C - Sounds of Music C 2020-2021 - BEARSO - 10-24-2020

October 10th, 2020

Hello! This is Sounds of Music. You'll have 50 minutes to complete the test.

You are strictly prohibited from using the internet. Please make this a fair test for everyone! Don't be that guy who cheats :((

You may only resort to your notes and your partner. Feel free to use scratch paper and stand-alone calculators of any type.

You won't lose points for wrong/unanswered questions so I highly recommend dividing the workload and trying both of your best!

Good luck and have fun! :)

Here is an image of a keyboard for your convenience:

PART 1: Fill in the blank/multiple choice

Name the class of each instrument based on how their sound is produced (e.g. idiophone). Be careful: if answers are misspelled, they will be marked incorrect by the autograder. Capitalization doesn't matter.

1. (1.00 pts) Piano

chordophone

2. (1.00 pts) Timpani

Membranophone

3. (1.00 pts) Accordion

Aerophone

4. (1.00 pts) Kazoo

Membranophone

5. (1.00 pts) Sitar

Chordophone

6. (1.00 pts) Theremin

Electrophone

7. (1.00 pts) An equal-tempered scale must have:

- A) equal distances in frequency between adjacent notes
- B) equal frequency ratios between adjacent pairs of notes
- C) equal distances in amplitude between adjacent notes
- D) equal amplitude ratios between adjacent pairs of notes

8. (1.00 pts) A musician blows harder into the mouthpiece of a clarinet. Which of the following increases?

- A) Wavelength
- B) Timbre
- C) Velocity
- D) Amplitude

9. (1.00 pts) Select the medium in which sound would travel the quickest:

- A) Dry air at 32°Celsius
- B) A solid with a density of 7870 g/cm³ and elastic modulus of 1144 GPa
- C) A stretched string with a linear density of 60 g/cm³ and tensional force 315N
- D) A liquid with a density of 997 kg/m³ and a bulk modulus of 225 GPa
- E) Both B and C
- F) Both C and D

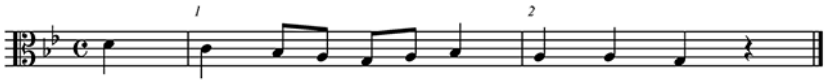
10. (1.00 pts) Name the mode given these notes of a scale: F, G♭, A♭, B♭, C, D♭, E♭, F

A) Mixolydian
B) Aeolian
C) Locrian
D) Dorian
E) Phrygian

11. (2.00 pts) There are _____ cents in a semitone and _____ cents in a centitone.

100 | 2

12. (2.00 pts)



Based on the fixed-do solfege system, select the correct ordering of syllables based on the above melody:

A) sol-fa-mi-re-do-re-mi-re-re-do
B) mi-re-do-ti-la-ti-do-ti-ti-la
C) do-ti-la-sol-fa-sol-la-sol-sol-fa
D) re-do-ti-la-sol-la-ti-la-la-sol
E) fa-mi-re-do-ti-do-re-do-do-ti

13. (1.00 pts) Select the instrument that is not a B♭-tuned instrument:

A) Bass Clarinet
B) Tenor Saxophone
C) Trombone
D) Euphonium
E) Alto Saxophone

14. (1.00 pts) Which of the following is NOT a Helmholtz resonator?

A) The body of a guitar
B) A conch shell
C) An empty bottle
D) Two-stroke engines
E) A funnel

15. (2.00 pts)
Let's say you tune a keyboard using standard Pythagorean tuning, using only perfect fifths and octaves, and F♯ is fixed to 375 Hz. What is the frequency of B above this F♯?

A) 450.9 Hz
B) 461.9 Hz
C) 474.6 Hz
D) 500.0 Hz
E) 506.8 Hz

16. (1.00 pts)
What's the leading tone/note of a C♯ harmonic minor scale? Specify any accidentals or naturals in your answer (e.g. if your answer is just E, type E natural. If it's B♭, type B flat).

