

2021-2022 NC Coaches Institute

Sounds of Music – MIDDLE SCHOOL RULES

- 1) Make sure every student has a copy of all three pages of Sounds of Music rules. READ the rules. The pitch math is handled by a scoring spread sheet, so don't worry too much about that. Give them a copy of this handout. It is full of juicy tips. There is even a sample log at the bottom.
- 2) Each team will bring just 1 instrument. No electric, toy, or professional parts may be used, except strings. What about 3D parts? The rules have a new statement. You must provide the required documentation in the log.
Full instruments built on a 3D printer or other machine will NOT be accepted.
- 3) The instrument must initially fit 60.0cm x 60.0cm x 100cm dimensions, but may become larger during the 2 minute setup time. If your instrument is too big, and cannot be corrected, it is a Construction violation, and it CANNOT be scored at all. Credit will be given for only the written test. See Rule 6f.
- 4) Participants have 2 minutes to set up and check tuning, using their own tuner. No more adjustments are allowed after this 2 minute period.
- 5) One or both participants must be able to play an ascending 8 note scale. The first note must be between F2 and C5 inclusive. Please note that C5 is the highest legal first note. Students **MUST** know the octave number of the starting pitch in the chosen scale. If the instrument cannot play a full 8 note scale, participants must say which notes will be skipped. If the student cannot state these things (See Rule 5 Part II e. i.), it is a Competition violation, and pitch score is multiplied by .9 as per Scoring Rule 6e.
- 6) Pitch accuracy matters. Each note of the scale will be tested using the software program provided by Nationals. MUST use Chrome or Firefox. <https://pascioly.org/sounds>
Make sure you use this same pitch tester when building your instrument! You can use this link directly, or download the program to your computer.

Pitch accuracy target is ± 10 cents for Regionals, ± 7 cents for States, and ± 3 cents for Nationals.
- 7) The Song Score test will be conducted after the pitch testing. Judging covers rhythmic and pitch accuracy, and playing must be completed within 25 seconds. Students must be able to play the last 4 measures of Yankee Doodle within 25 seconds. This requires 7 consecutive notes, and means that you must build a 9th note. For example, if you build a C4 scale (C4, D4, E4, F4, G4, A4, B4, C5), you also need to build D5 in order to play Yankee Doodle. If you don't have this extra note, you will simply lose some of the Song Score points.
- 8) Participants will be informed of their pitch and song results.
- 9) A log describing the testing of one pitch must be submitted before competition day. **Do NOT miss these easy 10 points.** Show this data in any form (prose, charts, or lists). Data must show your iterations to tune a single note.
 - List of materials
 - Data comparing pitch accuracy to design (i.e. pitch vs. length of tube or string)
 - Must include at least 5 data points
 - Labeling - title, team name, units
 - Labeled picture showing how the device changes pitch (i.e. fingering chart)

For example, a stringed instrument is tuned by tightening/loosening or shortening/lengthening the string. A first attempt to tune to C3 was 45 cents too sharp. The string was loosened (or lengthened), retest was 25 cents too sharp. Third attempt was still 15 cents too sharp. Fourth attempt was 10 cents flat. So the string was tightened (or shortened) this time and then tested as 3 cents sharp. Show this kind of data in any format you like.

- 10) There will be a written test on the Physics of Sound. This is worth 45% of the score. Prepare a 3 ring binder containing anything you want based on the topics listed. This is an open book test! For each of the 5 topics in Part 5 of the rules, hand write out terms and vocabulary words with definitions. Include sample problems that you can find. You can have a perfect instrument and do poorly in this event unless you prepare for this test.
- 11) Scoring is mathematically complicated. An Excel scoresheet is posted at the national website. This spreadsheet will be used to record all data, to calculate pitch score, and to rank teams. <https://www.soinc.org/scoresheets> This link also has the same checklist that the judges will use at this link. You can practice scoring your own instrument using the pitch tester and enter the values into a copy of this spread sheet!

Total Score = Test Score + Log Score + Pitch Score + Song Score

Test Score	45
Log Score	10
Pitch Score	36
Song Score	15
<u>Song Score</u>	<u>5</u>
Best Total	100

12) Tips:

- Make the log. This is 10 easy points you can do before competition.
- You must understand the octave numbers of the notes.
- An instrument may be perfectly tuned, but if any note is outside of the allowed range, a zero score is given for that pitch.
- Use the pitch tester provided. MUST use Chrome or Firefox. <https://www.pascioly.org/sounds/>
- Review the Constructed Devices policy. Judges must be satisfied that the students did the work. Very professional looking devices will receive scrutiny. Document with pictures. <https://ncscienceolympiad.ncsu.edu/about-us/policies/constructed-devices/>
- When tuning, remember that there are 100 cents between every half step. For example, if you intend the note to be F3, and it is +100 cents when you test it, that note is actually F# and no credit will be given. If it is -100 cents, the note is actually E. Again no credit will be given.
- Feel free to contact me with questions: Trish Mullins dbarron1@nc.rr.com

References Books

Musical Instrument Design by Bart Hopkins

[The Physics of Music and Musical Instruments](#) by David R. Lapp

Links to important docs:

Pitch Tester: <https://pascioly.org/sounds>

Checklist: <https://www.soinc.org/scoresheets> (This is what judges use to record your scores)

Scoresheet: <https://www.soinc.org/scoresheets> (All scores are entered into this spread sheet to determine winner.)

Helpful Web Sites:

Vocabulary

<http://www.sarahtulga.com/Glossary.htm>

Physics of Sound and Instruments

https://www.soinc.org/sites/default/files/uploaded_files/2020_Sounds_of_Music_Links_0.pdf

<http://www.sarahtulga.com/>

<https://method-behind-the-music.com/mechanics/physics/>

<http://www.animations.physics.unsw.edu.au/waves-sound/oscillations/index.html>

<https://entertainment.howstuffworks.com/10-connections-physics-music.htm>

<https://www.physicsclassroom.com/class/sound>

<https://westmont.edu/academics/departments/physics/documents/PhysicsOfMusic.pdf> (text book)

<http://kellerphysics.com/acoustics/Lapp.pdf> (Excellent text book)

Videos:

<https://www.youtube.com/watch?v=b8lq8kB-VIY>

<https://www.youtube.com/watch?v=XDsk6tZX55g>

<https://www.youtube.com/watch?v=jM6ztb0pWNE>

The first note of the scale must be between F2 and C5 inclusive. Make sure that students know the octave number of each note they build. Their best possible pitch score depends on it!



↑
F2

↑
C5

FREQUENCIES OF THE 12-TONE EQUAL TEMPERED SCALE (Hz)

C ₀	16.352	C ₃	130.81	C ₆	1046.5
	17.324		138.59		1108.7
D ₀	18.354	D ₃	146.83	D ₆	1174.7
	19.445		155.56		1244.5
E ₀	20.602	E ₃	164.81	E ₆	1318.5
F ₀	21.827	F ₃	174.61	F ₆	1396.9
	23.125		185.00		1480.0
G ₀	24.500	G ₃	196.00	G ₆	1568.0
	25.957		207.65		1661.2
A ₀	27.500	A ₃	220.00	A ₆	1760.0
	29.135		233.08		1864.7
B ₀	30.868	B ₃	246.94	B ₆	1975.5
C ₁	32.703	C ₄	261.63	C ₇	2093.0
	34.648		277.18		2217.5
D ₁	36.708	D ₄	293.66	D ₇	2349.3
	38.891		311.13		2489.0
E ₁	41.203	E ₄	329.63	E ₇	2637.0
F ₁	43.654	F ₄	349.23	F ₇	2793.8
	46.249		369.99		2960.0
G ₁	48.999	G ₄	392.00	G ₇	3136.0
	51.913		415.30		3322.4
A ₁	55.000	A ₄	440.00	A ₇	3520.0
	58.270		466.16		3729.3
B ₁	61.735	B ₄	493.88	B ₇	3951.1
C ₂	65.406	C ₅	523.25	C ₈	4186.0
	69.296		554.37		4434.9
D ₂	73.416	D ₅	587.33	D ₈	4698.6
	77.782		622.25		4978.0
E ₂	82.407	E ₅	659.26	E ₈	5274.0
F ₂	87.307	F ₅	698.46	F ₈	5587.7
	92.499		739.99		5919.9
G ₂	97.999	G ₅	783.99	G ₈	6271.9
	103.83		830.61		6644.9
A ₂	110.00	A ₅	880.00	A ₈	7040.0
	116.54		932.33		7458.6
B ₂	123.47	B ₅	987.77	B ₈	7902.1

(THIS IS A SAMPLE LOG FOR TRAINING PURPOSES)

Spring Flower Middle School - Varsity
 Petunia Snapdragon and Marigold Nasturtium

Log for the Tap-O-Phone

Materials List

5 Fluorescent Light Tube Guards, and caps (larger diameter version)
 Caps from One-A-Day Vitamin Bottles, 100 tablet count
 Duct Tape, Scissors

