PHY385H1F – "Introductory Optics"
Practicals Day 3 – Chapter 2, 3, 4 Review/Preview Session
October 3, 2011

Group Number: ____.

Facilitator Name:________________________________.

Record-Keeper Name:__________________________________. [Turn this sheet in for marks]

Time-keeper:______________________________.

Computer/Wiki-master:________________________________.

NOTE: The roles for the above must be *different* than the last two weeks!

Activity 3.1 – Chapter 2 Review: Harmonic Wave Equations

A harmonic travelling plane-wave in the electric field is moving in the negative *x*-direction with an amplitude of 2 $\hat{j}$ V/m, a wavelength of 3 m, and a period of 10^{-8} s. The electric field at the origin is zero at time zero. Immediately after $t = 0$, the electric field at the origin is in the +*y*-direction.

Part A: Write an equation for this wave using trigonometric functions.

Part B: Write an equation for this wave using complex exponentials.

Activity 3.2 – Chapter 3 Review: Using Equation 3.71, "The Dispersion Equation"

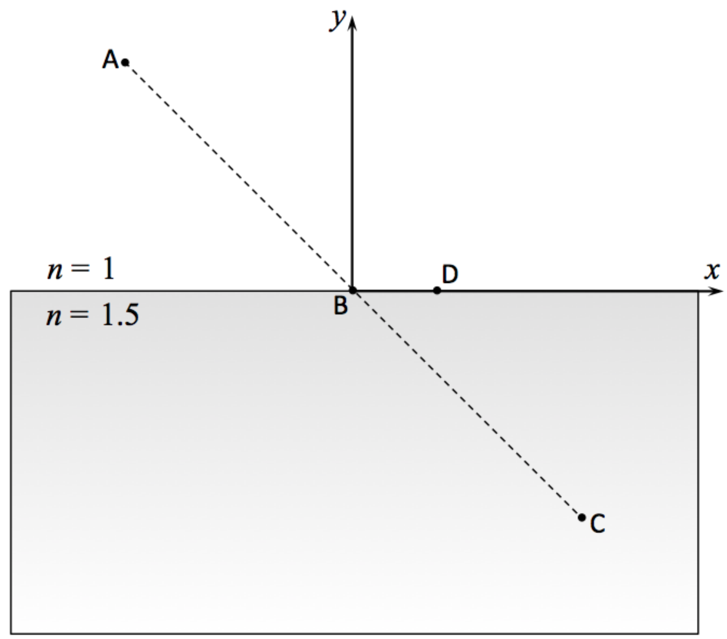
A crown-glass prism has a strong absorption resonance at a frequency of 2.9×10^{15} Hz. The electrons which contribute to the polarization density in the glass at this frequency have a density of $N = 1.4 \times 10^{29}$ m^{-3}. From this information, predict the index of refraction of glass for light with a frequency of 4.1×10^{14} Hz.

Activity 3.3 – Chapter 3 Review: Irradiance and Electric-Field Amplitude

Consider a long, narrow source of light that emits cylindrically symmetric electromagnetic radiation. Using energy arguments, show that the electric-field amplitude the waves must be proportional to $[\rho]^{-1/2}$, where ρ is the distance from the source.

Activity 3.4 – Thoughts on Chapter 4, Section 4.4: Refraction

A quick pulse of laser light is sent from point A, in air, to point B, on the surface of a large glass block. At point B, it immediately triggers another laser pulse to be sent to point C, which is within the glass. Points A, B and C lie along a straight line, as shown. Point A has coordinates: $(x_A, y_A) = (-1.0\text{ m}, +1.0\text{ m})$. Point B lies at the origin, and point C has coordinates: $(x_C, y_C) = (+1.0\text{ m}, -1.0\text{ m})$. The index of refraction of the glass for this laser light is $n = 1.50$. The time for the pulse to travel the path A-B-C is $t_{AB} + t_{BC} = x_{AB}/c + n\, x_{BC}/c = \frac{\sqrt{2}}{3\times 10^8}(1+n) = 11.8$ ns.



Part A: Consider the path A-D-C, where the coordinates of point D are $(x_D, y_D) = (+0.36265\text{ m}, 0\text{ m})$. Compute the time for the laser light pulse to travel along the path A-D-C.

Part B: Show that Snell's Law is obeyed for A-D-C, indicating that this is the *minimum possible travel time* from A to C for this pulse.

Activity 3.5 – Chapter 4 Preview: Fresnel's Equations

An EM plane wave begins in a material with index of refraction n_i, and is incident upon a flat surface of material with index of refraction n_t. The angle of incidence is θ_i and the angle of transmission is θ_t, and these are related by Snell's law.

Look at equation 4.40, which is the amplitude reflection coefficient $r_{||}$ for "TM mode" light, when the electric field oscillates parallel to the plane of incidence. Show that if $\theta_i = \tan^{-1}(n_t/n_i)$, this amplitude reflection coefficient is zero. (This important value of θ_i is usually denoted θ_p, and is called the **polarization angle**, or sometimes "Brewster's Angle")

Activity 3.6 –Lab Tour: Aephraim Steinberg's Entangled Photons Lab

Take a tour of the Professor Steinberg's lab in MP053. Please ask any question you would like and briefly record notes here. Feel free to ask anything you like, but here are some suggestions:

- What is a difference between single-photon optics and classical optics?
- What is frequency-doubling, and how is it achieved?
- How is polarization related to entanglement experiments?

TOUR NOTES: