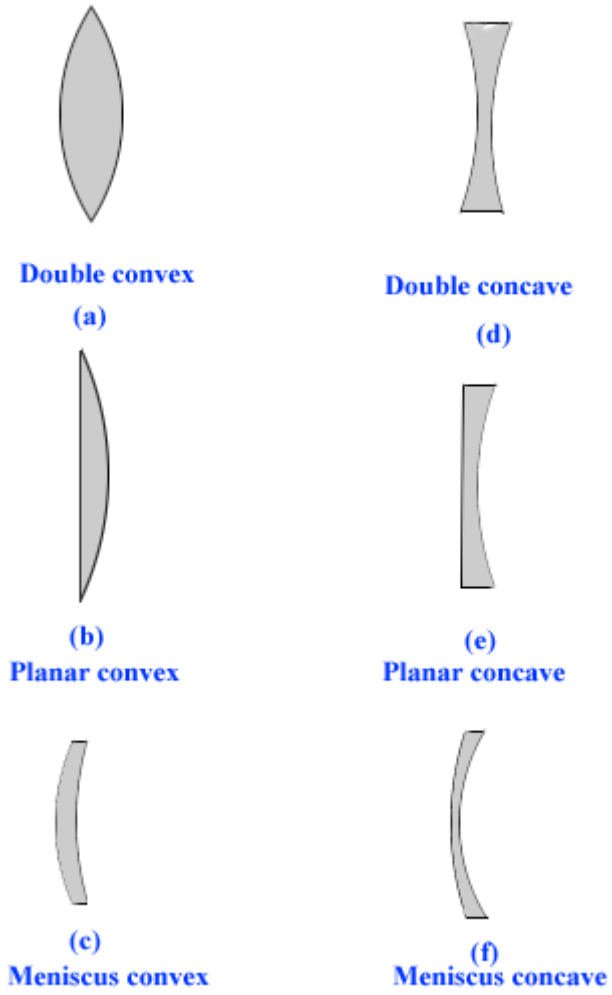
615.

Problem 44.17 (RHK)

We have a supply of flat glass disks $(n = 1.5)$ *and a lens grinding machine that can be set to grind radii of curvature of either* 40 cm *or* 60 cm. *We are advised to prepare a set of six lenses like those shown in the figure. We have to find the focal length of each lens.* (*Note*: *Where we have a choice of radii of curvature, we will select the smaller one.*)



Solution:

We will use the lens-maker's formula

$$\frac{1}{f} = (n-1)\left(\frac{1}{r_1} - \frac{1}{r_2}\right),$$

and the sign convention that r is positive if the centre of curvature lies in the *R*-side of the lens and is negative if the centre of curvature lies in the *V*-side of the lens.

Also, the radius of curvature of a plane surface is ∞.

In the following we calculate the focal length of the six lenses shown in the figure:

(a)

Double convex lens

$r_1 = 40$ cm, $r_2 = -60$ cm, and $n = 1.5$.

We have

$$\frac{1}{f} = (1.5-1)\left(\frac{1}{40}+\frac{1}{60}\right) \text{ cm}^{-1}$$

or

$$f = \frac{60\times 40}{0.5\times 100} \text{ cm} = 48 \text{ cm} .$$

(b)

Planar convex

$r_1 = \infty$, $r_2 = -40$ cm, and $n = 1.5$.

We have

$$\frac{1}{f} = 0.5\times\frac{1}{40 \text{ cm}},$$

and

$$f = 80 \text{ cm} .$$

(c)

Meniscus convex

$r_1 = 40$ cm, $r_2 = 60$ cm, and $n = 1.5$.

We have

$$\frac{1}{f} = (1.5-1)\left(\frac{1}{40} - \frac{1}{60}\right) \text{ cm}^{-1}$$

or

$$f = \frac{40 \times 60}{20 \times 0.5} \text{ cm} = 240 \text{ cm}.$$

(d)

Double concave

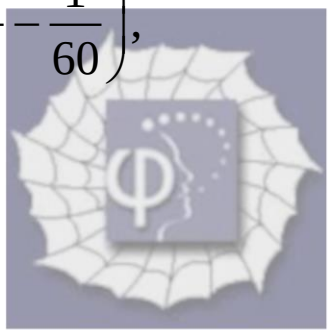
$r_1 = -40$ cm, $r_2 = 60$ cm, and $n = 1.5$

We have

$$\frac{1}{f} = (1.5-1)\left(-\frac{1}{40} - \frac{1}{60}\right),$$

and

$$f = -48 \text{ cm}.$$



(f)

Planar concave

$r_1 = \infty$, $r_2 = 40$ cm, and $n = 1.5$.

We have

$$\frac{1}{f} = -0.5 \times \frac{1}{40 \text{ cm}},$$

and

$$f = -80 \text{ cm}.$$

(g)

Meniscus concave

$r_1 = 60$ cm, $r_2 = 40$ cm, and $n = 1.5$.

We have

$$\frac{1}{f} = (1.5 - 1)\left(\frac{1}{60} - \frac{1}{40}\right) \text{ cm}^{-1}$$

or

$$f = -\frac{40 \times 60}{20 \times 0.5} \text{ cm} = -240 \text{ cm} .$$