MESA DAY CONTEST RULES 2026-2027
(DRAFT)

Moon Base

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: California State University, East Bay MESA College Prep Center
California State University, Long Beach MESA College Prep Center

OVERVIEW: In the future, space agencies from many nations are planning to return to the moon with plans to establish permanent research stations. As is obvious from the many craters on the moon visible from the Earth, meteor strikes are a relatively common occurrence with devastating results. Your task is to design a structure to house these new moon-based research activities that will protect the astronaut from meteor strikes.

Students will design and construct an original structure using only recycled cardboard that can withstand the highest amount of impact, is lightweight, and meets the specific size requirements outlined below. **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.

LAB REPORT: An **engineering lab report** is a required component of this competition that is meant to clearly demonstrate and illustrate evidence of the application of the Engineering Design Process in the MESA project. The purpose of the Engineering Lab Report 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 report 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.

For the Engineering Lab Report, **electronic submission will be required**. Teams should use an electronic portal/application such as Google Docs to keep and maintain a lab report. Access and permission to the lab report must then be given to MESA Day staff and judges OR lab report 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 report for local and for regional events.** See "MESA Day 26-27 Engineering Lab Report Guidelines" at https://mesa.ucop.edu/.

MATERIALS:

For the structure, the only allowable material is deconstructed, post-consumer, not plastic coated, unpainted cardboard without seams with up to a maximum 5mm thickness. **No other materials are allowed.**

The Host Center will provide the following during the competitions:

1) Safety Goggles
2) Scale for weighing the structures
3) Measurement device (tape measure, rulers, calipers and/or other appropriate measurement devices to measure specifications)
4) 20 cm radius half-sphere Internal Measurement Device (see Figure 3)
5) The Impact Testing Device (pulley system must be used during Prelims and Regionals)
    a) As needed, a step stool for assembling the impact testing device may be used
6) An empty 12 ounce standard soda can (with height of 12.1 cm) for the Astronaut
7) Paint (fingerpaint, bright colored, glow-in-the-dark, etc.), brushes for applying paint or plates for dipping cans into paint
8) Square Guide for centering "astronaut" (24 inch x 24 inch printout)
9) Floor
    a) As needed, a surface to protect the integrity of the floor may be used.

GENERAL RULES:

1) The students' full name, grade level, school name, and MESA center must be clearly labeled on the structure. A 10% penalty in the score will be assessed for failing to properly label. Once the structure has been checked in, changes and alterations are not allowed.
2) Only recycled, deconstructed, post-consumer, not plastic coated, unpainted cardboard without seams (e.g., teams cannot submit a post-consumer box as is) with up to a maximum 5 mm thickness can be used to create the structure (polymers, wood, metal, ceramics, etc. are not allowed). Students are NOT allowed to create glued connections or laminates on the existing cardboard or mix substances (e.g., water) with the cardboard; however, cardboard can be layered.
    a) After the project has been tested, there will be a forensic inspection to ensure no additional materials are used on the internal structure and no individual piece of cardboard is thicker than 5 mm.
3) All joints or connections must be created with allowed materials; no glue, tape, or other external adhesive of any type can be used in any way or form. Carved, mortise, tenon, or other systems using exclusively cardboard are allowed.

4) The structure (including all parts - joints, connectors, etc.) MUST fit the following specifications. Note that the shapes and geometry of the Moon Base are up to the teams to determine as long as they meet the specifications (See Figure 1):
    a) Maximum linear length = 55 cm
    b) Maximum linear width = 55 cm
    c) Maximum linear height = 25 cm
    d) Minimum interior clearance = must fit a 20 cm radius half sphere in the center.
    e) Maximum Structure Weight = 600 grams
5) Structure must be **fully enclosed**, except the following:
    a) The entire structure must NOT have a base/floor.
    b) The structure must ONLY have two rectangular openings, to allow the "astronaut" to be seen by the audience and to allow the inspection of the structure with the following dimensions (see Figure 2):
        i) A height of between 9 cm and 11 cm
        ii) A MINIMUM width of 10 cm to a MAXIMUM width of 20 cm
6) No material (e.g., paint, varnish, hairspray, etc.) may be applied to the structure, with the exception of the ink or pencil used to identify students' full name, grade level, school, and MESA center. Any tape that is on the post-consumer cardboard must be removed (e.g., tape on an Amazon box). Pre-existing markings and printings from manufacturing are acceptable (see What is Cardboard? for examples).
7) Please remember that the purpose of this contest is to use creativity to build the best structure within the framework of the rules. The purpose is not to break the rules and see if you can get away with it.
8) The structure and lab report must be the original work of the students. Judges may ask questions to confirm authenticity.
9) Digital media (e.g., photos, video recordings, etc.) will not be accepted for judging purposes. **All judging decisions are final.**

FIGURE 1

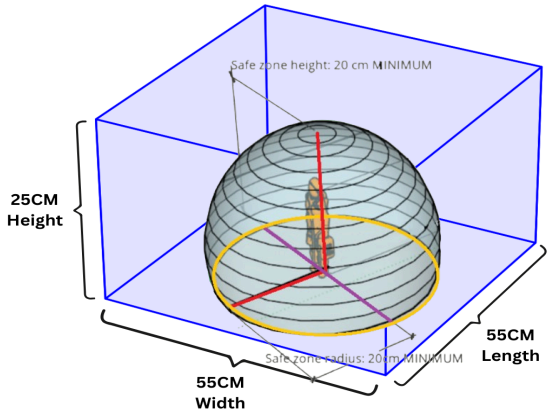

FIGURE 2

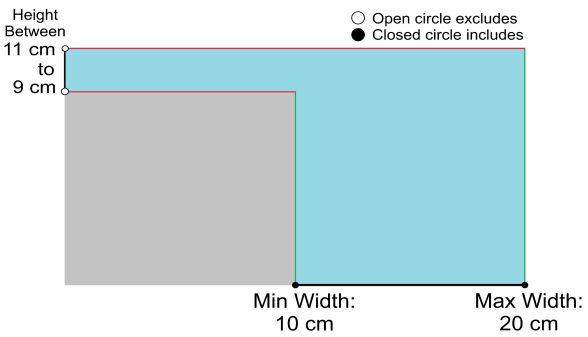

Figure 1. Demonstrates the maximum build dimensions for the moon base structure and the minimum interior clearance of the 20 cm radius half-sphere "safe zone". for the moon base structure. Structures can be any shape as determined by the teams, but must fit over the half sphere and within the 55 x 55 x 25 cm.

Figure 2. Demonstrates the allowed shape and size of the 2 openings. The height must be between 9 cm and 11 cm, and the width can range from a minimum of 10 cm (gray) to a maximum of 20 cm (gray+blue).

JUDGING:

1) Prior to load testing, the structure receives a specification check to determine whether it conforms to the weight, dimensions, and construction rules. An internal measurement device (see Figure 3 below) will be used to ensure that competing teams have left enough clearance inside of their structure to meet specifications.
2) The competing structure is weighed and its mass "m_s" is recorded in grams.
3) The structure will be centered on a flat, sound surface under the Impact Testing Device. A "crash test dummy astronaut" (i.e., an empty 12 ounce standard soda can) with a height of 12.1 cm will be centered in the interior space. After each test, the Moon Base and astronaut must be re-centered below the testing device.
    a) In setting up the competition, place the square guide on the ground to denote the center. Teams are responsible for placing their device as close to the center as possible.
4) A load with a mass "m_l" (in grams) will impact the structure, starting at an elevation of 50 cm, measured from the flat surface where both the structure and testing device are standing. After the impact, the judges will verify that the structure remains intact and did not touch the astronaut body (i.e., the empty 12 oz standard soda can). If the structure has touched the body of the astronaut or the hitchball breaks through the structure entirely, either will count as the point of failure because it did not protect the astronaut. The hitch ball, used as the load, will need to be weighed ("m_l") prior to testing.
    a) The Host Center will provide a 12.1 cm tall "astronaut" made of an empty 12 ounce standard soda can. Bright-colored paint will be placed on the top of the "astronaut's head" to see if the structure hit the astronaut.
    b) A new can should be used for each team unless the can used in the previous trial was not touched by the Moon Base.
5) If the structure or impact weight/hitch ball did not touch the astronaut or break through the structure, the height of the impact will be increased by increments of 25 cm up to 200 cm (i.e., 75 cm, 100 cm, 125 cm, 150 cm, 175 cm and 200 cm). The impact height "H" (in cm) is the highest measured impact height that still protects the astronaut; the highest measured impact height is recorded.
    a) A structure that does not protect the astronaut at its initial impact height of 50 cm will be disqualified.
6) Disqualified structures are not eligible for awards. However, they may be tested in private, time permitting.

