Sounds of Music (On the team schedule - 30 minutes)

Description: Teams will answer questions on the physics of sound and using the provided materials create a musical note of their choice between E5 and A3.

Participants per assigned Team Number: 2

- If your school has 1 team you will send 2 students
- If your school has 2 teams you will send 2 students per team number; team numbers may not intermix
- If your school has 3 teams you will send 2 students per team number; team numbers may not intermix

Spirit of the Problem:

- ➢ The goal of competition is to give one's best effort while displaying honesty, integrity, and good sportsmanship. Everyone is expected to display courtesy and respect (see Science Olympiad Pledges below). Teams are expected to make an honest effort to follow the rules and the spirit of the problem (not interpret the rules so they have an unfair advantage).
- ➢ It is a rules violation if coaches, parents, mentors, or spectators enter the competition area or communicate with the team members at any time during the competition. Violation of this rule will place the team below all other teams.

Teams Must Bring:

- Pen/Pencil
- Teams may not bring any notes, calculators, books, for any portion of this event
- Teams will not bring pre-made devices

Materials provided

- 1- round microwavable 621 ml stoneware bowl: width 13 cm outside to outside dimeter; height 6.3 cm rim to table
- A wooden spatula
- A metal spoon
- An elementary music class xylophone mallet
- 1 to 2 cup Standard/Metric measuring cup
- 10 ml Pipette and 10 ml Syringe
- Water

The competition: This event will have a written test and a station for the teams to produce 2 musical notes. These will run concurrently. When the team is not producing their notes, they are taking their test and vice versa.

Part 1: Knowledge

The written test will consist of 25-40 questions based on the following topics and vocabulary.

- Principles of Acoustics
- How different surfaces interact with sound waves
- Human auditory system
- Units of sound measurement (Hz, dB)
- Sound Wave Theory
- Circle of 5^{th} Theory
- Constructive vs. destructive interference
- Doppler effect
- Families of instruments
- Music Theory
- Notes, Scales
- Common music terms

Vocabulary

Acoustic pressure
Compressions
Diffraction
Dispersion
Displacement amplitude
Doppler effect
Flats
Frequency
Harmonics
Intensity
Interference
Key
Key signature
longitudinal wave
Loudness
Major scales
Minor scales
Note names
Octaves
Overtones
Partials
Pitch
Power relating to sound
Rarefactions
Reflection
Refraction
Resonance
Sharps
Speed
Speed
Tempo
Largo: widely (i.e., slowly)
Lento: slowly
Moderato: moderate
Allegro: fast
Presto: very fast
Wavelength

Part 2: Sound Quality (~ 3 minutes to judge)

- The Event Supervisor will use an online tuner to test the teams. An online music tuner detects the pitch of the notes played on an instrument and indicates whether they are sharp (too high), flat (too low), or in tune. It helps musicians adjust their instruments to achieve the correct pitch for optimal sound.
- The teams will have 2 minutes, using the provided materials, to construct and test two musical notes between C4 (Middle C - approximately 261.63 Hz), and C5 (approximately 523.25) Hz of their choosing.
- The first note will not be graded but will be used by the teams to get used to the materials and the tuner. They will have full view of the online tuner as they are testing for this note.
- The Event Supervisor will then hide the tuner from the team for the rest of their time and the team will prepare their second and official note using their remaining time.
- At the end of the two minutes or before, the team will notify the Event Supervisor they are ready to play their second note.
- Teams may use the mallet up to three hits to receive a recorded measurement

Scoring:

a. Acronyms
  i. Competition Assessment Score (CAS) = the highest assessment score for all teams
  ii. Team Assessment Score (TAS) = the team assessment score
  iii. Competition Sound Score (CSS) = the lowest sound score for all teams (closest score to the sound chosen to create)
  iv. Team Sound Score (TSS) = the sound score for the team
  v. Final Score (FS)
  vi. Assessment Score (TAS ÷ CAS) x 50; rounded to the 100th place value; maximum 50 points
  vii. Sound Score (CSS ÷ TSS) x 50; rounded to the 100th place value; maximum 50 points

b. Example
  i. (CAS) = 15. The team scores 9 on the assessment. (TAS) for the team= (9 ÷ 15) x 50 = 30 points
  ii. (CSS) = 3.56 seconds. The team's time is 1.45. (TSS) for the team= (1.45 ÷ 3.56) x 50 = 20.36 points
  iii. (FS) = 30 + 20.36 = 50.36 points

Tiebreakers:

- 1st, Best sound quality
- 2nd, Best knowledge score

Possible Resources:

1. Division A will not release previous tests, or the exact resources used by the Event Supervisor or test writer for any events.

2. **Use the listed resources and study guides as starting points. The study guide was created using Gemini AI and is meant as a beginning foundation! It may or may not contain topics occurring within the competition. It is up to the competitor to research further.**
    i. **Sounds of Music Pitch Test 2023**
    ii. Your music teacher.

