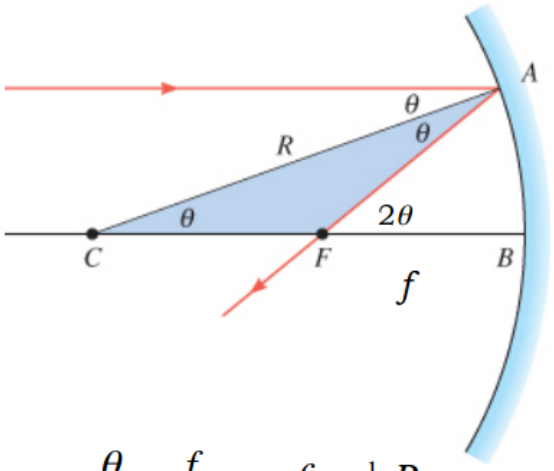
Proof:

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

Assume θ is small, i.e. that the incoming parallel ray is close to the principal axis. Then, *CAB* and *FAB* are approximately right triangles with the same opposite side *AB*.



From *CAB*, $\tan\theta = \frac{AB}{CB} = \frac{AB}{R}$

From *FAB*, $\tan 2\theta = \frac{AB}{FB} = \frac{AB}{f}$

Dividing, $\frac{\tan\theta}{\tan 2\theta} = \frac{AB/R}{AB/f} = \frac{f}{R}$

But for small θ ➔ tan $\theta \sim \theta$ and tan $2\theta \sim 2\theta$ ➔ $\frac{\theta}{2\theta} = \frac{f}{R}$ ➔ $f = \frac{1}{2}R$

Ray Diagrams for Concave Mirrors

It depends on the location of the object relative to the center of curvature (*C*) and the focus point (*f*) of the mirror.

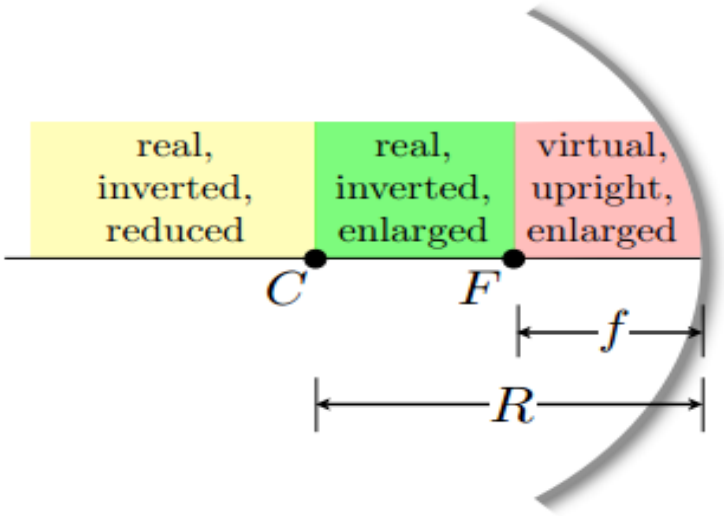
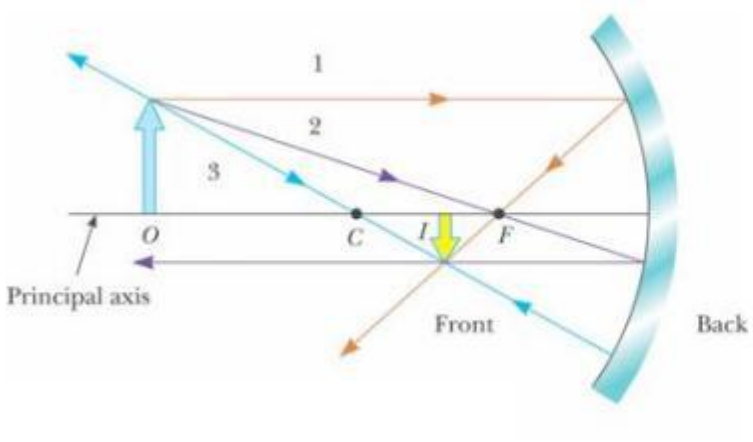


Figure 14. Ray Diagrams for Concave Mirrors

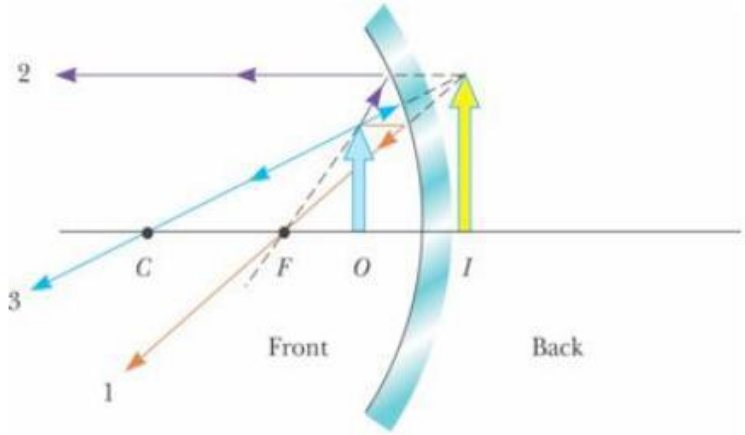
Examples:

