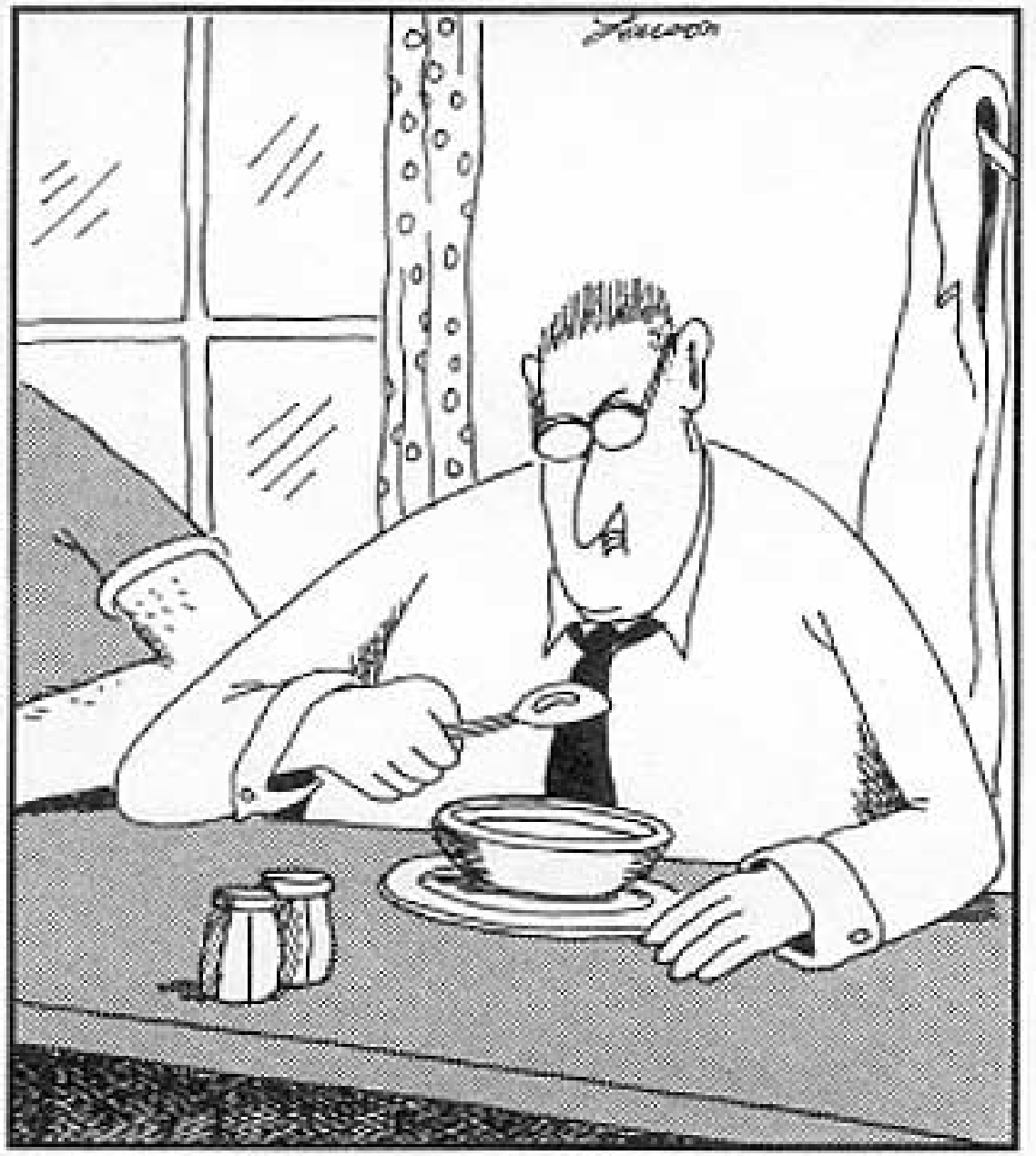
November 17th

Images

Chapter 35

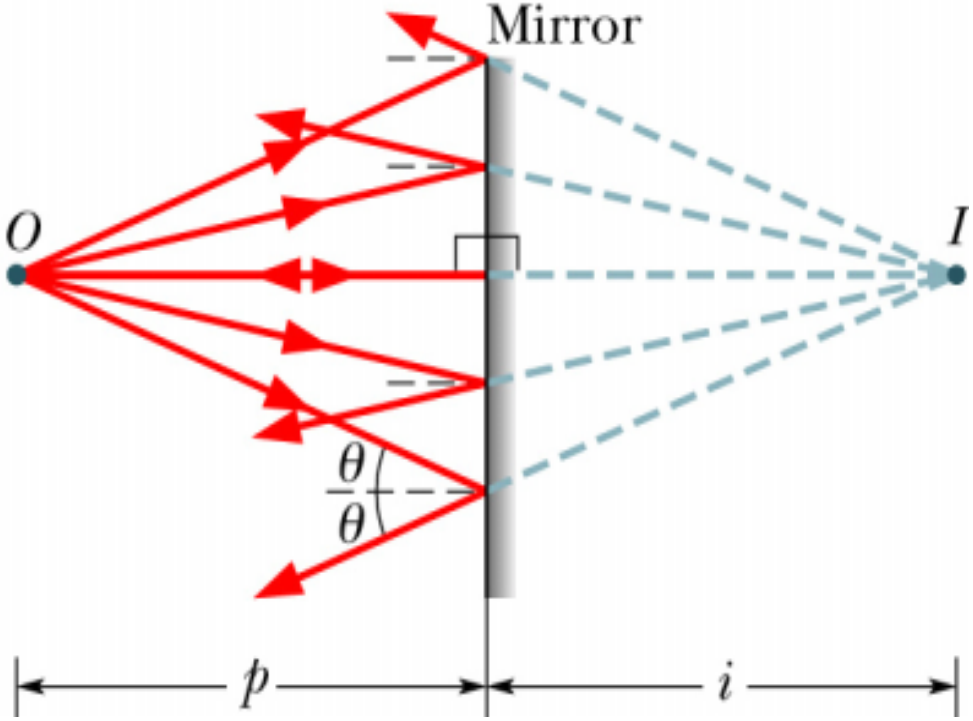


Darrell suspected someone had once again slipped him a spoon with the concave side reversed.

Plane mirrors (Fig. 35-2)

- Mirror – surface which reflects light in one direction instead of scattering it in many directions or absorbing it
- Plane mirror – flat reflecting surface

