AP Physics B
2000 Student Samples

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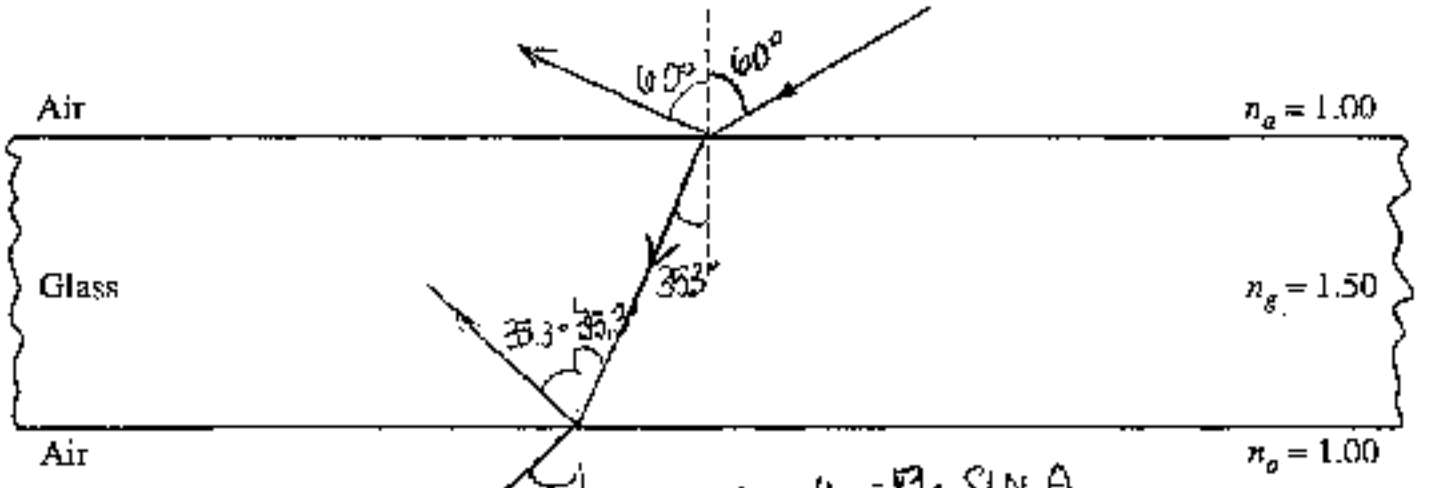
Q1

4. (15 points)

A sheet of glass has an index of refraction $n_g = 1.50$. Assume that the index of refraction for air is $n_a = 1.00$.

(a) Monochromatic light is incident on the glass sheet, as shown in the figure below, at an angle of incidence of 60°. On the figure, sketch the path the light takes the first time it strikes each of the two parallel surfaces. Calculate and label the size of each angle (in degrees) on the figure, including angles of incidence, reflection, and refraction at each of the two parallel surfaces shown.



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

$1 \sin 60° = 1.50 \sin\theta_2$

$\frac{\sin 60}{1.50} = \sin\theta_2$

$\theta = 35.3°$

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

$1.50 \sin 35.3 = 1 \sin\theta$

$\theta = 60.0°$

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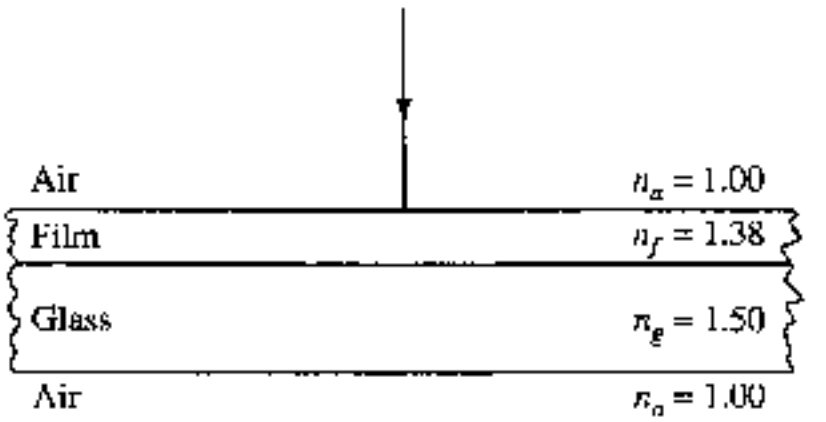
Q2

(b) Next a thin film of material is to be tested on the glass sheet for use in making reflective coatings. The film has an index of refraction $n_f = 1.38$. White light is incident normal to the surface of the film as shown below. It is observed that at a point where the light is incident on the film, light reflected from the surface appears green ($\lambda = 525$ nm).



i. What is the frequency of the green light in air?

