Substituting *i* and *r* from Eqs. (9.13) and (9.14), we get

$$\frac{n_1}{OM} + \frac{n_2}{MI} = \frac{n_2 - n_1}{MC} \tag{9.15}$$

Here, OM, MI and MC represent magnitudes of distances. Applying the Cartesian sign convention,

OM = $-u$, MI = $+v$, MC = $+R$

Substituting these in Eq. (9.15), we get

$$\boxed{\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}} \tag{9.16}$$

Equation (9.16) gives us a relation between object and image distance in terms of refractive index of the medium and the radius of curvature of the curved spherical surface. It holds for any curved spherical surface.

Example 9.6 Light from a point source in air falls on a spherical glass surface (n = 1.5 and radius of curvature = 20 cm). The distance of the light source from the glass surface is 100 cm. At what position the image is formed?

Solution

We use the relation given by Eq. (9.16). Here
u = – 100 cm, v = ?, R = + 20 cm, n_1 = 1, and n_2 = 1.5.
We then have

$$\frac{1.5}{v} + \frac{1}{100} = \frac{0.5}{20}$$

or $v = +100$ cm

The image is formed at a distance of 100 cm from the glass surface, in the direction of incident light.

EXAMPLE 9.6

9.5.2 Refraction by a lens

Figure 9.18(a) shows the geometry of image formation by a double convex lens. The image formation can be seen in terms of two steps: (i) The first refracting surface forms the image I_1 of the object O [Fig. 9.18(b)]. The image I_1 acts as a virtual object for the second surface that forms the image at I [Fig. 9.18(c)]. Applying Eq. (9.15) to the first interface ABC, we get

$$\frac{n_1}{OB} + \frac{n_2}{BI_1} = \frac{n_2 - n_1}{BC_1} \tag{9.17}$$

A similar procedure applied to the second interface* ADC gives,

$$-\frac{n_2}{DI_1} + \frac{n_1}{DI} = \frac{n_2 - n_1}{DC_2} \tag{9.18}$$

* Note that now the refractive index of the medium on the right side of ADC is n_1 while on its left it is n_2. Further DI_1 is negative as the distance is measured against the direction of incident light.