



MESA DAY CONTEST RULES 2017 - 2018

Rube Goldberg Device

- LEVEL:** Grades 9/10 and 11/12
- TYPE OF CONTEST:** Team
- COMPOSITION OF TEAM:** 2-3 students per Team
- NUMBER OF TEAMS:** Preliminary – As determined by your local MESA Center
Regional – 3 for 9th/10th Grade; 3 for 11th/12th Grade per Center
- SPONSOR:** Ben Louie, Associate Director, USC MSP

OVERVIEW: Students will design and construct a device that utilizes four to eight different sequential and dependent actions from four different energy categories that will ultimately launch a vinyl kick ball to land the closest distance to a target in the greatest amount of time. Students must design their device to be transported by bus or car. **Participation logistics and limits and competition facilities may vary by host site. Advisors and students are responsible for verifying this information with their Center Director.**

An engineering notebook is a required component of this competition. The purpose of the Engineering Notebook is for students to more closely follow the practices of an engineer in the completion of their MESA Day project. The Engineering Notebook will encourage students to take a purposeful and sustained approach to building their devices. 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. The notebook should provide a written record of the thought and insight that a student put into their project, from initial ideas to the final completed project.

MATERIALS: For the device, all materials are legal with the exception of remote control devices, hazardous materials, or unsafe energy.

For the Engineering Notebook, any standard notebook, including but not limited to spiral and subject notebooks and composition books may be used. Notebook page size must be equivalent or greater than that of a composition book page (approx. 9.75" length x 7.5" width). Pocket sized notebooks, post it notes, flashcards, etc. cannot be used. Computer generated notebooks and/or pages are allowed.

The Host Center will provide the following:

- 2-inch vinyl kick ball / hacky sack weighing between 25 and 30 grams
- Safety goggles

GENERAL RULES:

- 1) The students' full name, school name, grade and MESA Center must be clearly labeled on the device. A 10% penalty in the score will be assessed for failing to properly label.
- 2) All parts of the device must fit into a 50 cm by 50 cm by 50 cm cube. No parts may extend outside of the defined cube at any time during inspection or during competition, except the single operation to initiate the device in Rule 3.
- 3) The device must be initiated by a single operation (e.g. pull a string, flick a switch, cut a string, push a button, etc.) provided by the team. The single operation **MUST** be performed outside of the *Safety Zone* (see Supplemental Section).
- 4) No human power may be used to add potential or kinetic energy for the entire operation of the device, including initiation.
- 5) The device 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** use one of the following listed categories of energy:
 - a. Categories of energy, **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. Pressurized fluids (such as air or water)
 - b. Four (4) different categories of energy listed above **MUST** be used.
 - c. Sequential and dependent actions must use a different category of energy (i.e. a free fall using gravity to a ramp using gravity will be counted as one action).
 - d. Use of energy not listed will not be counted as actions or categories of energy.
 - e. The action to initiate the device does NOT count as one of the four to eight actions.
 - f. The sequence of actions must end with an action that launches the vinyl kick ball.
- 6) The device must be able to load the host supplied vinyl kick ball prior to the initiation of the device. No alterations to the vinyl kick ball are allowed.
- 7) The device must launch the vinyl kick ball within 60 seconds of the initiation of the device.
- 8) The device must have moving parts visible at all times once the device is initiated to verify actions and categories of energy (see Rule 5).
- 9) All construction materials are acceptable, with the exception of remote control devices, explosives, caustic chemicals, or other hazardous materials that may cause personal injury or damage to host facilities.
- 10) The engineering notebook must contain the following sections with each section tabbed/labeled:
 - a. Proper Labeling
 - i. Proper labeling is required of each notebook. Students must have group member names, grades, school and MESA center on the inside cover of their MESA Engineering Notebooks.
 - b. Project Introduction
 - i. A one page introduction for the project. Students can write about why they chose the project that they are worked on and what challenges they expect to run into with this project. They may also briefly describe the project criteria and constraints. This introduction should be honest and genuine.