B sharp

17. (1.00 pts)
Given an ideal gas with sound speed *x*, say the speed of sound in this gas becomes 5% greater. Does the average kinetic energy of its molecules increase or decrease? And by how much?

- A) Increases by 5%
- B) Increases by 10%
- C) Increases by 25%
- D) Decreases by 5%
- E) Decreases by 10%
- F) Decreases by 25%

18. (1.00 pts)
A source of sound moves at 280 m/s while an observer moves at −169 m/s. Both start from the origin and move along the same axis. Given the source emits frequency *f*, the observer hears a frequency of

- A) $\frac{343+169}{343+280}f$
- B) $\frac{343-169}{343-280}f$
- C) $\frac{343-169}{343+280}f$
- D) $\frac{343-169}{343-280}f$

19. (1.00 pts) How many pressure antinodes exist in the fundamental frequency of an open pipe?

- A) 0
- B) 1
- C) 2
- D) 3
- E) Cannot be determined

20. (2.00 pts) Name the notes needed to create a diminished 7th triad on A♭.

Expected Answer: Full 2 points if they have A♭, C♭, E♭♭, G♭♭ (♭ can be written out as flat) OR A♭, C♭, E♭♭ since "triad" was included in the question, creating confusion on whether to provide 3 or 4 notes. 1 point ONLY if at least one of the following occur: B (or B natural) is used instead of C♭ D (or D natural) instead of E♭♭ F instead of G♭♭

21. (1.00 pts) The speed of sound *v* in a medium depends on a formula $v = B(\lambda^2)$ where *B* is a constant in units of 1/(m·s) and λ is the wavelength. This medium must

- A) Be a refractive medium

B) Be a reflective medium

C) Be a dispersive medium

D) Disobey Snell's Law when λ is approximately zero

E) Experience chromatic aberration

22. (1.00 pts)
400 simultaneous trumpets produce a sound intensity level of 78 dB according to an observer. How many people would need to play at once for the observer to record a sound intensity level of 68dB?

A) 10

B) 40

C) 98

D) 205

E) 349

23. (1.00 pts)
Imagine you're playing Darude Sandstorm on the piano in common time at 70 BPM, work W on the air. If we wanted half of the work to be performed $W / 2$, around what BPM should you play at and why?

A) 35 BPM, because a slower tempo doubles the length of the waves and decreases frequency by half

B) 35 BPM, because slowing the tempo by half reduces the work by half; the values are proportional.

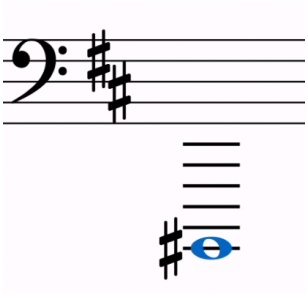
C) 53 BPM, because the tempo scales by three-quarters for every half the amount of work is reduced.

D) Same tempo, because work is independent of tempo.

E) 140 BPM, because doubling the tempo reduces the work by half

F) 140 BPM, because doubling the tempo doubles the relative frequency.

24. (1.00 pts)



What note is this?

A) $B\#_0$

B) $B\#_1$

C) $C\#_0$

D) $C\#_1$

E) $C\#_2$

F) $D\#_1$

25. (1.00 pts) Which of the following terms refer only to an increase in tempo?

- A) *allegretto*
- B) *celeriter*
- C) *vivace*
- D) *accelerando*
- E) *subito*
- F) *presto*

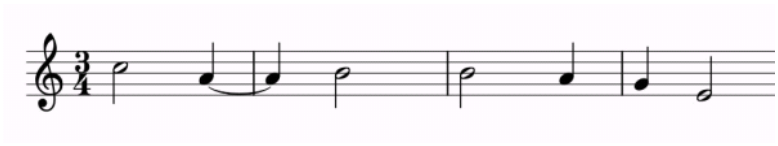
26. (1.00 pts)
In a _____ wave, the particles of the medium are vibrating in the same direction as energy transport while in a _____ wave, they are vibrating at right angles to the direction of energy transport. (Spelling matters)

longitudinal | transverse

27. (1.00 pts) For an open pipe of length L, what is the angular frequency of the second harmonic with displacement amplitude x?

