

# Hit the Target

## Overview

This is the culminating activity, requiring students to use all the practiced skills from the previous activities. An emphasis should be placed on making accurate measurements and predictions of angles, and in following the rules of the challenge.

## Students Will Learn...

- ◆ How to use the law of reflection to design an “obstacle course” for a laser using multiple mirrors to direct the laser beam to a specific target.

## What You Need

*For each group of 2-3 students:*

- 3 mirrors (3”x3”), mounted in plastic holders
- 1 laser
- 3 paper or plastic protractors
- String
- Roll of masking tape
- Copy of paper target
- 1 yardstick or ruler
- Copy of “STUDENT HANDOUT: Hit the Target” (put Scorecard on the back side)

*HINT:* The  $\frac{1}{2}$  bullseye design target requires that students take the planar nature of the law of reflection into account. It is more difficult than the vertical stripes target.

## Getting Ready

1. If possible, recruit an assistant or two to help you manage this activity. It is likely that multiple groups will have their setups ready at approximately the same time, and if they are waiting on you, the students will be tempted to turn on the laser while you aren’t looking.
2. Make sure there is sufficient space in which the groups will work, either on the floor or on a large, flat surface.

## GO: Hit the Target

1. Remind students of laser safety considerations. With multiple lasers being used throughout the room, it is especially careful that students be aware of where their laser beam is likely to go.
2. Describe the challenge to the students. Remind them that the challenge includes designing the setup **WHILE THE LASER IS TURNED OFF**. They should **NOT** turn the laser on at any point before they have called the instructor over to inspect the setup.
3. Pass out the “STUDENT HANDOUT: Hit the Target” to each group.



4. Set up a kitchen timer or other alarm to notify students when a round is completed.
5. Decide in advance how you will award points if the laser beam appears directly on a boundary between two regions of the target. Tally points on the board or on chart paper.

### Going Further

1. Do not give the students the laser in advance, but only perhaps the box. Bring the laser to each group as they are ready. The group has an additional one minute to align the laser.
2. An advanced challenge could involve incorporating the 3-dimensional nature of the law of reflection. Students would place the laser, for example, on a table or desk with the mirrors set up so that the laser beam hits a target on or near the floor.
3. Create new, more challenging targets for students to use.
4. Reduce the amount of time given for each round or the number of tries allowed per round.

*HINT:* As a reminder, this activity will be particularly difficult if students are finding that the mirrors are not perpendicular to the surface. Carpeted surfaces are especially bad for this activity. Some suggestions to improve the situation are:

- Use paper or some other “shim” to prop up one side of the mirror holder, much as you might do with a wobbly table.
- Rotate the mirror by  $90^\circ$ , so that the mirror holder is on the side (vertical).
- Use two mirror holders per mirror, with the holders placed vertical and the mirror bottom not touching the surface.



# STUDENT HANDOUT: Hit the Target

Now that you have had practice measuring and using the law of reflection, you can apply what you've learned to hit a target with a laser by strategically placing mirrors.

## Your Challenge

Round 1- Hit the target using one mirror

Round 2- Hit the target using two mirrors

Round 3- Hit the target using three mirrors

## What You Need

(Note: you do not have to use all provided materials)

- 3 mirrors (3"x3"), mounted in plastic holders
- 1 laser
- 3 protractors
- String
- 1 roll of masking tape
- 1 target
- 1 yardstick or ruler

## Rules

1. **Most importantly: the laser must be turned off while you are moving the mirrors.**
2. The target must be placed 4 feet away from the laser and not in its direct path.
3. Mirrors must be 1-4 feet away from each other and the laser.
4. Once the laser position is set, it cannot be moved. Tape the laser to the floor.
5. Call your instructor over when you are ready to test your setup. He or she will turn on the laser. You will have three tries to hit the target. After each attempt the laser will be turned off so you can make adjustments. Record your score after each attempt.
6. Repeat with one additional mirror for each round. Each round will last approximately 20 minutes. The team with the most points at the end of Round 3 is the Master of Reflections.



## Questions for each group to ponder:

- How will you keep track of the laser's path?
- How will you make sure the path you mark is straight?
- Will you decide on the mirror positions first or decide on the path of the laser first?
- How will you use the protractors to predict the path of your reflections?
- Are there other methods of checking that your setup will work?
- How will you manage your time to get in 3 accurate attempts for each round?

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# Hit the Target Scorecard



You get three attempts to hit the target in each round. Record your scores in the table below.

