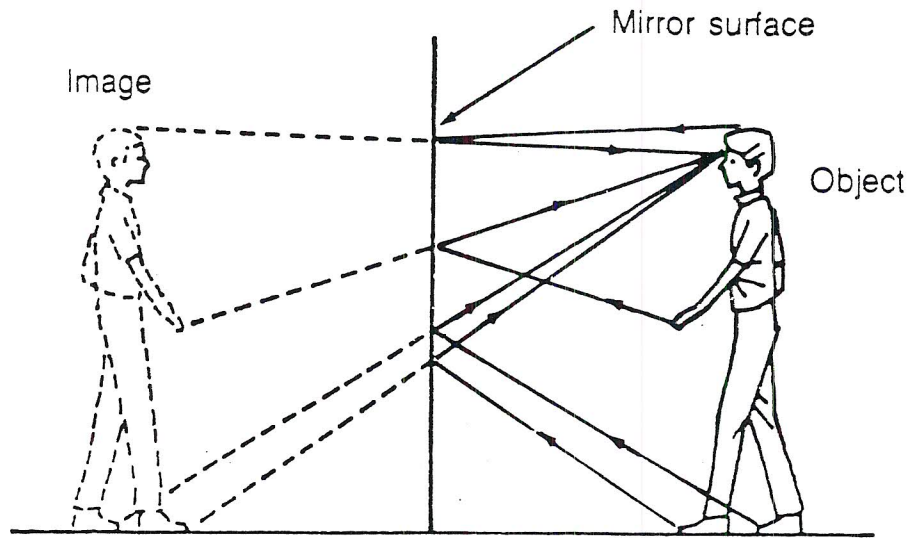


Image Properties of Mirrors and Lenses (Concave/Convex)

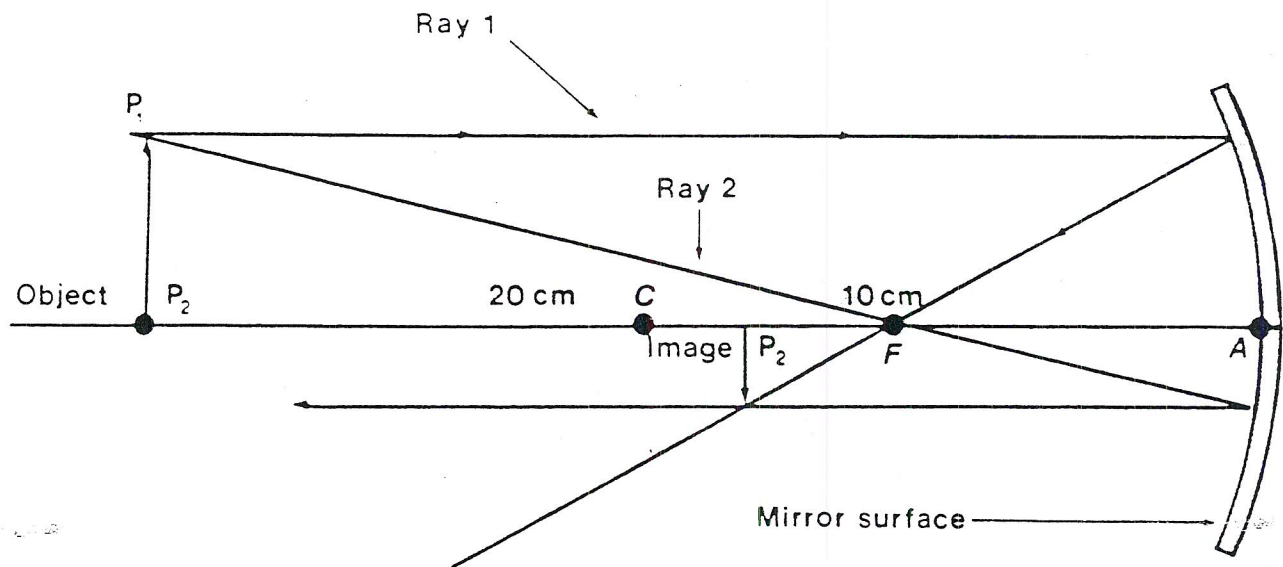
	Concave Mirrors				Convex Mirrors			
d_o	d_i	h_i	image orientation	type of image	d_i	h_i	image orientation	type of image
less than f	farther > d_o , < f	larger	erect	virtual	closer < f	smaller	erect	virtual
at f	no image	---	---	---	close < f	smaller	erect	virtual
between f and C	farther beyond C	larger	inverted	real	closer < f	smaller	erect	virtual
at C	equal at C	same	inverted	real	closer < f	smaller	erect	virtual
Beyond C	closer between	smaller	inverted	real	closer < f	smaller	erect	virtual

	Concave Lenses				Convex Lenses			
d_o	d_i	h_i	image orientation	type of image	d_i	h_i	image orientation	type of image
less than f	closer < f	smaller	erect	virtual	farther > d_o , < f	larger	erect	virtual
at f	close < f	smaller	erect	virtual	no image	---	---	---
Between f and $2f$	closer < f	smaller	erect	virtual	farther beyond C	larger	inverted	real
at $2f$	closer < f	smaller	erect	virtual	equal at C	same	inverted	real
Beyond $2f$	closer < f	smaller	erect	virtual	closer between	smaller	inverted	real

