CATAPULT DESIGN

OVERVIEW

Applying leadership and 21st century skills, participants design and produce a working catapult, within specified guidelines, that is adjustable and propels hacky sacks (weighing about 50 grams each) at a scoring target between 15' and 25' away.

ELIGIBILITY

Open to middle school and high school chapters. Three (3) teams of two to six (2-4) members per chapter may participate.

ATTIRE

TSA competition attire is required.

PREPARATION

A. Participants focus their efforts on researching, developing, and testing a working catapult with a supplementary documentation portfolio.
B. Semifinalists participate in an interview.

REGULATIONS AND REQUIREMENTS

Students will work to develop their leadership and 21st century skills in the process of preparing for and participating in this Colorado TSA competitive event. The development and application of those skills must be evident in their submission, demonstration, and/or communication pertaining to the entry.

A. The Documentation Portfolio
    a. Documentation materials (comprising "a portfolio") are required and must be secured in a clear front report cover with the following single-sided, 8 ½", x 11" pages, in this order:
        i. Title page with the event title, the conference state, the year, and the team ID number; one (1) page
        ii. Table of contents; pages as needed
        iii. Materials list; one (1) page
        iv. Details of the research and inspiration to help determine the design for a catapult; pages as needed
        v. A design log (that includes testing and adjustment notes) from the start date to present; pages as needed
        vi. A firing log, indicating firing tests of the device, along with results of tests and adjustments made after each test; pages as needed
        vii. A calibration table, indicating how to configure the device to achieve various distances; pages as needed
        viii. FOR HIGH SCHOOL ONLY: High School competitors are required to include all calculations (pages as needed) with a copy of the pure formula(s) used, substitutions, and final results with units for:
            1. Initial angle of trajectory
            2. Distance
            3. Initial velocity
            4. Time aloft
        ix. FOR MIDDLE SCHOOL ONLY: Middle School competitors are NOT required to include calculations but are encouraged to do so for extra credit; pages as needed
        x. Sketches and pictures of the design process; pages as needed
B. The Catapult
    i. Participants must bring and wear safety goggles during the performance stage of the event
    ii. Teams must provide their own tape measure (at least 25' in length)
    iii. The catapult may be no larger than 2' tall x 2' long x 1.5' wide, including the base
    iv. The catapult should have a base that will firmly hold the catapult to the ground before, during, and after launch, and during the reloading/rearming process. The base must be included in the 2' x 2' x 1.5' envelope for the catapult. Bases cannot be affixed to the ground through any sort of anchoring mechanism (e.g., screws, anchor bolts, tape, etc.). The base must be held down only by ballast. The base must accommodate enough ballast to hold the catapult on the ground and prevent the catapult from tipping over or leaving the ground before, during, and after launch and during the reloading/rearming process. Some ballast

will be provided on site, but teams should plan on providing their own ballast. Ballast must be either solid materials (weights), or in tightly SEALED containers. Teams that do not have ballast that meets these criteria will not be allowed to use it. Teams are responsible for ANY cleanup related to a spill of any ballast during testing. The ballast provided on site will be in the form of sandbags as illustrated here. Each bag is approximately 11"x11"6". *For safety reasons, team members may not step on or hold the catapult down with their hands or feet during the launch.*

v. The catapult must have a single throwing arm, similar to that of a onager or mangonel. Ballistas and trebuchets, while forms of a catapult, are NOT acceptable constructs for this event. Their power and range far exceed safety limits for this event. **Any device that does not launch a hacky sack from a single throwing arm (e.g., through a barrel and/or bow-like system in a flat trajectory, via a sling attached to the throwing arm, or a throwing arm with a gravity weight) will be disqualified and will not be allowed to test.**

vi. The catapult must use elastic, such as bungie cords or similar to power the arm, but all parts must be contained within the 2' tall x 2' long x 1.5' wide maximum footprint prior to launch. Use of metal springs is not allowed.

vii. The catapult must operate completely within the given area; the throwing arm may extend beyond the catapult only while launching.

