(1) Part of a search and rescue training test is being able to estimate how far a diver must swim to retrieve an object. A search and rescue worker in training is being trained to estimate the distance of an object located in water. The exercise takes place at the University of Minnesota wellness center pool.   (1.5 points)

An orange backpack has been dropped into a pool that is 12 feet deep. A search light is mounted on the pool's edge about 5 feet above the surface of the water. The light hits the surface of the water at a 60 degree angle of incidence. Assume index of water is 1.33 and the water lossless.

The rescue worker uses the search light to locate the backpack in the pool. **What is the distance of the backpack from the pool's edge?** Include a sketch with the various dimensions and angles in your solution and present lengths in feet. Also, indicate which electromagnetics law you used to determine your solution.

(2) A matching circuit is needed to connect an antenna with an impedance of 25+j50 ohms to a network with an impedance of 50 ohms at 1 GHz.   (1.5 points)

You are given a technician's toolkit with a quarter-wave transformer, a series reactive element and a shunt reactive element. **Using the transformer and one additional element, design your solution.** You can determine what the reactive element type – inductive or capacitive – will be in your design. Your solution must include a labeled circuit drawing with line lengths in meters. A smith chart is included, if needed. Assume the system impedance is 50 ohms.

(3) **Design a 1GHz capacitor using the capacitor layout below to represent an impedance of –j25 ohms.** Show your final answer in meters. (1.0 points)
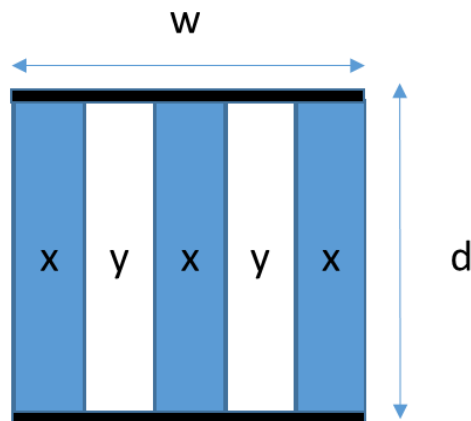

Figure 1 – Capacitor cross-section with specifications of w=1 mm, X section: er=4, width = 20% of w; Y section: er=1 and width= 20% of w, Assume length: L=1mm