Instructions (shown before students start the test)

Sounds of Music

Per Texas Science Olympiad rules, you must have printed notes for this event. If you are communicating with your partner through a voice or video call, please start it before you begin the test itself.

Significant time spent outside of the browser window is grounds for a penalty or disqualification per TSO policies.

Introduction (shown after students start the test)

This exam is 65 questions with 20 T/F, 30 MC (4 of them are actually brief short answers), and 15 Free Response questions.

Note: Unless there is information in the question that allows you to determine what the speed of sound for that particular scenario is, you may assume that it is 343 m/s.

Good luck!

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1. (1.00 pts) The tuba is classified as an aerophone under Hornbostel–Sachs classification system.

○ True ○ False

2. (1.00 pts) Sound waves are longitudinal waves.

○ True ○ False

3. (1.00 pts) A theremin is a type of aerophone.

○ True ○ False

4. (1.00 pts) Allegro describes a tempo which is faster than presto.

○ True ○ False

5. (1.00 pts) Treble, Bass, Alto, and Tenor are all types of clefs.

○ True ○ False

6. (1.00 pts) The bassoon and oboe are two instruments which use double reeds.

○ True ○ False

7. (1.00 pts) Superposition can occur between two waves traveling on different mediums at the same time.

○ True ○ False

8. (1.00 pts) Clarinets and Saxophones are both conical bore instruments.

○ True ○ False

9. (1.00 pts) Sound waves can travel in a vacuum.

○ True ○ False

10. (1.00 pts) C and D are enharmonic equivalent.

○ True ○ False

11. (1.00 pts) A pentatonic scale has 6 distinct notes.

○ True ○ False

12. (1.00 pts) Compound intervals are intervals that are higher than a perfect octave.

○ True ○ False

13. (1.00 pts) A D Lydian mode scale has different notes than a D major scale.

○ True ○ False

14. (1.00 pts) The pythagorean perfect fourth has a different frequency ratio than a just perfect fourth.

○ True ○ False

15. (1.00 pts) A5 is double the frequency of A4 regardless of tuning style.

○ True ○ False

16. (1.00 pts) Owls can hear higher frequencies than humans.

○ True ○ False

17. (1.00 pts) Rayleigh waves and love waves are types of surface waves.

○ True ○ False

18. (1.00 pts) The difference between the crest and the trough of a wave is called its amplitude.

○ True ○ False

19. (1.00 pts) Diffraction is the bending of white light into different colors in a prism due to the different frequencies.

○ True ○ False

20. (1.00 pts) The fundamental and first overtone refer to the same frequency.

○ True ○ False

21. (2.00 pts) What are the common tones between G sharp major and F minor?

○ A) C Db Eb Fb G A

○ B) Cb Db Eb

C) C Db Ab Bb
D) C Db Fb Ab Bb
E) C Db Eb F G Ab Bb

22. (2.00 pts) Which major scale has the highest number of accidentals?

A) C
B) C#
C) Db
D) F#
E) Ab

23. (2.00 pts) Which mnemonic can be used to determine the order of flats in a major key signature?

A) Brawl ends and down goes chuck fedrick
B) Big elephant gets apple down fire car
C) Eddie's bar got five angry drunk cats
D) Birds eat fat cats down grand alley
E) Blanket explodes and cold feet get damp

24. (2.00 pts) What is the order of whole tones between notes in a major scale?

A) 1, 0.5, 1, 1, 0.5, 1, 1
B) 0.5, 1, 1, 1, 0.5, 1, 1
C) 1, 1, 0.5, 1, 1, 1, 0.5
D) 1, 1, 1, 0.5, 1, 1, 0.5
E) 0.5, 1, 1, 0.5, 1, 1, 1

25. (2.00 pts) What is the order of whole tones between notes in a minor scale?

A) 1, 0.5, 1, 1, 0.5, 1, 1
B) 0.5, 1, 1, 1, 0.5, 1, 1
C) 1, 1, 0.5, 1, 1, 1, 0.5
D) 1, 1, 1, 0.5, 1, 1, 0.5
E) 0.5, 1, 1, 0.5, 1, 1, 1

26. (2.00 pts) What is the interval between Eb3 and D4?

