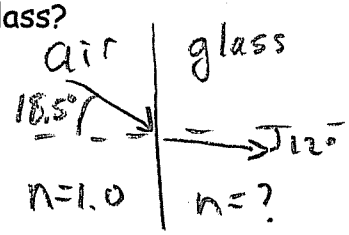
PHYSICS 11

NAME: _____

Snell's Law & Critical Angles

1. Light entering a block of glass from air at an angle of incidence of 18.5° leaves the boundary between the air and the glass at an angle of 12.0°. What is the index of refraction of this type of glass?



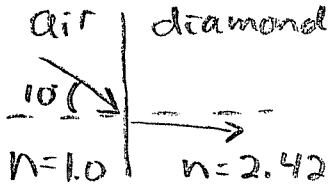
$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$1.0 \sin 18.5° = n_2 \sin 12°$

$.317 = n_2 (.208)$

$n_2 = \frac{.317}{.208} = 1.52$

2. Light from air is incident on diamond at an angle of 10.0°. At what angle will it refract?



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

$1.0 \sin 10° = 2.42 \sin\theta_2$

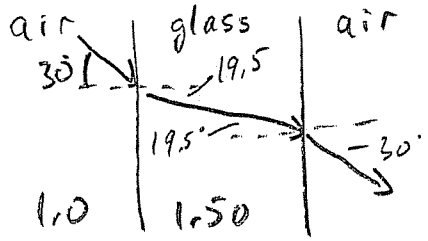
$.174 = 2.42 \sin\theta_2$

$\sin\theta_2 = .071$

$\theta = \sin^{-1}(.071)$

$= 4.1°$

3. A beam of light is incident on a sheet of glass in a window at an angle of 30°. Describe exactly what path the light beam will take (a) as it enters the glass and (b) as it leaves the other side of the glass. Assume n=1.500.



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

$1.0 \sin 30 = 1.5 \sin\theta_2$

$.5 = 1.5 \sin\theta_2$

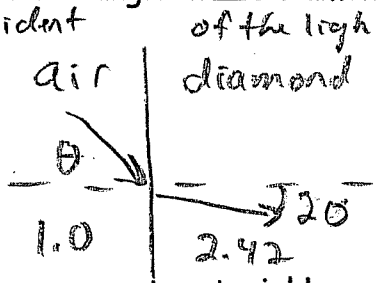
$.333 = \sin\theta$

$\sin^{-1}(.333) = 19.5°$

4. Light traveling in air has an angle of ~~incidence~~ of ~~40~~° as in passes into diamond. What is the ~~refracted~~ angle ~~in the diamond~~?

refraction 20°

incident of the light



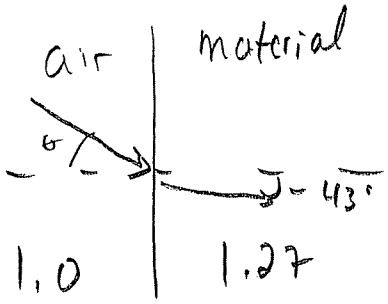
$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$1.0 \sin\theta_1 = 2.42 \sin 20°$

$\sin\theta = .828$

$\sin^{-1}(.828) = 56°$

5. A transparent material has a refractive index of 1.27. What is the angle of incidence in air when the angle of refraction in the substance is 43°?



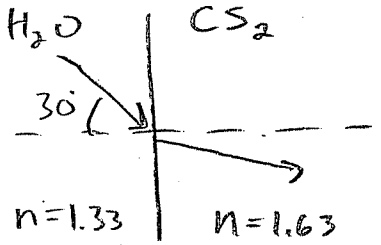
$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$1.0 \sin\theta = 1.27 \sin 43°$

$\sin\theta = .866$

$\theta = 60°$

7. 6 A ray of light passes from water into carbon disulphide (n=1.63) with an angle of incidence of 30°. What is the angle of refraction in the carbon disulphide?



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

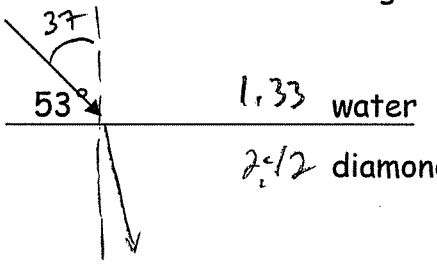
$1.33 \sin 30° = 1.63 \sin\theta_2$

$.665 = 1.63 \sin\theta_2$

$\sin\theta = .408$

$\theta = 24°$

8. 7 Using Snell's Law with n = 1.33 for water and n = 2.42 for diamond determine the angle of refraction in the diamond for the following situation.



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

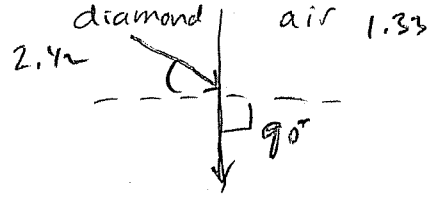
$1.33 \sin 37° = 2.42 \sin\theta_2$

$.8 = 2.42 \sin\theta_2$

$.33 = \sin\theta_2$

$\theta_2 = 19.3°$

11. 6 Calculate the critical angle for diamond into air.



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

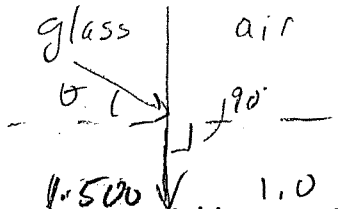
$2.42 \sin\theta_1 = 1.33 \sin 90°$

$\sin\theta_1 = \frac{1.33}{2.42} = .549$

$\sin^{-1}(.55)$

$\theta = 33°$

12. 9 What is the critical angle for a glass into air that has an index of refraction of 1.500?



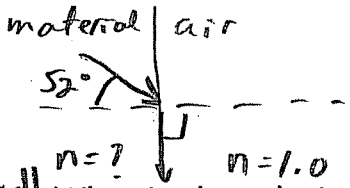
$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$1.50 \sin\theta_1 = 1.0 \sin 90°$

$\sin\theta_1 = \frac{1}{1.50}$, $\theta = 42°$

13. 10 A certain material has a critical angle of 52.0°. What is its index of refraction?

material into air



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

$n \sin 52° = (1)(\sin 90°)$

$n = \frac{1}{.788} = 1.30$

14. 11 What is the velocity of light in quartz?

$n = 1.54$

$n = \frac{V_{vac}}{V_{med}}$, $1.54 = \frac{3\times10^8}{V_{med}}$, $V_{med} = \frac{3\times10^8}{1.54} = 1.95\times10^8$ m/s

Answers: 1. n_r = 1.53 2. r = 4.1° 3. r = 19.5° r = 30.0° 4. r = 15.4° 5. i = 60.0° 6. n_r = 1.19 7. r = 24.1° 8. r = 19.3° 9. r = 55.7° 10. n = 1.41 l = 5.60×10^{-7} m l = 3.97×10^{-7} m 11. i_c = 24.4° 12. i_c = 41.8° 13. n = 1.27 14. f = 4.29×10^{14} Hz 15. 2.244×10^8 m/s, 4.41×10^{-7} m