COMPOUND MACHINES

Read the General Rules in the manuals and on www.soinc.org as they apply to every event.

1. **DESCRIPTION**: This event includes activities and questions related to simple and compound machines.

   A TEAM OF UP TO: 2 **EYE PROTECTION**: None **IMPOUND**: Yes **APPROX. TIME**: 50 Minutes

2. **EVENT PARAMETERS**:
   a. The event has two parts: Part 1 - written test on simple/compound machines, and Part 2 - device testing.
   b. Competitors may bring a single pre-made device, tools, supplies, reference materials, writing utensils and any type of calculators for use during both competition parts. Calculators do not need to be impounded.
   c. The device and any tools and/or supplies must fit inside a box no larger than 100 cm x 100 cm x 50.0 cm (at impound) and must be impounded prior to the start of competition.
   d. All reference materials to be used during all parts of the competition must be secured in a 3-ring binder, so that regardless of orientation nothing can fall out.
   e. Event Supervisors provide all masses. Masses must have a flexible loop of fishing line or similar material on top, large enough to slide a standard golf ball through. The masses, including the fully stretched out flexible loop, must be able to fit inside of a 15.0 cm x 15.0 cm x 15.0 cm cube.
   f. Allowed masses may be between 50.0-1200.0g. The ratio of the large mass to the smaller mass must not exceed 12:1 for Regionals, 16:1 for States and 20:1 for Nationals. Competitors must not bring masses or include them in devices.

3. **CONSTRUCTION**:
   a. The device must be a class 1 lever connected directly in series to a class 2 lever, each with a single beam of length $\leq$ 50.0 cm.
   b. The device may be made out of any materials. Electric or electronic components are prohibited.
   c. The device must be constructed to accommodate the masses.

4. **THE COMPETITION**: All teams must be given the same total amount of time to complete both parts of the competition.
   a. Part 1: Written Test:
      i. Where appropriate, answers must be provided in SI units with appropriate significant figures.
      ii. The competition must consist of at least one question from each of the following areas:
         1. Simple / compound machine concepts (e.g., types, terminology)
         2. Simple / compound machine calculations (e.g., ideal/actual mechanical advantage, efficiency, load, effort, potential / kinetic energy, coefficient of friction)
         3. Simple / compound machine history (e.g., Greek/Renaissance discoveries)
      iii. Questions are limited to the following static equilibrium simple machines:
         1. Lever (all three classes)
         2. Inclined Plane
         3. Wedge
         4. Pulley (up to two triple pulleys)
         5. Wheel and Axle
         6. Screw
      iv. Prohibited topics include: dynamic calculations, strengths of materials, and angle of repose

b. Part 2: Device Testing
   i. The objective is to quickly determine an unknown mass using a known mass and a lever.
   ii. While all teams are working on Part 1, the supervisor will individually call each team up to a station. Multiple identical stations may be used, but all teams must have the same values of masses.
   iii. Supervisors must verify that devices meet construction specs. Devices that do not meet construction specs must not be tested until brought into spec via modification with the tools and supplies brought by the team. Competitors may use their Part 1 time for this, but must not interfere with the device testing of other teams
   iv. Part 2 timing begins when the supervisor provides a known and unknown mass to the competitors and reveals the value of the known mass. The supervisor must ensure that value is not revealed to other teams who have not yet competed in Part 2.
   v. Using the basic mathematical principles of a lever and adjusting only the relative positions along the lever beams of the masses and fulcrums, competitors must calculate the value of the unknown mass. Teams may use their resources, calculators and tools to produce their calculation.
   vi. Competitors must not mark on, attach anything to, or modify the masses.
   vii. Part 2 timing must stop when the competitors provide the supervisor with a calculated value of the unknown mass or 4 minutes has elapsed. Supervisors must record the elapsed time to the nearest whole second. No changes are allowed to be made to the calculated value once timing stops.

5. **SCORING**:

a. Exam Score (ES): The test used for Part 1 of this event must be worth 50 points.
b. Time Score (TS) = ((240 - team's part 2 time) / 240) x 20 points.
c. Mass Score (MS) = (1-(abs (AM - CV) / AM)) x 30 points. The smallest possible MS is 0. AM is the actual mass of the unknown mass (measured to the best precision of the equipment available to the event supervisor) and CV is the calculated value of the unknown mass.
d. Teams with no device or mass estimate, or that do not make an honest attempt to utilize a compound lever to determine the unknown mass value receive MS & TS of 0.
e. Final Score (FS) = ES + MS + TS. The maximum possible FS is 100 points. High score wins.
f. Tie Breakers: 1st - Best MS; 2nd - Best ES; 3rd - Best TS; 4th - specific test questions.

Recommended Resources: All reference and training resources including the **Chem/Phy Sci CD** are available on the Official Science Olympiad Store or Website at www.soinc.org