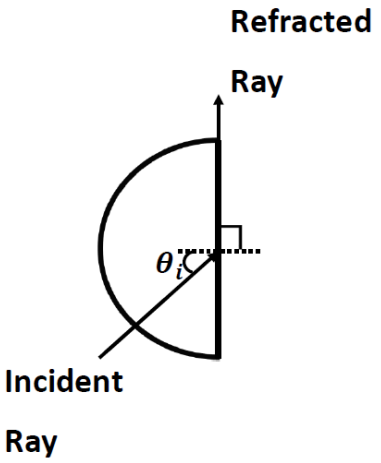
Quiz Average 6.9 **Quiz High Score** 10

PH 202 **Quiz # 09 (10 pts)** **Name** Solution



An incident ray of light with wavelength of $560.0\ \text{nm}$ is shown in the diagram on the left. Upon striking the flat wall of the plastic object$\left(\text{n}_{\text{plastic}} = 2.746\right)$, the light is refracted into air $\left(\text{n}_{\text{air}} = 1.000\right)$ at an angle of refraction of $90.0°$. What is the angle of incidence?

A. $68.6°$ **B.** $70.0°$ **C.** $20.0°$ **D.** $\mathbf{21.4°}$

$$\boldsymbol{n_{plastic}\sin(\theta_i) = n_{air}\sin\left(\theta_{refracted}\right)}$$

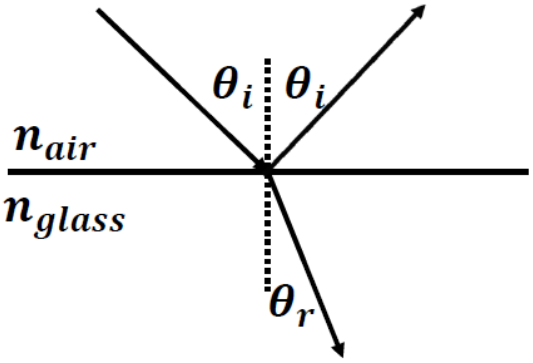
Solve for $\boldsymbol{\theta_i}$

$$\boldsymbol{\sin(\theta_i) = \frac{n_{air}\sin\left(\theta_{refracted}\right)}{n_{plastic}} = \left(\frac{n_{air}}{n_{plastic}}\right)\sin\left(\theta_{refracted}\right) = \left(\frac{1.000}{2.746}\right)\sin(90.0°) = 0.36417}$$

$$\boldsymbol{\theta_i = \sin^{-1}(0.36417) = 21.4°}$$

So, the correct answer is D !

A beam of red light ($\lambda_{\text{air}} = 650.0\ \text{nm}$) strikes the interface between air ($\text{n}_{\text{air}} = 1.000$) and glass with an angle of incidence of ($\theta_{\text{i}} = 43.0°$). Inside the glass the light appears to be green ($\lambda_{\text{glass}} = 540.0\ \text{nm}$). What is the index of refraction of this glass?



A. 0.821 **B.** 1.765 **C.** **1.204** **D.** 1.123

$$\lambda_{glass} = \frac{\lambda_{air}}{n_{glass}}$$

Solve for the index of refraction

$$n_{glass} = \frac{\lambda_{air}}{\lambda_{glass}} = \frac{650.0\ nm}{540.0\ nm} = 1.204$$

So, the correct answer is C !

While swimming underwater ($\text{n}_{\text{water}} = 1.333$), Sue looks up and sees a drone hovering directly above her. Sue estimates that the drone is 0.616 m above the surface of the water. Use ($\text{n}_{air} = 1.000$). What is the actual height of the drone above the surface of the water?

A. 0.821 m **C.** 0.205 m

B. **0.462 m** **D.** 1.85 m

For apparent depth use the lens maker equation

$$\frac{n_o}{o} + \frac{n_i}{i} = \frac{n_i - n_o}{R} = \frac{n_i - n_o}{\infty} = 0$$

Solve for object distance

$$o = -i\left(\frac{n_o}{n_i}\right) = -i\left(\frac{n_{air}}{n_{water}}\right) = -(-0.616\ m)\left(\frac{1.000}{1.333}\right) = +0.462\ m$$

- sign with 0.616 m indicates virtual image! The object being positive indicates real object!

So, the correct answer is B !

At an Ocean Spray facility, a large amount of cranberry juice is spilled creating a large puddle on the floor. When a light ray makes an angle of incidence of $53.49°$ on the interface between air $(\mathrm{n}_{air} = 1.000)$ and the cranberry juice, the light ray that is reflected is completely plane polarized parallel to the horizontal. What is the index of refraction for the cranberry juice?

A. $\mathbf{1.351}$ **B.** 0.804 **C.** 1.244 **D.** 1.681

The angle of incidence for the reflected ray to be completely horizontally polarized is known as Brewster's angle and it is found from the expression:

$$\boldsymbol{n_{air}\sin(\theta_{inc}) = n_{cranberry}\sin(\theta_{ref})}$$

The refracted ray and the reflected ray make a right angle so

$$\boldsymbol{\theta_{ref} + \theta_{inc} = 90°}$$

Or

$$\boldsymbol{\theta_{ref} = 90° - \theta_{inc}}$$

$$\boldsymbol{n_{air}\sin(\theta_{inc}) = n_{cranberry}\sin(\theta_{ref}) = n_{wcranberry}\sin(90° - \theta_{inc}) = n_{cranberry}\cos(\theta_{inc})}$$

rearranging

$$\boldsymbol{n_{air}\frac{\sin(\theta_{inc})}{\cos(\theta_{inc})} = n_{air}\tan(\theta_{inc}) = n_{air}\tan(\theta_{Brewster}) = n_{cranberry}}$$

$$\boldsymbol{n_{cranberry} = n_{air}\tan(\theta_{Brewster}) = (1.000)\tan(53.49°) = 1.351}$$

So, the correct answer is A !

A beam of light ($\lambda_0 = 614.0\ \text{nm}$) is traveling in a vacuum when it enters an experimental material. The angle of incidence is $0.00°$ and when measured the wavelength of the light is now ($\lambda_n = 2.330\ \text{nm}$). What is the speed of this light inside this experimental material?

A. $7.90 \times 10^{10}\ {}^{\text{m}}/_{\text{s}}$

B. $4.88 \times 10^{5}\ {}^{\text{m}}/_{\text{s}}$

C. $\mathbf{1.14 \times 10^{6}\ {}^{m}/_{s}}$

D. $1.29 \times 10^{6}\ {}^{\text{m}}/_{\text{s}}$

$$\boldsymbol{\lambda_n = \frac{\lambda_0}{n}}$$

Solving for n

$$\boldsymbol{n = \frac{\lambda_0}{\lambda_n} = \frac{c}{v_n}}$$

Solving for speed in medium

$$\boldsymbol{v_n = \frac{c\lambda_n}{\lambda_0} = \frac{(2.998\ x\ 10^{8}\ {}^{m}/_{s})(2.330\ nm)}{614.0\ nm} = 1.14\ x\ 10^{6}\ {}^{m}/_{s}}$$

So, the correct answer is C !

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