Name: ____ Date: ______________________ Class: ___________________

Refraction and Biosensors Quiz Answer Key

Let's suppose you have in your possession a porous silicon thin film that has a strand of DNA in it that can sense a certain cancer-causing gene. How you came to have such a thing is a long story that's not important. What is important is that you know the film's index of refraction is 1.85. Use this one piece of information to answer the questions and problems below. Show all your work to receive full credit.

1. **Suppose you shine light from air (n = 1) into the film at an angle of 45° relative to the normal. At what angle would you expect the light to be refracted within the film?**

   Using Snell's Law: $n_1 \sin\theta_1 = n_2 \sin\theta_2$:

   (1)sin 45° = 1.85 (sin ϴ), so ϴ = 22.47°

2. **Now suppose you use this film in an optical biosensing experiment, by exposing it to a solution containing your own DNA. After doing so, you notice that shorter wavelengths of light are reflected from the sample. What does this indicate about your own genetic make-up (that is, do you have the cancer-causing gene)? Explain your answer in complete sentences, or prove it mathematically.**

   Example written explanation: Shorter wavelengths of light reflected indicate that the index of refraction of the thin film has changed, so your own gene did in fact bond with the target gene in the film. This means that you do have the cancer-causing gene. More specifically, shorter wavelengths being reflected indicate a shorter path traveled by the light wave. This would indicate a greater bending of the light, which would happen at smaller angles of refraction, which are caused by an increase in the index of refraction. Bonding with the target molecule would cause an increase in index of refraction.

   Example mathematical explanation: If bonding to target molecule occurs, index of refraction would increase.

   So, if n = 1.95, then (1)sin 45° = 1.95 (sin ϴ), so ϴ = 21.26° This is a smaller angle of refraction than previously, so the light is bent more, causing a more direct (or shorter) path through the film, resulting in reflection of shorter wavelengths. Students may also demonstrate this in a drawing.