PRACTICE MIDTERM

PHYS 1240

Sound and Music

Summer 2019

Name: _____

Start Time: 11:00 AM

End Time: 12:35 PM

Total Allotted Time: 1 hour and 35 minutes

Permitted Materials: one $8\frac{1}{2}$"×11" sheet of paper with anything written on one side, calculator without internet access, pencils, erasers

*Instructions: Write your name on the front page of the exam, but DO NOT open the exam booklet until told to do so. When told to begin, you may open the exam and begin working until time is called. Answer **all** questions in the space provided in the test booklet, and show all your work.*

There are 38 multiple choice questions, each worth 2.63%.

SI Prefixes:

milli (m)	0.001	10^{-3}
centi (c)	0.01	10^{-2}
deci (d)	0.1	10^{-1}
kilo (k)	1,000	10^{3}
mega (M)	1,000,000	10^{6}

Conversion factors:

1 m $\approx$ 3.28 ft

1 hr = 60 min = 3600 s

1 atm $\equiv$ 101,325 N/m^2 $\approx$ 14.7 psi

1 Pa $\equiv$ 1 N/m^2

1 Hz $\equiv$ 1 s^{-1}

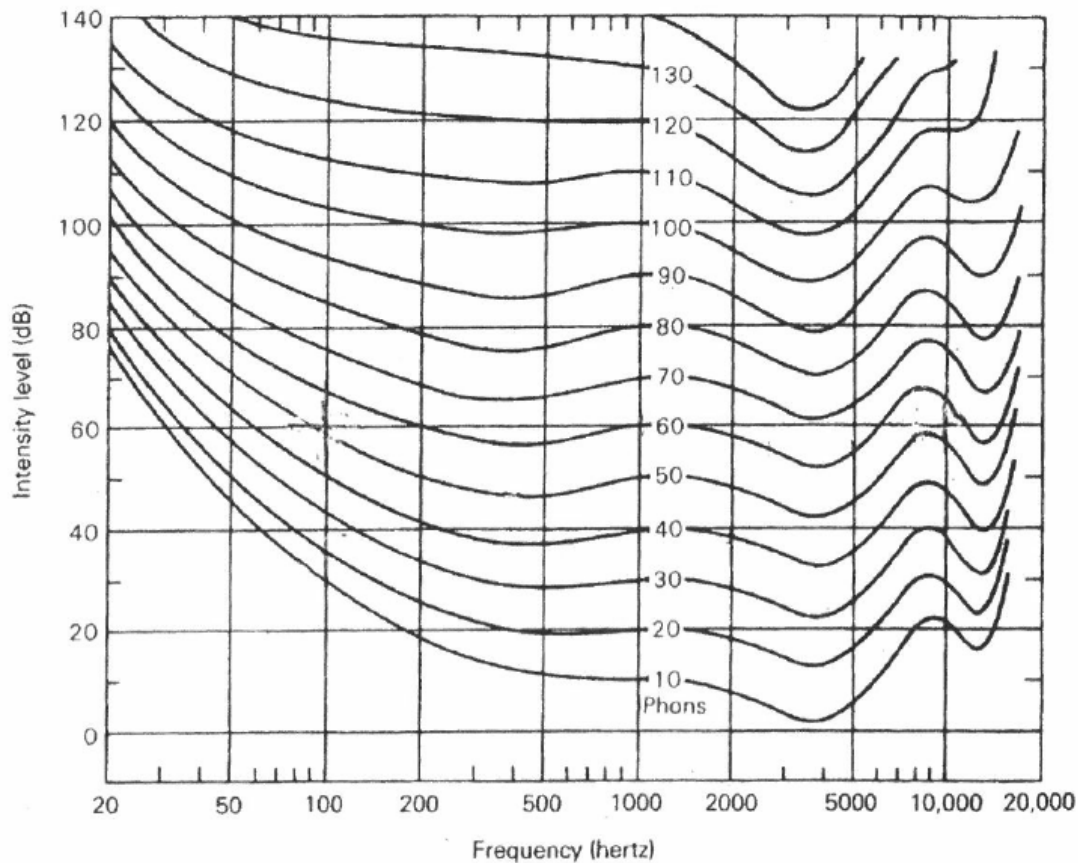**Formulas:**

$$v = \lambda f \qquad\qquad v[\text{m/s}] = 331 + 0.6\ T[°\text{C}]$$

$$f = \frac{1}{2\pi}\sqrt{\frac{\text{stiffness}}{\text{mass}}} \qquad\qquad \%\text{ change in } f = \frac{\Delta v}{v_{\text{sound}}}$$

