Light and Optics 3

Thinking back to harmonic motion.

1. * If a string vibrates back and forth 10 times each second, how many times does the air around it vibrate each second?
2. So, what stays the same as a wave (or energy) passes from one material to another (as it crosses a boundary)?

3. A 350nm light wave is traveling thru air.
   A. Givens: What is its speed? What is its wavelength (in meters)?
   B. * Calculate its frequency in air.

   The light wave then passes into glass. Light travels in glass at a speed of 1.97×10^8 m/s.
   C. * What is the frequency of the light after it has passed into the glass?
   D. Calculate the wavelength of the light in glass.

You will need your "Refraction Notes"...

4. Why does light bend as it travels from one material to another?

5. What is the index of refraction for air? For water?
6. Noticing the arrow on the left side of the index of refraction table, in which substance is light faster:
   A. Ice or glass? B. Glass or air?
7. After studying the index of refraction example problem, calculate the speed of light in water.

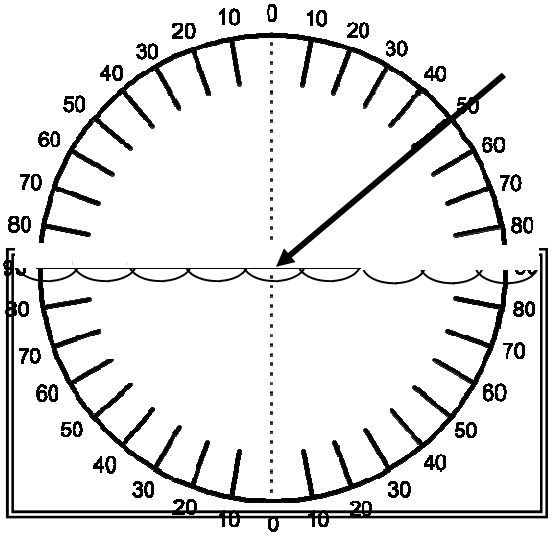
8. A new substance is found with an index of refraction of 2.22.
   A. Will light travel faster or slower in the new substance when compared to in air?
   B. * What is speed of light in the new substance?

   C. If the incident light has a wavelength of 20 nm in air, what is its frequency in the new substance?

After studying the Snell's Law section and example problem...

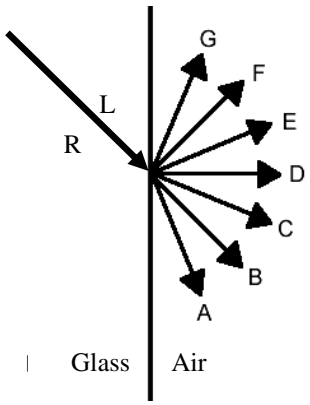
9. All angles must be measured from where?
10. Light is traveling at 35º in air. It passes into glass.
    A. Substance 1 is air or glass? B. So, n_1 = _____
    C. Substance 2 is air or glass? D. So, n_1 = _____
    E. * Calculate its angle in the glass.

11. Light passes from air into water as shown at the right.
    A. Substance 1 is air or water? B. So, n_1 = _____
    C. Substance 2 is air or water? D. So, n_1 = _____
    E. Calculate its angle in the water.



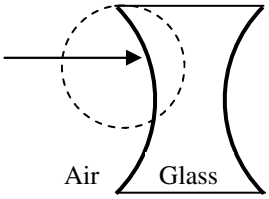
   F. Draw its path in the water.

   G. Did the light bend toward or away from the normal?

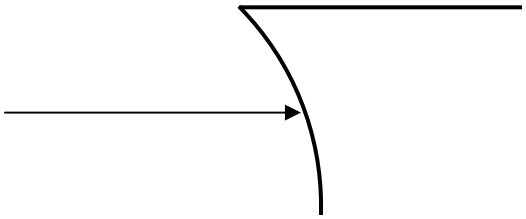


12. * In the first diagram, light travels from glass to air.
    A. In which substance does light travel faster?
    B. Looking from light ray's point of view, which side of the light ray hits the air first: left or right?
    C. Label the "straight path" as "SP".
    D. Label the normal as "N".
    E. What path will the light ray follow in the air?

Remember that the "normal" is an imaginary line drawn perpendicular to the surface NOT THE LIGHT RAY. We only care about the normal at boundaries: when a light ray passes into or out of a medium. The next example will hopefully help.



13. A light ray passes into a concave lens. We will first concentrate on the first boundary: when the light passes into the lens.
    A. Continue the incoming light ray with a dashed line. This is the straight path. Label it "SP".
    B. Draw a second dashed line that is perpendicular to the surface at the point where the light ray hits the glass. Label it "N".
    C. Is this boundary transition fast to slow or slow to fast?
    D. Draw where the light ray will refract. It doesn't have to be exact.



Air Glass

Q1) 10 times Q3B) $v = f\lambda$ and $v = c$, so $f = c/\lambda = 3E8/350E\text{-}9 = 8.57E14$ Hz
Q3C) freq stays the same across a boundary.
8B) 1.35E8 m/s 10E) 22.2 degrees
Q12E) path A, away from the normal