

SOLAR POWER Draft 4-May-18

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 **EYE PROTECTION:** None **IMPOUND:** No **APPROX. 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. The information may be removed during the event.
- b. Each team may bring their solar collector device, copies of graphs and/or tables for scoring, tools, supplies, writing utensils, a three-ring binder and two dedicated calculators of any type for use during any part of the event.
- c. Event supervisors will supply the water, 250 ml standard beaker, thermometers, or probes (recommended). Non-contact thermometers are allowed.
- d. Prior to competition, teams must calibrate their devices by preparing graphs and/or tables showing the relationship between elapsed solar collection time and ending water temperature. A labelled device picture, or 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 must be on a separate sheet of paper. 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.
- e. 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 and may be penalized per the policy.

3. **CONSTRUCTION:**

- a. Devices may be constructed of and contain any materials (e.g., cardboard, aluminum foil, reflective fabric or material, glue, tape, mirrors, tiles and lenses).
- b. The device, including beaker, must fit within a 35.0 cm x 35.0 cm x 35.0 cm cube when setup for testing.
- c. Within the device, participants must be able to insert and remove a beaker supplied by the event supervisor (see 2.b).
- d. The device must also easily accommodate the insertion and removal of a thermometer/probe into the beaker.
- e. 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.
- f. All parts of the device must not be significantly different from room temperature at the start of the event.

4. **THE COMPETITION:**

Part I: Device Testing

- a. Teams will be given 5 minutes to setup, or modify, their devices at the start of the competition block and use their graphs and/or tables to begin temperature prediction calculations. Devices that do not meet the construction specs will not be allowed to be tested until brought into spec.
- b. Each team will be given a 250 ml beaker containing 100 ml of water from a common source. The students will place the beaker inside the collector. Teams may utilize their own thermometers to measure the starting water temperature in their beakers.
- c. Teams will use their graphs and/or tables to calculate the temperature of the water in their beaker at the end of the warming time. They must provide the supervisors with their estimate prior to beginning part II.
- d. Each station will have a lamp with a clear 150-watt bulb mounted above the area where testing takes place. The distance from the bottom of the bulb to the top of the imaginary cube in which the collector is placed will be announced at the start of the competition. The bottom of the bulb will be no closer than 5 cm to the top of the imaginary cube.
- 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. 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.

- f. The supervisor will review with the team the Part I data recorded on their scoresheet.
- g. Teams filing an appeal regarding Part I must leave their device in the competition area.

Part II: Written Test

- h. Teams will take a test on alternative energy concepts during the remaining time. All teams will have the same amount of time to take the test.
- i. Unless otherwise requested, answers must be in metric units with appropriate significant figures.
- j. 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.
- k. The competition must consist of at least five questions from each of the following areas:
 - i. Basic information and definitions about energy, work, heat and heat transfer, temperature, temperature scales, thermal energy and insulation.
 - ii. General information about renewable energy including but not limited to solar, wind, hydroelectric, tidal, ocean thermal energy conversion (OTEC), and geothermal.
 - iii. General information about energy conservation practices including but not limited to recycling, reusing, and using materials with greater efficiency.
 - iv. Mathematical relationships and equations used in determining heat loss and gain, specific heat, and heat transfer.

5. SCORING:

- a. High score wins.
- b. All scoring calculations are to be done in degrees Celsius.
- c. The final score = TS + CS + HS + PS; a scoring spreadsheet is at www.soinc.org:
 - i. Test Score (TS) = Part II score / Highest Part II score for all teams) x 50 points
 - ii. Chart Score (CS) = max of 10 points
 - iii. The Heat Score (HS) = (HRF / Highest HRF of all teams) x 15 points; HRF (Heat Retention Factor) = (final beaker water temp / starting beaker water temp)
 - iv. Prediction Score (PS) = (PE / Highest PE of all teams) x 25 points; PE (Prediction Estimate) = (1-(abs (final beaker water temp - predicted final beaker water temp) / final beaker water temp)).
- d. One of the submitted graphs and/or tables selected by the event supervisor, must be scored as follows for the Chart Score. Partial credit may be given.
 - i. 2 points for including data spanning at least one variable range listed in 4.a.
 - 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 graph or table turned in (up to 2 points total as long as they are not the same).
 - v. 2 points for including a labelled device picture or diagram.
- e. If a team violates any COMPETITION rules, their HR and, PE values will be multiplied by 0.9 when calculating the scores.
- f. If any CONSTRUCTION violation(s) are corrected during the Part I testing period, or if the team misses impound, the HRF and PE values will be multiplied by 0.7 when calculating the scores.
- g. 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 II.
- h. Tie Breakers: 1st - Best TS; 2nd - Best HS; 3rd - Best PS