PHYS 111
1ST semester 1439-1440

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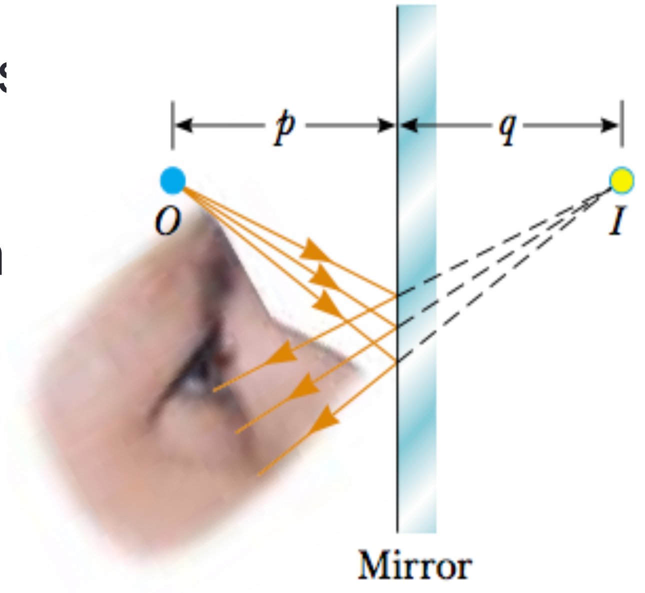
Lecture 17

Chapter 36
Image Formation

36.1 Images Formed by Flat Mirrors

- Consider a point source of light placed at *O*,
- The distance *p* is called the **object distance.**
- Light rays leave the source and are reflected from the mirror.
- Upon reflection, the rays continue to diverge (spread apart). The dashed lines are extensions of the diverging rays back to a point of intersection at *I*.
- The diverging rays appear to the viewer to com from the point *I* behind the mirror.
- Point *I* is called the **image** of the object at *O*.
- We always locate images by extending diverging rays back to a point at which they intersect.
- Because the rays appear to originate at *I*, which is a distance *q* behind the mirror, this is the location of the image.
- The distance *q* is called the **image distance.**

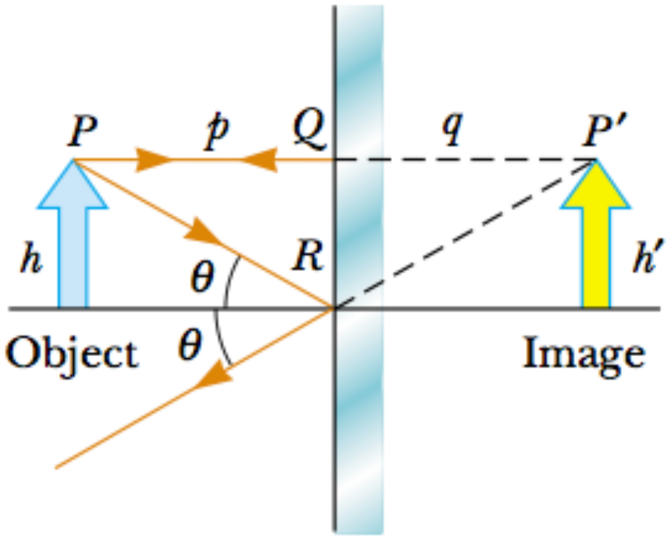


36.1 Images Formed by Flat Mirrors

- Images are classified as **real** or **virtual.**
- A **real** image is formed when light rays pass through and diverge from the image point.
- A **virtual** image is formed when the light rays do not pass through the image point but only appear to diverge from that point.
- The image of an object seen in a flat mirror is *always* **virtual**.
- **Real** images can be displayed on a screen (as at a movie), but **virtual** images cannot be displayed on a screen.

36.1 Images Formed by Flat Mirrors

- We can use the simple geometry to examine the properties of the images of extended objects formed by flat mirrors.
- We need to choose only **two** rays to determine where an image is formed.
  - One of those rays starts at *P*, follows a horizontal path to the mirror, and reflects back on itself.
  - The second ray follows the oblique path *PR* and reflects as shown, according to the law of reflection.
- We conclude that the image formed by an object placed in front of a flat mirror is as far behind the mirror as the object is in front of the mirror.



36.1 Images Formed by Flat Mirrors

- **Lateral magnification**

$$M \equiv \frac{\text{Image height}}{\text{Object height}} = \frac{h'}{h}$$

- For a flat mirror, *M*=1 for any image because *h'*=*h*.

