Orlando Science Schools

Division C Invitational
Sounds of Music 2019-20

Do not begin until you are told to do so.

This test uses these conventions unless implied or stated otherwise:

- All frequencies are greater than 20 Hz.
- Sound sources are points emitting continuously in windless 20°C air at sea level.
- All strings and pipes are of very small, nonzero radius.
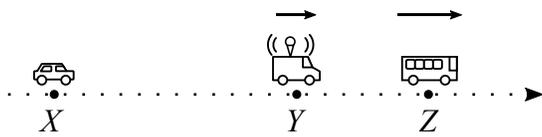- An octave consists of twelve equally distant half steps referenced to $A_4 = 440$ Hz.

School: _____   Team number: _____

Student names: _____

Test score: _____/total   Final score: _____   Rank: _____

1. Car *X*, ice cream truck *Y*, and bus *Z*, lie respectively at 0 m, 20 m, and 30 m on the *x*-axis. The car is at rest, while the ice cream truck and bus move at velocities of +10 m/s and +20 m/s respectively. If the ice cream truck plays a note, the driver of which vehicle hears the highest frequency?

   (A) *X*
   (B) *Y*
   (C) *Z*
   (D) Both *Y* and *Z*
   (E) Both *X* and *Z*

2. What is the first overtone of a string with fundamental f?

   (A) $f/4$
   (B) f
   (C) $2f$
   (D) $3f$
   (E) $4f$

3. A major third consists of how many cents?

   (A) 150
   (B) 300
   (C) 400
   (D) 600
   (E) 700

4. 300 simultaneous, identical claps produce a sound intensity level of 87 dB according to an observer. How many people would need to clap at once for the observer to record a sound intensity level of 77 dB?

   (A) 3
   (B) 17
   (C) 30
   (D) 95
   (E) 265

5. Some headphones are designed to cancel out noise by generating sound at a pressure difference opposite to that of background noise. This best illustrates the phenomenon of

   (A) Constructive interference
   (B) Destructive interference
   (C) Refraction
   (D) Absorption
   (E) Presupposition

6. The ability of humans to discern the position of a sound relative to themselves is known as

   (A) Sound localization
   (B) Critical-band perception
   (C) Fletcher-Munson effect
   (D) Kinesthetic sense
   (E) Vestibular sense

7. The ratio of the frequency of $B\flat_6$ to the frequency of $E\flat_6$ is most closely

   (A) 0.58
   (B) 0.67
   (C) 1.25
   (D) 1.33
   (E) 1.50

8. A person hears beats of 2 Hz. If he hears a tone of 761 Hz, what other possible tones could be playing at the same time?

   (A) Only 759 Hz
   (B) Only 763 Hz
   (C) Both 759 Hz and 763 Hz at once
   (D) Either 759 Hz or 763 Hz, or both at once
   (E) Either 759 Hz or 763 Hz, but NOT both at once

Questions 9-10 refer to the information below.

A teacher assigns her students to find the seventh harmonic of a closed pipe. After consulting a standard reference manual of physics, the students determine the frequency to be

$$f = \frac{nv}{4L}.$$

9. In the equation provided, L represents which physical quantity?

   (A) Speed of sound
   (B) Loudness
   (C) Length of wave produced by pipe
   (D) Length of pipe
   (E) Diameter of pipe

10. The students measure L to 3 significant figures. They are told that $v = 331.1$ and $n = 7$. (The test writer has omitted units intentionally.) What number of significant figures is appropriate for their calculation of f?

    (A) 1
    (B) 2
    (C) 3
    (D) 4
    (E) Additional information is needed to
        determine the answer

11. Two very long strings of different mass densities are connected by massless glue and held rigid. A wave of frequency f is sent from the low-density string to the high-density string. When the wave travels onto the high-density string, its frequency

    (A) will remain unchanged
    (B) will be lower than f
    (C) will be higher than f
    (D) cannot be determined without knowing the
        density of the more massive string
    (E) cannot be determined without knowing the
        densities of both strings

Questions 12-13 refer to the information below.

A scientist randomly selects a bass, viola, and violin used in a typical symphony orchestra. For each individual instrument, she measures the average frequency of its strings and the average wave speed of its strings.

12. Which of the following correctly ranks, from least to greatest, the average frequency f on strings of the three instruments?

	Least				Greatest
(A)	f_{viola}	$<$	f_{violin}	$<$	f_{bass}
(B)	f_{violin}	$<$	f_{bass}	$<$	f_{viola}
(C)	f_{bass}	$<$	f_{viola}	$<$	f_{violin}
(D)	f_{bass}	$<$	f_{violin}	$<$	f_{viola}
(E)	Additional information is needed to determine the answer				

13. Which of the following correctly ranks, from least to greatest, the average wave speed $\bar{v}$ on strings of the three instruments?

