

OPTICS/PHYSICS LAB 05

(needs significant modification for Div. B and maybe combine/use some of the Reflection Relay tasks)

DESCRIPTION: Students will compete in lab activities in the areas of **geometric and physical optics**.

EVENT PARAMETERS: Students may bring and use any type of calculator. No **other** resource materials may be used unless provided by the event supervisor.

A TEAM OF UP TO: 2

APPROXIMATE TIME: 45 Minutes

THE COMPETITION: The competition will consist of experimental tasks and questions related to **geometric optics and physical optics**. All answers will need to be provided in SI units (such as Watts, Joule, Newtons, kilograms, meters, Volts, Ampere, Ohm, **lumen, candela, lux**, and seconds) with proper significant figures.

1. Geometric optics may include the following topics:

- a) Wave fronts and rays (Huygens's Principle)
- b) Reflection (Law of reflection, specular reflection, diffuse reflection)
- c) Refraction (measurement of index of refraction, Snell's Law)
- d) Critical Angle (measurement of critical angle, fiber optics)
- e) Dispersion Due to a Prism
- f) Simple Lens and mirrors (ray tracing, measurement of focal length, mirror equation, thin lens equation, magnification, lens maker's equation)

2. Physical Optics may include the following topics:

- a) Interference and superposition of waves
- b) Double Slit Interference (Young's experiment--location of peaks only, not intensity)
- c) Lasers (theory of operation, difference between coherent and non-coherent light)
- d) Electromagnetic Spectrum
 - 1) wavelength, frequency, velocity, nomenclature of EM spectrum,
 - 2) inverse square law applied to the intensity of light
 - 3) Doppler Shift,
 - 4) Energy and momentum of photons,
 - 5) Bright Line Spectra,
 - 6) Absorption Spectra

At the National Tournament, in honor of the World Year of Physics and Einstein's 100th anniversary of his three papers that changed physics, the lab will also include Photoelectric Effect, Work Function, and Thermionic Emission topics. See www.physics2005.org for more details.

Where feasible, supervisors are encouraged to provide students with brief demonstration(s) of data collection by computer and/or calculator sensors/probes followed by distribution of previously prepared data sets. If used, data will be presented to students in a tabular and/or graphic format(s) and students will be expected to analyze and/or interpret the data.

SCORING: Points will be awarded for correct answers, measurements, calculations, and analysis of data. Supervisors are encouraged to provide a standardized form on which students can show all measurements and calculations. Ties will be 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.

National Science Education Standards: Physical Science CONTENT STANDARD B: As a result of their activities in Grades 9-12, all students should develop an understanding of interactions of energy and matter.

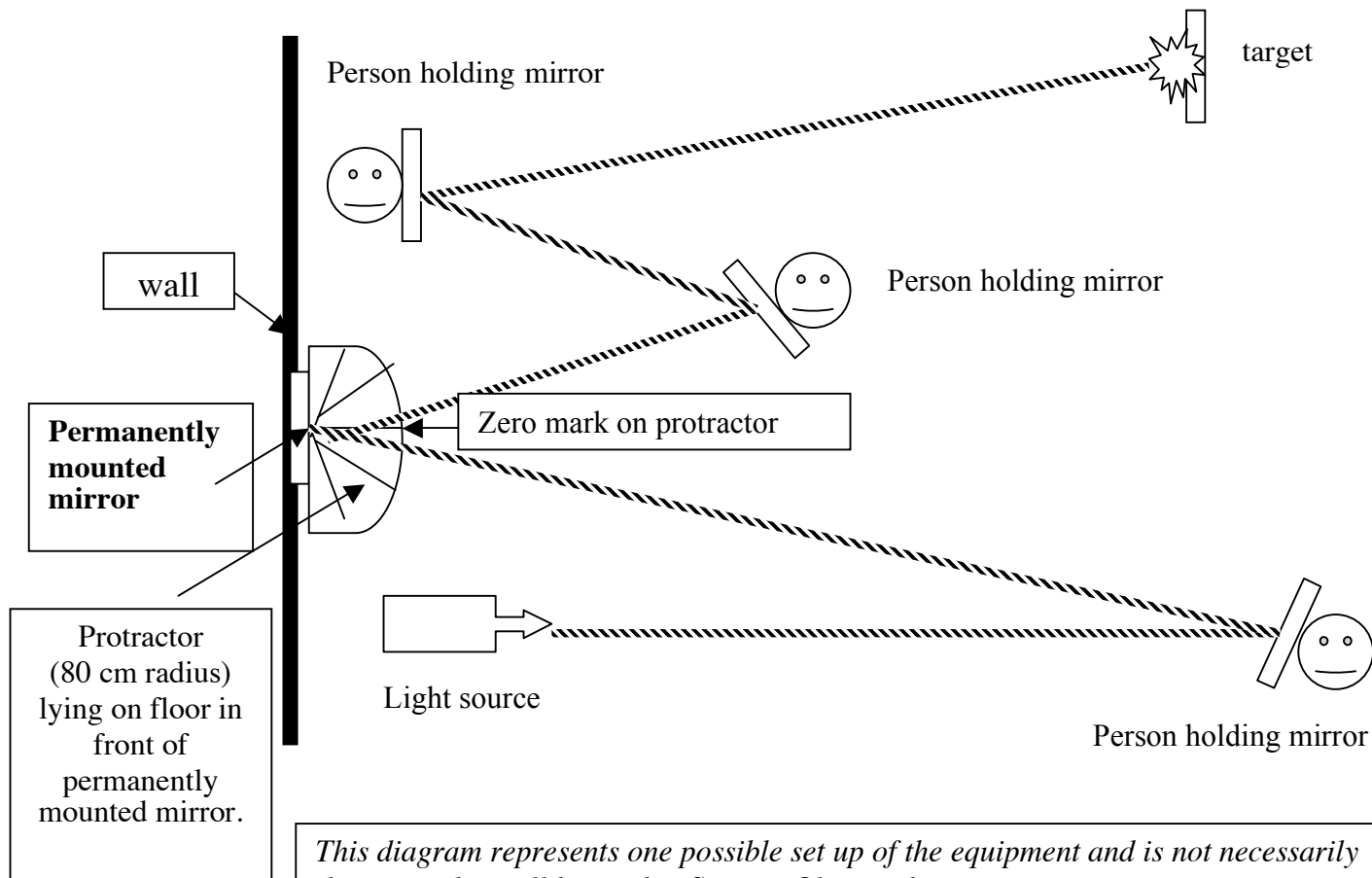
DESCRIPTION: Three team members supplied with four mirrors approximately 3" X 4", cooperate to bounce a light beam onto a predetermined target. One of the mirrors will be mounted on the wall and cannot be moved. Team members must use the judge's mirrors.

TEAM SIZE: 3 students

APPROXIMATE TIME: 10 minutes

THE COMPETITION:

1. The light must strike each of the four mirrors before hitting the target. There may be obstacles that the beam of light will have to be directed around (see sample diagram).



This diagram represents one possible set up of the equipment and is not necessarily the set up that will be used at Science Olympiad.

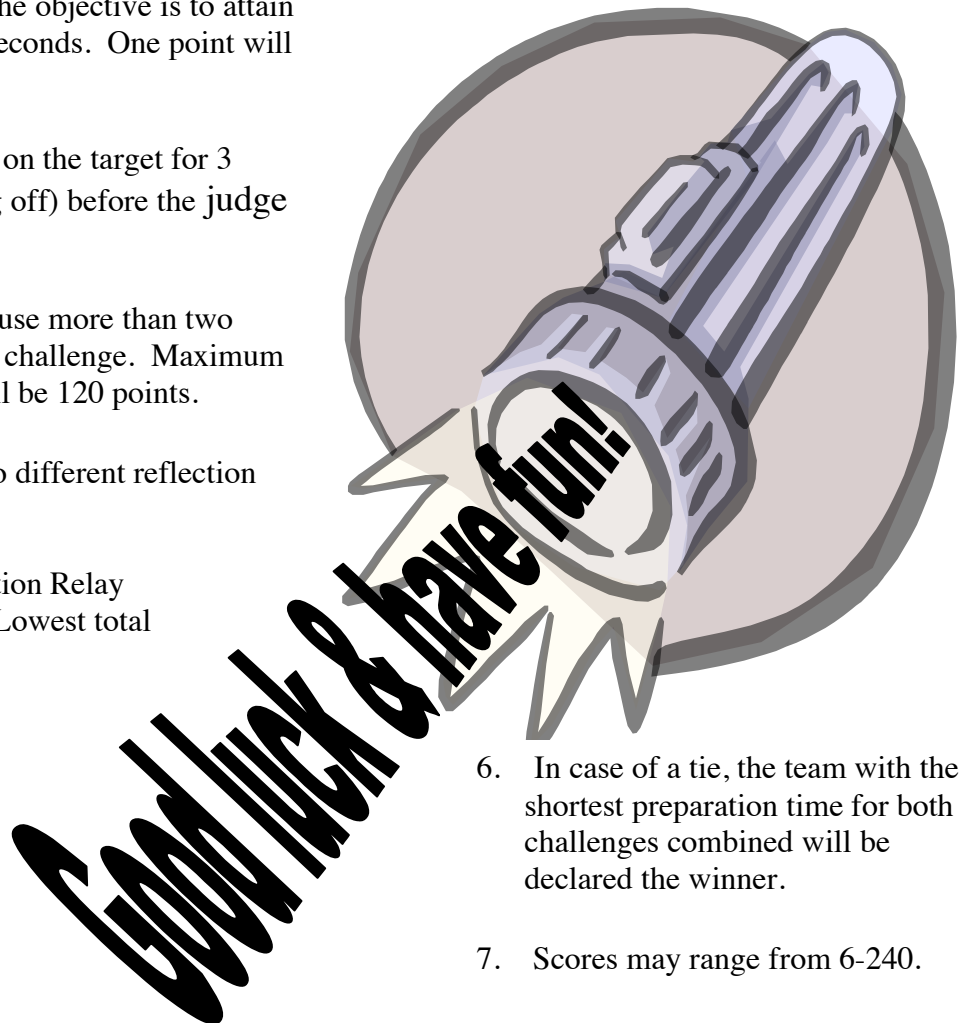
NOTE: The angles of reflection and incidence in this diagram have not been measured and are not necessarily accurate.

