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Physics 102 - Final exam May 23, 00 Instructions: This exam consists of 9 printed pages and an NCS Answer Sheet. Before you begin, fill in your name in letters and in the more circles on the answer sheet. Then answer Part I (Multiple Choice, Questions 1-80) to the answer sheet by filling in one of the corresponding circles. Answer Part II (Quantitative, questions 81-100) on the last sheet of the set you are now reading. Each question is worth one point, for a total of 100 points. Further instructions on the quantitative part and accounting for grades can be found on page 8. Read questions carefully. Only correct answers count against your rating, there is no penalty for incorrect answers, so it pays to answer all questions. In the quantitative part, it pays to explain your reasoning, for partial credit even if your final answer is wrong. The exam will last 120 minutes, including reading these instructions and handing over papers. You will submit only the answer sheet and page 9. I. Multiple choice questions 1. To double the wavelength of a sound wave, you should only (a) double its amplitude (b) double its frequency (c) halve its amplitude (d) halve its frequency. 2. When two sine waves that are 180o out of phase are added together, the amplitude of the sum (a) always zero (b) is always less than the amplitude of either wave (c) equal to the amplitude of the smaller wave (d) always less than the amplitude of the larger wave (e) always greater than the amplitude of the smaller wave. 3. A sound wave has SIL = 50 dB. Recall that  $SIL = 10 \log(I / (10^{-12} W/m^2))$ . The intensity I of this wave, in W/m<sup>2</sup>, is therefore (a) 50 (b) 5 (c) 10<sup>-5</sup> (d) 10<sup>-7</sup> (e) 10<sup>-10</sup>. 4. A sound wave with SIL = 50 dB is reflected by a fabric-covered wall that absorbs 75 % of its intensity. The sieve of the reflected scale is (a) 75 dB (b) 47 dB (c) 44 dB (d) 25 dB (e) 12.5 dB. 5. Light and sound are both waves; anyway, we can hear a car coming from behind the corner of a building before we can see the car. This is because (a) sound travels faster than light (b) then Isound &gt; llight, sound diffracts more than light (c) sound is not reflected by buildings (d) sound and light interfering, with sound winning out. 6. A moving locomotive rings its horn when crossing a highway. There are people in all directions from the locomotive - in front, in the back, right and left. Compared to the "true" pitch, as heard by the engineer, the horns pitch heard by these people is (a) higher (b) lower (c) the same for all people (d) higher for some, true to others, and lower for even others of the people The chart below is a plot in motion of a mass that bobs and down on a spring. The vertical scale shows the height of the mass above the floor, and the horizontal scale shows time. Only part of the movement, starting at 5 sec, is displayed. Use this site to answer questions 7-10. 1mm Image omitted 7. This movement is (a) not periodic (b) periodic but not simple harmonic (c) simple harmonic (d) none of the above 8. How many periods are displayed? (a) one (b) two (c) three (d) four 9. What is the period? (a) 1 sec (b) 2 sec (c) 4 sec (d) 7 sec (e) 9 sec 10. What is the amplitude? a) 1 cm (b) 1.5 cm (c) 2 cm (d) 2.5 cm (e) 4 cm The above observation plots show displacement (vertical) vs time (horizontal). Use them to identify the vibrations in questions 11-14. 0.8mm Image omitted 11. A square wave, amplitude modulated by a sawtooth wave. 12. A subdued harmonic vibration. 13. A triangle wave tasted (and held) at 20 times the frequency of the wave. 14. The type of vibration that is heard as "beats. 15. The frequency of note B4 is close to 500Hz. The period for this vibration is (a) 500 sec (b) 1 sec (c) 0.2 sec (d) 2 msec (e) none of these 16. A sine wave and a square wave cannot have the same (a) loudness (b) wavelength (c) frequency (d) tone quality (e) pitch 17. An electric clock works in a vacuum. We cannot hear the sound of the watch because (a) air is needed to conduct the electric current to the watch (b) the watch's metal cannot vibrate in vacuum (c) there is no air to conduct the vibrations to our ears (d) the vacuum jar absorbs the sound (e) the sound of the pump is louder than the sound of the clock. 