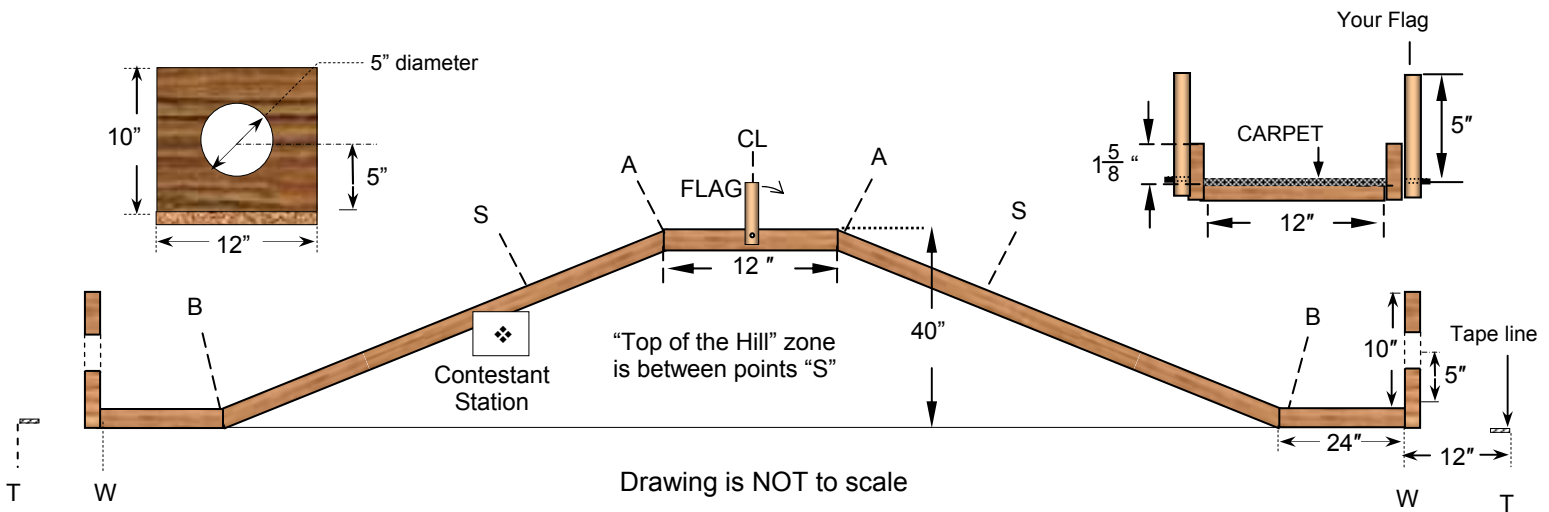


## 2009 DESIGN COMPETITION: RULES OF THE ROAD



Label	CL	A	S	B	W	T
Name	Centerline	Apex	Start Line	Bottom	Wall	Tape
Distance from A	6 in	--	12 in	8 ft	10 ft	11 ft

### THE CHALLENGE:

To design and construct a vehicle capable of performing each of the following tasks in no particular order (unless specified otherwise):

- *descend* a hill from the start line (S)
- *insert* a “hackysack” bean bag through the hole in a vertical wall (W) at the bottom of the hill.
- *propel* the hackysack past the “tape line” (T) on the other side of the wall.
- *ascend* the hill to reach the “top-of-the-hill” zone (must earn descending points first)
- *knock* over a flag located at the top of the hill (to the right of the vehicle as it ascends),
- *stop* at the top-of-the-hill
- *hold* position against an opposing vehicle at the “top-of-the-hill” zone
- *be closest* to the centerline (CL) of the “top of the hill” at the end of a 20-second time interval.

For the purpose of this competition, a “run” is defined as a single attempt against another vehicle, and a “round” as one or more runs against the same vehicle.

### THE TRACK:

The illustration above shows the approximate dimensions of the track. The 12-inch width of the track may vary by  $\pm 0.5$  inches along its length. The side rails are made from 1-by-3-inch boards. The carpet is a standard, commercial grade. The “top of the hill” zone is defined by the two start lines (S). Two flags, each consisting of a 1/2” dowel extending approximately 5 inches above the track bed (see illustration), are mounted on either side of the track at the centerline. A vehicle’s flag is located on the right side of the track as the vehicle ascends toward the “top of the hill.” A vehicle’s flag will pivot only in the direction of the forward motion of that vehicle. Contestants will approach the left-hand side of the ramp as seen from the side view (see ♣ above); this position is also the right-hand side as seen looking up the ramp from the bottom. The diameter of the hacky sack hole is 5”. The far edge of the tape, defining the “tape line” (T), is placed 12 inches beyond the back side of the wall.

