

- LEVEL:** Middle School/High School
- NUMBER OF TEAMS:** One (1) team per school can participate at the MESA Day state competition. Three (3) teams can participate at MESA Regionals.
- TEAM MEMBERS:** Two (2) to Six (6) students
- OBJECTIVE:** To construct and build both a golf ball launcher and receptacle, which will achieve the following objectives:
- 1) Launch one (1) golf ball into the receptacle within the specified time limit
 - 2) Safely catch the golf ball in the receptacle without letting it bounce out

Students will also be required to submit their Engineering Design Notebooks during specification check for review and scoring.

MATERIALS: Any materials that coincide with the design parameters may be used to build the launcher. Hazardous materials are not allowed.

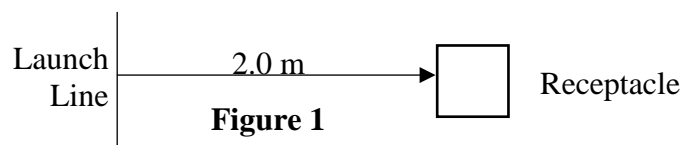
The receptacle may not include food, soap, glass or any substance that will splatter or shatter.

DESIGN PARAMETERS:

1. Golf Balls dimensions must be within the following limits:
 - a. 40-45 mm in diameter
 - b. 44-48 grams in mass
2. The golf ball cannot be altered or covered in any way except for marking/coloring using ink markers.
3. Teams must design, build and operate their launcher and receptacle.
4. All parts of the receptacle must fit within the boundaries of a 50 cm x 50 cm square area.
5. Receptacle volume will be used for scoring. Teams should will need to have a volume calculation in their Design Notebooks as a reference for judges.
6. Any launcher and/or receptacle design is allowed unless deemed unsafe by the judges. Unsafe designs could include use of compressed gas (other than air) and/or caustic materials.
 - a. If compressed gas is used, teams should document at least one successful pressure test to 150% of maximum launch pressure in their Design Notebook to assist in the judge's safety evaluation,.
7. Receptacles must be constructed so that spillage of materials used will not occur under normal circumstances (i.e. transporting or ball landing).

TESTING CONDITIONS:

1. At least two team members are required to be present during testing.
2. Testing will be done on grass.
3. The front edge (or closest point) of the receptacle must be placed a minimum of 2 m from the Launch Line (see figure 1). Teams can choose to position the receptacle any distance greater than or equal to 2 m from the Launch Line for each of their launches, limited by the overall size of the event area (approximately 20-30 m).



4. No part of the launcher may cross over the Launch Line, either before, during, or after launch (including moving pieces). If any part crosses over the line, the team will receive a performance score of zero for that launch.
5. When launched, no part of the ball can touch the ground after leaving the launcher and before contacting the receptacle. The ball must travel in the air the entire distance between the launcher and receptacle.
6. All measurements will be made from the Launch Line to the front edge or closest point to the Launch Line of the receptacle. Items ejected from the receptacle that happen to land closer to the Launch Line than the front edge or closest point of the receptacle will not reduce the distance measurement.

MINIMUM SAFETY EQUIPMENT:

1. All team members participating in the launch must wear plastic hard hats and goggles.
2. Team members shall remain behind the launch line during testing.
3. Teams should bring their own safety equipment. A set of hard hats and goggles will be available at the event if needed.

SPECIFICATION CHECK:

1. During specification check, teams will check in to the competition area and submit their launcher, receptacle, golf ball, and Engineering Design Notebook for impounding.
 - Essential components or scored components of the Engineering Design Notebook are listed in a rubric on the reverse side of the score sheet.
2. Immediately upon submission for competition, each launcher, golf ball, and receptacle receives a specification check to determine whether it conforms to dimensions, materials, and construction rules. Receptacles will be checked for spillage. Any launcher or receptacle which fails the specification check will be given a performance score of zero. Neither may be modified for competition during or after judging.
3. Judges **may disqualify** any entry if, in their opinion, the testing of the device might create a safety hazard for spectators, team members, or property (i.e. sharp edges).
4. The volume of the receptacle to the nearest cubic cm (cc) will be recorded and used for scoring purposes.
 - a. If the receptacle is a regular shape (i.e. Prism, Cylinder, Cone) the formula for the volume of that shape will be used.
 - b. If the receptacle is an irregular shape then it will be treated as a prism and the greatest measurements of height, width and length will be used to determine the volume.
5. Golf balls will be checked to ensure that the diameter and mass are within the range listed above.
6. Devices (launcher and receptacle) must be in testing condition prior to device inspection. If devices are disqualified during inspection check, design changes will not be allowed. Only devices passing inspection will be allowed to participate in the performance tasks.
7. Repairs are allowed, replacement parts and materials only, and all repairs must be done in the impound area under supervision of a judge. The addition or exchange of parts that, in the opinion of the judge, would alter the design or function of the launcher or receptacle is NOT allowed. No tools or supplies will be available at the event. Teams should bring any repair tools and repair materials with them.
8. All repair materials to be used during the competition must be impounded with the device. Tools may be kept by the team and need not be impounded.
9. After clearing specification check, all launchers and receptacles will be impounded until testing.