$c = f\lambda$

$3 \times 10^8 \text{ m/s} = f(525 \times 10^{-9} \text{ m})$

$f = 5.71 \times 10^{14} \text{ Hz}$

ii. What is the frequency of the green light in the film?

$5.71 \times 10^{14} \text{ Hz}$

iii. What is the wavelength of the green light in the film?

$n = c/v$

$1.38 = \frac{3 \times 10^8 \text{ m/s}}{v}$

$v = 2.17 \times 10^8 \text{ m/s}$

$v = f\lambda$

$2.17 \times 10^8 \text{ m/s} = (5.71 \times 10^{14} \text{ Hz})\lambda$

$\lambda = 3.81 \times 10^{-7} \text{ m}$

iv. Calculate the minimum thickness of film that would produce this green reflection.

2 PHASE SHIFTS

$2t = m\lambda$

$2t = 1(3.81 \times 10^{-7} \text{ m})$

$t = 1.905 \times 10^{-7} \text{ m}$

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R1

4. (15 points)

A sheet of glass has an index of refraction $n_g = 1.50$. Assume that the index of refraction for air is $n_a = 1.00$.

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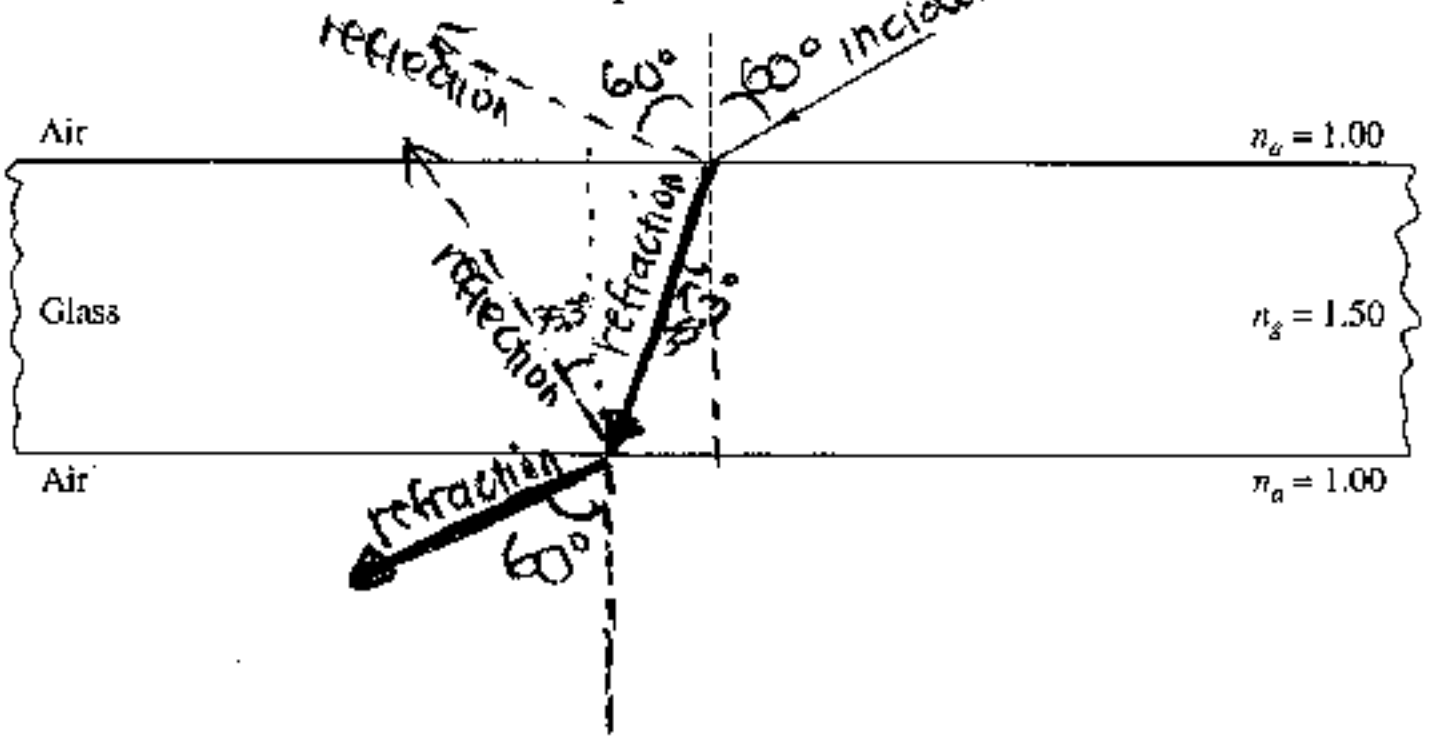

