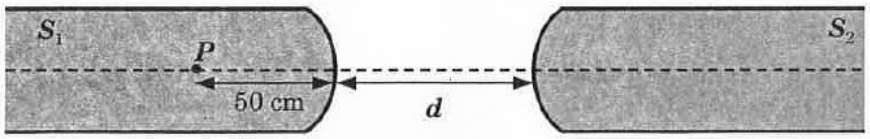
Two identical glass rods S_1 and S_2 (refractive index = 1.5) have one convex end of radius of curvature 10 cm. They are placed with the curved surfaces at a distance d as shown in the figure, with their axes (shown by the dashed line) aligned. When a point source of light P is placed inside rod S_1 on its axis at a distance of 50 cm from the curved face, the light rays emanating from it are found to be parallel to the axis inside S_2. The distance d is



(A) 60 cm (B) 70 cm (C) 80 cm (D) 90 cm

Solution

For 1st refraction, $\frac{\mu}{v}-\frac{1.5}{-50}=\frac{\mu-1.5}{-10}$ .....(1)

The image obtained from 1st refraction acts as an object for the 2nd refraction.

For 2nd refraction, $\frac{1.5}{\infty}-\frac{\mu}{(v-d)^*}=\frac{1.5-\mu}{10}$

$\therefore \frac{\mu}{d-v}=\frac{1.5-\mu}{10}$

$\therefore v=d-\frac{10\mu}{1.5-\mu}$

From equation (1), $\frac{\mu}{d-\frac{10\mu}{1.5-\mu}}+\frac{1.5}{50}=\frac{\mu-1.5}{-10}$

It looks unlikely that μ would get cancelled. Assuming that the system is placed in vacuum/air and taking $\mu=1$,

$\frac{1}{d-20}+\frac{1.5}{50}=\frac{1}{20}$

$\therefore d=70\,\text{cm}$

Hence, Option (B).

*v-d takes care of any sign that v has.