## Round 1 : One mirror

Attempt	Score
1	
2	
3	

Round 1 Total : \_\_\_\_\_

## Round 2 : Two mirrors

Attempt	Score
1	
2	
3	

Round 2 Total : \_\_\_\_\_

## Round 3 : Three mirrors

Attempt	Score
1	
2	
3	

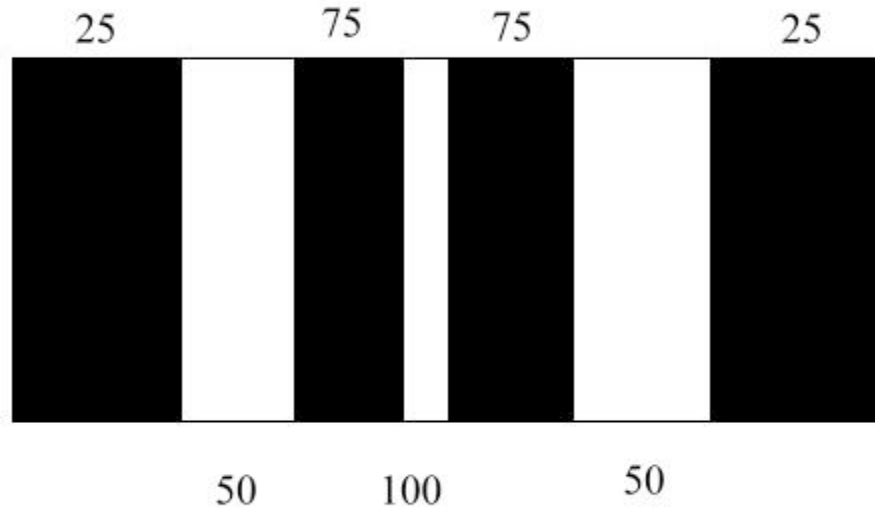
Round 3 Total : \_\_\_\_\_

**Grand Total:** \_\_\_\_\_

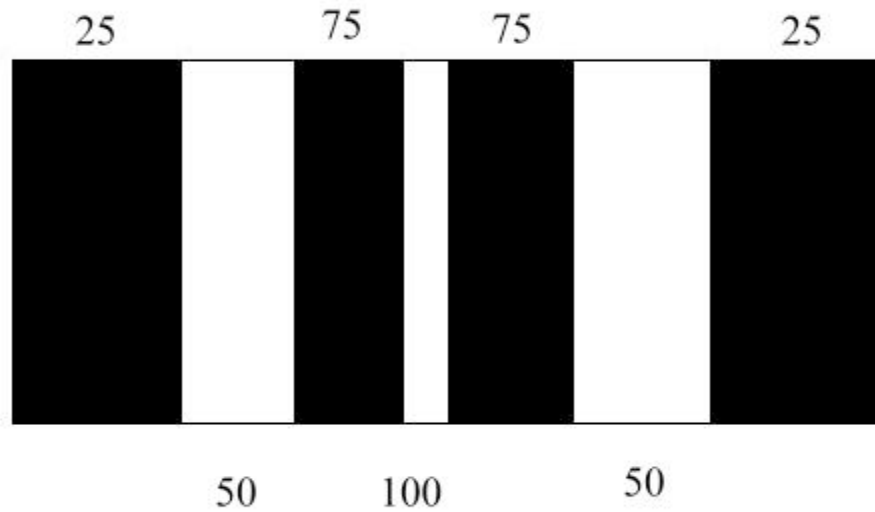
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# Targets for the *Hit the Target* Activity



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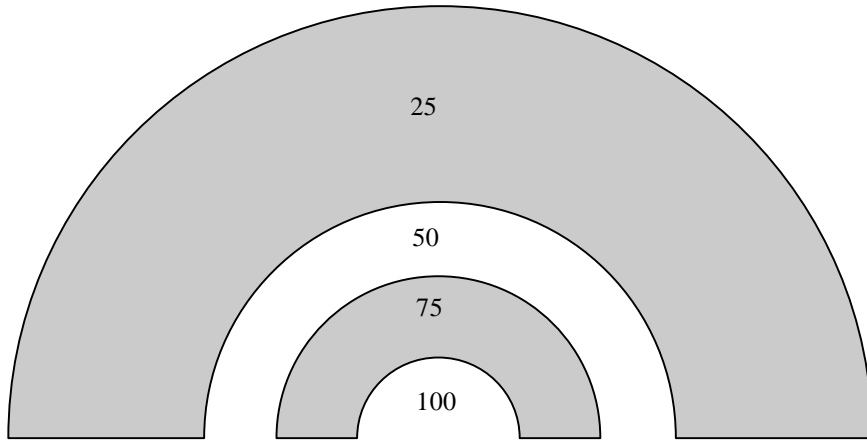


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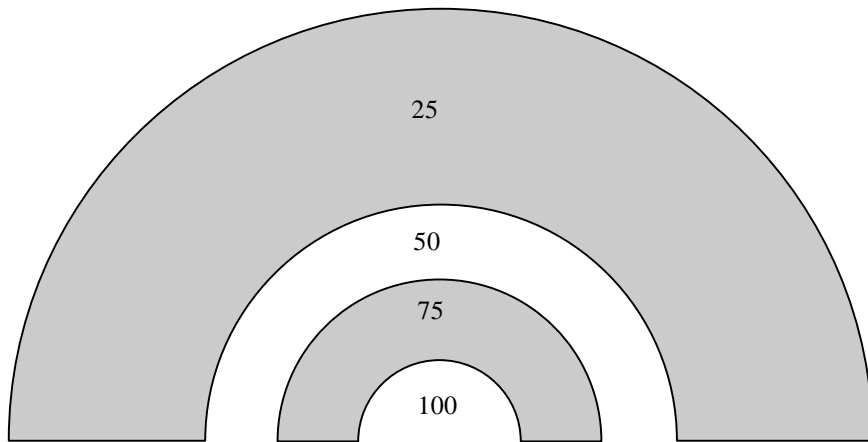


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