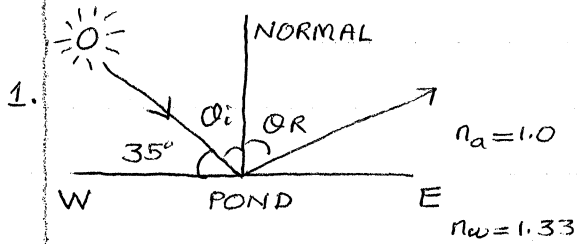
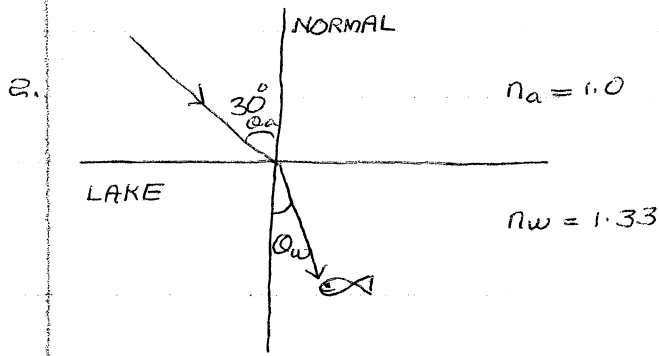


HOMWORK #4 SOLUTIONS



- a) $\theta_i = 55^\circ$
- b) $\theta_r = 55^\circ$
- c) EAST, 35°

$$\tan \theta = n_w = 1.33 \quad \therefore \theta = \tan^{-1}(1.33) = 53.06^\circ$$

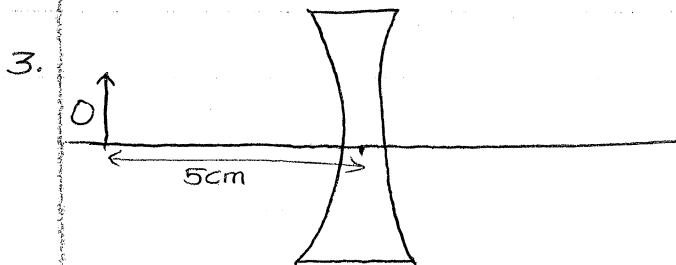


$$n_a \sin \theta_a = n_w \sin \theta_w$$

$$\sin \theta_w = \sin \theta_a \left(\frac{n_a}{n_w} \right)$$

$$\sin \theta_w = \left(\frac{1.0}{1.33} \right) \sin 30^\circ = \frac{0.5}{1.33} = 0.376$$

$$\therefore \theta_w = 22.09^\circ$$



$$d_o = 5 \text{ cm}$$

$$f = -20 \text{ cm}$$

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$\frac{1}{d_i} = \frac{1}{f} - \frac{1}{d_o} = \frac{-1}{20} - \frac{1}{5} = \frac{-1}{20} - \frac{4}{20} = \frac{-5}{20} = \frac{-1}{4}$$

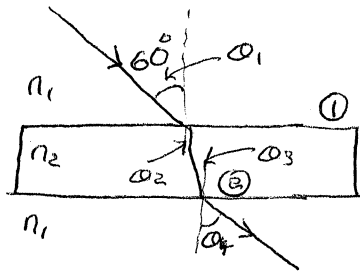
$$\boxed{d_i = -4 \text{ cm}}$$

Image location : same side of the lens,
4 cm away.

$$M = -\frac{d_i}{d_o} = -\frac{(-4)}{5} = \boxed{\frac{4}{5}}$$

Image is upright and virtual

4.



$$n_1 \sin \theta_1 = n_2 \sin \theta_2 \quad \text{at (1)}$$

$$n_2 \sin \theta_3 = n_1 \sin \theta_4 \quad \text{at (2)}$$

We have $\theta_2 = \theta_3$ $\therefore n_2 \sin \theta_2 = n_2 \sin \theta_3 \Rightarrow$

$$n_1 \sin \theta_1 = n_1 \sin \theta_4$$

$$\therefore \theta_1 = \theta_4$$

$$\theta_1 = 60^\circ \quad \therefore \boxed{\theta_4 = 60^\circ}$$

5. a) $n_a \sin \theta_a = n_d \sin \theta_d$ — (1)

$n_d \sin \theta_d = n_d \sin \theta_c$ when $\theta_d = \theta_c$, critical angle.

$$(1) \rightarrow 1.0 \sin 90^\circ = 2.41 \sin \theta_c$$

$$\therefore \sin \theta_c = \frac{1}{2.41} \quad \therefore \theta_c = \sin^{-1} \left(\frac{1}{2.41} \right) = 24.52^\circ$$

for air

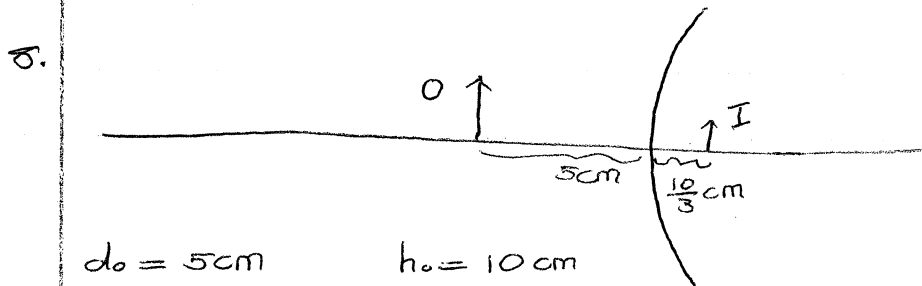
b) $2.41 \sin \theta_c = 1.33 \sin 90^\circ$

$$\therefore \theta_c = 33.5^\circ \quad \text{for water}$$

c) Critical angle is more for water. That means "less number" of rays are totally internally reflected when diamond is placed in water. Thus diamond sparkles less in water than in air.

6. $\sin \theta_c = \frac{1.4}{1.2} > 1 \Rightarrow$ "Sin" of an angle cannot be greater than 1. Therefore there is no critical angle for this interface.

7. $E = \sigma T^4 A$
 $= (5.67 \times 10^{-8}) (5000)^4 \pi (695 \times 10^6)^2$
 $= ~~7.73378~~ 5.375 \times 10^{25} \text{ J}$



$d_o = 5 \text{ cm}$ $h_o = 10 \text{ cm}$

$f = -10 \text{ cm}$

$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$

$\frac{1}{d_i} = \frac{1}{f} - \frac{1}{d_o} = \frac{-1}{10} - \frac{1}{5} = \frac{-1}{10} - \frac{2}{10} = \frac{-3}{10}$

$\therefore d_i = -\frac{10}{3} \text{ cm}$

$m = -\frac{d_i}{d_o} = -\left(-\frac{10}{3}\right) / 5 = +\frac{2}{3}$

$m = \frac{h_i}{h_o} \Rightarrow \frac{2}{3} = \frac{h_i}{10} \quad \therefore h_i = \frac{2}{3} \times 10 = \frac{20}{3} \text{ cm}$

$h_i = \frac{20}{3} \text{ cm}$

Image is virtual