



1. **DESCRIPTION:** Teams must construct a collecting device prior to the tournament that is designed to collect heat and complete a written test on alternative energy concepts.

**A TEAM OF UP TO:** 2

**IMPOUND:** No

**APPROX. 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. Sheet protectors, lamination, tabs and labels are permitted. Participants may remove information or pages for their use during any part of the event.
- Each team may bring their heat collection device, an unaltered, glass or plastic, standard (height ~1.4 times the diameter) 250 mL beaker, copies of graphs and/or tables for scoring, tools, supplies, writing utensils, and two stand-alone calculators of any type for use during any part of the event.
- Event supervisors will supply the water, and thermometers or probes (recommended). Non-contact thermometers are allowed.
- 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:**

- Devices may be constructed of and contain any materials (e.g., cardboard, aluminum foil, reflective fabric or material, glue, tape, mirrors, tiles and lenses).
- The device, including beaker, must fit within a 35.0 cm x 35.0 cm x 35.0 cm cube when set up for testing.
- Within the device, participants must be able to insert and remove a beaker that they supply (see 2.b).
- The device must also easily accommodate the insertion and removal of a thermometer/probe into the beaker. Parts of the device may be inside the beaker, but the device must not contact the water.
- Devices will be inspected to ensure that there are no energy sources (e.g., no electrical components, small battery powered heaters, chemical reactions, etc.) to help warm the water. At the event supervisor's discretion, teams must disassemble their devices at the end of the testing period in order to verify the materials used in construction.
- All parts of the device must not be significantly different from room temperature at the start of the event.
- Prior to competition, teams must calibrate devices by preparing graphs/tables showing the relationship between elapsed time and water temperature. A labeled device diagram should be included.
  - 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.
  - 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](http://www.soinc.org).
  - Teams are encouraged to have a duplicate set to use, as those submitted may not be returned.

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 competition must consist of at least five questions from each of the following areas:
  - Basic information and definitions about energy, work, heat and heat transfer, temperature, temperature scales, thermal energy and insulation.
  - General information about renewable energy including but not limited to solar, wind, hydroelectric, tidal, ocean thermal energy conversion (OTEC), and geothermal.
  - General information about energy conservation practices including but not limited to recycling, reusing, and using materials with greater efficiency.
  - Mathematical relationships and equations used in determining heat loss and gain, specific heat, and heat transfer.

**Part II: Device Testing**

- At the start of the competition block, teams will be given 5 minutes to set up or modify their devices and use their graphs and/or tables to calibrate them. Devices that do not meet the construction specs will not be allowed to be tested until brought into specification.



- b. At each station, the event supervisor will provide an incandescent lamp with a bell-shaped reflector. The lamp will be mounted, facing down, above the testing surface (on which teams will set up their device) such that the bottom of the bulb is at least 40.0 cm from the testing surface. Multiple identical stations may be used.
  - c. At the start of a team's device testing period the supervisor, using their own measuring device, will dispense 100 mL of water into the team's beaker. A team may elect to install the beaker in a device prior to this, but must leave sufficient access to the beaker. Otherwise the team may then place the beaker into their device.
  - d. Teams will use their graphs and/or tables to predict the temperature of the water in their beaker at the end of the 10-minute heating time. After receiving water, teams will be given at least 3, but no more than 5 minutes to make their final predictions. During this time, teams may use their own thermometers to measure the starting water temperature in their beaker, but after this time must remove them.
  - e. The supervisor will insert a probe/digital thermometer into the water to measure and record the initial temperature to the nearest tenth of a degree. Supervisors may leave thermometers/probes in the devices for the entire heating period, but will announce if they will do so before impound. Otherwise they will insert a thermometer/probe into the beaker in the device, wait at least 20 seconds, and record the resulting temperature. Multiple thermometers/probes may be used at the supervisor's discretion
  - f. The light source must be turned on and a stopwatch started. At the end of 10 minutes the light will be turned off and the thermometer/probe will be read and recorded to the nearest tenth of a degree to determine the gain in temperature.
  - g. The supervisor will review with the team the Part II data recorded on their scoresheet.
  - h. Teams filing an appeal regarding Part II must leave their device in the competition area.
5. **SCORING:**
- a. High score wins.
  - b. All scoring calculations are to be done in degrees Celsius.
  - c. Final Score (FS) = TS + CS + HS + PS; The maximum possible FS is 100 points. A scoring spreadsheet is available at [www.soinc.org](http://www.soinc.org).
  - d. Test Score (TS) = (Part I score / Highest Part I score for all teams) x 50 points
  - e. 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.
    - i. 2 points for including data spanning at least one variable range
    - ii. 2 points for including at least 10 data points
    - iii. 2 points for proper labeling (e.g., title, team name, units)
    - iv. 0.5 points for each distinct graph or table turned in (up to 2 points total)
    - v. 2 points for including a labeled device diagram
  - f. Heat Score (HS) = (HRF / Highest HRF of all teams) x 15 points; HRF (Heat Retention Factor) = (final beaker water temp / starting beaker water temp)
  - g. Prediction Score (PS) = (PE / Highest PE of all teams) x 25 points; PE (Prediction Estimate) =  $(1 - (\text{abs}(\text{final beaker water temp} - \text{predicted final beaker water temp}) / \text{final beaker water temp}))$ . The minimum PS possible is 0 points.
  - h. If a team violates any COMPETITION rules, their HRF and PE values will be multiplied by 0.9 when calculating the scores.
  - i. If any CONSTRUCTION violation(s) are corrected during the Part II testing period the HRF and PE values will be multiplied by 0.7 when calculating the scores.
  - j. Teams that are disqualified for unsafe operation or do not bring a collecting device receive zero points for their HRF and PE scores. Teams will be allowed to compete in Part I.
  - k. Tie Breakers: 1<sup>st</sup> — Best TS; 2<sup>nd</sup> — Best HS; 3<sup>rd</sup> — Best PS