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 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 2 liters of water.
   c. Must be able to be carried without the use of any hands.
   d. Must incorporate a re-useable lid, 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, 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 containers will be weighed, filled with water and tested.
5. During testing, students will be asked to carry their filled container over a determined course, which may include varied terrains, stairs, and other obstacles.
6. After completing the course, filled containers will be impounded and placed on a table until the end of the testing period. (30 minutes total)

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/or 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 reconstruct their containers.

3. At the end of thirty minutes, completed containers will be weighed and students will tell judges how much water they want to add to their container. 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 the desired amount of water. 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 and record it 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 less the mass of the empty container will be recorded. Any container that cannot hold 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 less the mass of the empty container will be recorded.

4. A design efficiency multiplier (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 10.

5. The mass at the end of the testing period will be divided by the mass of the empty container recorded at the end of the construction period, to determine the Container Score (C).

6. The container score will then be multiplied by the efficiency multiplier to determine the performance score (P).

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 weight of the container will be used to determine the winner.

School:
Event Specifications
Duct Tape Survival Challenge
MESA Day 2016

Student Names: ____________________________________________________________

________________________________________________________

For Official Use Only

Specification Check (circle one):

Team has submitted an Engineering Design Notebook?    Pass   Fail
    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:___________

Lead Judge Signature:_____________________________________________________

Student Signature:_______________________________________________________

Comments/Suggestions:
# Rubric for Engineering Design Notebooks (EDN)

Note: Judges will only choose 5 categories to assess each team’s Engineering Design Notebook.

<table>
<thead>
<tr>
<th>EDN Goals</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>0. EDN Organization</strong></td>
<td></td>
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<tr>
<td>0.1 Structured. Includes Table of Contents, Glossary &amp; Appendix so readers can easily find key elements of EDN as well as resources researched (citations) &amp; vocabulary learned.</td>
<td>Thorough organization utilizes defined sections.</td>
<td>Basic...</td>
<td>Minimal...</td>
<td>No...</td>
</tr>
<tr>
<td>0.2 Readability. Notebook answers potential questions of reviewers. Highly readable notebooks are thorough, clear, legible &amp; detailed (e.g. length &amp; date of tasks documented) and provide summary updates when needed.</td>
<td>All questions reviewer might pose are clearly answered.</td>
<td>Most...</td>
<td>Few...</td>
<td>No...</td>
</tr>
<tr>
<td><strong>1. Explore</strong></td>
<td></td>
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<tr>
<td>1.1 Problem Statement. Accurately articulates, in their own words, the design objective (includes success criteria, constraints)</td>
<td>Specific articulation of problem, success criteria, constraints</td>
<td>Basic...</td>
<td>Weak...</td>
<td>No...</td>
</tr>
<tr>
<td>1.2 Depth of Free exploration. Prior knowledge, brainstorming &amp; hands-on exploration documented.</td>
<td>Numerous examples of brainstorming and hands-on exploration observations.</td>
<td>Regular...</td>
<td>Few...</td>
<td>No...</td>
</tr>
<tr>
<td>1.3 Research in STEM. Explores how math &amp; science concepts inform project (e.g. math formulas, laws of physics, etc.), and how they might optimize their design considering the variables and constants involved.</td>
<td>Clear documentation of math &amp; science concepts considered.</td>
<td>Basic...</td>
<td>Scant...</td>
<td>No...</td>
</tr>
<tr>
<td>1.4 Research in Design. Evaluates aspects of other designs that might be utilized or modified in this design (e.g. shape, functionality, efficiency, impact, cost, or other design parameters).</td>
<td>Clear analysis of other design pros/cons.</td>
<td>Basic...</td>
<td>Scant...</td>
<td>No...</td>
</tr>
<tr>
<td><strong>2. Design</strong></td>
<td></td>
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<tr>
<td>2.1 Design rationales. Includes clear rationales throughout notebook on design choices (materials used, modifications, etc.). Choices are predominately based on data from past trials, research and design considerations rather than trial &amp; error.</td>
<td>Thorough rationales given (based on data or research) for each design choice.</td>
<td>Basic...</td>
<td>Scant...</td>
<td>No...</td>
</tr>
<tr>
<td>2.2 Design plan. Prior to testing, team articulates project plan timeline, testing procedure &amp; performance prediction(or hypothesis).</td>
<td>Detailed articulation of testing procedure &amp; performance prediction or hypothesis.</td>
<td>Basic...</td>
<td>Scant...</td>
<td>No...</td>
</tr>
<tr>
<td>2.3 Design sketching and/or photos. Prior &amp; during build, team sketches 2-D or 3-D perspective drawings.</td>
<td>Numerous representations of each design iteration.</td>
<td>Regular...</td>
<td>Scant...</td>
<td>No...</td>
</tr>
<tr>
<td><strong>3. Test</strong></td>
<td></td>
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<tr>
<td>3.1 Observation. Clearly reflected through data &amp; written observations (tables, graphs, labeled drawings, etc.).</td>
<td>Numerous presentation of relevant quantitative &amp; qualitative data, graphs, charts that follow design progression.</td>
<td>Regular...</td>
<td>Scant...</td>
<td>No...</td>
</tr>
<tr>
<td>3.2 Reflection/Analysis. Assesses pros and cons of design/materials, testing procedure, etc. Returns to restatement of purpose. Applies test results and analysis to pose a theory, recommend and argue for a next step, predict a design impact, or draw an insightful conclusion.</td>
<td>Detailed reflection shows how design considerations and logic flowing from research, test analysis, etc.</td>
<td>Basic...</td>
<td>Scant...</td>
<td>No...</td>
</tr>
<tr>
<td>3.3. Team Assessment. Notebook shows evidence of team self-assessment, peer assessment, design status presentations to various audiences, etc.</td>
<td>Detailed entries show assessment of team’s design process as evidenced by notebook.</td>
<td>Basic...</td>
<td>Scant...</td>
<td>No...</td>
</tr>
<tr>
<td><strong>4. Overall Use of Design Process</strong></td>
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<tr>
<td>4.1 Use of Engineering Design Process and/or Scientific Method is carefully &amp; consistently documented so that steps are logically &amp; sequentially connected.</td>
<td>Consistent, high-quality documentation of all aspects of design process</td>
<td>Occasional</td>
<td>Scant…</td>
<td>No...</td>
</tr>
</tbody>
</table>

| Column Totals | | | | |
| (for selected categories) | | | | |

Comments/Suggestions:

Final Score (out of 100)