$$f_{\text{beat}} = f_2 - f_1 \qquad\qquad SIL\ [\text{dB}] = 10\ \log\left(\frac{I\ [\text{W/m}^2]}{10^{-12}}\right)$$

1. You see a bolt of lightning behind the foothills of Boulder and hear the peal of thunder about three and a half seconds later. Approximately how far away was the bolt (assume the air is 20°C and that light travels instantaneously)?

    a) 500 m
    b) 1.0 km
    c) 1.2 km
    d) 3.5 km
    e) none of the above

2. If the marching band is practicing in Folsom Field and you are behind a building around the corner from the field, what are you most likely to hear?

    a) nothing, since the building corner blocks the sound
    b) the high-pitched instruments like the flutes / piccolos, since higher frequencies diffract more
    c) the low-pitched instruments like the bass drums / tubas, since lower frequencies diffract more
    d) all instruments equally, since diffraction doesn't depend on frequency

3. Two wine glasses, one empty and one full of water, are both tapped with a rod to produce a pinging sound. Which will have a higher pitch?

    a) the empty glass
    b) the full glass
    c) they'll both have the same pitch

4. Two trombones play with the following frequencies: 185 Hz and 187.5 Hz. What is the period between the beats?

    a) 2.5 Hz
    b) -2.5 Hz
   c) 0.4 s
    d) 0.0054 s
    e) none of the above

5. A guitar string is tuned to a frequency of 488 Hz. What is the wavelength of the sound waves generated at this frequency?

    a) 0.703 m
    b) 1.42 m
    c) 0.5 m
    d) 2.04 m
    e) none of the above

6. A xylophone mallet typically remains in contact with the wooden bar for only a few milliseconds, but during that short time it can exert a force of about 600 N. That force is concentrated in a small contact area of perhaps 2 square millimeters (1 square millimeter $= 10^{-6}$ m^2). How much pressure is being exerted on that part of the bar?

   a) 300 Pa
   b) 150 kPa
   c) 300 kPa
   d) 15 MPa
   e) 300 MPa

7. Simple harmonic motion produces a sinusoidal displacement as a function of time.

   a) true
   b) false
   c) the answer depends on the mass and the stiffness of the spring

8. Suppose there is a tall and wide brick wall at a distance. The temperature is 30°C. You make a loud clap. You hear an echo of this same clap with a delay of exactly 2.0 seconds. How far are you from the wall?

   a) 350 m
   b) 700 m
   c) 1,400 m
   d) 688 m
   e) 344 m

9. Which sound would have a larger amplitude?

   a) a high-pitched sound
   b) a low-pitched sound
   c) a loud sound
   d) a quiet sound
   e) they would all have the same amplitude

10. When would sound waves travel faster?

   a) at higher frequencies
   b) at lower frequencies
   c) at lower temperatures
   d) at higher temperatures
   e) more than one of the abov

11. Here in Boulder, normal atmospheric pressure is NOT 1 atm (that's down at sea level). Let's call it 0.860 atm on a given day. If the rarefactions of a particular sound wave then reduce the pressure to 0.858 atm, what is the amplitude of the pressure wave?

    a) 0.004 atm
    b) 0.003 atm
    c) 0.14 atm
    d) 0.28 atm
    e) none of the above

12. Can a healthy person in their 20s hear a sinusoidal tone that has a period of 0.00001 seconds?

    a) yes
    b) no

13. How long does it take for sound to arrive at the back of a big auditorium if the temperature is 25°C and the stage is 20 m away?

    a) 0.0576 s
    b) 0.0581 s
    c) 0.115 s
    d) 17.20 s
    e) 17.35 s

14. If the period of a complex period waveform is doubled, what happens to the pitch?

    a) it goes down an octave
    b) it goes up an octave
    c) it goes down a fifth
    d) the timbre change, but there is no change to the pitch
    e) none of the above

