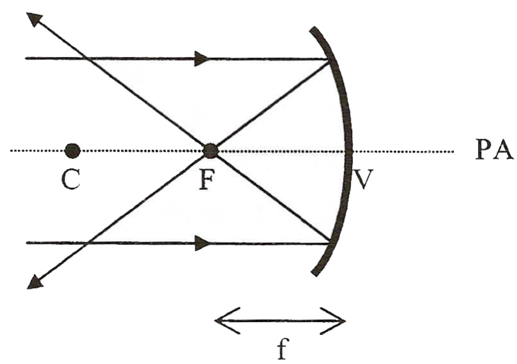
E. REFLECTION OF LIGHT (EMR) IN CURVED MIRRORS

E1. Types of Curved Mirrors

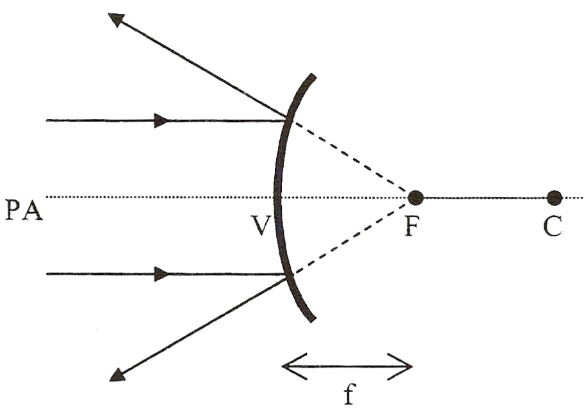
There are two types of curved mirrors:

1. Concave Mirrors (converging)



Applications of concave mirrors:
- Satellite dishes
- Solar cookers
- Telescopes
- Sound dishes
- Creating a parallel beam (bright)

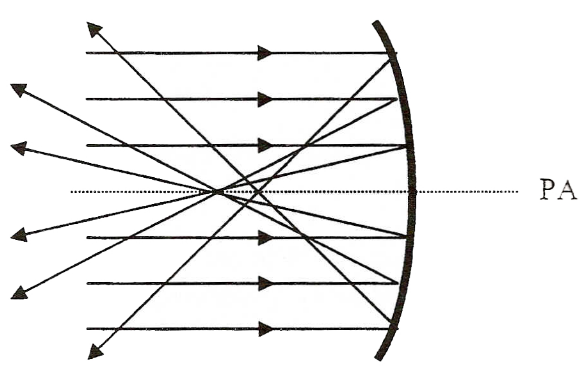
2. Convex Mirrors (Diverging)



Applications of convex mirrors:
- Store mirrors
- Truck mirrors
- Sound reflectors on ceiling
- Street lights

<u>Note</u>: Spherical Aberration

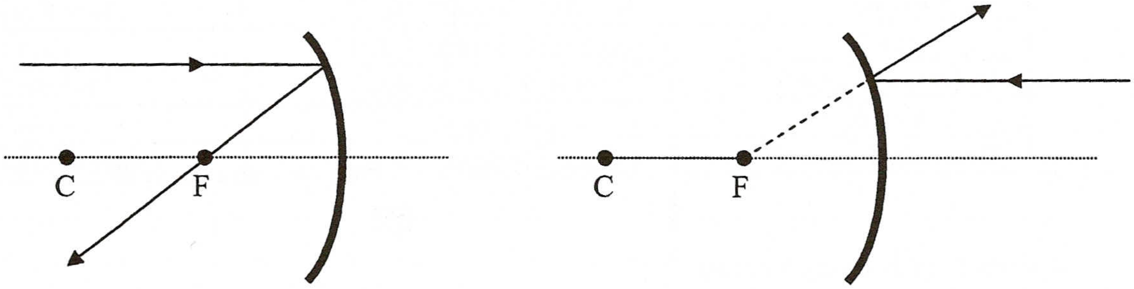
- if the mirror is spherical, the parallel incident rays will not converge on the same focus
- the further the rays are away from the principal axis, the further they go away from the principal focus
- a better focus is obtained using parabolic mirrors