$n_a \sin\theta_a = n_g \sin\theta_g$

$(1.00)(\sin 60°) = (1.50)\sin\theta_g$

$\theta_g = 35.3°$

$60° = \theta$ in re-entering air because medium = same as first medium before entering glass

Thus n_a = same & $\sin\theta_a$ = same as before

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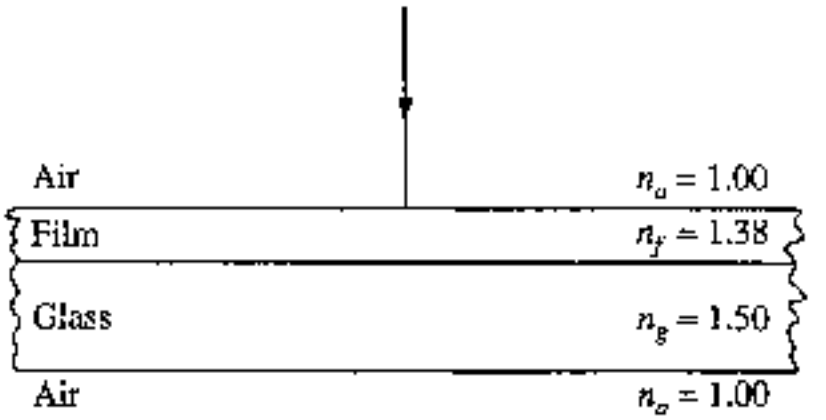
R2

(b) Next a thin film of material is to be tested on the glass sheet for use in making reflective coatings. The film has an index of refraction $n_f = 1.38$. White light is incident normal to the surface of the film as shown below. It is observed that at a point where the light is incident on the film, light reflected from the surface appears green ($\lambda = 525$ nm).



i. What is the frequency of the green light in air?

$C = f\lambda$ $\quad \lambda = 525\times10^{-9}\,m$

$f_{air} = \frac{3.0\times10^{8}}{525\times10^{-9}} = \boxed{5.7\times10^{14}\ Hz}$

ii. What is the frequency of the green light in the film?

$\frac{c}{v_f} = n = 1.38$ $\quad \frac{f_{film}}{f_{air}} = 1.38$

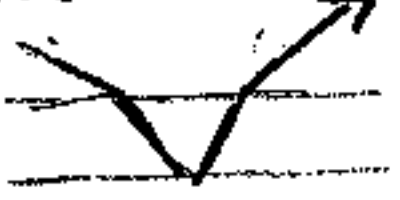
$f_{film} = (5.7\times10^{14}\ Hz)(1.38) = \boxed{7.89\times10^{14}\ Hz}$

iii. What is the wavelength of the green light in the film?

$C = \lambda f$ $\quad \lambda = \frac{c}{f_f} = \frac{3.0\times10^{8}}{7.89\times10^{14}\ Hz} = \boxed{3.8\times10^{-7}\,m}$

iv. Calculate the minimum thickness of film that would produce this green reflection.

min. thickness =



$\frac{1}{2}\lambda = \frac{3.8\times10^{-7}}{2} = \boxed{1.9\times10^{-7}\,m}$

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S1

4. (15 points)

A sheet of glass has an index of refraction $n_g = 1.50$. Assume that the index of refraction for air is $n_a = 1.00$.

