# EE 434 Electricity and Magnetism, Spring 2009
# Homework #8 Solution

**6.19**
Begin with Snell's law

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

Assume that $n_1 = 1$, and $n_2 = A + \frac{B}{\lambda^2}$, we get

$$\sin\theta_1 = \left(A + \frac{B}{\lambda^2}\right)\sin\theta_2$$

and

$$\theta_2 = \sin^{-1}\left[\frac{\sin\theta_1}{(A + \frac{B}{\lambda^2})}\right]$$

Now using the given values we get

| color | wavelength (nm) | refraction angle (degrees) |
|---|---|---|
| violet | 400 | 19.058 |
| blue | 450 | 19.144 |
| green | 550 | 19.251 |
| yellow | 600 | 19.286 |
| orange | 650 | 19.313 |
| red | 700 | 19.334 |

**6.20**
**(a)** We use Snell's law at the 1-2 interface

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

$$\theta_2 = \sin^{-1}\left(\frac{n_1}{n_2}\sin\theta_1\right)$$

Next we use Snell's law at the 2-3 interface

$$n_2 \sin\theta_2 = n_3 \sin\theta_3$$

$$\begin{aligned}\theta_3 &= \sin^{-1}\left(\frac{n_2}{n_3}\sin\theta_2\right)\\ &= \sin^{-1}\left(\frac{n_2}{n_3}\frac{n_1}{n_2}\sin\theta_1\right)\\ &= \sin^{-1}\left(\frac{n_1}{n_3}\sin\theta_1\right)\end{aligned}$$

**(b)** We are looking for the value of $\theta_1$ which will make $\theta_3 = 90°$. That is

$$90^\circ = \sin^{-1}\left(\frac{n_1}{n_3}\sin\theta_1\right)$$

$$\sin\theta_1 = \frac{n_3}{n_1}$$

$$\theta_1 = \sin^{-1}\left(\frac{n_3}{n_1}\right)$$

**(c)** It does not differ.
**(d)** To have total internal reflection at the first interface we require that $\theta_2 = 90^\circ$, which means

$$90^\circ = \sin^{-1}\left(\frac{n_2}{n_1}\sin\theta_1\right)$$

$$\theta_1 = \sin^{-1}\left(\frac{n_2}{n_1}\right)$$