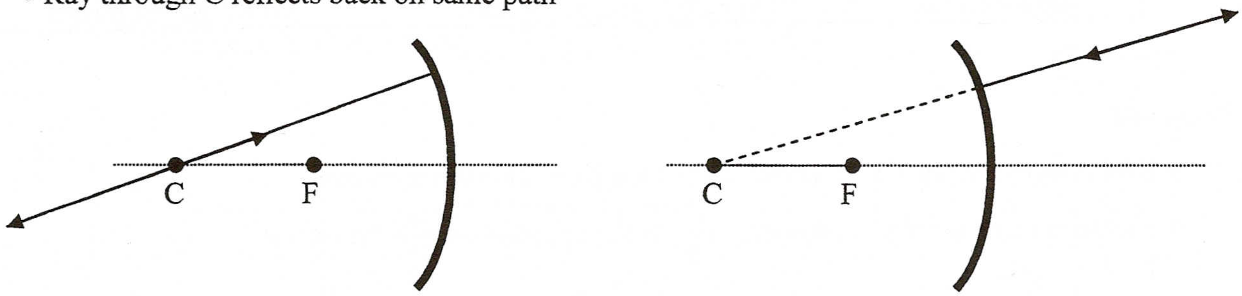
E2. Images in Curved Mirrors

Step 1: Sketch 2 of the following reflected rays:

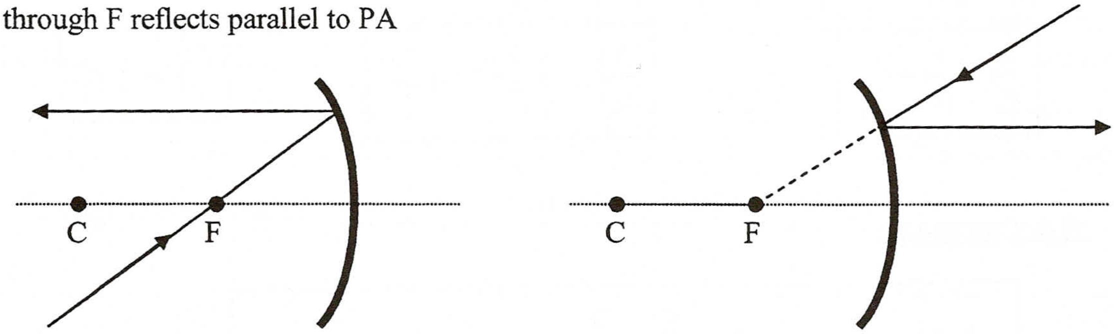
- Ray parallel to the PA reflects through F (*or* diverges from F)



- Ray through C reflects back on same path



- Ray through F reflects parallel to PA



Step 2: Locate the image

- image is always located where the **REFLECTED** rays converge (intersect)
- sketch the image from the PA to the intersection

Step 3: Describe the image

- Size - larger / smaller / same size as the object
- Attitude - inverted (flipped vertically) or upright
- Type - real (formed by real rays) or virtual

SUMMARY FOR CURVED MIRROR

1. Concave (Converging Mirrors)

	Image Characteristics	Location of Image
Beyond C	Smaller, Inverted, Real	Btw F and C
On C	Same size, Inverted, Real	On C
Between C and F	Larger, Inverted, Real	Beyond C
On F	No image	----------
Between F and V	Larger, Upright, Virtual	Other side of mirror

2. Convex (Diverging Mirrors)

	Image Characteristics	Location of Image
All locations	Smaller, Upright, Virtual	Other side of mirror

In general

- Real images are always **inverted** and on the same side of the mirror
- Virtual images are always **upright** and on the opposite side of the mirror

E3. Equations for Curved Mirrors

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

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

$$R = 2f$$

Sign Convention

h, Mag	+	Upright	Measured from PA
	–	Inverted	
d , *f*	+	Real	Measured from V
	–	Virtual	

Note:

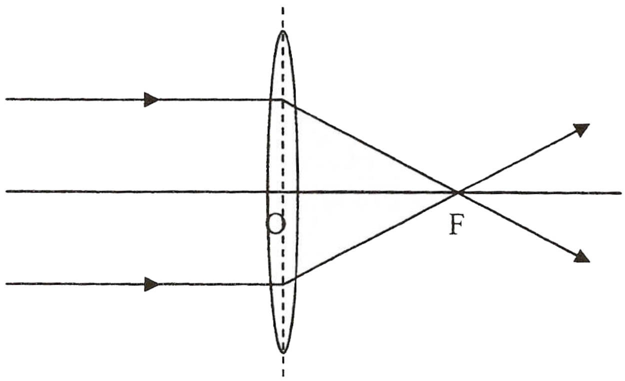
If Mag < 1, then the image is smaller than the object
If Mag = 1, then the image is the same size as the object
If Mag > 1, then the image is larger than the object