REFLECTION RELAY

2. The three-team members must cooperate to direct the beam of light on the target. They must use all four mirrors to change the light's path.
3. Team members must stay at least 80 cm away from the permanently placed mirror. A large protractor (radius of 80 cm) will be placed on the floor in front of the mirror. This will mark the distance the participants must stay away from the mirror and will also provide a measuring device if the participants choose to use it.
4. Each team will be given up to one minute of preparation time before the clock is started.
5. Materials that will be provided for each team: light source, 3 moveable mirrors, 1 non moveable mirror, 1 protractor (80 cm radius), target.

SCORING:

1. Each team will be timed. The objective is to attain the lowest elapsed time in seconds. One point will be added for each second.
2. The beam of light must rest on the target for 3 seconds (without wandering off) before the judge stops the timer.
3. No team will be allowed to use more than two minutes to accomplish each challenge. Maximum score for each challenge will be 120 points.
4. Each team will be given two different reflection relay challenges.
5. Scores from the two Reflection Relay challenges will be totaled. Lowest total score wins.



6. In case of a tie, the team with the shortest preparation time for both challenges combined will be declared the winner.
7. Scores may range from 6-240.

REFLECTION RELAY

PART I:

Description:

Three team members, each supplied with a pocket mirror, cooperate to bounce a light beam from a filmstrip projector onto a predetermined target.

Number of Participants: 3 Approximate Time: 30 minutes

The Competition:

1. The light must strike each of the three mirrors before hitting the target, and there may be obstacles that the beam of light will have to be directed around (see sample diagram).

SEE ESO MANUAL FOR DIAGRAMS

2. The three team members must cooperate to direct the beam of light on the target. They must use all three mirrors to change the light's path.
3. Each team will be given up to one minute of preparation time before the clock is started.

Scoring:

1. Each team will be timed. The objective will be to attain the lowest elapsed time in seconds. One point will be added for each second.
2. No team will be allowed to use more than two minutes to accomplish the task. Maximum score will be 120 points.

PART II:

Description:

Three team members, each supplied with a mirror on a stand (mirror perpendicular to the floor), cooperate to calculate the placement of their mirrors in order to bounce a light beam onto a predetermined target. During mirror placement the light source is turned off.

The Competition:

1. Students may use a variety of supplies (string, paper, home-made protractors, etc.) brought by the student, to aid them in calculating their mirror placement (no light sources allowed).
2. The three team members must cooperate to calculate the placement of the mirrors while the beam is turned off. They must use all three mirrors to change the light's path and hit the predetermined target. There may be obstacles that the beam of light will have to be directed around (see sample diagram).
3. Each team will be given up to five minutes preparation time before the light source is turned on and the score is determined.

Scoring:

1. Each team will start with a score of 120. The objective will be to reduce this score as low as possible.
2. Once the light source is turned on, the team's score will be reduced by 30 points per mirror that is hit by the light and minus 30 for hitting the target. A perfect score of 0 will be awarded to any team that uses all three mirrors to bounce the beam of light and hit the target.
3. Scores from PART I and PART II will be totaled. Lowest total score wins.
4. In case of a tie, the team with the shortest preparation time for both parts combined will be declared the winner.
5. Scores may range from 1-240.