

- 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 regional events.
- TEAM MEMBERS:** Two (2) to Four (4) Students per Team
- OBJECTIVE:** Using only tape and paper, design and construct a boat that can hold the most water bottles while having the smallest weight and staying afloat.
- Students will also be required to submit their Engineering Design Notebooks during specification check for review and scoring.

MATERIALS: The only materials allowed are paper and tape.

DESIGN PARAMETERS:

1. Boats must be:
 - a. Entirely constructed from tape and paper.
 - b. Have a keel (i.e. no flat bottom)
 - c. Must be designed to fit in a container 64cm x 42 cm x 39 cm in dimension (the size of a 20 gallon tote <http://www.homedepot.com/p/HDX-20-Gal-Tote-2020-0108/202523597>)
 - d. Boats must have a 10 centimeter clearance on all sides of the testing container when placed inside.
 - e. Must have space to place weights on interior of boat.
 - i. Weights will be full 8 fl oz water bottles

TESTING PARAMETERS:

1. Two (2) team members are required to be present during testing.
2. Team will place their boat in the water to ensure that it floats for at least 15 seconds before weight is added.
3. At a constant rate (every 5 seconds), weight will be added to the boat.
4. When the boat sinks, the last weight added before sinking will be counted as the final weight.
 - i. Sinking is defined as the point when the water level is equal to the top of the boat
5. If the boat disintegrates, the last weight added before disintegration will be counted as the final weight.
 - i. Disintegration is defined as the loss of unity or integrity by breaking into pieces or complete structural collapse
6. If the boat capsizes, the last weight added before capsizing will be counted as the final weight.
 - i. Capsizing is defined the overturning of the boat

SPECIFICATION CHECK:

1. During specification check, teams will check in to the competition area and submit their boat and Engineering Design Notebook.
2. Teams that use material other than tape and paper will be disqualified.
3. Teams that do not have an engineering design notebook will be penalized 10 points.
4. Boats that do not meet the size requirements will be receive a performance score of zero.
5. Essential components or scored components of the Engineering Design Notebook will be listed and included in a rubric on the reverse side of the score sheet.

JUDGING:

1. The students will place their boat in the container.
2. The judge will wait for 15 seconds to ensure the boat does not sink or capsize.
3. The judge will place a weight in the boat and wait 5 seconds. The cycle will repeat until the boat either sinks, capsizes, or disintegrates.
4. The last weight placed before the boat sank or disintegrated will be the final weight
5. The judge will record the weight held on the score sheet.

SCORING CRITERIA:

1. Boats will be weighed, in grams, before being placed in the water.
2. Boat will be placed in water to ensure boat does not sink or capsize. If it does sink or capsize, the Performance Score will be 0.
3. Weights will be added every 5 seconds until the boat sinks or disintegrates.
4. The last weight placed in the boat before sinking or disintegrating will be the final weight.
5. The Performance Score will be determined by dividing the weight added by the weight of the boat. The Performance Score will be rounded to the nearest tenth.

For example, if the boat weighed 25 grams and held 4 bottles of water that weighed 240 grams each, the performance score would be $(4 \times 240) \div 25 = 38.4$ (rounded to the nearest tenth)

School: _____

Student Names: _____

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Specification Check (circle one):

- | | | |
|---|-----|----|
| Team has submitted an Engineering Design Notebook* | Yes | No |
| The boat fits in the testing container with 10 cm clearance on all sides? | Yes | No |
| Boat is made of only paper and tape | Yes | No |

Record the boat weight (nearest gram): _____ g

If team fails specification check, they are disqualified (except during regional events)	Pass	Fail
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Design Testing:

Does the boat capsize or disintegrate immediately?	Yes	No
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If "Yes" is circled for the question above performance score is zero.

Weight of Boat (grams)	
Weight Held (grams)	
Performance Score (Weight Held/Weight of Boat)	
Engineering Design Notebook*	
<small>*10 points max, 10 point penalty if missing notebook</small>	

Lead Judge Signature: _____

Student Signature: _____

Comments/Suggestions:

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			(S ÷ 25) x 10	
Score (out of 10)				

Comments/Suggestions: