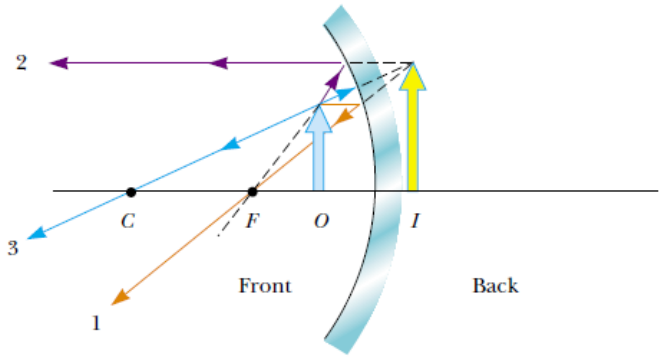
Answer on Question #52214, Physics, Optics

A dedicated sports car enthusiast polished the inside and outside surfaces of a hubcap that is a section of a sphere. When he looks into one side of the hubcap, he sees an image of his face 30.0cm in back of it. He then turns the hubcap over, keeping it the same distance from his face. He now sees an image of his face 10.0cm in back of the hubcap. How far is his face from the hubcap? What is the magnitude of the radius of curvature of the hubcap?

Solution:

For first case:



MIRROR EQUATION

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

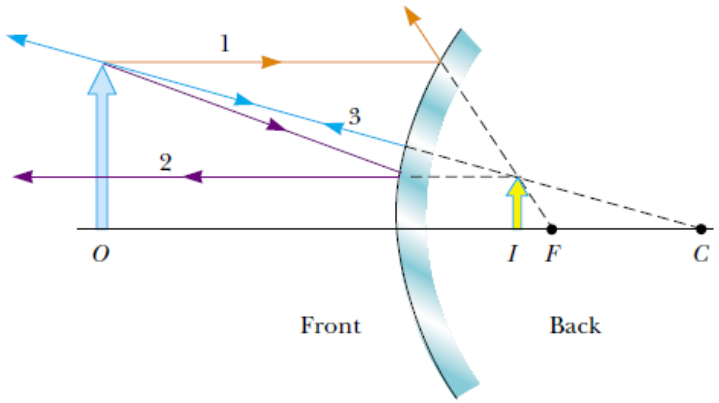
$$\frac{1}{\text{object distance}}+\frac{1}{\text{image distance}}=\frac{1}{\text{focal length}}$$

The image is behind the mirror, so $q = -30\ \text{cm}$

Thus,

$$\frac{1}{p}-\frac{1}{30\ \text{cm}}=\frac{1}{f}$$

For second case:



$$\frac{1}{p}-\frac{1}{q}=-\frac{1}{f}$$

Thus,

$$\frac{1}{p}-\frac{1}{10\text{ cm}}=-\frac{1}{f}$$

We have system of equations:

$$\frac{1}{p}-\frac{1}{30}=\frac{1}{f}$$
$$\frac{1}{p}-\frac{1}{10}=-\frac{1}{f}$$

$$\frac{1}{p}-\frac{1}{10}=-\left(\frac{1}{p}-\frac{1}{30}\right)$$
$$\frac{2}{p}=\frac{1}{10}+\frac{1}{30}=\frac{3}{30}+\frac{1}{30}=\frac{4}{30}$$

Thus,

$$p=\frac{30}{2}=15\text{ cm}$$
$$\frac{1}{f}=\frac{1}{15}-\frac{1}{30}=\frac{1}{30}$$
$$f=30\text{ cm}$$

The radius of mirror is

$$R=2f=60\text{ cm}$$

Answer: How far is his face from the hubcap? 15 cm.

What is the magnitude of the radius of curvature of the hubcap? 60 cm.