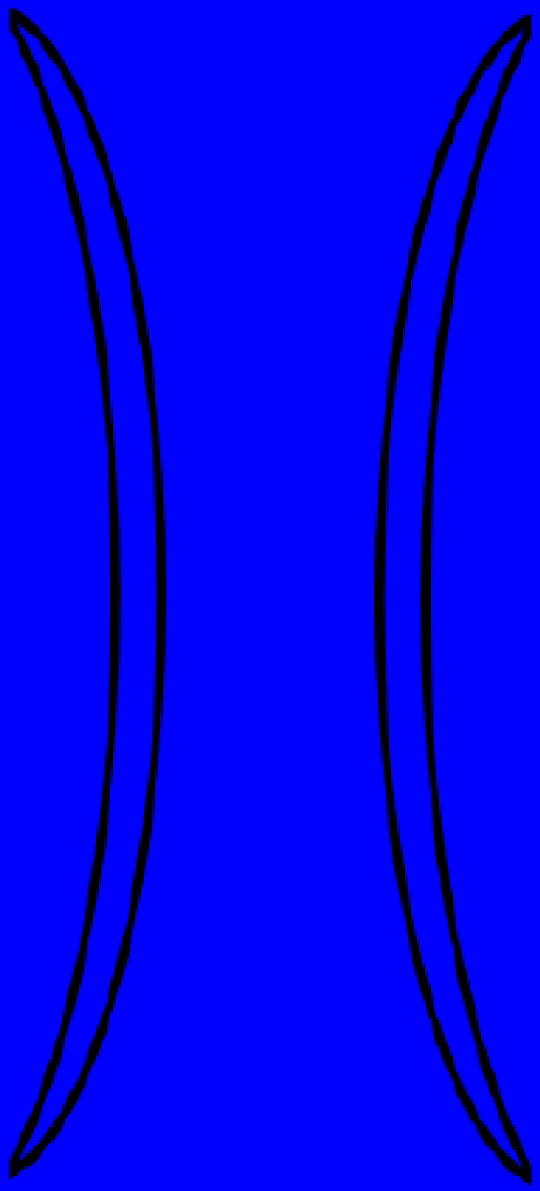
Concave

and

Convex Mirrors



POS Checklist:

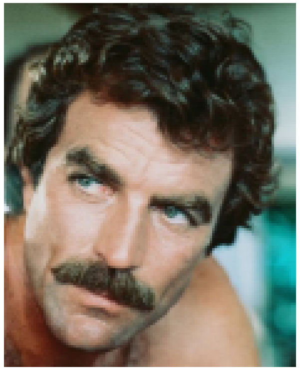
- ☐ describe, quantitatively, the phenomena of reflection and refraction, including total internal reflection.
- ☐ describe, quantitatively, simple optical systems, consisting of only one component, for both lenses and curved mirrors.

Diploma Question (Jan 1984) Alert!

2) If the angle between a plane mirror and an incident ray is 20°, then the angle between the incident ray and the reflected ray is:

a) 140°
b) 90°
c) 40°
d) 20°

Diploma Question (Jan 1984) Alert!



4. When light goes from air into water, the

a) frequency increases
b) speed increases
c) frequency decreases
d) wavelength decreases

5. After light passes from air into a second medium, its speed is observed to be 2.0×10^8 m/s. The index of refraction of the second medium is

a) 0.67
b) 1.3
c) 1.5
d) 6.0

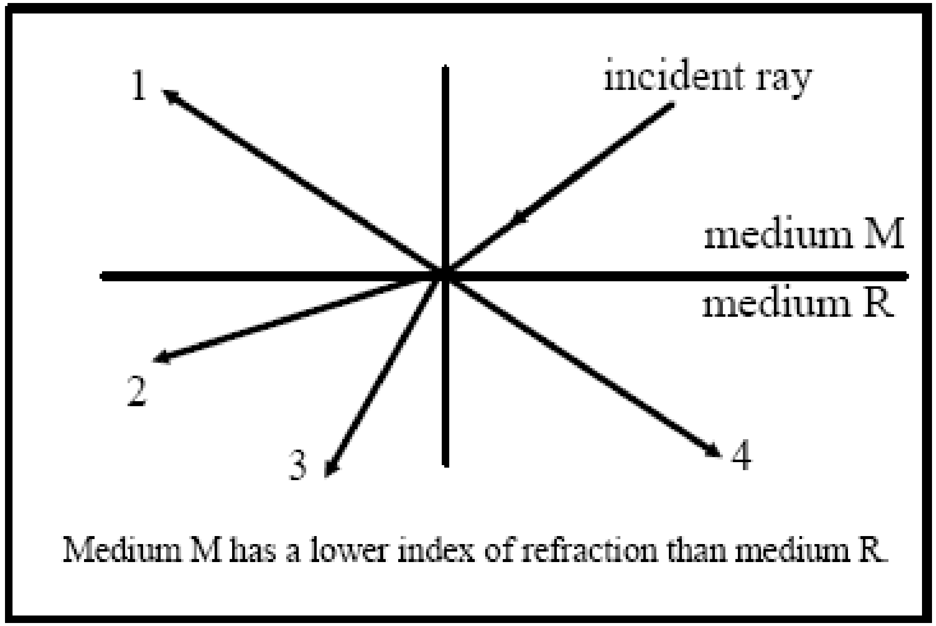
Diploma Question (Jan 1985) Alert!

