OPTICS

1. **DESCRIPTION**: This event includes activities and questions related to geometric and physical optics.

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

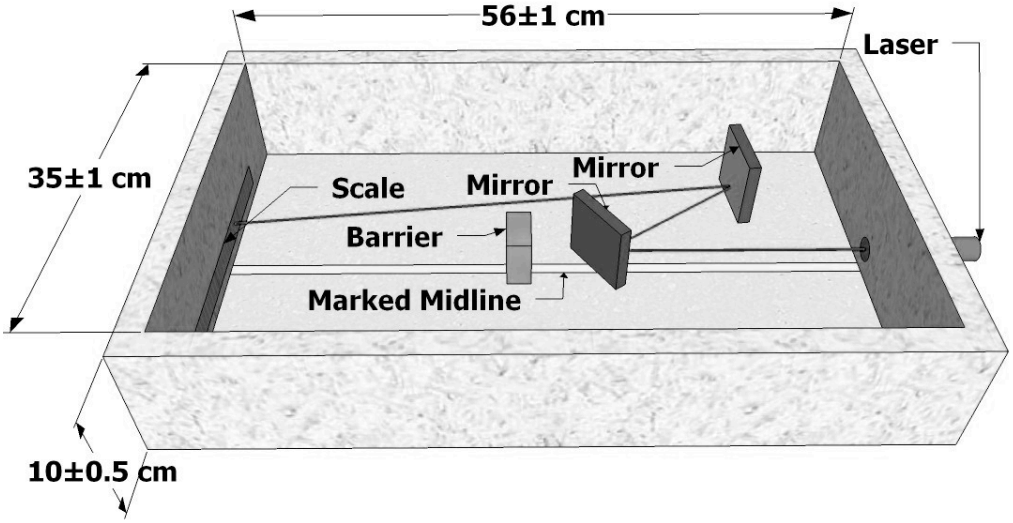
2. **EVENT PARAMETERS**:
   a. Competitors may bring tape measures, rulers, protractors, and use any type of calculator for use during any part of the competition.
   b. All reference materials to be used during the competition must be secured in a 3-ring binder, must be 3-hole punched and inserted in the binder so that regardless of orientation nothing can fall out.

3. **THE COMPETITION**: The competition consists of three parts that include experimental tasks and questions related to geometric optics and physical optics. All answers are to be provided in SI units with proper significant figures.
   a. Part 1: Geometric Optics, which may include the following topics:
      i. Law of reflection (Spectral / Diffuse)
      ii. Refraction (measurement of index of refraction, Snell's Law, critical angle)
      iii. Prism (Deviation and 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, thin lens equation, lensmaker's equation, and images (real/virtual, erect/inverted, magnification)

      State and National Tournaments may also include:
      vi. Propagation of wave fronts (Huygens' Principle)
      vii. Ray tracing of two perpendicular or parallel plane mirrors (corner reflector and/or periscope)
      viii. Ray tracing of two lens systems: real and virtual objects, images (real/virtual, erect/inverted, magnification)
   b. Part 2: Physical Optics, which may include the following topics:
      i. Visible Spectrum (colors: primary/secondary, additive/subtractive, color absorption, color reflection, and human color sensitivity)
      ii. Structure and function of the parts of the eye
      iii. Wavelengths, frequencies, velocities, and nomenclature of the various portions of the EM spectrum
      iv. Doppler shift
      v. Bright Line Spectra
      vi. Absorption Spectra
      vii. Light Intensity (Inverse square law, SI units)
      viii. Energy and momentum of photons

      State and National Tournaments may also include:
      ix. Interference and superposition of waves (Young's experiment--location of light and dark peaks only, not intensity)
      x. Lasers (theory of operation, difference between coherent and non-coherent light)
   c. Part 3: Laser Shoot - The objective is to reflect a laser beam with two mirrors, around a barrier to strike a given target.
      i. The maximum set-up time is 5 minutes. The event supervisor will use a timer to record to the nearest second the amount of time the team uses to set-up the mirrors.
      ii. The Laser Shoot Surface (LSS) is a horizontal flat surface enclosed by a 2 ± 0.5 cm thick wall; the surface may be a table top.
      iii. The size of the enclosed horizontal surface is 56 ± 1 cm x 35 ± 1 cm.
      iv. The height of the wall above the laser shoot surface is 10 ± 0.5 cm.
      v. The mirrors must have a width and height of at least 5 cm. The mirror is mounted so that it stands vertically (at a 90 degree angle to the LSS) and can be easily relocated on the LSS by the students.

vi. A laser (provided by the Event Supervisor) is mounted in a horizontal plane through the approximate center of one of the 35 cm long walls at a height of 2 ± 0.5 cm above the LSS.
vii. Class 2 Lasers (1mW or less) are to be used. Green lasers are preferred but not required.
viii. The laser must be securely mounted through the wall such that it cannot be moved and the laser beam is perpendicular to the wall through which it is mounted.
ix. A line 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 the next team is permitted to see the LSS.
x. Competitors are not permitted to touch the laser or change its orientation and/or position. The laser must remain fixed throughout the entire event.
xi. A metric scale with a resolution of at least 1 mm will be attached horizontally to the target wall at the level at which the laser strikes. One of the marks on the scale must align with the center of the laser beam where it strikes the wall. This mark is the Target.
xii. A barrier is placed somewhere between the emitting tip of the laser and the Target. The barrier must have a width of 2 to 4 cm and the laser beam must strike the barrier at approximately the horizontal center. The barrier must be in the same position and orientation in respect to the LSS for all competitors.
xiii. Competitors must make all measurements, calculations, and mirror placement/alignment within the 5 minute time allowed. The laser must not be turned on until the competitor(s) complete the mirror placement /alignment.
xiv. All mirrors must be placed in a home position designated by the event supervisor before the next competitors are permitted to see the laser shoot station.
xv. Competitors must not mark on or modify the LSS.



4. **SCORING:**
   a. The highest total points wins. Points are awarded for correct answers, measurements, calculations, analysis of data, laser shoot set-up time and laser shoot accuracy. Supervisors are encouraged to provide a standardized form on which students can show all ray tracings, measurements and calculations.
   b. Points are distributed in the following manner:
      i. Part 1: Geometric Optics — % correct answers x 30 points
      ii. Part 2: Physical Optics — % correct answers x 30 points
      iii. Part 3: Laser Shoot set-up time — (300-t)/300 x 10 points
      iv. Part 3: Laser Shoot Accuracy — 30 – (distance from TP to center of laser beam (in mm)/10)
      (Note: if the distance is > 300 mm, set the result to 0 for 4.b.iv.)
   c. Ties are broken using a designated task(s) or question(s). The event supervisor will identify the tiebreaker question(s) or task(s) on the answer form provided to the students at the beginning of the competition period.

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