HIGH SCORER

Common Core Standard

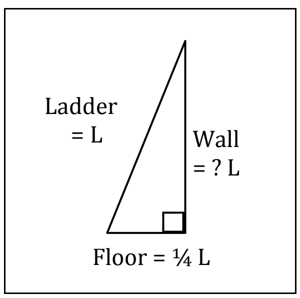
G.SRT.B.5 Use similarity and/or congruence to solve problems.

The Task

The scoreboard in your school's gymnasium periodically needs some routine repairs (light replacement, cleaning, wiring, etc.). It seems no one can find the ladder needed to reach the top of the scoreboard for this maintenance. A new ladder will need to be purchased.

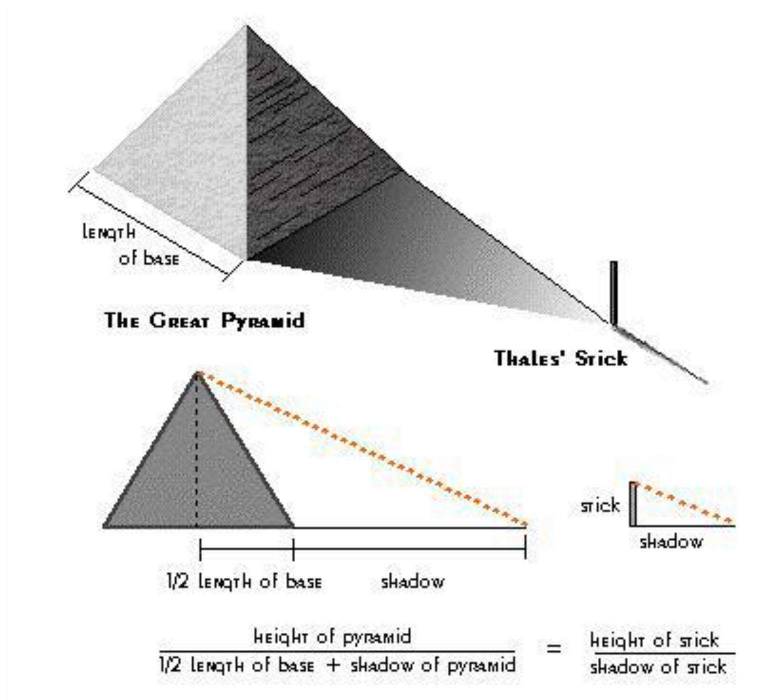
You will need to determine how high above the floor it is to the top of the scoreboard and then use that distance to compute how long the ladder will need to extend in order to reach the top. Since there is no ladder available, you will need to visit your school gymnasium and determine a strategy to find the unknown distances. You will be provided a meter stick, a small mirror, and a calculator.

Once you have found the distance, you will need to compute what length the ladder will be need to be to safely set the ladder to climb up. It is an O.S.H.A. standard that the horizontal distance from the wall to the base of the ladder should be ¼ the length of the ladder, as shown in the diagram below.



