Physics 111 Homework Solutions Collected on Monday 10/27

Wednesday, October 22, 2014

Chapter 20

Questions

- none

Multiple-Choice

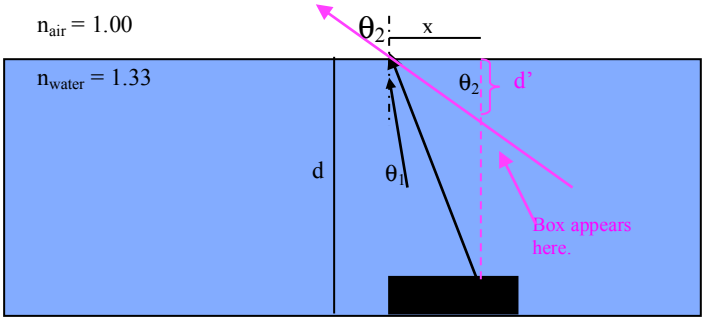
- none

Problems

20.15 We find the critical angle from

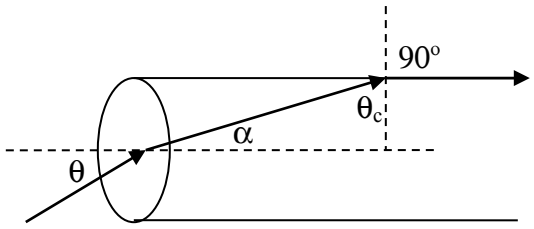
$n_1 \sin\theta_1 = n_2 \sin\theta_2 \rightarrow n_1 \sin\theta_c = n_2 \sin 90 \rightarrow \sin\theta_c = \frac{1.00}{1.33} \rightarrow \theta_c = 48.8^o$. The radius of the ring of light is given from $r = d \tan\theta_c = 8' \tan 48.8 = 9.1'$

20.16 We use Snell's Law with $n_{water} \sin\theta_1 = n_{air} \sin\theta_2 \rightarrow 1.33 \sin\theta_1 = \sin\theta_2$. Defining x as the distance from the normal to the surface to where the ray originates, we can express θ_1 in terms of d and x and θ_2 in terms of x and d' as follows: $\tan\theta_1 = \frac{x}{d}$ and $\tan\theta_2 = \frac{x}{d'}$. Since the angles involved are small, we can use the small angle approximation to get $\sin\theta_1 \approx \tan\theta_1 = \frac{x}{d} \rightarrow x = d \sin\theta_1$ and $\sin\theta_2 \approx \tan\theta_2 = \frac{x}{d'} \rightarrow x = d' \sin\theta_2$. Therefore, $x = d \sin\theta_1 = d' \sin\theta_2 = d' \frac{n_{water}}{n_{air}} \sin\theta_1$. Thus the apparent depth is given as $d' = \frac{n_{air}}{n_{water}} d$. A ray diagram is shown below.



20.17 From the diagram below we apply Snell's Law at the upper surface where we want the ray to strike at the critical angle. We have therefore $n_{pipe}\sin\theta_c = n_{air}\sin 90 = 1.0\sin 90 \rightarrow \theta_c = \sin^{-1}\left(\frac{1.00}{1.30}\right) = 50.3^o$. From the geometry we see that the angle of refraction of light off of the front surface of the pipe, α is $\alpha = 90^o - \theta_c = 90^o - 50.3^o = 39.7^o$. Therefore θ can be found by applying Snell's Law on the front surface and we have

$$n_{air}\sin\theta = n_{pipe}\sin\alpha \rightarrow \theta = \sin^{-1}\left(\frac{n_{pipe}\sin\alpha}{n_{air}}\right) = \left(\frac{1.30\sin 39.7}{1.00}\right) = 54.2^o.$$



Thursday, October 23, 2014

Chapter 21

Questions

- none

Multiple-Choice

- none

Problems

- none