### VEHICLE SPECIFICATIONS:

1. The complete vehicle must be designed to fit inside a 12-inch cube at the beginning of each run. The complete vehicle is defined by all its parts. Appendages, such as an arm, may extend beyond this limit once activated, but cannot be activated before the start of the run. The vehicle must remain contiguous throughout the competition. That is, it may not jettison any unattached

objects, and may not divide into two or more separate sections or pieces. All parts must remain attached to the vehicle. For the purpose of this rule, the definition of “attached” is meant to exclude attachment by string, wire, or other flexible tether.

2. The weight of the vehicle, including batteries, must not exceed 1.8 kg (4 pounds).

3. The vehicle must have a “reference point” for judging its position on the hill. This point must be chosen by the team and marked with a colored, adhesive dot (supplied by the judges). The dot must be placed on the rigid body of the vehicle, not on any extension, dropped object, or flexible string or wire. The dot must be visible from above. The position of the dot can be changed from round to round but must remain in the same place during a given round against another vehicle.

4. Judges will supply competition hackysacks at each ramp. Hackysack specifications and a recommended vendor is available at [www.bu.edu/eng/design](http://www.bu.edu/eng/design).

5. The vehicle must be stationary prior to the start, and it cannot be pushed by a team member as part of the start. After the start signal, the vehicle’s propulsion system may be activated using any suitable method, such as a switch or lever, but cannot be activated prior to the start.

6. In the execution of its tasks, the vehicle may not damage the track, its walls, or the roadway carpet. It may not make contact with the opposing vehicle anywhere beyond the (S) line on the opponent’s side of the hill.

7. Onboard computing devices, such as microcontrollers, are optional, but are permitted. However, after the start signal, no wire tethers or wireless control is permitted.

#### **POWER:**

8. Power to propel the vehicle and to run any onboard activation or electronic devices may be derived using any combination of battery types, including over-the-counter AAA, AA, C, D, and 9 V batteries, specialty power packs, and rechargeable batteries. Batteries may be connected to the vehicle in any configuration, and there is no limit to the number of batteries. Batteries may be combined in series, but may not produce a total voltage in excess of 18 V. Mechanical power may be derived from such devices as springs, mousetraps, balloons, and rubber bands. Metal compressed gas cylinders, chemical reactions, or combustion of any type are *not* allowed. Mercury switches of any type are *not* allowed.

#### **SAFETY:**

9. The objective of the competition is to foster engineering creativity and cooperation. The judges are ultimately responsible for ensuring safety of participants and spectators during the competition. Contestants utilizing any vehicle or feature deemed dangerous by the judges may be asked at any time to suitably modify the vehicle before continuing in the competition. It is the intent of the competition that vehicles not destroy or damage other vehicles. Offending vehicles may be disqualified at the discretion of the judges. Questions

may be directed to the judges prior to competition day ([engineering@bu.edu](mailto:engineering@bu.edu)), or in person on the day of the competition.

#### **RULES OF ENGAGEMENT:**

10. Team members will have two minutes to reach the starting position after being called for a round. At the judges’ discretion, any vehicle not ready after the two minute countdown will forfeit the round. If neither vehicle responds to the start, both will forfeit the round.

11. To start each run, the ramp judge will initiate a verbal countdown: “three, two, one, *go*.” The run will last for 20 seconds. Contestants may maintain contact with vehicles prior to “go” but may not touch vehicles during the 20-second run interval, even if one vehicle appears to be the winner. If a team touches its vehicle before 20 seconds has elapsed, the vehicle will be disqualified for that run.

12. If any part of either competing vehicle crosses the start line prior to the “go” signal, a false start will be declared. Any vehicle causing three false starts within a given round will forfeit that round.

13. After the start, all vehicle wheels must remain within the side rails of the track at all times. Deployed appendages may extend beyond the side rails after the start, but the tops of the side rails may not be used to support the vehicle in any way.

14. Teams may change vehicle batteries at any time except when a run is underway. If batteries are changed between runs within a round, a one-minute time limit will be given.

15. Teams may modify vehicles between rounds, but not between runs of the same round.

16. Only team members may enter the roped-off competition area and the vehicle repair area. Similarly, only team members may request verification of opposing vehicles for compliance with contest rules and design limits. Spectators are not permitted to make such requests.

17. Any vehicle compliance challenge must be made to the judges prior to the awarding of points for a particular round. If a vehicle is challenged and found to violate context requirements, it may be disqualified for that round.

18. Scoring challenges for a particular round must be made by the end of that round of the competition, and may only be made by team members. Resolution to point challenges will be made at the discretion of the judges.

