Physics 208: Week 3 Quiz  
Waves, interference, and diffraction

1. The index of refraction of water is 1.33. What is the speed of light in the water? (the speed of light in vacuum is $3 \times 10^8$ m/s).

\[ v_{\text{glass}} = \frac{v_{\text{vacuum}}}{n_{\text{glass}}} = \frac{3 \times 10^8 \text{ m/s}}{1.33} = 2.26 \times 10^8 \text{ m/s} \]

2. Two light waves with a phase difference between them are added together. Which of these phase differences lead(s) to a wave with zero amplitude? Circle all that apply.

A) $\pi/2$  
B) $\pi$  
C) $3\pi/2$  
D) $2\pi$  
E) $3\pi$  

Destructive interference requires that the crest of one wave lines up with the trough of another. This requires that they be shifted from one another by $\frac{1}{2}$ wavelength, $1 \frac{1}{2}$ wavelengths, $2 \frac{1}{2}$ wavelengths, etc. A one wavelength shift corresponds to a $2\pi$ phase shift, so either $\pi$ or $3\pi$ phase shift would give destructive interference.

3. In a two-slit interference experiment, an interference pattern is projected on a distant screen. The separation between the interference maxima is observed to be 1 mm. The wavelength of the light is now decreased by a factor of two. The spacing between the interference maxima becomes

A) 0.414 mm  
B) 0.5 mm  
C) 1 mm  
D) 2 mm  
E) 4 mm

If the wavelength is halved, the required path-length difference for constructive interference is also halved. Since the screen is far away, the small-angle approximation is valid, and the separation of interference maxima is halved.

4. Reflected red light is observed when white light is shined down on the surface of an oil film of uniform thickness floating on water. This is due to interference between light reflected from two places. These two places are

A) the air above the oil film and the top surface of the oil film  
B) two different parts of the top surface of the oil film  
C) two different parts of the bottom surface of the oil film  
D) the top and bottom surfaces of the oil film  
E) the middle of the oil film and the bottom surface of the oil film

Reflection occurs at any interface where the medium changes index of refraction. Interference occurs when light along two different paths, with different phase shifts, are superposed.

5. The wavelength of a light wave ______ decreases ________ as it moves into a medium where its propagation speed is smaller.

The frequency stays constant, and the wavelength decreases according to $\lambda f = v$