18. The wavelength of "shortwave radio waves is smaller than that of standard radio waves (AM). They both propagate at the same speed. This allows you to conclude that, compared to AM waves, the "shortwaves have (a) lower frequency (b) longer period (c) higher frequency (d) smaller amplitudes 19. When a sound wave enters from air to a metal, where the speed of sound is much greater than in air, it does not change its (a) wavelength (b) frequency (c) speed (d) all these (a-c) change 20. The sound moves at 345 m/sec against a rock wall, reflects and returns (like an echo). The roundtrip takes 2 sec. How far is the wall? (a) 70 m (b) 170 m (c) 340 m (d) 345 m (e) 350 m 21. Two identical audio sources differ in distance from the listener by 1/2λ. The result is (a) no sound at the listener (b) constructive interference (c) sound twice as loud as a source strikes Questions 22-27 refers to the following number, which shows a stretched string, [ 1/2] m long, fixed at the ends. 1mm Image omitted 22. The dotted curve shows the vibration of this string in its fundamental position. The wavelength of this wave is (a) 0.25 m (b) 0.5 m (c) 1 m (d) 2 m (e) 4 m 23. The vibration is (a) transverse (b) transverse (c) travelling (d) longitudinal (e) triangular 24. The heavy fixed curve shows the vibration of this string at which harmonic number N: (a) 1 (b) 2 (c) 3 (d) 4 (e) 5 25. How many nodes are there in the vibrations of the fixed curve? (a) (a) (b) 2(c) 3 (d) 4 (e) 5 26. The wave speed of this string is v = 100 m/sec. The fundamental frequency is therefore f = (a) 25 Hz (b) 50 Hz (c) 75 Hz (d) 100 Hz (e) 200 Hz 27. The tension of the string is made 4 times as large as before. As a consequence (mark the best answer) (a) the frequency becomes twice what it was for (b) the period decreases by a factor of two (c) the new degree is an octave higher than the old (d) all of the above. 28. A musical tone of frequency 750 Hz, compared to one of frequency 500 Hz, is (a) A fourth higher (b) one fifth higher (c) an octave higher (d) an octave and a fifth higher (e) not higher but lower. 29. A closed and an open tube have the same fundamental frequency. Which is longer? (a) the open tube (b) the closed tube (c) they are equally long (d) depends on the speed of sound 30. The two tubes in the previous question are placed in a gas at a speed of sound greater than the speed of sound in air. What happens to their fundamental frequencies: (a) the longer tube increases its fundamental more than the shorter (b) the shorter tube increases its basic more than the longer (c) both frequencies increase equally (d) both frequencies decrease equally. 31. What is the length of an open tube whose basic is 345 Hz, when the speed of sound is 345 m/sec? (a) 345 m (b) 3.45 m (c) 1 m (d) [ 1/2] m (e) [ 1/3.5] m 32. If the basic resonance of a closed tube is 200 Hz, what is the frequency of the next higher resonance? (a) 300 Hz (b) 400 Hz (c) 500 Hz (d) 600 Hz (e) 800 Hz 33. A graph showing the amplitude of response of a system vs driving frequency is called (a) resonance curve (b) Fourier spectrum (c) speed pattern (d) Lissajous figure (e) sonogram 34. The mathematical statement that each periodic wave of frequency f can be synthesized from waves of frequencies f, 2f, 3f, ... called (a) Bernoullis principle (b) Fouriers theorem (c) Helmholtz equation (d) Huygens principl e Ohm's Law 35. Two waves having the same Fourier spectrum may differ in (a) waveform (b) sound (tone quality) (c) intensity (d) frequency (pitch) (e) period Issue 36-39 touches the waves so numbered, shown below. For each wave, mark the letter corresponding to its Fourier spectrum, also shown below. For example, if you think wave 36 has fourier spectrum (c) (which it doesn't), mark C for question 36 on the answer sheet. The time on each graph in the top row runs from 0 to 1 msec, so that wave 36 for example has a frequency of 1000 Hz. Due to the finite range available, graphs (a) and (b) show only part of the spectrum; these two spectra are supposed to continue to higher harmonics, with regularly decreasing amplitudes. 1.00mm Image omitted 40. Changing only the phase of component waves in the Fourier synthesizer showed that (a) tone quality is independent of phase (b) waveform is independent of phase (c) tone quality depends on harmonic content (d) waveform depends on harmonious content. 41. The envelope generator of a synthesizer is typically used to (a) generate the audio signal. (b) achieve a vibrato effect. (c) check the attack and disintegration characteristics of the sound. (d) provide a trigger for the keyboard. (e) provide an envelope to mail in payments for the synthesizer. 