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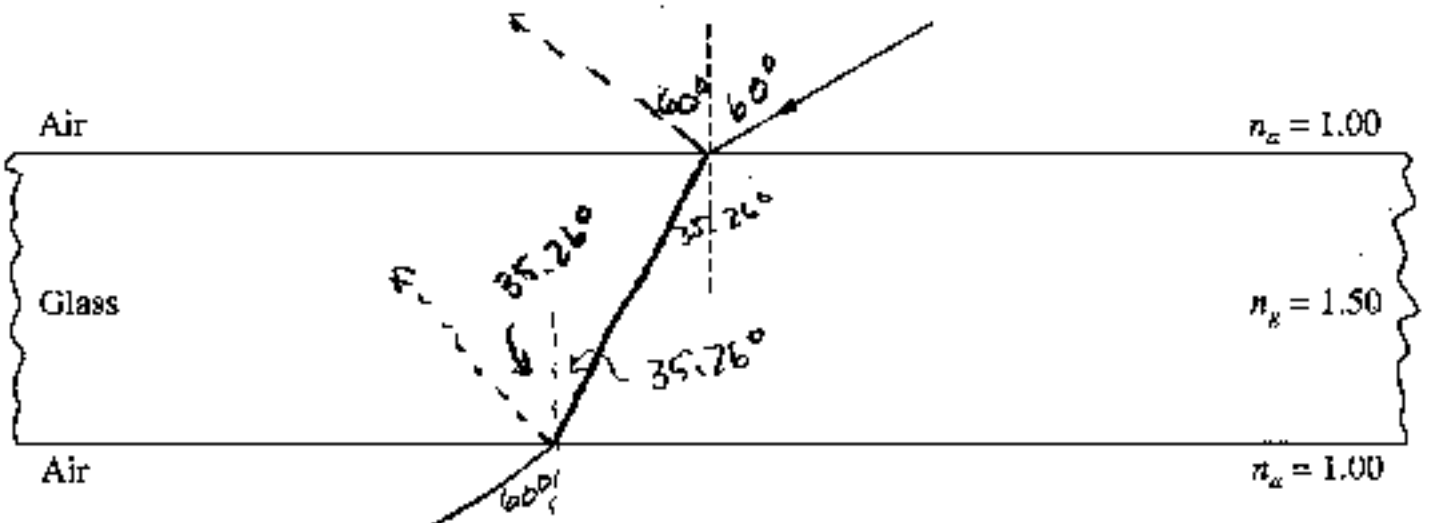


$n_g = \frac{\sin i}{\sin r}$

$1.5 = \frac{\sin 60°}{\sin r}$

$\sin r = \frac{\sin 60°}{1.5}$

$\sin r = .577$

$r = 35.26°$

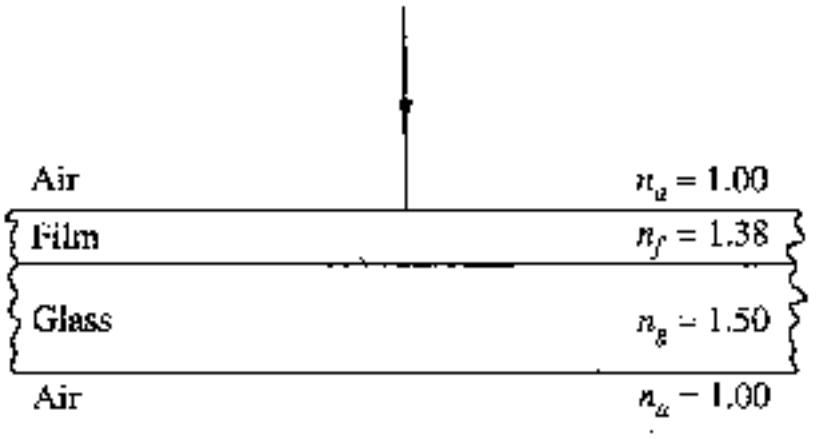
$\frac{1}{n_g} = \frac{\sin i}{\sin r}$

$\sin r = \sin i \times n_g$

$\sin r = \sin 35.26° \times 1.5$

$r = 60°$

(b) Next a thin film of material is to be tested on the glass sheet for use in making reflective coatings. The film has an index of refraction $n_f = 1.38$. White light is incident normal to the surface of the film as shown below. It is observed that at a point where the light is incident on the film, light reflected from the surface appears green ($\lambda = 525$ nm).



i. What is the frequency of the green light in air?

$V = f\lambda$

$3 \times 10^8 = f \times 525 \times 10^{-9}$

$f = 5.714 \times 10^{14}$ Hz

ii. What is the frequency of the green light in the film?

iii. What is the wavelength of the green light in the film?

iv. Calculate the minimum thickness of film that would produce this green reflection.