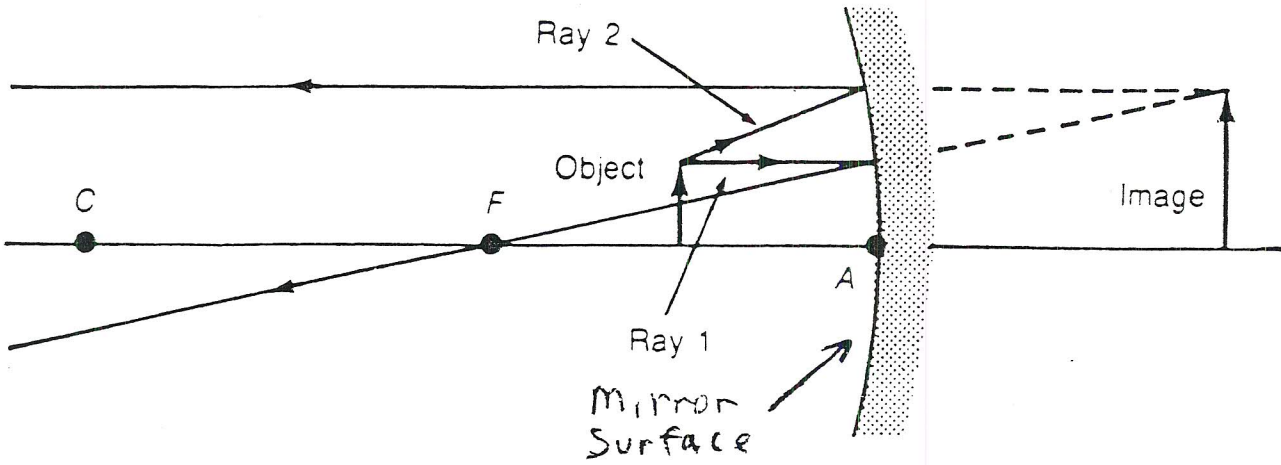
IMAGE FORMED BY A PLANE MIRROR



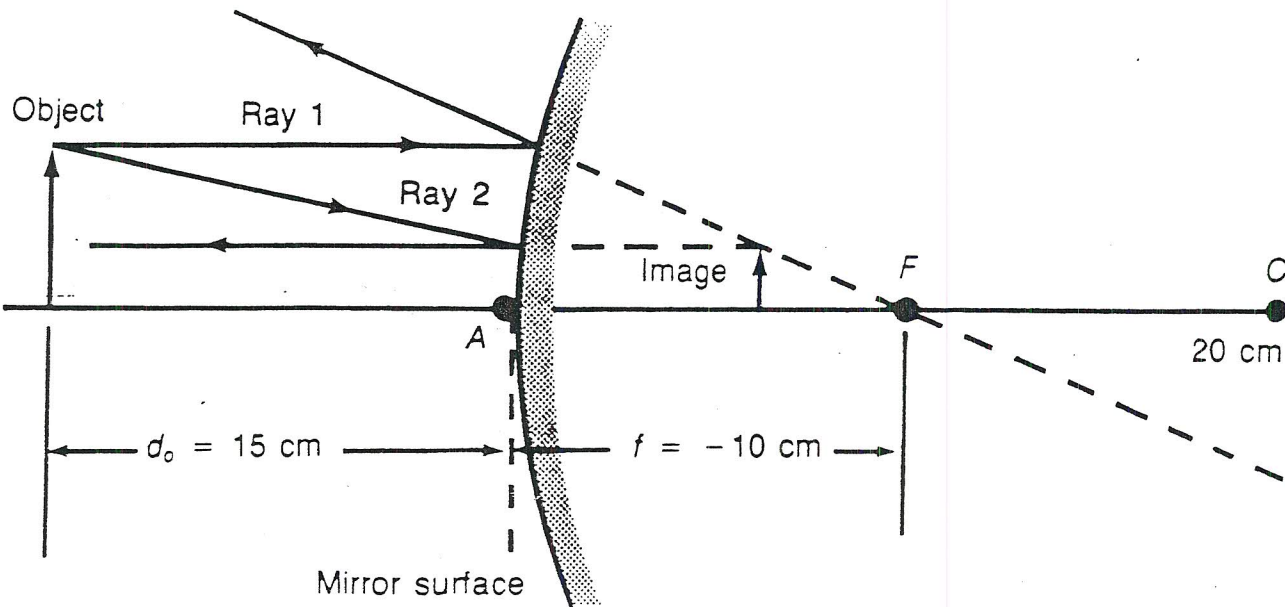
REAL IMAGE FORMED BY A CONCAVE MIRROR



VIRTUAL IMAGE FORMED BY A CONCAVE MIRROR



VIRTUAL IMAGE FORMED BY A CONVEX MIRROR



VIII Optical Situations

In I & II rays converged at F. In IV, rays do not meet.

