1. **DESCRIPTION**: Prior to the competition, the teams design, build, test, and document a "Rube Goldberg®-like Device" that completes a required task.

   A TEAM OF UP TO: 3 **IMPOUND**: Yes **EYE PROTECTION**: #2 **TIME**: Set-up-30 min/Run: 3 min

2. **EVENT AND CONSTRUCTION PARAMETERS:**
   a. All competitors must properly wear safety spectacles with side shields.
   b. All parts of the device must fit within an imaginary box (50 cm x 50 cm x 80 cm).
   c. Each device must pass a safety inspection before operation. Devices with potential hazards or unsafe procedures must not run unless safety concerns are resolved to the satisfaction of the event supervisor. Unsafe devices receive only participation points.
   d. The device must be designed and constructed to execute a sequence of tasks from the list in section 4.
      i. The Starting Task must be Task 4.a. and the Final Task must be Task 4.n.
      ii. Teams may choose up to 8 additional tasks from 4.b. - 4.m. These may occur in any order.
      iii. After the Starting Task, the device must operate autonomously.
      iv. Each task in the device must contribute to the completion of the Final Task.
      v. Parallel tasks are not allowed. Other non-listed tasks may be built into the device but must contribute to the completion of the Final Task and they will not earn any points.
   e. Electric components must be limited to batteries, wires, resistors, motors, capacitors, solenoids, mechanical switches, electro-mechanical relays, LEDs, and light bulbs. Computers or integrated circuits must not be used in the device.
   f. The only liquids allowed are water and vinegar. Substances may be added to these during operation.
   g. Uncontrolled projectiles, hazardous spills, flames, and hazardous materials (e.g. matches, rat traps, candles, model rocket engines, lighters, fireworks, gunpowder, flammable substances) are not permitted.
   h. No more than 10.0 volts will be permitted to power any single electrical circuit. All batteries must be factory-sealed and voltage labeled by the manufacturer. No lead-acid batteries will be allowed.
   i. Energy devices such as flashlights, batteries, and mousetraps may be set/activated prior to starting the device, but not the motors (see Penalties, 8.d.).
   j. Devices must not be remotely timed or controlled.
   k. Tasks receive points only if successful, listed, and contribute toward Final Task completion.

3. **THE TASKS: No part(s) of a mousetrap will count as a simple machine.**
   a. Starting Task- Drop a U.S. quarter from above the entire device. The quarter must physically touch and snap the mousetrap, which begins the chain of events. (100 points)
   b. (20 points) Use a force to push a wedge between two objects to separate and cause the next action.
   c. (20 points) Use an IMA 3 pulley system to lift a mass at least 15cm. The mass must cause the next action.
   d. (20 points) Turn a screw so its tip stays in contact with an object, forcing the object to move at least 2 cm and cause the next action.
   e. (20 points) Use a third-class lever to cause the next action.
   f. (30 points) Inflate a balloon with a gas such that the inflated balloon causes the next action.
   g. (30 points) Use a closed hydraulic system to cause the next action.
   h. (30 points) Move a volume of air (not pneumatic) such that the moving air causes the next action.
   i. (40 points) Initiate an enclosed chemical reaction that creates gas and use that gas to cause the next action.
   j. (40 points) Convert circular motion to linear motion, without the use of gears or screws, and use the linear motion to cause the next action.
   k. (50 points) Decrease an object's temperature such that the change in temperature causes the next action.
   l. (50 points) Stack 5 wooden blocks, no smaller than 5 cm x 5 cm x 2 cm, such that the stack of 5 blocks causes the next action. The blocks cannot touch each other in their un-stacked state and must stay completely within the boundary of the device. Once stacked, each block must completely support the blocks stacked on top of it.
   m. (Variable points) Use sand that acts as a timer by allowing a stream of sand to fall from one container to another. The sand timer must operate for at least 15 seconds and the mass of the accumulating sand must cause the next action. Electricity must not be used for further actions after the sand timer has started.

n. <u>Final Task-</u> Raise a sign completely above the top of the device using a single pre-filled (prior to device operation) helium balloon. The sign must start in contact with the lowest point in the device, hang from the bottom of the balloon, and display the team school name. The balloon must be released from the device, remain tethered to the device by a string, and rise only due to its buoyancy. The sign must be easily detached and given to the judges to be massed after the task is completed. The sign and attachments, except the balloon tether, are included in the **sign mass**.

4. **TASK SEQUENCE LIST (TSL):** (An example list is on the National website.)
   a. The TSL details the scorable sequence of tasks to occur during device operation. Tasks in section 4, intended to earn points, must be numbered and identified by letter in the TSL and device.
   b. Additional actions or tasks need not be identified in the TSL.
   c. The TSL must be submitted at impound or as announced by the tournament director.

5. **OPERATION OF DEVICE:**
   a. The **timing of the device begins** when a team member releases a quarter into the device (4.a).
   b. **Timing stops** when the final task has been completed or when 180 sec have elapsed (whichever comes first); the points earned up to then determine the score. The ideal operation time is 60 sec at Regionals, between 60-90 sec at States, and between 90-120 sec at Nationals (time announced after impound).
   c. If the device stops, jams or fails, the team may adjust it to continue operation with penalty points deducted. Any obvious stalling to gain a time advantage results in disqualification.
   d. If an action inadvertently starts a task out of sequence on the TSL then all tasks skipped in the listed sequence will not earn points even if they are completed.
   e. If the team completes a task themselves or makes an adjustment that leads directly to completion of the task in the very next action, that task will not receive points (even if it is the final task).

6. **SCORING POINTS:**
   a. 25 points, if the TSL is submitted on time.
   b. 25 points, if the TSL uses the format specified.
   c. 25 points, if the TSL is 100% accurate in documentation of expected device operation.
   d. 25 points, if the tasks are labeled properly in the device.
   e. 50 points, if the team uses no more than 30 minutes for set up.
   f. 100 points, if the team starts the device correctly.
   g. 2 points, for each full second of operation up to the ideal time.
   h. 20, 30, 40, or 50 points for the first time each lettered task from section 4 is successfully completed.
   i. 100 points, if all conditions of the sand timer are successfully met.
   j. 2 points for each full second of sand timer operation before causing next action, including the 15 sec required for task completion. No sand timer points awarded after the device reaches the ideal time.
   k. 1 point per 0.1 g of sign mass (only if final task is successfully completed).
   l. 250 points, if all conditions for the Final Task are successfully completed in 180 sec.

7. **PENALTIES:**
   a. 1 point deducted for each second that the device operates beyond the "ideal" time until the device completes the Final Task, or reaches the three-minute time limit (whichever occurs first).
   b. 15 points each time the device is touched, adjusted, or restarted.
   c. 50 points, one time, for any substance that leaves the boundary of the device during operation (except the balloon, tether string, and sign at the point of task completion).
   d. 100 points for each motor running prior to the start of the device.
   e. 100 points if the device does not begin with the Starting Task.
   f. Teams with construction violations, parallel design, or "dead end" paths are ranked below all other teams.
   g. Teams with an unsafe device must not be allowed to run their device but receive participation points.

8. **TIES** are broken by this order: a. fewest penalty points; b. greatest sign mass rounded to 0.1 g (only if the final task is completed); c. longest run time of sand timer up to ideal time; d. closest to ideal time.

<u>**Recommended Resources:**</u> All reference and training resources are available at http://www.soinc.org.

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