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**Math Questions** - Partial credit will be given. If you can't find the number, give the method. If you don't know the method, give your thoughts. (Note: Be sure to answer everything asked.)

1. (12 pts) Sketch a waveform that represents the displacement of a mass vibrating at a single driven frequency near resonance at the end of a spring. Then sketch a second wave that is one-fourth of a cycle in advance of the first. It turns out that this represents the motion of the driven end of the spring. Label the waveforms "driver" and "mass" correctly.
  
  
  
  
  
  
  
  
  
  
2. (15 pts) Determine the frequencies of the fundamental and the first overtone (second partial) for the following (neglect end corrections):
  - (a) a 16 ft open organ pipe (open-open),
  
  
  
  
  
  
  
  - (b) a 16 ft stopped organ pipe (open-closed), and
  
  
  
  
  
  
  
  - (c) a 25 ft long hallway with all doors closed.
  
  
  
  
  
  
  
  
  
  
3. (12 pts) Find the difference in the fundamental frequency, calculated with and without the end correction, of an open organ pipe 2 m long and 10 cm in diameter.

4. (12 pts) Assume that the outer ear canal is a cylindrical pipe 3 cm long, closed at one end by the eardrum. Calculate the resonance frequency of this pipe. Our hearing should be especially sensitive to frequencies near this resonance.
  
5. (12 pts) Measure the distance between your ears and describe how you do so. At what frequency does the wavelength of sound equal the distance between your ears? What is the significance of this with respect to your ability to localize sound?
  
6. (12 pts) Divided the distance between your ears by the speed of sound to find the maximum difference in arrival time when a sound comes directly from the side.
  
7. (25 pts) Britney Spears wakes up to find herself in the local mad scientist, cloning office. A Britney II has been created. Britney I screams at this prospect (as would most of the free world for one reason or another). Her scream is almost a pure tone.

Flaro, the mad scientist (whose ears happen to be 17.2 cm apart), is facing perpendicular to Britney when she screams. He is amazed to find that he cannot tell if she is directly to his left or his right.

- (a) What do you guess the frequency of her scream would be if you can assume it is greater than 200 Hz? **Give your reasoning.**
  
- (b) If Britney I's scream had contain inharmonic partials, do you think Flaro would still have had trouble localizing her scream? **Give your reasoning.**