viii. All parts of the catapult must initiate behind the firing line, but parts may extend over the line during and after the launch.

ix. The catapult cannot have wheels.

x. The catapult must be made entirely from PVC pipe, with the exception of the launch mechanism, firing mechanism, fasteners, and safety items. These items may be wood or metal and must be constructed in a safe way, so as not to damage the device, the testing area, or cause harm to others.

xi. The following materials may NOT be used:
1. Glass
2. Flammable, corrosive, or explosive materials
3. Compounds that produce odors or gases
4. Metal (other than for the launch mechanism, firing mechanism, fasteners, and safety items). Metal cannot be used to reinforce any part of the structure or serve as a stopping mechanism.

xii. The catapult must have at least a five (5)-foot pull cord to launch from a safe distance. For safety, all team members must step away from the catapult during a launch, but may move back in to reload the catapult during testing only to move away again before the catapult is fired. No team member may remain next to the catapult during the firing.

xiii. When the catapult is on display or not in the performance stage. It must be fully disabled and unable to be readied for firing.

xiv. Teams will receive a bucket of five (5) hacky sacks (each weighing approximately 50 grams) for the testing stage.

xv. One team member will use a 25' tape measure for measuring and recording the distance from the catapult to the target as it is set for the given test day.

xvi. Teams will position their catapult ON the "firing line" and wait for the command to fire. No catapult will be allowed to launch if it is NOT on the firing line. Teams need to ensure that the device is on the line before each shot.

xvii. Calibration should be completed prior to the conference. Teams may have a printed calibration table (see portfolio documentation) present to set and adjust their catapult.

xviii. There will be three 5 gallon buckets as targets set up between 15' and 25' away, and up to 3' off the ground, which will be labeled blue, green, and red in order of difficulty.

xix. Teams will be allowed 1 optional test shot per target, followed by 4 scoring shots. Only one hacky sack may be fired at a time.

xx. Scoring is as follows: red target, 15 points; green target, 10 points; blue target, 5 points.

xxi. Hacky sacks must enter the target directly and be fully in the scoring container to score points. No points will be earned for bounced-in or half-in/half-out hacky sacks.

xxii. Ties in score will be broken based on whichever team scored the most on the more difficult targets (e.g. two teams with 90 points, one scored 3 times in the red target, and the other scored twice in the red target, the one with 3 scores on red would win the tie).

xxiii. Final ranking will be determined from points earned 1) the catapult's performance. 2) for the design portfolio and.

xxiv. Team members must collect all hacky sacks after each target once judges complete recording points, and before leaving the event area after the final target.

C. Submission

i. Participants will check in their entry at the time and place stated in the conference schedule.

ii. Catapults are inspected by evaluators to determine among other things, safety. Catapults that meet all Go/No-Go regulations will be approved for the performance stage of the event. Any unsafe devices will be disqualified. Judges will make a final determination about the operational safety of a catapult.

iii. If an entry's catapult is approved for the performance stage of the event, the entry's design portfolio will be evaluated.

iv. A time sheet will be provided for sign up at check-in.

v. Students must be present for the performance stage of the event.

vi. Entries received after the time listed in the conference schedule will not be judged.

b. Judges score the entries.

c. Winners are announced.

EVALUATION

A. The documentation portfolio

B. The catapult/testing

Refer to the official rating form for more information.

STEM INTEGRATION

This event aligns with the STEM (Science, Technology, Engineering, and Mathematics) educational standards.