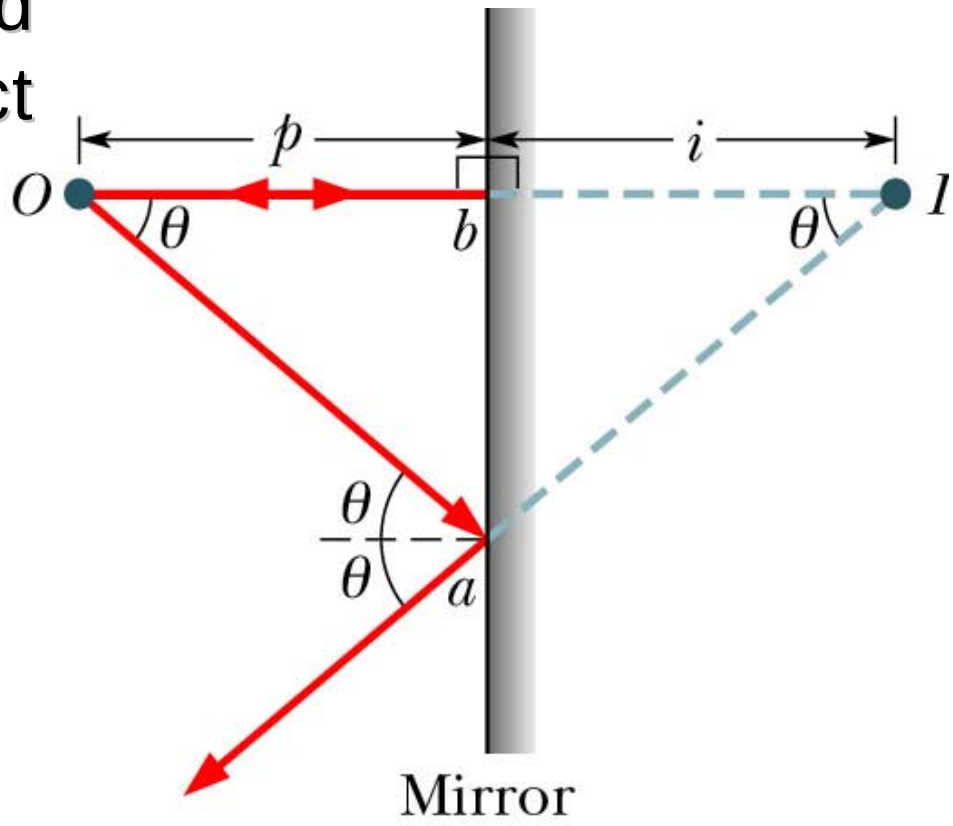
- Extend reflected rays from O behind mirror
- Intersect at point of virtual image I



Plane mirrors (Fig. 35-3)

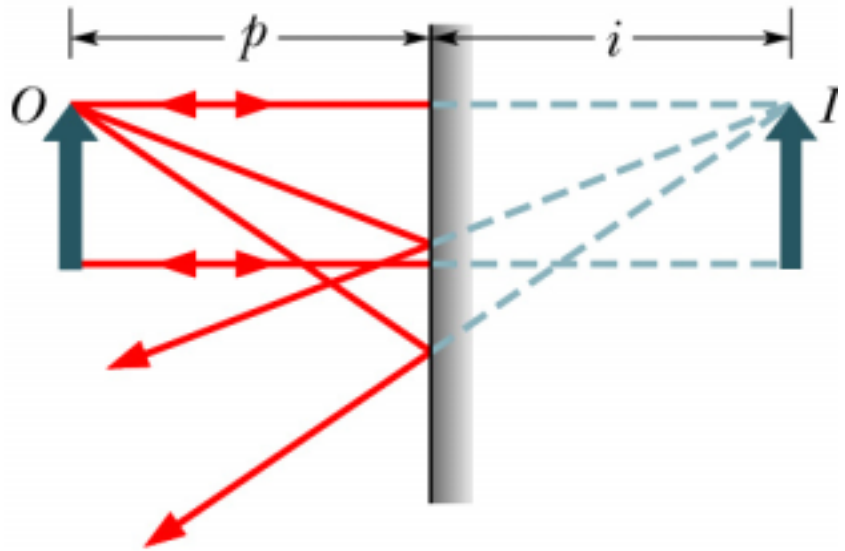
- Plane mirror – virtual image I is as far behind the mirror as the object O is in front of it
- By convention, object distances p are positive, image distances i for virtual images are negative

