

Catch It!

1. **DESCRIPTION:** Teams shall design and build the most efficient Structure that spans a given opening, and catches and holds a Steel Ball, dropped from a sequence of increasing heights. The Structure must absorb the kinetic energy of the Steel Ball from each drop.

A TEAM OF UP TO: 2 **IMPOUND: NO** **EYE PROTECTION: #2** **MAXIMUM TIME: 10 minutes**

2. **EVENT PARAMETERS:**

- a. Each team may enter only one Structure, which must be built prior to the competition.
- b. Team members must bring and wear Safety Spectacles with Side Shields during the set-up and testing of the Structure or they will not be allowed to compete.
- c. The assessment devices, testing apparatus, hardware, and steel test balls will be provided by the Event Supervisor. No other items or materials may be used for assessment or testing.

3. **CONSTRUCTION PARAMETERS:**

- a. The Structure shall span an opening of 20.0 cm. x 20.0 cm. in a Test Base (as defined in 4.b below). The Structure may span the opening in any direction from any sides of the opening.
- b. No part of the Structure may extend into the opening of the Test Base prior to each attempt. The Structure may not be braced against any edge of the Test Base for support.
- c. The maximum Structure height shall be 10.0 cm.
- d. There is no minimum or maximum Structure width. The Structure shall be constructed to set on the Test Base.
- e. The Structure shall be constructed of wood and bonded by glue. No other materials may be used (e.g. no particleboard, OSB, Masonite, bamboo, paper, or commercially laminated wood, etc.).
- f. Individual pieces of wood shall be ¼" x ¼" (approx. 6 mm x 6 mm) or less in cross section dimensions.
- g. Any type of commercially available bonding material (glue) may be used. Epoxy putty may not be used.
- h. Wood may be laminated without restriction by the team.
- i. The structure may not be coated with any material (i.e. paint, stain, glue, etc.). Excess glue that is continuous over the wood surface between joints will be considered to be a coating.
- j. Structures that fail to meet one or more of the requirements of the Construction Parameters will be ranked after those that meet all Construction Parameter requirements.

4. **TESTING APPARATUS:**

- a. The testing apparatus and materials shall be provided by the Event Supervisor. No other items or materials may be used for testing.
- b. The Test Base shall be a rigid, level surface supported at least 30.0 cm. above the floor. The surface size shall be at least 35.0 cm x 35.0 cm, and shall have a square hole approximately at its center measuring 20.0 cm x 20.0 cm. The edges of the opening shall be parallel to the edges of the Test Base. The Test Base shall have a smooth, hard, relatively low-friction surface such as high-pressure plastic laminate (Formica), melamine, metal, etc. The Test Base shall not restrain Structures from sliding off the surface.
- c. A vertical guide tube with clearly marked drop locations shall be used to hold and release the Steel Ball over the center of the opening of the Test Base. The guide tube shall extend from 20.0 cm to 190.0 cm above the Test Base. A release pin or similar device shall be located at each drop location. The Steel Ball shall free-fall through the guide tube from the drop locations onto the Structure when released by the team.
- d. The drop locations shall be 30.0 cm, 60.0 cm, 90.0 cm, 120.0 cm, 150.0 cm, and 180.0 cm. vertically from the Test Base to the Steel Ball.
- e. The Steel Ball shall be a standard, commercially available, 1" nominal diameter steel ball, provided by the Event Supervisor. The Steel Ball shall be massed at the beginning of the competition, and used throughout for all drops by all teams. The Event Supervisor may choose to have alternate Steel Balls available for use in the competition, but all balls must be massed at the beginning of the competition, and all alternate Steel Balls must mass within 0.2 grams of the mass of the primary Steel Ball.

5. COMPETITION:

- a. No alterations, substitutions, or repairs may be made to the Structure after check-in for competition, except as noted in line (5.e.vi) below.
- b. The Event Supervisor shall assess all Structures prior to testing for compliance with Construction Parameters.
- c. Prior to testing, the Event Supervisor shall determine the Structure mass, in grams to the nearest 0.01 g, and the Structure height in cm, to the nearest 0.1 cm or to the best precision available. Team members shall handle the Structure during assessment whenever possible.
- d. Teams shall place the Structure on the Test Base and align the Structure with the anticipated impact point of the Steel Ball. Teams may check the alignment with a plumb bob, to be provided by the Event Supervisor.
- e. Teams may make a maximum of twelve (12) attempts to catch the Steel Ball as follows:
 - i. The first drop shall be from the lowest level, 30.0 cm. above the Test Base.
 - ii. The Structure must catch and hold the Steel Ball above the Test Base surface after all motion stops. If the Structure catches and holds the Steel Ball without failure at any given level, the team shall advance to the next higher drop level. Teams may only score a catch once at each level.
 - iii. If the Structure fails to catch and hold the Steel Ball above the Test Base surface, the team shall reset the Structure and continue to drop the Steel Ball from the same level, until the Structure catches the Steel Ball, or the Structure is too damaged to attempt a catch, or until a cumulative maximum of twelve attempts (including attempts at all levels) have been made.
 - iv. Drop levels shall be taken in order from lowest to highest. No drop levels may be skipped.
 - v. Pieces of the structure may break and fall off. Broken pieces may not be repaired.
 - vi. Pieces of the Structure which project into the opening of the Test Base after a drop attempt must be removed or reset by the team before making the next attempt. No repairs or other modifications may be made.
- f. A failed drop attempt is defined as any of the following:
 - i. Failure to catch and hold the Steel Ball. The Steel Ball must be held completely above the level of the Test Base surface, without contacting the Test Base, after all motion stops.
 - ii. The Structure falls through or off from the Test Base so that it is supported by the floor or any other surface than the Test Base surface.
 - iii. The inability to reset the Structure on the Test Base due to breakage, including any pieces of the Structure which project into the Test Base opening which cannot be removed.
- g. All judgments concerning failure of the Structure will be made by the Event Supervisor, after all motion has stopped. A failed drop attempt will be scored as zero points, and will count as one of the twelve attempts.

6. SCORING:

- a. Each drop level from which the Steel Ball is successfully caught shall earn points as follows: 30.0 cm = 30, 60.0 cm = 48, 90.0 cm = 77, 120.0 cm = 123, 150.0 cm = 197, and 180.0 cm = 315.
- b. Structures will be scored and ranked by highest Score, as defined by the following equation: **Score = [(sum of drop points)*(mass of Steel Ball)] / [(mass of structure)*(height of the structure)]**. Height shall be expressed in cm, and masses in grams.
- c. In the event of ties for Score, the Structures shall be ranked favoring lower mass of the Structures. If still tied, the Structures shall be ranked favoring lower height of the Structures. If still tied, Structures will be ranked favoring fewer drop attempts.
- d. Structures will be released by the Event Supervisor immediately, assuming there are no pending arbitrations. If a Structure is removed there can be no further challenges for scoring or ranking.
- e. Example calculations: for a Steel Ball massing 67.0 g:
For a structure massing 40.0 grams, 8.0 cm high, with successful catches on the first four drop heights,
 $Score = [(30+48+77+123)*67.0]/[40.0*8.0] = 58.21$
For a structure massing 53.0 grams, 9.5 cm high, with successful catches on all six drops heights,
 $Score = [(30+48+77+123+197+315)*67.0]/[53.0*9.5] = 105.12$
For a structure massing 19.3 grams, 5.5 cm high, with successful catches on the first two drop heights,
 $Score = [(30+48)*67.0]/[19.3*5.5] = 49.23$