



# MESA DAY CONTEST RULES

2023-2024

(FINAL/OFFICIAL)

## MESA Machine: Wind-Powered Vehicle

- LEVEL:** High School (HS)
- DIVISION(S):** Grades 9/10 and Grades 11/12
- COMPOSITION OF TEAM:** 2-3 students per team
- NUMBER OF TEAMS:** Preliminary – Determined by your local MESA center  
Regional – # of teams per division at the discretion of each region  
(Northern/Central, LA/Central Coast, and Southern)
- SPONSORS:** University of Southern California MESA College Prep
- OVERVIEW:** Students will design and construct a complex machine that utilizes four to eight different sequential and dependent actions from designated categories of energy/simple machines that will ultimately in the greatest amount of time propel a vehicle with wind to stop closest to the target **3 meters** away. Students must design their vehicle to be propelled as a bus or car. Competition suggested to be held indoors on smooth vinyl flooring. **Participation logistics, limits, and competition facilities may vary by host site. Advisors and students are responsible for verifying this information with their local MESA center.** Students should take into consideration the transportation of projects; competition ready projects must be transported safely to the competition site.
- An engineering lab book is a required component of this competition. The purpose of the Engineering Lab Book is for students to better understand the process an engineer goes through in the creation of a project. MESA projects are not designed to be completed in a single class period or day, but to be the result of thoughtful research, planning, analysis and evaluation. Keeping a lab book throughout the design process will help to keep a designer on track, using a logical progression of planning, in order to develop their project efficiently.
- 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.

For the Engineering Lab Book, **electronic submission will be required.** Teams should use an electronic portal/application such as Google Docs to keep and maintain a lab book. Access and permission to the lab book must then be given to MESA Day staff and judges OR lab book is submitted electronically (e.g., PDF file, WORD file) for review. **Please check with your local MESA center for the deadline and submission platform to submit your team's lab book for local and for regional events.** See "MESA Day 23-24 Engineering Lab Book Guidelines" at <https://mesa.ucop.edu/>.

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 team 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 (i.e., the MESA 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 four (4) to eight (8) actions that are sequential and dependent upon the previous action. Each of the four to eight actions **MUST only** use one of the following listed categories of energy/simple machines:
  - a. Categories of energy/simple machines, **which MUST be safe and not cause personal injury or damage to host facilities**, are LIMITED to the following:
    - i. Gravity (e.g., free fall, ramps, etc.)
    - ii. Springs or rubber bands (e.g., tension springs, bungee cords, torsional springs, mousetrap, etc.)
    - iii. Levers or pulleys (e.g., seesaw, bottle opener, tongs, fixed pulley, movable pulley, compound pulley, etc.)
    - iv. Electronics (e.g., DC motors, circuit boards, generators, sensors, etc.) - electrical power will NOT be provided
    - v. Pressured fluids (e.g., air or water)
  - b. Four (4) different categories of energy/simple machines listed above **MUST** be used.
  - c. Sequential and dependent actions **MUST** use a different category of energy/simple machines (e.g., free fall using gravity to a ramp using gravity will be counted as one action, a circuit board using electronics to a DC motor using electronics will be counted as one action, etc.).
  - d. Each of the four (4) to eight (8) actions **MUST** be clearly identified/labeled as "1", "2", "3", "4", etc. next to the corresponding action with a marker, masking tape or similar. A separate 10% penalty in the team score will be assessed for failing to label each action.
  - e. Use of energy/simple machines not listed will **NOT** be counted as actions or categories of energy/simple machines.

- f. The action to initiate the machine does NOT count as one of the four (4) to eight (8) actions.
  - g. The sequence of actions must end with an action that provides wind to propel the vehicle; the device that provides the wind must be turned on by the previous action.
- 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 energy/simple machines (see General Rule 5).
  - 8) All parts of the **wind-powered vehicle** (e.g., wheels, axles, frame, sail, any moving parts) must fit into the 25 cm by 25 cm *Vehicle Start Zone*, including all lengths and widths of the 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. As a bus or car, the vehicle must have two or more axles with wheels.
  - 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.
  - 11) The lab book is meant to clearly demonstrate and illustrate evidence of the application of the Engineering Design Process in the MESA project.

## JUDGING:

- 1) Machines and wind-powered vehicles will be checked for specifications prior to the start of the competition. Teams that do not meet specifications 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 disqualification.
- 2) Teams that meet the specification check 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 will be allowed two (2) non-consecutive trials.
- 5) Each team must be ready when called or the team will forfeit that trial.
- 6) Each team will be given up to 120 seconds (2 minutes) to prepare the machine, make ready the wind-powered vehicle, and verify the machine actions (i.e., each action) to the judge.
- 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. For machine points, the number of actions will be determined by those that are executed (i.e., only actions that work will be counted).
  - b. For time points, time will be measured to the nearest 00.01 seconds from the initiation of the machine (i.e., “START” order) to the end of the last action that provides wind to propel the vehicle.
  - c. For accuracy points, distance will be measured from the final resting position of the

midpoint of the front axle of the vehicle to the *Target*. See Attachments/Appendix for competition area specifications.

- 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 Actions and zero (0) points will be given for both Machine Time **and** Accuracy).
- 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 Action Score
  - a. 10 points for each sequential and dependent action executed (maximum of 80 points)
- 2) Machine Time Score
  - a. 1 to 29.99 seconds = 5
  - b. 30 to 59.99 seconds = 15
  - c. 60 to 90 seconds = 25
- 3) Accuracy Score
  - a. 0 cm to 25 cm to the *Target* = 25
  - b. 25.1 cm 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
- 4) Team Score = Machine Action Score + Machine Time Score + Accuracy Score
- 5) **Performance Points (best of two trials)**
  - a. Winning Performance ( $P_w$ ) = team with the best team score from all teams in the same Division/Grade Level (receives 75 points)
  - b. Team Performance ( $P_t$ ) = team's best team score out of two trials
  - c. Team Performance Ratio =  $P_t$  divided by  $P_w$
  - d. **Team Performance Points =  $P_t / P_w \times 75$**
- 6) Final Team Score = (Team Performance Points - Penalties) + Engineering Lab Book Points
- 7) Tiebreaker: if there is a tie, the lightest machine will be the winner.

### AWARDS:

- **Teams who do not submit an Engineering Lab Book will NOT be eligible for any awards.**
- Awards will be given per division: Grades 9/10 and Grades 11/12.
- Medals will be awarded for 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> place based on the highest Final Team Score.
- Ribbons will be awarded for Innovative Engineering Design.
- Only teams that place in the Final Score category will advance to Regional MESA Day; please check with your MESA center to determine the # of teams that advance to Regional MESA Day.

### ATTACHMENTS/APPENDIX:

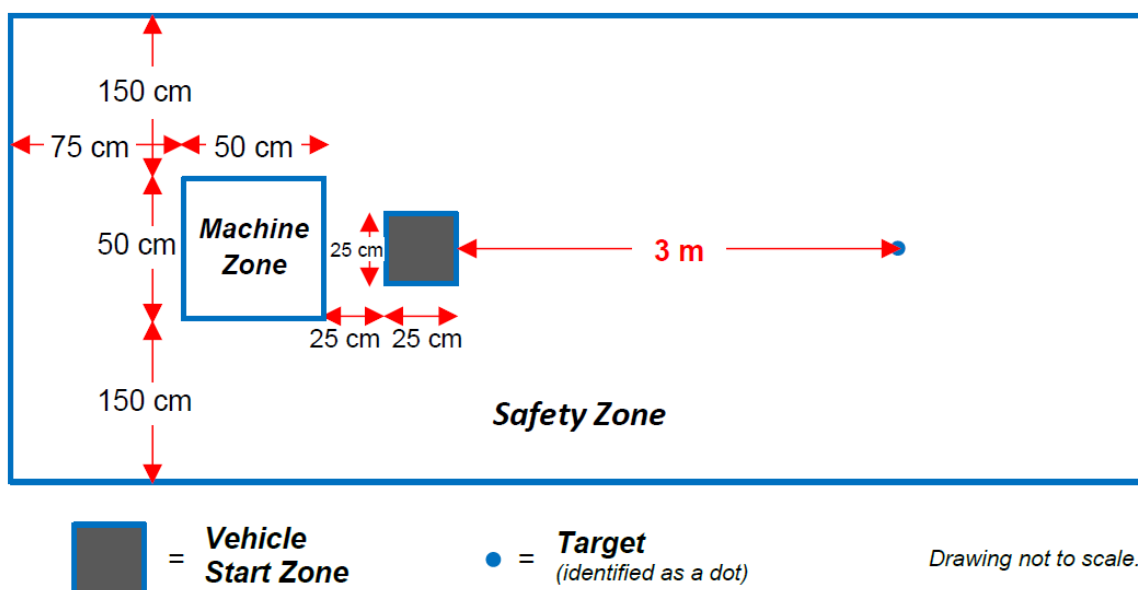
- MESA Machine 2023-2024 Online Modules
- Competition Area Specifications
- Recommended Equipment
- Judging Recommendations
- Inspection & Score Sheet for The MESA Machine

