Physics

Dr. Bob

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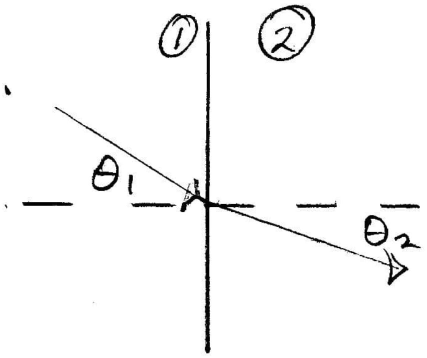
1. Reflected Ray
2. Normal Line
3. Inciden Ray
4. Refracted Ray
5. —
6. Angle of Reflection
7. Angle of Incidence
8. —
9. —
10. Angle of Refraction
11. —
12. Interface

2.




Assume air for the other medium $n_1 = 1.000$ $\theta_i = \theta_1$

$n_2 = 1.50$ $\theta_R = \theta_2$

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

a) $\theta_1 = 0°$ $\theta_2 = 0°$

Rays hitting parallel to the normal & perpendicular to the interface are not refracted.

b) $\theta_1 = 30°$

$\theta_2 = ?$

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

$\frac{n_1}{n_2} \sin\theta_1 = \sin\theta_2$

$\theta_2 = \arcsin\left(\frac{n_1}{n_2} \sin\theta_1\right) = \left(\frac{1.000}{1.50} \sin 30°\right)$

$\boxed{\theta_2 = 19.5°}$

c) $\theta_1 = 60°$ $\theta_2 = ?$

$\theta_2 = \arcsin\left(\frac{1.000}{1.50} \sin 60°\right) \cong 35.3°$

$\boxed{\theta_2 = 35.3°}$

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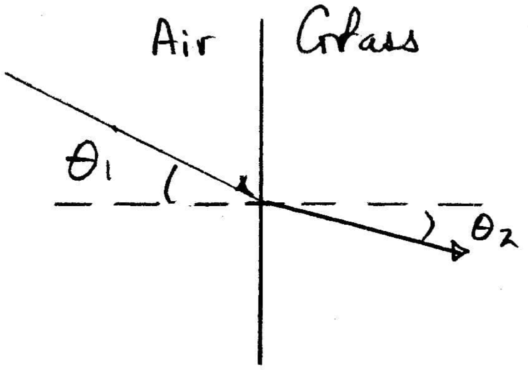
3. $n_{red} = n_r = 1.52$  $\theta_1 = 30°$

$n_{violet} = n_v = 1.54$  $n_1 = 1.000$

$\theta_2 = ?$




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

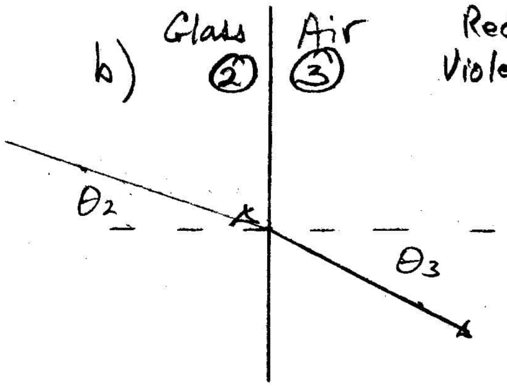
a) Red: $\theta_2 = \arcsin\left(\frac{1.000}{1.52}\sin 30°\right)$

$\boxed{\theta_R = \theta_2 = 19.2°}$

Violet: $\theta_2 = \arcsin\left(\frac{1.000}{1.54}\sin 30°\right)$

$\boxed{\theta_R = \theta_2 = 18.9°}$

b)




