

OPTICS C DRAFT RULES 17

1. DESCRIPTION: Teams participate in an activity involving positioning mirrors to direct a laser beam towards a target and are 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. Each team may bring one three-ring binder of any size containing information in any form and from any source, attached using the available ring(s). The information may be removed during the event. Sheet protectors and laminated sheets are allowed.
 - b. Participants may bring any measuring tools, premade templates, writing utensils and two dedicated calculators of any type for use during any part of the competition. Participants must not bring lasers or mirrors.
3. LAZER SHOOT SET UP:
 - a. Example setups are available on the event page at www.soinc.org.
 - b. The event supervisor will provide the Laser Shoot Setup (LSS), including laser, mirrors and barriers.
 - c. 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 tabletop. A surface with a ferrous metal component to which magnets will adhere is recommended. Directions, and resources, on how to retrofit existing LSSs can be found at www.soinc.org. The height of the wall above the surface is 9 ± 1.5 cm.
 - d. 5 movable flat mirrors with a width of 5.0-8.0cm must be placed in the LSS and must be front surface mirrors or mirror like reflective material (e.g., Mylar stickers). 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 participants. In order to facilitate measurements by competitors, no part of the mirror support may extend in front of the reflective surface. The mirror faces must initially be covered with a cardboard sleeve or other easily removable non-reflecting, opaque material. The mirrors may have magnets affixed to them to secure them in place on a ferrous metal bottom surface of the LSS.
 - e. 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 must remain fixed throughout the entire event. The Laser Policy on www.soinc.org must be followed.
 - f. 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.
 - g. A metric scale with a resolution of at least 1 mm must be attached horizontally to the other 35 cm wall at the level, which the laser strikes. One of the marks on the scale is the Target point. A sheet of paper must also be fastened to the wall, with a mark on the paper indicating the Target Point location.
 - h. Three barriers must be placed in the LSS. One will be somewhere along the midline to block the laser beam (non-perpendicular angles permitted). The other two will be placed elsewhere in the LSS.
 - i. Barriers 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. Barriers must have mirrors similar to the others attached to one side and covered similarly.
4. THE COMPETITION:
 - Part 1: Written Test
 - a. Teams will be given a minimum of 20 minutes to complete a written test consisting of multiple choice, true-false, completion, or calculation questions/problems.

- b. The competition must consist of at least two questions from each of the following areas; topics in *italics* are only assessed at State and National tournaments.
 - i. Law of reflection: specular, diffuse
 - ii. Refraction: index of refraction, including Snell's law & critical angle
 - iii. Prism: deviation, dispersion
 - iv. Convex, concave, and plane 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).
 - 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 that produce images and color perception
 - ix. Polarization of light using polarizing films or by scattering
 - x. Optical absorption spectra: films, chemicals, dyes
 - xi. *Ray tracing off two perpendicular or parallel plane mirrors: corner reflector, periscope images (erect/inverted, magnification)*
 - xii. *Lasers: theory of operation, difference between coherent and non-coherent light*
- c. Unless otherwise requested, answers must be in metric units with appropriate significant figures.

Part II: Laser Shoot:

- d. The objective is to reflect a laser beam with mirrors around barriers towards the Target Point.
- e. The event supervisor will select a Target Point location and home position for the mirror(s) that is the same for all teams. Teams will be informed of the Target Point when it is their turn to compete in Part II.
- f. All mirrors must be placed in designated home position before each team is permitted to see the LSS.
- g. The supervisor will demonstrate the beam's alignment before each team begins theory laser shoot.
- h. When a team is ready to begin, the event supervisor will give a countdown of "3, 2, 1 start" and then start a timer. Each Supervisor will give teams a warning when 3 minutes have elapsed.
- i. Participants must make all measurements, calculations, and mirror placement/alignment within a 4-minute time period. Participants may choose to use between 1 and 5 movable mirrors.
- j. Timing stops when 4 minutes have elapsed or the participants intentionally remove the material covering the face of one mirror. Participants must not make any additional adjustments to the mirrors other than to remove the other mirror and barrier coverings. The supervisor must not remove the coverings.
- k. Participants must not mark on or modify the LSS nor adjust the barrier(s) position.
- l. Participants must not touch the laser or touch 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 about the metric scale where the laser strikes it to record the results. Only the intended, normally reflected, path of the laser will be counted (e.g. secondary beams due to beam splitting or halos must be ignored). Participant's tools/templates may remain on the LSS during this process.
- n. Multiple LSS's may be used to facilitate all teams being able to compete in a timely manner.
- o. The supervisor must verify with the team the correct recording of Part II data on the team score sheet.

5. SCORING:

- a. A scoring rubric is available on the event page on www.soinc.org.
- b. Final Score (FS) = TS + MS + AS + BS. The maximum possible FS is 100 points. High score wins.
- c. Test Score (TS) = (Part 1 score / Highest Part 1 Score of all teams) x 60 points.
- d. Mirror Score (MS) = # of movable mirrors the laser reflects off of x 2 points. The max possible MS is 10.
- e. Accuracy Score (AS) = (15 - (accuracy (in mm)/10)) points. The smallest possible AS is 0.
- f. Accuracy is the horizontal distance from the Target Point to the center of where the laser strikes on the 35 cm Target Wall. If the laser strikes another wall, 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. If the laser does not strike a wall, AS is 0, but the MS and BS are calculated.
- g. Barrier Score (BS) = # of barriers the laser reflects off of x 5 points. The max possible BS is 15 points.
- h. Teams disqualified for unsafe operation receives an AS, MS, and BS of 0, but still compete in Part 1.
- i. Violations of rules in the COMPETITION section result in the AS, MS, and BS being multiplied by 0.9 when calculating the Final Score.
- j. Ties are broken using test questions(s) designated by the supervisor at the start of the competition.