Physics 2220
Spring 2001
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SIXTH MIDTERM

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Discussion Section # _____ Student ID #: _____

REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

(a) A two-slit interference pattern is projected on a screen 3.50 cm from the slits using a laser light of wavelength 525 nm. If the slits are 0.200 mm apart and are very narrow, find the distance between the m = 0 and m = 1 maxima.

$a\sin\theta = m\lambda$
$\Delta y = L\tan\theta$
$\sin\theta \approx \tan\theta$
$\Delta y = L\frac{m\lambda}{a} = 3.50\,cm \times \frac{1 \times 525\times10^{-9}\,m}{0.2\times10^{-3}\,m} = 9.19\times10^{-3}\,cm$

(b) A single slit of width 0.050 mm is illuminated with light of 525 nm as above. The distance from slit to screen is 3.50 m. Calculate the distance on the screen between the m = +1 and m = −1 minima.

$a\sin\theta = m\lambda \quad \sin\theta = \frac{m\lambda}{a} = \frac{2\times525\times10^{-9}\,m}{0.05\times10^{-3}\,m} = 0.0210 \quad \theta = 1.20^\circ$

$\Delta y = L\tan\theta = 3.50\,m \times \tan 1.20^\circ = 0.0735\,m = 7.35\times10^{-2}\,m.$

(c) White light is incident perpendicular on a soap film (n = 1.34) of thickness 0.750×10^{-6} m. Calculate ALL the wavelengths in the visible (400 nm to 700 nm) that show constructive interference in reflection.

$2nd = (k+\tfrac{1}{2})\lambda \quad 2\times1.34\times0.750\times10^{-6}\,m = (k+\tfrac{1}{2})\lambda \quad \lambda = \frac{2010\,nm}{k+\frac{1}{2}}$

$k=1$: $\lambda = 1340$ nm
$k=2$: $\lambda = 804$ nm
$k=3$: $\lambda = 574$ nm
$k=4$: $\lambda = 447$ nm
$k=5$: $\lambda = 365$ nm
⋮

The visible wavelengths are: 574 nm, 447 nm

(d) Determine the critical angle for total internal reflection for diamond (n = 2.40) immersed in water (n = 1.34)

$\sin\theta = \frac{n_{water}}{n_{Diamond}} = \frac{1.34}{2.40} = 0.558 \quad \theta = 33.9^\circ$

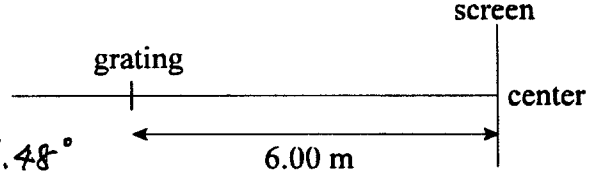
(e) Find the polarizing angle for light incident on a diamond under water.

$\tan\theta = \frac{n_{Diamond}}{n_{water}} = \frac{2.40}{1.34} = 1.79 \quad \theta = 60.8^\circ$

(f) For a diffraction grating with 75.0 lines/mm, calculate the distance from the center for green light (λ = 500 nm) in 3rd order.

$d = \frac{1\,mm}{75.0\,lines} = 0.0133\,mm = 1.33\times10^{-5}\,m$

$\sin\theta = \frac{m\lambda}{d} = \frac{3\times500\times10^{-9}\,m}{1.33\times10^{-5}\,m} = 0.113 \quad \theta = 6.48^\circ$



$\Delta y = L\tan\theta = 6.00\,m \times \tan 6.48^\circ = 0.681\,m$