15. Assuming the temperature of the background air is 20°C, when I speak, do the air molecules travel directly from my mouth to your ear at 343 m/s?

    a) yes
    b) no

16. On a typical sunny day in Boulder, when is the speed of sound faster?

    a) early morning
    b) midday
    c) midnight
    d) the speed of sound does not change throughout the day

17. Which types of waves are examples of longitudinal waves?

   a) waves on a string
   b) sound waves
   c) light waves
   d) both a and b
   e) none of the above

18. Two speakers are playing the exact same pure tone at 343 Hz. You are 1 m from one speaker and 2 m from the other speaker. What will you observe?

   a) constructive interference
   b) destructive interference
   c) there would not be any spatial interference
   d) beats
   e) both b and d

19. If the frequency of a sound wave increases by a factor of 3, what happens to its wavelength?

   a) the wavelength increases by a factor of 3
   b) the wavelength decreases by a factor of 3
   c) the wavelength does not change
   d) insufficient information to determine

20. If you went up six perfect 5th intervals, approximately how many octaves would that be?

   a) 11
   b) between 3 and 4
   c) between 4 and 5
   d) 7

21. Equal-tempered tuning

   a) uses fractions of small integers to determine intervals and notes
   b) uses a factor of the twelfth foot of $2 \approx 1.05946$ between half steps
   c) uses linear spacing
   d) none of the above
   e) both a and c

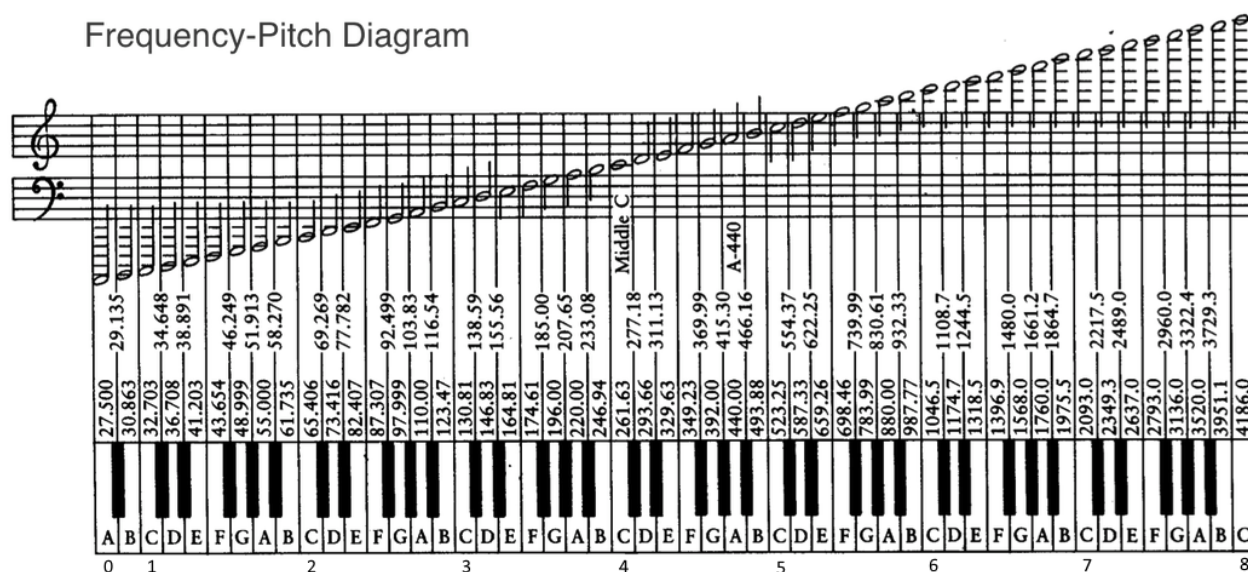22. The following standing wave on a string has how many antinodes?
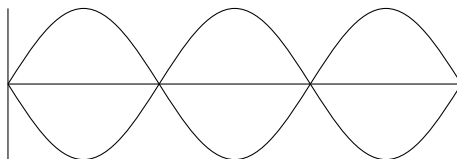
   a) 1
   b) 2
   c) 3
   d) 4
   e) none of the above

