OPTICS

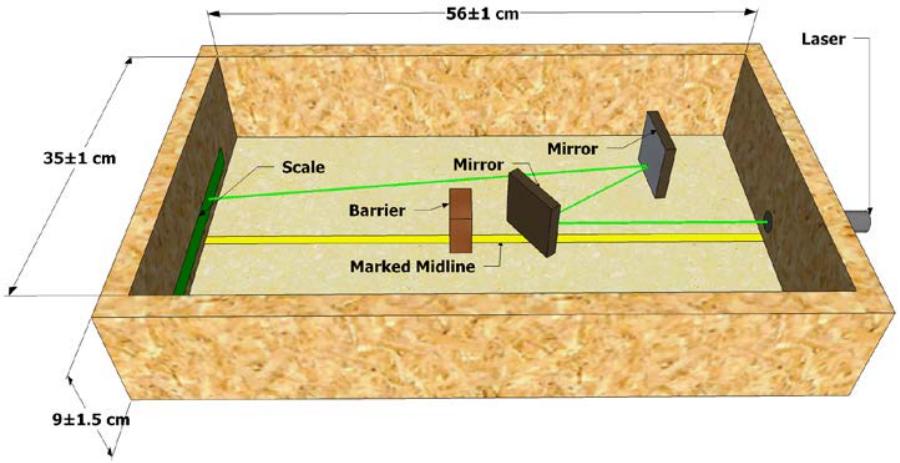
See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.

1. **DESCRIPTION**: Teams must participate in an activity involving positioning mirrors to direct a laser beam towards a target. Teams must also be tested on their knowledge of geometric and physical optics.

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

2. **EVENT PARAMETERS**:
   a. All reference materials to be used during all parts of the competition must be initially secured in a 3-ring binder, so that regardless of orientation none can fall out.
   b. Competitors may bring any measuring tools, premade templates, writing utensils and any type of calculators for use during any part of the competition. Competitors must not bring lasers or mirrors.

3. **LASER SHOOT SETUP**: Example setups are available on the event page on www.soinc.org
   a. The event supervisor must provide the Laser Shoot Setup (LSS), including laser, mirrors and barriers. Multiple LSS's may be used to facilitate all teams being able to compete in a timely manner.
   b. The LSS has a horizontal flat surface 56 ± 1.0 cm by 35 ± 1.0 cm enclosed by a 2 ± 0.5 cm thick wall. The bottom surface may be a table top. The height of the wall above the surface is 9 ± 1.5 cm.



   c. 5 moveable flat mirrors with a width of 5.0 – 8.0 cm must be placed in the LSS and must be back-surface mirrors. Each mirror must be mounted so that it stands vertically (~90 degree angle to the bottom surface), does not have excess mounting material on its sides, has its approximate center at the level of the laser beam and can be easily relocated anywhere in the LSS by the competitors. The mirror faces must initially be covered with a cardboard sleeve or other easily removable non-reflecting, opaque material.
   d. A laser is mounted through the approximate center of one of the 35 cm walls at a height of 1.5 - 6.0 cm above the bottom surface. The laser must be securely mounted such that it cannot be moved and the beam is perpendicular to the wall through which it is mounted. The Laser Policy on www.soinc.org must be followed. The laser must remain fixed throughout the entire event.
   e. A midline is drawn on the LSS from a point directly below the emitting tip of the laser to a point directly below the center of the laser beam where it strikes the opposite wall. The event supervisor must test the beam's alignment before each team is permitted to see the LSS.
   f. A metric scale with a resolution of at least 1 mm must be attached horizontally to the other 35 cm wall at the level at which the laser strikes. One of the marks on the scale is the Target Point. A sheet of paper must be also fastened to the wall, with a mark on the paper indicating the Target Point location.
   g. A barrier must be placed somewhere along the midline to block the laser beam (non-perpendicular angles permitted). In Division C only, 2 additional barriers must be placed elsewhere in the LSS.
   h. Barrier(s) must have a width of 2.0 to 8.0 cm and be tall enough to block the laser beam. They must be fixed in the same position and orientation in the LSS for all teams. One barrier must have a mirror similar to the others attached to one side and covered similarly. Competitors must not adjust the mirror's position. In Division C, any of the three barriers may have the mirror.

