



MESA DAY RULES

2020-2021

(FINAL/OFFICIAL)

The MESA Machine: Wind-Powered Vehicle

LEVEL: High School

DIVISION(S): Grades 9/10 and Grades 11/12

COMPOSITION OF TEAM: 1-3 students per team

NUMBER OF TEAMS: Preliminary – Determined by your local MESA Center
Regional – one team per division per Center

SPONSORS: University of Southern California MESA College Prep
Cal State East Bay MESA College Prep

OVERVIEW: Students will design and construct a complex machine that utilizes six to twelve different sequential and dependent actions from designated categories of simple machines/energy that will ultimately in the greatest amount of time propel a vehicle with wind to stop the closest to a target. Students must design their complex machine and vehicle to be transported by bus or car. **Participation logistics, limits, and competition facilities may vary by host site. Advisors and students are responsible for verifying this information with their Center Director.**

These competition rules are designed for in-person events. For virtual competitions, please refer to your Center Director for competition modifications and submission instructions. Recommendations for virtual events are provided in the Attachments/Appendix.

For the continued safety of students, families, advisors, and others, please follow your current COVID-19 local and university center guidelines.

MATERIALS: For the complex machine, all materials are legal with the exception of hazardous materials or unsafe energy.

For the wind-powered vehicle, all materials are legal with the exception of additional stored energy; kits are NOT allowed.

The Host Center will provide the following:

- Safety goggles

GENERAL RULES:

- 1) The students' full name, grade level, school name, and MESA Center must be clearly labeled on the machine. A 10% penalty in the score will be assessed for failing to properly label.

- 2) The complex machine must be initiated by a single operation of pulling a string provided by the team; the string or cord may be any type, thickness, material, etc. The pulling of the string **MUST** be performed outside of the *Safety Zone* (see Attachments/Appendix).
- 3) All parts of the complex machine must fit into a 50 cm by 50 cm by 50 cm cube (i.e., the *Machine Zone*). No parts, including moving parts such as marbles and levers, may extend outside of the *Machine Zone* at any time during inspection or during competition, except the parts for the single operation to initiate the machine in Rule 2.
- 4) No human or other assistance, interference, aid, etc. may be used for the entire operation of the complex machine (i.e., the machine must do all the work) **AFTER** the initiation of pulling the string.
- 5) The complex machine must incorporate between six (6) to twelve (12) actions that are sequential and dependent upon the previous action. Each of the six to twelve actions **MUST only** use one of the following listed categories of simple machines/energy:
 - a. Categories of simple machines/energy are **LIMITED** to the following seven:
 - i. Inclined plane (simple machine)
 - ii. Lever (simple machine)
 - iii. Wedge (simple machine)
 - iv. Wheel and axle (simple machine)
 - v. Pulley (simple machine)
 - vi. Screw (simple machine)
 - vii. Electronics (e.g., DC motors, circuit boards, generators, sensors, etc.) – electrical power will **NOT** be provided
 - b. Sequential and dependent actions must use a different category of simple machines/energy (e.g., an inclined plane to another inclined plane or an electronic to another electronic will be counted as one action).
 - c. Use of energy not listed will not be counted as actions.
 - d. The action to initiate the machine does **NOT** count as one of the six (6) to twelve (12) actions.
 - e. The sequence of actions **must end with an action that provides wind** to propel the vehicle.
- 6) The complex machine must propel the wind-powered vehicle within 90 seconds of the initiation.
- 7) The complex machine must have moving parts visible at all times to verify actions and categories of simple machines/energy (see Rule 5).
- 8) All parts of the **wind-powered vehicle** must fit into the 25 cm by 25 cm *Vehicle Start Zone*, including all lengths and widths of vehicle; no restriction on the height.
 - a. The vehicle must be solely powered by the wind energy provided by the complex machine; no other energy source may be added to the vehicle.
 - b. The vehicle may **NOT** have contact with the complex machine (e.g., the vehicle may not be attached to the complex machine with a rubber band or any other part).
 - c. The vehicle must have two or more axles (i.e., each with a wheel or group of wheels).
 - d. All wheels of the vehicle must stay in contact with the ground (i.e., the surface the competition area is set up on).
- 9) All construction materials are acceptable, with the exception of explosives, caustic chemicals, or other hazardous materials that may cause personal injury or damage to host facilities.
- 10) Digital media (e.g., photos, video recordings, etc.) will not be accepted for arbitration purposes.

