

will be in  
two rooms

presented  
1/12/12

## Optics B/C 2012

We will go by the book, following the advertised rules.

### Binder

- One 3-ring binder with reference material per team.
- No loose reference material allowed.
- Students need to have all diagrams, equations, etc. included in the binder. These won't be provided.

### Test

- Multiple choice questions, except for tiebreakers (one question in each part).
- Part 1: Geometric Optics (reflection, refraction, prism, lenses, mirrors, etc.).
- Part 2: Physical Optics (Doppler, wavelengths, colors, human vision, etc.).
- Div C only: Irradiance ("intensity") of light, and energy/momentum of photons.
- Some questions may include a combination of topics.

### Laser Shoot

- Each team (both partners) will be called in turn. They will take a short break from the test.
- 1 barrier (Div B) 3 barriers (Div C).
- Same barrier positions for all teams in each division.
- Up to 5 mirrors can be used (2 are required to hit the target).
- Points are awarded only for mirrors the laser reflects off of.
- Up to 4 minutes to set up the mirrors.
- No extra points for finishing early (but will get back to the test sooner...).
- Students remove all mirror covers promptly (no adjustments allowed at that time).
- Calculators, writing instruments, measuring tools (no laser/optical tools), and templates allowed, but cannot be shared between teams.
- No objects allowed on the Laser Shoot Surface (except mirrors and barriers, of course) when the laser is operated. *-discussed*

### Notes and Tips

- Part 1 = 30%. Part 2 = 30%. Laser Shoot = 40%. ✓
- Mirror count = 20%, so laser shoot accuracy is only 20% this year.
- Optical equipment principles (microscope, telescope, camera, glasses) - new this year.
- Pay attention to units and significant figures.
- Calculator strongly recommended for test. ✓

### May Result in DQ

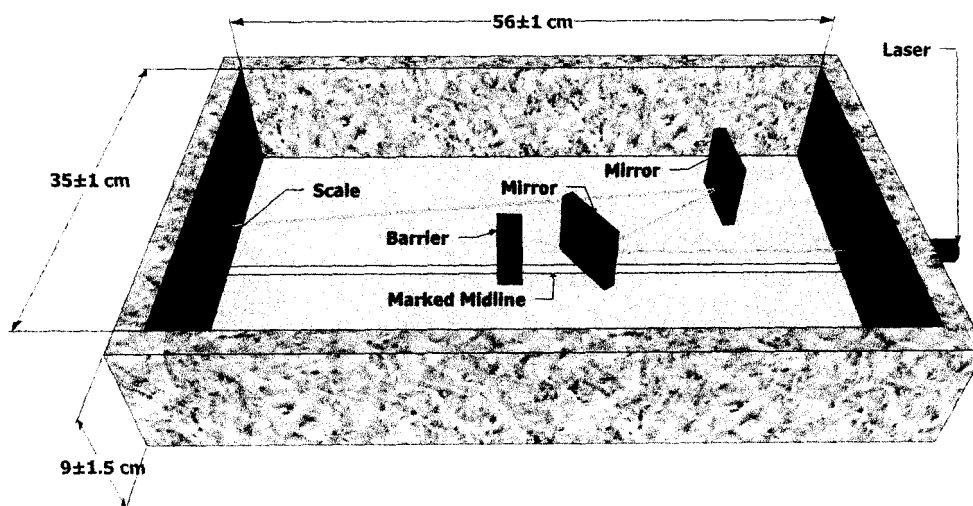
- Using or bringing in prohibited tools/aids.
- Touching the laser (only event managers/assistants will operate the laser.)
- Marking on the Laser Shoot Surface.
- Talking to other teams while in the event rooms.
- Use of cell phone in the event rooms (including ringing phone).
- Any inappropriate conduct.

will use 8cm mirrors  
once cover is removed from 1<sup>st</sup> mirrors, no further  
adjusting can be done

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 **any measuring tool, premade templates, writing utensils** and use any type of **calculators** for use during any part of the competition.
  - b. All reference materials to be used during **all parts of** 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.
  - c. **Event Supervisors provide the Laser Shoot Surface (LSS), laser, mirrors and barriers. Multiple LSS's may be used to facilitate all teams being able to compete in a timely manner.**
3. **THE COMPETITION:**
  - a. 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.
  - b. Part 1: Geometric Optics, which may include the following topics:
    - i. Law of reflection (**Specular** / Diffuse)
    - ii. Refraction (measurement of index of refraction)
    - 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, and images (real/virtual, erect/inverted, magnification)
    - vi. **Operating principles of optical equipment (microscopes, telescopes, cameras, glasses)**
  - c. Part 2: Physical Optics, which may include the following topics:
    - i. Visible Spectrum (primary/secondary colors, additive/subtractive, absorption/reflection)
    - ii. Structure and function of the parts of the **human eye**
    - iii. Wavelengths, frequencies, velocities, and nomenclature of the various portions of the EM spectrum
    - iv. Doppler shift
    - v. Bright Line and Absorption Spectra
  - d. Part 3: Laser Shoot - The objective is to reflect a laser beam with **mirrors around barriers** to a target.
    - i. The maximum set-up time is **4 minutes. Timing must stop when 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.**
    - ii. The Laser Shoot Surface (LSS) is a horizontal flat surface enclosed by a  $2 \pm 0.5$  cm thick wall; the surface may be a table top.
    - iii. The size of the enclosed horizontal surface is  $56 \pm 1$  cm x  $35 \pm 1$  cm.
    - iv. The height of the wall above the laser shoot surface is  $9 \pm 1.5$  cm.
    - v. The **5 flat mirrors** must have a width of **5 - 8 cm. Each mirror is mounted so that it stands vertically (at a 90 degree angle to the LSS), does not have excess mounting material on its side edges, has its approximate center at the level of the laser beam and can be easily relocated anywhere on the LSS by the students. The mirror faces must initially be covered with a cardboard sleeve or other easily removable non-reflecting, opaque material.**
    - 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 **1.5 - 6.0** 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.