A) M6
B) M7
C) m6
D) m7
E) A6

27. (2.00 pts) What is the interval between A5 and D7?

A) M9
B) P10
C) A10
D) D10

E) P11

28. (2.00 pts) Which of the following time signatures are compound time? (select all that apply)

(Mark **ALL** correct answers)

- [ ] A) 2 4
- [ ] B) 4 4
- [ ] C) 6 8
- [ ] D) 3 4
- [ ] E) 9 8

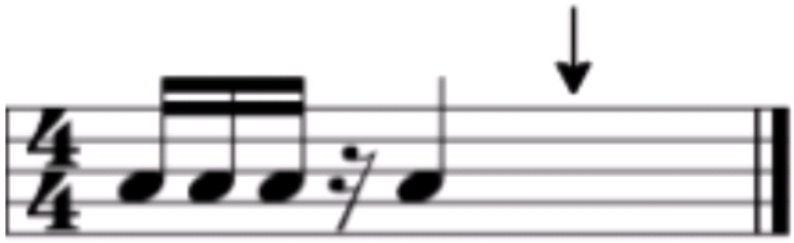
29. (2.00 pts) A note is played for 2X beats. If the same note is now double dotted, what is its new rhythmic value?

- A) 2.5X
- B) 3X
- C) 3.5X
- D) 4X
- E) 5X

30. (2.00 pts) Which interval is an example of dissonance?

- A) M3
- B) P5
- C) M6
- D) M7
- E) Octave

31. (2.00 pts) What note can be used to finish the measure?



- A) Eighth note
- B) Quarter note
- C) Half note
- D) Dotted quarter note
- E) Dotted half note

32. (2.00 pts) Why is treble sometimes referred to as G clef?

33. (2.00 pts) How many just major 3rds are in a just major 6th?

34. (2.00 pts) How many whole tones is G4 above E#2?

35. (2.00 pts) What notes are in a Gm triad in the 1st inversion?

36. (2.00 pts) A tube closed at one end has a length of 0.8 meters. What are the frequencies of its second and third overtones?

- A) 343 Hz, 572 Hz
- B) 457 Hz, 686 Hz
- C) 343 Hz, 457 Hz
- D) 229 Hz, 343 Hz
- E) 114 Hz, 229 Hz

37. (2.00 pts) The function y(x,t) = Asin(kx - wt) can be used to describe the motion of a wave. What does the variable “k” typically represent?

- A) Amplitude
- B) Period
- C) Wave Number
- D) Angular Frequency
- E) Wavelength

38. (2.00 pts)
A student realizes that if she blows in an empty water jug, it produces a sound. She measures the diameter of the neck of the jug to be 5 cm, and the neck length to be 10 cm. She also determines that the volume of the body of the jug is 0.02 cubic meters. What is the resonant frequency of the water jug?

- A) 17 Hz
- B) 54 Hz
- C) 108 Hz
- D) 273 Hz
- E) 410 Hz

39. (2.00 pts)
Part of what allows an airplane to fly is the varying velocities of air and pressures above and below the wings of the plae. Please select the correct choice that accurately describes how the pressure and velocity of air vary for the top side of the wing with respect to the bottom side.

- A) Lower Pressure, Higher Velocity of Air
- B) Lower Pressure, Lower Speed of Air
- C) Higher Pressure, Higher Velocity of Air
- D) Higher Pressure, Lower Speed of Air

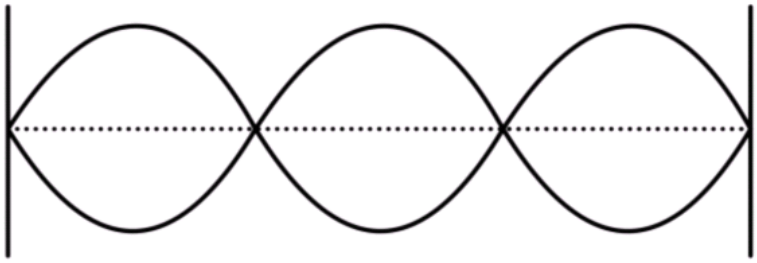
40. (2.00 pts)
A student cuts an open-ended pipe with a radius of 3 cm to a length of 1 meter in order to achieve a certain pitch. However, the note is slightly lower than the ideal pitch. He determines that he is unlucky and the wave actually began before the opening of the pipe. What is the length of the end correction that can be added to the length of the pipe to determine the real pitch of the pipe?

- A) 0.9 cm
- B) 1.5 cm
- C) 1.8 cm
- D) 2.1 cm
- E) 3.6 cm

41. (2.00 pts)
A Rockstar is trying out the speakers for her upcoming concert. While she is standing 20 ft away from the speaker, she approximates that the speaker is playing at 100 dB. What would this intensity be in watts per square meter?

- A) 1*10^-2 W/m^2
- B) 1*10^-3 W/m^2
- C) 1*10^-4 W/m^2
- D) 1*10^-5 W/m^2
- E) 1*10^-6 W/m^2

Questions 42 and 43 pertain to the following image:



42. (2.00 pts) How many nodes and antinodes are there in the standing wave shown above?

- A) 3 Nodes, 3 Antinodes
- B) 3 Nodes, 4 Antinodes
- C) 4 Nodes, 3 Antinodes
- D) 4 Nodes, 4 Antinodes

43. (2.00 pts) Which overtone is shown by the standing wave shown above?

- A) 1st Overtone
- B) 2nd Overtone
- C) 3rd Overtone
- D) 4th Overtone

44. (2.00 pts)
Water is in a pipe traveling from point A to point B. At point A, the radius of the pipe is 3 cm, and the speed of the water is 20 m/s. As the water travels to point B, the radius gradually increases to a length of 8 cm at point B. What is the speed of the water in the pipe at point B?

- A) 2.8 m/s

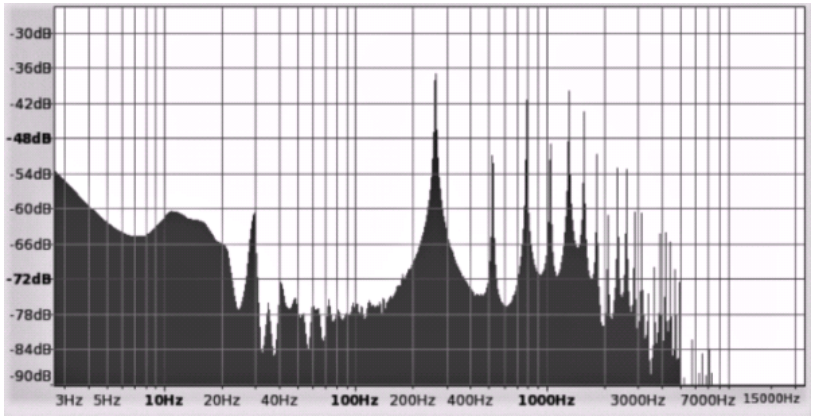
B) 7.5 m/s

C) 20 m/s

D) 53 m/s

E) 142 m/s

45. (2.00 pts) The Fourier spectrum of a note being played by an oboe is shown below. What note is the oboe playing?



A) C1

B) C4

C) C5

D) G5

E) C6

46. (2.00 pts)
Trumpets are closed tube instruments, meaning that they only can play odd harmonics, however it is very desirable for players to be able to play all harmonics. Which part of the trumpet allows for higher resonance frequencies to be pushed down to a lower frequency?

A) Mouthpiece

B) Bell

C) First valve slide

D) Third valve slide

E) None of the above

47. (2.00 pts)
Scientists have decided to use a new material called Bryanium to make balls since balls made out of this material only have their volume reduced by 10% when subjected to uniform stress of 20,000 N/m2. What is the bulk modulus of Bryanium?