- A) $2\pi x / (Lv)$
- B) $2\pi v / L$
- C) $Lv / (2\pi)$
- D) $2\pi vL$
- E) $2Lv / \pi$

28. (1.00 pts)



~~What vegetable am I thinking of?~~

Which of the following terms best describes what occurs in the melody above?

- A) arpeggio
- B) imitation
- C) tenuto
- D) ostinato
- E) hemiola

PART 2: Short Answer Responses

(These will be manually graded so don't worry about formatting or styling errors)

Here's the same image of the keyboard for your convenience:

29. (2.00 pts) Type out the notes of the relative major scale of G♯ minor in order, including accidentals!

Expected Answer: B, C#, D#, E, F#, G#, A#, B

30. (2.00 pts) Type out the notes of the parallel minor scale of F♯ major in order, including accidentals.

Expected Answer: F#, G#, A, B, C#, D, E, F#

31. (3.00 pts) How does the tone color and loudness of a flute vary if the player blows faster air as opposed to slower air?

Expected Answer: (1 points) At slower air/ low pressure, the sound waves are closer to pure sinusoidal with weak harmonics and a strong fundamental. Sound is like a pure fundamental, but weaker, with less resonance. (Reed also has less resonance, just as an aside) (1 points) At higher pressure, sound waves contain stronger harmonics. Sound is more full, timbre improves, and sound amplifies. 1 point if both are correct, or give partial based on explanation

32. (2.00 pts) On a piano, why do we generally use longer strings on the bass notes, while higher registers have multiple strings to compensate?

Expected Answer: (1 point) Longer strings on the bass notes reduces stiffness and allows fundamentals on the bass note to be more in tune, allows each chord to be grounded more and easier to hear (1 point) Thin strings are weaker, so they need to have more strings to reduce pressure The smaller strings are de-tuned in order to increase nonlinearity and cause more color on the top notes.

33. (1.00 pts)
An observer at a distance of r from a sound source hears an intensity level of 45 dB. What is the intensity level when the observer is at a distance of $r/3$ from the source?

Expected Answer: Accept any answer around 54.54 dB.

34. (2.00 pts) Describe the difference between tremolo and vibrato.

Expected Answer: Tremolo has two definitions, either of which would be accepted for one point: fluctuations in the loudness of a note, or rapid alternations between a series of distinct notes. Another point is earned for comparing the definition to that of vibrato, which is fluctuations in the pitch of a single note

35. (1.00 pts)
A pure tone has pressure amplitude *p*. What is the pressure amplitude, in terms of *p*, of another pure tone that is one octave higher and has three times the displacement amplitude?

Expected Answer: 6 or 6p

36. (3.00 pts) (Tiebreaker) Write the frequency ratios (e.g. 8/6) of the following intervals in Pythagorean tuning:

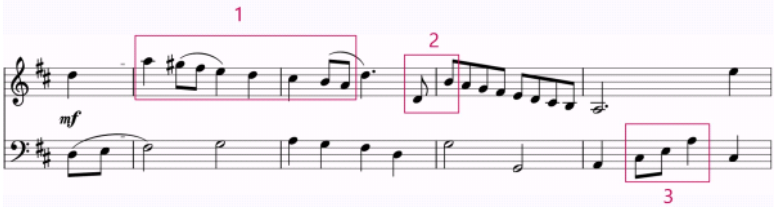
Major Second

Perfect Fourth

Major Seventh

9/8 | 4/3 | 243/128

The following questions **(37 - 41)** are based on the excerpt below:



37. (1.00 pts) What key is this piece in?

