

## HOVERCRAFT DRAFT RULES 17

1. DESCRIPTION: Participants will be tested on their knowledge of classic mechanics and related topics as well as their ability to construct a self-propelled air-levitated vehicle that moves down a track.  
A TEAM OF UP TO: 2 EYE PROTECTION: B IMPOUND: Yes 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. The information may be removed during the written test portion of the event. Sheet protectors and laminated sheets are allowed.
  - b. Participants may bring writing utensils & dedicated calculators of any type for use during any part of the event.
  - c. The vehicle, as well as any graphs/tables submitted, must be labeled with the team name and tournament specific team number and must be impounded. Bonus points will be awarded for vehicles impounded in a box. Tools, supplies, and three-ring binders do not need to be impounded.
  - d. Prior to competition, teams must calibrate their devices by preparing graphs and/or tables showing the relationship between time and distance for various device configurations.
    - 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 on [www.soinc.org](http://www.soinc.org).
    - iii. Teams are encourage to have a duplicate set to use, as those submitted may not be returned.
  - e. Participants must wear eye protection during part II. Participants without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows.
3. CONSTRUCTION:
  - a. The vehicle may be made of any material and mass but must fit into a 40.0cm x 40.0cm x 40.0cm box when levitated with any inflated skirt. Vehicles must not modify or damage the track.
  - b. The vehicle must levitate on a cushion of air as it moves down the track. Participants may be asked to demonstrate levitation by pushing the vehicle slightly down. If it then rises then it is levitating. Continuous contact of the inflated skirt with the base surface, occasional contact of other vehicle components with the base surface, or any contact with inside edge of the side rails is permitted.
  - c. The vehicle may have up to two motors each rotating one propeller/impeller. All propellers/impellers, including under the device, must have shielding which prevents a 3/8" dowel from touching them.
  - d. For timing purposes, the vehicle must have a 1/4" or larger dowel vertically attached within 5.0 cm of its front edge such that the top end is at least 20.0 cm above the lowest vehicle surface.
  - e. The vehicle may carry a mass consisting of up to 16 standard, unopened rolls of U.S. pennies, provided by the event supervisor (50 pennies per roll, mass  $\approx$  125g).
  - f. Commercial batteries, not exceeding 9.0 V as labeled, may be used to energize the motor on the vehicle. Multiple batteries may be connected together as long as the expected voltage across any points does not exceed 9.0 v as calculated by their labels. The vehicle must not

have any other energy sources. The use of lithium batteries must follow the Battery Policy found on [www.soinc.org](http://www.soinc.org).

- g. Electrical components shall be limited to batteries, wires, motors, switches, resistors, circuits are not permitted unless they are an integral part of, or embedded into, commercially available fans used for cooling electronics or computers.
- h. Vehicles must have an electric switch to permit safe starting. Relying on inserting batteries or twisting wires together to start is not allowed. A stopping system is recommended.
- i. Participants must be able to answer questions regarding the design, construction, and operation of the vehicle per the Building Policy found on [www.soinc.org](http://www.soinc.org).

#### 4. THE COMPETITION:

##### Part 1: Written Test

- a. Teams will be given a minimum of 20 minutes to compete a written test consisting of multiple choice, true-false, completion, or calculation question/problems.
- b. The written test will consist of at least five questions from each of the following areas:
  - i. Newton's Laws of Motion: inertia, force, impulse, action-reaction.
  - ii. Kinematics: projectile velocity, speed, acceleration, position.
  - iii. Kinetic energy: calculation, momentum, non-relativistic
  - iv. Division C only – Fluid mechanics: density, buoyancy, viscosity, Bernoulli's principle, Pascal's law,
- c. Unless otherwise requested, answers must be in metric units with appropriate significant figures.

##### Part 2: Vehicle Testing

- d. Teams have a total of 8 minutes to adjust and repair their vehicle and make 5 failed or 2 successful runs; whichever comes first. Supervisors will give a warning at 7 minutes. Practice runs are not allowed.
- e. A failed run occurs if a vehicle does not meet construction specifications when timing for that run starts, fails to move for 3 seconds at any time, fails to cross the finish line within 45 seconds, or any part of the vehicle, including pennies, falls off. Teams are not allowed to declare a run a failed run.
- f. A run will count as long as it is started before the 8 minute period has elapsed.
- g. The length of the timed portion of the track is fixed at  $165 \pm 0.5$ cm for Division B and variable between 165.0 and 260.0cm for Division C. Supervisors will mark the distance on the track and provide the length (Division C only) during the vehicle testing. The distance will be the same for all teams.
- h. The target time is 15.0 seconds. Supervisors are encouraged to use photogates for timing with at least one back up manual timer. If only manual timers are used, 3 timers are recommended with the middle value of the 3 being the officially recorded time. Time is recorded in seconds to the device precision.
- i. Supervisors will check vehicle specifications during impound or right before a team's testing period. Teams must be notified as soon as possible if a vehicle is out of spec. Teams may modify the vehicle to bring it into compliance during impound or during their 8-minute testing period, if time is available.
- j. Participants will be allowed to select 0 to 16 penny rolls to load on their vehicle during the testing period. The number of rolls used may change between runs.
- k. To begin a run, a team will place their vehicle on the track before the start line against the wood block placed by the event supervisor. A team will then activate their vehicle's motors.
- l. The team will give a countdown of "3, 2, 1 launch"; then the event supervisor will remove the wood block releasing the vehicle. Timing starts when the dowel crosses the start line and stops when it crosses the finish line.
- m. A team must not touch a vehicle until it passes the finish line or the supervisor declares a failed run. If touched, the run is successful with a TS and a MS of 0.

- n. The supervisor will review with the team the Part II of data recorded on their score sheet.
- o. A team filing an appeal regarding Part II must leave their vehicle in the competition area.

#### 5. THE TRACK:

- a. The supervisor will supply a track, which is  $60 \pm 2.5\text{cm}$  and at least  $215.0\text{cm}$  long area on a non-carpeted floor or other firm based surface, such as a countertop or large board. The outside boundary of the track is composed of beams each with a width and height of at least  $30.0\text{mm}$  (standard 2x4 framing studs recommended). The supervisor will also supply a cushioned barrier to stop vehicles and a small wood block to hold the vehicle at the start line. Example setups are at [www.soinc.org](http://www.soinc.org).
- b. Each beam must be firmly affixed to the floor, base, or each other.
- c. A start line must be marked that is at least  $45.0\text{cm}$  from the edge of the track. The finish line must be marked. (see 4.g for location) and a cushioned barrier at least  $5.0\text{cm}$  past it must block the channel.
- d. Multiple tracks, with similar dimensions, may be used to facilitate teams competing in a timely manner.

#### 6. SCORING:

- a. Final Score (FS) = best run MS + best run TS + ES + CS + IB; maximum FS=100. High Score wins. The MS and TS may come from different runs. A scoring rubric is available on [www.soinc.org](http://www.soinc.org).
- b. Mass Score (MS) = (mass of load/ mass of heaviest successful load of all teams) x21 points.
- c. Time Score (TS) =  $21 - \text{abs}(\text{runtime}-15)$  points. The smallest possible TS is 0.
- d. Exam Score (ES): (Part I score/Highest Part I score for all teams) x 45points.
- e. One of the submitted graphs and/or tables, selected by the event supervisor, must be scored as follows for the Chart Score(CS, max of 10 points). Partial credit may be given.
  - i. 2 points for including data spanning at least one variable range (e.g., distance, load).
  - ii. 2 points for including at least 10 data points.
  - iii. 2 points for proper labeling (e.g., title, team name, units)
  - iv. 1 point for each graph or table turned in (up to 4 total, as long as they are not the same).
- f. Impound Bonus (IB) = 3 points if vehicle is impounded in a box labeled with team name & number.
- g. Teams with no successful runs, or that are disqualified for unsafe operation, receive a TS and MS of 0. Teams must still be allowed to compete in Part I.
- h. The mass of the load must be multiplied by 0.7 when calculating the MS if any construction violation(s) are corrected during the Part II testing period or if the team misses impound.
- i. A team violating any COMPETITION rules during a successful run will have their TS multiplied by 0.9 when calculating the Final Score. Rule violations during failed runs do not result in this penalty.
- j. Tie Breakers: 1<sup>st</sup> –Best ES; 2<sup>nd</sup> – Best MS; 3<sup>rd</sup> – Best other successful run TS; 4<sup>th</sup>- specific test questions.