- c. Daily Entries
 - i. At least ten daily entries will be required. Each entry must have the date of entry and be at least half a page long. They should answer the following questions:
 - What did you work on/discuss today?
 - What was the result of your work?
 - What do you need to do during your next meeting?
- d. Project Sketches
 - i. Notebooks must contain at least two distinct project sketches that should be placed towards the back or end of the completed notebook pages. The sketches should indicate a progression in the thinking and design of the device, and be detailed. Sketches must be larger than half a page, and can either be drawn on the notebook page directly or attached.
- e. Applied Mathematics
 - i. Notebooks must contain evidence of two (2) applied mathematics principles as it pertains to the project. This section **MUST** include the calculations for two of the following three:
 - Calculate the kinetic energy for each and every action using gravity as the category of energy. Label the corresponding action for each calculation.
 - Calculate the potential energy for each and every action using springs/ rubber bands as the category of energy. Label the corresponding action for each calculation.
 - Calculate the mechanical advantage for each and every action using levers/pulleys as the category of energy. Label the corresponding action for each calculation.

JUDGING:

- 1) Devices will be checked for specifications prior to the start of the competition. If devices are disqualified during the specification check, design changes will not be allowed.
- 2) Each device will be allowed two (2) non-consecutive launches.
- 3) Repairs are only allowed with replacement parts and materials.
- 4) Each device must be ready when called or team will forfeit that launch.
- 5) Each team will be given up to 90 seconds to prepare device, load vinyl kick ball, and verify to the judge the four to eight actions and the four different categories of energy.
- 6) One team member will be responsible for the initiation of the device and will indicate to the judge that the device is ready to launch. The team member must wait until the judge gives the "START" order.
- 7) Judge will record the following:
 - a. Time will be measured from the initiation of device (i.e. "START" order) to the time the device launches the vinyl kick ball to the nearest 00.01 seconds.
 - b. Distance will be measured from the *Target* to the point of initial impact of the vinyl kick ball. See Supplemental Section for competition area specifications.
- 8) If the device does not launch the vinyl kick ball within 60 seconds of the initiation of the device, the judge will declare a mistrial; team will receive zero (0) points for that launch.
- 9) Team members may not touch or interfere with the device once the initiation has been triggered.
- 10) The order of the competition will be randomly selected.
- 11) All team members and spectators must stand outside of the *Safety Zone* during each launch. Only judges are allowed inside the *Safety Zone*.

SCORING:

- 1) Device points = 10 points for each sequential and dependent action. (maximum of 80 points)
- 2) Time-to-distance ratio = launch time in seconds (00.00) divided by distance in cm from *Target*.
 - a. For vinyl kick balls landing on the *Target*, a distance of 0.1 cm will be given.
 - b. For vinyl kick balls landing outside of the *Target Zone*, a distance of 101 cm will be given.
- 3) Team Score = device points + time-to-distance ratio.
- 4) The best team score of the two launches will be used.
- 5) A deduction of 20% of the best team score will be assessed for a missing or incomplete engineering notebook.

AWARDS:

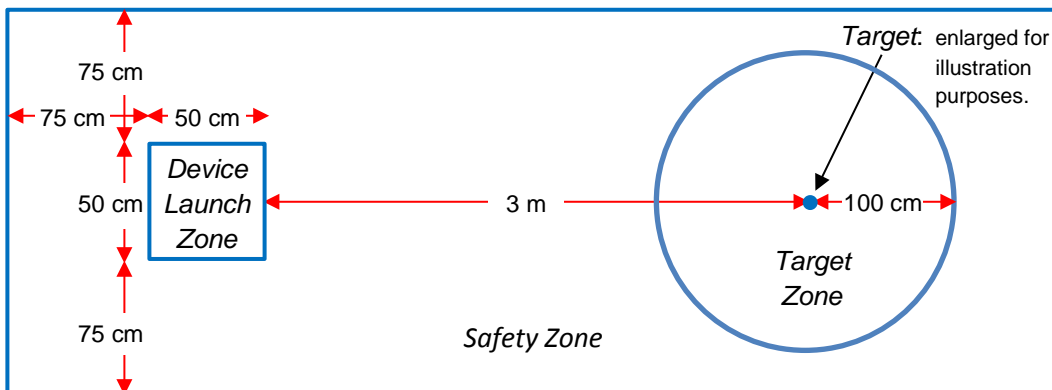
- Awards will be given per grade level: 9th/10th grade and 11th/12th grade.
- Medals will be awarded for 1st, 2nd and 3rd place based on greatest team score.
- Ribbons will be awarded for Innovative Engineering Design.
- Only teams placing in the team score category will advance to Regional MESA Day.

ATTACHMENTS/APPENDIX:

- Competition Area Specifications
- Recommended Equipment
- Inspection & Score Sheet for Rube Goldberg Device
- Engineering Notebook Requirement Rubric

Competition Area Specifications:

- *Device Launch Zone* is 50 cm by 50 cm.
- *Target* is 3 meters from and centered to the *Device Launch Zone*, and centered in the *Target Zone* with a radius of 100 cm.
- The *Safety Zone* is 2 meters by 6 meters.

**Recommended Equipment**

- 2 inch vinyl kick balls / hacky sacks
- Measuring tape (metric)
- Blue painters tape or other supplies to outline *Device Launch Zone* and *Safety Zone*
- Colored paper with a “dot” taped to ground for *Target*
- Chalk or other supplies to outline *Target Zone*
- 1 stop watch to record launch time
- 3 safety goggles (required)

INSPECTION AND SCORE SHEET FOR RUBE GOLDBERG DEVICE
High School – Grades 9/10 and 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 device

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____

List corresponding category of energy used

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____

Section below to be completed by Judges

INSPECTION LIST:	YES	NO
All parts of device fit into 50 cm x 50 cm x 50 cm	<input type="checkbox"/>	<input type="checkbox"/>
Device is initiated by a single operation performed outside of <i>Safety Zone</i>	<input type="checkbox"/>	<input type="checkbox"/>
Device incorporates four (4) to eight (8) actions that are sequential and dependent upon the previous action (do not count action to initiate device as one of the four to eight)	<input type="checkbox"/>	<input type="checkbox"/>
Four (4) different categories of energy used	<input type="checkbox"/>	<input type="checkbox"/>
Device able to load vinyl kick ball prior to the initiation of device	<input type="checkbox"/>	<input type="checkbox"/>
No remote control devices, hazardous materials, or unsafe energy are used	<input type="checkbox"/>	<input type="checkbox"/>
Device labeled properly (students' full name, school name, grade and MESA Center)	<input type="checkbox"/>	<input type="checkbox"/>

Innovative Engineering Design (ranking – 1, 2, 3, etc.): _____

LAUNCH 1

of sequential and dependent actions (*see Rule 5*): _____ x 10 =

Launch Time (00.00 seconds): _____ ÷

Accuracy Distance (cm): _____ =

Device Points: _____ + **Time/Distance Ratio:** _____

Mistrial (reason): _____

TEAM SCORE: _____

LAUNCH 2

of sequential and dependent actions (*see Rule 5*): _____ x 10 =

Launch Time (00.00 seconds): _____ ÷

Accuracy Distance (cm): _____ =

Device Points: _____ + **Time/Distance Ratio:** _____

Mistrial (reason): _____

TEAM SCORE: _____

Device Labeling Penalty (10% of best of two launch Team Scores) - _____

Engineering Notebook Penalty (20% of best of two launch Team Scores) - _____

Final Team Score (best of two launches) _____

MESA DAY 2017-2018*Engineering Notebook Requirement Rubric*

Please use this rubric to assess notebook entries. An incomplete or missing notebook will lead to a 20% deduction from the total team score.

Criteria		YES	NO
1	Is the notebook properly labeled? <i>(Names, Grades, School, MESA Center)</i>		
2	Does the notebook contain a one page introduction to the project? <i>(On the first page of the notebook)</i>		
3	Are there at least 10 dated entries in the notebook?		
4	Is each entry at least half a page long?		
5	Are there at least two distinct project sketches included?		
6	Is there evidence of two (2) of the three (3) following applied mathematics principles? <ul style="list-style-type: none"> - Calculate the kinetic energy for <u>each and every action</u> using gravity as the category of energy. Label the corresponding action for each calculation. - Calculate the potential energy for <u>each and every action</u> using springs/rubber bands as the category of energy. Label the corresponding action for each calculation. - Calculate the mechanical advantage for <u>each and every action</u> using levers/pulleys as the category of energy. Label the corresponding action for each calculation. 		
TOTAL			

Does the notebook meet the requirement? (circle one) **YES** **NO**
Notebooks must meet ALL 6 criteria to fulfill this requirement