#### **SCORING:**

For each round of open competition, a maximum of seven points will be awarded as follows:

**Descending Points:** One point will be awarded to each vehicle that successfully descends to the “bottom of the hill” on its own side of the ramp. To earn “bottom of the hill” points, the vehicle, and all its parts, must reside between points (B) and (W) at any point during the 20-second time interval.

**Hackysack Points:** One point will be awarded to each vehicle that successfully drops its hackysack through the hole in the wall. An additional point will be awarded to

each vehicle that propels the entire diameter of its hacky sack beyond the (T) line.

**Climbing Points:** One point will be awarded to each vehicle that resides, including all its parts, within the “top-of-the-hill” zone between the two start lines (S) at the end of the 20-second time interval. To receive climbing points, a vehicle must first earn descending points.

**Flag Points:** One point will be awarded to each vehicle whose flag (to its right as it ascends the hill) is knocked down during the 20-second time interval. Flag points will be awarded to a vehicle whose flag is knocked down regardless of which vehicle is responsible for the action.

**Top-of-the-Hill Points:** Two points will be awarded to the one vehicle whose “reference dot” is closest to the centerline at the end of the 20-second time interval. In order to receive “top-of-the-hill” points, the vehicle must reside within the S-lines that define the top of the hill. If the judges deem that the “reference dots” of two competing vehicles “on top of the hill” are at equal horizontal distances from the centerline, both will receive one point.

**Penalty Deductions:** Two points will be deducted from the run score of a vehicle that makes contact with its opponent beyond the (S) line on the opponent’s side of the hill before that vehicle has entered to top-of-the-hill zone. One point will be deducted for any vehicle that does not remain contiguous throughout the run. The minimum score for a run is zero; penalty points cannot yield negative scores.

**19.** If a vehicle *raises* the downed flag of its opponent, the opponent still retains its flag point.

**20.** If a new run is deemed necessary by the judges (for example, due to a false start) then both vehicle point scores return to zero for the new run.

**21.** If a vehicle falls off the ramp for any reason, it will retain points earned for the run prior to the mishap, as long as those points are earned before the end of the 20-second time limit.

### COMPETITION STRUCTURE:

Prior to the start of the official competition, teams are invited to participate in a “calibration round” against a random opponent. Judges will inform teams what their score would have been had the actual competition been underway. Vehicle inspections will also take place at this time.

**22.** Teams will compete in four rounds of open competition against four different opponents. Vehicles will be matched and scheduled for rounds at the discretion of the judges.

**23.** After the first four rounds of competition, the top 16 teams will advance to the semifinals based on total points accumulated during the open competition. If ties cause more than 16 teams to be in the top grouping, additional

single rounds, based on random pairings of the tied vehicles, will be held among the lowest scoring vehicles to reduce the semifinal contestants to 16 teams. Teams advancing to the semifinals will be seeded based on scores from the open competition. Four rounds of “best-of-three” elimination will determine the winner. The best-of-three rounds between teams will be held in succession on the same ramp.

**24.** Teams will be assigned work areas, but no tools will be supplied. Teams are expected to bring all necessary items to repair or modify vehicles during the competition, including spare batteries and parts.

**25.** After the official start of the competition, only registered student contestants will be allowed in the competition and work areas. Spectators are welcome to view the competition from the seating area adjacent to the competition ramp zone.

**26.** After each run, and prior to leaving the ramp area, teams are responsible for verifying that point totals have been correctly recorded by the ramp judge. Judges will be instructed to accommodate these checks.

**27.** In all cases, decisions of the judges are final.

### HELPFUL HINTS:

**28.** Design for both offensive and defensive strategies. Sometimes, it is advantageous to arrive at the top of the hill quickly and defend the position. An equally valid strategy may be to arrive at the top of the hill last and push back the opposing vehicle. Yet another strategy may be to avoid the centerline altogether and accumulate all other available points within the 20-second time interval.

**29.** Design so changes can be incorporated quickly. New ideas seen on other vehicles may be used. Vehicles may be redesigned or rebuilt at any time between rounds as long as they are operational when called for a round and meet specifications.

**30.** Design for durability. Opposing vehicles and accidents can damage a fragile design.

**31.** Design for easy repair. Keep the design simple. Complex designs are more likely to break and are difficult to repair.

**Note:** Periodic updates and answers to frequently asked questions will be posted on the College of Engineering Design Competition website at [www.bu.edu/eng/design](http://www.bu.edu/eng/design). Questions may also be directed to Sarah Silva event coordinator, at 617-353-6447, 800-578-1223, or [engineering@bu.edu](mailto:engineering@bu.edu).