Homework Assignment #4

Due in class, Friday January 31

Each problem is worth 10 points, for a total of 100 points.

2. Questions 10 and 12 of Chapter 21. Rotating tuning forks; Doppler effect.
3. Exercise 2 of Chapter 21. Pressure amplitude versus displacement amplitude. There is a typo at the end of the last line of the problem statement, where the units should be meters, not Pascals. \(3.2 \times 10^{-12} \text{ m}\)
4. Exercise 8 of Chapter 21. Sound intensity from crying babies. Also, explain why the word “independent” is crucial in the first sentence. That is, why would the statement in the first sentence not hold for addition of sound from coherent sources?
5. Exercise 10 of Chapter 21. Intensity versus distance. \((75.0 \text{ m, 707 W})\)
6. Chords (multiple notes played simultaneously) sound harmonious to our ear when one or more harmonics of one note are nearly equal to different harmonics of the other note. (a) Explain why notes differing by an octave are perfectly harmonious in this sense. (b) A piano is tuned to a “well tempered” scale (the octave equally divided on a logarithmic scale among the 12 notes). Then the A key (440.0 Hz) and E key (659.3 Hz) are played simultaneously (a nearly “perfect fifth” interval in music lingo). What beat frequency will be heard between the second harmonic of the E and the third harmonic of the A? (c) Then the A key and C# key (554.4 Hz) are played simultaneously (a “major third” interval). What is the first pair of harmonics of those two notes that come close to matching, and what is the beat frequency between them? (d) Which of these two chords will sound the most harmonious (the lowest beat frequency)? (e) To what frequency could the C# be tuned to make the major-third interval “perfect” (zero beat frequency between the two relevant harmonics).
7. Exercise 16 of Chapter 21. Train whistles and the Doppler effect. \((4 \text{ Hz beat frequency})\)
8. Exercise 20 of Chapter 21. Shock wave. \((2.23 \text{ seconds})\)
9. Problem 26 of Chapter 21. Ultrasound. \((0.0319 \text{ m/s})\)
10. Problem 32 of Chapter 21. Crab nebula. \((5200 \text{ light years distance})\)