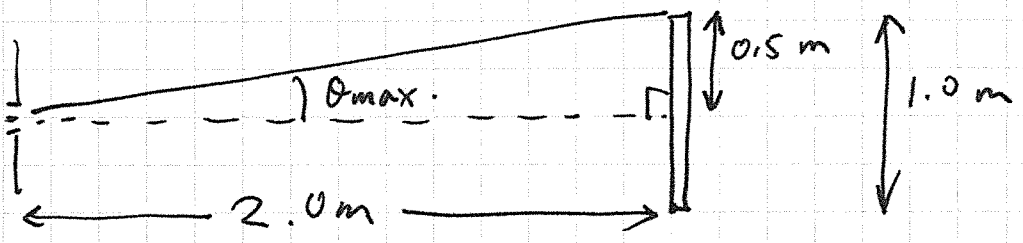
Practice Problem Set 10. - Solutions.

by Jason Harlow

-PHY152.

1.



By geometry, $\theta_{max} = \tan^{-1}\left(\frac{0.5\ m}{2.0\ m}\right) = 14.036^\circ$

Use the grating equation, Eq. 32.1a in Wolfson, pg. 604.

bright fringes → $d \sin\theta = m\lambda$ $\quad (m = 0, 1, 2, \ldots)$

We want the highest order number, m, such that $\theta < \theta_{max}$

$$m < \frac{d \sin\theta_{max}}{\lambda} = \frac{d \sin(14.036)}{633 \times 10^{-9}\ m}$$

$$m < d\left(3.8315 \times 10^{5}\right)$$

(a) if $d = 0.1 \times 10^{-3}\ m$, then $m < 38.3$

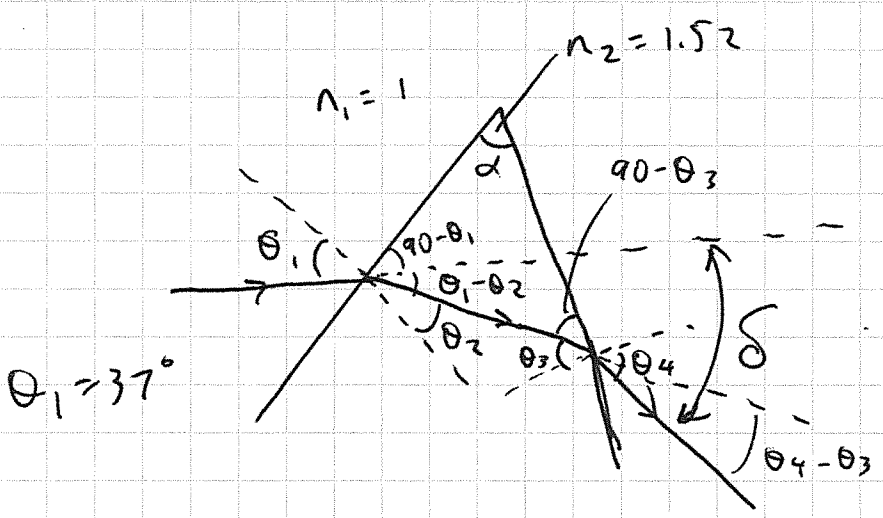
So highest integer order number is **38**

(b) if $d = 10\ \mu m = 10 \times 10^{-6}\ m$, $m < 3.83$

So highest integer order number is **3**

Practice PS 10.
Solutions

2.



1st interface $n_1 \sin\theta_1 = n_2 \sin\theta_2$

$$\theta_2 = \sin^{-1}\left(\frac{n_1}{n_2}\sin\theta_1\right) = \sin^{-1}\left(\frac{1}{1.52}\sin 37\right)$$

$$\theta_2 = 23.32405°$$

The sum of the interior angles in the triangle is 180°.

$$(90-\theta_1) + (\theta_1-\theta_2) + \alpha + 90-\theta_3 = 180$$

$$90 - \theta_1 + \theta_1 - \theta_2 + \alpha + 90 - \theta_3 = 180$$

$$-\theta_2 + \alpha - \theta_3 = 0$$

$$\theta_3 = \alpha - \theta_2 = 60 - 23.32405°$$
$$= 36.67595°$$

2nd interface: $n_2 \sin\theta_3 = n_1 \sin\theta_4$

$$\theta_4 = \sin^{-1}\left(\frac{n_2}{n_1}\sin\theta_3\right) = \sin^{-1}\left(\frac{1.52}{1}\sin 36.6759\right)$$

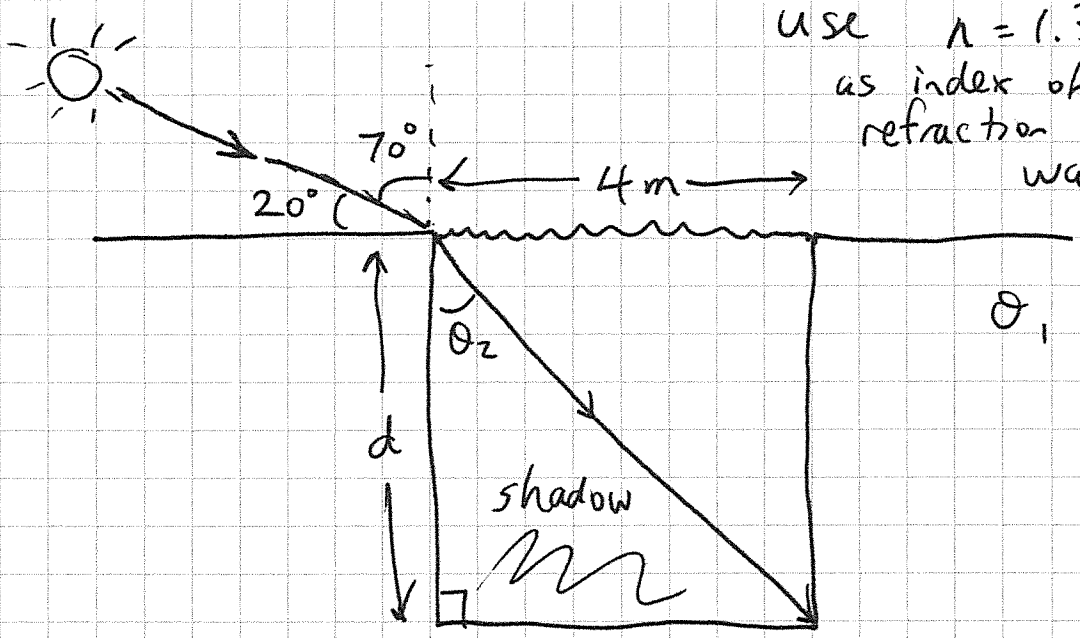
$$\theta_4 = 65.21378°$$

$$\delta = (\theta_1-\theta_2) + (\theta_4-\theta_3) = (37-23.32405) + (65.21378-36.67595)$$

$$\boxed{\delta = 42.2°}$$

Practice P510 solution

3.



use $n = 1.33$ as index of refraction of water.

$\theta_1 = 70°$

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

$$\theta_2 = \sin^{-1}\left(\frac{n_1}{n_2}\sin\theta_1\right) = \sin^{-1}\left(\frac{1}{1.33}\sin 70°\right)$$

$$\theta_2 = 44.95377°$$

geometry: $\tan\theta_2 = \frac{4}{d}$, $d = \frac{4}{\tan(44.95377)}$

$d = 4.006$ m

$\boxed{d = 4.0 \text{ m}}$

4. (a) $n_2 < n_1$

(b) some light gets reflected, some gets refracted.

(c) all the light gets reflected.

(d) all the light gets reflected.