EXAM 5

Name: ______________________ unid: u ________

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

(a) Calculate the critical angle for total internal reflection for glass \( n = 1.55 \) immersed in water \( n = 1.33 \).

\[
\frac{n_1 \sin \theta_i}{n_2 \sin \theta_2} \quad \text{and} \quad \frac{n_1 \sin \theta_i}{n_2 \sin 90^\circ} = \frac{\sin \theta_c}{n_1} = 1.33 \quad \therefore \theta_c = \sin^{-1} \left( \frac{1.33}{1.55} \right) = 59.1^\circ
\]

(b) A concave spherical mirror has a radius of curvature of 1.20 m. Calculate the position of the image of an object 1.45 m away from the mirror.

\[
\text{Concave mirror has positive focal length } f = \frac{R}{2} \quad \therefore \quad \frac{1}{p} + \frac{1}{q} = \frac{1}{f} \Rightarrow \frac{1}{1.45} + \frac{1}{q} = \frac{1}{0.6} \quad \therefore q = 1.02 \text{ m}
\]

(c) A soap film \( n = 1.33 \) is observed to show a reflection maximum in perpendicular incidence at a green wavelength of 525 nm. What is the minimum thickness of the soap film you can deduce from this data?

\[
\text{The light has a } 180^\circ \text{ phase change at the top of the film, but not when reflecting off the bottom. For constructive interference,} \quad t = \frac{\lambda}{4n} = \frac{525 \text{ nm}}{4(1.33)} = 98.7 \text{ nm}
\]

(d) Sunlight is incident on the physics parking lot with an intensity of 750 W/m². Calculate the maximum value of the magnetic field in this light beam.

\[
I = \frac{\lambda}{n} = \frac{c B_{\text{max}}^2}{2 \mu_0} \quad \therefore B_{\text{max}} = \sqrt{\frac{2 \mu_0 I}{c}} \quad \therefore B_{\text{max}} = \sqrt{\frac{2(4\pi \times 10^{-7}) \times 750}{3 \times 10^8}} = 2.51 \times 10^{-6} \text{ T}
\]

(e) A green laser has a wavelength of 525 nm. Calculate its wavelength in diamond \( n = 2.40 \).

\[
\lambda_n = \frac{\lambda_{\text{vacuum}}}{n} = \frac{525 \text{ nm}}{2.40} = 219 \text{ nm}
\]