42. The critical band for a frequency f is (a) the frequency band that the human ear can hear. (b) the region along the basilar membrane responding to the frequency f. c frequency band which sounds indistinguishable from the former) a band made of instruments all tuned to the frequency f. 43. The noise emanating from a diesel locomotive at a distance of 100 ft has a SIL of 100 dB. Suppose the reverse squares law is valid. What is SIL from this 200 ft locomotive? (a) 200 dB (b) 25 dB (c) 94 dB (d) 10 dB 44. What would be the noise of two such 100 ft diesel locomotives? (a) 200 dB (b) 120 dB (c) 103 dB (d) 102 dB (e) 50 dB 45. Inhalation of helium or other gas where the speed of sound is higher than in the air changes a person's voice because (a) the resonance frequencies of the person's voice and airway change. (b) helium affects the speech center in the brain. (c) helium causes the vocal folds to vibrate faster. (d) there is no change, the demo was a fake. 46. A clean tone with a frequency of 1000 Hz is played. A second pure tone, higher in frequency, is played with the first note. If two distinct tones are perceived, the tone must be (a) a frequency JND away from the first note (b) outside the critical band of the first note (c) such that beats can be heard (d) the subjective basis of the first note. 47. A 60 watt bulb is designed to absorb 60 W of electric power when connected to 120 Volts. What is the power through the light bulb? (a) 720 A (b) 120 A (c) 60 A (d) 2 A (e) 1/2 A 48. A tape recorder sets a signal of 1.5 V amplitude in an impedance of 50,000 W. The transmitted power is therefore (a) much less than 1 W (b) about 1 W (c) much more than 1 W 49. The acoustic purpose of a bhinism around a speaker is (a) to make the speaker look better (b) to avoid the wave from the back interfering destructively with it from the front (c) to resonate with the sound laid out by the speaker (d) to prevent excessive vibration of the speaker cone. 50. To put the same power into a speaker of 16 W as in a 4 W speaker, the voltage above the 16 W speaker terminals, compared to the one above 4 W speaker terminal, must be (a) equal (b) twice (c) four times (d) half (e) a quarter 51. The number 12 in binary is 1100. The number 13 in binary is (a) 1101 (b) 11000 (c) 11111 (d) 1200 (e) 1300 52. The largest number you can type with 10 binary bits is 1111111111, which is about 1000 in regular decimal notation. Suppose that a CD system used only 10 binary bits, so that the largest amplitude it could record would be about a thousand times the minimum amplitude. Suppose sil corresponding to the minimum amplitude is 0 dB and use the formula SIL = SIL0 + 20 log (A/A0). What would the dynamic range be in this situation? (a) 6 dB (b) 20 dB (c) 60 dB (d) 1000 dB (e) 2000 dB 53. The reverberation time was defined as the time required for the sound intensity to decrease by a factor of one million (1,000,000). This corresponds to a reduction in SIL by (a) 6 dB (b) 12 dB (c) 60 dB (d) 120 dB 54. If I increase the sound absorption of a room, for example by covering a tiled floor with a carpet, the reverberation time (a) (b) remains the same (c) decreases (d) depends on whether verbs or nouns are used. 55. Which experiment showed interference: (a) tap in vacuum (b) b) b) speakers and light (d) phase recirculation between stereo speakers 56. We showed a 3 dB increase in SIL by (a) replacing an oscillator, connected to a speaker, manually back and forth with 3 dB. (b) to ask the class to scream until a SIL meter showed a SIL of 3dB. (c) class in two and with first half clap, and then have the whole class clap. (d) plays a band with a sound that varied with 3dB. 57. What effect cannot be displayed with two sound oscillators entering an amplifier and speakers: (a) Faraday's Law of Induction (b) Critical Band (c) Sum and Difference Tones (d) Quality Stroke (e) Masking 58. We used a hairdryer and ping pong ball to illustrate (a) vibrations of the ball in the standing wave set up by the hairdryer. (b) the effect of air humidity on the speed of sound; c that a ping pong ball in dry air may become electrically charged. (d) that the air pressure is less on the side of the ball where the air flows faster; 59. We used a Fourier synthesizer to generate a square wave. We couldn't get a perfect square wave because (a) phase failure made it skewed (b) amplitude errors made the tops and bottoms rounded rather than flat (c) absence of very high frequency components caused fast wiggles at the top and bottom (d) we got a perfect square wave. 60. In one experiment a wire was suspended between the poles of a permanent magnet. When power was made to flow through the wire (a) the magnet rotated by the 90o (b) wire moved away from the magnet (c) the wire responded only to a change in the current through the (d) wire was drawn into the region of the strongest magnetic field. For the following questions, A marks "true" and B for "false" 61. A steady tone played on a violin is an almost perfect sine wave. 62. Different vowel sounds differ mainly in the relative frequency and amplitude of the first two formants. 