A) 2.0 * 10^2 N/m^2

B) 2.0 * 10^3 N/m^2

C) 2.0 * 10^4 N/m^2

D) 2.0 * 10^5 N/m^2

E) 2.0 * 10^6 N/m^2

48. (2.00 pts) Through which of the following mediums does sound travel the fastest?

A) Carbon Dioxide

B) Air

C) Water

D) Lead

E) Steel

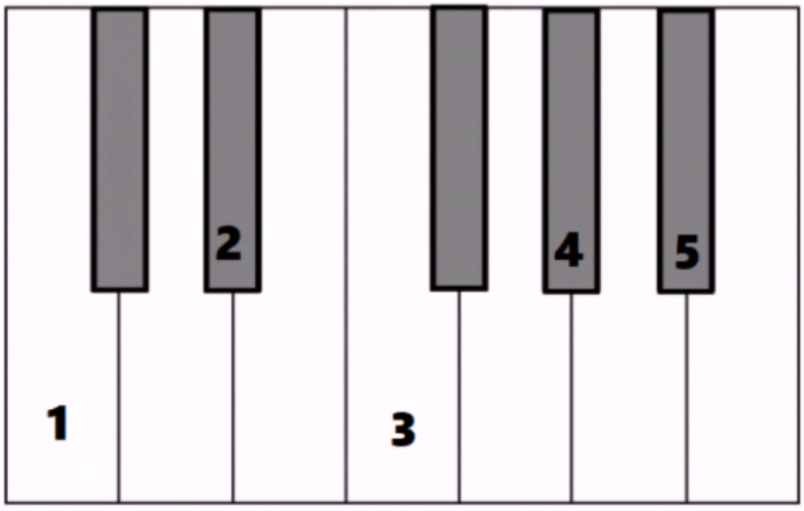
49. (2.00 pts) Which of the following terms refers to the reduction of an item's density?

- A) Compression
- B) Rarefaction
- C) Diffraction
- D) Refraction
- E) Reflection

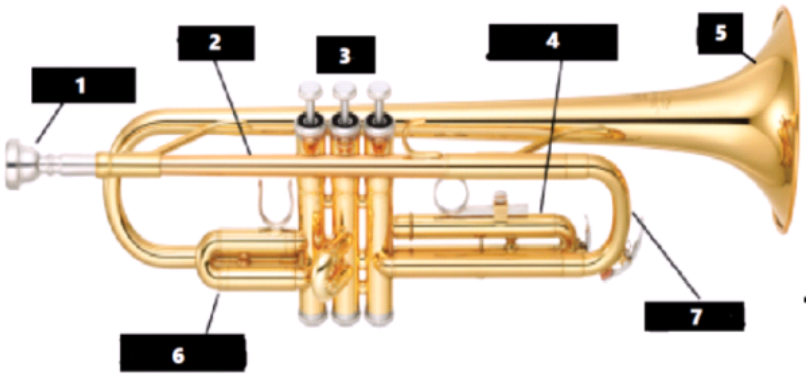
50. (2.00 pts) According to the Laplace correction for the velocity of sound, propagation of sound takes place through an _____ process.

- A) isothermal
- B) adiabatic
- C) isometric
- D) isochoric

51. (3.00 pts) Label the following notes:



52. (4.00 pts) Label the following diagram:



53. (6.00 pts)
The baritone horn and the trumpet are two similar yet very different instruments. Answer the following questions about the two instruments.

a) Which clefs do each of these instruments typically read off of?

b) Most wind instruments tend to have either cylindrical or conical bores. Which do trumpets have and which do baritone horns have?

c) Both trumpets and baritone horns have 3 valves. Which valves do you have to press on the trumpet to play C4? Which valves do you have to press on the baritone horn to play C4?

54. (4.00 pts) You are playing the violin in a room where the temperature is 21 °C. If you hear an echo in 0.789 s, how far away are you from the reflecting surface?

