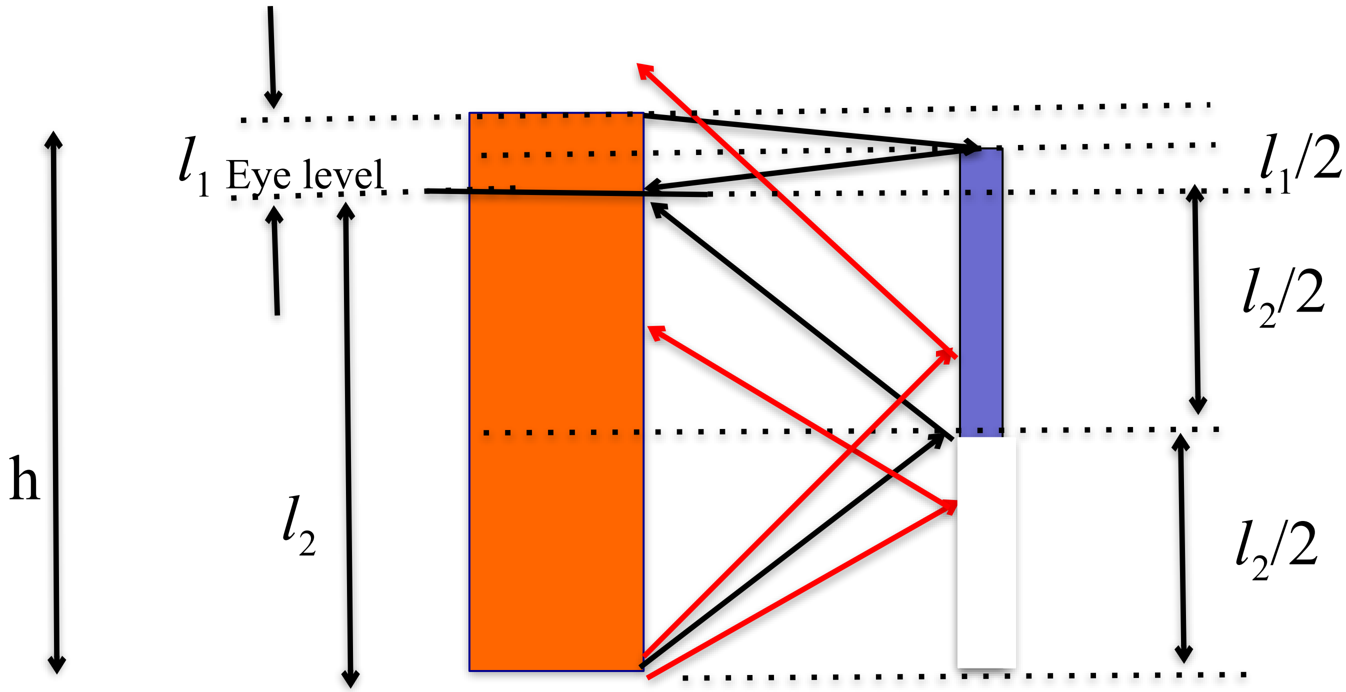
Optics and Waves

Lecture 11

Reflection and Refraction
(Cont.)
Examples

Choose the mirror

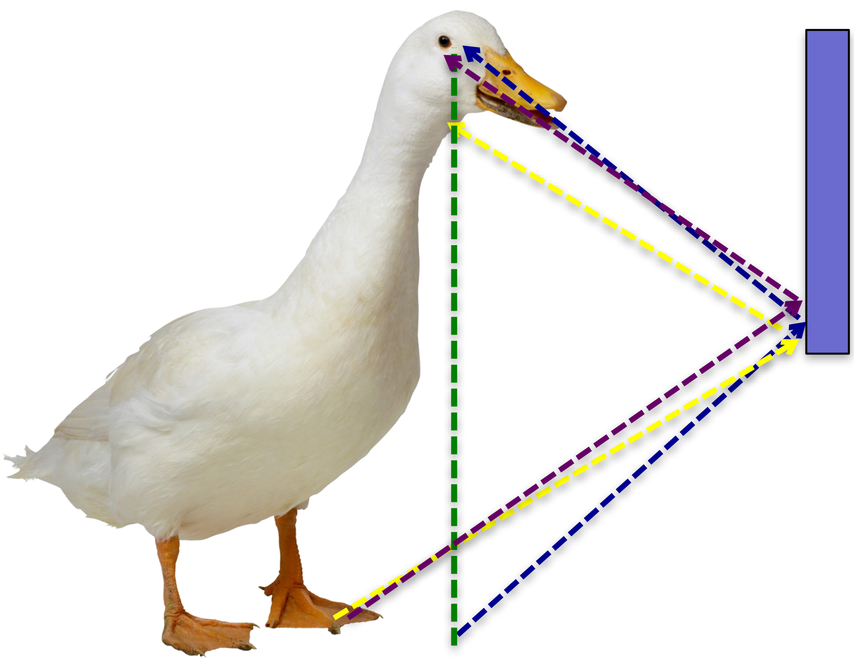
The man, standing in front of a mirror, is h meters high. What is the minimum height of the mirror if