Read the General Rules in the manuals and on [www.soinc.org](http://www.soinc.org) as they apply to every event.

- xi. A metric scale with a resolution of at least 1 mm must be attached horizontally to the far target wall at the level at which the laser strikes. One of the marks on the scale is the **Target Point**.
- xii. A **barrier** is placed somewhere along the line between the emitting tip of the laser and the **Target Point**. The barrier must have a width of 2 to 4 cm and be tall enough to block the laser beam. 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 4-minute time allowed. The laser must not be turned on until the competitor(s) complete the mirror placement /alignment. **Competitors may choose to use between 1 and 5 mirrors.**
- 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.



## SCORING:

- a. The highest total points wins. Points are awarded for correct answers, measurements, calculations, analysis of data, **number of mirrors used** 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 Mirrors**      # mirrors the laser reflects off of x 4 points
  - iv. Part 3: Laser Shoot Accuracy      (20 - (accuracy (in mm)/10))

(Note: Accuracy is the horizontal distance from the Target Point to the center of where the laser strikes a wall; if the distance is > 200 mm or the laser does not strike a wall, set the result to 0 for 4.b.iv., but still calculate the # mirrors score; If the laser strikes another wall instead of the wall the Target Point is on, the distance shall be the sum of the straight line measurements from the target to the corner along one wall and from the corner to the laser dot along the other wall.)
- c. Scoring example: A team correctly answers 7 out of 10 questions on Part 1 and 65 out of 100 on Part 2. They use 3 mirrors on the laser shoot and the laser beam ends up 21 mm away from the Target Point: Part 1 score:  $7/10 = 0.7 \times 30 = 21$  points, Part 2 score:  $65/100 = 0.65 \times 30 = 19.5$  points, Part 3 mirrors score:  $3 \times 4 = 12$  points, Part 3 accuracy score:  $20 - (21 / 10) = 17.9$  points. Total score:  $21 + 19.5 + 12 + 17.9 = 70.4$  points.
- d. Ties are broken using a designated task(s) or question(s). The supervisor must identify the tiebreaker on the answer form provided to the students at the beginning of the competition period.

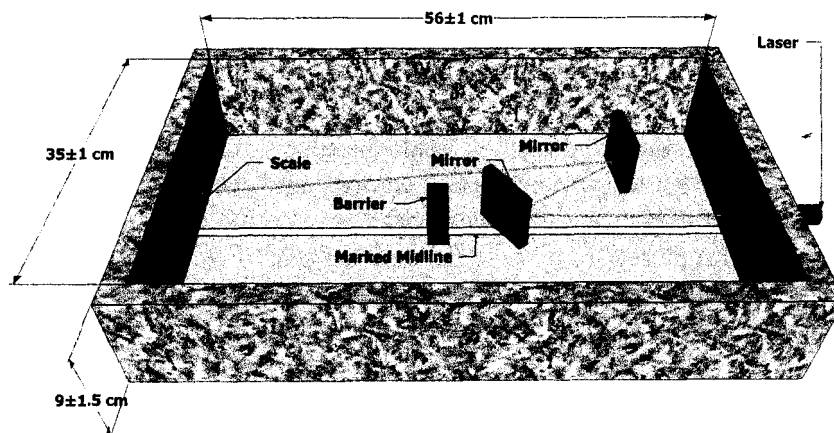
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    - ii. Refraction (measurement of index of refraction, Snell's Law, critical angle)
    - iii. Prism (Deviation and Dispersion)
    - iv. Convex, concave, and plain mirrors: ray tracing, focal length, real object, images (real/virtual, erect/inverted, 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)
    - vi. **Operating principles of optical equipment (microscopes, telescopes, cameras, glasses)**  
State and National Tournaments may also include:
      - vii. Propagation of wave fronts (Huygens' Principle)
      - viii. Ray tracing of two perpendicular or parallel plane mirrors (corner reflector and/or periscope)
      - ix. Ray tracing of two lens systems: real and virtual objects and images (erect/inverted, magnification)
  - c. Part 2: Physical Optics, which may include the following topics:
    - i. Visible Spectrum (primary/secondary colors, additive/subtractive, absorption/reflection)
    - ii. Structure and function of the parts of the **human eye**
    - iii. Wavelengths, frequencies, velocities, and nomenclature of the various portions of the EM spectrum
    - iv. Doppler shift
    - v. Bright Line and Absorption Spectra
    - vi. Light Intensity (Inverse square law, SI units), Energy and momentum of photons  
State and National Tournaments may also include:
      - vii. Interference/superposition of waves (Young's experiment--location of peaks only, not intensity)
      - viii. Lasers (theory of operation, difference between coherent and non-coherent light)
  - d. Part 3: Laser Shoot - The objective is to reflect a laser beam with mirrors around **barriers** to a target.
    - i. The maximum set-up time is **4 minutes. Timing must stop when 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.**
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- xi. A metric scale with a resolution of at least 1 mm must be attached horizontally to the **far** target wall at the level at which the laser strikes. One of the marks on the scale is the **Target Point**.
- xii. **3 barriers are placed on the LSS. At least 1 barrier is placed somewhere along the line between the emitting tip of the laser and the Target Point.** The **barriers** must have a width of 2 to 4 cm and **be tall enough to block the laser beam.** The **barriers** must be in the same position and orientation in respect to the LSS for all competitors.
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