MISSION POSSIBLE C

See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.



1. **DESCRIPTION:** Prior to the competition, competitors will design, build, test, and document a Rube Goldberg®-like device that begins with a specific Start Action and ends with a specific Final Action with an optional series of specific actions between the Start and Final Actions.

   A TEAM OF UP TO: 2 **APPROXIMATE TIME:** 40 minutes

   EYE PROTECTION: C **IMPOUND:** State & National only

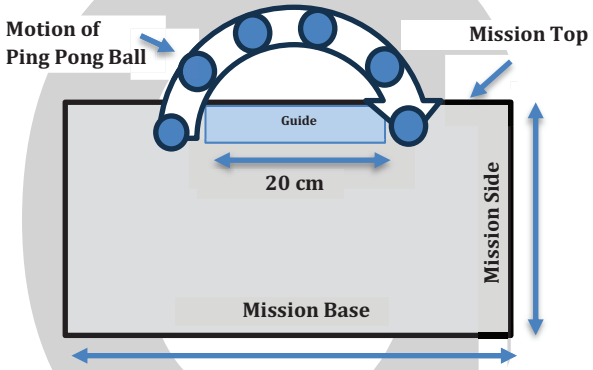
2. **EVENT PARAMETERS:**
   a. All participants must properly wear eye protection at all times. Participants without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows. Participants without eye protection will not compete and be ranked in Tier 3 based on device size.
   b. Each device must pass a safety inspection before operation.
   c. Event supervisors will need a voltmeter, meter sticks, stopwatches, and measuring tape as well as an unaltered US nickel, dime and quarter.
   d. Uncontrolled flames, cell phones, as well as hazardous liquids, gases and materials (e.g., rat traps, lead objects, combustible fuses, dry ice, liquid nitrogen, etc.) and unsafe handling of chemicals will not be permitted. No flammable gases allowed. Devices with potential hazards or safety concerns must not be permitted to run unless safety concerns are resolved to the satisfaction of the event supervisor; otherwise they must receive only participation points.

3. **CONSTRUCTION PARAMETERS:**
   a. During operation, device dimensions can be no greater than 80.0 cm (D) x 80.0 cm (W) x 80.0 cm (H).
   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.
   c. Any action in the device not designed to contribute to the completion of the Final Action will not count for points. Parallel and dead-end actions are not allowed and will not count for points.
   d. 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.
   e. Other non-scorable actions may be incorporated into the device but must contribute to the completion of the Final Action, receive no points and be listed on the Action Sequence List (ASL).
   f. Energy devices (i.e., springs/mousetraps) may be set prior to starting the device.
   g. Arduinos, Raspberry Pis, or integrated circuits are not allowed. Timing must not be powered by electricity or springs. Use of electricity is limited to the first 30 seconds of operation. If electricity is used beyond 30 seconds, a penalty will be assessed and the scorable action(s) using electricity will not count.
   h. Only commercial batteries, not exceeding 9 volts as labeled, may be used to energize each of the Device's electrical circuits. Multiple batteries may be connected in series or parallel as long as the expected voltage output across any two points does not exceed 9 volts as calculated using their labeled voltage. Teams must be able to show the event supervisors the labeled voltage. All energy storage devices must be contained in the device. All use of batteries must comply with the Science Olympiad Battery Policy at www.soinc.org. Non-compliant batteries must be removed prior to and during device operation.
   i. Students must be able to answer questions regarding the design, construction, and operation of the device per the Building Policy found on www.soinc.org.

4. **DEVICE OPERATION:**
   a. **Start Action** (25, 50, or 200 points) –To get any points for starting the device, the device must have a vertical coin slot on one side that is only large enough to allow one coin to be added at a time. All coins used in the Official Run will be supplied by the ES and returned to the ES after the Official Run. The scoring for the start sequence is as follows:
      i. When signaled by the team, the ES will put a US nickel or dime (per ES selected Coin Drop Order) in the coin slot. If the coin initiates the first action, then award 25 points and let it continue. The first action must be one that is clearly visible to the ES because timing starts along with the first action, not the insertion of the coin.
      ii. If the device does not start by adding the first coin, the ES will add the second coin (a dime or nickel). If the first action is initiated, timing will begin and 50 points will be awarded instead of 25.
      iii. If the device still does not start, the ES will add a US Quarter through the slot. If the Quarter initiates the first action, then award 200 points and begin timing when the first action is initiated.

iv. If the device does not start with the quarter, the ES will implement a 20 second countdown for a member of the team to drop another un-altered US Quarter into the device from a point entirely above the device to initiate the first action. Timing will begin with the first action and no starting points will be awarded.
v. If the team must touch the device to start it, then no points will be awarded for the start and a penalty for the first touch will be assessed. If the task that is touched is scorable, then it will not count either.
vi. All coins must be returned to the ES at the end of the operation of the Device or a Competition Violation will be assessed.

b. **Scorable Actions** (50 points each) – Participants may have up to 12 scorable unique actions to count for points.
i. Use vinegar and baking soda to inflate a balloon so that it expands 20 cm, then the balloon strikes an object that originally was at least 20 cm above the balloon, causing the object to initiate the next action.
ii. Use an endothermic action that initiates the next action because of the reduction in temperature.
iii. Drop two Alka Seltzer tablets into water so that the reaction triggers the next action.
iv. Use a 1st class lever to launch an unaltered ping pong ball completely out of the top of the Device, flies at least 20 cm horizontally before re-entering, initiating the next action, and staying in the Device. A guide of 20 cm must 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.
v. Use an infrared beam where the transmitter and receiver are at least 20 cm apart to initiate the next action. The transmitter must be an IR LED and the receiver must be a photodiode-based receiver.



vi. Push or pull an object with a mass ≥ 400 g up an inclined plane with an IMA ≥ 2 at least 10 vertical cm before the object initiates the next action. The mass must be removeable for the ES to verify.
vii. Use a pulley system with an ideal mechanical advantage (IMA) of at least 3 to lift an object with a mass ≥ 400 g at least 10 vertical cm before the object initiates the next action. The mass must be removeable for the ES to verify.
viii. Use the mechanical advantage of all 3 classes of levers in any sequence to initiate the next action.
ix. Use gravity to clearly rotate a screw so that it operates as a screw converting rotational force into linear force. The screw must complete at least two full rotations and move an object at least 2 cm before that object initiates the next action. The screw must be marked to make its rotational movement clearly visible.
x. Use an Archimedes Screw to raise a marble at least 20 cm before the marble initiates the next action**.** The entire action must be visible.
xi. Use electricity to directly or indirectly break a string or fishing line so that the breaking of the line drops an object that initiates the next action.
xii. Remove a magnet from a surface so that a magnetic object falls due to the removal of the magnetic force. That falling object must initiate the next action.

c. Participants may designate one water 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 water timer runs before the Target Time.
ii. The timer may run past the Target Time but will not receive points for seconds after the Target Time.
iii. The timer must initiate the next action for any bonus points to count.
iv. For State/National tournaments, the team must demonstrate how this timer is adjusted to account for the increased length of Target Time for bonus points to count.



d. **Final Action** (250 points) After attempting all scorable actions, the device will dispense (drop) a commercially purchased, unaltered 5-stick pack of chewing gum (team supplied) at least 50 cm vertically onto a platform ("tray") made of flat, rigid, solid, unpadded material that is no more than 12 cm x 12 cm x 0.5 ccm with no sides. The platform must have no barriers/walls within 4 cm of the edge. The top of the platform is at least 2 cm above the top of the base. Teams will not be allowed to touch the action that leads to releasing the pack of gum to complete the Final Action. If this action is touched by a team member, then no points will be awarded for the Final Action and zero time points will be scored.
e. To receive any points for the Final Action, the only thing allowed on the platform is the dropped pack of gum. The pack of gum must be supported only by the platform, clearly visible on the platform and there must be an opening on the same side of the device as the coin slot that is large enough for a team member to reach in and remove the pack of gum. The Final Action points will not be awarded if the gum is not removed.
f. An Action Sequence List (ASL) must be submitted to the event supervisor at impound. The ASL must be a:
   i. Legible, neat, and accurate documentation of each intended scorable and non-scorable action of the device's operation.
   ii. Scorable and non-scorable actions must be numbered and documented in the ASL and correspondingly labeled in the device.
   iii. Scoring will be based only on the Scorable Actions listed (by numeral) in the ASL. See www.soinc.org for an example of the format required.

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:
      i. 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.
         (1) Regionals/Invitationals will be 60 seconds.
         (2) State tournaments will be 61 to 90 seconds.
         (3) National tournament will be 91 to 120 seconds.
      ii. The Coin Drop Order (Nickel, Dime, then Quarter or Dime, Nickel, then Quarter) will be selected by the ES. Teams will be informed of the Coin Drop Order at the start to their set up time. The order at a competition will be the same for all teams.
   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 and/or safety concerns must not be permitted to run unless safety concerns are resolved 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 the first action starts after the coin is deposited into the device. Timing stops when the pack of gum comes to rest on the platform, or after 2x the Target Time in seconds has 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. 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.

f. If an action starts out of order on the ASL, all actions skipped in the listed sequence, even if completed, earn zero (0) points.
g. The Event Supervisor will review with teams their data recorded at the end of their Event Time.
h. 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 is used 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 the ASL is submitted on time at device impound or at check-in for Regionals.
   d. Award 25 points if ASL is 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 points for completing the Start Action as outlined below:
      i. Award 25 points if the device starts with insertion of the first coin by the Event Supervisor.
      ii. Award 50 points if the device starts with insertion of the second coin in the slot after trying to start with the first coin by the Event Supervisor.
      iii. Award 200 points if only the insertion of a quarter starts the first action after both other coins have been tried by the Event Supervisor.
   i. Award 250 points for completing the Final Action if the device dispenses an unaltered pack of gum in the tray as described after all scorable actions had been attempted.
   j. 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.
   k. Award 1 point per full second that a Water Timer runs before the Target Operation Time if all conditions are met, and the next action is initiated by the timer.
   l. Award 0.1 point for each 0.1cm that the Device dimensions are under 80 cm x 80 cm x 80 cm. The maximum score awarded for each dimension is 30 points, for a total of 90 points (Only at in-person tournaments.)
   m. Award 75 points for a Device that has no adjustments during operation.
   n. 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 for each dimension of the Device that exceeds its limit of 80 cm.
   c. Deduct 25 points if the top and 2 vertical walls are not open or transparent.
   d. Deduct 25 points for each touch/adjust up to 3 times. If the device stops after the third touch, it will not be allowed to be touched/adjusted and the time will be scored as 0 (zero) seconds. No other scoring is allowed after the third touch.



e. Deduct 50 points for the first solid or liquid leaves the measured dimensions of the Device with the exception of the ping pong ball during the operation of action 4.b.iv.
f. Deduct 250 points for use of electricity after 30 seconds, and allow no scoring for any action that is initiated by electricity after 30 seconds.
g. Devices with any dimension greater than 82 cm will be allowed to run but will be scored in Tier 2.
h. Teams failing to impound their Device on-time will be scored in Tier 3.
i. Teams failing to answer build questions will be scored in Tier 3.

8. **TIERS:**
   a. Tier 1: Devices without any violations
   b. Tier 2: Devices with construction or run violations that were not already penalized.
   c. Tier 3: Devices impounded after the deadline, participants without eye protection, teams failing to answer build questions.
9. **TIEBREAKERS:**
   a. Ties are broken as follows: a) Fewest penalty points and b) Smallest overall dimension (L+D+H) of the device.
10. **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. *Electricity*: A form of energy that results from the movement/flow of charged particles, electrons to create electric current.
   c. *Endothermic*: process is a physical or chemical change that absorbs heat energy from its surroundings, causing them to cool down.
   d. *Ping Pong Ball* must be a commercially available product and sold as a ping pong ball.
   e. *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.
   f. *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 coin(s), the Water Timer (if one is included), the sequence of unique scorable actions, all non-scorable actions, and the action that drops the pack of gum, 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.b.i. to 4.b.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.b.iv.).
   g. *Touches*: A single touch can consist of multiple physical contacts with the Device; but is only considered over when the Device resumes operation on its own. If a participant completes a scorable action or makes an adjustment that leads directly to the completion of the action, then that action will not count for points, even if it is part of the Final Action.
   h. *Parallel and Dead End Paths*: Parallel actions have no direct relationship to one another and if one of the two actions fails, the overall sequence of events can still continue or lead to a "dead-end" path. Parallel actions are not measured in a chronologic manner but in a causality manner. That is to say, if one action causes the next action, then they are not parallel.