$$i = -p$$

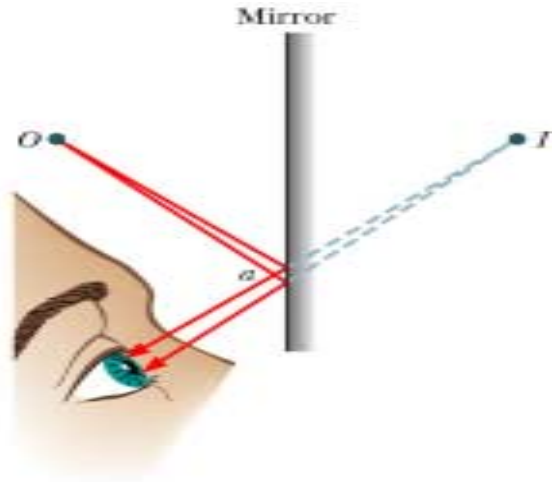


Plane mirrors (Figs. 35-4, 35-5)

- Plane mirror – virtual image I has same orientation and height as object O

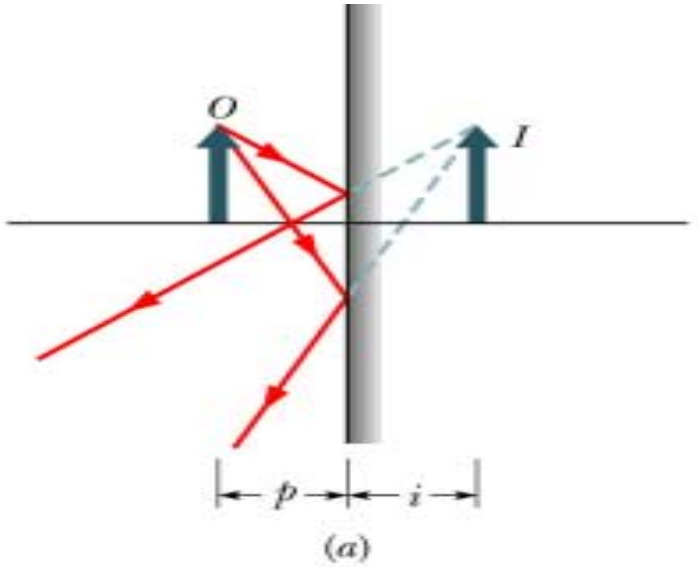


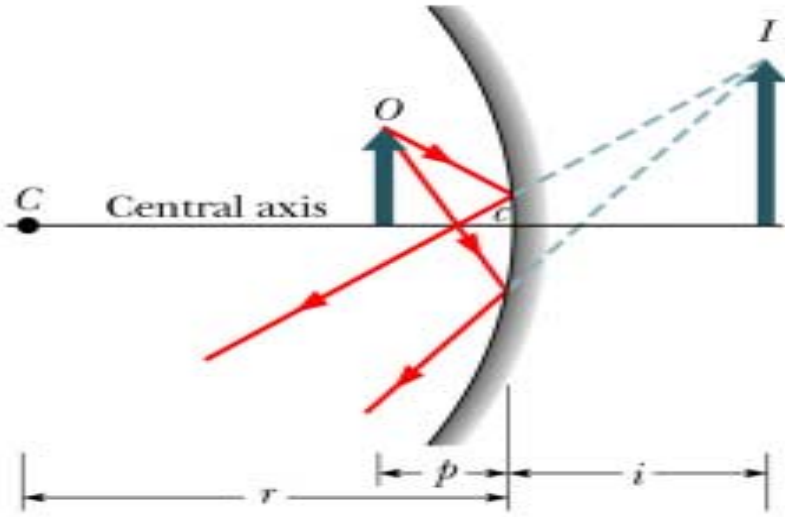
- Only portion of mirror smaller than pupil of eye is used to form images



Spherical mirrors (Fig. 35-6)

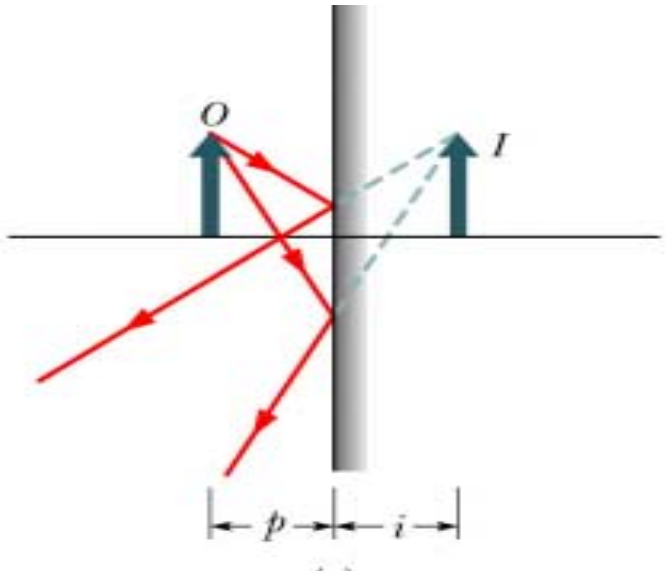
- Spherical mirror – small section of the surface of a sphere
- Concave mirror – plane mirror caved in
- Center of curvature is in front of mirror
- Field of view is smaller
- Image is farther behind mirror and taller
  - Make-up or shaving mirror