D Major

38. (1.00 pts) Since no time signature is provided, determine what the time signature should be:

- A) 2/4
- B) 6/8

- (●) C) 4/4
- ( ) D) 12/8
- ( ) E) 3/4

39. (1.00 pts) Name the scale in **section 1** and its quality (e.g. C Major)

A Major

40. (1.00 pts) Which of the following is the correct name of the interval in **section 2**?

- ( ) A) Perfect 5th
- ( ) B) Augmented 5th
- ( ) C) Minor 6th
- (●) D) Major 6th
- ( ) E) Diminished 7th

41. (1.00 pts) Which scale degree does the triad at **section 3** classify as?

- ( ) A) Supertonic
- (●) B) Dominant
- ( ) C) Mediant
- ( ) D) Submediant
- ( ) E) Subdominant

The following questions no longer relate to the above excerpt.

42. (1.00 pts) A thin rod has shear modulus 4.4×10^{10} Pa, and bulk modulus 1.30×10^{11} Pa. The rod has a density of 8.96×10^{4} kg/m^3 . What is the speed of sound in the material?

Expected Answer: Answer: 1.15×10^3 m/s (the answer is not 1.20×10^3 m/s, which comes from the bulk modulus instead of Young's modulus)

43. (1.00 pts) The speed of a wave is 390 m/s and the wavelength is 60.0m. What is the frequency of the wave?

Expected Answer: 390/60 or 6.5 Hz.

44. (1.00 pts) (Tiebreaker) Name the best vegetable that can be used as an instrument and why. (This is a last resort tiebreaker, don't stress or spend too much time on this haha).

Expected Answer:

Part III: Free Response

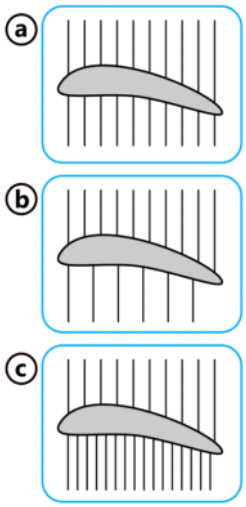
45. (2.00 pts) How do different fingerings change the pitch of a trumpet?

Expected Answer: fingerings on a trumpet change pitch by changing the length of the air column/swapping one pipe for another pipe (2 points).

46. (3.00 pts)
A scientist intends to generate a pitch of frequency *f* with a pitch-generating smartphone app. However, the frequency of the generated pitch has an average error of 10 Hz from the intended frequency. If *f* is increased, will it be easier, harder, or the same for a human listener to notice the error? Explain your response.

Expected Answer: 1 point is awarded for stating that it will be harder to discern the error. 2 points are awarded for a correct justification. Correct justifications include (1) because humans detect pitch based on ratios/humans detect pitch logarithmically, the ratio of 10 Hz to the true note will be smaller (2) any justification that considers what would happen if f decreased, and reasons that the opposite must happen if f increased (3) a justification that considers extreme cases; for example, if f were as small as 20 Hz, then an error of 10 Hz would be a 50% error (or a perfect fifth of error), which is very noticeable, so increasing f would decrease how easily the person could notice it.

47. (3.00 pts)
An airplane flies directly towards a very distant sound source. Which of the three diagrams below best illustrates the sound waves passing by the wings of the airplane? Justify your answer. The diagrams are illustrated so that the plane is flying to the left of the screen. Ignore any sound generated by the movement of the plane itself.



Expected Answer: 1 point is awarded for correctly answering choice C. 2 points are awarded for a correct justification: the air is moving faster above the wing. Note: teams CANNOT get full credit for stating "Bernoulli's principle" without further justification. Remark: It is a common naive belief (perpetuated even by physics books) that air takes equal amounts of time to travel both the top and bottom of the wings, and because the top of the wing is longer, the airspeed is faster at the top. Although it leads to the right answer, this justification is wrong. It's true that by Bernoulli's principle, the pressure at the bottom of the wing is higher than at the top (that's how the plane flies), but that doesn't mean that the air travels both

the top and the bottom in the same time. Perhaps surprisingly, if you knew nothing about airplanes and used only sounds of music knowledge, you'd be likely to avoid this belief (although the answer would be the same anyways).

