Hit the Target

A competition for LaserFest

Based on Hands-On Optics created by NOAO, SPIE, and OSA

By Robert T. Sparks, Stephen M. Pompea, and Constance E. Walker
Credits

This competition has been adapted from Hands-On Optics: Making an Impact With Light, funded by the National Science Foundation.

Hands-On Optics was a partnership between the National Optical Astronomy Observatory, SPIE, and the Optical Society of America.

NOAO Development Team

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LaserFest is a collaboration between the American Physical Society, the Optical Society, SPIE, and IEEE Photonics Society. Go to http://laserfest.org for more information about the laser, a variety of fun activities, and information on LaserFest events being held throughout 2010.
Table of Contents

Overview . . . . . . . . . . . . . . . . . . 2
Introduction to Lasers . . . . . . . . . 3
Materials Master List . . . . . . . . . 4
Laser Safety . . . . . . . . . . . . . . . . 5
Target . . . . . . . . . . . . . . . . . . . . 6
LaserFest Target . . . . . . . . . . . 8
Getting Ready . . . . . . . . . . . . 10
Hit-the-Target Rules . . . . . . . . 12
Scorecard . . . . . . . . . . . . . . . . . 13
Overview

LaserFest is a yearlong celebration of the 50th anniversary of the laser, which was first demonstrated in 1960 by Theodore Maiman and his co-workers C. K. Asawa and I. J. D’Haenens. Lasers have become ubiquitous in the ensuing decades, finding uses in DVD players, medical and industrial applications and communications.

Because lasers generate light that has the property of staying in a straight, condensed, monochromatic (one-color) beam, it is a perfect light source for lessons on observing, measuring, and using reflecting beams.

You will be using lasers in a game called “Hit the Target”. Your goal will be to use your knowledge of light and reflection to guide the laser to hit a target on the wall. There is a catch: you must set up the laser and mirrors with the laser turned off. Once you have set the laser and mirrors, you turn on the laser to see if you successfully “Hit the Target.”
Introduction to Lasers

Has someone ever unknowingly blinded you because the Sun reflected off their watch and into your eyes? Have you ever tried to look around a corner with a mirror? Every day we use or experience reflected light. A small makeup mirror and a large telescope the size of a building both use reflections.

Imagine that you are a scientist trying to build a new telescope. Wouldn’t you like to be able to predict how it will collect light and magnify distant objects? Is it possible to predict the path light follows when it reflects off a surface or bends through a lens?

In this activity we will see if it is possible to predict how light reflects from mirrors. To study reflection, we will be using lasers. LASER stands for Light Amplification by Stimulated Emission of Radiation. A laser is a powerful and concentrated source of light. Unlike a flashlight that sends out a cone of light that spreads out after a short distance, the laser light stays in a straight line and doesn’t spread as much. This is what is meant by saying a laser produces “collimated” light. While laser beams aren’t the only things that reflect, they are a simple and effective light source for this module. In fact, all light, from the Sun, lamps, fire, and many other sources, reflects in the same manner.

Lasers are everywhere we look today. Since their invention in 1960, they have worked their way into our CD players, grocery store scanners, factories, classrooms, levels for hanging pictures, and printers. They can be powerful enough to cut through metal. Some are large enough to fill an entire room while others are so small that you need a microscope to see them. While the lasers we are using throughout this activity are safe to shine on your skin, they can hurt your eyes if you stare directly into the beam. You must get used to taking safety precautions while using them, to avoid looking into the laser beam.

To learn how a laser really works, there is a short explanation in Stop Faking It: Light that you could read. You can also go to your local library or search online.
Materials Master List

The materials supplied in the kit are designed for five teams to play Hit the Target.

- 5 lasers
- 10 AAA batteries
- 15 mirrors glued into CD Cases
- 2 rolls red string
- 10 rulers
- 10 protractors
- 5 rolls masking tape
- 1 set instructions
- 4 Explore Optics magazines

Additional Materials (supplied by the instructor)
- Scissors
- Replacement batteries
- Floor tape (optional)
LASER SAFETY

Laser safety is important!

Never look into the laser. Be aware of where the beam is aimed at all times. Never look into the beam to see if it is on. Point the laser at a wall or at the floor to see if the beam can be seen.

Turn on the laser only when it is aimed in a safe direction, away from people.

Always keep your head away from and above the laser beam.

Do not wave the laser around the room or shine it on other people. Do not move the beam when it is on, if possible.

Do not allow the beam to inadvertently reflect from metal or glass surfaces. Take off any shiny jewelry such as watches, rings, or bracelets that may reflect the laser light into your or someone else’s eyes. Be aware of reflective surfaces that are near the path of the beam.