11. Light with the longest wavelength is

a) yellow
b) violet
c) blue
d) red

Diploma Question (Jan 1985) Alert!

Use the following diagram to answer the next question:



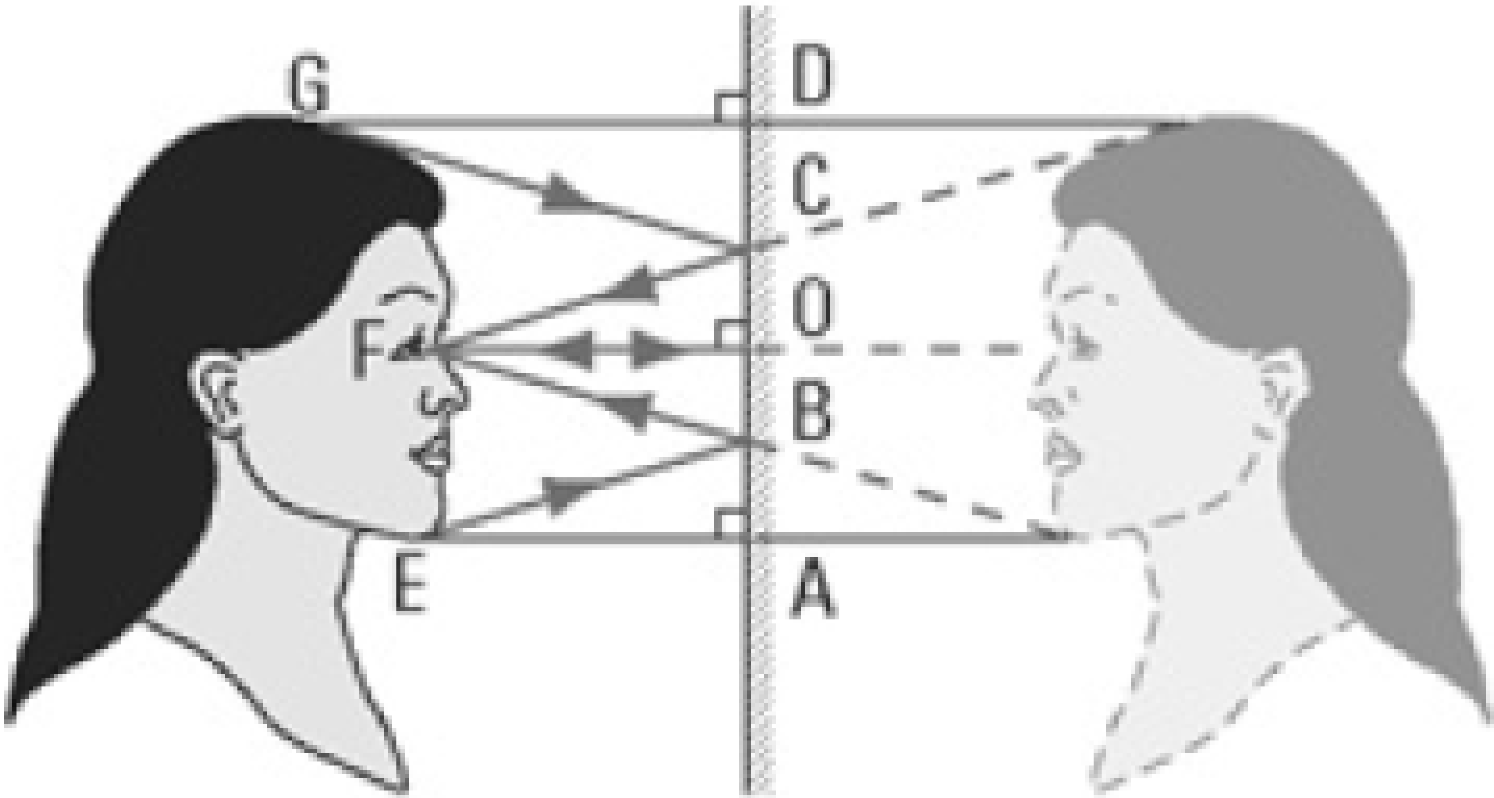
12. The ray representing the refracted light is