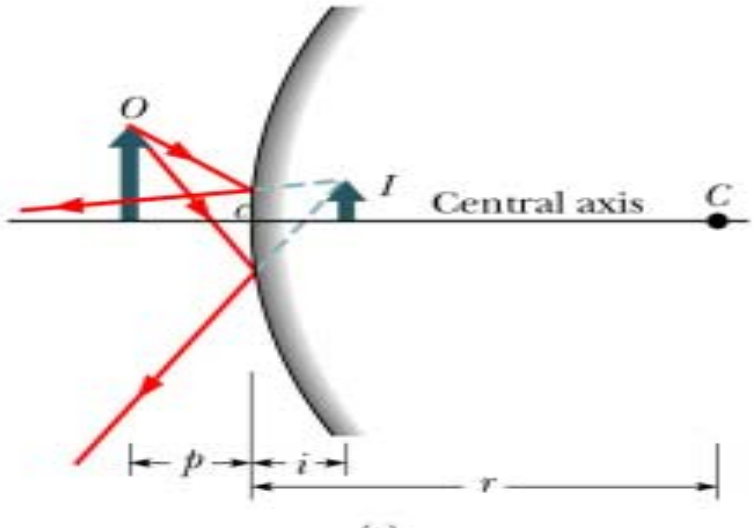




Spherical mirrors (Fig. 35-6)

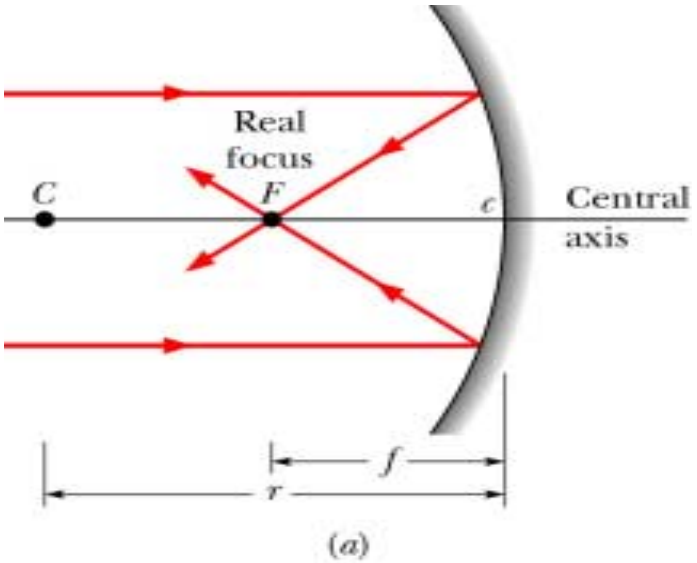
- Convex mirror – plane mirror is flexed out
- Center of curvature is behind the mirror
- Field of view is larger
- Image is closer to the mirror and smaller
  - Surveillance mirror

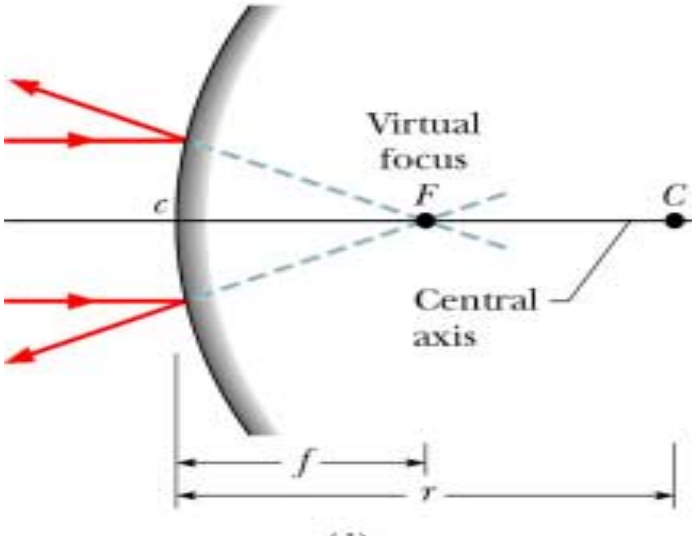




Spherical mirrors (Fig. 35-7)

- Object O infinite distance from mirror on central axis
  - Concave mirror – focuses real image at a focal point in front of the mirror
  - Convex mirror – focuses a virtual image at a focal point behind the mirror
- Distance from center of mirror to image is called focal length, *f*