### MESA Machine 2023-2024 Online Modules

- Learn about the project, get clarifications on competition rules, get an overview of judging, and consider important science and mathematical concepts (**includes Judging Resources**)

### Competition Area Specifications

- Competition suggested to be held indoors on smooth vinyl flooring.
- *Machine Zone* is 50 cm by 50 cm and centered along the 2 m wide *Safety Zone*.
- *Vehicle Start Zone* is 25 cm by 25 cm, and 25 cm from and centered along the width of the *Machine Zone*.
- *Target* is **3 meters** from and centered to the Vehicle Start Zone; the Target is identified as a dot.
- *Safety Zone* is 6 meters by 3.5 meters.



### Recommended Equipment

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

### Judging Recommendations

At least three (3) judges are recommended with the following roles:

- 1 = Lead Judge / 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 the distance from the target to the final resting position of 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 four to eight actions of machine	List corresponding category of energy used (see Rule 5)
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.
8.	8.

**Section below to be completed by JUDGES**

INSPECTION LIST:	YES	NO
Wind-powered vehicle fits 25 cm x 25 cm, including all lengths and widths .....	<input type="checkbox"/>	<input type="checkbox"/>
Wind-powered vehicle has no other energy source, no contact w/machine, and ≥ two axles .....	<input type="checkbox"/>	<input type="checkbox"/>
All parts of the machine fit into 50 cm x 50 cm x 50 cm .....	<input type="checkbox"/>	<input type="checkbox"/>
Machine is initiated by pulling a string outside of the Safety Zone .....	<input type="checkbox"/>	<input type="checkbox"/>
Machine incorporates four (4) to eight (8) actions (see Rule 5) .....	<input type="checkbox"/>	<input type="checkbox"/>
Machine uses four (4) different categories of energy/simple machines (see Rule 5) .....	<input type="checkbox"/>	<input type="checkbox"/>
No hazardous materials or unsafe energy are used .....	<input type="checkbox"/>	<input type="checkbox"/>
Machine labeled properly (students' full name, grade, school name, and MESA center) .....	<input type="checkbox"/>	<input type="checkbox"/>
Each Machine Action clearly identified/labeled (1, 2, 3, 4, etc.) .....	<input type="checkbox"/>	<input type="checkbox"/>

Weight: \_\_\_\_\_ Innovative Engineering Design (ranking – 1, 2, 3): \_\_\_\_\_

TRIAL 1					
Machine Actions		Machine Time		Accuracy (cm = distance to Target)	
# of actions executed (see Rule 5 – max. of 8)		1-29.99 sec = 5		0 to 25 = 25	
	x 10	30-59.99 sec = 15		25.1 to 50 = 15	
		60-90 sec = 25	> 90 s = 0 points	50.1 to 150 = 5	> 150 cm = 0
Score		+ Score		+ Score	

Trial 1 Mistrial (reason): \_\_\_\_\_ **TRIAL 1 Team Score =** \_\_\_\_\_

TRIAL 2					
Machine Actions		Machine Time		Accuracy (cm = distance to <i>Target</i> )	
# of actions executed ( <i>see Rule 5 – max. of 8</i> )		1-29.99 sec = 5		0 to 25 = 25	
	x 10	30-59.99 sec = 15		25.1 to 50 = 15	
		60-90 sec = 25	> 90 s = 0 points	50.1 to 150 = 5	> 150 cm = 0
Score		+ Score		+ Score	

Trial 2 Mistrial (reason):

TRIAL 2 Team Score = \_\_\_\_\_.

**FINAL TEAM SCORE (best of two trials)**

Team Score ( $P_t$ )		<b>Winning Performance Team Score (<math>P_w</math>)</b> from all teams in the same Division/Grade Level		Team Performance Points = $P_t / P_w \times 75$	
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Team Performance Points	
Machine Labeling (names, grade level, school, center) Penalty (10%)	-
Machine Action (i.e., 1, 2, 3, 4, etc) Labeling Penalty (10%)	-
<b>Subtotal</b>	=
Engineering Lab Book Points (0 to 25 points)	+
<b>Final Team Score</b>	

Engineering Lab Book Submitted:  Yes  No

*Teams who do not submit an Engineering Lab Book will NOT be eligible for any awards.*