a) 1
b) 2
c) 3
d) 4

Images

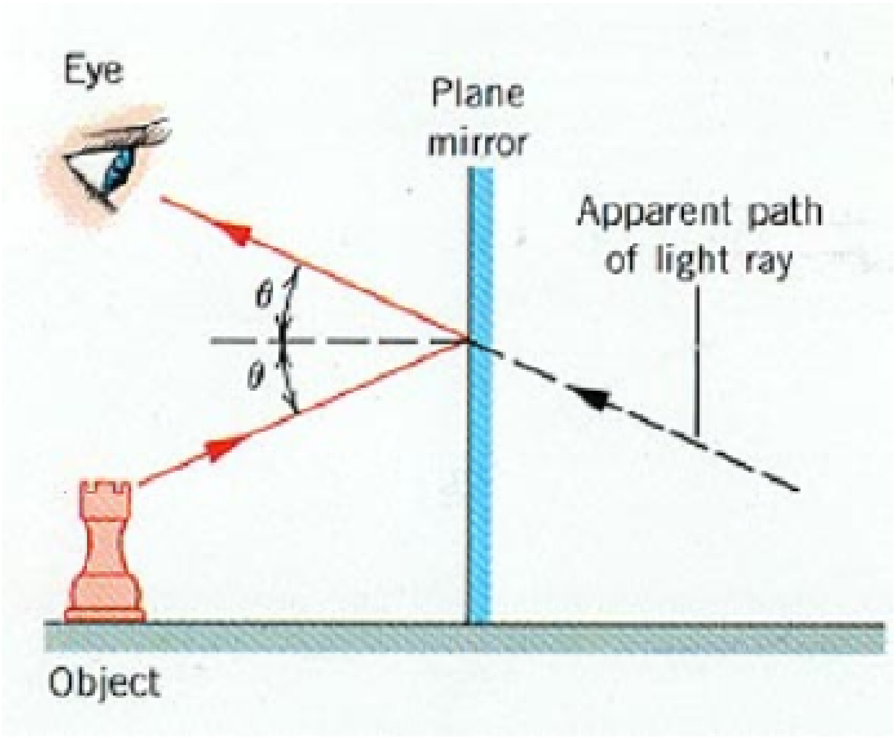
- **When you look into a plane (flat) mirror, it appears that your reflection is *behind* the mirror. This type of image is said to be a virtual image.**
- **Optically, there is no difference between a virtual image and a real image; that is, your eye can not tell the difference between the two.**

Images



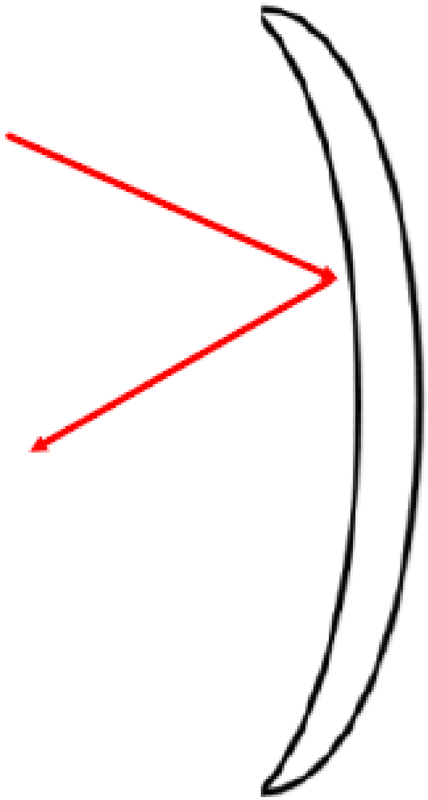
Curved Mirrors

- Curved mirrors work on the same principle as plane mirrors: reflection

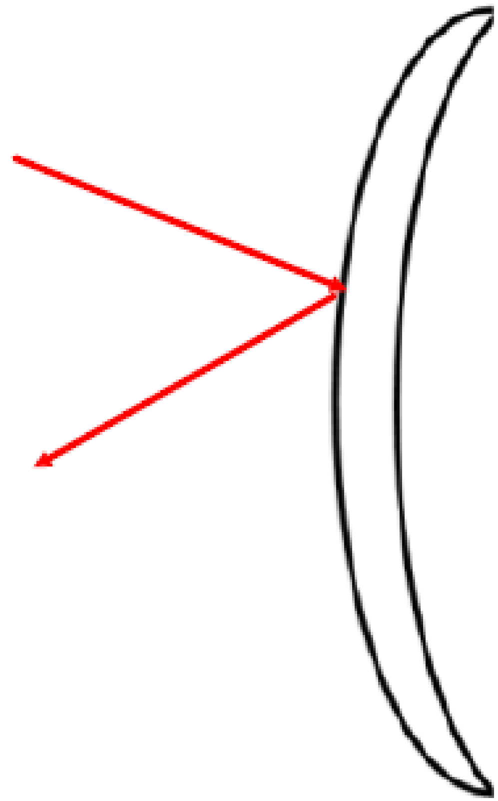


Law of Reflection:
The angle of incidence is equal to the angle of reflection.

There are two types of curved mirrors that we will deal with:

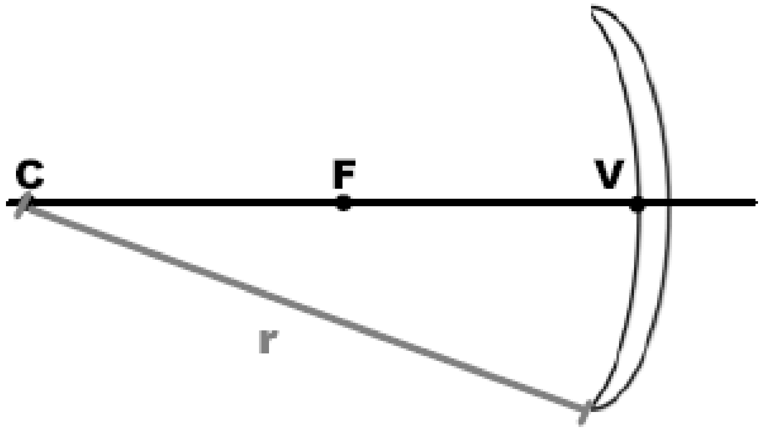


Concave



Convex

Concave Mirrors - converge light:



C - centre of curvature: if the mirror was a sphere, this point would be the centre.

r - radius of curvature: distance between C and mirror.

V - vertex: centre of the mirror.

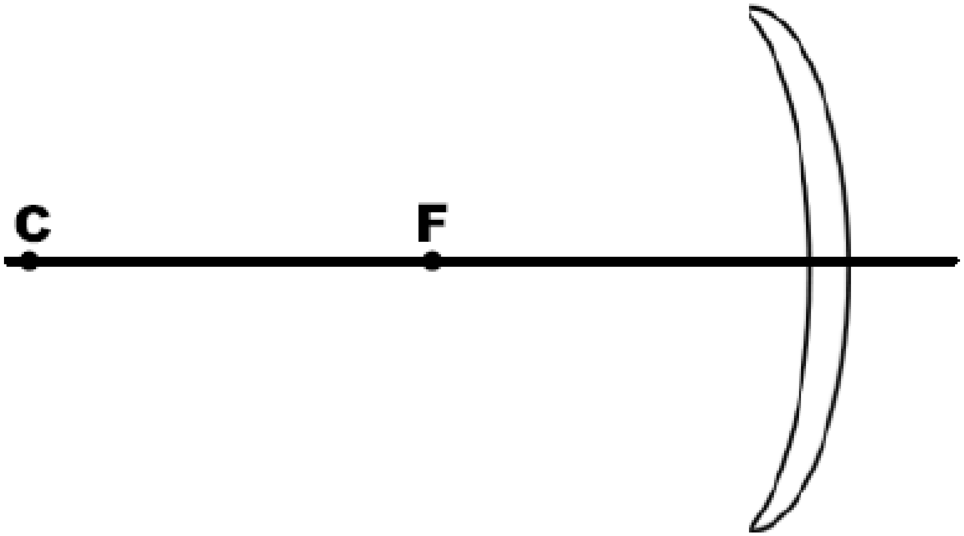
F - focal point: the point where the light rays converge (come together) or appear to converge, after reflection.

f - focal length: distance between the mirror and focal point. $f = r/2$.