63. The threshold for hearing is at 0 phons for all frequencies. 64. A standing wave remains constant, with no change in time anything. 65. The precedence effect allows us to hear the fundamental frequency of a complex wave, even when that frequency is absent in the Fourier spectrum. 66. In the well-tempered scale, only the octaves are perfect intervals. 67. Light is a longitudinal wave, while the sound is transverse. 68. A triangle wave contains fourier components with a higher frequency than a sine wave of the same periodicity. 69. In a CD player, the disk rotates at a constant linear speed. 70. In a dynamic speaker the sound is produced by the vibration of a permanent magnet. 71. In an audio system, the AM-FM tuner, tape recorder and CD player each require its own separate amplifiers and speakers. 72. The sounds "ee" and "oo" cannot be said (or sung) in such a way that their Fourier spectrum is the same. 73. Therefore, the sounds "ee" and "oo" cannot be spoken (or sung) on the same pitch. 74. To make the acoustics of an auditorium more vivid, the wall, ceiling, and floor surfaces should be made as sound-absorbing as possible. 75. In white noise all frequencies are present, and all have the Intensity. 76. Attack transients help determine the tone quality of a musical tone. 77. The sound quality of a violin depends only on the resonances of its strings; the violin body has no resonances of its own. 78. Percussion instruments have only a single resonance. 79. For two electrical appliances connected to the same voltage, the smaller power is drawn with the smaller resistance. 80. In order to avoid interference between different AM stations, each station uses a carrier that is different from any of the other stations. Further instructions: Questions 81-90 should be answered on the last page (page 9). Type your name in the space provided, and either now or when you're done, unload that page so the only page 9 can be submitted (i.e. without multiple-choice Part I). If you want your rating published on the phys102 website, type "please post" under your name and also give a "secret code" to yourself during which you can post your rating (legible, please!). At the end, there is an option for you to fill in answers to questions 81-100 on the answer sheet. You can't "lose" anything (except for a little while) by doing so, because we will still look at your drawings and, for any partial credit, at every written response to the 81-100 you didn't get a perfect score. II. Quantitative Questions Your Name For these problems, use speed of sound = 345 m/sec. 81-90. A. Draw an open tube, and within the transverse representation of the speed pattern of a standing sound wave at harmonic number N = 3. b. The open tube is 4.2 cm (= 0.042 m) long. Find the frequency of N = 3 overtones in Hertz, exactly to five digits (that is, forget the numbers after the decimal point). View your work below. C. Draw a closed tube, and within the "transverse representation of the speed pattern of a standing sound wave at harmonic number N = 3. d. How long should the closed tube be so that its N = 3 harmonic has the same frequency as for the open tube of part (a)? 91-100. At a distance of 6 m from a source, the sound intensity is 4.8×10<sup>-8</sup> W/m<sup>2</sup> = 0.00000048 W/m<sup>2</sup>. A. What is the intensity (in W/m<sup>2</sup>) at 12 m from the source? B. How far from the source do you have to move for the intensity to fall to 1/16 of the intensity at 6 m? C. The silof this source of 6 m is 47 dB. What is SIL at 3 m? Optional - Help us rating: For question 81-90, mark the five digits of your answer to b., in sequence, in spaces 81-85 of the answer sheet; and mark the two non-zero digits in your answer to d., consecutively, in spaces 86-87 in the answer sheet. Select spaces 88-90 with A. For questions 91-100, select the two non-zero digits in your answer to a., in spaces 91-92, and also in spaces 93-94, of the response sheet; and mark the two non-zero digits in your answer to b., in sequence, in spaces 95-96, and 97-98, of the answer sheet; and select the two digits of your answer to c., in sequence, in spaces 99-100 in the answer sheet. We will of course still look at your written answers! Thank you, and have a great summer. File translated from TEX by TTH, version 3.05.On Dec 13, 2002, 5:30 pm. 17:30.

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