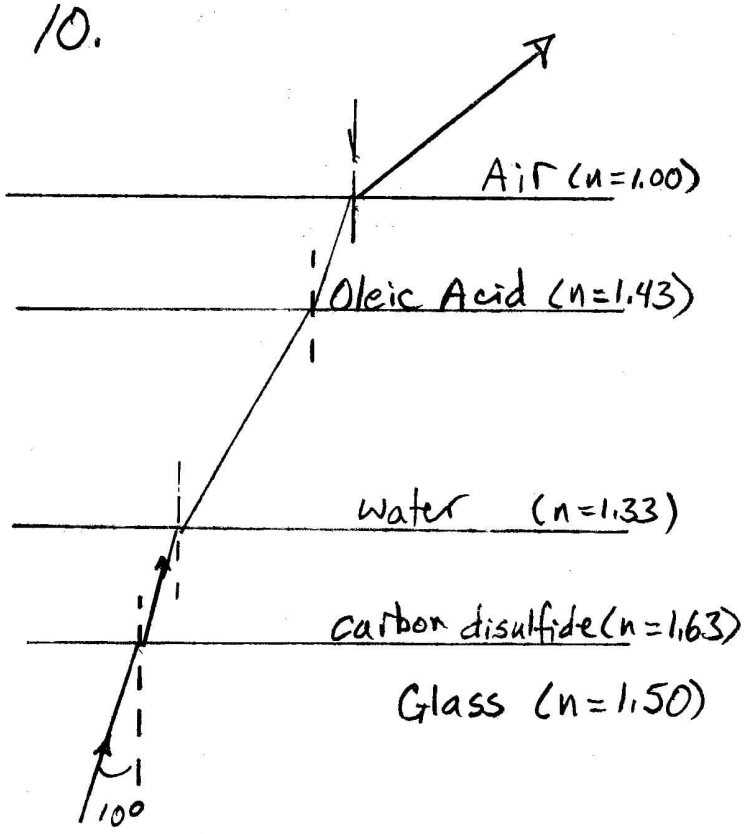
Dr. Bob

10.



After each interface the angle of refraction becomes the new angle of incidence.

$$\theta_2 = \arcsin\left(\frac{n_1 \sin\theta_1}{n_2}\right)$$

Glass - carbon disulfide $n_1 = 1.50$ $\theta_1 = 10°$
$n_2 = 1.63$ $\theta_2 = ?$

$$\theta_2 = \arcsin\left(\frac{1.50}{1.63}\sin 10°\right) = 9.195°$$

Carring 1 extra sig fig for calculations

Carbon-disulfide - water $n_1 = 1.63$ $\theta_1 = 9.195°$
$n_2 = 1.33$ $\theta_2 = ?$

$$\theta_2 = \arcsin\left(\frac{1.63}{1.33}\sin 9.195°\right) = 11.294°$$

Water - Oleic Acid $n_1 = 1.33$ $\theta_1 = 11.294°$
$n_2 = 1.43$ $\theta_2 = ?$

$$\theta_2 = \arcsin\left(\frac{1.33}{1.43}\sin 11.294°\right) = 10.495°$$

10. (continued)

Oleic Acid-Air $\quad n_1 = 1.43 \quad \theta_1 = 10.495°$
$n_2 = 1.000 \quad \theta_2 = ?$

$$\theta_2 = \arcsin\left(\frac{1.43}{1.000}\sin 10.495°\right) = 15.13°$$

$$\boxed{\theta_2 = 15.1°}$$

What would the angle be if you went from glass ($n = 1.50$) directly to air ($n = 1.000$)?

Glass - Air $\quad n_1 = 1.50 \quad \theta_1 = 10°$
$n_2 = 1.000 \quad \theta_2 = ?$

$$\theta_2 = \arcsin\left(\frac{1.50}{1.000}\sin 10°\right) = 15.1°$$

$$\theta_2 = 15.1°$$

So, if you were in a hurry you just do the last step as long as you explain why this works.

The angle of refraction at the end of a series of parallel interfaces is the same as it would be for an interface between the first & last medium.

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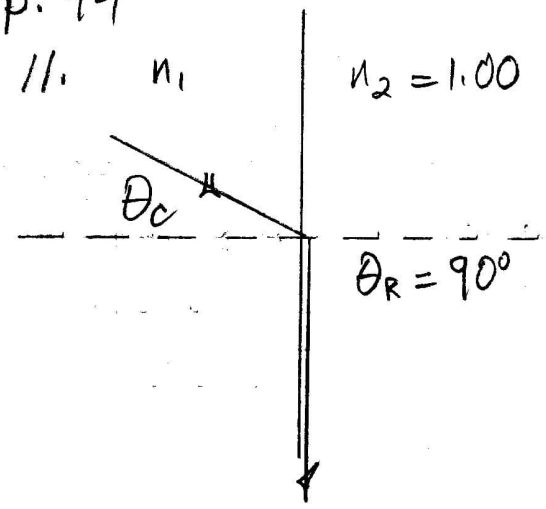
11. 

$\theta_c = 27°$

& $\theta_c = 32°$

$\theta_c = \sin^{-1}\left(\frac{n_2}{n_1}\right)$

$\sin\theta_c = \frac{n_2}{n_1}$

$n_2 = 1.00$

$n_1 = \frac{n_2}{\sin\theta_c} = \frac{1.00}{\sin\theta_c}$

$\theta_c = 27°$ $n_1 = \frac{1}{\sin 27°} = 2.20$

$\theta_c = 32°$ $n_1 = \frac{1}{\sin 32°} = 2.00$

Light traveling in the medium with a critical angle of 32° travels faster.

$V = \frac{c}{n}$

12.

a) The angle of incidence is 0° so no refraction occurs.

b) The angle of incidence (45°) is greater than the critical angle (which for glass (n = 1.50) to air is 41.8°).

c) $\theta_i = \theta_R = 45°$

d) In other words, what is the index of refraction for a critical angle of 45°?

$n_2 = 1.000 \quad \theta_c = 45°$

$n_1 = ?$

$$\theta_c = \arcsin\left(\frac{n_2}{n_1}\right)$$

$$\sin\theta_c = \frac{n_2}{n_1}$$

$$n_1 = \frac{n_2}{\sin\theta_c} = \frac{1.000}{\sin 45°}$$

$$\boxed{n_1 = 1.41}$$

The index of refraction of the prisms must be greater than 1.41.