PHYS 1304, Ch 36 solutions, 7th Ed.

P36.3 The flatness of the mirror is described

by $R=\infty$, $f=\infty$

and $\dfrac{1}{f}=0$.

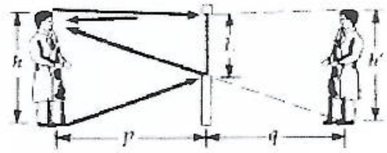

FIG. P36.3

By our general mirror equation,

$$\frac{1}{p}+\frac{1}{q}=\frac{1}{f}=0$$

or $q=-p$.

Thus, the image is as far behind the mirror as the person is in front. The magnification is then

$$M=\frac{-q}{p}=1=\frac{h'}{h}$$

so $h'=h=70.0$ inches.

The required height of the mirror is defined by the triangle from the person's eyes to the top and bottom of his image, as shown. From the geometry of the triangle, we see that the mirror height must be:

$$h'\left(\frac{p}{p-q}\right)=h'\left(\frac{p}{2p}\right)=\frac{h'}{2}.$$

Thus, the mirror must be $\boxed{\text{at least 35.0 inches high}}$.

P36.6 For a concave mirror, both R and f are positive.

We also know that $f=\dfrac{R}{2}=10.0$ cm.

(a) $$\frac{1}{q}=\frac{1}{f}-\frac{1}{p}=\frac{1}{10.0\text{ cm}}-\frac{1}{40.0\text{ cm}}=\frac{3}{40.0\text{ cm}}$$

and $\boxed{q=13.3\text{ cm}}$

$$M=-\frac{q}{p}=-\frac{13.3\text{ cm}}{40.0\text{ cm}}=\boxed{-0.333}.$$

The image is 13.3 cm in front of the mirror, $\boxed{\text{real, and inverted}}$.

(b) $$\frac{1}{q}=\frac{1}{f}-\frac{1}{p}=\frac{1}{10.0\text{ cm}}-\frac{1}{20.0\text{ cm}}=\frac{1}{20.0\text{ cm}}$$

and $\boxed{q=20.0\text{ cm}}$

$$M=-\frac{q}{p}=-\frac{20.0\text{ cm}}{20.0\text{ cm}}=\boxed{-1.00}.$$

The image is 20.0 cm in front of the mirror, $\boxed{\text{real, and inverted}}$.

(c) $$\frac{1}{q}=\frac{1}{f}-\frac{1}{p}=\frac{1}{10.0\text{ cm}}-\frac{1}{10.0\text{ cm}}=0$$

Thus, $q=$ infinity.

$\boxed{\text{No image is formed}}$. The rays are reflected parallel to each other.

P36.9 (a) $\frac{1}{p}+\frac{1}{q}=\frac{2}{R}$ becomes $\frac{1}{q}=\frac{2}{60.0\text{ cm}}-\frac{1}{90.0\text{ cm}}$

$q=\boxed{45.0\text{ cm}}$ and $M=\frac{-q}{p}=-\frac{45.0\text{ cm}}{90.0\text{ cm}}=\boxed{-0.500}$.

(b) $\frac{1}{p}+\frac{1}{q}=\frac{2}{R}$ becomes $\frac{1}{q}=\frac{2}{60.0\text{ cm}}-\frac{1}{20.0\text{ cm}}$

$q=\boxed{-60.0\text{ cm}}$ and $M=\frac{-q}{p}=-\frac{(-60.0\text{ cm})}{(20.0\text{ cm})}=\boxed{3.00}$.

(c) The image (a) is real, inverted and diminished. That of (b) is virtual, upright, and enlarged. The ray diagrams are similar to Figure 36.15(a) and 36.15(b) in the text, respectively.