Principal Axis: the line drawn from the vertex, perpendicular to the surface of the mirror.

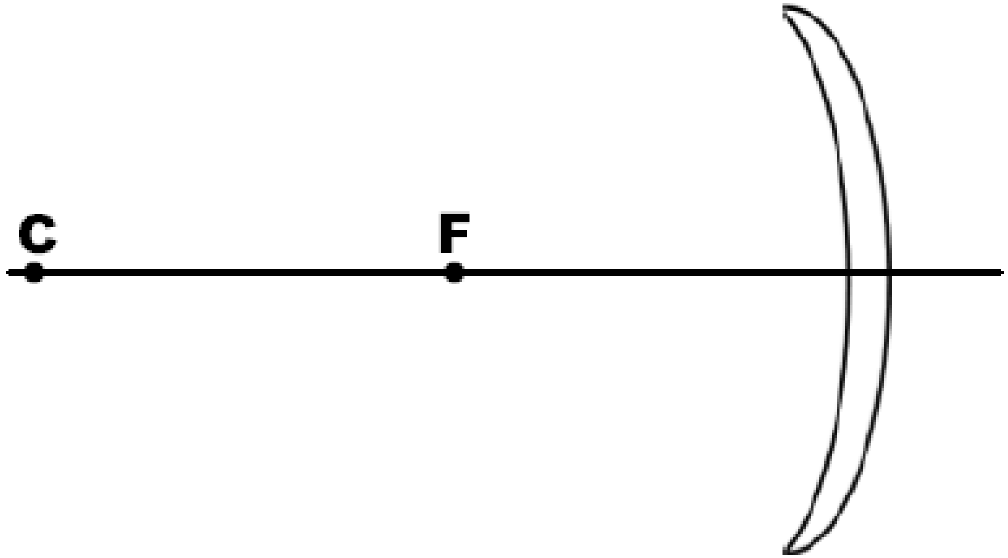
Q: What would an image look like when viewed in a concave mirror?

A: You need to draw 2 special rays to determine the image...



Ray 1) parallel to the principal axis, reflecting through the focal point.

*Any ray parallel to the PA will pass through the focal point.

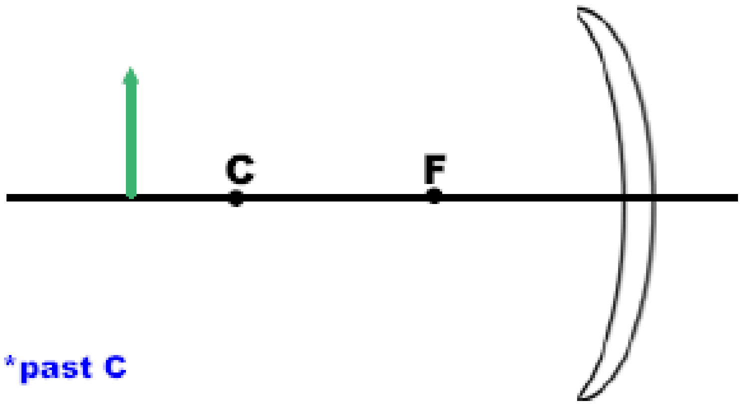


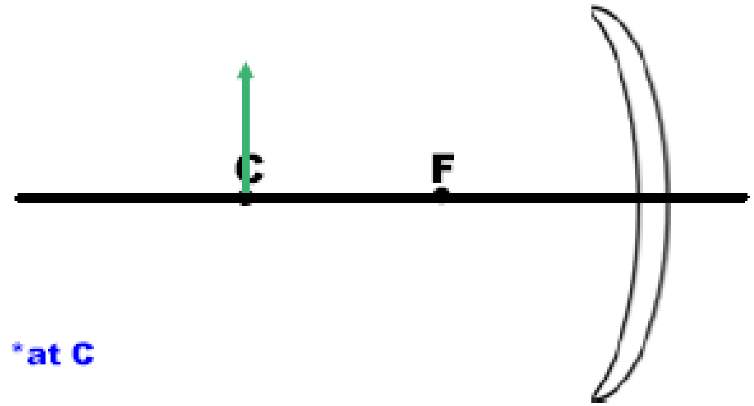
Ray 2) ray traveling through the focal point, reflecting parallel to the PA.