23. For the standing wave shown in the problem above, the transverse wave speed is 200 m/s and the length is 1 m. What is the frequency of this particular standing wave?

   a) 100 Hz
   b) 200 Hz
   c) 300 Hz
   d) 400 Hz
   e) none of the above

24. A sound is made up of pure tones at the following frequencies: 400 Hz, 500 Hz, 550 Hz. What is the frequency of the perceived pitch?

   a) 300 Hz
   b) 200 Hz
   c) 100 Hz
   d) 50 Hz
   e) none of the above

25. A vocalist starts singing a note at 400 Hz, goes up a perfect 5th, then up a perfect 4th, then down an octave. What frequency does the vocalist end on?

   a) 400 Hz
   b) 450 Hz
   c) 300 Hz
   d) 375 Hz
   e) 800 Hz

26. If the amplitude of a sound wave is quadrupled, by what factor will the intensity increase?

    a) 4
    b) 8
    c) 16
    d) 60.2
    e) it will decrease

27. You can buy meters which measure the intensity of sound in W/m^2. If such a device in your room says that the intensity of sound coming from your stereo is 1×10^{-5} W/m^2, what does this correspond to in the more familiar dB system?

    a) 70 dB
    b) 50 dB
    c) 5 dB
    d) 10^{-5} dB
    e) -5 dB

28. A double bass is producing a tone of frequency 50 Hz, and a decibel meter (like the one we used in class) is reading 70 dB. We've talked in class about how your perception of loudness does not always match exactly with the meter. Figure out, roughly, the loudness level (in phones) of this tone.

    a) 50 phons
    b) 40 phons
    c) 30 phons
    d) 60 phons
    e) 10 phons

29. If one violin produces a reading of 70 dB on your sound level meter, what reading do you expect from 4 violins together?

    a) 87.5 dB
    b) 76 dB
    c) 70.6 dB
    d) 106 dB
    e) none of the above

30. If the volume on an amplifier is turned up 30 dB, how much has the intensity (in W/m^2) increased?

    a) 3 times
    b) 30 times
    c) 300 times
    d) 1,000 times
    e) 10,000 times

31. When different regions of the basilar membrane vibrate, what information does this provide to the auditory nerve?

   a) differences in intensity
   b) differences in loudness level
   c) differences in frequency
   d) loudness protection patterns
   e) none of the above

32. What are the small bones that transfer vibrations from the eardrum to the oval window?

   a) basilar membranes
   b) bony shelf rails
   c) ossicles
   d) scala vesti
   e) none of the above

33. The volume of an old amplifier is increased so that the intensity (measured in units of W/m^2) of quiet music increases by a factor of 10,000. How will the quality of the sound change? Assume that the amplifier increases all frequencies the same amount.

   a) the overall quality of the sound will not change
   b) it will be much quieter
   c) it will become more brassy or shrill
   d) the bass frequency will sound too loud

34. What will cause the frequency of a guitar string to increase the most?

   a) double the mass of the string
   b) decrease the mass of the string by a factor of two
   c) double the length of the string
   d) decrease the tension on the string by a factor of two
   e) triple the tension on the string

35. Why is there a middle ear?

   a) to convert sound waves to vibrations at the oval window
   b) to protect the inner ear from extremely loud sounds
   c) to maintain the ear drum in proper pressure equilibrium
   d) all of the above
   e) none of the above

36. If the frequency of the 2nd harmonic is 203 Hz, what is the frequency of the 3rd harmonic?

    a) 304.5 Hz
    b) 609 Hz
    c) 406 Hz
    d) 330 Hz
    e) none of the above

37. Which harmonic is a 5th musical interval above the second harmonic?

    a) 2nd
    b) 3rd
    c) 4th
    d) 5th
    e) none of the above

38. A particular sound has specific peaks in the frequency spectra at 220 Hz, 440 Hz, and 660 Hz. What might the sound be?

    a) gong
    b) snare drum
    c) bowed violin
    d) both a and b
    e) both a and c

Frequency-Pitch Diagram

End of Examination