Phyx 135-3, Quiz 2 (10 am) **Name:** _____

1) (10 points) You are cruising down the highway in your car at 25 m/s. Suddenly a fire truck pulls directly out in front of you (from a fire station) and roars away from you. As you trail behind the truck, you can hear the siren on the truck wailing at 970 Hz (you have perfect pitch), but you happen to know that the sirens on fire trucks always sound at 1000 Hz. How fast is the fire truck moving? You may assume that the speed of sound in air is 343 m/s.

Solution

From the Dopper equation, we know that $f_L / f_S = (c \pm v_L) / (c \pm v_S)$. In this case, we are given that $f_L = 970$ Hz, $f_S = 1000$ Hz, and $v_L = 25$ m/s. The trick is in determining the plus/minus signs. Since you are moving towards the fire truck, your motion is trying to increase the frequency of the sound, so you must increase the numerator, i.e., place a plus sign in front of v_L. Since the fire truck is moving away from you, its motion is trying to decrease the frequency of the sound source, so you must increase the denominator, i.e., place a plus sign in front of v_S.

Carrying out the algebra gives us: $343 + v_S = (343 + 25)(1000 / 970)$, or $v_S =$ 36.4 m/s

2) (10 points) You have a block of glass for which the index of refraction for blue light is $n_B = 1.524$, and the index of refraction for red light is $n_R = 1.509$. Suppose that blue and red light rays perpendicularly enter the glass block together. After the red light has moved 5000 nm into the glass, how far into the glass will the blue light have moved? (Assume that $c = 3 \times 10^8$ m/s.)

Solution

We know that the speed of the red light in the glass block will be $v_R = c/n_R$. Therefore, the time that it will take the red light to move 5000 nm is just $t = d/v = d\, n_R / c$. The blue light will move for the same amount of time, but its speed is $v_B = c/n_B$, so it will move $v_B\, t = (c/n_B)(d\, n_R/c) = d\, (n_R/n_B) = (5000)(1.509)/(1.524) =$ 4951 nm into the glass block.