JUDGING:

1. Teams (including launchers and receptacles) must be ready for competition when called or forfeit that launch.
2. Teams will be given three launches. Teams can choose a different distance for each launch. Teams that choose to attempt less than three launches (including device breakage that precludes launching) will receive a performance score of zero for any launch not attempted.
3. All team members participating in the launch shall wear at least the minimum safety equipment prior to starting launch set-up until launching is complete. If any team member fails to wear the minimum safety equipment, the team will receive a zero score for that launch.
4. Launch set-up is limited to two (2) minutes. Teams can choose to position the receptacle any distance greater than or equal to 2 m from the launch pad. Teams not ready after two (2) minutes will receive a performance score of zero for that launch. The timer will then restart for the next launch.
5. Teams are required to use their own golf ball.
6. The team member responsible for operation of the device will indicate to the judge that the devices are in the “ready-to-operate” condition.
7. Judges will give the launch order and students may release their ball.
8. If the ball successfully lands in the receptacle judges will record the distance of the launch to the nearest cm.
9. Balls that bounce out of the receptacle will receive a score equal to half the distance of the launch.
10. If a ball hits or touches the ground before reaching the receptacle, a score of zero will be given for that launch.
11. The ball will be returned to the team and two (2) minutes will be given to reposition their receptacle and ready their launcher for the next launch. The distance will be recorded for each successful launch and catch, up to three total launches.

SCORING:

1. Final team rankings will be based on the Total Score (T) which will be determined by the sum of the Performance Score (P) and Engineering Design Notebook Score.
2. The Performance Score (P) will be determined by dividing the Launch Score (L) by the Volume Score (V).
3. The Launch Score (L) will be determined by adding the scores for each launch, measured in cm.
4. The Volume Score (V) will be determined by dividing the volume of the receptacle, measured in cubic cm (cc) by 100.
5. Score for each successful launch and catch will be equal to the distance in cm.
6. Score for each successful launch, no catch (ball bounces out of receptacle) will be equal to half of the distance score.
7. Engineering Design Notebook Score (5 point maximum)

Example Score:

- Launch Score:
 - Launch 1 – 2 meters, ball stays in receptacle. Score = 200
 - Launch 2 – 5 meters, ball bounces out. Score = $500/2 = 250$
 - Launch 3 – 4 meters, ball stays in receptacle, Score = 400
 - Launch Score (L) = $200 + 250 + 400 = 850$
- Volume Score:
 - Volume of Receptacle is $25\text{ cm} \times 25\text{ cm} \times 15\text{ cm} = 9375$
 - Volume Score (V) = $9375/100 = 93.75$
 - Performance Score (P) = $L/V = 850/93.75 = 9.067$
 - Engineering Design Notebook Score (N) = 3 points
 - Total Score = $P + N = 9.067 + 3 = 12.72$

School: _____

Student Names: _____

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Specification Check	Pass <input type="checkbox"/>	Fail <input type="checkbox"/>
1. Receptacle fits within 50 cm square area?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
2. Receptacle uses no illegal materials?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
3. Spillage of receptacle materials will not occur under normal circumstances?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
4. Receptacle is safe for competition?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
5. Launcher is safe for competition?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
6. Golf Ball is within 40-45 mm in diameter?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
7. Golf Ball is 44-48 grams is mass?	Yes <input type="checkbox"/>	No <input type="checkbox"/>

If Golf Ball does not meet specifications, teams may use a MESA provided ball

8. Receptacle Volume: _____ cm³(rounded to nearest whole number)

Receptacle Shape & Dimensions: _____

Testing

Launch	Distance (cm)	Ball Landed in Receptacle (Y/N)	Ball Remained in Receptacle (Y/N)	Score = Distance (if ball did not remain in receptacle, divide distance by 2. If ball did not land in receptacle, score = 0)
Launch 1				
Launch 2				
Launch 3				
Launch Score: (sum of scores for launches)				
Volume Score: (volume divided by 100)				
Performance Score: (Launch Score divided by Volume Score)				
Engineering Design Notebook Score (max of 5 points)				
Total Score (Performance Score plus Notebook Score)				

Lead Judge Signature: _____ Student Signature: _____

Judge Comments:

Rubric for Engineering Design Notebooks (EDN).

EDN Goals	3	2	1	0
1. Explore				
1.1 Problem Statement. Accurately describes, in your words, the design objective (includes success criteria, constraints constants and variables)	Specific description of problem, success criteria, constraints, variables and constants	Basic...	Weak...	No...
1.2 Depth of Free exploration. Prior knowledge, brainstorming & hands-on exploration documented.	Numerous examples of brainstorming and hands-on exploration observations.	Regular...	Few...	No...
1.3 Research in Design: Research ideas about your design that might be useful. Record information using different sources (e.g. books, websites, interviews from experts).	Clear analysis of other design pros/cons.	Basic...	Scant...	No...
2. Design				
2.1 Design Plan. Includes reasoning on your design choices (materials used, modifications, etc.). Use data from past trials, research and design considerations.	Clear reasons given (based on data or research) for each design choice.	Basic...	Scant...	No...
2.3 Design sketching and/or photos. Prior & during build, team sketches, 2-D or 3-D perspective drawings.	Numerous representations of each design iteration.	Regular...	Scant...	No...
3. Test				
3.1 Observation. Data & written observations (tables, graphs, labeled drawings, etc.).	Numerous presentation of quantitative & qualitative data, graphs & charts follow design progression.	Regular...	Scant...	No...
3.2 Reflection/Analysis. Assesses pros and cons of design/materials, testing procedure, etc. Apply test results and analysis to pose a theory, recommend and argue for a next step, or draw an insightful conclusion. Restate the purpose in your conclusion.	Detailed reflection shows how design considerations and logic flowing from research, test analysis, etc.	Basic...	Scant...	No...
4. EDN Organization				
4.1 Structured. Includes Table of Contents with key elements. Elements of EDN can be used to answer judges questions easily	Clear organization utilizes defined sections.	Basic...	Minimal..	No...
4.2 Labeled. Clearly labeled with School and Team Members names.			Yes	No
Column Totals (for selected categories)				
Subtotal (out of 25)				
Modifier			Subtotal ÷ 5	
Score (out of 5)				

Comments/Suggestions: