Midterm 2, Take-Home Section: 36 pts

Physics 204, John Jay College of Criminal Justice, the CUNY, Prof. Max Bean

Consider the following two scenarios:

Scenario 1: You're standing (still) on 10^{th} street one night, minding your own business, when a car goes zooming by at a speed of 50 m/s. As the car approaches you, you hear someone inside it screaming at the top of their lungs.

Scenario 2: You're blasting down 10^{th} avenue one night at 50 m/s, in a brand new sports car (just, you know, for fun), when you hear someone ahead of you scream at the top of their lungs.

Assume for now that, in both scenarios, it is a clear, still night with no wind.

A. Draw a picture of EACH scenario—that's two pictures. Label them clearly so I can tell which is witch. Each picture should include:
   i. the car and the person on the street;
   ii. a vector arrow to show the velocity of the car;
   iii. carefully placed circles to show successive sound-wave fronts.

   (6 pts.)

B. In EACH scenario, will you hear the scream at a lower pitch, higher pitch, or the same pitch as the screamer hears it? Provide a separate answer for each scenario. ***Explain your reasoning thoroughly***. (6 pts.)

C. What is similar about the two scenarios (in terms of the Doppler effect)? What is different about them? Are they *equivalent*—i.e. is there any difference between you driving towards screamer and screamer driving towards you? Given some frequency at the source, would the receiver hear the same frequency in both scenarios? Explain clearly. Refer to relevant underlying principle of physics. Full credit for this question requires a detailed response. (6 pts.)

D. Now imagine that the two scenarios are combined: the screamer is driving towards you at 50 m/s. *Also*, you are driving 50 m/s the opposite direction (down 10^{th} Ave! Against traffic! You maniac.) Assume that ***you*** hear the scream at a frequency of 1600 hz. Compute the following (show ***thorough work & justification for each***): (18 pts.)
   i. the speed of the relevant sound-waves, in ***your*** frame of reference;
   ii. the speed of the relevant sound-waves, in ***the screamer's*** frame of reference;
   iii. the wavelength of the relevant sound-waves, in ***your*** frame of reference;
   iv. the wavelength of the relevant sound-waves, in ***the screamer's*** frame of reference;
   v. the frequency of the sound waves ***the screamer*** hears.

   HINT: Notice we gave you the frequency that the ***receiver*** hears, not the frequency that the source hears. Also, of course, ***both*** people are moving. This might seem weird & scary, but as long as you keep calm and think about what you're doing, you can follow exactly the same method as you used in the original four cases—except analyzing the receiver first and then the source.