*Any ray parallel to the PA will pass through the focal point.

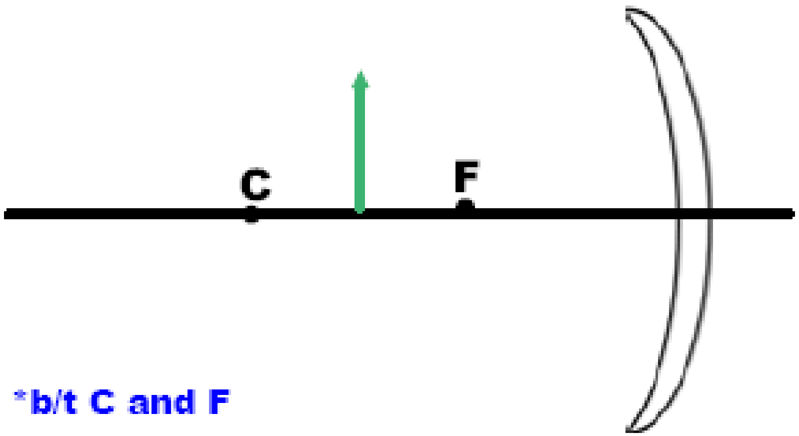
This is all we need to determine what an object will look like in a concave mirror.

ex) Determine the image characteristics (magnification, attitude, position, type) if an object appears at the following positions in a concave mirror:

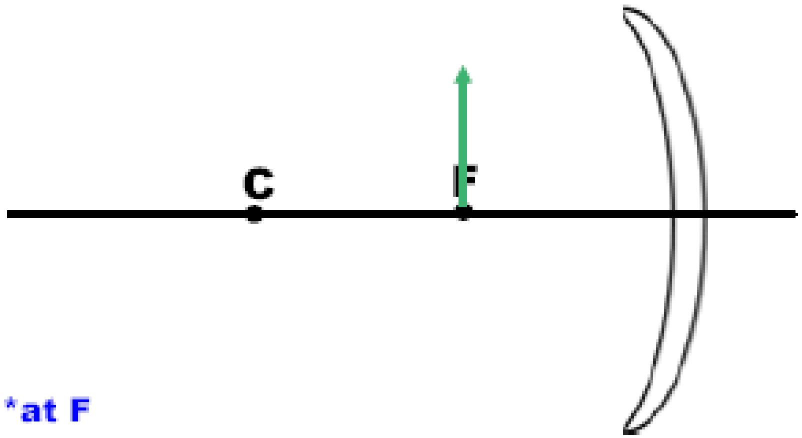




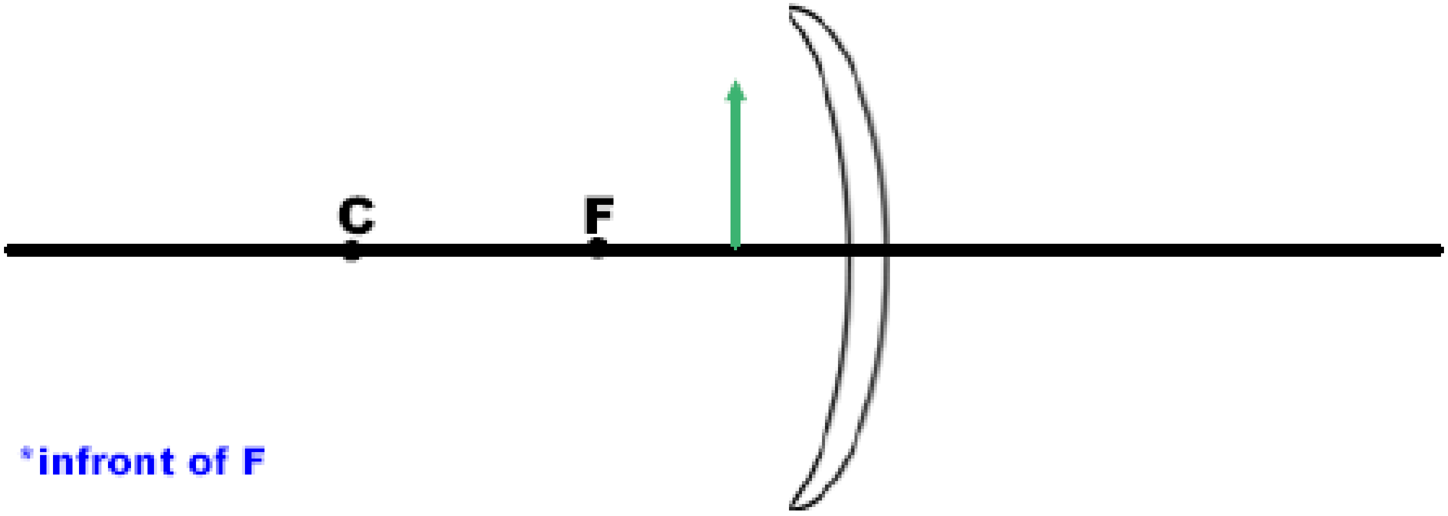
[Mirror App]