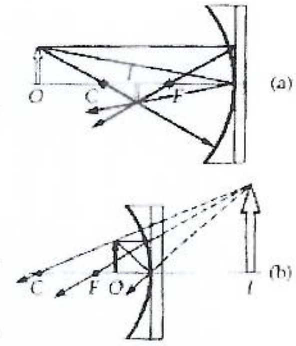

FIG. P36.11

P36.21 $\frac{n_1}{p}+\frac{n_2}{q}=\frac{n_2-n_1}{R}=0$ and $R\to\infty$

$$q=-\frac{n_2}{n_1}p=-\frac{1}{1.309}(50.0\text{ cm})=-38.2\text{ cm}$$

Thus, the virtual image of the dust speck is $\boxed{\text{38.2 cm below the top surface}}$ of the ice.

P36.28 Let R_1 = outer radius and R_2 = inner radius

$$\frac{1}{f}=(n-1)\left[\frac{1}{R_1}-\frac{1}{R_2}\right]=(1.50-1)\left[\frac{1}{2.00\text{ m}}-\frac{1}{2.50\text{ cm}}\right]=0.050\,0\text{ cm}^{-1}$$

so $f=\boxed{20.0\text{ cm}}$.

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P36.30 For a converging lens, f is positive. We use $\frac{1}{p}+\frac{1}{q}=\frac{1}{f}$.

(a) $\frac{1}{q}=\frac{1}{f}-\frac{1}{p}=\frac{1}{20.0\text{ cm}}-\frac{1}{40.0\text{ cm}}=\frac{1}{40.0\text{ cm}}$ $\boxed{q=40.0\text{ cm}}$

$M=-\frac{q}{p}=-\frac{40.0}{40.0}=\boxed{-1.00}$

The image is $\boxed{\text{real, inverted}}$, and located 40.0 cm past the lens.

(b) $\frac{1}{q}=\frac{1}{f}-\frac{1}{p}=\frac{1}{20.0\text{ cm}}-\frac{1}{20.0\text{ cm}}=0$ $\boxed{q=\text{infinity}}$

$\boxed{\text{No image}}$ is formed. The rays emerging from the lens are parallel to each other.

(c) $\frac{1}{q}=\frac{1}{f}-\frac{1}{p}=\frac{1}{20.0\text{ cm}}-\frac{1}{10.0\text{ cm}}=-\frac{1}{20.0\text{ cm}}$ $\boxed{q=-20.0\text{ cm}}$

$M=-\frac{q}{p}=-\frac{(-20.0)}{10.0}=\boxed{2.00}$

The image is $\boxed{\text{upright, virtual}}$ and 20.0 cm in front of the lens.

P36.33 We are looking at an enlarged, upright, virtual image:

$M=\frac{h'}{h}=2=-\frac{q}{p}$ so $p=-\frac{q}{2}=-\frac{(-2.84\text{ cm})}{2}=+1.42\text{ cm}$

$\frac{1}{p}+\frac{1}{q}=\frac{1}{f}$ gives $\frac{1}{1.42\text{ cm}}+\frac{1}{(-2.84\text{ cm})}=\frac{1}{f}$

$\boxed{f=2.84\text{ cm}}$.

FIG. P36.33

P36.35 $\frac{1}{p}+\frac{1}{q}=\frac{1}{f}$: $p^{-1}+q^{-1}=\text{constant}$

We may differentiate through with respect to p: $-1p^{-2}-1q^{-2}\frac{dq}{dp}=0$

$\frac{dq}{dp}=-\frac{q^2}{p^2}=-M^2$.

P36.37 (a) $\frac{1}{p}+\frac{1}{q}=\frac{1}{f}$ $\frac{1}{20.0\text{ cm}}+\frac{1}{q}=\frac{1}{(-32.0\text{ cm})}$

so $q=-\left(\frac{1}{20.0}+\frac{1}{32.0}\right)^{-1}=\boxed{-12.3\text{ cm}}$

The image is 12.3 cm to the left of the lens.

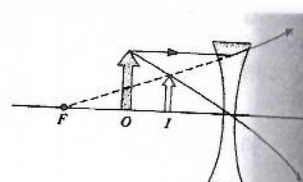

FIG. P36.37

(b) $M=-\frac{q}{p}=-\frac{(-12.3\text{ cm})}{20.0\text{ cm}}=\boxed{0.615}$

(c) See the ray diagram to the right.