G. LENSES

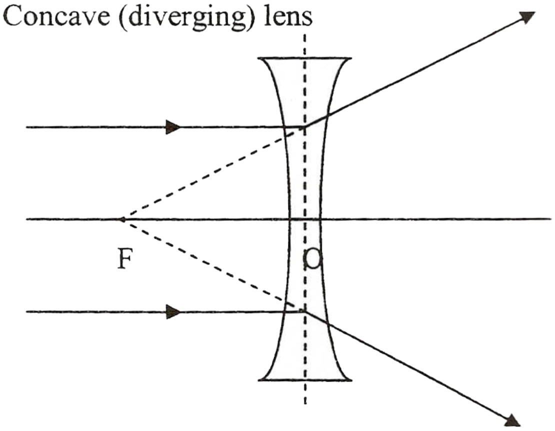
G1. Types of Lenses

- there are two types of lenses we will deal with:

Converging (convex) lens



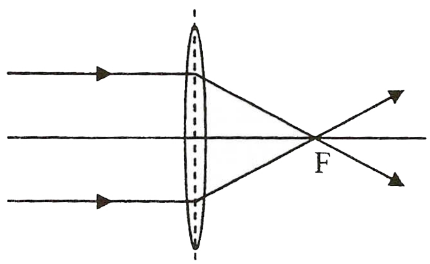
Concave (diverging) lens

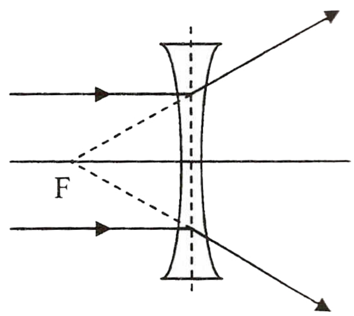


G2. Images Formed by Lenses (very narrow)

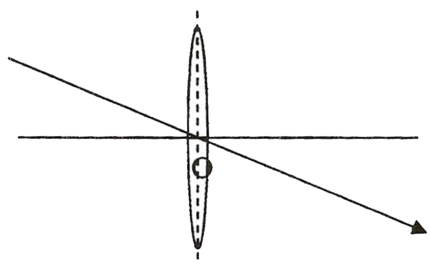
3 RULES (*similar to mirrors*)

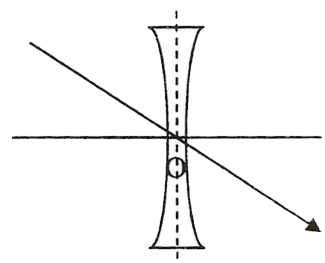
1. A ray parallel to the principal axis will refract through (or will appear to diverge from) the principal focus (F).



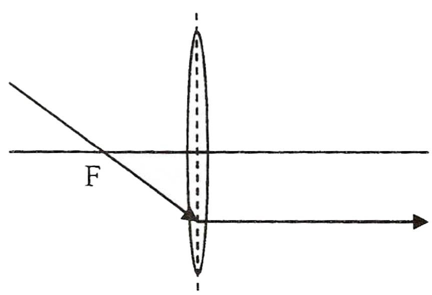


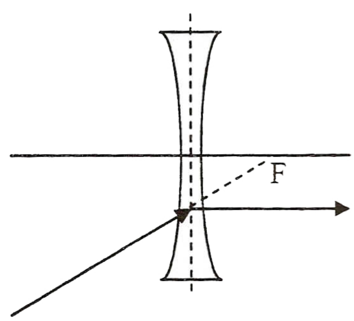
2. A ray through the optical centre (O) does not change direction. (*Ignoring any lateral shift*)





3. A ray through the principal focus (F) will refract parallel to the principal axis.





DRAWING THE IMAGE

- where the refracted rays intersect (if real rays, real image; if virtual rays, then a virtual image)
- image is drawn from the principal axis to the point of intersection

SUMMARY FOR LENSES

1. Converging (Convex) Lenses

	Image Characteristics	Location of Image
Beyond 2F	Smaller, Inverted, Real	Btw F and 2F
On 2F	Same size, Inverted, Real	On 2F
Between 2F and F	Larger, Inverted, Real	Beyond 2F
On F	No image	----------
Between F and O	Larger, Upright, Virtual	Same side of lens

2. Diverging (Concave) Lenses

	Image Characteristics	Location of Image
All locations	Smaller, Upright, Virtual	Same side of lens

In general

- Real images are always **inverted** and on the other side of the lens
- Virtual images are always **upright** and on the same side of the lens

G3. Equations for Lenses

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

$$\frac{h_i}{h_o} = -\frac{d_i}{d_o} = \text{Mag}$$

$$R = 2f$$

Sign Convention

h, Mag	+	Upright	Measured from PA
	–	Inverted	
d , f	+	Real	Measured from O
	–	Virtual	

Note:

If Mag < 1, then the image is smaller than the object
If Mag = 1, then the image is the same size as the object
If Mag > 1, then the image is larger than the object