JUDGING:

- 1) Machines and wind-powered vehicles will be checked for specifications prior to the start of the competition. Disqualified teams after this initial check will have an opportunity to compete if they meet ALL of the following conditions:
 - a. Accept an automatic “Mistrial” and therefore no score for Trial #1.
 - b. Make repairs/modifications as necessary to bring the device to proper specifications and be ready to compete when called for Trial #2.
 - c. Make repairs/modifications only in the designated area as indicated by the judges.
 - d. Failure to adhere to any of a, b, or c will result in the disqualification being upheld.
- 2) Teams that are not disqualified but wish to make repairs and modifications may do so, but they **MUST** be ready to compete when called for Trial #1.
- 3) Modifications and repairs are allowed during the competition; however, the team must provide all parts, materials, and supplies.
- 4) Each team must be ready when called or the team will forfeit that trial.
- 5) Each team will be allowed two (2) non-consecutive trials.
- 6) Each team will be given up to 120 seconds (2 minutes) to prepare the machine, make ready the wind-powered vehicle, and verify to the judge the six to twelve actions.
- 7) One team member will be responsible for the initiation of the machine (i.e., pulling of the string); the entire body, including hands and fingers, of the member must be outside of the *Safety Zone* (this is to ensure the safety of the student). The designated member will indicate to the judge the machine is ready. The team member must wait until the judge gives the “START” order.
- 8) Judge will record the following:
 - a. The number of actions will be determined for machine points by those that are executed (i.e., only actions that work will be counted).
 - b. Distance will be measured from the midpoint of the front axle of the wind-powered vehicle in the *Vehicle Start Zone* to the final resting position of the midpoint of the front axle of the vehicle for accuracy points. See Attachments/Appendix for competition area specifications.
 - c. Time will be measured to the nearest 00.01 seconds from the initiation of the machine (i.e., “START” order) to the start of the last action that provides wind to propel the vehicle for time points.
- 9) If the machine does not propel the wind-powered vehicle within 90 seconds of the initiation of the machine, the judge will only award points for the number of actions executed up to the 90 seconds limitation (i.e., points will be given for Machine and zero (0) points will be given for Distance **and** Time).
- 10) Team members may not touch, assist, aid or interfere with the machine once the string has been pulled.
- 11) The order of the competition will be randomly selected.
- 12) All team members and spectators must stand outside of the *Safety Zone* during each trial. Only judges are allowed inside the *Safety Zone*.

SCORING:

- 1) Machine points
 - a. 7 points for each sequential and dependent action executed (maximum of 84 points).
- 2) Accuracy points
 - a. 0 cm to 25 cm to the target = 25
 - b. 25.1 to 50 cm to the target = 15

- c. 50.1 cm to 150 cm to the target = 5
 - d. Greater than 150 cm to the target = 0
- 3) Time points
- a. 1 to 29.99 seconds = 5
 - b. 30 to 59.99 seconds = 15
 - c. 60 to 90 seconds = 25
- 4) Team Score = machine points + accuracy points + time points
- 5) The best team score of the two trials will be used.
- 6) **Tie Breaker:** if there is a tie among Final Team Scores, the lightest machine will be the winner.

AWARDS:

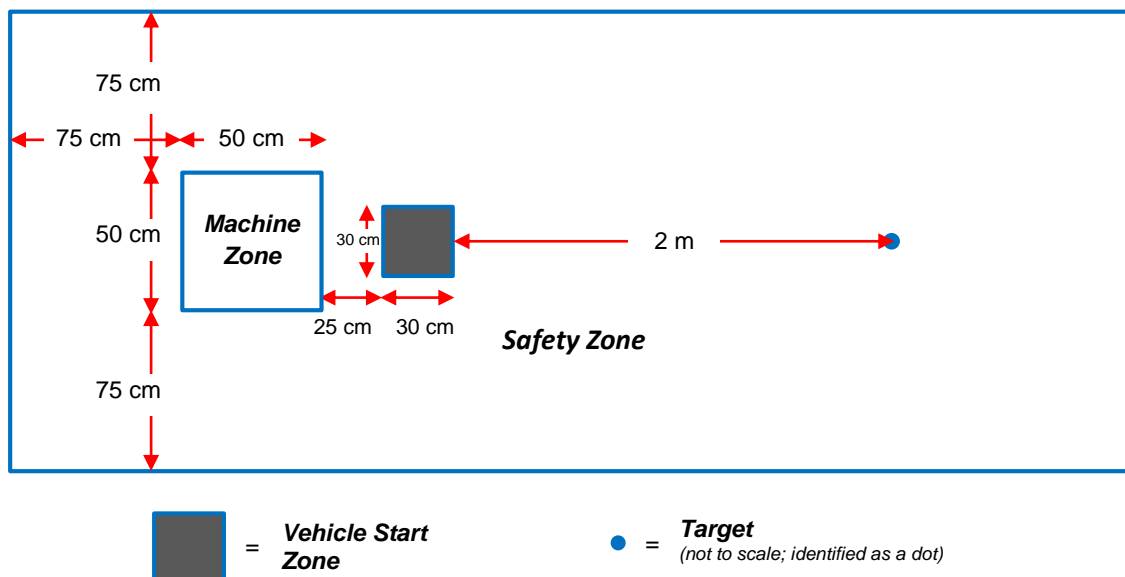
- Awards will be given per division: Grades 9/10 and Grades 11/12.
- Medals will be awarded for 1st, 2nd and 3rd place based on the highest final team score.
- Ribbons will be awarded for Innovative Engineering Design.
- Only 1st Place in the team score category in each division will advance to Regional/State MESA Day.

ATTACHMENTS/APPENDIX:

- Competition Area Specifications
- Recommended Equipment
- Judging Recommendations
- Virtual Competition Recommendations
- Inspection & Score Sheet for The MESA Machine

Competition Area Specifications

- *Machine Zone* is 50 cm by 50 cm.
- *Vehicle Start Zone* is 30 cm by 30 cm and 25 cm from and centered to *Machine Zone*.
- *Target* is 2 meters from and centered to the *Vehicle Start Zone*; the *Target* is identified as a dot.
- The *Safety Zone* is 5 meters by 2 meters.



Recommended Equipment

- Scale to weigh machines
- Measuring tape (metric)
- Blue painter's tape to outline *Machine Zone*, *Vehicle Start Zone* and *Safety Zone*
- Blue painter's tape to identify *Target*
- 1 stop watch to record trial time
- 3 safety goggles (required)

Judging Recommendations

At least four (4) judges are recommended with the following roles:

- 1 = Lead Judge
- 1 = Machine Monitor 1 to determine number of actions executed; judge may request the help of one team member to verify number of actions executed.
- 1 = Machine Monitor 2 to judge no parts extending outside of the *Machine Zone*.
- 1 = Time Keeper
- Additional judges can measure distance the vehicle traveled.

Virtual Competition Recommendations:

Please check with your center director for local competition modifications and submission instructions.

- Add General Rule: Teams must submit a video showing each action of The MESA Machine and the features of the wind-powered vehicle AND the operation of the machine from beginning to

end with the propelling of the wind-powered vehicle, including the measurement of the distance traveled. Submitted videos should not exceed 3 minutes in length.

