Geometrical Optics, Practical 2

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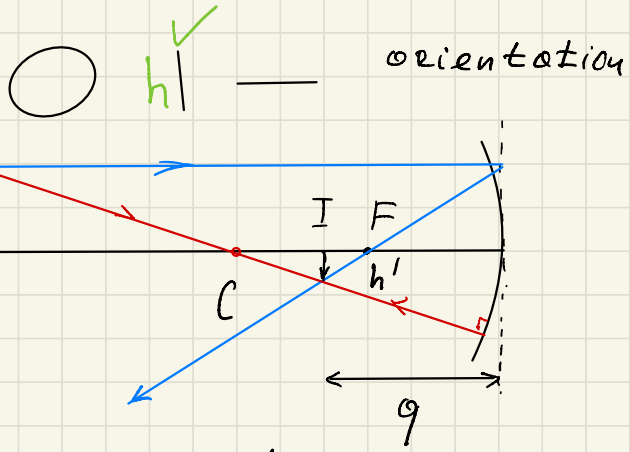
1. A coin of 3 cm in diameter is 12 cm away from a concave mirror with a radius of curvature of 6 cm. Find the image of the coin. You can choose an orientation of the coin.

Solution

$R = 6$ cm
$p = 12$ cm
$h = 3$ cm



$$f = \frac{R}{2} = 3\text{cm}$$

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f} \Rightarrow \frac{1}{q} = \frac{1}{f} - \frac{1}{p} = \frac{1}{3\text{cm}} - \frac{1}{12\text{cm}}$$

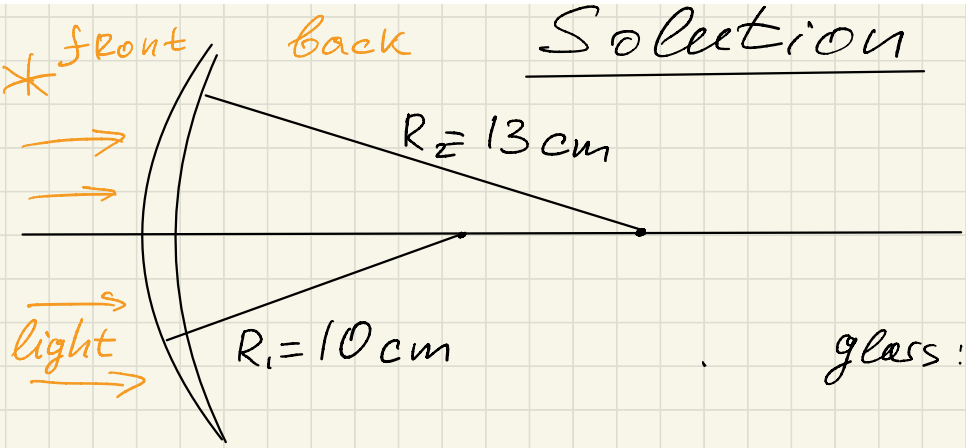
$$q = 4\text{cm}$$

$$M = \frac{h'}{h} = -\frac{q}{p} = -\frac{4\text{cm}}{12\text{cm}} = -\frac{1}{3}$$

$$h' = -\frac{1}{3} \cdot 3\text{cm} = -1\text{cm}$$

2. A converging convex-concave glass lens is made with two spherical surfaces of 13 cm and 10 cm in radius. Find its focal length in air.

Solution



glass: $n = 1.5$

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = (1.5-1)\left(\frac{1}{10\,cm} - \frac{1}{13\,cm}\right)$$

$$= 87\,cm$$

If light is from the right:

$R_1 = -13\,cm$

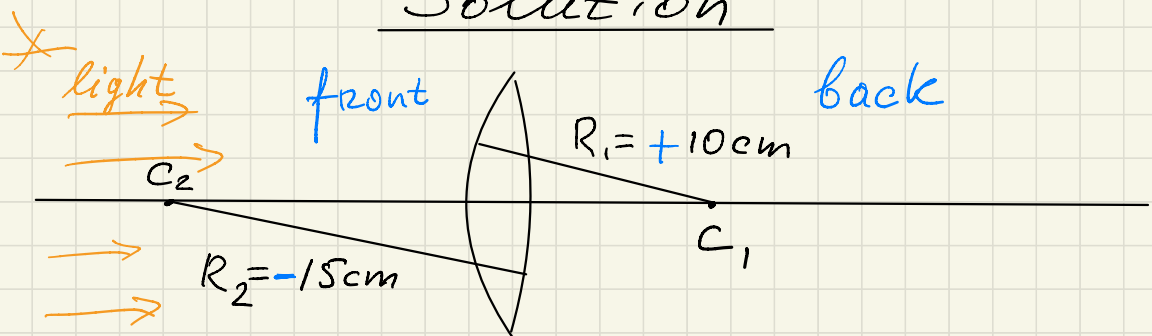
$R_2 = -10\,cm$

$$\frac{1}{f} = (n-1)\left(\frac{1}{-13\,cm} - \frac{1}{-10\,cm}\right) =$$

$$= (1.5-1)\left(\frac{1}{10\,cm} - \frac{1}{13\,cm}\right) = 87\,cm$$

3. A biconvex glass lens is made with two spherical surfaces of 15 cm and 10 cm in radius. Find its focal length in air.

Solution



glass: $n = 1.5$

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) =$$

$$= (1.5-1)\left(\frac{1}{10\,cm} - \frac{1}{-15\,cm}\right) = \frac{1}{12\,cm} \; ; \; f = 12\,cm$$

Check if the light comes from the right, the answer will be the same.

4. A coin of 1.2 cm in diameter is 4 cm away from a biconvex lens that has a focal length of 12 cm. Find the image of the coin. You can choose an orientation of the coin.

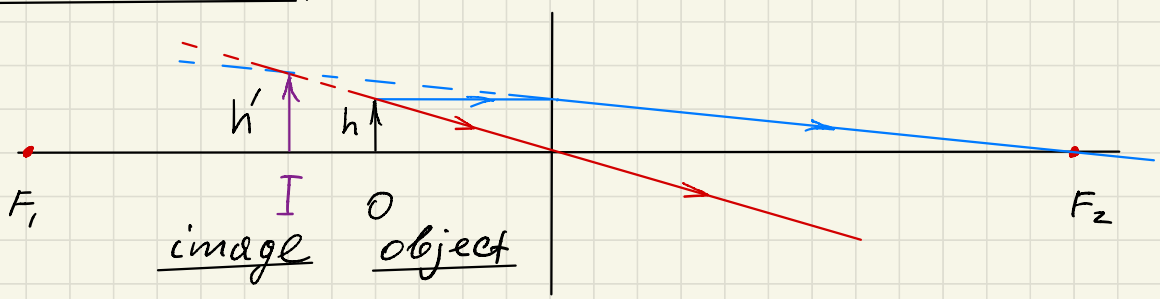
Solution

orientation

$h = 1.2\,cm$

$f = 12\,cm$

$p = 4\,cm$



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

$$\frac{1}{q} = \frac{1}{f} - \frac{1}{p} = \frac{1}{12\,cm} - \frac{1}{4\,cm}$$

$q = -6\,cm$

image is in front of lens

$$M = \frac{h'}{h} = -\frac{q}{p} = -\frac{-6\,cm}{4\,cm} = 1.5$$

$$h' = Mh = 1.5 \cdot 1.2\,cm = 1.8\,cm$$