he wants to see a full image of himself?



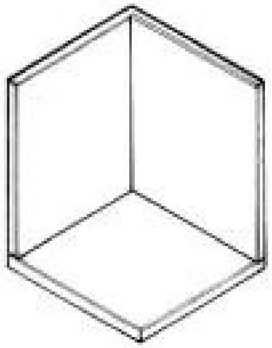
The minimum height of the mirror should be:

$l_1/2 + l_2/2 = (l_1 + l_2)/2 = h/2$

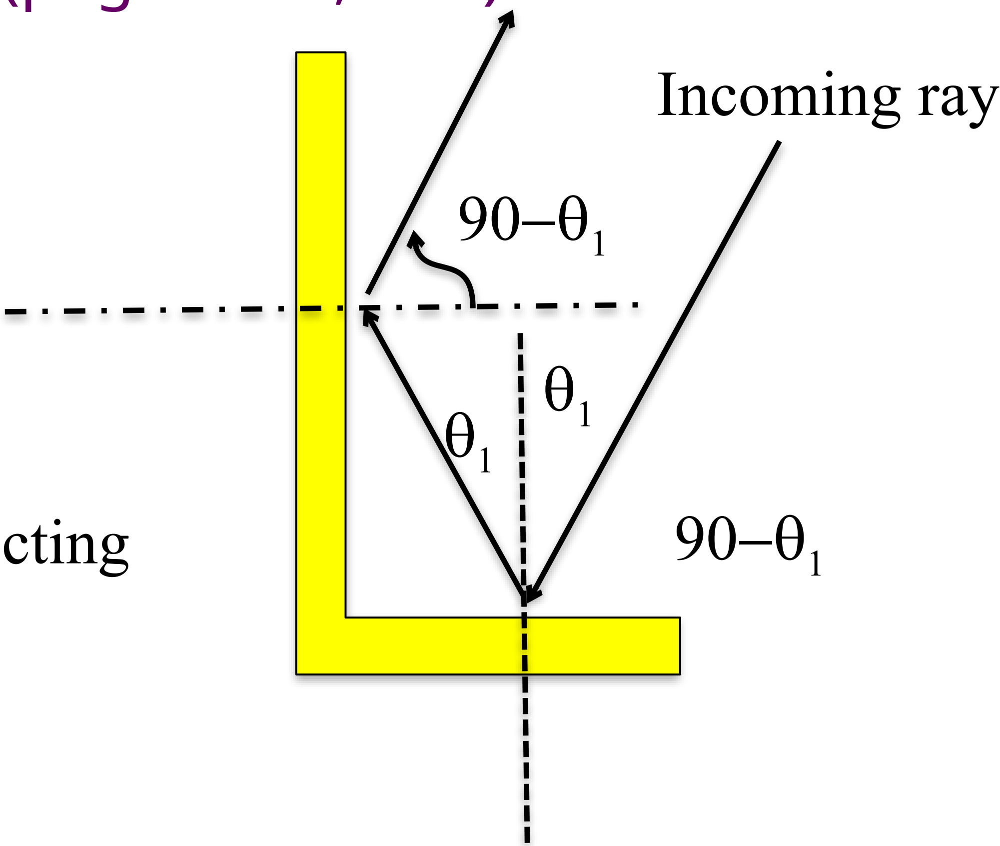
Top of the mirror half way between eye level and top of the head.