C= geometric center (point of drafting compass)
F= focus

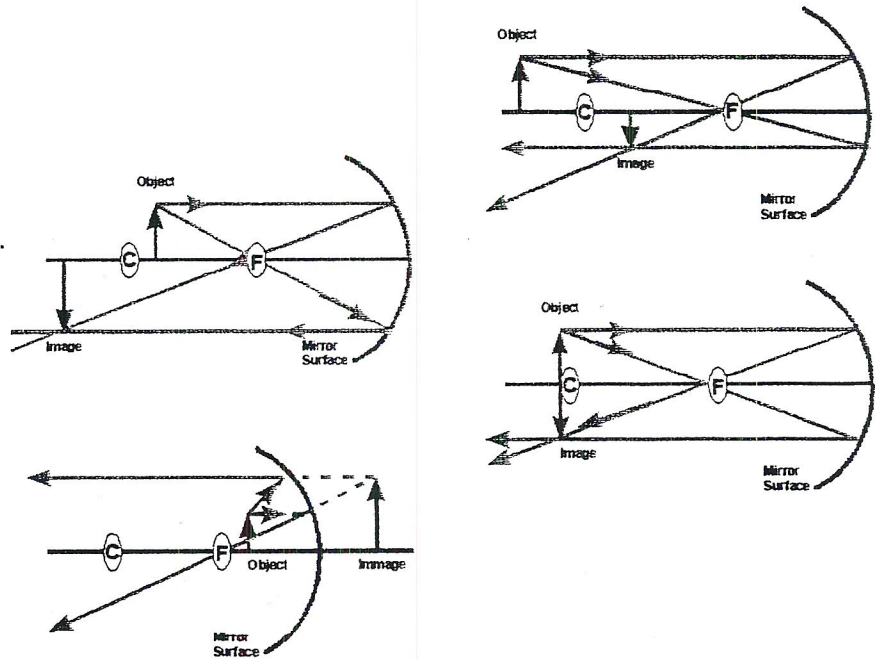
4 Rules for Concave Mirrors.

I. Object outside of C. inverted; -m; real

II. Object between C and F. inverted; +m; real

III. Object is at C. inverted; $\pm m$; real

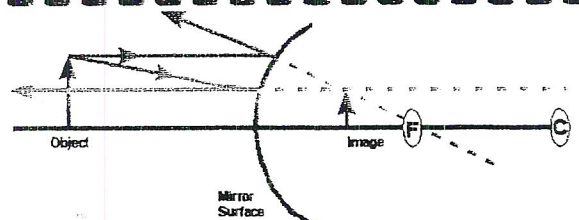
IV. Object between F and mirror. erect; +m; virtual



1 Rule for Convex Mirrors.

V. Object in front of mirror. erect; -m; virtual

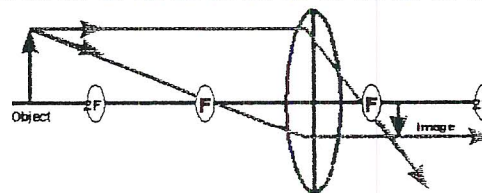
Rays do not meet



2 Rules for Convex Lenses.

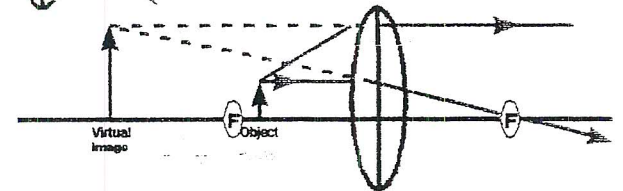
VI. Object located beyond F. inverted; -m; real

VII. Object located between focus and lens. erect; +m; virtual



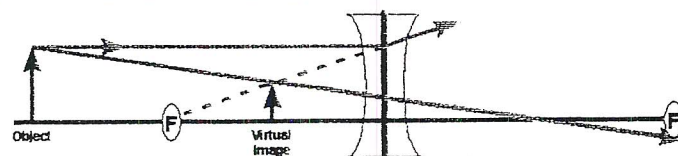
Rays meet

Rays do not meet



1 Rule for Concave Lenses.

VIII. Images formed by concave lenses are always: erect; -m; virtual



Concave lenses always cause light to diverge.

Important Formulas

Focal length for spherical mirror:

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

Spherical mirror equation:

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

Thin lens equation (where $f \neq R/2$):

$$d_i = \frac{d_o f}{d_o - f}$$

Magnification:

$$M = -\frac{d_i}{d_o}$$

Sign Convention for Spherical Mirrors

Concave mirror: f positive

Convex mirror: f negative

d_o always positive

d_i	Image	M	Image
+	Real	+	Upright
-	Virtual	-	Inverted

Sample problem

Find M , and get used to working with sign conventions...

1. Since the mirror is convex, f is negative.

$$2. d_i = \frac{(15)(-10)}{15 - (-10)} = -6$$

3. Since d_i is negative, the image is virtual.

$$4. m = -\frac{(-6)}{15} = .4$$

5. M is positive, so the image is upright

VIRTUAL IMAGE FORMED BY A CONVEX MIRROR

