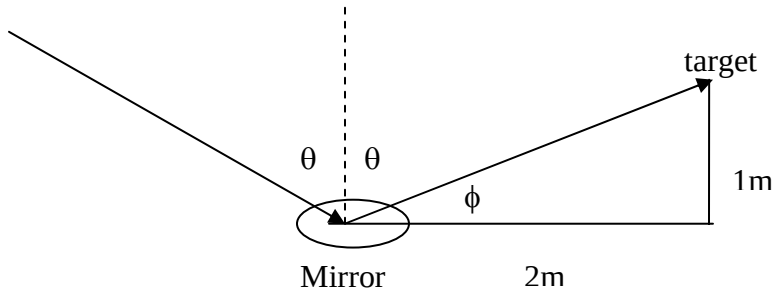
Physics 123 Homework Solutions

Week #1 – Unit O Geometric Optics

O1.1



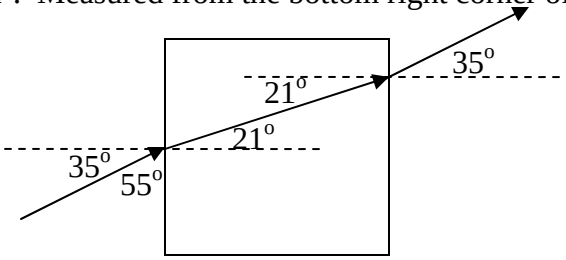
$$\tan\phi = \frac{1m}{2m} \rightarrow \phi = 26.6^o$$
$$90 = \theta + \phi \rightarrow \theta = 63.4^o$$

O1.3

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$
$$1.4 \sin 50 = n \sin 90$$
$$n = 1.07$$

O1.4

At the front interface, $n_1 \sin\theta_1 = n_2 \sin\theta_2 \rightarrow 1.0 \sin 35 = 1.59 \sin \rightarrow \theta_2 = 21.1^o$. At the back interface, the ray strikes at 21.1^0 and thus emerges by Snell's Law, at 35^0. It has been displaced by an amount x above the center of the square block given by $x = d \tan\theta_2 = 0.39d$. Measured from the bottom right corner of the block, this gives *0.89d*.



O3.1

The image distance is given from the thin lens equation with d_o at infinity. This gives the image distance equal to the focal length of the converging lens. Thus $d_i = f = 20cm$.

O3.2

$$\frac{1}{d_o}+\frac{1}{d_i}=\frac{1}{f}\rightarrow\frac{1}{d_i}=\frac{1}{f}-\frac{1}{d_o}=\frac{1}{50cm}-\frac{1}{100cm}\rightarrow d_i=100cm$$

$$M=\frac{h_i}{h_o}=-\frac{d_i}{d_o}=-\frac{100cm}{100cm}=-1\rightarrow h_i=-1h_o=-1cm$$

The image is thus real, inverted, and 1cm high.

O3.5

The image distance is given from the thin lens equation with d_o at infinity. This gives the image distance equal to the focal length of the diverging lens. Thus $d_i = f = -20cm$.

O3.6

$$\frac{1}{d_o}+\frac{1}{d_i}=\frac{1}{f}\rightarrow\frac{1}{d_i}=\frac{1}{f}-\frac{1}{d_o}=\frac{1}{-50cm}-\frac{1}{100cm}\rightarrow d_i=-33.3cm$$

$$M=\frac{h_i}{h_o}=-\frac{d_i}{d_o}=-\left(\frac{-33.3cm}{100cm}\right)=0.33\rightarrow h_i=-1h_o=0.33cm$$

The image is upright, virtual and reduced.

Numerical solutions to other selected problems.

O1.2

Needs more information in order to answer: Assume that $n_2 = 1.0$, so that $\theta_2 = 36.3^o$.

O3.3

d_i = infinity

O3.4

d_i = -30cm (30 cm to left of the lens.) Image is twice as large as object with the image virtual and upright.

O3.7

d_i = -15cm

O3.8

d_i = -10.5cm and the image height is $0.7h_o$. Thus the image is upright reduced and virtual.