

1. **DESCRIPTION:** Prior to the competition, participants design, build, test, and document a Rube Goldberg®-like Device that completes required Start and Final Actions through a series of specific actions.

A TEAM OF UP TO: 2

APPROXIMATE TIME: 40 minutes

EYE PROTECTION: C

IMPOUND: State & National Only

2. **EVENT PARAMETERS:**

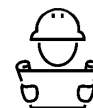
- a. Only one Device: One Device designed and built by the team prior to the competition.
- b. Impound: At State and National Tournaments only, the Team must impound their Device, Action Sequence List (ASL), and any tools or parts that they will use during their set-up time or run before the first time slot. Electric outlet access will not be available.
- c. Eye Protection: Class C is required (See Eye Protection policy on soinc.org).
- d. Event Time: Teams will have approximately 40 minutes to adjust, repair, and run their Device.

3. **CONSTRUCTION PARAMETERS:**

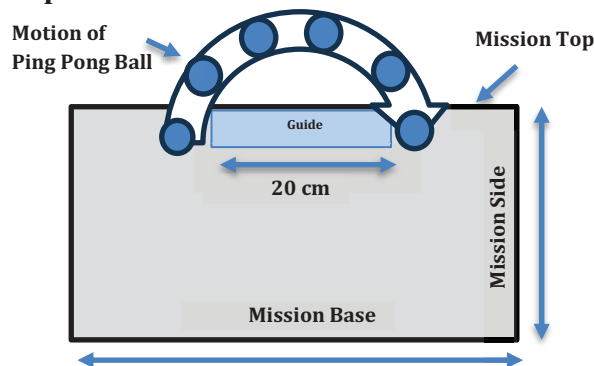
- a. During operation, the Device's outer dimensions must be no greater than **80.0cm x 80.0cm x 80.0cm**, in any orientation.
- b. All actions used for scoring must be visible and/or verifiable. The top and at least two vertical walls must be open or transparent for viewing all actions. Actions must be consecutive. Parallel and/or dead-end actions will not count for points. Any action in the Device not designed to contribute to the completion of the Final Action will not count for points.
- c. Each movable/adjustable physical object in the Device must be utilized by at most one assigned action. An object at the end of one action may initiate the next action **but must not be used in any further action**.
- d. Use of electricity is prohibited anywhere in the Device.
- e. Candles, flames, matches, hazardous liquids, lead objects (even if encased), gases, **pressure vessels (hydraulic or pneumatic)**, and hazardous materials (e.g. rat traps, combustible fuses, dry ice, liquid nitrogen) and unsafe handling of chemicals will not be permitted.
- f. **If actions 4.d.i. Wheel and Axle, 4.d.iv. Inclined Plane, and 4.d.xi. Paddle Wheel are used, the object must be easily detachable so the Event Supervisor (ES) can weigh the object.**

4. **DEVICE OPERATION:**

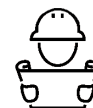
- a. Start Action: (100 points) - **Participants must quickly dump into the Device from above the Device, from a team provided 12-16 oz. commercially available plastic cup, a mixture of 10 wooden golf tees (nominal size range 1.5" to 2.75"), 10 metal paperclips (small size #1 or Jumbo), and 10 glass or ceramic marbles (size range 12mm to 42mm). All the mixture items must be commercially produced. The ES will shake the mixture in the cup, return the cup to the team prior to the competitor dumping it into the Device. The fall of the mixture must initiate the next action. Separation of the mixture may not begin until the Final Action. (Stalling is not permitted and may result in a penalty.)**
- b. Scorable Actions: (50 points each) – Participants may have up to 12 scorable unique actions to count for points. Simple machines required in the actions must be used as the simple machine name implies. For example, a wedge must be "wedged" against an object rather than used as a gate. An axle must turn a wheel or vice-versa for it to be considered a wheel & axle.
- c. The 12 unique scorable actions may be completed in any order. Other actions may be inserted between those that could count, but the inserted actions will not be scorable and must be included on the ASL.
- d. Each of the actions below may be attempted only once in the Device for points.
 - i. **Use a wheel & axle, with an IMA of at least 2, to raise an object weighing at least 50g at least 15cm vertically before the object initiates the next action.**
 - ii. Remove a wedge that keeps a golf ball from rolling, so that the golf ball rolls at least 20 cm horizontally before the golf ball initiates the next action.
 - iii. **Use the IMA action of a screw to move an object 5cm horizontally before the object initiates the next action.**
 - iv. Push or pull an object with a mass of at least 100g up an inclined plane with an IMA of at least 3 so that the object is vertically raised at least 10cm before it initiates the next action.
 - v. **Use a combination of a 2nd class and 3rd class lever, in any order, to raise an object 15cm before the object initiates the next action.**



- vi. Operate a pulley system with IMA of 2 to raise an object at least **15cm** before the object initiates the next action.
- vii. Use a marble to knock over a series of 5 dominoes so the last domino moves another marble to initiate the next action.
- viii. **Use a 1st class lever to launch an unaltered ping pong ball completely out of the top of the Device, flies at least 20cm horizontally before re-entering the Device to initiate the next action. A guide of 20cm should be included at the top level of the Device to ensure compliance. The 1st class lever is considered part of the Device for Device dimension measurement.**



- ix. Use a single marble to hit a chain of 5 touching marbles so that the last marble moves at least **15cm** horizontally and then initiates the next action.
- x. Use water to raise a golf ball at least 5cm before the golf ball rolls out of the container to initiate the next action.
- xi. Use more than one falling marble to turn a paddlewheel. **The paddlewheel must raise an object of at least 50g mass vertically 5cm before the object initiates the next action.**
- xii. Use an Archimedes screw to raise a marble 20cm vertically before the marble triggers the next action. If the Archimedes screw is encased, the walls/tube must be transparent.
- e. Participants may designate one sand timer, an action taking over 10 seconds, to be eligible for bonus points. This timer must not be one of the scorable actions.
 - i. A 1-point bonus will be awarded for every full second the sand timer runs before the Target Operation Time. The timer may run past the Target Operation Time but will not receive points for the duration after the Target Operation Time.
 - ii. The timer must successfully initiate the next action for any bonus points to count.
 - iii. For State/National tournaments, the team must demonstrate how this timer is adjusted to account for the increased length of Target Operation Time for the bonus points to count.
- f. Final Action:
 - i. **After all other planned scorable actions have been attempted, the Device must separate the original mixture into three separate (marked by material) containers that are different from the original container where the mixture was dropped.**
 - ii. **After the last material reaches its container, the Device must ring a clearly audible bell to mark the end of the final task completion and the end of timing.**
 - iii. **Points will be awarded for each item from the original mixture that is in the correct marked container when the Device stops. Points will be deducted for each incorrect item from the original mixture that is in the wrong container. Bonus points will be awarded for each of the 3 marked containers that contain all 10 of the correct original items and no other original items.**
 - iv. **Team members will not be allowed to touch any of the original 30 items during Device operation.**
- g. Action Sequence List:
 - i. Two printed copies of an Action Sequence List must be given to the Event Supervisor at the time of check-in (Regionals)/impound (State and National).
 - ii. The format should be the same as the one posted on the Science Olympiad website.
 - iii. Scoreable actions in the ASL and distances should also be labeled at the proper places within the Device.

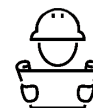


5. COMPETITION:

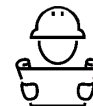
- a. Impound before first time slot (Only for State and National tournaments).
 - i. Teams must impound their Device, Action Sequence List (ASL), and any tools or parts that they will use during their set-up time or run.
 - ii. **Inspections will NOT take place during impound as any of the 15 member team may impound.**
- b. **Before the first time slot begins**, the Target Operation Time will be selected by the ES. The Target Operation Time at a competition will be the same for all teams. Teams will be told the Target Operation Time at the start of their Setup Time.
 - i. Regionals/Invitationals will be 60 seconds.
 - ii. State tournaments will be 61 to 90 seconds.
 - iii. National tournament will be 91 to 120 seconds.
- c. Check-In
 - i. Only the participants will enter the event area. Once participants start the Check-In process, they must not leave or gain any outside assistance or materials until their Event Time is completed.
 - ii. Teams will be instructed by the ES when to retrieve their impounded items (State & National).
 - iii. Each Device must pass a safety inspection before operation. Devices with potential hazards, safety concerns **or use of electricity** must not be permitted to run unless safety concerns are resolved **and electricity removed** to the satisfaction of the Event Supervisor, otherwise they must receive only participation points.
 - iv. **ES will take all measurements including dimensions and masses before or after the Device's Official Run at the ES discretion. ES may re-measure after the Official Run if the dimensions change.**
 - v. Participants must be able to answer questions regarding the design, construction, and operation of the Device per the Building Policy found on www.soinc.org.
- d. Setup Time
 - i. The ES will notify the participants when their time starts. The ES will record the team's start time for scoring.
 - ii. Participants will start preparing their Device for an Official Run. Teams are permitted to adjust, repair, and test their Device during their Setup Time.
 - iii. Participants must notify the ES when ready to start their Device for scoring. ES will record the number of minutes of Setup Time used.
- e. Official Run
 - i. Timing and scoring begin when a participant starts dumping the Mixture into the Device. Timing stops when the bell is rung, or after 2x the Target Time in seconds have elapsed, whichever comes first. **No points will be earned after timing stops.**
 - ii. Teams that have a run time of twice the Target Time will receive no (zero) points for running time.
 - iii. If the Device stops, jams, or fails, the participants will be allowed to adjust it to continue operation up to three times. An adjustment may consist of multiple physical touches and is only completed once the Device runs again on its own. Obviously adjusting only to stall or impact operation time will result in disqualification.
 - iv. If a participant completes a scorable action or makes an adjustment that leads directly to the completion of that action, then that action will not count for points, even if it is part of the Final Action.
 - v. **Participants will not be allowed to touch the Device to release original items into a container.**
- f. The Event Supervisor will review with teams their data recorded at the end of their Event Time.
- g. Teams filing an appeal must leave their Device and ASL in the event area.

6. SCORING:

- a. High score wins.
- b. **Award 50 points if not more than 30 minutes to set up their Device.**
 - i. **At State & Nationals only: Award 75 points if participants use not more than 15 minutes to set up their Device or 50 points if not more than 30 minutes.**
- c. Award 25 points if 2 printed copies of the ASL are presented at the proper time.
- d. Award 25 points if ASLs are in proper format.
- e. Award 25 points if all scorable and non-scorable actions are included and accurately described.



- f. Award 25 points if the original number (column 1) in the ASL are properly labelled in the Device and the action number (column 3) is the roman numeral of the 12 optional intermediate tasks (i to xii).
 - g. Award 50 points the first time each unique action in Section 4. is successfully completed as described in the rules.
 - h. Award 100 points for completing the Start Action.
 - i. Award 10 points for each original item placed completely in the correct marked container.
 - j. Award 50 points for each marked container that holds all 10 of the original items and none of the other original items.
 - k. Award 100 points for ringing the bell after the last items are placed in their container and the Device stops.
 - l. Award 2 points for each full second (rounded down) of operation up to the Target Operation Time. Devices running twice the Target Time will receive zero time points.
 - m. Award 1 point per full second that a **sand** timer runs before the Target Operation Time if all conditions are met, and the next action is initiated by the timer.
 - n. Award 0.1 point for each 0.1cm that the Device dimensions are under **80cm x 80cm x 80cm**. The maximum score awarded for each dimension is 30 points, for a total of 90 points (Only at in-person tournaments.)
 - o. Award 75 points for a Device that has no adjustments during operation.
 - p. Teams receive only participation points for impounding a Device but not competing, unsafe Devices, or Devices that are remotely timed/controlled.
7. **PENALTIES:**
- a. Deduct 2 points for each full second (rounded down) that the Device operates past the Target Operation Time up to **2x the Target Time seconds**.
 - b. Deduct 25 points:
 - i. For each dimension of the Device that exceeds its limit of **80cm x 80cm x 80cm**.
 - ii. If the top and 2 vertical walls are not open or transparent.
 - iii. For each time the Device is adjusted during operation, up to 3 times. If the Device stops or fails after the third adjustment, scoring stops and the operation time will be **2x the Target Time** in seconds.
 - c. Deduct 10 points for each original item that is in the wrong marked container.
 - d. Deduct 50 points if any solid or liquid leaves the measured dimensions of the Device **with the exception of the ping pong ball in action 4.d.vii.**
 - e. **Devices with any dimension greater than 85cm x 85cm x 85cm will be allowed to run but will be scored in Tier 2.**
 - f. **Teams failing to impound their Device on-time will be scored in Tier 3.**
 - g. **Teams failing to answer build questions will be scored in Tier 3.**
8. **TIEBREAKERS:**
- a. Ties are broken as follows: a) Fewest penalty points; b) Smallest overall dimensions (L+D+H) of the Device.
9. **DEFINITIONS:**
- a. *Event Supervisor (ES)* is responsible for ensuring the event runs correctly. The ES can assign one or more event helpers to perform various competition tasks.
 - b. *Container:* Receptacle (such as a box or jar) for holding goods or items. A container needs sides to hold and protect its contents. The specific design and material of the sides and base can vary greatly depending on the container's purpose. The base does not need to be flat or solid. The base cannot be the Mission Device base.
 - c. *Electricity:* A form of energy that results from the movement/flow of charged particles, electrons to create electric current. Electric current in any form (static or dynamic) is not allowed. This would disallow the use of batteries for electric current.
 - d. *Marbles* used in the Device must be glass or ceramic. These cannot be metal. Must be commercially available and sold as a marble. Allowed marble size (12mm to 42mm).
 - e. *Dominoes* must be commercially available, not 3-D printed, not homemade, etc.
 - f. *Sand* must be a commercially available product and sold as sand.
 - g. *Ping Pong Ball* must be a commercially available product and sold as a ping pong ball.



- h. *Ideal Mechanical Advantage (IMA)* is a theoretical calculation of a machine's force-magnifying ability, assuming no energy is lost to friction or other inefficiencies.
- i. *Action Sequence List (ASL)* The list must include all sequential actions in the machine including but not inclusive of this list:
 - i. Indicate the Start, the action initiated by the mixture, the Sand Timer (if one is included), the sequence of unique scorable actions, all non-scorable actions, and the action that rings the bell, etc.
 - ii. ASL column 1 should be an ordinal number that matches the number in your Mission Possible Device for easy tracking.
 - iii. ASL column 2 should specifically call out the object by name in 4.d.i. to 4.d.xii. that is to be moved.
 - iv. ASL column 3 should be the specific task that the points are to be requested (e.g. 4.d.iv.).

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries a variety of resources to purchase; other resources are available on the Event Pages at soinc.org.

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