

1. **DESCRIPTION:** Teams will answer questions related to time and they may construct and bring one non-electrical device to measure time intervals between 10 and 300 seconds.

A TEAM OF UP TO: 2 EYE PROTECTION: None **IMPOUND:** Yes **APPROX. TIME:** 50 minutes

2. **EVENT PARAMETERS:**

- a. The event supervisor must hide from view any clocks present in the competition room.
- b. 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 any part of the event.
- c. Each team may also bring tools, supplies, writing utensils, and two stand-alone calculators of any type for use during any part of the event. These items need not be impounded.
- d. Each team must impound only one device and all components that are integral to its operation (e.g. water, sand, etc.), a device diagram, and copies of graphs and/or tables for scoring. Components needed to set up, calibrate, and clean up (e.g. tools, clean-up supplies, reference materials, other time keeping devices) need not be impounded.
- e. The impounded device and any storage boxes must be clearly marked with the team's school name and competition number. At impound, the device and all impounded components must be able to fit into an 80.0 cm x 80.0 cm x 80.0 cm cube and be moveable by the competing team members without outside assistance. The device may be larger after setting up for Part II.
- f. The device must be designed and operated in such a way that it does not damage or alter the competition area.
- g. 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.
- h. The device must be constructed to be able to provide a distinct audible and/or visual signal at the end of a time interval set by the competitor.
- i. Prior to competition, teams must calibrate devices by preparing graphs/tables showing the relationship between elapsed times and device configuration parameters. A labeled device diagram should be included.
 - i. Any number of graphs and/or data tables may be submitted but the team must indicate up to four to be used for the Chart Score, otherwise the first four provided are scored.
 - ii. Graphs and/or tables may be computer generated or drawn by hand on graph paper. Each data series counts as a separate graph. A template is available at www.soinc.org.
 - iii. Teams are encouraged to have a duplicate set to use, as those submitted may not be returned.

3. **CONSTRUCTION PARAMETERS:**

- a. Examples of acceptable non-electrical devices include water or sand glasses, simple or torsional pendulums, or oscillating springs.
- b. Commercial counters, tally devices, timepieces or their parts are not allowed. Commercial balances, scales, test tubes, beakers, graduated cylinders, and burettes are not considered counters and are allowed.
- c. The device must be constructed to contain spillage.
- d. The device must be constructed to minimize possible impacts on other teams when running (e.g., as quiet as possible, occupies a reasonable amount of space when set up, etc.).

4. **DESIGN LOG:**

- a. Teams must submit a Design Log along with their device. The log must include the following:
 - i. Materials used to construct the device
 - ii. A labeled diagram or picture that identifies and describes the parts of the device
 - iii. Team name, team number, and appropriate metric units for all numerical values
- b. If a 3-D printer, laser cutter, CNC machine or similar device was used as a tool to build the team's device, or any component thereof, the following information must also be supplied in the log.
 - i. Information about the tool hardware, software, materials, and supplies used
 - ii. Details of the source of any digital files (e.g.; CAD, STL, OBJ) utilized by the tool including but not limited to when and where the file was obtained, including the web address if downloaded from the internet
 - iii. Descriptions of how the team constructed the final device from the tool created components
- c. All submitted logs will be returned to teams.



5. 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 must consist of at least four questions from each of the following areas:
 - i. Time standards (e.g., UTC, sidereal time, leap years/seconds, time zones, daylight savings time, text-based time formats, and the Gregorian, Hebrew, Islamic, Julian, and Persian calendars)
 - ii. Physics of modern timekeeping devices (e.g., atomic clocks, quartz clocks, electronic oscillations)
 - iii. Historical time keeping devices (e.g. pendulum clocks, water clocks, sundials, ancient astronomical observatories, early clocks and watches, primary timekeeping mechanisms)
 - iv. Waves and frequencies (e.g., electromagnetic waves, frequency analysis, harmonics, normal modes, resonance)
 - v. State and Nationals only - Dynamical systems (e.g., equations of motion, planetary motion, gravity, relativity, half-life)
 - vi. State and Nationals only - Computer representations of time, methods of time synchronization, and situations in which accurate time keeping has significant impact, e.g., navigation, electronic financial transactions, the Internet of Things, security protocols, and signal multiplexing