48. (4.00 pts) Why does end correction occur? Why is end correction dependent on pipe radius?

Expected Answer: Here, a slash represents two equally valid responses; for instance, for the first point, students do not need to write both pressure and impedance, but only one of them for full credit. a) 1 point is awarded for stating the pressure/impedance inside a pipe is slightly different from the pressure/impedance outside the pipe. b) 1 point for stating that pipe resonances/harmonics/frequencies/modes/standing waves occur due to reflection when pressure/impedance change (students must mention all 3 parts, resonances, reflection, & pressure to earn this point). c) 1 point for stating that the greater the radius of the pipe, the more gradual the transition of pressure/impedance. d) If parts (a) through (c) are all correct, then award 1 additional point. This is because it is extremely difficult to write an objective rubric for how students can synthesize parts (a)-(c) to fully answer the questions, but we assume they have that knowledge if they can answer all three parts correctly.

49. (2.00 pts)
In a concert flute, the player blows against a sharp edge to produce sound. If the flute is not manufactured with a sufficiently sharp edge, the flute will be much softer or even inaudible. However, when you blow on a sharp piece of paper, you don't hear a flute-like sound. Explain this phenomenon.

Expected Answer: 1 point: the sharp edge accumulates energy/the air around the edge forms vortices/the air flows turbulently. 1 point: the edge must be coupled to a pipe/tube/air column for the energy to be used to play a note. Note that teams don't have to use this exact vocabulary to earn full credit; for example, for the latter point, "the tube steals energy from the edge tone" or "air in the tube and some of the air around the edge must vibrate together at the same frequency" or "the air around the edge sets the tube into resonance" would all be accepted for full credit.

50. (1.00 pts)
Helicopter A ascends to a height of 2000 m, and helicopter B ascends to a height of 1000 m. An observer C stands directly below both helicopters so that all three lie on a line. A point source of sound is attached to the outside of helicopter B. Will the sound reach helicopter A before, after, or at the same time as it reaches observer C?

- A) It reaches A first
- B) It reaches C first
- C) Reaches both at the same time
- D) There's not enough information to tell

51. (2.00 pts) Justify your answer.

Expected Answer: The speed of sound is much slower in colder air at higher altitudes (1 point). Therefore, it takes longer to reach the top helicopter (1 point).

52. (0.00 pts)
Following the above scenario, both pilots from each helicopter shut off the engine and parachute out simultaneously. Both helicopters start falling (no big deal), while the sound source on helicopter B continues playing the same frequency as before. According to an observer on the ground, which helicopter would have greater frequency?

Expected Answer: This question was not counted for points due to the confusing wording. It was supposed to be about the frequency encountered by A, not by C. 1 point for saying that both helicopters fall at the same rate/velocity/speed/acceleration. 1 point for saying that no relative motion means that the frequency doesn't change. (If students argue that helicopter B is falling slightly faster than helicopter A, they MUST mention that B is closer to Earth or is experiencing a greater gravitational force. Then, they must explain that helicopter B is getting farther away from A, so the frequency must decrease. However, they must have ALL parts of this explanation to earn both points; if they argue "frequency decreases" without this full justification, they cannot earn any points; it's all or nothing two points.)

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53. (0.00 pts)
(Worth zero points) Please let me know about any issues that came up or anything in general(e.g. lack of clarity/validity in a question, technical difficulties, your partner bailed :(, you're bored, how quarantine has been, would do the coffin dance etc.)

Expected Answer:

54. (0.00 pts) (Worth zero points) How difficult or easy was the test? What can be improved?

Expected Answer:

The end! Congrats on reaching the end of the test! :) Here is your reward:

and of course as a tribute to the lovely musical:

Good luck on any other events you might have! Stay safe and don't forget to wear a mask!!! >:(