Red $n_2 = 1.52$  $\theta_2 = 19.2°$  $n_3 = 1.000$

Violet $n_2 = 1.54$  $\theta_2 = 18.9°$  $\theta_3 = ?$

$$\theta_3 = \arcsin\left(\frac{n_2}{n_3}\sin\theta_2\right)$$

Red: $\theta_3 = \arcsin\left(\frac{1.52}{1.000}\sin 19.2°\right)$

$\boxed{\theta_3 = 30°}$

Violet $\theta_3 = \arcsin\left(\frac{1.54}{1.000}\sin 18.9°\right)$

$\boxed{\theta_3 = 30°}$

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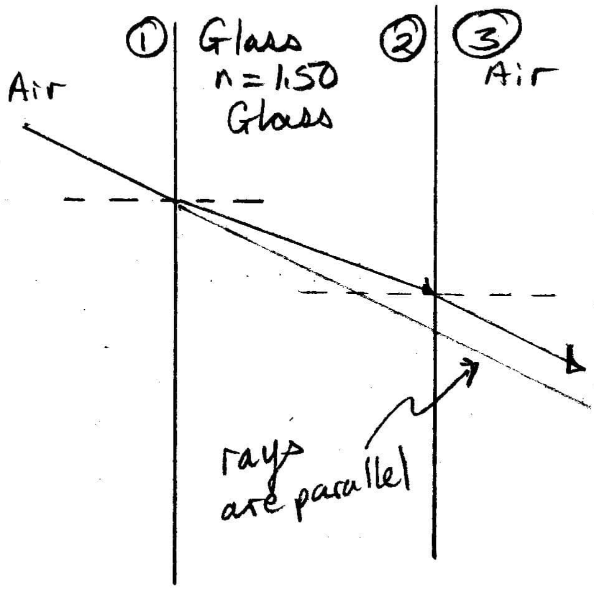
4.




As we saw in problem 3, the amount of refraction going into ar medium (glass) is compensated by refraction @ the 2nd surface.

The amount the ray bends towards the normal going air to glass is compensated by the amount the ray bends away from the normal going from glass to air

5. Crown glass $n = 1.53$ violet

$n = 1.51$ red

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

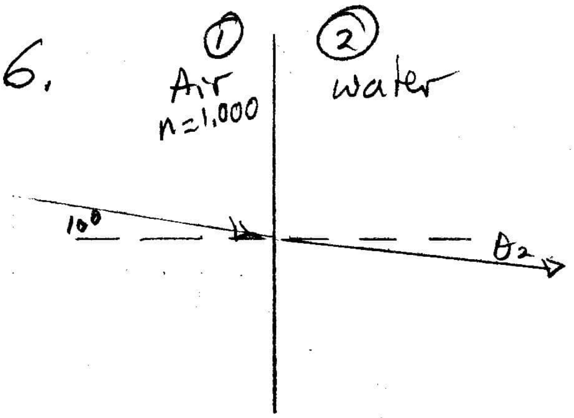
Violet $V = \frac{3.00 \times 10^8 \, m/s}{1.53}$

$$\boxed{V = 1.96 \times 10^8 \, m/s}$$

Red $V = \frac{3.00 \times 10^8 \, m/s}{1.51}$

$$\boxed{V = 1.99 \times 10^8 \, m/s}$$

6.




$\theta_1 = 10°$ $\theta_2 = ?$

$n_1 = 1.000$

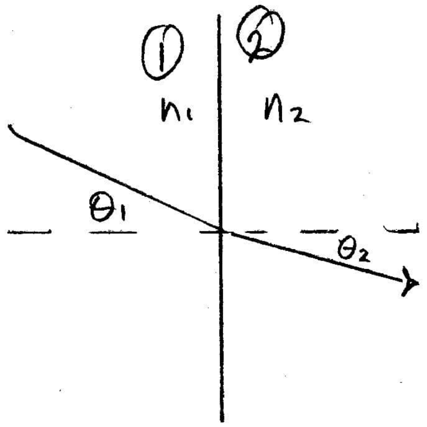
$n_2 = \frac{c}{v} = \frac{c}{(3/4)c} = \frac{4}{3}$

$n_2 = \frac{4}{3}$

$\theta_2 = \arcsin\left(\frac{n_1}{n_2}\sin\theta_1\right) = \arcsin\left(\frac{1.000}{4/3}\sin 10°\right)$

$\theta_2 = 7.48°$

7.




Since $n_1 < n_2$

$\theta_1 > \theta_2$

As $n_2$ gets larger, $\theta_2$ will get smaller. In the extreme case as $n_2$ becomes very large, $\theta_2$ approaches 0° with the ray exiting parallel to the normal.
Total internal reflection is the opposite case since refracted ray will bend until $\theta_2 = 90°$ and the ray runs parallel to the interface.

