

Magnetic Levitation – Division C

1. DESCRIPTION: Contestants may construct up to two self-propelled vehicles powered by batteries that turn up to two propellers and move the vehicle down a magnetic track while pulling a maglev sled. Students must collect data and develop a graph showing the relationship between the mass being pulled and the time required to reach the finish line. Students must also be tested on their knowledge of magnetism and related topics.

A TEAM OF UP TO: 2 **EYE PROTECTION:** #5 **IMPOUND:** Yes **APPROX. TIME:** 50 minutes

2. EVENT PARAMETERS:

- a. Prior to the competition, students must develop data charts and graphs to help them determine how quickly their car can travel to the finish line while pulling the mass of a maglev sled.
- b. The vehicle(s), a copy of the data table and graph, and any equipment required by the students must be impounded prior to the start of competition.
- c. The mass of the maglev sled must be a minimum of 50 grams and a maximum of 400 grams (in increments of 50 grams for Regionals, 10 grams for States, and 5 grams for Nationals). The exact mass of the maglev sled must be announced after impound has been completed.
- d. All reference materials for the test portion of this event must be secured in a 3-ring binder, must be 3-hole punched and inserted in the binder so that regardless of orientation none can fall out.

3. CONSTRUCTION:

- a. Vehicles may be made of any material chosen by the competitors, but must meet all specifications.
- b. The length of the car must not be any less than 10 cm and must not exceed 18 cm.
- c. The part of the vehicle that floats below the side rails of the track must fit on a standard maglev track.
- d. There is no limit to the width of the vehicle that floats above the side rails of the track.
- e. The material chosen for the vehicle must not damage the track in any way.
- f. The mass of the vehicle (including batteries) must be no less than 200 grams.
- g. The car must not change in length during its run.
- h. The vehicle must tow a maglev sled behind it (this sled must be provided by the event supervisor). Students must secure a screw eye (1/8" or larger) to the rear of their vehicle to allow the maglev sled to be attached. The length of the vehicle specified above includes the screw eye. See the following web page:
<http://www.newyorkscioly.org/SOPages/COTResources.html>
- i. Up to two 9-volt batteries (rated at 9 volts each) may be used in parallel, not in series, to power the car. No other energy must be stored or used in the running of the car.
- j. The batteries may power up to two propellers affixed to the car.
- k. Any magnets except rare earth magnets may be used on the vehicle, but students must be able to modify the placement of the magnets so that the car can travel in either direction on the track. There is no limit to the number of magnets that may be used.
- l. The motor must be a DC motor between 3 and 12 volts.
- m. The vehicle must be 100% levitated as it moves down the track.
- n. No kits may be used.

4. THE TRACK:

- a. The track must be a standard maglev track as used in technology classes with a length of 2.4 m and a vehicle track dimension of 2 9/16 inches (~6.5 cm).
- b. The height of the side rails of the track must be between 3.175 cm and 5 cm.
- c. The track must be placed on a flat surface such as a table with enough room to allow a cushioned barrier to be placed 28 cm beyond the end of the track to prevent the vehicle from falling to the floor or colliding with something that will cause damage to the vehicle.
- d. The track must not be electrified in any way.

5. THE COMPETITION:

- a. Part I:
 - i. At the end of impound, the Event Supervisor must announce which direction the vehicles must travel on the track (either the right side will be the north seeking pole or the left side will be the north seeking pole). Note: the north seeking pole is the one that points to the Earth's north magnetic pole when suspended by a string.
 - ii. Competitors must have 5 minutes to orient their vehicle to travel in the correct direction on the track, attach the maglev sled to their vehicle using the screw eye at the rear of their vehicle (the maglev sled will have a length of 10.15 cm or less), and make two runs on the track.

- iii. Before the first run the contestants must predict their vehicle's Travel Time. They may not change the prediction for the second run.
 - iv. Competitors must place their vehicle and the sled on the track behind a line 30.5cm from beginning of the track. They must place a pencil on the line in front of their vehicle to keep it from moving.
 - v. When ready they may turn on their motor and indicate to the judges that their vehicle is ready.
 - vi. They must not touch their vehicle after they have turned on their motor.
 - vii. The judge must give a countdown of “3, 2, 1, launch”. The competitors may then release their vehicle by removing the pencil and step back from the track. At the same time the judge must start the clock.
 - viii. The judge must stop the clock when the front of the vehicle crosses the end of the track. If a photogate is used the pencil must be placed behind the line to avoid triggering the photogate in advance.
 - ix. Both runs may be done with one vehicle or they may use different vehicles for each of the two runs. The second run must count as long as it is started before the 5 minute period has expired.
 - x. If a vehicle fails to move after 5 seconds teams must be allowed to restart their vehicle with no penalty. They must be given one restart during the competition. If the vehicle fails to move on the restart their car must be judged a “did not finish” for that run.
 - xi. Vehicles judged “did not finish” for both runs must be given a Run Score and a Prediction Score of 0.
 - xii. If a car moves only part of the way down the track and stops it must be judged a “did not finish” for that run. The distance it moved must be measured.
 - xiii. If during the first run any part of the vehicle falls off, the run must be scored as a 0. The team may attempt to repair their vehicle and make a second run.
 - xiv. Teams may remove their vehicle from impound once their two runs are completed. Teams may not file an appeal after they have taken their vehicle from impound.
- b. Part II:
- i. Teams must be given a set amount of time (20 – 30 minutes is suggested) to complete a written test.
 - ii. The following topics may be included: Basic information on physics of magnetism, common uses of magnets, medical uses of magnets, superconductors.

6. SCORING:

- a. Run Score: The team with the fastest time receives 50 points. All other teams receive points determined by the following formula: $\text{Run Score} = (\text{fastest time recorded for all teams} / \text{team's fastest time}) \times 50$
- b. Prediction Score: $\text{Prediction Score} = ((\text{Predicted Time} - |\text{Predicted Time} - \text{Travel Time}|) / \text{Predicted Time}) \times 30$. The Travel Time used must be the time of the fastest run.
- c. Graph Score: Students must turn in one sheet of paper with the data they have collected arranged in a table and a graph that is derived from that data. This sheet must receive points as follows: 5 points for a completed data table, 5 points for a graph, 5 points if the graph matches the data table, 5 points for correct labeling: title, team name, x & y axis variables, & increments with units.
- d. Test Score: The test used for Part II of this event must be worth 100 points
- e. Final Score: The final score for each team must be determined as follows:

$$\text{Final Score} = \text{Run Score} + \text{Prediction Score} + \text{Graph Score} + \text{Test Score}$$
- f. Tie Breakers: 1st - fastest Run Score, 2nd - highest Test Score, 3rd - best Prediction Score, 4th - farthest distance traveled, 5th - the mass of the car (lighter car wins).
- g. Tiers: Teams must be ranked in the following tiers: Tier 1: Meet all construction requirements and complete at least one run in two attempts. Tier 2: Meet all construction requirements but fail to complete at least one run intact. Tier 3: Fail to meet construction requirements and complete at least one run. Tier 4: Fail to meet construction requirements and do not complete at least one run. Tier 5: Fail to impound.

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