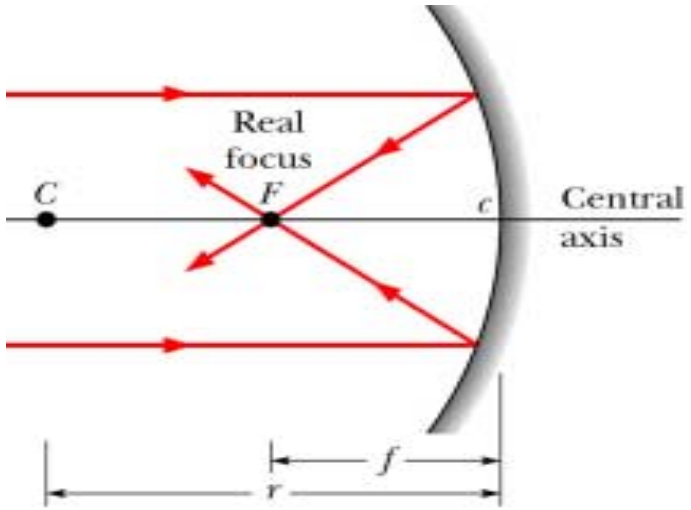




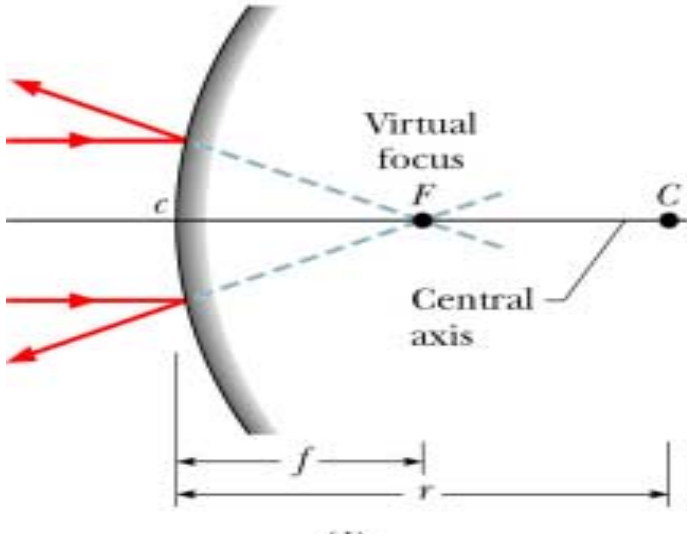
Spherical mirrors (Fig. 35-6)

- Concave mirror has a real focal point
- Convex mirror has a virtual focal point indicated by a negative focal length
- Focal length, *f* is related to radius of curvature, *r* of mirror
  - *r* is + for concave, - for convex

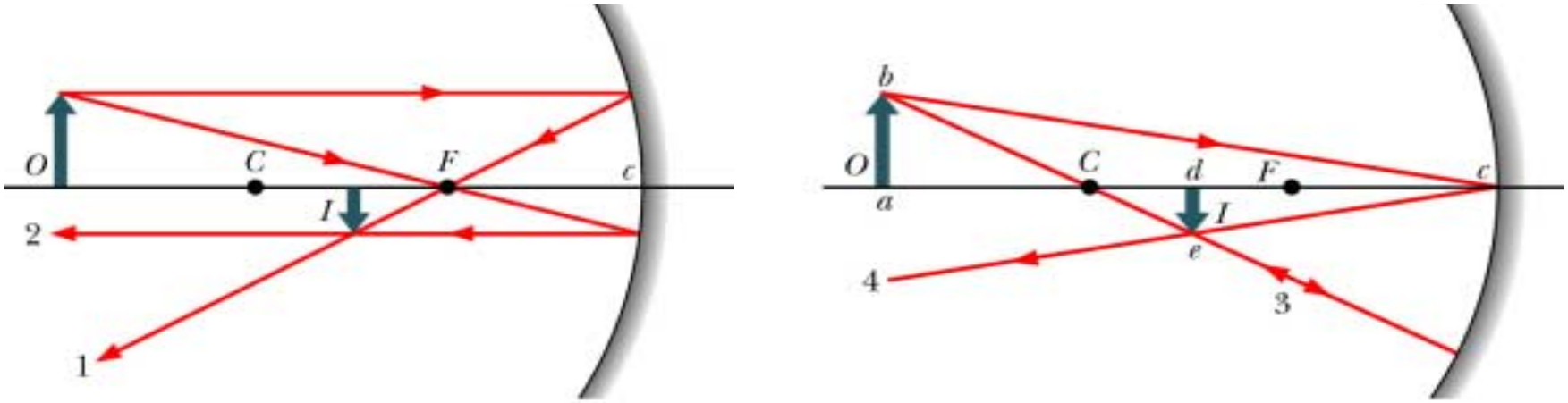
$$f = \frac{1}{2} r$$



(a)



