

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

A TEAM OF UP TO: 2

EYE PROTECTION: None

IMPOUND: No

APPROXIMATE TIME: 50 minutes

2. **EVENT PARAMETERS:**

- a. 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. **Sheet protectors, lamination, tabs and labels are permitted.** Participants may remove information or pages for their use during the event.
- b. Each team may also bring writing utensils and two stand-alone calculators of any type for use during any part of the event.
- c. Teams may bring a personal tuner, which may be an app on their cell phone, for use during set up. Access to an electrical outlet is not guaranteed.
- d. If testing a stringed **device**, a team may bring rosin.
- e. Prior to the competition, teams must tune their device to play eight notes from a **two-octave** major scale of the team's choice. A log describing the process of tuning one pitch must be submitted.
- f. 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.

3. **CONSTRUCTION PARAMETERS:**

- a. The **device** may be constructed of and contain any materials except for the following: electric or electronic components, toys, 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.
- b. The device must be able to play an **ascending** major scale **beginning on any note between F2 and F3 (inclusive)**. ($A4 = 440 \text{ Hz}$) **The scale must include an octave jump after the fourth note of the scale. For example, G2, A2, B2, C3, octave jump, D4, E4, F#4, G4**
- c. **The device must also be able to play additional pitches within the scale's skipped range in order to play the first four bars of "Twinkle, Twinkle". The song excerpt (attached at the end of the rules) must be played in 15 seconds and must be played within one octave.**
- d. **For a bonus, the device may have one additional pitch (outside of the two octave range) EITHER:**
 - i. **At least one octave lower than the lowest note of the required scale in 3.b. (In the example above, G1 or lower),**
 - ii. **At least one octave higher than the highest note of the required scale in 3.b. (In the example above, G5 or higher).**
- e. **The energy to produce the pitches must come from the participants and may not be stored.** Participants may not hum or sing to cause the device to produce its pitches.
- f. 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

- a. 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.
- b. Unless otherwise requested, answers must be in metric units with appropriate significant figures.
- c. The test will consist of at least three questions from each of the following areas:
 - i. General principles of acoustics (e.g., wave theory, Bernoulli Effect)
 - ii. Basic terminology regarding sound, sound production, and related science terms
 - iii. Fundamental elements of musical sound, perception, and resonance
 - iv. The design, function, and construction of the instrument types (e.g., how it makes sound, what determines the pitch, how is volume changed)
 - v. Notes, scales, solfege, intervals, **time signatures, tempos, and associated music terms**

Part II: Device Testing

- a. Device testing should take place in a room separate from the Part I written test to minimize disruption and to ensure the accuracy of the device readings.
- b. Devices will be evaluated on their ability to produce accurate pitches. **A recommended pitch measuring software program is available on the event page at soinc.org.**

- c. Teams will have two minutes to set up their device. During the two minutes, teams may use their personal 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 set up the device.
 - d. At the end of the two minutes, the team's 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).
 - e. 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 and what note they will start on. **Participants must know the octave number of their starting pitch.**
 - ii. Participants will play one pitch at a time, holding it for a duration of **3** seconds as indicated by signals from the Event Supervisor. For devices with a quick decay time, multiple attacks on the pitch are allowed (e.g., striking a bar with a mallet or plucking a string multiple times). The pitch measurement will be the **average** value during the **3** 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. **The microphone may be moved as close as necessary to the device to register the pitch. If a pitch is so soft that it cannot register on the measurement equipment, the device scores zero for that Individual Pitch Score or Bonus.**
 - iv. If the device is unable to play some of the required pitches, the participants must notify the Event 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.
 - f. Once the Pitch Score Test is completed the participants will conduct their **Song Score Test**.
 - i. No alterations of the device are allowed between the Pitch and **Song Score** tests.
 - ii. Participants will select a starting note from **the range encompassed by the pitch test scale**.
 - iii. **Participants must play the "Twinkle, Twinkle" song excerpt within 15 seconds.**
 - iv. **The Song Score test is scored based on ability to play the song within the time and the Event Supervisor's perception of the rhythmic and pitch accuracy of the song.**
 - g. **Teams may also try to play a Bonus Pitch. This may be before or after the Song Score Test.**
 - i. **No alterations of the device are allowed.**
 - ii. **Participants will indicate what their Bonus Pitch is.**
 - iii. Participants will play the pitch for 3 seconds as required by 4.Part II.e.ii.-iii..
 - iv. **Bonus points will be awarded based on the accuracy of the pitch.**
 - h. The Event Supervisor will review with the teams the Part II data recorded on their scoresheet.
 - i. **Teams filing an appeal regarding Part II must leave their device in the competition area.**
5. **SCORING:**
- a. High score wins. A complete scoring rubric is available on the Sounds of Music page on soinc.org
 - b. The Final Score = TS + LS + PS + SS + Bonus;
 - 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) **The IPS score varies by tournament level:**
 - a. **Regionals: If $C \leq 10$, IPS = 4.5; If $C > 10$, IPS = $5 - 0.05 \times C$**
 - b. **States: If $C \leq 7$, IPS = 4.5; If $C > 7$, IPS = $5 - 0.1 \times C$**
 - c. **Nationals: If $C \leq 3$, IPS = 4.5; If $C > 3$, IPS = $5 - 0.2 \times C$**
 - (4) **The minimum IPS score is 0 no matter the level of the tournament.**
 - iv. Song Score (SS) = (Device Song Score / Highest Device Song Score of all teams) x 9 points
 - v. Bonus – max of 5 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 points - For a list of materials used in the device

- ii. 2 points - For including data comparing pitch accuracy to **changes made to** an appropriate design element (e.g., pitch vs length of tubing) **in order to tune one pitch**
- iii. 2 points - For including at least 5 data points **in tuning the one pitch**
- iv. 2 points - For proper labeling (e.g., title, team name, units, team number)
- v. 2 points - For including a labeled picture showing how **to play** different pitches (e.g., a fingering chart)
- vi. LS = 0 if no device is brought to the event
- d. **The Device Song Score points will be assigned as follows:**
 - i. **3 points – Rhythmic accuracy**
 - ii. **3 points – Pitch accuracy**
 - iii. **3 points – Was the song played within 15 seconds from the start of playing**
- e. **The Bonus will be assigned as indicated:**
 - i. **Regional Level – 5 points, if the played pitch is within 10 cents of the selected pitch. Otherwise zero points**
 - ii. **State Level – 5 points, if the played pitch is within 7 cents of the selected pitch. Otherwise zero points**
 - iii. **National Level – 5 points, if the played pitch is within 3 cents of the selected pitch. Otherwise zero points**
- f. If a team violates any COMPETITION rules, their IPS values will be multiplied by 0.9 when calculating the scores.
- g. If any CONSTRUCTION violation(s) are corrected during the Part II setup period, the IPS values will be multiplied by 0.7 when calculating the scores.
- h. 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 SS scores. Teams will be allowed to compete in Part I.
- i. Ties will be broken using the following categories in the listed order:
 - i. Best PS
 - ii. Best SS
 - iii. Best TS
 - iv. Questions on the written test

“Twinkle, Twinkle” excerpt:

Note that the excerpt may be transposed into an appropriate key. **The time signature for this piece should be 4/4.**



Recommended Resources: The Science Olympiad Store (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.