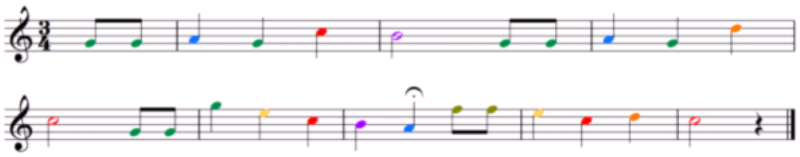
55. (6.00 pts)
A tuning fork of frequency 300 Hz is activated and sends a sound wave toward a classroom wall, and the echo is detected at the location of the tuning fork 0.06 s later.

(a) Determine the wavelength of the sound wave.

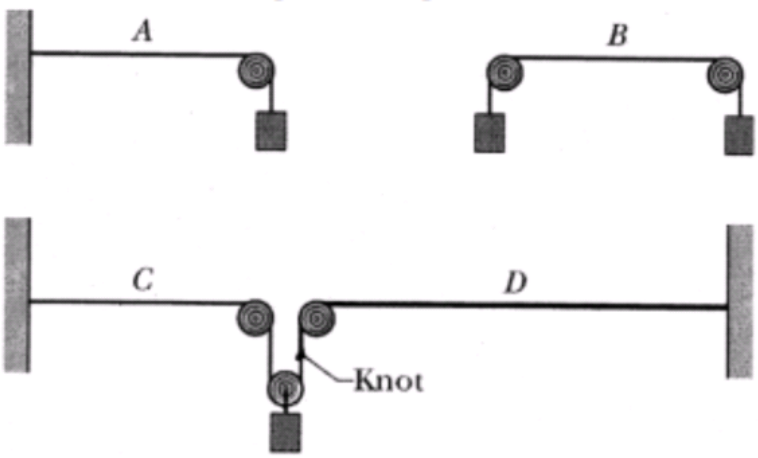
(b) Determine the distance from the tuning fork to the wall

56. (4.00 pts)
You are making a musical instrument with glass bottles filled with water. To make a sound you blow across the opening of the bottles and while tuning one of the bottles you notice that it is slightly sharp. Do you add or remove water to get it in tune? Explain your answer.

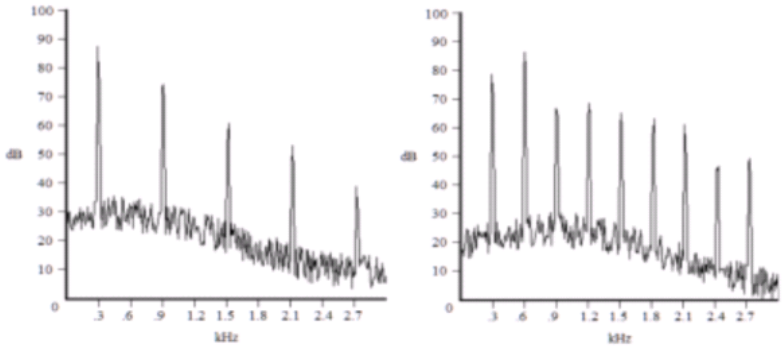
57. (5.00 pts) What is the name of the popular song shown by the sheet music below?



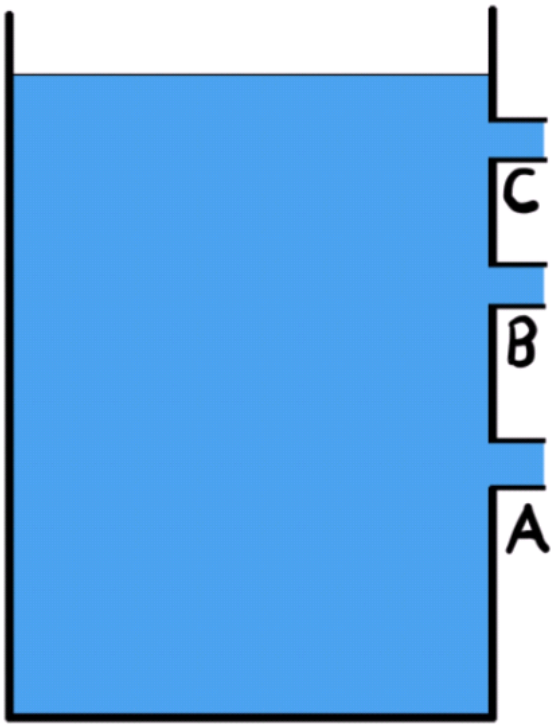
58. (4.00 pts)
Four Strings (A,B,C, and D) are held under tension by equally weighted blocks. Strings A,B, and C are made of the same material but string D is thicker than the rest. What is true about the speed that waves will have when sent along the string? Express you answer as an inequality string (ex: A < B < C = D)



