

PHYS 3345:

OPTICS

Quiz 05: Chapter 04

Spring 2008

Answer each of the questions below, showing your work. Each question is worth 5 points. Work on the front and back of this page, attaching additional sheets if necessary.

1. The index of refraction for turpentine is 1.472. You have a beaker of turpentine on the workbench, and accidentally drop a washer in. The liquid depth is 15cm, and you know the washer lies on the bottom of the beaker. But what is its apparent depth due to the refractive medium? Assume near-normal incidence.

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

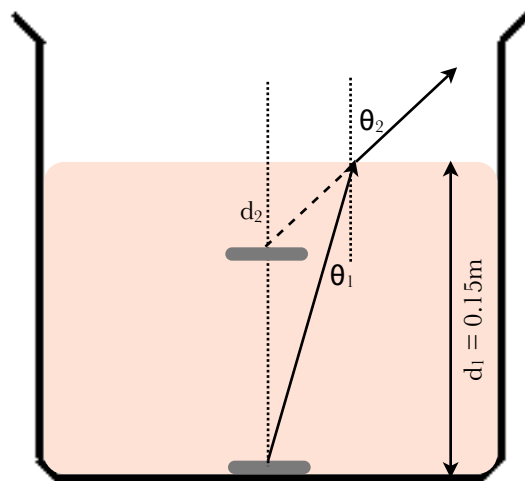
$$\tan \theta_1 = \frac{x}{d_1} = \frac{\sin \theta_1}{\cos \theta_1}$$

$$x = \frac{d_1 \sin \theta_1}{\cos \theta_1}$$

$$\tan \theta_2 = \frac{x}{d_2} = \frac{\sin \theta_2}{\cos \theta_2}$$

$$d_2 = \frac{x \cos \theta_2}{\sin \theta_2} = d_1 \left(\frac{\sin \theta_1}{\sin \theta_2} \right) \left(\frac{\cos \theta_2}{\cos \theta_1} \right)$$

$$\cos \theta_1 \cong \cos \theta_2 \cong 1$$



$$d_2 = d_1 \left(\frac{n_2}{n_1} \right)$$

$$d_2 = (15\text{cm}) \left(\frac{1}{1.472} \right) = 10.2\text{cm}$$

2. A fish looks straight up. He is, of course, under the water ($n = 1.33$). No matter what his depth, he sees a circle of the universe (a *very* small circle, given the size of the universe, but he's a fish and the concept of infinite space really is beyond his ken), surrounded by darkness. Is this some mystical fish experience? No, just optics. Show that the fish is receiving a cone of light, and determine the cone angle.

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

$$(1) \sin 90^\circ = (1.33) \sin \theta_2$$

$$\theta_2 = 48.6^\circ$$

$$\text{cone angle} = 2(48.6^\circ) = 97^\circ$$

