CAPA 8

A light wave has a 624.7nm wavelength in air. Its wavelength in a transparent solid is 418.0nm. What is the speed of light in this solid?

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What is the light's frequency in the solid?

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A sheet that is made of plastic (n = 1.60) covers one slit of a double slit. When the double slit is illuminated by monochromatic light (λ_{vacuum} = 632 nm), the center of the screen appears dark rather than bright. What is the minimum thickness of the plastic?

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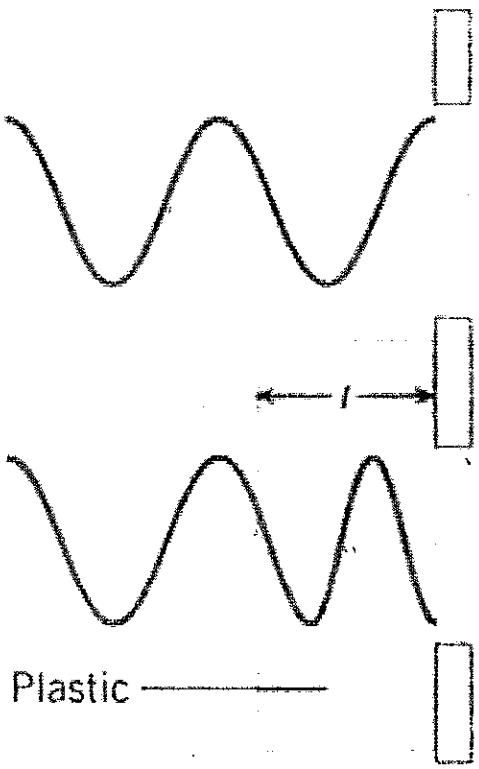

A glass fiber (n = 1.50) is submerged in water (n = 1.33). What is the critical angle for light to stay inside the optical fiber?

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A pair of narrow, parallel slits separated by 0.294mm are illuminated by the green component from a mercury vapor lamp (λ =546.1nm). The interference pattern is observed on a screen 1.30m from the plane of the parallel slits. Calculate the distance from the central maximum to the first bright region on either side of the central maximum.

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Calculate the distance between the first and second dark bands in the interference pattern.

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What is the frequency of ultraviolet light that has a wavelength of 22.1nm?

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What is the frequency of infrared light that has a wavelength of 1669.0nm?

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What is the index of refraction of a material in which the red-light wavelength is 896.0nm? The wavelength of the red light in a vacuum is 650.0nm. Enter no units.

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What is the wavelengh of a 1.51MHz ultrasound wave travelling through aluminum?(the speed of sound in aluminum is 6420 m/s)

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What frequency of electromagnetic wave would have the same wavelength as the ultrasound wave above?

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A transparent film (n = 1.33) is deposited on a glass plate (n = 1.52) to form a nonreflecting coating. The film has a thickness that is 1.73E-7 m. What is the longest possible wavelength (in vacuum) of light for which this film has been designed?

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A soap film (n = 1.33) is 441.9 nm thick and lies on a glass plate (n = 1.52). Sunlight, whose wavelengths (in vacuum) extend from 380 to 750 nm, travels through the air and strikes the film perpendicularly. For which wavelength in this range does destructive interference cause the film to look dark in reflected light?

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A beam of light of wavelength 538nm passes through two closely spaced glass plates, as shown in the

figure below. For what minimum nonzero value of the plate separation, d, will the transmitted light be bright?

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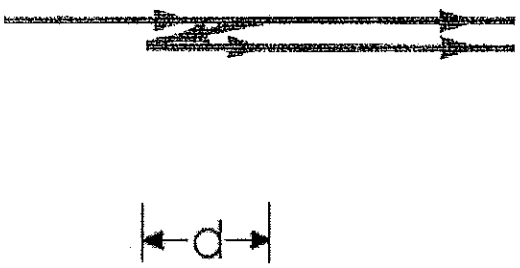

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Physics 1A03
Assignment 8

7. a) $v_1 = \lambda_1 f$

$$f = \frac{v_1}{\lambda_1}$$

$$= \frac{3.0\times10^8 \text{ m/s}}{624.7\text{ nm}}$$

$$= 4.8\times10^{14}\text{ Hz}$$

$v_2 = \lambda_2 f$

$= (418.0\text{nm})(4.8\times10^{14}\text{Hz})$

$= 2.01\times10^{8}\text{ m/s}$

b) frequency of light does not change from one medium to another.

2. speed of light through plastic is:

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

$$= \frac{c}{1.6}$$

since the screen is dark, there is destructive interference going on → the slower wave is $\frac{1}{2}\lambda$ out of phase.

so: in the time it takes the unimpeded light to travel the distance of the plastic's thickness, x, the impeded light has travelled $\Delta d = \frac{\lambda}{2}$ less.

$$x = c\cdot t \qquad x - \Delta d = v\cdot t$$

$$t = \frac{x}{c} \qquad t = \frac{x-\Delta d}{v}$$

so: $\frac{x}{c} = \frac{x - \Delta d}{v}$

$= \frac{x - \Delta d}{\frac{c}{1.6}}$

$\frac{x}{c} = \frac{1.6(x - \Delta d)}{c}$

$x - 1.6x = -\Delta d$

$-0.6x = -\Delta d$

$x = \frac{\Delta d}{0.6}$

$= \frac{\lambda}{2} \cdot \frac{1}{0.6}$

$= \frac{632\,nm}{2(0.6)}$

$= 526.7\,nm$

3. $n_1 \sin\theta_1 = n_2 \sin\theta_2$ $\quad 1 = glass$

When the critical angle $\quad 2 = water$

θ_1 is reached, $\theta_2 = 90°$.

so:

$1.50 \sin\theta_1 = 1.33 \sin 90$

$\sin\theta_1 = \frac{1.33 \cdot 1}{1.50}$

$= 0.89$

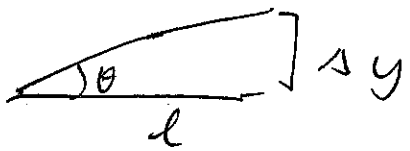
$\theta_1 = 62.5°$

4. a) $d \sin\theta = m\lambda_1 \quad m = 1$

$$\sin\theta = \frac{\lambda}{d}$$

$$= \frac{546.1\,nm}{0.261\,mm}$$

$$\theta = 0.106°$$



$$\tan\theta = \frac{\Delta y}{l}$$

$$\tan(0.11°) = \frac{\Delta y}{1.30\,m}$$

$$\Delta y = 2.41\,mm$$

b) $m_1 = 0.5 \quad m_2 = 1.5$

$\Delta m = 1$ just as in a)

so: $\Delta y = 2.41\,mm$

5. a) $f = \frac{c}{\lambda}$

$$= \frac{3.0 \times 10^8\,m/s}{22.1\,nm}$$

$$= 1.36 \times 10^{16}\,Hz$$

b) same method as a $\Rightarrow 1.80 \times 10^{14}\,Hz$

c) $n = \frac{\lambda_{vac}}{\lambda_{mat}}$ * rearrange snell's law

$$= \frac{650\,nm}{896\,nm}$$

$$= 0.725$$

6. a) $\lambda = \frac{v}{f}$

$= \frac{6420\ m/s}{1.51 \times 10^6\ Hz}$

$= 4.25\ mm$

b) $f = \frac{c}{\lambda}$

$= \frac{3.0 \times 10^8\ m/s}{4.25\ mm}$

$= 7.06 \times 10^{10}\ Hz$

7. non-reflective → destructive interference!

$2d = \frac{1}{2} \cdot \frac{\lambda}{n}$ (n of film)

$\lambda = 4dn$

$= 4(1.73 \times 10^{-7}\ m)(1.33)$

$= 920\ nm$

8. $2d = (m + \frac{1}{2}) \frac{\lambda}{n}$ → destructive interference

$\lambda = \frac{2dn}{m + \frac{1}{2}}$

$= \frac{2(441.9\ nm)(1.33)}{(m + \frac{1}{2})}$

if $m = 0$:

$\lambda = 2350.9\ nm$ ✗; out of range

if $m = 1$:

$\lambda = 783.6\ nm$ ✗; out of range

if $m = 2$:

$\lambda = 470.2\ nm$ ✓

9. $2d = m\lambda$, $m = 1$

$$d = \frac{1 \cdot \lambda}{2}$$

$$= \frac{\lambda}{2}$$

$$= \frac{538\,nm}{2}$$

$$= 269\,nm$$