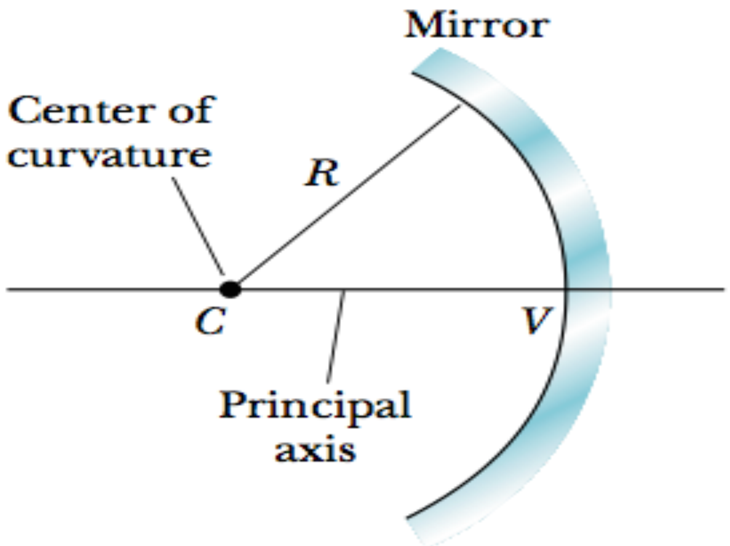
- We conclude that the image that is formed by a flat mirror has the following properties:

  - The image is as far behind the mirror as the object is in front.
  - The image is unmagnified, virtual, and upright. (By upright we mean that, if the object arrow points upward as in Figure 36.2, so does the image arrow.)
  - The image has front–back reversal.

Quick Quiz 36.2 You are standing about 2 m away from a mirror. The mirror has water spots on its surface. True or false: It is possible for you to see the water spots and your image both in focus at the same time.

36.2 Images Formed by Spherical Mirrors

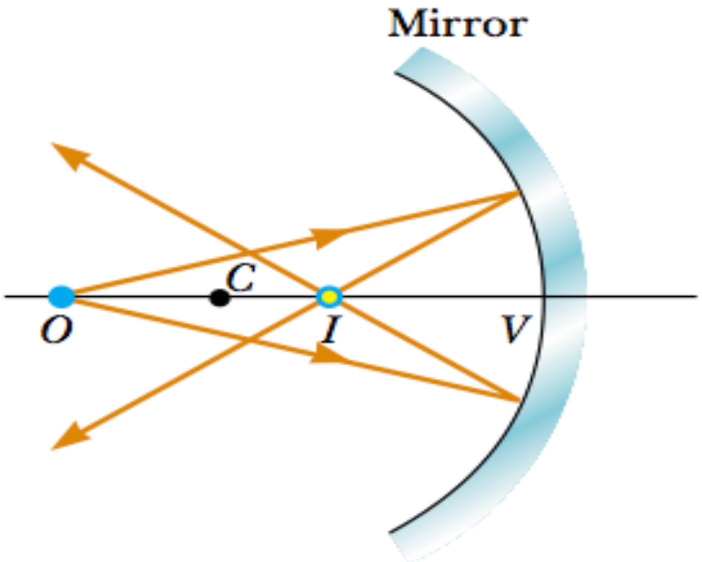
- **<u>Concave Mirrors</u>**
- A **spherical mirror** has the shape of a section of a sphere.
- If the light is reflected from the inner, concave surface, is called a **concave mirror.**
- The mirror has a radius of curvature *R*, and its center of curvature is point *C*. Point *V* is the center of the spherical section, and a line through *C* and *V* is called the **principal axis** of the mirror.



(a)

36.2 Images Formed by Spherical Mirrors

- Consider a point source of light placed at point, where *O* is any point on the principal axis to the left of *C*.
- Two diverging rays that originate at *O*.
- After reflecting from the mirror, these rays converge and cross at the image point *I*. They then continue to diverge from *I* as if an object were there.
- As a result, at point *I* we have a **real** image.



(b)

