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Institution: Beijing-Dublin International College
Module: University Physics 2 (BDIC2008J)
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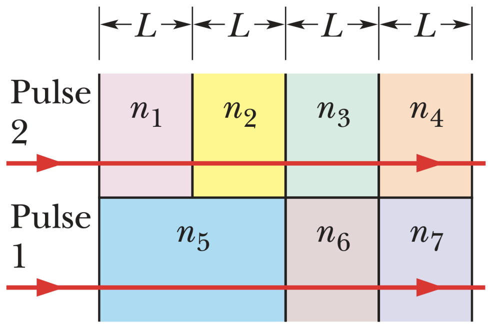
Problem Set 8

Optical Wave Interference

Problem 1. *The wavelength of yellow sodium light in air is* 589 nm*.* ***(a)*** *What is its frequency?* ***(b)*** *What is its wavelength in glass whose index of refraction is 1.52?* ***(c)*** *From the results of (a) and (b), find its speed in this glass.*

Problem 2. *In the figure below, two light pulses are sent through layers of plastic with thicknesses of either L or $2L$ as shown and indexes of refraction $n_1 = 1.55$, $n_2 = 1.70$, $n_3 = 1.60$, $n_4 = 1.45$, $n_5 = 1.59$, $n_6 = 1.65$, and $n_7 = 1.50$.* ***(a)*** *Which pulse travels through the plastic in less time?* ***(b)*** *What is the difference in the traversal times of the pulses in multiple L/c?*



Problem 3. *In a double-slit arrangement the slits are separated by a distance equal to 100 times the wavelength of the light passing through the slits.* ***(a)*** *What is the angular separation in radians between the central maximum and an adjacent maximum?* ***(b)*** *What is the distance between these maxima on a screen* $50.0\,\mathrm{cm}$ *from the slits?*

Problem 4. *A double-slit arrangement produces interference fringes for sodium light* ($\lambda = 589\,\text{nm}$) *that have an angular separation of* $3.50 \times 10^{-3}\,\text{rad}$. *For what wavelength would the angular separation be 10.0% greater?*

Problem 5. *A double-slit arrangement produces interference fringes for sodium light* ($\lambda = 589\,\text{nm}$) *that are* 0.20° *apart. What is the angular separation if the arrangement is immersed in water* ($n = 1.33$)*?*

Problem 6. *Suppose that Young's experiment is performed with blue-green light of wavelength* $500\,\mathrm{nm}$. *The slits are* $1.20\,\mathrm{mm}$ *apart, and the viewing screen is* $5.40\,\mathrm{m}$ *from the slits. How far apart are the bright fringes near the centre of the interference pattern?*

Problem 7. *In a double-slit experiment, the distance between slits is* $5.0\,\mathrm{mm}$ *and the slits are* $1.0\,\mathrm{m}$ *from the screen. Two interference patterns can be seen on the screen: one due to light of wavelength* $480\,\mathrm{nm}$*, and the other due to light of wavelength* $600\,\mathrm{nm}$*. What is the separation on the screen between the third-order* $(m = 3)$ *bright fringes of the two interference patterns?*

Problem 8. *We wish to coat flat glass* ($n = 1.50$) *with a transparent material* ($n = 1.25$) *so that reflection of light at wavelength* $600\,\mathrm{nm}$ *is eliminated by interference. What minimum thickness can the coating have to do this?*

Problem 9. *White light is sent downward onto a horizontal thin film that is sandwiched between two materials. The indexes of refraction are 1.80 for the top material, 1.70 for the thin film, and 1.50 for the bottom material. The film thickness is* $5.00 \times 10^{-7}\,\mathrm{m}$*. Of the visible wavelengths* $(400$ *to* $700\,\mathrm{nm})$ *that result in fully constructive interference at an observer above the film, which is the* ***(a)*** *longer and* ***(b)*** *shorter wavelength? The materials and film are then heated so that the film thickness increases.* ***(c)*** *Does the light resulting in fully constructive interference shift toward longer or shorter wavelengths?*

Problem 10. *The left figure shows a lens with radius of curvature R lying on a flat glass plate and illuminated from above by light with wavelength λ. The right figure (a photograph taken from above the lens) shows that circular interference fringes (known as Newton's rings) appear, associated with the variable thickness d of the air film between the lens and the plate. Find the radii r of the interference maxima and minima assuming $r/R \ll 1$.*