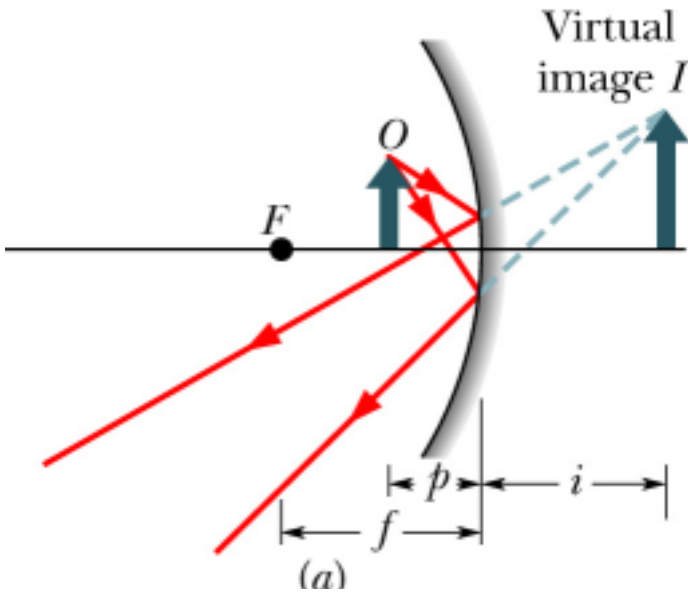
Spherical mirrors (Fig. 35-9)



- Locate images by drawing rays
  - Ray parallel to central axis, reflects through focal point (Ray 1)
  - Ray passing through focal point, reflects parallel to central axis (Ray 2)
  - Ray passing through center of curvature returns along itself (Ray 3)
  - Ray hits mirror at intersection with central axis, reflects symmetrically about central axis (Ray 4)

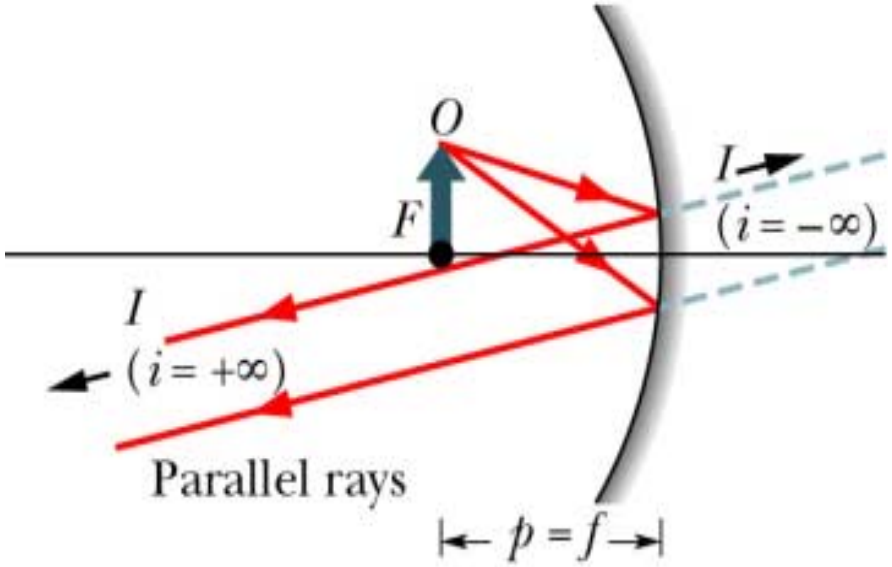
Concave mirrors (Fig. 35-8)

- If object O inside focal point, $p<f$
- Extend rays behind mirror to find image I
- Image I is
  - Virtual
  - Bigger than object O
  - Same orientation as object



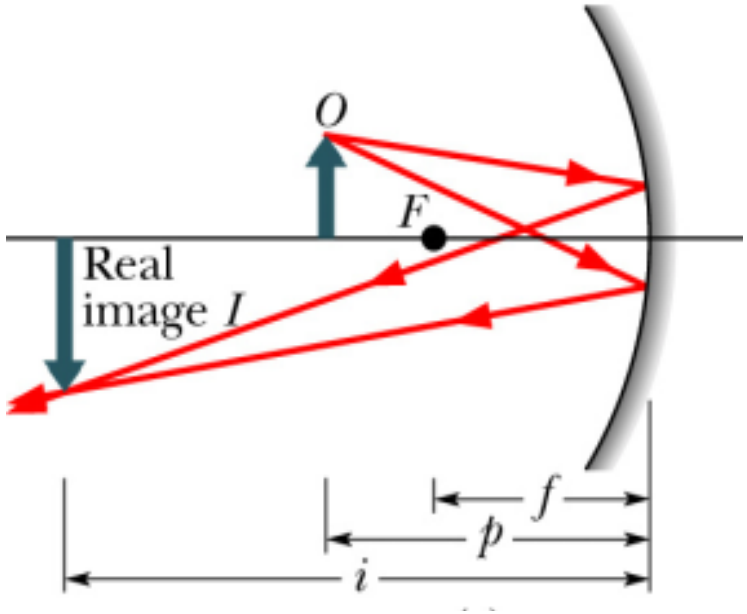
Concave mirrors (Fig. 35-8)

- If object O at focal point, $p=f$
- Neither reflected or extended rays cross to form image
- Image is moved to infinity