Part II: Device Testing

- a. Teams must be allowed to interact with their device before, during, between and after the time trials, except while the device is actively timing a time trial.
- b. The event supervisor must pre-select a different target interval (as described under SCORING) for each of 3 time trials. The same target intervals must be used for all teams. Teams must be informed of the selected intervals at the start of their competition block. Time trials must run in the order listed in the SCORING section.
- c. At the start of the competition block, teams will be given 5 minutes to setup or modify their devices and use their graphs and/or tables to calibrate them. Devices that do not meet construction specs will not be allowed to be tested until brought into specification. All other time keeping devices (e.g., watches, cell phones, etc.) must then be collected by the event supervisor prior to the start of the time trials.
- d. While all teams are working on Part I, the Event Supervisor will individually call each team to a station. Multiple identical stations may be used.
- e. Prior to the start of a team's time trials, the team must demonstrate the audible and/or visual signal that the device makes when it is done timing an interval.
- f. Event Supervisors are strongly encouraged to utilize 3 Timers on all time trials. The median time in seconds to the precision of the device used, recorded by the 3 Timers, is the official time trial value. The Event Supervisor will make sure 3 timers are ready and then signal a team member to make a loud announcement of, "3, 2, 1, START!" Then a team member will proceed to start the device. Timers will stop when the device signal is audible and/or visible.
- g. Teams must then have at least 90 seconds at Regionals, 60 seconds at States, 30 seconds at Nationals to configure and prepare their device for the next time trial.
- h. Teams must completely clean up before leaving the competition area.
- i. The Supervisor will review with the team the Part II data recorded on their scoresheet.
- j. Teams filing an appeal regarding Part II must leave their device in the competition area.



6. **SCORING:**

- High score wins; Final Score (FS) = ES + TT1 + TT2 + TT3 + CS. The maximum possible FS is 100 points. A scoring spreadsheet is available at www.soinc.org.
- Teams must start with the points listed below per time trial (TT), for a total of 45 possible points for TT1 + TT2 + TT3.
- Points must be deducted from the initial points as described below. The score for a trial must NOT be less than zero. There must not be any carry-over of penalty points between trials. The trial interval ranges and points deducted are:

Time Trial #	Time Interval Range	Points Deducted / ± 0.1 sec error	Initial Points
Trial 1	10 to 90 sec	0.3 pts. per 0.1 sec	15
Trial 2	60 to 300 sec	0.2 pts. per 0.1 sec	15
Trial 3	10 to 300 sec	0.1 pts. per 0.1 sec	15

- Exam Score (ES) = (Part I score / Highest Part I score for all teams) x 45 points.
- Chart Score (CS): One of the submitted graphs/tables, selected by the Event Supervisor, is scored using i., ii., and, iii., described below for a maximum of 6 points. Four (4) additional CS points are available via items iv. and v. Partial credit may be given. A device must be present to receive a CS.
 - 2 points for including data spanning the possible time range
 - 2 points for including at least 10 data points in each data series
 - 2 points for proper labeling (e.g., title, team name, units)
 - 0.5 points for each distinct graph or table turned in (up to 2 points total). Different series of tests measuring the same variables are considered distinct graphs or tables
 - 2 points for including a labeled device diagram
- If a team violates a COMPETITION rule, their TT1, TT2, and TT3 scores will be multiplied by 0.9.
- If any CONSTRUCTION violation(s) are corrected during the competition block, or if the team misses impound, their TT1, TT2, and TT3 will be multiplied by 0.7.
- Teams with no device, no time estimates, or that do not make an honest attempt to utilize a device to determine the time periods receive TT1, TT2, and TT3 of 0. Such teams will be allowed to compete in Part I (the written test).
- Tiebreakers: 1st - best score from Time Trial 3, 2nd - designated questions from the test.

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries a variety of resources to purchase for this event; other resources are on the Event Pages at soinc.org