Event Specifications
Duct Tape Water Bottle Challenge
MESA Day 2017

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 duct tape, design a water carrying device that can effectively carry at least 2 liters of water. At competition, device must be quickly and accurately reproduced and demonstrated.

Students will also be required to submit 1-page instruction sheet for building their design and their Engineering Design Notebooks during specification check for review and scoring.

MATERIALS: The only allowed material is duct tape. At MESA Day teams will be provided with 20 yards of duct tape approximately 2 inches wide.

BACK STORY:

A zombie apocalypse has ravaged the world, causing grief, loss, and destruction. In the process basic supplies have perished. Because the mail system no longer functions, the government needs to email design directions to the general public on how to make cheap water containers using only duct tape.

DESIGN PARAMETERS:

1. Water containers must be:
   a. Entirely constructed from duct tape. Duct tape with an approximate width of 2 inches will be used on MESA Day.
   b. Must be designed to have a volume of at least 2 liters. In other words, it must be able to hold at least 2 liters of water.
   c. Must be able to be carried without the use of any hands.
   d. Must incorporate a re-useable lid or cap, also constructed of duct tape.
   e. Must retain water when set down on a flat table.
2. Prior to competition, teams must generate a 1-page instruction sheet that could be used by anyone to re-construct the water container. Both sides of the sheet may be used for the instructions. Instructions should include both illustrations for construction and at least one illustration of what the final product should look like.

TESTING PARAMETERS:

1. Only one team member is required to be present during testing.
2. Each team will be provided with one roll of duct tape, a ruler, scissors and a six-foot table.
3. When testing begins teams may only have their instruction sheet with them to assist in the construction of their containers.
4. Teams will be given 30 minutes to construct their container, after which all empty containers will be weighed, filled with a minimum of 2 liters of water, weighed again, and tested.
   a. During testing, students will be asked to carry their filled container over a determined course, which may include varied terrains, stairs, and other obstacles.
5. After completing the course, filled containers will be impounded and placed on a table until the end of the testing period. (30 minutes total)
6. After the end of the 30 minutes testing period. Containers will be weighed again.

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SPECIFICATION CHECK:

1. During specification check, teams will check in to the competition area and submit their instruction sheet and Engineering Design notebook for impounding.
2. Teams that do not have an instruction sheet and an engineering design notebook will be disqualified.
3. 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 be allowed to collect their instruction sheet from impound and enter the construction area.
2. The judge will signal the start of the construction period. Students will then have 30 minutes to re-construct their containers.
3. At the end of thirty minutes, completed containers will be weighed and containers will be filled. Unfinished containers or containers that do not hold at least 2 liters will be given a zero performance score. No additions or modifications will be allowed after this.
4. Containers will be filled with at least 2 liters of water, however, teams can design larger containers and ask judges to fill beyond 2 liters. The judge will then start a new 30 minute timer. Students will then enter the device performance area and carry their filled containers through the designated course. They cannot use their hands to carry the containers nor can they interfere with any other students or student devices.
5. Once the student has completed the course, they will place the filled containers onto a table and leave the testing area.
6. At the end of the 30 minute testing period, judges will measure how much water remains in the container by weighing it and record the weight on the scoring sheet.

SCORING CRITERIA:

1. Containers will be weighed at the end of the construction period. Mass in grams will be recorded
2. Containers will be filled at start of testing period and filled containers will be re-weighed. Mass in grams will be recorded. Any container that cannot hold at least 2 liters of water will receive a performance score of zero.
3. At the end of the 30 minutes testing period, containers will be weighed again. Mass in grams will be recorded.
4. A Design Efficiency score (E) will be determined by dividing the mass at the end of the testing period by the mass at the beginning of the testing period multiplied by 100.
5. A Container score (C) will be determined by dividing the mass of 20 yards of duct tape by the empty mass of the container.
6. The Performance score (P) will be determined by adding the Design Efficiency (E) score and the Container Score (C).
7. Engineering Design Notebooks will be scored on a scale of 0-10 points and this score will be added to the performance score.
8. The winning team will be the team with the highest combined points.

9. If there is a tie, the highest container score will be used to determine winner.

Scoring Example:

- Hypothetically 20 yards of duct tape equals 200 grams. Actual weight will be measured at MESA Day.

Team A

- Container mass (empty): 150 grams
- Container mass (filled): 2500 grams
- Container mass (final): 2200 grams
- Notebook Score: 8 points
- Efficiency (E) = 2200/2500 x 100 = 88
- Container Score (C) = 200/150 = 1.33
- Performance Score = E + C = 88 + 1.33 = 89.66
- Total Score = 89.33+8 = 97.33

Team B

- Container mass (empty): 180 grams
- Container mass (filled): 2000 grams (mass of water =1820 grams, mass of container = 180 grams)
- Container mass (final): 1950 grams
-Notebook Score: 7 points
- Efficiency (E) = Not Calculated
- Container Score (C) = Not Calculated
- Performance Score = 0 (container did not hold at least 2 liters)
- Total Score = 0 + 7 = 7

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School:_____

Student Names:_____

_____

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Specification Check (circle one):	**Pass**	**Fail**
Team has submitted an Engineering Design Notebook?	Yes	No
Team has submitted an instruction sheet (1 sheet only)?	Yes	No

If team failed specification check they are disqualified.

Design Testing:

Was device completed during 30 min building session?	Yes	No
Holds at least 2 liters?	Yes	No
Can be carried without the use of any hands	Yes	No
Incorporates a re-usable lid made of duct tape	Yes	No

If "No" is circled for any of the questions above performance score is zero.

Container mass (empty):_____grams

Container mass (filled):_____grams

Container mass (final):_____grams

Engineering Design Notebook Score:_____(10 max)

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: