Question. A convex lens forms a real image of a point object at a distance of $50\ cm$ from the convex lens. A concave lens is placed $10\ cm$ behind the convex lens on image side. On placing a plane mirror on the image side and facing the concave lens, it is observed that the final image now coincides with the object itself. The focal length of the concave lens is?

a) $50\ cm$; b) $20 cm$; c) $40\ cm$; d) $25\ cm$.

Solution.

The image coincides with the object only if the ray retraces its path. So the rays are perpendicular to the plane mirror. This means that the images is formed at infinity by the concave lens when there is no mirror.

$$d = \infty.$$

Since the image supposed to form $50\ cm$ from the convex lens and the concave lens is $10\ cm$ away from the convex lens,

$$s = 10 - 50 = -40\ cm.$$

According to the lens formula

$$\frac{1}{d} + \frac{1}{s} = \frac{1}{f}$$

for the concave lens we have

$$\frac{1}{\infty} - \frac{1}{40} = -\frac{1}{f}\ \rightarrow\ f = 40\ cm.$$

Answer. $f = 40\ cm.$