4. **THE COMPETITION**:
   Part I: Written Test
   a. Unless otherwise requested, answers must be in metric units with appropriate significant figures.
   b. Teams must be given a minimum of 20 minutes to complete a written test.

c. Questions may be multiple choice, true-false, completion, or calculation problems.
d. The competition must consist of at least two questions from each of the following areas:
   i. Law of reflection: specular, diffuse
   ii. Refraction: index of refraction. In Division C also Snell's law & critical angle
   iii. Prism: deviation, dispersion
   iv. Convex, concave, and plain mirrors: ray tracing, focal length, real object, images (real/virtual, erect/inverted, magnification)
   v. Convex and concave lens: ray tracing, focal length, real object, images (real/virtual, erect/inverted, magnification). In Division C also thin lens & lensmaker's equations
   vi. Operating principles of optical equipment: microscopes, telescopes, cameras, glasses
   vii. Visible spectrum: primary/secondary colors, additive/subtractive, absorption/reflection
   viii. Structure and function of the parts of the human eye
   ix. Polarization of light using polarizing films or by scattering
   x. Optical absorption spectra: films, chemicals, dyes

   Division C at State and National Tournaments only:
   xi. Ray tracing of two perpendicular or parallel plane mirrors: corner reflector, periscope
   xii. Ray tracing or measurement to find the focal length of a lens system: real and virtual objects and images (erect/inverted, magnification)
   xiii. Lasers: theory of operation, difference between coherent and non-coherent light

Part II: Laser Shoot

e. The objective is to reflect a laser beam with mirrors around barriers towards the Target Point.
f. The event supervisor must select a Target Point location that is the same for all teams. Teams must not be informed of the location until it is their turn to compete in Part II of the event.
g. All mirrors must be placed in a home position designated by the event supervisor before each team is permitted to see the LSS.
h. When a team is ready to begin, the event supervisor must give a countdown of "3, 2, 1 start" and start a timer. Event Supervisors must give teams a warning when 3 minutes have elapsed.
i. Competitors must make all measurements, calculations, and mirror placement/alignment within a 4 minute time period. Competitors may choose to use between 1 and 5 moveable mirrors.
j. Timing must stop when 4 minutes have elapsed or the competitors remove the material covering the face of one mirror. Competitors must not make any additional adjustments to the mirrors at that point other than to remove the other mirror coverings. The supervisor must not remove the coverings.
k. Competitors must not mark on or modify the LSS.
l. Competitors must not touch the laser or change its orientation and/or position.
m. The laser must not be turned on until timing stops. Once turned on, the event supervisor must mark on the paper mounted above the metric scale where the laser strikes it to record the results. Competitor tools/templates may remain on the LSS during this process.
n. The supervisor must verify with the team the correct recording of Part II data on the team scoresheet.

5. **SCORING:** A scoring rubric is available on the event page on www.soinc.org
   a. Test Score (TS) = (Part I score / Highest Part I score of all teams) x 50 points
   b. Mirrors Score (MS) = # moveable mirrors the laser reflects off of x 4 points. The max possible MS is 20.
   c. Accuracy Score (AS) = (25 – (accuracy (in mm)/10)) points. The smallest possible AS is 0.
   d. The accuracy is the horizontal distance from the Target Point to the center of where the laser strikes a wall. If the laser strikes another wall instead of the wall the Target Point is on, the accuracy is the sum of the straight line measurements from the Target Point to the corner along one wall and along the other wall from the corner to the laser dot.
   e. If the laser does not strike a wall, AS is 0, but the MS and BS should still be calculated.
   f. Teams that are disqualified for unsafe operation receive an AS, MS and BS of 0, but must still be allowed to compete in Part I.
   g. The AS, MS, and BS must be multiplied by 0.9 when calculating the Final Score if the team violates any of the rules in THE COMPETITION.
   h. Barrier Score (BS) = 5 points if the laser reflects off the barrier mirror
   i. Final Score (FS) = TS + MS + AS + BS. The maximum possible FS is 100 points. High score wins.
   j. Ties are broken using designated question(s) on the written test. The supervisor must identify the tiebreaker to the competitors at the beginning of the competition period.

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