Optics for Energy

Fall 2012

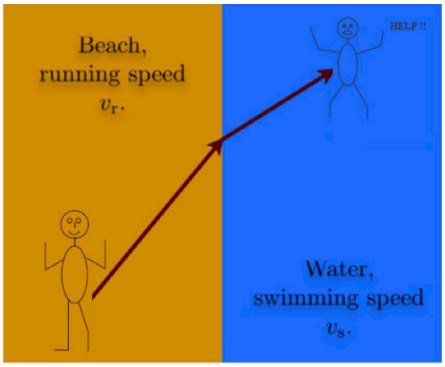
Quiz 1

Please show all steps.

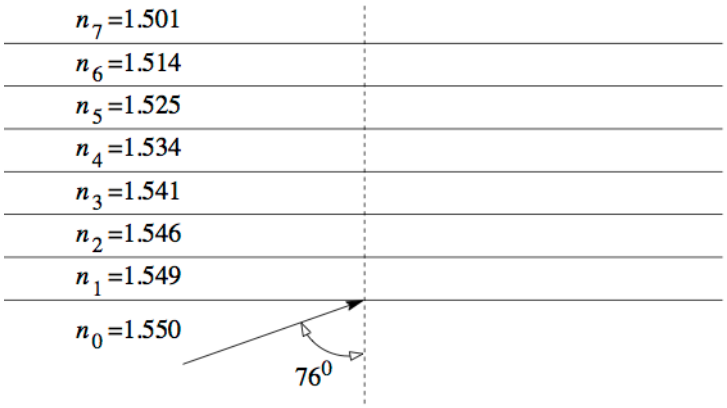
1. [5 points] Using the principle of conservation of energy and the fact that power (in Watts) is proportional to the square of the electric-field amplitude, show that the amplitude of a spherical wave should decay like 1/r as function of distance r from the source of the spherical wave.

2. The radiant energy from the sun outside the earth's atmosphere is ~1366 W/m^2.
   a. [5 points] How many commercially available light bulbs (assume 100W each) placed at 1m away from the atmosphere's edge would generate the same amount of irradiance on an area of 1m^2? *Hint: assume that the bulbs are point sources.*
   b. [5 points] What is the equivalent photon flux, i.e., how many photons per second are received from the sun? Assume that the solar energy is uniformly distributed between the ultraviolet (300nm) and infrared (1μm).

3. [5 points] The lifeguard shown below can run at speed v_r on the sand, and swim at speed v_s in water ($v_r > v_s$). The lifeguard notices a drowning person at an angle with respect to the normal from the lifeguard's position to the coastline. Establish your own notation for this geometry, and plan the lifeguard's path that reaches the swimmer in minimum time.



4. [5 points] A light ray is incident on a dielectric stack of refractive indisces as shown below at 76 degrees with respect to the normal. What is the exit angle of the ray?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76^0