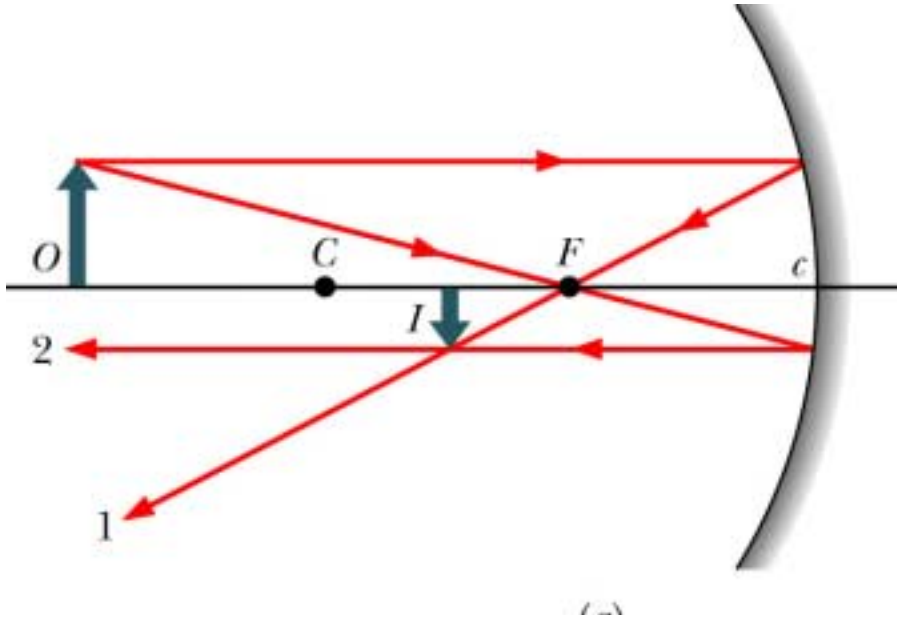
Concave mirrors (Fig. 35-8)

- If object O between focal point *f* and twice the focal length, *f<p<2f*
- Image I is
  - Real
  - Bigger than O
  - Inverted
  - At distance, *i>2f*



Concave mirrors (Fig. 35-9)

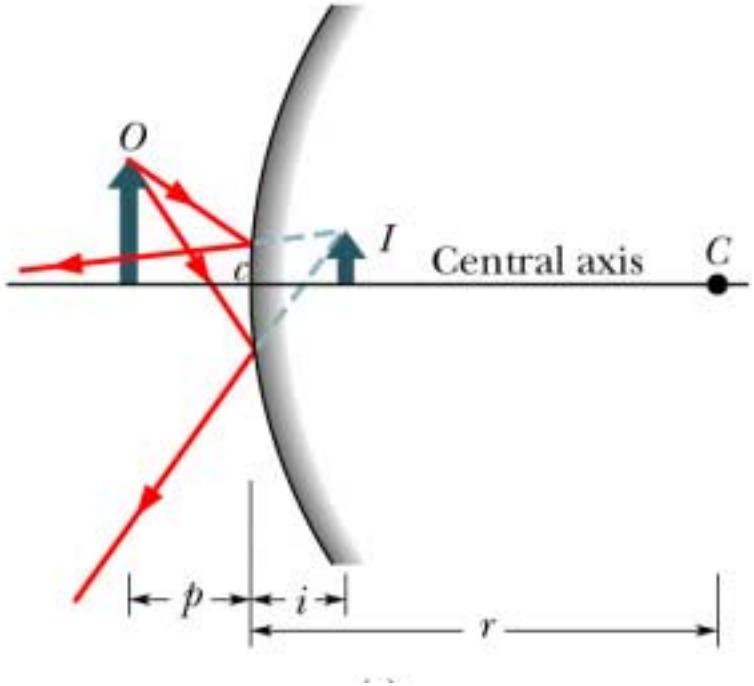
- If object O outside two focal lengths, O>2f
- Image I is
  - Real
  - Smaller than O
  - Inverted
  - At a distance *f<i<2f*



- If object O is at *2f*
- Image I is
  - Real
  - Equal in size to O
  - Inverted
  - At distance *i=2f*

Convex mirrors (Fig. 35-6)

- If object O placed anywhere on central axis
- Image I is
  - Virtual
  - Smaller than O
  - Same orientation
  - At distance, $i<f$

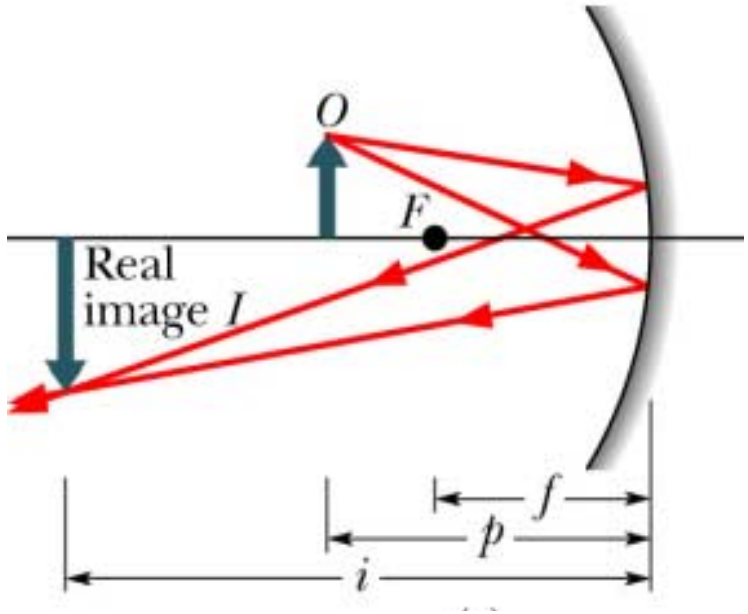


- For mirrors – real images on side where object is, virtual images on opposite side
- Convex and plane mirrors only form virtual images, have same orientation as object

