”

This is an example of a real image formed by mirrors.