LEADERSHIP AND 21ST CENTURY SKILLS DEVELOPMENT

This event provides opportunity for students to build and develop leadership and 21st century skills including but not limited to:

- Communication
- Collaboration/Social Skills
- Initiative
- Problem Solving/Risk Taking
- Critical Thinking
- Perseverance/Grit
- Creativity
- Relationship Building/Teamwork
- Dependability/Integrity
- Flexibility/Adaptability

CAREERS RELATED TO THIS EVENT

This competition has connections to one (1) or more of the careers below:

- Engineering technician
- Mathematician
- Mechanical engineer
- Physics teacher

Participant/Team ID#

CATAPULT DESIGN

2022 OFFICIAL RATING FORM

MIDDLE AND HIGH SCHOOL

Judges: Using minimal (1-4 points), adequate (5-8 points), or exemplary (9-10 points) performance levels as a guideline in the rating form, record the scores earned for the event criteria in the column spaces to the right. The X1 or X2 notation in the criteria column is a multiplier factor for determining the points earned. (Example: an "adequate" score of 7 for an X1 criterion = 7 points; an "adequate" score of 7 for an X2 criterion = 14 points.) A score of zero (0) is acceptable if the minimal performance for any criterion is not met.

Go/No Go Specifications

- Before judging the entry, ensure that the items below are present; indicate presence with a check mark in the box.
- If an item is missing, leave the box next to the item blank and place a check mark in the box labeled ENTRY NOT EVALUATED.
- If a check mark is placed in the ENTRY NOT EVALUATED box, the entry is not to be judged.

Documentation portfolio was submitted
Team members all have safety goggles
The catapult has a base and appropriate weights to hold it stable
during launch
The catapult is the correct size
The catapult is built with the correct materials
The catapult launches with a pull cord
The catapult is safe to operate
ENTRY NOT EVALUATED

DOCUMENTATION PORTFOLIO (70 points)				
CRITERIA	**Minimal performance**	**Adequate performance**	**Exemplary performance**	Record scores in the column spaces below
	1-4 points	**5-8 points**	**9-10 points**	
Portfolio (X1)	Portfolio is unorganized and/or missing three or more components.	Portfolio has most components, and it is somewhat organized.	One or no components are missing in the portfolio, and content and organization are clear.	
Research (X1)	There is little evidence of research to help determine the design for a catapult.	Some research is present to help determine the design for a catapult.	Ample and thorough research to help determine the design for a catapult is evident.	
Design Log (X2)	Design log lacks information about the design process (including testing and adjustments) for the final catapult.	Design log adequately conveys the design process (including testing and adjustment) for the final catapult.	Design log provides thorough and quality information about the design process (including testing and adjustments) for the final catapult.	
Firing Log/Calibration Table (X1)	The firing log is missing or incomplete (showing fewer than 8 test shots); the calibration table is missing or incomplete.	A firing log shows at least 8 test shots; a calibration table is present and shows how to configure the device to reach specified distances.	A detailed firing log is present, indication adjustments made between shots; a detailed calibration table is present and shows how to configure the device to reach specified distances.	
Sketches and Pictures (X1)	Sketches and/or pictures do not help illustrate the design process.	Sketches andor pictures are appropriate and help illustrate the design process.	Sketches and/or pictures are of excellent quality and thorough illustrate the design process.	
Calculations Required for HS; Extra Credit for MS (X1)	There are no calculations present or they are incomplete.	Calculations for initial angle of trajectory, distance, initial velocity and time aloft are present. Base formula is shown along with substitutions and final answer.	Calculations for initial angle of trajectory, distance, initial velocity and time aloft are present. Base formula is shown with substitutions with final answer and units.	

DOCUMENTATION PORTFOLIO SUBTOTAL (70 points)	0

Rules violations (a deduction of 20% of the total possible points for the above sections) must be initialed by the judge, coordinator, and manager of the event. Record the deduction in the space to the right. Indicate the rule violated: _____	

CATAPULT PERFORMANCE (120 points)	Record Scores Below
Red Target - 15 points each	
Green Target - 10 points each	
Blue Target - 5 point each	
CATAPULT PERFORMANCE SUBTOTAL (120 points)	0

Rules violations (a deduction of 20% of the total possible points for the above sections) must be initialed by the judge, coordinator, and manager of the event. Record the deduction in the space to the right. Indicate the rule violated: _____	

To arrive at the TOTAL score, add any subtotals and subtract rules violation points, as necessary. **TOTAL SCORE (possible 190 points)**	0