59. (6.00 pts)
A Fast Fourier transform is an algorithm that can convert sound signals to a representation of its frequency. The FFT of 2 instruments are shown to the right as they both play the same note(300 Hz). What is the difference between the 2 instruments with respect to their physical design?



60. (5.00 pts)
Robert wants to spray his friend with water from a cup (he's a physicist he can't just use a water gun). Since he is a trickster, he wants the water to hit his friend with maximum speed, for the full effect. He determines that the only spots on the cup thin enough to poke a whole in them are labeled A, B, and C. Which point should Robert use if he wants the water to hit his friend with maximum speed? Explain your answer using physics concepts.



61. (5.00 pts)
Richard is trying to tune his guitar with his friend Elizabeth. When Richard plays the G string, it plays the note perfectly on pitch. However, when Elizabeth plays the G string, they hear a beat frequency of 4 Hz, and notice that Emma's pitch sounds a bit too sharp. If their guitars are 1 m long, and the linear density of the strings are 7.20 g/m, how much should the tension in the G string of Emma's guitar change by in order for the two guitars to be in tune with each other?

62. (6.00 pts)
Luther is a music teacher at Austin Elementary School. He wants to make a pan flute for one of his students, but he is missing three of the pipes. The missing pipes should play the notes D4, F4, and G4 on a day with normal temperature. He has excess pipe that he can cut to make the remaining pipes. What should the respective lengths of these pipes be for him to complete his pan flute? (Assume speed of sound is 343 m/s)

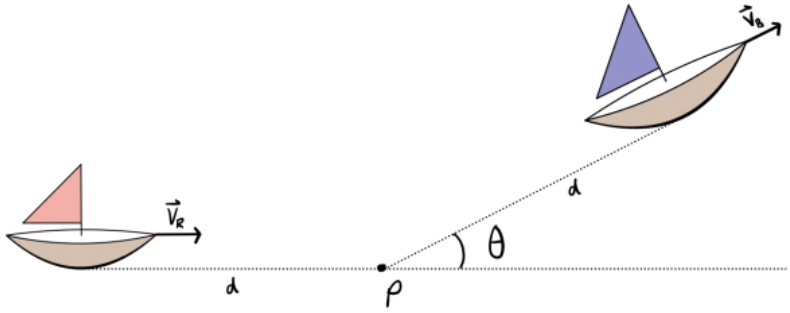
Questions 63 and 64 pertain to the following image:

63. (4.00 pts) On a chilly 10°C day, two boats Red and Blue are racing each other. The blue boat releases a honking victory sound which has a frequency of 420 Hz.

What is the speed of sound on such a day?

64. (5.00 pts)
Using your answer from question 51, if the velocity of the red boat is 35 m/s and the velocity of the blue boat is 45 m/s while they are a distance D apart, what is the frequency of the honking sound that the red boat hears from the blue boat? (Round to tenth place)

65. (8.00 pts)
After winning the blue boat now goes off at an angle θ away from the point P to go home. The red boat honks its horn at the blue boat as a way of saying goodbye. If the magnitude of velocities of the boats are the same as they were in question 52, and θ = 30°, what frequency will the blue boat hear from the red boat when they are both a distance d away from point P, and the frequency of the horn emitted from the red boat is 500 Hz? (Use the speed of sound from question 51 in your solving of the problem) (Round to nearest tenth)



We hope you enjoyed this exam! If you have any feedback about any of the exams at this tournament, please let us know through this form: https://tinyurl.com/utreg21feedback (https://tinyurl.com/utreg21feedback)