1. a- Object beyond the Centre of curvature

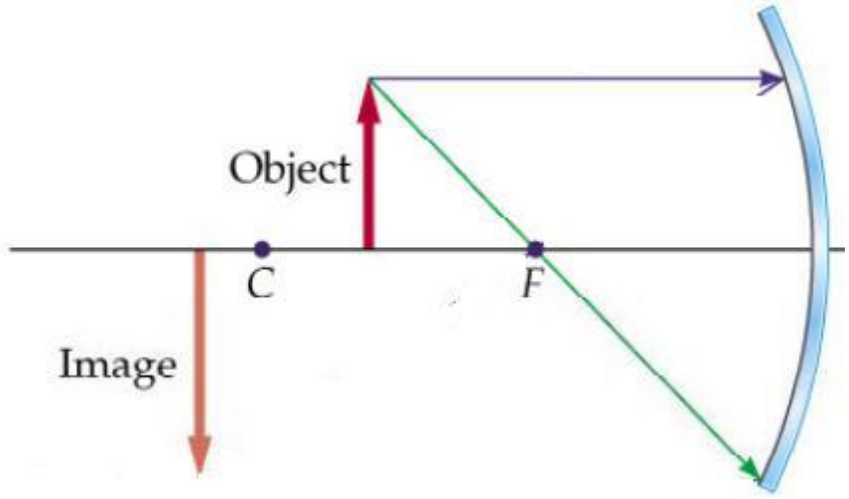
b-The image is;
– Real
– Inverted
– Smaller than the object (reduced)



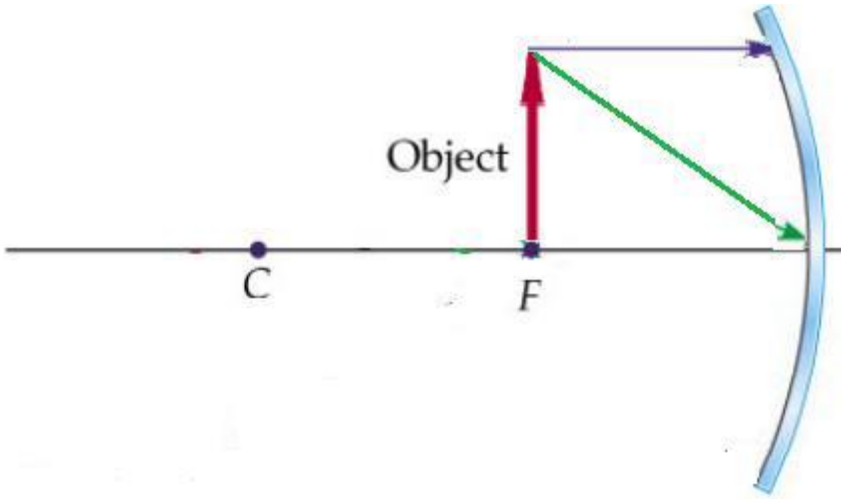
2. a- The object is between the mirror surface and the focal point
b- The image is;
– Virtual
– Upright
–Larger than the object (enlarged)



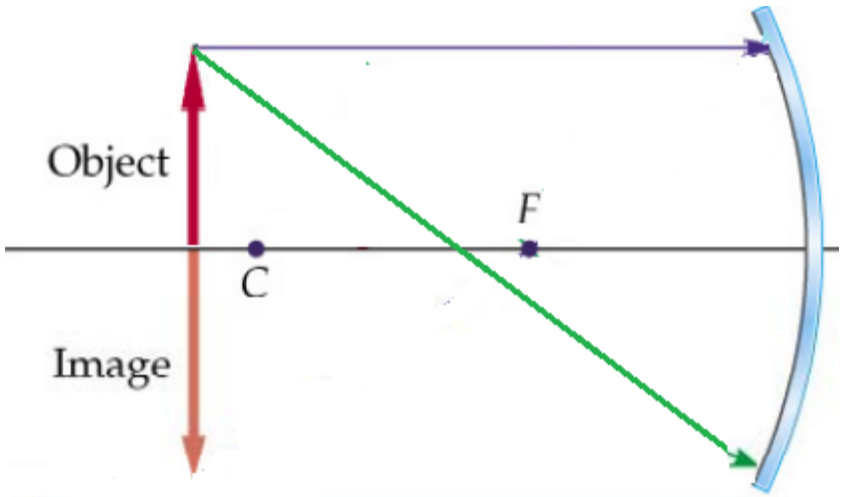
HOMEWORK
c- When Object is between Centre of Curvature and the Focus point



d-When the Object at the Focus point



e- When Object is at the Centre of Curvature



Example: A Real Image formed by a Concave Mirror. A 2.0 cm high object is placed 7.10 cm from a concave mirror whose radius of curvature is 10.20 cm. Find the location of the image and its size?

