PHYS306 Homework#3 (Due on 06Mar2022)

Q#1:

Show that the standing wave $f(z,t) = A\sin(kz)\cos(kvt)$ satisfies the wave equation and express it as the sum of a wave travelling to the left and a wave travelling to the right.

Q#2:

(a) Formulate an appropriate boundary condition to replace $\left.\frac{\partial f}{\partial z}\right|_{0^-} = \left.\frac{\partial f}{\partial z}\right|_{0^+}$ (equations 9.27 in the book) for the case of two strings under tension T joined by a knot of mass m.

(b) Find the amplitude and phase fo the reflected and transmitted waves for the case where the knot has a mass m and the second string is massless.

Q#3:

Write down the real electric and magnetic field for a monochromatic plane wave of amplitude Eo, frequency ω,a dn phase angle zero that is

(a) travelling in the negative x-direction and polarized in the z-direction.

(b) Travelling in the direction from the origin to the point (1,1,1) with polarization parallel to the xz-plane. In each case, sketch the wave, and give the explicit Cartesian components of **k** and $\hat{\boldsymbol{n}}$.

Q#4:

Calculate the exact reflection and transmission coefficients, without assuming $\mu_1 = \mu_2 = \mu_o$. Confirm that $R + T = 1$

Q#5:

Analyze the case of polarization perpendicular to the plane of incidence (for example, electric field in the y-direction when the wave is travelling in the z-direction and boundary is along xz-plane.)

(a) Use the boundary conditions to get the Fresnel equations for $\tilde{E}_{o_R}$ and $\tilde{E}_{o_T}$.

(b) Sketch $\left(\frac{\tilde{E}_{o_R}}{\tilde{E}_{o_I}}\right)$ and $\left(\frac{\tilde{E}_{o_T}}{\tilde{E}_{o_I}}\right)$ as a function of θ_I for the case of $\beta = \frac{n_2}{n_1} = 1.5$

(c) Show that there is no Brewster's angle for any n_1 and n_2.

(d) Check that Fresnel's equations reduce to the proper form at normal incidence.

(e) Computer the reflection and transmission coefficient and they add up to 1.

Q#6:

The index of refraction of diamond is 2.42.

(a) Sketch $\left(\frac{\tilde{E}_{o_R}}{\tilde{E}_{o_I}}\right)$ and $\left(\frac{\tilde{E}_{o_T}}{\tilde{E}_{o_I}}\right)$ as a function of θ_I assuming ($\mu_1 = \mu_2 = \mu_o$).

(b) Calculate the amplitudes at normal incidence.

(c) Calculate the Brewster's angle

(d) Calculate the crossover angle at which the reflected and transmitted amplitudes are equal.