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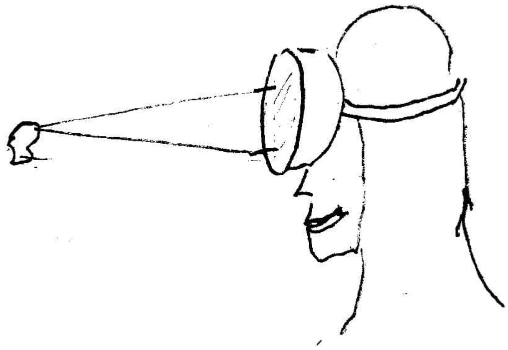
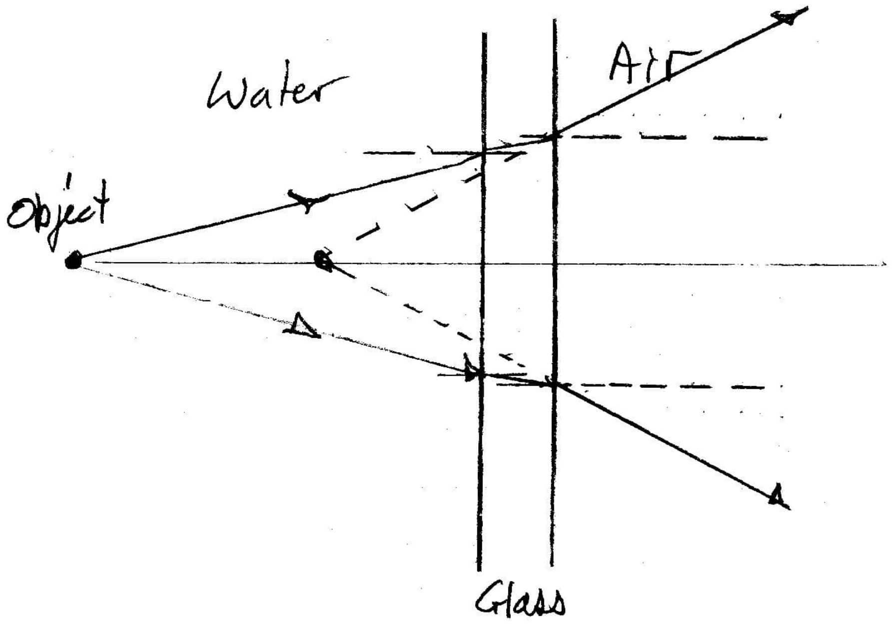
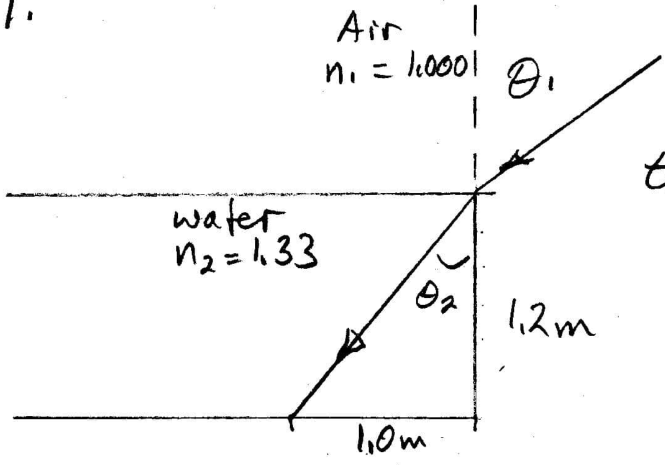
8.






Because the light rays will bend away from the normal compared to initial ray the object will appear closer than is really is.

9.




$\theta_1 = ?$

$\tan\theta_2 = \frac{1.0\,\text{m}}{1.2\,\text{m}}$

$\theta_2 = \arctan\left(\frac{1}{1.2}\right)$

$\theta_2 = 39.8°$

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

$= \arcsin\left(\frac{1.33}{1.000}\sin\left(\arctan\left(\frac{1}{1.2}\right)\right)\right)$

$\boxed{\theta_1 = 58.4°}$