Sounds of Music

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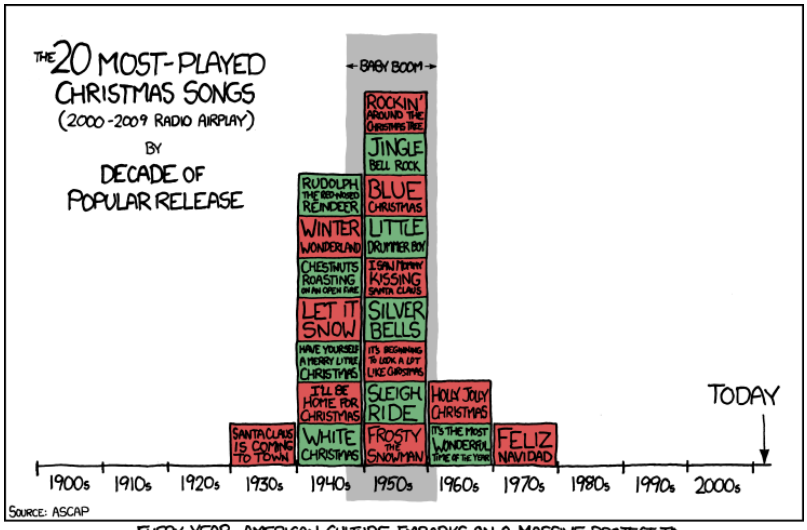

Directions:

- You will have about 50 minutes.
- A scientific calculator, a binder, writing utensils, and your brain are permitted. No graphing calculators, cell phones, or other electronic devices are allowed during the test.
- Assume conditions are 1 atm and 20°C unless otherwise specified; that is, that the speed of sound is 343 m/s.
- For calculations, always use significant figures.
- You may use any third-party application, such as Discord or Zoom, to communicate with your partners. Voice/video call is permitted.

Page:	2	3	4	Total
Points:	15	30	30	75
Score:				

1 Multiple Choice - 15 Points

1. (1 point) Which of the following is the length of time that it takes for a wave to complete one cycle?

   A. Wavelength B. Amplitude C. Period D. Frequency

2. (1 point) Which of the following is defined as the number of cycles of a wave per second?

   A. Wavelength B. Amplitude C. Period D. Frequency

3. (1 point) Which of the following is defined as the range of frequencies above the limit of human hearing?

   A. Infrasonic B. Ultrasonic C. Supersonic D. Subsonic

4. (1 point) Which of the following are longitudinal waves?

   A. P-Waves B. Sound Waves C. Light Waves D. Waves on a String

5. (1 point) Approximately, which of the following is the longest wavelength of wave that a human can hear?

   A. $0.017m$ B. $0.17m$ C. $1.7m$ D. $17m$

6. (1 point) Convert 12 dB to intensity, in $\frac{W}{m^2}$.

   A. $1.585 \cdot 10^{-11} \frac{W}{m^2}$ B. $3.170 \cdot 10^{-12} \frac{W}{m^2}$ C. $1.585 \cdot 10^{-11} \frac{W}{m^2}$ D. $3.170 \cdot 10^{-12} \frac{W}{m^2}$

7. (1 point) Sound would travel the fastest in which of the following mediums?

   A. Steel B. Water C. A vacuum D. Air

8. (1 point) What is the relationship between sound intensity and sound pressure?

   A. $I \propto \sqrt{p}$ B. $I \propto p$ C. $I \propto p^2$ D. $I \propto p^3$

9. (1 point) Which of the following correctly describes the range of notes of a typical piano?

   A. C0-A7 B. A0-C8 C. C1-A8 D. A1-C9

10. (1 point) A typical piano has how many keys?

    A. 82 B. 84 C. 86 D. 88

11. (1 point) "Sol" in fixed do solfege corresponds to which of the following notes?

    A. A B. C C. E D. G

12. (1 point) Which of the following correctly describes the D Dorian scale?

    A. D, E, F, G, A, B, C, D
    B. D, E, F♯, G, A, B, C♯, D
    C. D, E, F, G, A, B♭, C♯, D
    D. C, D, E, F, G, A, B, C

13. (1 point) What is the kazoo, according to the Hornbostel-Sachs system of instrument classification?

    A. Idiophone B. Aerophone C. Membranophone D. Chordophone E. Electrophone

14. (1 point) A clarinet can best be described as having what kind of air column?

    A. Cylindrical, Open at Both Ends B. Cylindrical, Closed at One End C. Cylindrical, Closed at Both Ends
    D. Cone, Open at Both Ends E. Cone, Open at One End

15. (1 point) Which of the following is a compound time signature?

    A. $\overset{3}{4}$ B. $\overset{4}{4}$ C. $\overset{2}{2}$ D. $\overset{12}{8}$

2 Definitions - 10 points

Write a definition for each of the following terms.

16. (2 points) Arpeggio
17. (2 points) Hemiola
18. (2 points) Dal Segno
19. (2 points) Stringendo
20. (2 points) Ruhig

3 Short Answer - 20 Points

A man is alive. This is what happened to his ear.