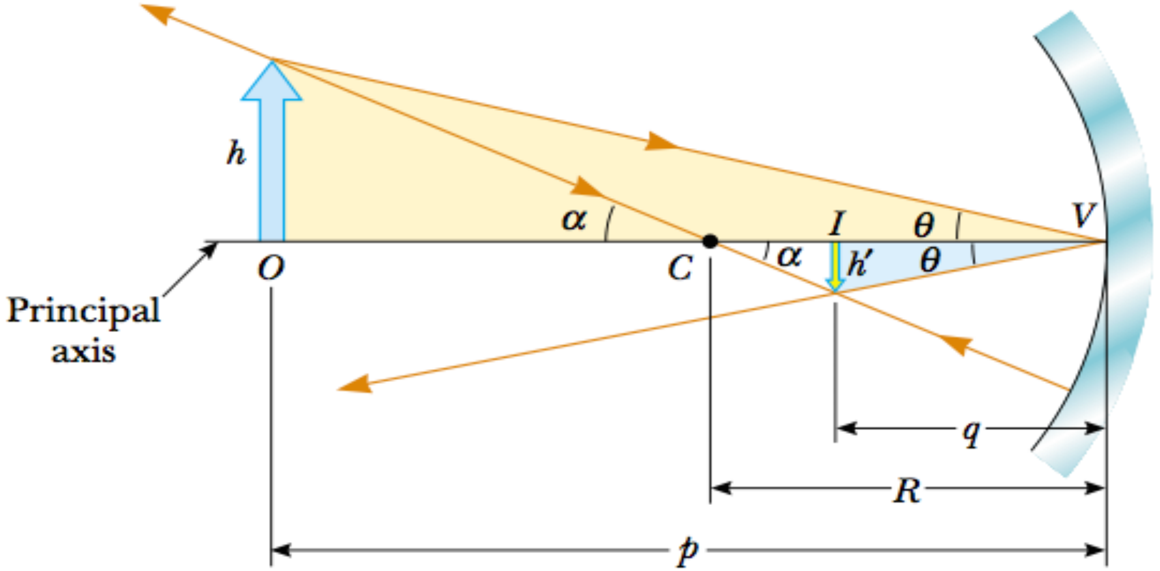
36.2 Images Formed by Spherical Mirrors

- The magnification of the image is

$$M = \frac{h'}{h} = -\frac{q}{p}$$

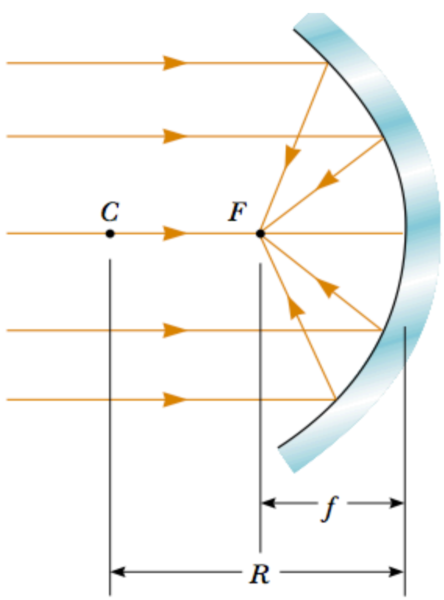
- The **mirror equation.**

$$\frac{1}{p} + \frac{1}{q} = \frac{2}{R}$$

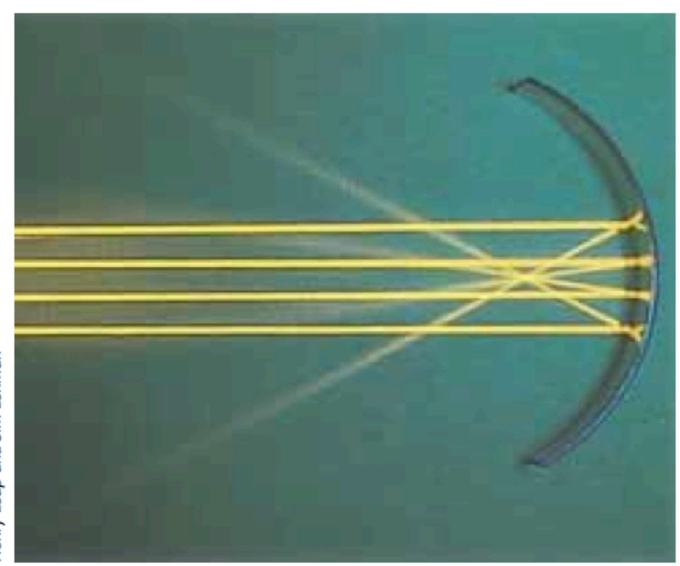


36.2 Images Formed by Spherical Mirrors

- If the object is very far from the mirror (if p is so much greater than R), $p \rightarrow$ infinity—then $1/p \approx 0$, and $q = R/2$.
- That is, when the object is very far from the mirror, the image point is halfway between the center of curvature and the center point on the mirror.
- The incoming rays from the object are essentially parallel.



Henry Leap and Jim Lehman



36.2 Images Formed by Spherical Mirrors

- We call the image point in this special case the **focal point** *F* and the image distance the **focal length** *f*, where

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

- Focal length is a parameter particular to a given mirror and therefore can be used to compare one mirror with another.
- The mirror equation can be expressed in terms of the focal length:

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$$