

1. **DESCRIPTION:** Teams must construct and tune one device prior to the tournament based on a 12-tone equal tempered scale and complete a written test on the physics of sound.

**A TEAM OF UP TO:** 2

**IMPOUND:** No

**EYE PROTECTION:** None

**APPROXIMATE TIME:** 50 minutes

2. **EVENT PARAMETERS:**

- Each team may bring one three-ring binder of any size containing information in any form and from any source attached using the available rings. Participants may remove information or pages for their use during the event.
- Each team may also bring writing utensils and two stand-alone calculators of any type for use during any part of the event.
- Teams may bring a personal tuner, this may be an app on their cell phone, for use during set up. Access to an electrical outlet is not guaranteed.
- If testing a string instrument, a team may bring rosin.
- Prior to the competition, teams must tune their device to play consecutively the eight notes of a one octave major scale of the teams' choice. A log describing the process of tuning one pitch must be submitted.
- Participants must be able to answer questions regarding the design, construction, and operation of the device per the Building Policy found on [www.soinc.org](http://www.soinc.org).

3. **CONSTRUCTION PARAMETERS:**

- The instrument may be constructed of and contain any materials except for the following prohibited materials: electric or electronic components, toy or professional instruments or parts of such instruments (e.g., bells, whistles, mouthpieces, reeds or reed blocks, audio-oscillators, tuning pegs, etc.). The only exception is that strings (instrumental or otherwise) of any type are permitted.
- One or both, if required by device design, participant(s) must be able to play all the notes of a one octave major scale of the team's choosing. All notes of the scale must lie between F2 and F5. (A4 = 440 Hz)
- Competitors may not hum or sing to cause the device to produce its pitch.
- Each device must fit within a 60.0 cm x 60.0 cm x 100.0 cm box when brought into the competition area and be moveable by the participants without outside assistance. Devices may become larger once set up.

4. **THE COMPETITION:**

**Part I: Written Test**

- Teams will be given a minimum of 20 minutes to complete a written test consisting of multiple choice, true-false, completion, or calculation questions/problems.
- Unless otherwise requested, answers must be in metric units with appropriate significant figures.
- The test will consist of at least three questions from each of the following areas:
  - General principles of acoustics (e.g., wave theory, Bernoulli Effect)
  - Basic terminology regarding sound, sound production, and related science terms
  - Fundamental elements of musical sound, perception, and resonance
  - The design, function, and construction of the instrument types (e.g., how it makes sound, what determines the pitch, how is volume changed)
  - Notes, major scales, and intervals

**Part II: Device Testing**

- Device testing should take place in a room separate from the Part I written test to minimize disruption to and to ensure the accuracy of the device readings.
- Devices will be evaluated on their ability to produce accurate pitches and a large in-tune dynamic volume.
- The supervisor will mark a distance 1.0 m away from the testing equipment beyond which the participants may set up their device.
- Participants will have two minutes to set up their device, which may face any direction, but no part of the device or the participants may be closer than 1.0 m to the testing equipment. During the two minutes, Participants may use their own tuner, including a cell phone app, to adjust the pitches on their device. One participant may continue working on the written test if not needed to play or setup the device.
- At the end of the two minutes, the participants' tuner must be put away. Failure to do so will result in a construction violation. No further alterations of the device are allowed other than those that would occur naturally while playing different pitches (such as covering different holes with fingers or moving a slide).
- Once the device is ready, or the two-minute set-up period has expired, the participants will begin their Pitch Score Test:

- i. Participants will inform the event supervisor which major scale they are playing, whether they are playing it ascending or descending and what note they will start on (e.g., F3 or F4 in playing an F major scale).
  - ii. Participants will play one pitch at a time, holding it for a duration of 5 seconds as indicated by signals from the event supervisor. For devices with a quick decay time, multiple attacks on the pitch are allowed (for example, striking a bar multiple times with a mallet or plucking a string). The pitch measurement will be the best value during the 5 seconds. Participants will wait until the supervisor records the measured pitch frequency and indicates that they may proceed before playing the next note in the sequence.
  - iii. If the device is so quiet that the equipment has trouble registering the pitch, the supervisor may move the microphone closer to the participants' setup for the Pitch Test only.
  - iv. If the device is unable to play some of the required pitches, the participants must notify the supervisor before playing the first note which pitches in the sequence will be skipped. Otherwise it will be assumed that the participants are playing the next note in the scale sequence. Points will be awarded per note.
- g. Once the Pitch Score Test is completed the participants will conduct their Volume Score Test to determine the maximum volume of their device:
- i. No alterations of the device are allowed between the pitch and volume tests. If the supervisor moved the test equipment closer for the pitch test, it must be moved back to its original location (1.0 m away).
  - ii. Participants will select a single note from the pitch test. Participants will play the pitch for 5 seconds; multiple attacks on the pitch are allowed. The event supervisor will score the loudest volume reached during the 5 seconds.
  - iii. If the volume exceeds 85 dB, the supervisor will stop the testing and a volume of 85 dB will be recorded.
- h. The event supervisor will review with the teams the Part II data recorded on their scoresheet.
5. **SCORING:**
- a. High score wins. A complete scoring rubric is available on the Sounds of Music page on [soinc.org](http://soinc.org)
  - b. The Final Score = TS + LS + PS + VS;
    - i. Test Score (TS) = (Part I score / Highest Part I score for all teams) x 45 points
    - ii. Log Score (LS) = max of 10 points
    - iii. Pitch Score (PS) = (Sum of IPS for the Device / Highest IPS Sum for all teams) x 36 points  
 IPS (Individual Pitch Score for each pitch) =
      - (1) C (cents) = abs |cents off the target frequency|.
      - (2) IPS for skipped pitches = 0
      - (3) If  $C \leq 5$ ,  $IPS = 4.5$ ; If  $C > 5$ ,  $IPS = 5 - 0.1 \times C$ , with a minimum IPS score of 0
    - iv. Volume Score (VS) = (Device max dB / Highest dB over all teams) x 9 points
  - c. The log must track the iterations of calibrating one pitch on the device. The Log Score (LS) points will be assigned as follows:
    - i. 2 pts - For a list of materials used in the device
    - ii. 2 pts - For including data comparing pitch accuracy to an appropriate design element change (e.g., pitch vs length of tubing)
    - iii. 2 pts - For including at least 5 data points
    - iv. 2 pts - For proper labeling (e.g. title, team name, units)
    - v. 2 pts - For including a labeled picture showing how the device changes for the different pitches (ex. a fingering chart)
    - vi. LS = 0 if no device is brought to the event.
  - d. If a team violates any COMPETITION rules, their IPS and max dB values will be multiplied by 0.9 when calculating the scores.
  - e. If any CONSTRUCTION violation(s) are corrected during the Part II setup period, the IPS and max dB values will be multiplied by 0.7 when calculating the scores.
  - f. Teams that are disqualified for unsafe operation, do not bring a device, or whose device does not meet construction parameters at the end of their setup time receive zero points for their PS and VS scores. Teams will be allowed to compete in Part I.
  - g. Ties will be broken using the following categories in the listed order: 1) Best PS, 2) Best VS, 3) Best TS, and 4) Questions on the written test

**Recommended Resources:** The Science Olympiad Store ([store.soinc.org](http://store.soinc.org)) carries the Sounds of Music Video Download and Chem/Phy Science CD; other resources are on the event page at [soinc.org](http://soinc.org).