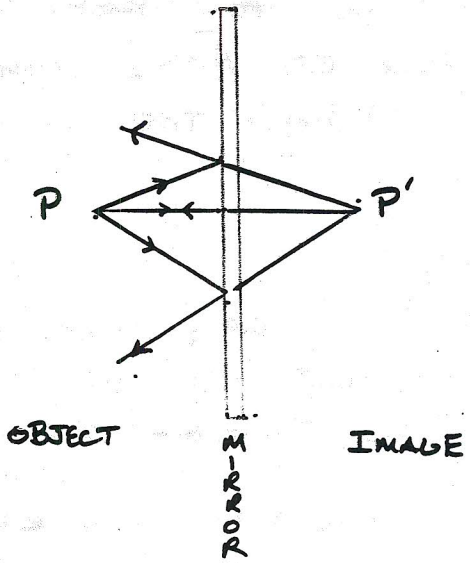
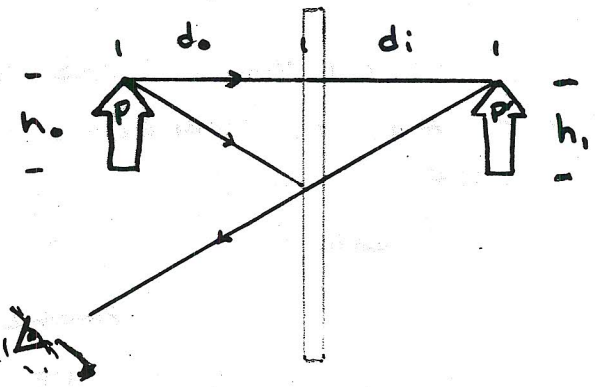
# CHAPTER 18: MIRRORS AND LENSES

**PLANE MIRROR:** a mirror with a flat surface

⇒ Plane mirrors create virtual images

- Point from which light rays appear to diverge without actually doing so.




$d_o$ = object distance
$d_i$ = image distance
$h_o$ = object height
$h_i$ = image height

* The image formed by a plane mirror appears to be at a distance behind the mirror that is equal to the distance of the object in front of the mirror.

## MAGNIFICATION

$$m = \frac{image height}{object height} = \frac{h_i}{h_o}$$

# SPHERICAL MIRRORS

**CONVERGING MIRROR:** A mirror where parallel rays will intersect at a common point (focal point) upon reflection (Concave Mirror)

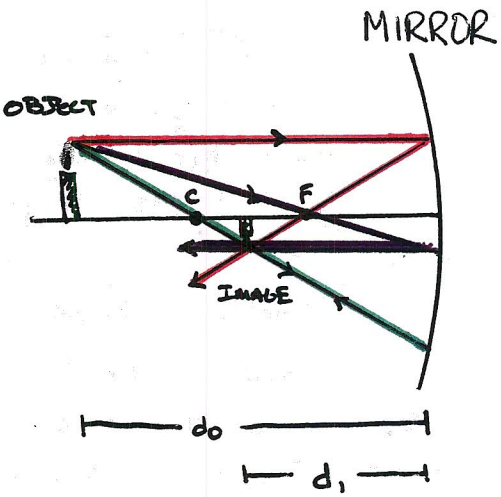
**DIVERGING MIRROR:** A mirror where parallel rays will diverge upon reflection, as though the reflected rays came from a focal point behind the mirrors (Convex Mirror)

# RAY DIAGRAMS

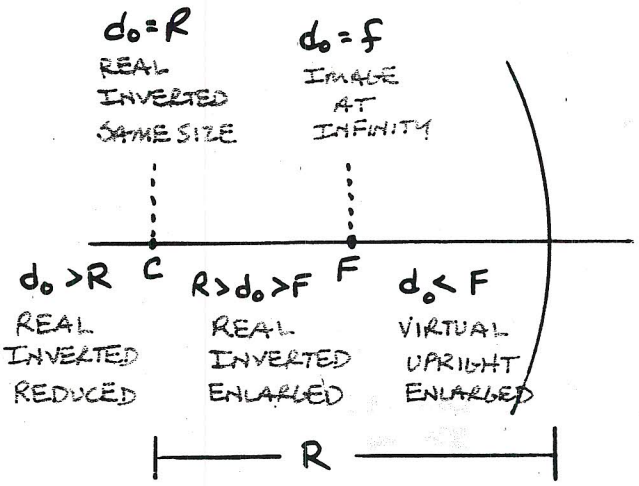
⇒ A **PARALLEL RAY** is a ray that is incident along a path parallel to the optic axis and is reflected through the focal point.

⇒ A **CHIEF RAY** or radial ray is a ray that is incident through the center of curvature (C). Since it is incident normal to the mirror's surface, this ray is reflected back along its incident path, through C.

⇒ A **FOCAL RAY** is a ray that passes through the focal point and is reflected parallel to the optic axis.




