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Institution: Beijing-Dublin International College

Problem Set 9

Module: University Physics 2 (BDIC2008J)

Lecturer: Dr. Hao Zhu

Optical Wave Diffraction & Polarization

Problem 1. *The distance between the first and fifth minima of a single-slit diffraction pattern is 0.35 mm with the screen 40 cm away from the slit, when light of wavelength 550 nm is used. (a) Find the slit width. (b) Calculate the angle θ of the first diffraction minimum.*

Problem 2. *A plane wave of wavelength 590 nm is incident on a slit with a width of $a = 0.40$ mm. A thin converging lens of focal length $+70$ cm is placed between the slit and a viewing screen and focuses the light on the screen. (a) How far is the screen from the lens? (b) What is the distance on the screen from the centre of the diffraction pattern to the first minimum?*

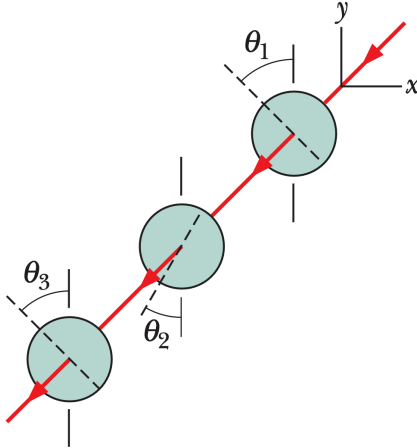
Problem 3. *A single slit is illuminated by light of wavelengths λ_a and λ_b , chosen so that the first diffraction minimum of the λ_a component coincides with the second minimum of the λ_b component. (a) If $\lambda_b = 350\text{ nm}$, what is λ_a ? For what order number m_b (if any) does a minimum of the λ_b component coincide with the minimum of the λ_a component in the order number (b) $m_a = 2$ and (c) $m_a = 3$?*

Problem 4. *Monochromatic light of wavelength 441 nm is incident on a narrow slit. On a screen 2.00 m away, the distance between the second diffraction minimum and the central maximum is 1.50 cm. (a) Calculate the angle of diffraction θ of the second minimum. (b) Find the width of the slit.*

Problem 5. *A slit 1.00 mm wide is illuminated by light of wave-length 589 nm. We see a diffraction pattern on a screen 3.00 m away. What is the distance between the first two diffraction minima on the same side of the central diffraction maximum?*

Problem 6. *Light of wavelength 600 nm is incident normally on a diffraction grating. Two adjacent maxima occur at angles given by $\sin \theta = 0.2$ and $\sin \theta = 0.3$. The fourth-order maxima are missing. (a) What is the separation between adjacent slits? (b) What is the smallest slit width this grating can have? For that slit width, what are the (c) largest, (d) second largest, and (e) third largest values of the order number m of the maxima produced by the grating?*

Problem 7. In the figure below, initially unpolarized light is sent into a system of three polarizing sheets whose polarizing directions make angles of $\theta_1 = 40^\circ$, $\theta_2 = 20^\circ$, and $\theta_3 = 40^\circ$ with the direction of the y axis. What percentage of the light's initial intensity is transmitted by the system? (Hint: Be careful with the angles.)



Problem 8. We want to rotate the direction of polarization of a beam of polarized light through 90° by sending the beam through one or more polarizing sheets. **(a)** What is the minimum number of sheets required? **(b)** What is the minimum number of sheets required if the transmitted intensity is to be more than 60% of the original intensity?

Problem 9. *Light that is traveling in water (with an index of refraction of 1.33) is incident on a plate of glass (with index of refraction 1.53). At what angle of incidence does the reflected light end up fully polarized?*

Problem 10. In the figure below, a light ray in air is incident on a flat layer of material 2 that has an index of refraction $n_2 = 1.5$. Beneath material 2 is material 3 with an index of refraction n_3 . The ray is incident on the air – material 2 interface at the Brewster angle for that interface. The ray of light refracted into material 3 happens to be incident on the material 2 – material 3 interface at the Brewster angle for that interface. What is the value of n_3 ?