Study Guide: Acoustics and Music Theory

This study guide will help you prepare for your test on acoustics and music theory. Remember, the test will have 25-40 questions.

I. Principles of Acoustics

- What is Acoustics? The science of sound.
- Sound Waves: Sound travels in waves.
    - Longitudinal Wave: The particles of the medium vibrate parallel to the direction the wave travels (like a slinky). Sound waves are longitudinal.
    - Compressions: Areas of high pressure in a sound wave (particles are close together).
    - Rarefactions: Areas of low pressure in a sound wave (particles are spread apart).
- Frequency: The number of sound wave cycles per second. Measured in Hertz (Hz).
    - High frequency = High pitch (like a whistle)
    - Low frequency = Low pitch (like a tuba)
- Amplitude: The height of a sound wave. Related to loudness.
    - Large amplitude = Loud sound
    - Small amplitude = Soft sound
- Wavelength: The distance between two corresponding points on a wave (e.g., from one compression to the next compression).
- Speed of Sound: How fast sound travels. Depends on the medium (faster in solids than in liquids or gases).
- Intensity: The amount of energy a sound wave carries per unit area.
- Power: The rate at which sound energy is produced.
- Acoustic Pressure: The variation in pressure caused by a sound wave.
- Displacement Amplitude: The maximum distance that particles of a medium move from their resting position as a wave passes through.

II. How Surfaces Interact with Sound Waves

- Reflection: Sound waves bounce off a surface.
    - Echo: A reflected sound wave.
- Absorption: Sound waves are taken in by a surface (e.g., soft materials like carpets absorb sound).
- Transmission: Sound waves pass through a surface.
- Refraction: Sound waves bend as they pass from one medium to another (e.g., from air to water) because the speed of sound changes.
- Diffraction: Sound waves bend around obstacles or spread out through an opening.
- Dispersion: The spreading of a wave, where different frequencies travel at different speeds.
- Resonance: An object vibrates with increased amplitude when exposed to a sound wave of its natural frequency.

III. Human Auditory System

- The Ear: The organ that detects sound. (You don't need to go into extreme detail for middle school, but know the basic parts: outer ear, middle ear, inner ear.)
- How We Hear: Sound waves enter the ear, are converted to vibrations, and then to electrical signals that the brain interprets.

- Loudness: How we perceive the intensity of sound.
- Pitch: How we perceive the frequency of sound.

IV. Units of Sound Measurement
- Hertz (Hz): The unit of frequency. 1 Hz = 1 cycle per second.
- Decibel (dB): The unit of sound intensity level or loudness. A logarithmic scale.

V. Sound Wave Theory
- See Section I: Principles of Acoustics

VI. Constructive vs. Destructive Interference
- Interference: When two or more sound waves overlap.
- Constructive Interference: When waves combine to make a larger amplitude (louder sound). This occurs when the waves are in phase (crests align with crests).
- Destructive Interference: When waves combine to make a smaller amplitude (softer sound, or even silence). This occurs when the waves are out of phase (a crest aligns with a trough).

VII. Doppler Effect
- Doppler Effect: The change in perceived frequency (and pitch) of a sound wave when the source of the sound and the listener are moving relative to each other.
    - If the source is moving towards you, the pitch sounds higher.
    - If the source is moving away from you, the pitch sounds lower.

VIII. Families of Instruments
- String Instruments: Instruments that produce sound by vibrating strings (e.g., violin, guitar, cello, piano, harp).
- Woodwind Instruments: Instruments that produce sound by blowing air into a mouthpiece, causing a reed or air column to vibrate (e.g., flute, clarinet, oboe, saxophone, bassoon).
- Brass Instruments: Instruments that produce sound by buzzing your lips into a mouthpiece (e.g., trumpet, trombone, French horn, tuba).
- Percussion Instruments: Instruments that produce sound by being struck, shaken, or scraped (e.g., drums, cymbals, xylophone, piano).

IX. Music Theory
- Music Theory: The study of how music works.

X. Notes and Scales
- Note: A symbol representing a musical sound.
    - Note Names: A, B, C, D, E, F, G
    - Octaves: The interval between one musical pitch and another with double its frequency.
    - Sharps (#): Raise a note by a half step.
    - Flats (♭): Lower a note by a half step.
- Scale: A sequence of musical notes in ascending or descending order.
    - Major Scales: A specific pattern of whole and half steps that sounds bright or happy.
    - Minor Scales: A specific pattern of whole and half steps that sounds darker or sadder.
- Key: The central note, scale, or chord in a piece of music.
- Key Signature: Sharps or flats at the beginning of a piece of music that indicate the key.

XI. Common Music Terms
- Tempo: The speed of the music.
    - Largo: Very slow
    - Lento: Slow
    - Moderato: Moderate speed
    - Allegro: Fast
    - Presto: Very fast