<u>Problem Set: 6</u>

1. Assume we have two string joining at the origin (x = 0). The velocity of the wave in the string on the left (x < 0) is v1 = 20 m/sec whereas the velocity of the wave at right (x > 0) is 10 m/sec. The string on the left has a wave with an amplitude of 3 cm and a wavelength of 1 m moving towards the junction. (a) What are the amplitude of the reflected and transmitted waves and the wavelength of the transmitted wave ? (b) Calculate the ration of the power transmitted to the power reflected.
2. A beam of light enters a glass prism at an angle α and emerges into the air at an angle β. After passing through the prism, the beam is deviated from the original direction by an angle γ. Find the angle of the prism φ and refractive index of the material which it is made of?
3. Consider 3 waves, $\psi_1 = 2\sin(\omega t + \pi/3)$; $\psi_2 = 3\cos(\omega t + \pi/4)$; $\psi_3 = 5\sin(\omega t + \pi/5)$. Find out the resultant amplitude and phase when they superpose.
4. (a) Draw a graph of θ_t (angle of transmittance) vs θ_i (angle of incidence) for an air-glass boundary where the index of refraction of the glass is $n_g = 1.5$.
   (b) A glass prism whose cross section is an isosceles triangle stands with its (horizontal base in water; the angles which its two equal sides make with the base are each equal to θ as shown in the figure 1. An incident ray of light, above and parallel to the water surface and perpendicular to the prism's axis, is internally reflected at the glass-water interface and subsequently re-emerges into the air. Taking the refractive indices of glass and water to be 3/2 and 4/3 respectively find the angle θ

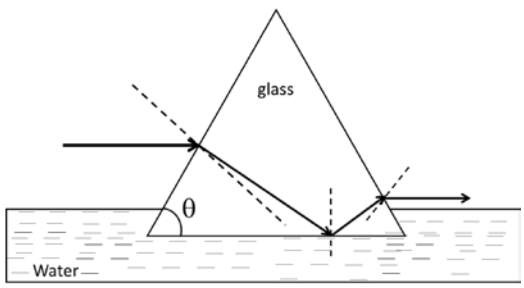

Fig. 1

5. (a) Consider Snell's law of refraction. If the medium of incidence has an index $n_1>0$ and the other medium has an index $n_2<0$, then draw the refracted ray by assuming some angle of incidence θ_i. What difference do you notice in comparison to the case when $n_1, n_2 >0$?
   (b) Recall that the refractive index can be written as $n = \sqrt{\epsilon_r \mu_r}$ where $\epsilon_r = \frac{\epsilon}{\epsilon_0}$ and $\mu_r = \frac{\mu}{\mu_0}$. It is known that ϵ and μ are complex quantities and also functions of ω, with their real and imaginary parts related to physical quantities. Show, with an example , that using $\epsilon < 0$ and $\mu < 0$ it is possible to have the refractive index n<0.
   (Note: Materials exhibiting negative refractive index have actually been made in recent times though the original proposal was by the Russian physicist V. Veselago, in 1967. Such materials are known as metamaterials)