



High School Chem-E-Car Competition Tuesday, April 28, 2009

The object of this competition is to design and construct a car that is powered with a chemical energy source that will travel a given distance and stop. The car closest to the given distance will be the winner. A best poster award will be given, and additional prizes may be given for the most creative design and the most consistent performance.

Application

In general, a school can have any number of entries at the Competition. However, the University of Tulsa Department of Chemical Engineering has the right to set a limit, should the need arise.

Applications can be made by phone, fax, mail, email, or through our website. Applications must include

- a. School name and city
- b. Teacher/advisor contact information (name, phone number, and email address)
- c. Optional student contact information (name, phone number, email address)
- d. Number of teams
- e. Total number of students participating

The application should be sent by Friday, March 27, 2009, to Laura Ford at:

Department of Chemical Engineering
University of Tulsa
600 S. College Ave.
Tulsa, OK 74104
(918) 631-2226, fax (918) 631-3268, Laura-ford@utulsa.edu
<http://www.che.utulsa.edu/CarComp.htm>

There are two required parts to the Chem-E-Car Competition: a poster competition and a car performance competition.

Chem-E-Car Poster Competition

- a. A poster board must be displayed with the autonomous vehicle on the day of the competition. Please bring a free-standing poster, such as a tri-fold posterboard. This poster should describe how the car is powered using the chemical reaction, the unique features of the car, and environmental and safety features in the design. Entries will also be judged on creativity. **Safety and safe transportation procedures are important items to address.** If obvious safety violations have occurred, the judges and competition administrators have the discretion to disqualify the entry.

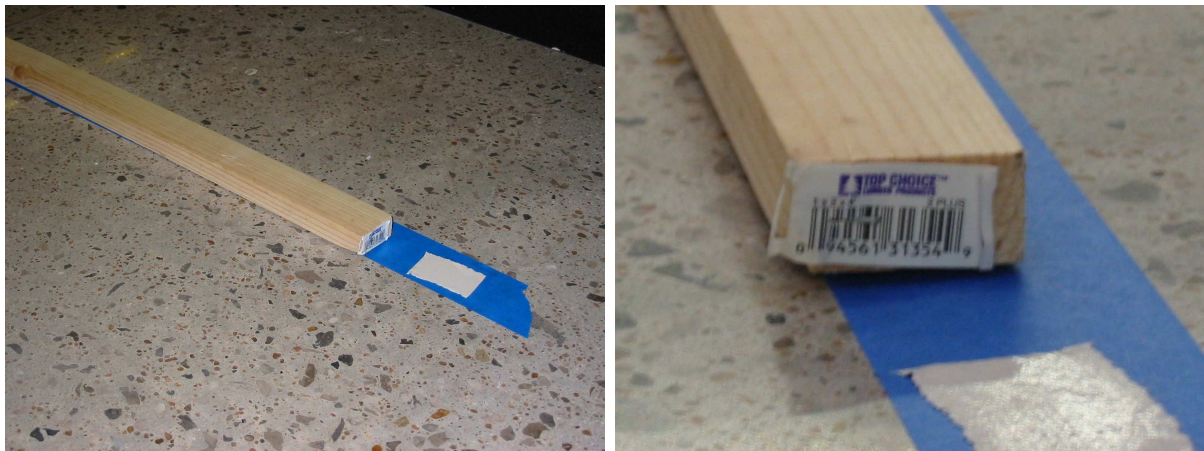
- b. The poster competition display and judging will occur prior to the Chem-E-Car Performance Competition. Team members should be present during judging to answer questions from the judges.
- c. The judges may choose a creativity winner during the poster competition. Creativity points may be earned for using a different reaction (not vinegar and baking soda), a special drive train, or unique safety feature, among other things.
- d. The winners of the poster and creativity competitions will be announced at the end of the performance competition.
- e. A team must achieve a score of 70% in the poster competition to be able to advance to the Chem-E-Car Performance Competition. Posters will be judged according to the following with a maximum of 20 possible points (equal weighting):
 - Description of the chemical reaction/power source
 - Environmental and safety features (particularly chemical hazards, required personal protective equipment, and safety tests done on the car)
 - Quality of the poster
 - Quality of team member presentationsPlease see the Competition website for the poster judging scoresheet to get a better idea of what is involved in each category.

Chem-E-Car Performance Competition

- a. Each car will be given two opportunities to traverse a specified distance. The required distance will be given to each team at least one-hour prior to the start of the performance competition. The distance will be between 20 - 45 ft \pm 0.5 inch. Teams may not adjust their vehicle weight once the poster session has started. Teams are allowed to adjust "fuel" or reactants that participate in the car's chemical reaction.
- b. The car will start with its front axle just above the designated starting point. There will be a designated finish line. The distance will be measured with respect to the front axle of the car. The goal of the competition is to have your car stop closest to the specified finish line. The course will be a track with a starting point and the prescribed distance clearly marked. A vehicle that jumps the track will have its distance measured from the finish line to where it jumped the track and will receive a penalty of an additional 10 feet. When measuring the distance from the finish line it does not matter if the car goes longer or shorter than the prescribed distance. If a car travels so far over the specified distance that it goes off the end of the track, a 10 ft penalty will be added to the distance from the finish line to the end of the track. If the car has not reached the finish line within two minutes, the distance will be measured at the two-minute mark.
- c. The track is 24 inches wide and 64 ft long. The surface of the track is the polished concrete floor. The track has edges of 1"x 2"x 8' dimensional lumber that is taped to the floor (painter's tape on the floor with double-sided duct tape on top of that). The 2" face of the lumber is horizontal (see Figure 1 for a picture of the track edge.) Your car **MUST** either go fairly straight down the track or have a mechanism to keep it from running into the wood and stopping. Once a car leaves the start line, **NO ONE** will be allowed to straighten the car if it runs into the rails. We will try to make the track available on a Saturday before the competition for trial runs. The car must be designed to maintain contact with the floor

throughout the run. If a car is stopped by a defect in the track, the judges will consult with the other teachers about allowing another run.

Figure 1. The new track edge is 1"x 2" x 8' dimensional lumber taped to blue painter's tape on



the floor with double-sided, white duct tape. The floor is polished concrete (fake terrazzo). The 2" face of the lumber is horizontal.

- d. The Chem-E-Car Competition judges (or MC) will announce each team just prior to the start of its run. The team members then have five (5) minutes to get to the starting line, introduce their entry to the audience (school name and briefly description of propulsion system) and start their car. Each car will have two (2) attempts with a duration of seven (7) minutes (suggested allocation, ~5 minutes to start and ~2 minutes to run the course) per attempt to complete the contest. The better score of these two attempts will be used in the judging. The next team to compete should be ready and at the staging area at least ten (10) minutes before its anticipated run time. (Use this time to measure your chemicals, and use the time between the poster session and the race to make dilutions.)
- e. In the first round of competition the order of the teams will be by random drawing. At the completion of the first round there will be a short break before the second round begins. The competition order in the second round will be determined by the first round standings, beginning with the team that had the entry furthest from the prescribed distance and ending with the team that was closest.
- f. The event will be timed to a precision of ± 0.5 s.
- g. Ties will be decided by the best average distance from the finish line.
- h. An objective of this contest is a demonstration of the ability to control a chemical reaction. The only energy source for the propulsion of the car is a chemical reaction. Commercial batteries (for example, AA batteries) are allowed as the power source **if** a controlled chemical reaction is used elsewhere in the car's system (as a stopping mechanism, for example). The phase change of dry ice to gaseous CO_2 is not a chemical reaction.
- i. The car can be built with just about any parts. The car may be built with K'NEXTM, LEGOs®, or a car kit purchased from a hobby store. The car may be a deconstructed model car. You may build your own car entirely from various parts.