Do not turn on the laser until you are aware of where it will go and are convinced that it will not shine in someone’s eyes directly or through a reflection.
Getting Ready

You will need to clear a large area for the competition. Each team will need to hang their target on a vertical surface, ideally a wall around the edge of a large room. Gymnasiums and multi-purpose rooms work well. Be sure the teams are spread out enough that they will not bump equipment being used by their neighboring teams.

If you have a large area and time, you may wish to mark out each team's designated area with floor tape. An area of 8×8 feet (2×2 meters) should be sufficient for each team. Tape the target to the wall in the middle of the playing area. Be sure to leave a few feet between each team's playing area. You may place a strip of tape four feet from the target to indicate the minimum laser distance.

Test all the lasers and be sure to have extra batteries on hand. Set out the appropriate number of lasers and mirrors at each station. You will also want to cut a long piece of string and set it out at each station. Set out the protractors and rulers.

Be sure you have an adequate number of judges for the event. If you have all the teams lined up against one wall, one judge can monitor 4-5 teams. If the teams are more spread out, you will need extra judges. Make a copy of the score sheet for each team. You can give each team a name or identifying number. Be sure the judge has a scoresheet for each team.

Before you start, you should decide how many rounds you will play, how many mirrors will be used in each round, and how many attempts per round each team will receive. You will need to consider the age of the students as well as the amount of time you have for the competition. On the next page are several possible competition scenarios.
Scenario #1: For Younger Students

For younger students you may wish to give them more attempts per round and use fewer mirrors. For example, Round #1 would consist of four attempts using one mirror. Round #2 would consist of four attempts using two mirrors. Our experience shows allowing 20–25 minutes for each round is sufficient for most students to complete four shots.

Scenario #2: For Older Students

Older students can be given fewer attempts per round but use more mirrors. For example, Round #1 would consist of three attempts with one mirror. Round #2 would consist of three attempts with two mirrors. Round #3 would consist of three attempts with three mirrors. Allow 15-20 minutes per round (although students may find doing three mirrors in this time challenging!).

Scenario #3: For Advanced Students

To make the final round more challenging and add an element of strategy, you can let the students choose the number of mirrors they use. Using more than three mirrors is more difficult but would result in bonus points awarded to each successful shot. For example, Round #1 would consist of three attempts with two mirrors. Round #2 would consist of three attempts with three mirrors. Round #4 would consist of three attempts with 3-5 mirrors. If the students used three mirrors, they would score the value indicated on the target. If the students used four mirrors, they would score 25 bonus points in addition to the value on the target (if they hit 100, they would score 125 for that shot). If the students used five mirrors, they would receive 50 bonus points in addition to the value on the target. Students would NOT receive any points if they failed to hit the target.
Hit the Target Rules

1. Before the competition, review the Laser Safety Rules with all participants. Failure to follow the Laser Safety Rules will result in immediate disqualification.

2. Remind the competitors that NO PRACTICE SHOTS ARE ALLOWED.

3. The laser must be placed at least 4 feet (1.2 m) from the target.

4. The mirror(s) must be at least 1 foot (30 cm) from the laser, 1 foot (30 cm) from the target, and 1 foot (30 cm) from any other mirror (for rounds with multiple mirrors).

5. Each team must position the laser and mirror(s) so the laser will bounce off the mirror(s) and hit the target. The laser must be turned off the entire time they are positioning the mirrors and laser. If the laser is turned on prematurely, the team forfeits that attempt and will receive zero points.

6. Once the team is ready to attempt to hit the target, they must notify one of the judges. When the judge is present, one of the team members will turn on the laser (they may not move the laser) and the judge will award points based on where they hit the target. TEAMS MUST NOT SIGNAL FOR A JUDGE UNTIL THEY ARE READY TO TAKE A SHOT. The judge cannot make other teams wait while someone makes their final adjustments.

7. If the team does not score 100 points, they may turn off the laser, make adjustments to their set up and signal the judge for another attempt when they are ready. If the team scores 100 points, they must move the mirror at least a distance of 1 foot (30 cm) from the previous spot before their next attempt.

8. If you are playing multiple rounds, teams may not start the next round until the previous round is complete.

9. Once all rounds are complete, total up the points of all the teams for each round. The team with the most points will be declared the winner.
# Hit the Target Scorecard

**Team:** ______________________

## ROUND 1: One mirror

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**Round 1 Total:** _________

## ROUND 2: Two mirrors

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**Round 2 Total:** _________

## ROUND 3: Three mirrors

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**Round 3 Total:** _________

**Grand Total:** ___________

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