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 of 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 consecution 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
Song Score	5
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 of 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.)

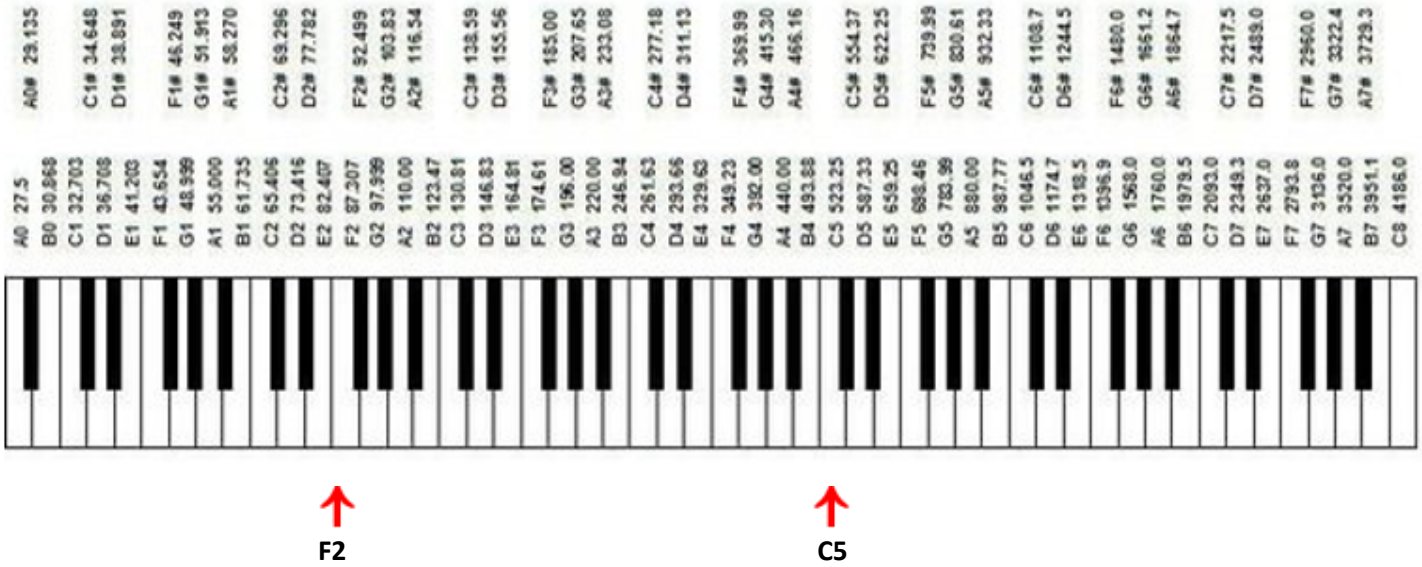
Helpful Web Sites:

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!



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

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

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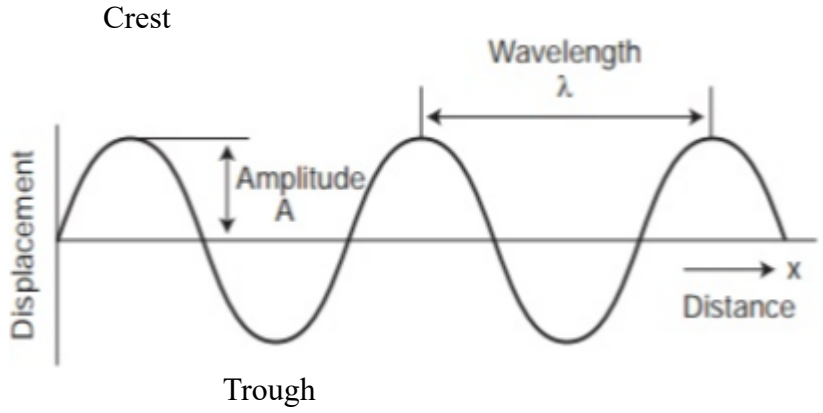
Sounds of Music Written Test Primer

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:
$\mathbf{v = \lambda f}$ $\mathbf{f = 1/T}$

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.

a. Frequency of the 3rd harmonic of E4.
b. 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:

a. 329.63 Hz x 3 = <u>988.89 Hz</u>
b. Wave speed *c* (or v) = frequency x wavelength
293.66 Hz x 117.48 cm/100 =<u>110.03 meters/second</u>