Question

A thin lens made of glass (refractive index = 1.5) of focal length f = 16cm is immersed in liquid of refractive index 1.42. If its focal length in liquid is f_l, then the ratio $\frac{f_l}{f}$ is closest to the integer:

A 9

B 17

C 5

D 1

Solution

Correct option is
A)

We know that , $\frac{1}{f} = \left(\frac{\mu_l}{\mu_m} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

where $\mu_l \rightarrow$ Refractive index of lens

$\mu_m \rightarrow$ Refractive index of medium

In air, $\mu_m = 1 \Rightarrow \frac{1}{f} = \frac{1}{16} = (\mu_l - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ ___(1)

In liquid, $\mu_m = 1.42 \Rightarrow \frac{1}{f_l} = \left(\frac{\mu_l}{\mu_m} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ ___(2)

$\frac{1}{f_l} = \left(\frac{1.5}{1.42} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ ___(2)

Dividing equation (1) by (2)

$$\frac{\frac{1}{16}}{\frac{1}{f_l}} = \frac{(1.5-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)}{\left(\frac{1.5}{1.42} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)}$$

$$f_l = \frac{16 \times 0.5 \times 1.42}{0.08}$$

$$\text{Ratio } \frac{f_l}{f} = \frac{\left(\frac{16 \times 0.5 \times 1.42}{0.08}\right)}{16} = 8.875$$

$$\frac{f_l}{f} \simeq 9$$

Ans = 9