	Least				Greatest
(A)	$\bar{v}_{viola}$	$<$	$\bar{v}_{violin}$	$<$	$\bar{v}_{bass}$
(B)	$\bar{v}_{violin}$	$<$	$\bar{v}_{bass}$	$<$	$\bar{v}_{viola}$
(C)	$\bar{v}_{bass}$	$<$	$\bar{v}_{viola}$	$<$	$\bar{v}_{violin}$
(D)	$\bar{v}_{bass}$	$<$	$\bar{v}_{violin}$	$<$	$\bar{v}_{viola}$
(E)	Additional information is needed to determine the answer				

14. What color of noise refers to randomly distributed frequencies of equal intensity?

    (A) Pink
    (B) Brownian
    (C) Red
    (D) Grey
    (E) White

15. Music may be considered as a form of mechanical energy in which work is performed on molecules of gas. A piano piece is initially played in $\frac{4}{4}$ time at ♩ = 60 (*largo*) and performs nonzero work W on the air. How much work is done on the air when the piece is played at ♩ = 120 (*allegretto*)?

(A) $\dfrac{W}{4}$

(B) $\dfrac{W}{\sqrt{2}}$

(C) $\dfrac{W}{2}$

(D) W

(E) $2W$

16. Which of the following instruments has the properties of an open pipe?

(A) Bassoon
(B) Flute
(C) Clarinet
(D) Bell
(E) Oboe

17. A keyboard instrument where strings are plucked and later damped best describes a

(A) piano
(B) psaltery
(C) mandolin
(D) clavichord
(E) harpsichord

18. In musical notation, ⌢ refers to which of the following?

(A) *fermata*
(B) dotted note
(C) slur
(D) *stacato*
(E) tie

Questions 19-22 refer to classes of the Hornbostel Sachs system listed in the answer choices below.

(A) Aerophones
(B) Chordophones
(C) Electrophones
(D) Idiophones
(E) Membranophones

19. Which class includes harmonicas?

20. Which class includes the Moog?

21. Which class is generally associated with string instruments?

22. An instrument that produces sound from bulges on the instrument's surface when stroked with the fingers would best fit which class?

23. What note is shown above?

(A) D_2
(B) E_2
(C) C_3
(D) D_3
(E) E_3

24. What does the tiny 8 thingy at the bottom of the clef indicate?

(A) It raises notes by an octave
(B) It lowers notes by an octave
(C) It is a shorthand for $\frac{6}{8}$ time
(D) It is a shorthand for eight-tone equal temperament
(E) It indicates that eighth notes should be swing eighths

4

25. What is the first note in fixed-*do* solfège?

   (A) *la*
   (B) *ti*
   (C) *re*
   (D) *mi*
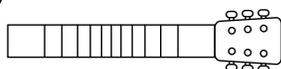   (E) *do*

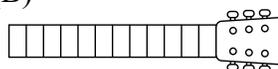26. Which of the following chord symbols would correctly represent the chord shown?

   (A) E
   (B) E_4^6
   (C) Em
   (D) E°
   (E) E^{sus2}

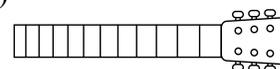27. Which of the following most accurately depicts a portion of the patterns of frets on a modern guitar?
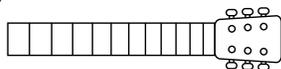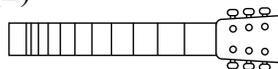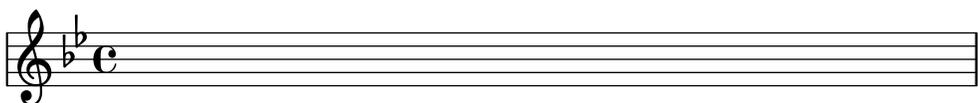
(A)

(B)

(C)

(D)

(E)

Short answer

A response with just one word or phrase is acceptable for most of these questions; no questions need more than a sentence for you to answer for full credit.

28. The speed of a wave is 300. m/s and the wave length is 40.0 m. What is the frequency of the wave?

29. Transverse waves are sent along a string at 4.00×10^2 m/s. The wavelength is 7.00 m. If an observer stands beside the string, how much time will it take for one complete cycle of the wave to pass the observer?

30. The British English musical term *minim* refers to what equivalent musical term in American English?

31. Write the time signature commonly known as *cut time*.

32. Neither the snare drum nor the bass drum have definite pitch. However, to the human ear, the snare drum sounds unquestionably higher pitched than the bass drum. Why does this occur?

33. Perfect pitch is the ability to accurately identify any pitch. However, professional scientists typically do not use the term "perfect pitch." What synonym of perfect pitch do they use instead?

34. A dog whistle is a whistle that produces a frequency so high, that dogs can hear a sound but humans cannot. Identify one way in which the sound produced by a dog whistle may be harmful to humans.

35. What are the notes in a V^7 chord in the key of E?

36. (Tiebreaker) List as many expressions as you can with the meaning of "somebody who plays flute."

37. Transpose the staff labeled with ($*$) into the key of B♭. Write your answers on the blank staff labeled with ($**$). (12 points)