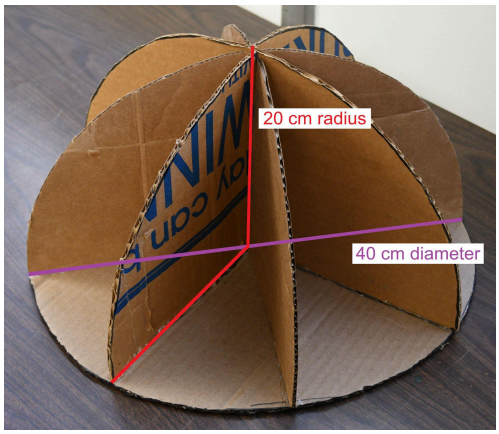

Figure 3. Internal measuring device.

The "safe zone" internal measuring tool was created by Julian Peña, Lead Judge with the San Jose State University MESA Center and improved by CSU Long Beach MESA Center. Image by CSU Long Beach MESA Center.

SCORING:

1) The structures will be scored by their Impact-to-Mass Ratio, "I/M" calculated as:

   $I/M = m_l * g * (H * 10^{-2}) / m_s$

   Where: m_l is the mass of the hitch ball in grams; g is the gravity, 9.81 m/s^2; H is highest impact elevation in centimeters; and m_s is the mass of the competing structure in grams.

2) **Performance Points**
   a) Winning Performance (P_w) = team with the highest Impact-to-Mass Ratio from all teams in the same Division/Grade Level (receives 75 points)
   b) Team Performance (P_t) = team's Impact-to-Mass Ratio
   c) Team Performance Ratio = P_t divided by P_w
   d) **Team Performance Points = P_t / P_w x 75**

3) Final Team Score = (Team Performance Points - Penalties) + Engineering Lab Report Points

AWARDS:

- Teams who do not submit an Engineering Lab Report 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 1st, 2nd, and 3rd place based on the best Impact-to-Mass Ratio.
- Ribbons will be awarded for 1st, 2nd, and 3rd place based on Innovative Engineering Design Ranking.
- Only teams that place in the Impact-to-Mass Ratio category will advance to Regional MESA Day; please check with your local MESA center to determine the number of teams that advance to Regional MESA Day.

ATTACHMENTS/APPENDIX:

- A: Moon Base Specifications Checklist
- B: Inspection and Score Sheet for Moon Base

A. MOON BASE SPECIFICATIONS CHECKLIST

This checklist is provided **ONLY** as a reference for teams to "pre-inspect" their Moon Base structures to ensure they meet the rules specifications. Teams may check-off each of the following items after comparing their competition-ready Moon Base structures with the rules. **This checklist will NOT be used by judges.**

- ☐ 2026-2027 rules are used.
- ☐ Engineering Lab Report is properly labeled with team members' full names, grade level, school name, and MESA center.
- ☐ Moon Base structure is properly labeled with team members' full names, grade level, school name, and MESA center.
- ☐ Only recycled, deconstructed, post-consumer, not plastic coated, unpainted cardboard is used.
- ☐ No glue, tape, or other external adhesives of any type are used.
- ☐ No individual piece of cardboard is thicker than 5 mm.
- ☐ The maximum linear length of the structure is not greater than 55 cm.
- ☐ The maximum linear width of the structure is not greater than 55 cm.
- ☐ The maximum linear height of the structure is not greater than 25 cm.
- ☐ The interior of the structure fits a 20 cm radius half sphere in the center (minimum interior clearance).

  Note: It is highly suggested that teams create their own internal measurement device to ensure that they build a structure that fits over it.
- ☐ The structure weighs 600 g or less.
- ☐ The structure is fully enclosed with the exception of the two rectangular openings and NO base/floor.
- ☐ Each of the two openings has a height of between 9 cm and 11 cm.
- ☐ Each of the two openings has a minimum width of 10 cm to maximum width of 20 cm.

B: INSPECTION AND SCORE SHEET FOR MOON BASE

High School – Grades 9/10 and Grades 11/12

Student Names: _____ Grade: 9/10 or 11/12 (circle one)

School: _____ MESA Center: _____

Section Below to be Completed by JUDGES

ENGINEERING LAB REPORT: ☐ Submitted ☐ Not Submitted (NOT eligible for any awards)

SPECIFICATION CHECK:

General Rules	YES	NO
Moon Base is labeled properly (students' full name, grade, school name, and MESA center)	No Penalty	-10%
Only recycled, deconstructed, post-consumer, not plastic coated, unpainted cardboard is used	PASS	DQ
No glue, tape, or other external adhesive of any type is used	PASS	DQ
Width of individual cardboard pieces is no thicker than 5 mm	PASS	DQ
Maximum linear length of the structure is not greater than 55 cm	PASS	DQ
Maximum linear width of the structure is not greater than 55 cm	PASS	DQ
Maximum linear height of the structure is not greater than 25 cm	PASS	DQ
Minimum interior clearance: Interior of structure fits a 20 cm radius half sphere in the center	PASS	DQ
Maximum structure weight is 600 g	PASS	DQ
Structure is fully enclosed with the exception of the two rectangular openings and no base/floor	PASS	DQ
Structure has two rectangular openings with a height of between 9 cm and 11 cm	PASS	DQ
Structure has two rectangular openings with a minimum width of 10 cm to maximum of 20 cm	PASS	DQ

Structure Weight (in grams): _____ **Innovative Engineering Design Ranking (1, 2, 3, etc.):** _____

TESTING RESULTS:

Mass of Hitch Ball (in grams)		Highest Impact Height (in centimeters)	

$I/M = m_l * g * (H * 10^{-2}) / m_s$

Where: m_l is the mass of the hitch ball in grams; g is the gravity, 9.81 m/s^2; H is highest impact height in centimeters; and m_s is the mass of the competing structure in grams.

Mass of Hitch Ball Multiplied by 9.81 (force of gravity)	Highest Impact Height multiplied by 10^{-2}	Multiply the result in column 1 to the result in column 2	Divide the result in column 3 by the weight of the Moon Base
Example: *Mass of hitch ball is 1154 g.* *1154 g x 9.81 m/s^2 = 11,320.74*	*Example:* *Highest Impact Height is 125 cm.* *125 cm x 10^{-2} = 1.25 m*	*Example:* *11,320.74 x 1.25 m* *= 14,150.925*	*Example:* *Structure weight is 231 g.* *14,150.95/231 g = 61.26*

FINAL TEAM SCORE:

Team Performance (team's I/M)	
Winning Performance (highest I/M from all teams in the same Division/Grade Level)	
Team Performance Ratio (Team Performance ÷ Winning Performance)	
Team Performance Points (Team Performance Ratio x 75)	
only if applicable - **Moon Base Labeling Penalty** (10%)	-
Engineering Lab Report Points (if lab report was not submitted, not eligible for any awards)	+
Final Team Score (Team Performance Points - Penalties) + Engineering Lab Report Points	