Physics 2220
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George A. Williams

FINAL EXAM

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

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(a) A diffraction grating has 5000 lines/cm. Laser light of 650 nm (red) is sent through this grating at normal incidence. What is the angle of the second order spot that comes out?

$\theta = 40.5°$

$2\lambda = d\sin\theta \quad \sin\theta = \frac{2\lambda}{d} = \frac{2\times 650\times 10^{-9}}{\frac{1}{5000}\times 10^{-2}} = 0.65 \approx$ ~~37.24°~~

(b) In a two-slit interference experiment the fifth, tenth, and fifteenth order spots are missing. If the slit separation is 0.275 mm, what is the slit width?

$\frac{5\lambda}{d} = \frac{1\lambda}{a} \quad d = 5a \Rightarrow a = \frac{1}{5}d = 0.055\ mm$

(c) Calculate the critical angle for total internal reflection for a diamond (n = 2.40) immersed in water (n = 1.33).

$\sin\theta_c = \frac{n_2\sin 90°}{n_1} = \frac{1.33}{2.40} = 0.554 \quad \theta_c \approx 33.65°$

(d) Calculate the polarizing angle for diamond (n = 2.40) immersed in water (n = 1.33), where the light is incident from the water.

$\tan\theta = \frac{n_2}{n_1} = \frac{2.4}{1.33} = 1.8 \quad \theta \approx 60.9°$

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(e) The intensity of sunlight is observed to be 980 W/m² in a plane perpendicular to the light beam. Calculate the peak value of the magnetic field in this light.

$\vec{S} = \frac{1}{\mu_0}\vec{E}\times\vec{B} \quad WC = \varepsilon_0 E^2 C = 980\ W/m^2 \times 2 = \frac{B^2 C}{\mu_0} \quad B = \sqrt{\frac{980\times 4\pi\times 10^{-7}}{(3.0\times 10^8)}} = 2.87\times 10^{-6}\ T$

$\sin\theta = \frac{10^{-2}}{4.5}$

(f) Laser light of wavelength 550 nm is incident on a single slit. On a screen 4.50 m away the two minima on either side of the center are 2.00 cm apart. Calculate the width of the slit.

$a\sin\theta = m\lambda \quad a = \frac{\lambda}{\sin\theta} = \frac{550\times 10^{-9}}{0.07/4.5} = 2.475\times 10^{-4}\ m \quad 0.2475\ mm$

θ, 2cm