Spherical mirrors (Fig. 35-8)

- Formula for focal length, *f*

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



- Object distance *p* is +
- Image distance *i* is + for real images, - for virtual images
- Focal length *f* is + for concave mirror, - for convex mirror

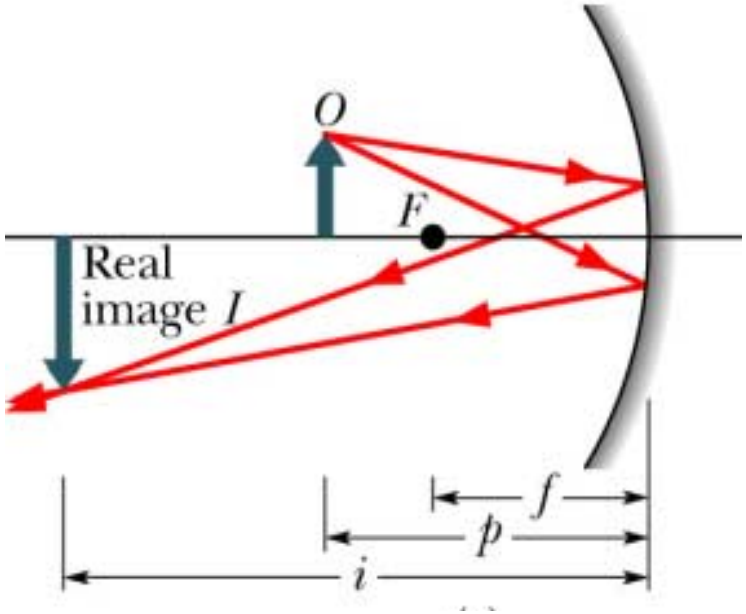
Spherical mirrors (Fig. 35-8)

- Size of object or image measured ⊥ to central axis is defined to be height h
- Ratio of image's height *h´* to object's height *h* is called lateral magnification

$$|m| = \frac{h'}{h}$$

- Also written

$$m = -\frac{i}{p}$$



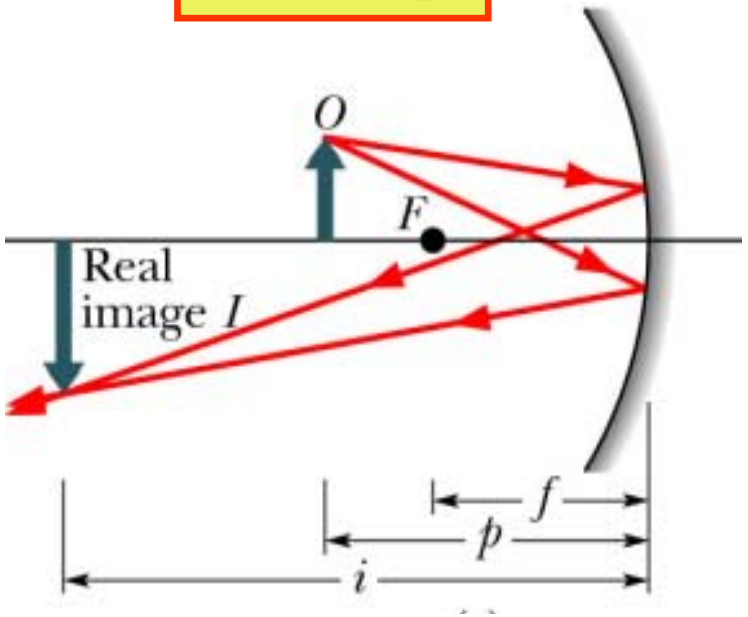
- m is + for same orientation
- m is – for inverted image
- Plane mirror $m = +1$

Checkpoint #2

- Vampire bat is dozing on central axis of spherical mirror. It is magnified by m=-4. Is this image a) real or virtual, b) inverted or same orientation as bat, c) on the same or opposite side of mirror as bat?

$$m = -\frac{i}{p}$$

- m =- 4 tells us image is bigger and inverted
- m is negative so i must be positive and the image is real
- Real images only occur on same side of mirror
- Only concave mirrors give real images



Spherical mirrors table

Mirror Type	Object Location	Image Location	Image Size	Image Type	Image Orient-ation	Sign of *f*	Sign of *i*	Sign of *m*
Plane	Any-where	i = - p	Equal	Virtual	Same	∞	-	+1
Concave	p < f	Any-where	Bigger	Virtual	Same	+	-	+
Concave	f <p<2f	i > 2f	Bigger	Real	Invert	+	+	-
Concave	p = 2f	i = 2f	Equal	Real	Invert	+	+	-
Concave	p > 2f	2f > i > f	Smaller	Real	Invert	+	+	-
Convex	Any-where	|i| < |f|	Smaller	Virtual	Same	-	-	+