parallel ray
chief ray
focal ray
C - Center of Curvature
F – Focal Point




# EQUATIONS

## SPHERICAL MIRROR EQUATION

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

$d_o$ = Object distance
$d_i$ = Image distance
f = Focal distance

$$\frac{1}{f} = \frac{2}{R} \quad \text{or} \quad f = \frac{R}{2}$$

R = Radius of Curvature

## ⇒ TO FIND IMAGE DISTANCE:

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

## ⇒ MAGNIFICATION FACTOR

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

Sign indicates orientation of Image

# IMAGES FORMED WITH CONCAVE MIRRORS

OBJECT BEYOND C

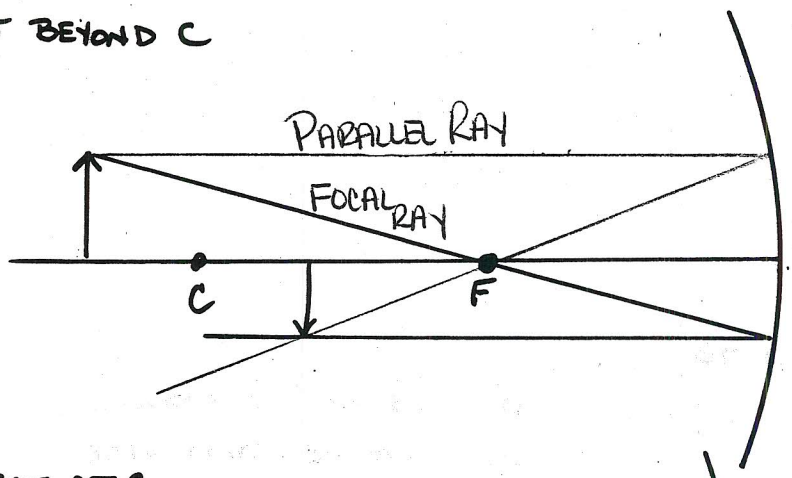



Image
- Real
- Inverted
- Smaller

$d_o > d_i$

$h_o > h_i$ $\therefore m < 1$

OBJECT AT C

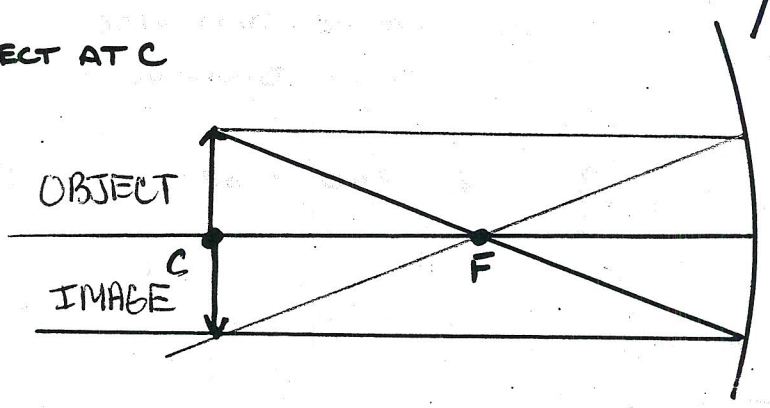



Image
- Real
- Inverted
- Same Size

$d_o = d_i$

$h_o = h_i$ $\therefore m = 1$

OBJECT BETWEEN C-F

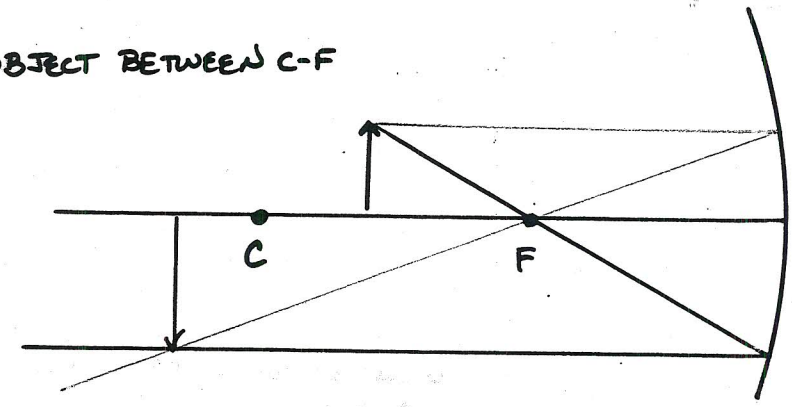



Image
- Real
- Inverted
- Larger

$d_o < d_i$

$h_o < h_i$ $\therefore m > 1$

OBJECT WITHIN F

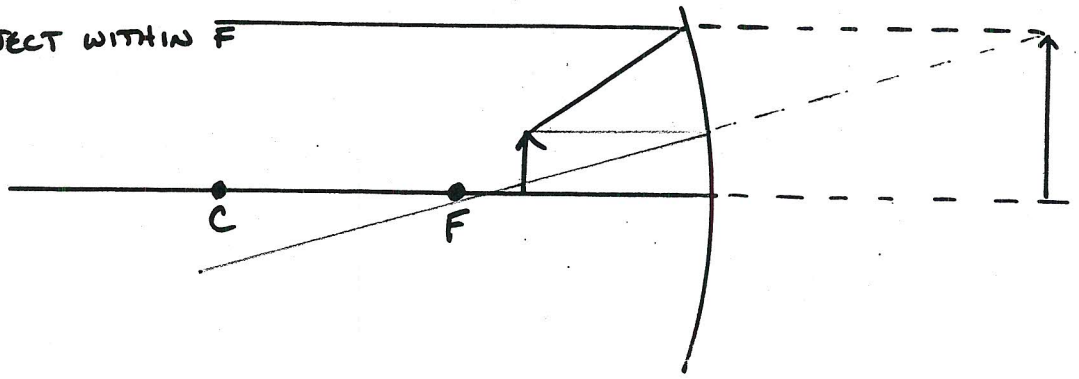



Image
- Virtual
- Erect
- Larger

$d_o < d_i$

$h_o < h_i$ $\therefore m > 1$

* When object is at F – No image is created.

# SIGNS IN EQUATIONS

$\Rightarrow$ The focal length $f$ (or R) is positive for concave mirrors and negative for convex mirrors.

$\Rightarrow$ The object distance $d_o$ is always positive.

$\Rightarrow$ The image distance $d_i$ is positive for a real image (same side of mirror as object) and negative for a virtual image (formed behind the mirror).

$\Rightarrow$ The magnification $m$ is positive for an upright image and negative for an inverted image.