Design

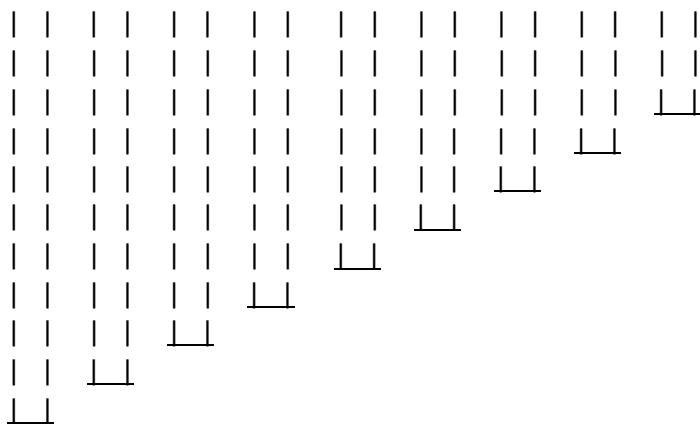
The instrument is a series of plastic tubes. It is played by tapping the closed end of each tube. It is a copy of a toy called BoomWhackers and uses only legal parts. Volume is controlled by how hard each tube is tapped. You can also whack each tube against the edge of a table. The scale covers C3 to C4, with extra note D4. Pitch tuning is done by adjusting tube length. The initial length of the C3 tube is estimated based on the toy instrument. All other tubes are based on C3 tube after it was tuned. All tubes are capped on one end with duct tape or a bottle cap to reduce harmonics when measuring the pitch. Once cut, material cannot be added back to lower the pitch. Take care to start with tubes longer than needed, cut incrementally until the pitch is achieved. Tubes are tuned a bit low to allow for future adjustments if needed before competition day. The closer the cent value gets to zero, the less material should be removed.

Tuning Data for C3

Tube length (cm)	Cents off from the target 261.62 Hz
70	-61
67	-48
66	-38
65.8	-35
65.5	-30
65	-20
64.8	-15
64.5	-12
64.4	-8
64.3	-3

Labeled Diagram

C3 D3 E3 F3 G3 A3 B3 C4 D4 (needed to play Yankee Doodle)

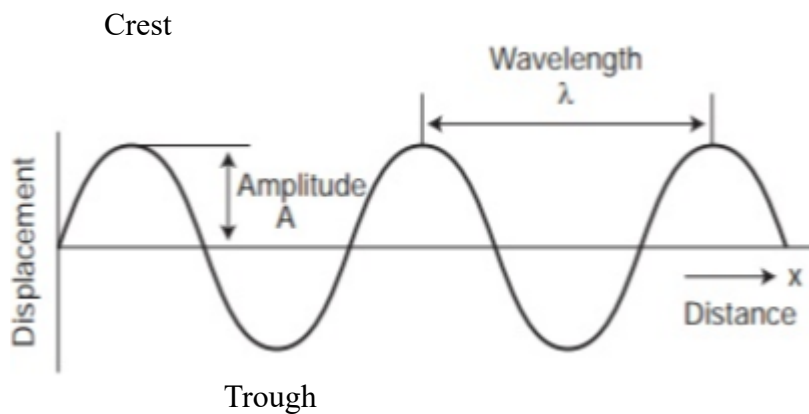


Sounds of Music Written Test Primer

All of the following categories will be represented, with a minimum of 15 questions. There will be no short answer questions, any calculators are allowed.

1. Principles of Acoustics
 - How different surfaces interact with sound waves
 - Human auditory system
 - Units of sound measurement (Hz, dB)
2. Sound Wave Theory
 - Constructive vs. destructive interference
 - Usage of the wave speed equation
 - Doppler effect
3. Musical Sound
 - Pitch and volume
 - Harmonics
 - Frequency relationships
4. Instrument Design
 - Families of instrument
 - Controlling pitch
 - Motive force
5. Music Theory
 - Notes, Scales
 - Common music terms

Be familiar with the parts of this basic wave diagram, and be able to use it along with the wave equation and period equation to determine unknown values of a given wave's characteristics.



Equations to know:

$$v = \lambda f \quad f = 1/T$$

v (wave speed)

λ (wavelength)

f (frequency, HZ)

T (time period in seconds)

Sample Math Problem

Use the chart information below to determine the following values. Show your work with correct significant figures and units.

- Frequency of the 3rd harmonic of E₄.
- What is the wave speed of D₄ at standard temperature and pressure? Show the formula, your work, and give your answer in meters/sec.

Note	Frequency (Hz)	Wavelength (cm)
C ₄	261.63	131.87
C [#] ₄ /D ^b ₄	277.18	124.47
D ₄	293.66	117.48
D [#] ₄ /E ^b ₄	311.13	110.89
E ₄	329.63	104.66
F ₄	349.23	98.79
F [#] ₄ /G ^b ₄	369.99	93.24
G ₄	392.00	88.01
G [#] ₄ /A ^b ₄	415.30	83.07
A ₄	440.00	78.41
A [#] ₄ /B ^b ₄	466.16	74.01
B ₄	493.88	69.85

Answer:

- $329.63 \text{ Hz} \times 3 = \underline{988.89 \text{ Hz}}$
- Wave speed c (or v) = frequency \times wavelength
 $293.66 \text{ Hz} \times 117.48 \text{ cm}/100 = \underline{344.99 \text{ meters/second}}$