*b/t C and F



*at F



*infront of F

A summary of these findings is listed on page 660 in your text.

Object Position	Image Characteristic
distant	real, inverted, and diminished, close to F
outside centre of curvature	real, inverted, and diminished, between F and C
at the centre of curvature, C	real, inverted, and same size, at C
between focal point and centre of curvature	real, inverted, and enlarged, beyond C
at focal point, F	undefined (no image forms), at infinity
between focal point and vertex	virtual, erect, and enlarged, behind mirror

You may have noticed that the distances between the object and mirror and image and mirror varied in the last examples. The magnifications also changed. The values can be related using the equations

The Mirror Equation

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

Where:

f = focal length
d_i = image d from mirror
d_o = object d from mirror

The Magnification Equation

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

Where:

m = magnification factor
h = object/image height
d = object/image distance from mirror

When we are taking these measurements, we are not really dealing with vectors, so the usual sign conventions (up/right = +ive, down/left = -ive) do not apply.

Instead, we adopt these sign conventions:

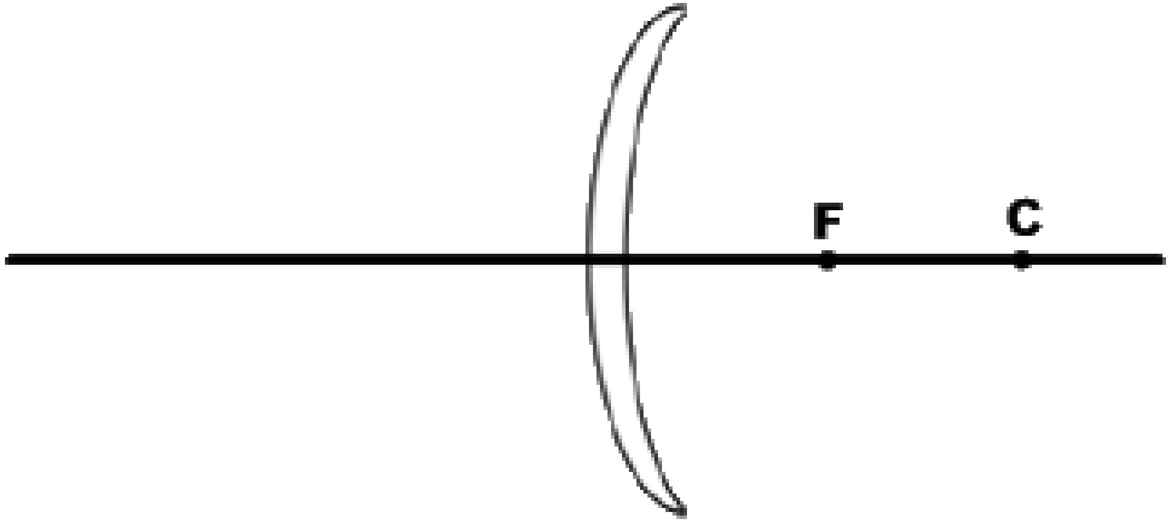
- **distances to real objects and images are +ive (infront of the mirror)**
- **distances to virtual images are -ive (behind the mirror)**
- **height is erect when +ive, inverted when -ive**
- **all distances are measured along the PA**

ex) A 8.5 cm candle is placed 13.6 cm from a concave mirror with focal length of 5.7 cm.

a) Find the distance the image is from the mirror.

b) Find the height of the image and the magnification factor.

