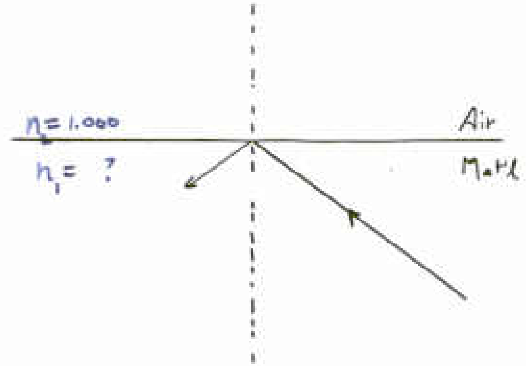
Name________________________________

Phys 122 — Section 4
Quiz #5

1. It is found that for a beam of light coming from unknown transparent material into air, total reflection occurs when the angle of incidence is 53°. What is the index of refraction for the material?

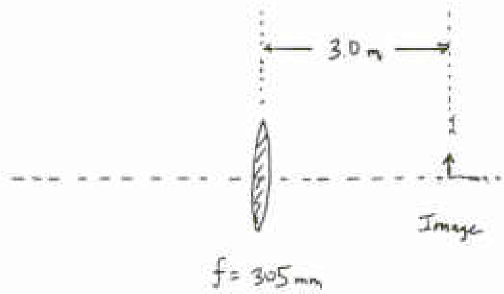


$\sin\theta_c = \frac{n_2}{n_1}$ Here, $n_2 = 1.000$, $\theta = 53°$.

Solve for n_1:

$$n_1 = \frac{n_2}{\sin\theta_c} = \frac{1.000}{\sin 53°} = \boxed{1.25}$$

2. An object is placed to the left of a (converging) lens of focal length 305 mm. The image appears 3.0 m to the right of the lens.



a) How far to the left of the lens was the object placed?

Here, $d_i = +3.0\,m$ and $f = 305\,mm$. Then

$$d_o = \frac{1}{f} - \frac{1}{d_i} = \frac{1}{305\,mm} - \frac{1}{3.0\times10^3\,mm} = 340\,mm = 34\,cm$$

Object was placed $\boxed{34\,cm}$ to the left of the lens.

b) What is the magnification of the image?

$$m = -\frac{d_i}{d_o} = -\frac{(3.0\times10^3\,mm)}{340\,mm} = \boxed{-8.8}$$

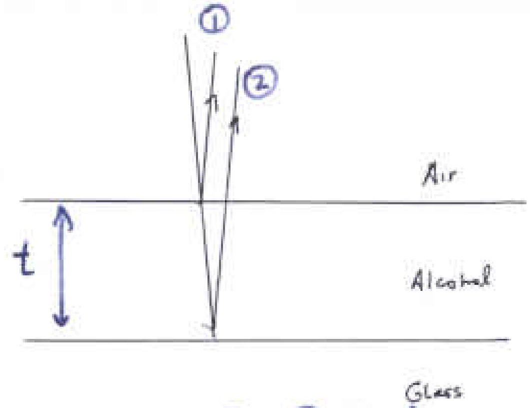
c) Is the image real or virtual? Upright or inverted with (respect to object)? Is it smaller or larger than the object?

It is <u>real</u> since it's on the right (i.e. the side of the lens where it is viewed.)

It is <u>inverted</u> since $m < 0$

It is <u>larger</u> since $|m| > 1$

Phys 122, Sec 4: Quiz #5



Ray 2 travels additional length of 2t

3. A thin film of ethyl alcohol ($n = 1.362$) covers a pane of glass ($n = 1.532$) and a beam of green light ($\lambda_{\text{vac}} = 551$ nm) shines perpendicularly on it (coming from air).

a) What is the wavelength of the light *inside the alcohol?*

$$\lambda_{alc} = \frac{\lambda_{vac}}{n_{alc}} = \frac{551 \text{ nm}}{1.362} = \boxed{405 \text{ nm}}$$

b) What is the minimum possible thinkness for the film if destructive interference is to occur? (Hint: *Both* of the reflected rays "bounce off" an optically *denser* material, so *both* do a half-wave change in phase, so there is no *net* phase difference just due to the reflections.)

Since there is no net phase difference due to the reflections, the extra distance traveled by ray 2 must be a half-odd-integral number of (in-film) wavelengths in order to get destructive interference. Thus:

$$2t = (m + \tfrac{1}{2})\,\lambda_{alc} \qquad m = 0, 1, 2, \ldots$$

Smallest t is when $m = 0$, so

$$2t = (0 + \tfrac{1}{2})\,\lambda_{alc} \Rightarrow 2t \quad \frac{\lambda_{alc}}{2} \Rightarrow t = \frac{\lambda_{alc}}{4} = \frac{405 \text{ nm}}{4} = \boxed{101 \text{ nm}}$$

You must show all your work!

$$\sin\theta_c = \frac{n_2}{n_1} \qquad \tan\theta_B = \frac{n_1}{n_2} \qquad \frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f} \qquad m = \frac{h_i}{h_o} = -\frac{d_i}{d_o} \qquad 1 \text{ diopter} = 1 \text{ m}^{-1}$$

Dark fringe: $\sin\theta = (m + \frac{1}{2})\frac{\lambda}{d}$ Light fringe: $\sin\theta = m\,\frac{\lambda}{d}$ $m = 0, 1, \ldots$

$\lambda_{\text{film}} = \frac{\lambda_{\text{vac}}}{n}$ Dark fringe: $\sin\theta = m\frac{\lambda}{w}$ $m = 1,, 2, \ldots$

Some EM units: Coulomb, Volt, Farad, Ampere, Ohm, Tesla, Weber, Henry