Phyx 135-3, Quiz 2 (1 pm) **Name: _____**

1) (10 points) You happen to be in a fire truck cruising down the highway at 25 m/s. Your siren is emitting a shriek at 1000 Hz. A hulking 18-wheeler is directly behind you and moving at 28 m/s towards you. The sound from your siren is reflecting off the 18-wheeler and coming back to you. What pitch do you hear for the reflected sound? You may assume that the speed of sound in air is 343 m/s.

Solution

We will need to apply the Dopper equation twice. First, the shriek being emitted by the siren will reach the 18-wheeler at a frequency of $f_L = f_S(c + v_L) / (c + v_S)$. We know that v_L is positive because the listener (the 18-wheeler) is moving towards the fire truck, i.e., it is trying to raise the pitch. v_S is also positive because the source (the fire truck) is trying to move away from the 18-wheeler, i.e., it is trying to lower the pitch.

Putting in numbers gives us: $f_L = 1000(343 + 28) / (343 + 25) = 1008$ Hz.

Next, the sound being reflected off the 18-wheeler will come back to the fire truck at a frequency of: $f_L = f_S (c – v_L) / (c – v_S)$. We know that v_L is negative because the listener (the fire truck) is trying to move away from the 18-wheeler, thus lowering the frequency. v_S must be negative because the "source" of the reflected sound (the 18-wheeler) is moving towards the fire truck, thus trying to raise the frequency. We have: $f_L = (1008)(343 – 25) / (343 – 28) =$ 1018 Hz.

2) (10 points) The index of refraction of diamond is n = 2.42, whereas n = 1.50 for a typical piece of glass. Suppose you somehow bonded a layer of diamond directly to a layer of glass. What is the maximum angle that a ray of light originating inside the diamond could possibly make with a perpendicular to the diamond-glass interface and still move into the glass?

Solution

Snell's Law tells us that $n_1 \sin\theta_1 = n_2 \sin\theta_2$, where both angles are measured from the perpendicular to the interface. The maximum angle θ_2 that the refracted ray can make is 90°; after that, the ray will undergo total internal reflection. We have: $(2.42)\sin\theta_1 = (1.50)\sin(90°)$, or $\theta_1 =$ 38.3°