Corner cube reflector (page 1088, Y&F)



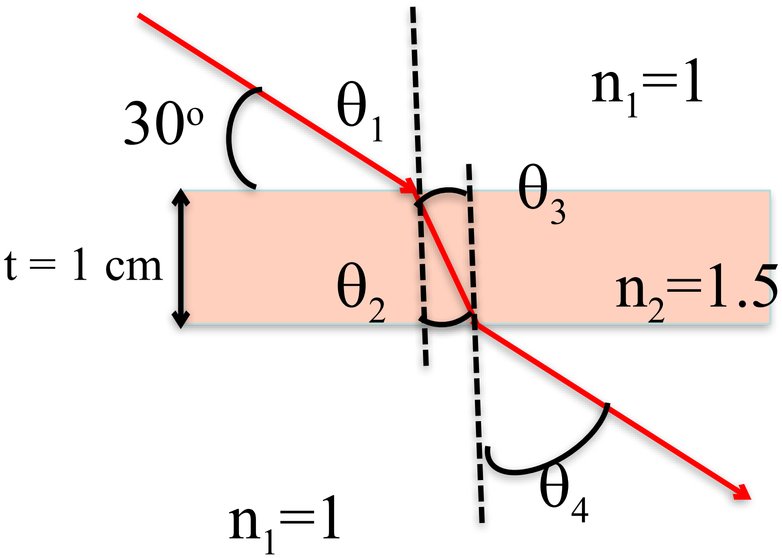
Three mutually orthogonal reflecting surfaces.



The ray is reflected twice: Once at each mirror.

Reflected ray travels in the opposite direction of the incoming ray. Compare this with a plane mirror.

Light travelling through a piece of glass



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

$$\theta_2 = \sin^{-1}\left(\frac{n_1 \sin\theta_1}{n_2}\right) = 35.3^o$$

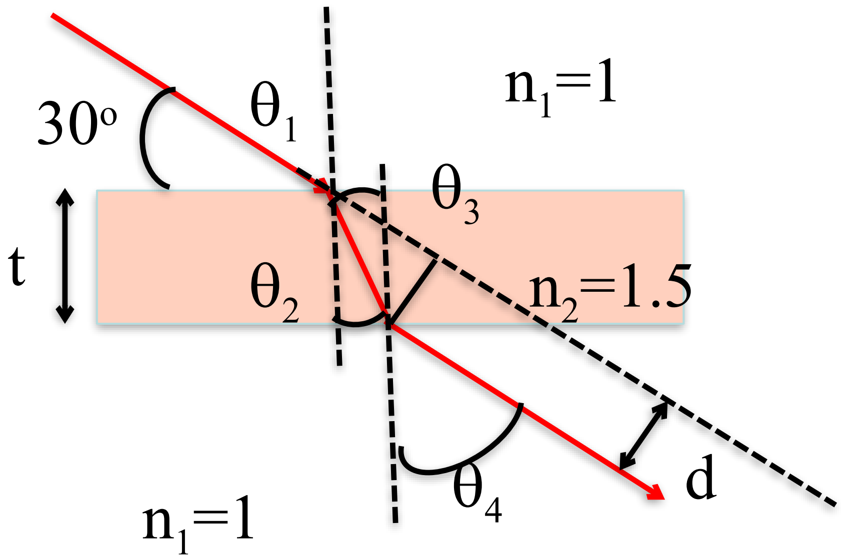
$$n_2 \sin\theta_3 = n_1 \sin\theta_4,$$