JC is a 33 year old man ☝, presenting to the doctor's office with a fever, headache, muffled hearing, trouble walking, and insomnia. He hadn't slept for the past 2 days. He tells the doctor that he started having symptoms a few days prior, after waking up from a nap. The doctor quickly concludes that he likely does not have COVID-19 due to the absence of a sore throat, dry cough, and other relevant symptoms. It is concluded that he likely has an ear infection. The man is not amused.

21. (2 points) Based on this information, what part of the ear is infected - inner, middle, or outer ear?
22. (2 points) What crystals are generally responsible for a proper sense of balance?

The man takes some antibiotics, but comes back to the doctor in three months, complaining that he's still hearing a G in one ear and a D sharp in the other ear when listening to music. The doctor is taken aback to see he has an infection in his other ear, which is experiencing draining.

23. (2 points) Through what should the fluid be draining through instead?
24. (2 points) What specific part of his ear is probably afflicted?

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25. (2 points) The standing wave of a violin string, 33.0cm long, travels at $504\frac{m}{s}$. What is the frequency of the sixth harmonic of the string?
26. (2 points) The length of an open-ended tube is 88.0cm. What is the fundamental frequency of the tube?
27. (2 points) Amazingly, Jacob's point-mass glider travels at a speed of $700\frac{m}{s}$ during launch. At this point in time, what is the angle between the Mach wave and the glider?
28. (2 points) Consider a 1L water bottle, which is an ideal Helmholtz resonator. If its neck is 12.00cm long and its neck has an area of 5.000 cm^2, what frequency does it vibrate at?
29. (2 points) Consider a 632°C room filled with pure Argon gas, with molar mass 40.0 amu. What is the speed of sound in this room?
30. (2 points) A 10-watt speaker sits on a table in front of Allen. If Allen sits 8.000m away from the speaker, how loud is it to him in dB?

4 Free Response - 30 Points

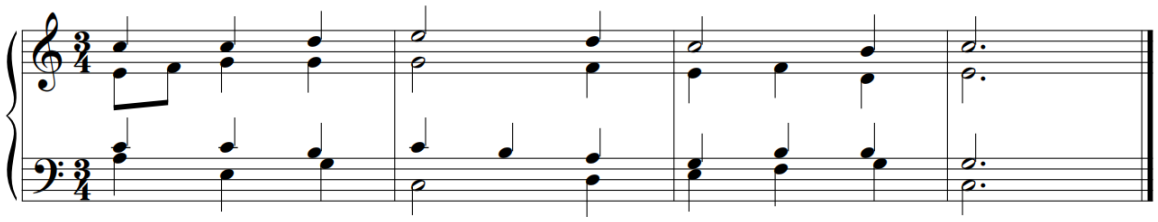
There are lots of different ways you can tune.

31. (3 points) Using 12-tone equal temperament, compute the pitch of an F5, given that A4 is 440.00 Hz. Then, compute it using Pythagorean tuning. Compare the two values and describe why they're different.

32. (3 points) Just intonation is famous for being horrendously out of tune if you tried to scale it. Use the ratios 3/2 (or 2/3) for perfect 5ths, 4/3 (or 3/4) for perfect 4ths, and 5/4 (or 4/5) for major 3rds to play C4 G4 D5 A4 E4 C4. Compute the ratio between the 2nd C4 and the 1st: $C4_2 : C4_1$. What phenomenon is this? Why does it occur?

33. (4 points) Allen plays first violin in an orchestra. It is perfectly in tune on an open string on a A4 (440.00 Hz). In orchestra, he plays with the second violins, who are playing an A4 (440.00 Hz). Allen plays an equal tempered C#5 (554.37 Hz) on the A string, which is 32.50 cm long. How many millimeters must Allen shift his finger in order to be in tune with 5-limit just intonation relative to the second violins? In which direction? Justify your answer.

Consider the following progression, taken from a Bach chorale, but with some voice leading errors.



34. (3 points) Identify the key (ie. "F# Major"), and the cadence in the last two chords. Cite specific parts of the chorale to justify your answer.

35. (5 points) Identify/correct the errors in voice leading in this exercise. You may want to analyze Roman Numerals first, though it is not required.

36. (2 points) What kind of nonharmonic tone is shown in the tenor line in measure 2? How do you know?

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37. (3 points) You probably know that the beat frequency between two tones f_1 and f_2 is $|f_1 - f_2|$, usually a small number. What happens to the *amplitude* of the composite sound as $f_1 \to f_2$?

38. (3 points) Briefly describe the name and how of each of the three pedals on a typical grand piano, from left to right, change the overall sound of the instrument. Explain how each pedal modifies the piano specifically to achieve the new sound.

39. (4 points) First, explain the phenomenon of missing fundamentals. Then, outline the process of creating a missing fundamental of 449 Hz.

5 Tiebreaker

Klebb sometimes [tries to] play alto saxophone. What is the loudest that Klebb can play, to the nearest 0.01 dB? Your score will be $\min\{\frac{\beta}{10G}, \frac{G}{10\beta}\}$, where β is the actual loudness and G is your guess.