- Eliminate or modify General Rules 1 (labeling), 3 (machine size restrictions) and 10 (digital media for arbitration).
- Eliminate or modify General Rule 2 (i.e., how MESA Machine is initiated).
- Modify size restrictions for the wind-powered vehicle in General Rule 8.
- Modify Judging with the following:
 - Project video will be judged during the defined period per the local competition schedule. Videos submitted after the deadline will NOT be judged.
 - Videos must be viewable and accessible to local center judges. If permissions are needed, please grant them to your local center staff. Videos that cannot be accessed will not be judged and scored. Regarding quality, videos must be clear enough to be able to see the following:
 - the machine (including the parts and each action),
 - the wind-powered vehicle (including the parts and features), and
 - the distance traveled by the wind-powered vehicle for judging and scoring (including measurement of the distance).

Machines and wind-powered vehicles that cannot be clearly seen will not be judged and scored.

- Tiebreaker: in the event of ties among Final Team Scores, teams will be evaluated based on the following stages:
 - Stage 1: number of working actions
 - Stage 2: total number of actions
 - Stage 3: distance of wind-powered vehicle from accuracy
 - Stage 4: time from the initiation of machine to the start of the last action that provides wind to propel the vehicle

INSPECTION AND SCORE SHEET FOR THE MESA MACHINE**High School – Grades 9/10 and Grades 11/12***Copies of this inspection and score sheet will be provided by the MESA Day Host Center.*Student Names: _____ Grade: **9/10** or **11/12** (circle one)

School: _____ MESA Center: _____

List six to twelve actions of machine in sequential order (do NOT list action to initiate machine)

- | | |
|----------|-----------|
| 1. _____ | 7. _____ |
| 2. _____ | 8. _____ |
| 3. _____ | 9. _____ |
| 4. _____ | 10. _____ |
| 5. _____ | 11. _____ |
| 6. _____ | 12. _____ |

Section below to be completed by Judges**INSPECTION LIST (for in-person events):** **YES** **NO**Wind-powered vehicle fits 25 cm x 25 cm, including all lengths and widths ☐ ☐Wind-powered vehicle has no other energy source, no contact with machine, and \geq two axles ☐ ☐All parts of machine fit into 50 cm x 50 cm x 50 cm ☐ ☐Machine is initiated by pulling a string outside of *Safety Zone* ☐ ☐Machine incorporates six (6) to twelve (12) actions (see Rule 5) ☐ ☐No hazardous materials or unsafe energy are used ☐ ☐Machine labeled properly (students' full name, grade, school name, and MESA Center) ☐ ☐**Weight:** _____ **Innovative Engineering Design (ranking – 1, 2, 3, etc.):** _____

TRIAL 1					
Machine		Accuracy (cm = closest to <i>Target</i>)		Time	
# of actions executed (<i>see Rule 5 – max. of 12</i>)		0 to 25 = 25		1-29.99 sec = 5	
		25.1 to 50 = 15		30-59.99 sec = 15	
	x 7	50.1 to 150 = 5	> 150 cm = 0	60-90 sec = 25	> 90 s = 0 points
Points		+ Points		+ Points	

Mistrial (reason): _____

TEAM SCORE: _____

TRIAL 2					
Machine		Accuracy (cm = closest to <i>Target</i>)		Time	
# of actions executed (<i>see Rule 5</i> – <i>max. of 12</i>)		0 to 25 = 25		1-29.99 sec = 5	
		25.1 to 50 = 15		30-59.99 sec = 15	
	x 7	50.1 to 150 = 5	> 150 cm = 0	60-90 sec = 25	> 90 s = 0 points
Points		+ Points		+ Points	

Mistrial (reason):

TEAM SCORE: _____**Best** of two trial Team Scores_____

Machine Labeling Penalty (10%) - _____

Final Team Score (best of two trials)...._____