Solution;

P=7.10 cm , h=2.0 cm, R= 10.20

$$2/R=1/P + 1/q$$

$$\frac{2}{10.20} = \frac{1}{7.10} + \frac{1}{q}$$

q=18 cm → Real image since positive

$$\frac{ḧ}{h} = -\frac{q}{P}$$

$$\frac{ḧ}{2.0} = -\frac{18}{7.10}$$

ḧ =5.1 cm → Magnified and inverted

2. **Convex Spherical Mirrors**

It tends to diverge incident rays. **Figure 15. Convex Mirror**

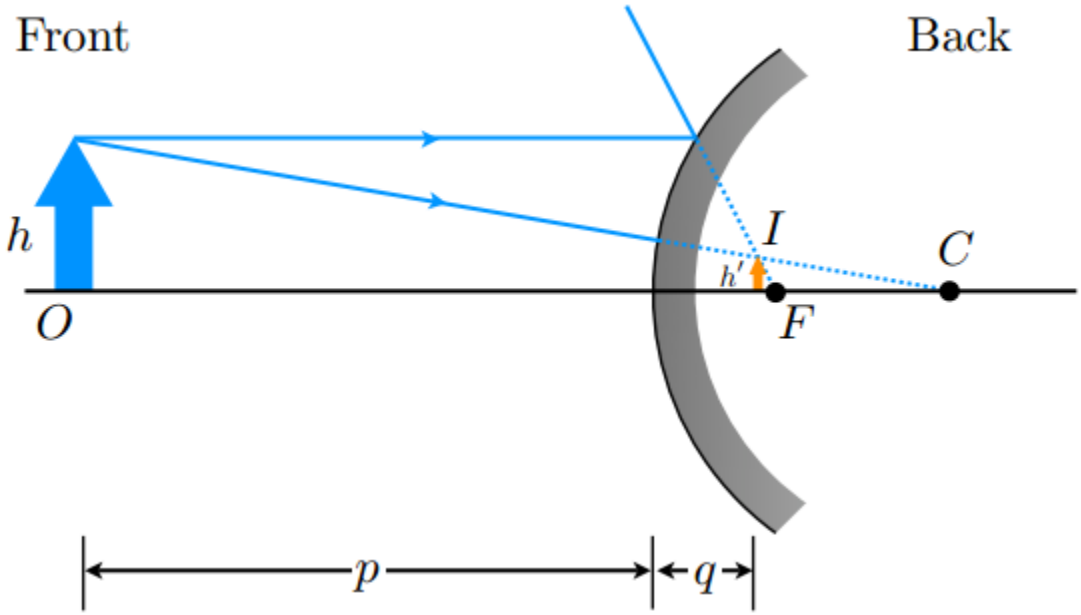
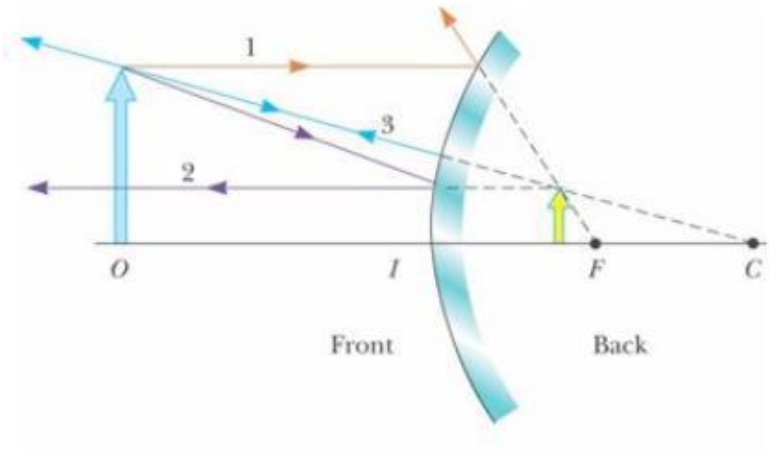


Figure 15. Convex Mirror

Ray Diagrams for Convex Mirrors



a- The object is in front of a convex mirror

b- The image is always;
– Virtual
– Upright
– Smaller than the object (reduced)

Example: A convex mirror is used to reflect light from an object placed 66 cm in front of the mirror. The focal length of the mirror is 46 cm in back of the mirror. Find the location of the image and the magnification?

Solution;

Since a the focal length of convex mirror is negative → f = -46 cm

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

$$\frac{1}{f} = \frac{1}{P} + \frac{1}{q}$$

$$\frac{1}{q} = \frac{1}{f} - \frac{1}{P} = \frac{1}{-46} - \frac{1}{66} = -0.037\ \text{cm}^{-1}$$

q= -27 cm → Image is virtual since negative

$$M = -\frac{q}{P} = -\frac{-27}{66} = 0.41$$ → image is upright and reduced