

## HOMEWORK SOLUTIONS FOR JULY 21

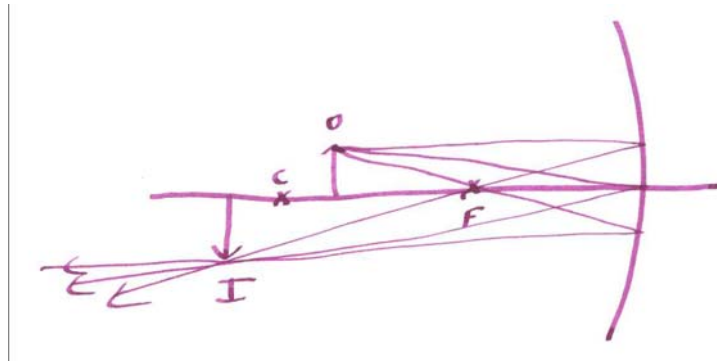
1. An object is placed 10 cm from the vertex of a concave mirror of radius of curvature 12 cm. Find the image distance and the magnification, and characterize the image in the usual way. Check your results by ray tracing using three different rays.

$$o = 10 \text{ cm and } f = +R/2 = +(12 \text{ cm})/2 = 6 \text{ cm}$$

$$1/i = 1/f - 1/o = 1/(6 \text{ cm}) - 1/(10 \text{ cm}) = (5 - 3)/(30 \text{ cm}) = 2/(30 \text{ cm}) = 1/(15 \text{ cm}) \text{ so}$$

$$i = 15 \text{ cm. Then } m = -i/o = -(15 \text{ cm})/(10 \text{ cm}) = -1.5.$$

Image is real, inverted, and 1.5 times as large as the object.



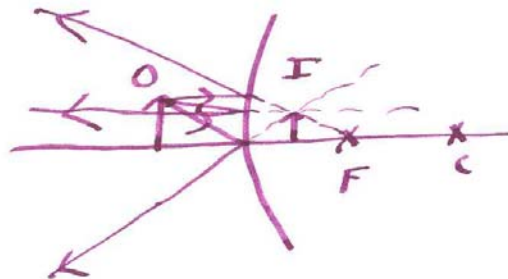
2. Repeat this for an object placed 12 cm from the vertex of a convex mirror of the same radius of curvature.

$$o = 12 \text{ cm and } f = -R/2 = -(12 \text{ cm})/2 = -6 \text{ cm}$$

$$1/i = 1/f - 1/o = 1/(-6 \text{ cm}) - 1/(12 \text{ cm}) = (-2 - 1)/(12 \text{ cm}) = -3/(12 \text{ cm})$$

$$= 1/(-4 \text{ cm}) \text{ so } i = -4 \text{ cm. Then } m = -i/o = -(-4 \text{ cm})/(12 \text{ cm}) = +1/3.$$

Image is virtual, erect, and 1/3 as large as the object.



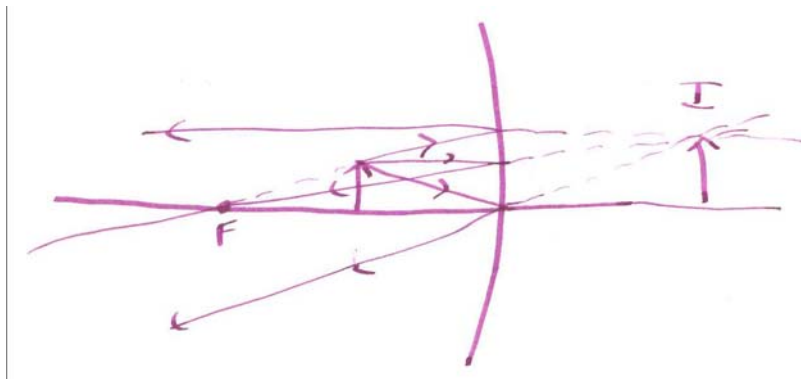
**3. An object is placed 5.00 cm from a concave mirror of focal length 10.0 cm. Find the radius of curvature of the mirror and the image distance and the magnification, and characterize the image in the usual way. Check your results by ray tracing using three different rays.**

$o = 5.00 \text{ cm}$  and  $f = 10.0 \text{ cm}$  so  $R = 2f = 20.0 \text{ cm}$ .

$$1/i = 1/f - 1/o = 1/(10 \text{ cm}) - 1/(5.0 \text{ cm}) = (1 - 2)/(10 \text{ cm}) = -1/(10 \text{ cm})$$

so  $i = -10 \text{ cm}$ . Then  $m = -i/o = -(-10 \text{ cm})/(5.0 \text{ cm}) = +2$ .

Image is virtual, erect, and twice as large as the object.



**4. When an object 1.00 mm high is placed 30 cm from a spherical mirror, an erect image 3.00 mm high is produced. What are the image distance and the focal length and the radius of curvature of the mirror? What kind of mirror is it (concave or convex)?**

The magnification has magnitude  $(3.00 \text{ mm})/(1.00 \text{ mm}) = 3$  and the image is erect, so

$m = +3$ . Since  $o = 30 \text{ cm}$ ,  $i = -om = -(30 \text{ cm})(+3) = -90 \text{ cm}$ .

$$1/f = 1/i + 1/o = 1/(-90 \text{ cm}) + 1/(30 \text{ cm}) = (-1 + 3)/(90 \text{ cm}) = 2/(90 \text{ cm})$$

$= 1/(45 \text{ cm})$  so  $f = 45 \text{ cm}$ . This is then a concave mirror (because  $f > 0$ ) with radius of curvature  $R = 2f = 90 \text{ cm}$ .