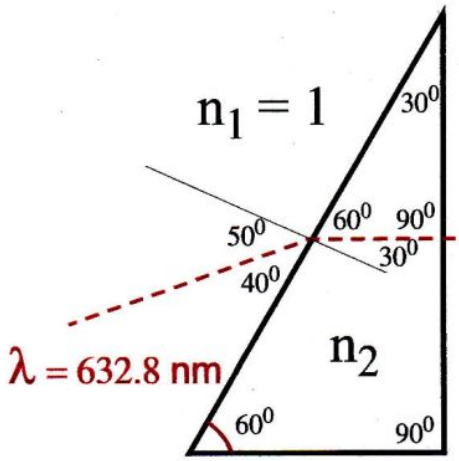
ANSWERS OPTICS, FYSA13

O1 Answers:

a) 1.96 x 10^8 m/s
b) 4.74 x 10^{14} Hz
c) 413 nm

O1 Solutions:



O1a)

$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$n_2 = \frac{\sin 50^0}{\sin 30^0} = 1.532$

$n = \frac{c}{v}$

$v = \frac{c}{n} = \frac{3\cdot 10^8}{1.532} = 1.96\cdot 10^8$ m/s

O1b) $\lambda = \frac{v}{f}$ $\quad f_{air} = \frac{3\cdot 10^8}{632.8\cdot 10^{-9}} = 4.74\cdot 10^{14}$ Hz

$f_{glas} = f_{air} = 4.74\cdot 10^{14}$ Hz

O1c) $\lambda = \frac{v}{f} = \frac{1.96\cdot 10^8}{4.74\cdot 10^{14}} = 413$ nm

O2 Answers:

a) 21.8 cm
b) 163 cm

O2 Solutions:

O2a) $R = 87$ cm $\Rightarrow f = 87/2 = 43.5$ cm

$m = -\frac{f}{s-f} \Rightarrow s - f = -\frac{f}{m} \Rightarrow s = f - \frac{f}{m}$

$s = 43.5 - \frac{43.5}{2} = 21.75$ cm

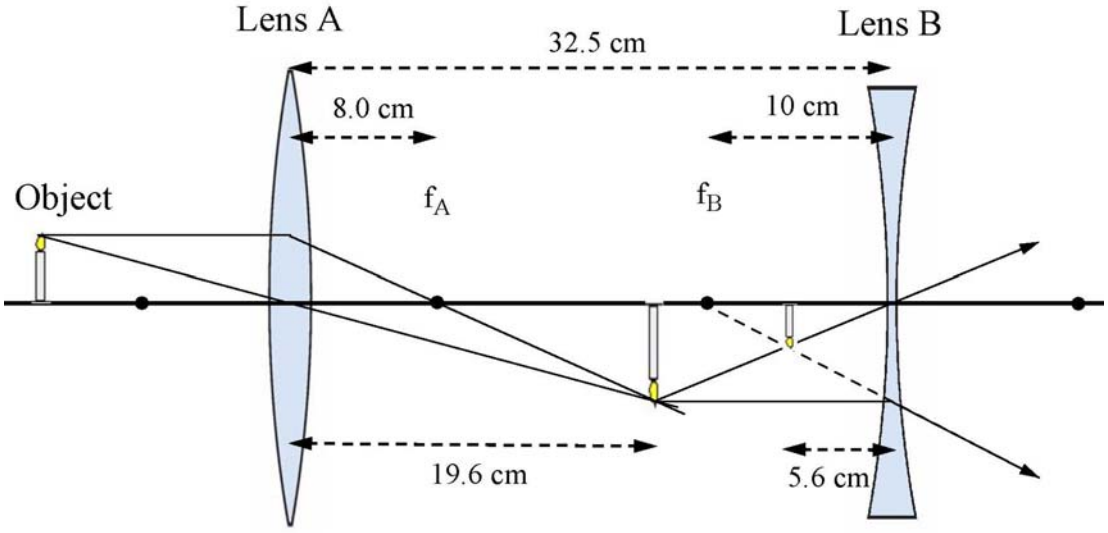
b) $s = f - \frac{f}{m} = 43.5 - \frac{43.5}{-4} = 54.38$ cm

$s' = \frac{sf}{s-f} = \frac{54.38\cdot 43.5}{54.38 - 43.5} = 217.5$ cm

Distance $= s' - s = 217.5 - 54.4 = 163.1$ cm

O3 Answers:

a) The radius of lens A is 9.0 cm and the radius of lens B is 11.2 cm.
b) Distance = 13.5 + 32.5 – 5.6 = 40.4 cm
c) 2.4 cm upside-down
d)



O3 Solutions:

O3a) $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

Lens A: $\begin{cases} R_1 = x \\ R_2 = -x \end{cases} \Rightarrow \frac{1}{f} = (n-1)\frac{2}{x} \Rightarrow x = 2(n-1)f \Rightarrow$

$x = 2(1.56-1)\cdot 8 = 8.96\,cm$

Lens B: $\begin{cases} R_1 = -x \\ R_2 = x \end{cases} \Rightarrow \frac{1}{f} = (n-1)\frac{-2}{x} \Rightarrow x = -2(n-1)f \Rightarrow$

$x = -2(1.56-1)\cdot(-10) = 11.2\,cm$

O3b) $S_A' = \frac{S_A \cdot f_A}{S_A - f_A} = \frac{13.5 \cdot 8.0}{13.5 - 8.0} = 19.64\,cm$

$S_B = 32.5 - S_A' = 32.5 - 19.6 = 12.9\,cm$

$S_B' = \frac{S_B \cdot f_B}{S_B - f_B} = \frac{12.9 \cdot (-10.0)}{12.9 - (-10.0)} = -5.63\,cm$

Distance object–image $= S_A + 32.5 + S_B' = 13.5 + 32.5 - 5.63$

$= 40.4\,cm$

O3c) $m_A = -\frac{f_A}{S_A - f_A} = \frac{-8.0}{13.5 - 8.0} = -1.45$

$Y_A' = m_A \cdot Y_A = -1.45 \cdot 3.8 = -5.53\,cm$

$Y_B = Y_A'$

$m_B = -\frac{f_B}{S_B - f_B} = \frac{-(-10.0)}{12.9 - (-10.0)} = 0.44$

$Y_B' = m_B \cdot Y_A' = 0.44 \cdot (-5.53) = -2.41\,cm$ (up-side down)