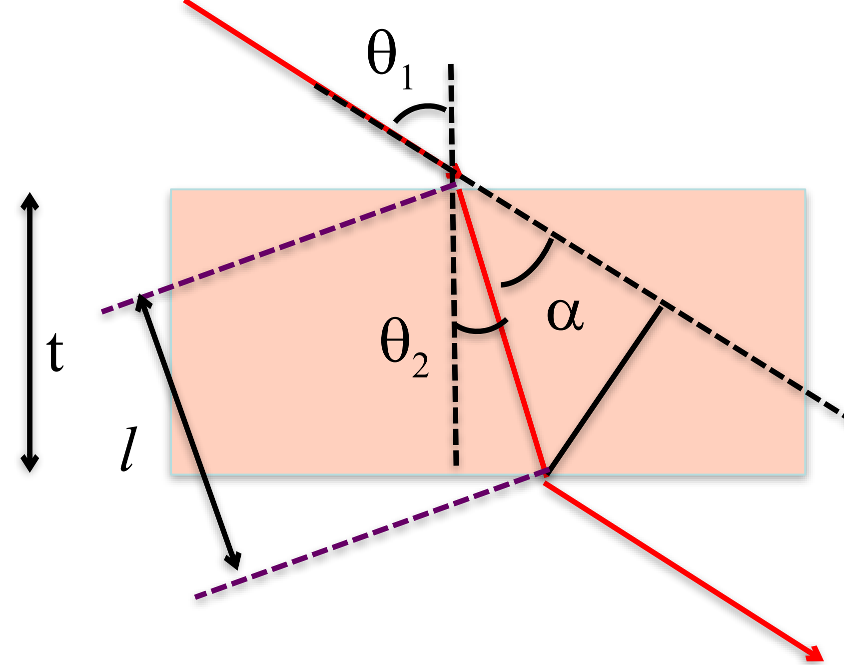
$$\theta_2 = \theta_3$$

$$\theta_4 = \sin^{-1}\left(\frac{n_2 \sin\theta_3}{n_1}\right) = 60^o$$

The outgoing beam travels in the same direction as the original incoming beam, (independent of thickness of glass), but it is displaced.

To find the displacement d:

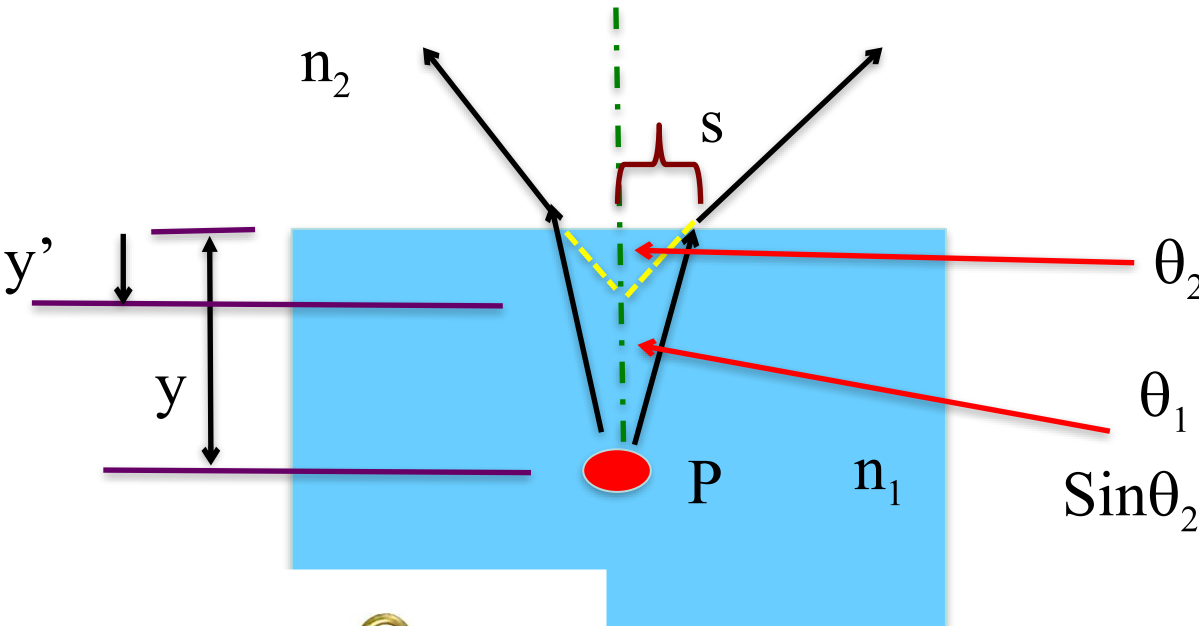




$$d = l\sin\alpha = l\sin(\theta_1 - \theta_2)$$

$$= \frac{t}{\cos\theta_2}\sin(\theta_1 - \theta_2) = 0.51\ \text{cm}$$

Apparent depth of an object



$\tan\theta_2 = s/y'$

$\tan\theta_1 = s/y$

$\tan\theta_2/\tan\theta_1 = y/y'$

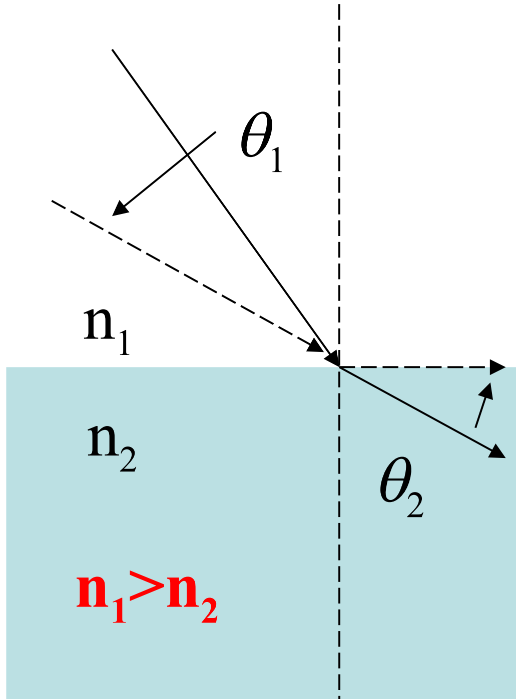
$\sin\theta_2\cos\theta_1/\sin\theta_1\cos\theta_2 = y/y'$

For very small angles,
$\cos\theta_1 = \cos\theta_2 = 1$

$\sin\theta_2/\sin\theta_1 = y/y' = n_1/n_2$

$y' = (n_2/n_1)y$

Total internal reflection



Snell's Law $\quad n_1 \sin(\theta_1) = n_2 \sin(\theta_2)$

when $\theta_2 = \pi/2 \qquad n_1 \sin(\theta_1) = n_2$

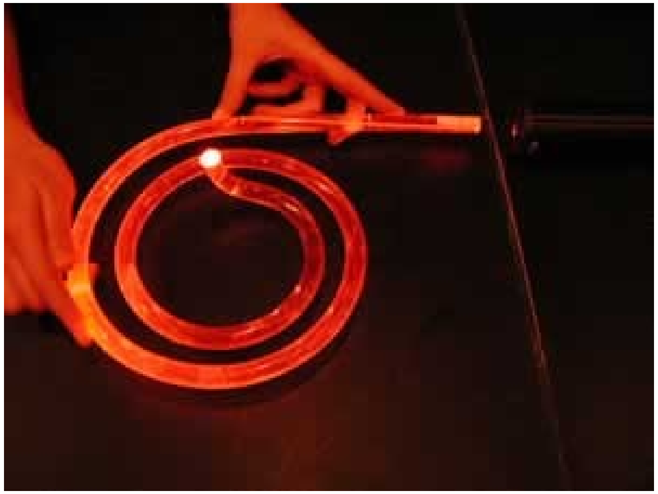
i.e.

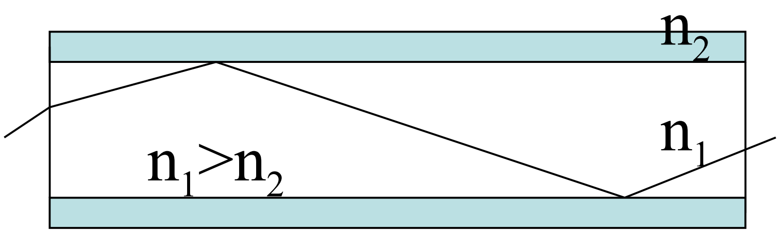
$\sin(\theta_c) = n_2 / n_1 \quad (\theta_c = 48.6^0$ for water to air)

θ_c is called the critical angle

http://www.youtube.com/wat

http://www.youtube.com/watc





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