- j. The car must be an autonomous vehicle and cannot be controlled remotely. Pushing to start the vehicle or a mechanical starting device is not allowed. Check with the Rules Coordinators if you have a specific question concerning your vehicle.
- k. No mechanical force can be applied to the wheel or ground to slow or stop the car (e.g. no brakes). The idea of the competition is that you control a chemical reaction to stop the car. A mechanism triggered or powered by a controlled, calibrated chemical reaction may be approved by the coordinators. Please contact the coordinators for prior approval.
- l. No mechanical or electronic timers are allowed.
- m. All components of the car must fit into a U-Haul[®] “small” box with dimensions of 16 inches x 12 inches x 12 inches. This box size is also available at office supply stores. The car may be disassembled to fit in the box. Cars will be tested before or during the poster session.
- n. The cost of the contents of the “small box” must be less than \$200.
- o. Schools are responsible for transportation of the chemicals to the competition sites. Safe transportation protocol must be followed. Schools are also responsible for arranging for the disposal of their chemicals and wastes. Generic acids, bases, and solvents may be disposed of on-site. **Hazardous chemical protocols must be followed and reported on the poster.** If obvious safety violations have occurred the judges have the discretion to disqualify the entry. If there is an uncertainty on an issue of safety contact the Rules Coordinators.
- p. All cars must safely operate inside a building. If a car is deemed unsafe, then the judges may disqualify it. **Only gases may be released from the car. SPILL PENALTY:** Any vehicle that releases anything besides gas by design will be penalized by adding 10 ft to the distance the car stops from the finish line. Given the general public's lack of understanding of general chemistry, anything that is visibly left behind may well be construed as chemical pollution and even hazardous. A team must clean up any accidental spills. Any entry using or producing a corrosive chemical(s) must have the chemical(s) sealed in a (or at least in a spill-proof) container. Any flame or smoke must be pre-approved, possibly by an outside demonstration before the competition. If there is an uncertainty on an issue of safety or other judging criteria contact the Rules Coordinators.
- q. The Occupational Safety and Health Administration has a list of chemicals that are considered to be special hazards (regulated chemicals). [Code of Federal Regulations, 1910 Subpart Z. Hazardous and Toxic Substances] Use or production of any of these chemicals in Chem-E-Cars is not allowed: asbestos, coal tar pitch volatiles, 4-nitrobiphenyl, alpha-naphthylamine, methyl chloromethyl ether, 3,3'-dichlorobenzidine, bischloromethyl ether, beta-naphthylamine, benzidine, 4-aminodiphenyl, ethyleneimine, beta-propiolactone, 2-acetylaminofluorene, 4-dimethylaminoazobenzene, n-nitrosodimethylamine, vinyl chloride, inorganic arsenic, benzene, 1,2-dibromo-3-chloropropane, acrylonitrile, ethylene oxide, formaldehyde, 4,4'-methylenedianiline, 1,3-butadiene, methylene chloride.
- r. A fume hood will be available for diluting chemicals between the poster competition and the race.
- s. Appropriate safety glasses or goggles must be worn by the team members operating the vehicle. Gloves should be worn as appropriate. All team members must wear long pants and closed-toe shoes to the competition.
- t. Pressurized gases may not be contained in PVC. If pressurized gas is used, calculations for the pressure generated are required. An entry that is pressurized must have evidence of proper/adequate pressure testing, and a pressure relief valve is recommended.

- u. Winners of the Chem-E-Car Competition will be recognized immediately following the performance competition. The number of awards will depend upon the number of participating teams: ≥ 4 teams, 2 places; ≥ 8 teams, 3 places.
 - 1st Place: \$300
 - 2nd Place: \$200
 - 3rd Place: \$100
- v. The \$100 prize for the Most Consistent Performance may be awarded at the judges' discretion. Consistency is defined as the smallest spread between the two runs (not distance from the finish line). A car must travel at least 20 ft to be eligible for the Most Consistent Performance Award.

Team Formation and Ethical Conduct

- a. Teachers or advisors may assist the students with ideas. Both the design and construction of the car should be done primarily by the students.
- b. The competition is a team competition. The minimum team size is five (5) participants. The team may be as large as an entire class or club. The entire team need not be present at the Chem-E-Car Competition; however, all members are encouraged to try to attend.
- c. A student may participate in only one team unless required by two different classes.

This document was prepared by the Rules Coordinators. It is modified from the rules of the American Institute of Chemical Engineers Chem-E-Car Competition, which may be read on their website at www.aiche.org/Students/Awards/ChemeCar.aspx.

Rules Coordinators:

Christi Patton
(918) 631-2978
Christi-patton@utulsa.edu

Laura Ford
(918) 631-2227
Laura-ford@utulsa.edu

Both are located in the Department of Chemical Engineering at the University of Tulsa, 600 S. College Ave., Tulsa, OK.