Convex Mirrors - diverge light

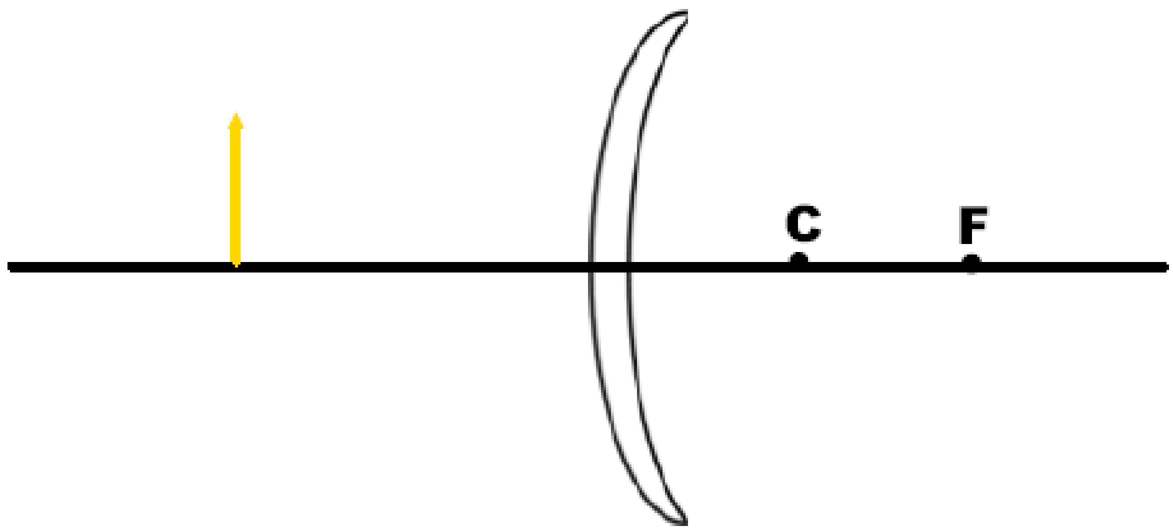


We draw the same two rays:

Ray 1) II to PA, reflecting through F.

Ray 2) Through C.

ex) Determine the image characteristics (magnification, attitude, position, type) if an object appears at the following positions in a convex mirror:

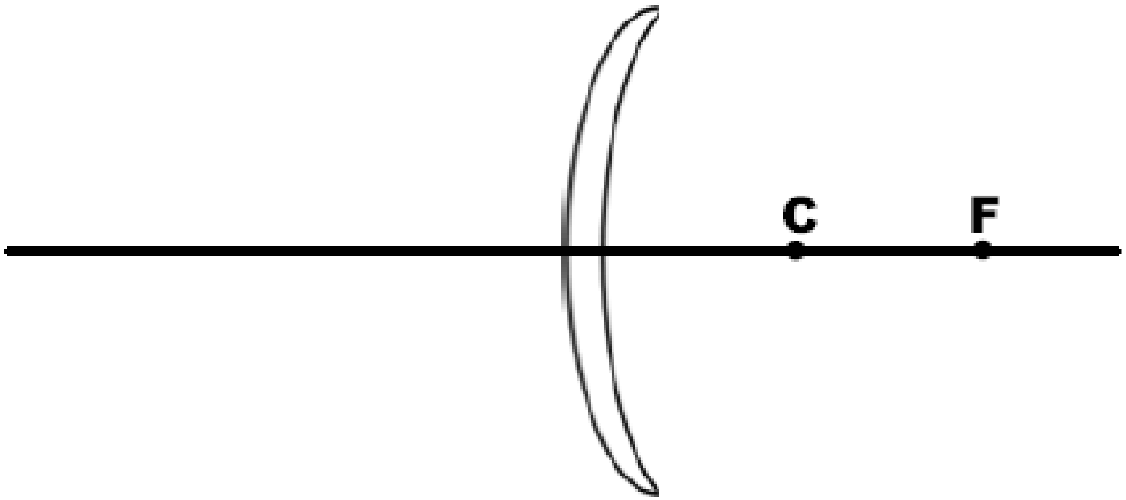


Note: It doesn't matter where the object is in the convex mirror, the image is always:

- **erect**
- **diminished**
- **virtual**

ex) A 2.5 cm high object is placed 9.0 cm in front of a convex mirror. The focal length of the mirror is 4.0 cm.

a) Draw the ray diagram for the virtual image.



*Hint: for convex mirrors, the focal point and centre of curvature have -ive signs to show they are behind the mirror.

b) Calculate the distance the image is away from the mirror.

c) Determine the image height.