MAGLEV

Read the General Rules in the manuals and on www.soinc.org as they apply to every event.

1. **DESCRIPTION**: Competitors may construct up to two self-propelled magnetically-levitated vehicles **each** with **one** battery-powered motor that turns **one** propeller to move the vehicle down a magnetic track. Competitors must also be tested on their knowledge of magnetism and related topics.

   A TEAM OF UP TO: 2 **EYE PROTECTION:** #1 **IMPOUND**: Yes **APPROXIMATE TIME**: 50 minutes

2. **EVENT PARAMETERS**:
   a. The event has two parts: Part 1 - **written test on magnetism concepts**, and Part 2 - **vehicle testing**.
   b. For Part 2, the vehicle(s) and any material needed to adjust the vehicle(s) (e.g., extra magnets, shims, masses, batteries, etc.) must be impounded prior to the start of competition. Competitors may bring their own maglev track to use during their run. Teams may share tracks, but must have different vehicles. Supervisors must check the track specifications before use. Tools and the track need not be impounded.
   c. For both parts, all reference materials must be secured in a 3-ring binder so that regardless of orientation, none can fall out. **Calculators of any type are allowed and need not be impounded.**
   d. Competitors must wear eye protection during set-up and testing of their vehicle(s). Teams without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows. If not, teams are not allowed to compete in Part 2.

3. **CONSTRUCTION**:
   a. Vehicles may be made of any material, but must meet all specifications and cannot **modify** the track.
   b. The length of the vehicle must be between 15.0 and 22.0 cm (**excluding an optional tether system, see 3.l.)** and cannot vary during the run. Vehicles, excluding dowel (see 3.f), must be less than 20.0 cm tall with the propeller in motion when non-levitated.
   c. The mass of the vehicle (including batteries and dowel) must be **between** 250.0 **and 2000.0** grams.
   d. If a team does not provide a track, their vehicle(s) must fit a standard track (2 9/16" wide). It is recommended that the vehicle(s) be adjustable to accommodate variations in track width, track height and track polarity.
   e. The entire vehicle, except for the propeller **and any propeller shielding (see 3.h.)**, must not extend outside of the vertical planes defined by the inside edge of the side rails of the track.
   f. The vehicle must have a **1/4**" dowel vertically attached within 5.0 cm of its front edge **such that the top end is between 30.0 and 35.0 cm above the lowest vehicle surface. The dowel must have a rigid flag (sized at least 5.0 x 5.0 cm) at the top such that one of the 5 cm sides is parallel to the track and another is parallel to the dowel, with the flag pointed to the rear of the vehicle.**
   g. 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.
   h. Vehicles **must have one motor rotating one propeller. Propellers must have a diameter of ≤ 14.0 cm and must be shielded from direct contact such that the event supervisor is not able to make contact with the propeller with a standard ¼" dowel. The supervisor must be able to verify these diameters.**
   i. Brushless motors and integrated circuits are not permitted.
   j. Rare earth magnets **must not** be used on the vehicle **or track. Vehicles must be able (or modifiable during the testing time) to travel in either track direction. Teams are permitted to rotate the track.**
   k. The vehicle must be levitated as it moves down the track (inadvertent contact is permitted). Competitors must demonstrate **levitation** by pushing the vehicle slightly down. **If it then rises it is levitated.**
   l. **Vehicles must have an electric switch to permit safe starting. A stopping system must be integrated into either the vehicle or the track that will either stop the motion of the vehicle or shut the motor off. A tethering system is permitted only if it is designed to stop the vehicle. Remote control is not permitted.**

4. **THE TRACK**: More information is provided on the event page on www.soinc.org
   a. The track must be a non-electrified track ≥ **119.0 cm** long and have an inside width between 2.0" and 3.0". On longer tracks, a **119.0 cm** segment must be marked for the competition.
   b. Event supervisors must provide at least one track for teams who do not bring a track or whose track does not meet specifications. This track must be a standard width track (2 9/16" between inner faces of rails) **Modification of the supervisor track is not permitted. Event supervisors must announce the specifications of their provided track at least two weeks prior to the competition.**
   c. The height of the inside edge of the side rails measured from the top of the magnets **on the base of the track** to the top of the railing must be between 2.00 and 5.00 cm. **Side rail magnets are allowed.**

d. Both commercially produced tracks and hand-made tracks are allowed. Instructions for making various tracks are available on the event page on www.soinc.org.
e. The track must be placed on a flat level surface with enough room to allow a cushioned barrier **or metal plate** to be placed at the end of the track and 25 cm beyond to prevent the vehicle from being damaged.

5. **THE COMPETITION**:
   a. **Part 1: Written Test**
      i. All answers must be provided in SI units with appropriate significant figures.
      ii. Teams must be given a set amount of time (20 – 30 minutes is suggested) to complete a written test.
      iii. **The competition must consist of at least one task/question from each of the following areas:**
         1. **Maglev transportation history.**
         2. **Magnetic fields / forces of current conductors, plates and loops; magnetic domains.**
         3. **Magnetic field energy; motion of charged particles in a magnetic field (Nationals only).**
         4. **Personal security and medical applications of magnetism (Nationals only).**
   b. **Part 2: Vehicle Testing**
      i. The length of the timed portion of the track is **95.0 cm**. Supervisors must mark the distance on all tracks with both start and finish lines. **The target time is between 5.0 and 15.0 s.** The event supervisor must announce the exact **time** after impound, which must be the same for all teams.
      ii. Competitors must have a total of 8 minutes to orient, adjust and repair their vehicle(s), and make two successful **or five failed** runs. Vehicles that do not meet the construction specs must not run until brought into spec, **and must be assessed the construction penalty**.
      iii. Competitors must place their vehicle on the track directly before the start line. They must place **an object** in front of their vehicle to keep it from moving. **Prior to starting a run, and without actually turning on the motor, teams must demonstrate a safe starting and ending process**.
      iv. When ready, competitors may turn on their motor and indicate that their vehicle is ready.
      v. Competitors must not touch their vehicle after they have turned on their motor.
      vi. The judge must give a countdown of "3, 2, 1, launch". The competitors must then release their vehicle by removing the **object** and stepping away from the track. **Timing must start when the dowel crosses the start line and stop when it crosses the finish line**.
      vii. **Supervisors are encouraged to use photogates for more precise timing and use at least one back-up manual timer. If only manual timers are utilized, 3 timers are recommended on all runs. The middle value of the 3 timers must be the officially recorded time. Time is recorded in seconds to the precision of the device**.
      viii. Runs may be done with one vehicle or competitors may use different vehicles for each of the runs. A run must count as long as it is started before the 8-minute period elapsed.
      ix. If a vehicle fails to move after 3 seconds, or moves only part of the way down the track, competitors must be allowed to restart their vehicle without penalty **up to four times** within the 8-minute window **or** until two successful runs have been completed. Additional successful runs are not allowed.
      x. If during a run any part of the vehicle falls off, the run must be counted **as a failed run** and the team will be allowed to repair and restart their vehicle or replace it with another impounded vehicle.
      xi. Teams filing an appeal regarding Part 2 must leave their vehicle(s) and track in the competition area.

6. **SCORING:** A scoring rubric is available on the event page on www.soinc.org
   a. **Mass Score (MS) = (mass of vehicle / mass of heaviest successful vehicle) x 25 points.**
   b. Teams whose vehicle(s) only move partially down the track get a **MS** = 0. Teams whose vehicle(s) do not move past the start line or attempt any runs get a **MS = -5**. Teams that fail to impound get a **MS = -10**.
   c. Time Score (TS) = (1-(abs (**run time** – **target** time)/**run time**)) x **25** points. The smallest possible TS is 0. Teams with no successful runs receive a TS and **MS** of 0.
   d. Exam Score (ES): The test used for Part **1** of this event must be worth 50 points.
   e. Penalties: 2 points - each Competition violation; **20 points - Construction violation (only once total).**
   f. Final Score (FS) = **MS** + TS + ES - Penalties. The maximum possible FS is **100** points. High score wins.
   g. Tie Breakers: 1st - Best **ES**; 2nd - Best **MS**; 3rd - Best TS; 4th - Best 2nd **TS**; 5th - specific test questions

Recommended Resources: All reference and training resources including the **MagLev DVD (MLD)** and the **Chem/Phy Science CD (CPCD)** are available on the Official Science Olympiad Store or Website at www.soinc.org