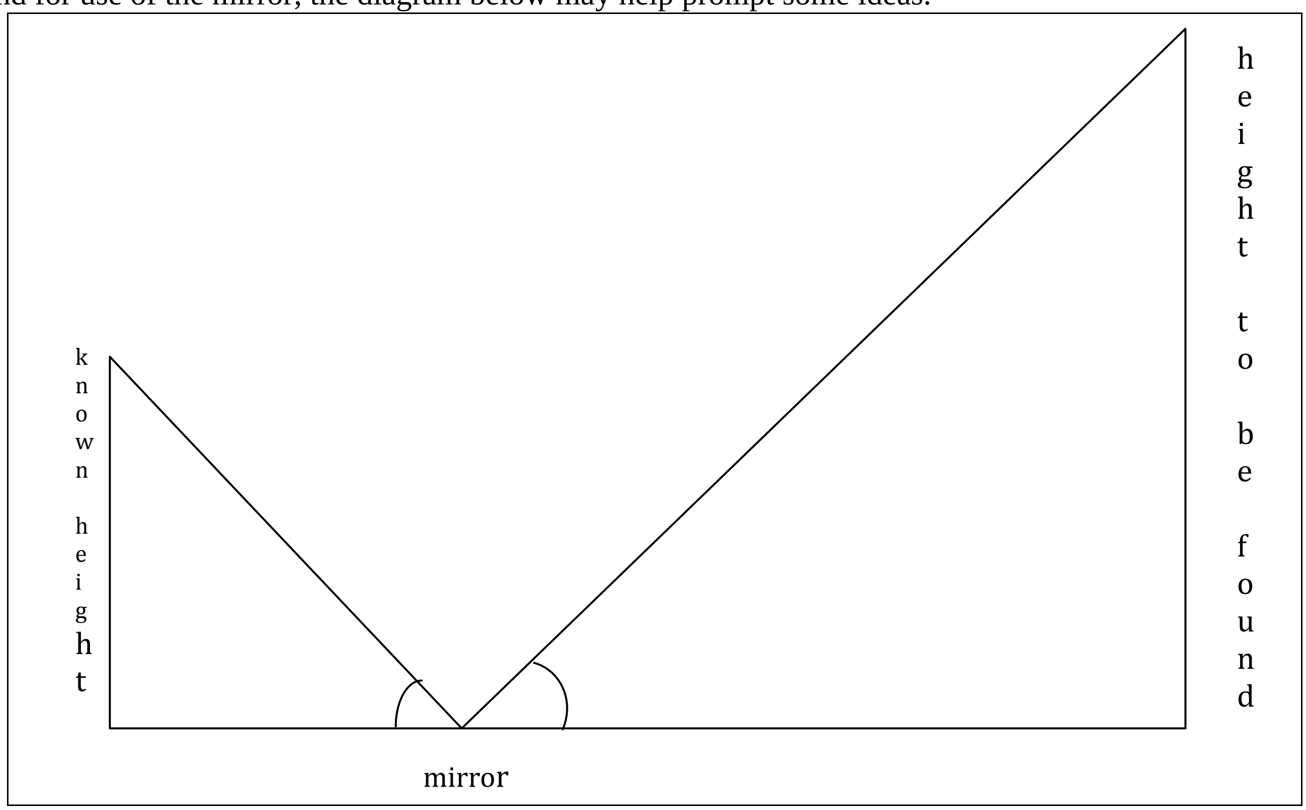
Facilitator Notes

1. Present the task to the class. Have groups write an initial guess of how high they think the scoreboard is.
2. Assign students to small groups. Give each group a meter or yard stick, a small mirror, and a calculator.
3. You may need to use this description of shadow reckoning to jump start the idea process



http://yourspace.minotstateu.edu/laurie.geller/TessaProj.pdf

And for use of the mirror, the diagram below may help prompt some ideas.



(These diagrams are both reproduced on the associated task sheet.)

4. Take the students to the gym to find the height of the scoreboard. Have groups compare their guess with the height they found.
5. After students have successfully found the height of the scoreboard in your gym, bring them back to class and have them use that height and the ladder diagram (also included in the associated task document) to find the proper length of the ladder.
6. Have groups compare answers and make any necessary revisions.

Follow-Up Questions

1. What other considerations should be included in choosing the height of the ladder?
2. What danger do you think O.S.H.A. feels might be present if the ladder is set too close to the wall? What danger do you think O.S.H.A. feels might be present if the ladder is set too far away from the wall?
3. Are there any other methods you can think of to find the height of the scoreboard?

Solutions

Part I

Students can find the height of the scoreboard in one of at least two ways:

1. Create similar triangles by laying the mirror on the floor and having a student stand back from the mirror and sight the top of the scoreboard in the mirror. By finding the measure of the height of the observers eyes, the distance they are from the mirror, and the distance the mirror is from the base of the wall, they can use those three lengths to create a proportion that can be solved for the height of the scoreboard.
2. Create similar triangles by having a student lay of the floor and line up the top of the scoreboard and the top of another student (or the meter stick), placed in between the wall and the student on the floor. (Shadows are usually difficult to create due to the type of lighting used in schools.) By measuring the distance from the observer to the base of the object (person) in between, the distance from the observer to the wall, and the height of the object (person) in between, they can use those three lengths to create a proportion that can be solved for the height of the scoreboard.

Part II

The height of the ladder can be found by using the Pythagorean theorem in general or direct way.

Solution 1 . A general use of the Pythagorean theorem can be used from the diagram.

$L^2 = (\frac{1}{4} L)^2 + (cL)^2$

Which, to find c, simplifies to:

$1 = 1/16 + c^2$

And solves to

c=.968
and then proportion can be used again to find the ladder length.

Solution 2. A more direct solution is to use the number for the height of the scoreboard directly into the Pythagorean theorem as follows. (With "h" being the number found for the height of the ladder)

$L^2 = (\frac{1}{4}L)^2 + h^2$

$15/16\, L^2 = h^2$

$L = (16/15\, h^2)^{1/2} = 4h/(15)^{1/2}$

Answers to Follow Up Questions:

1. Many answers are possible. Among them may be to order a ladder that can be extended longer for accessing higher items. Quality of the ladder may also be a consideration. Some students may know about other safety features and requirements that ladders may have.
2. If the ladder is set too close to the wall, there is a danger of the ladder falling backwards when in use. If the ladder is set to far away from the wall, there is a danger of the ladder sliding down the wall (with the base sliding away). Other answers are, of course, possible.
3. Students may recognize that they could try to measure the length of the hypotenuse of the right triangles along with one of the legs to find the height. Also there is an opportunity to foreshadow the idea of angle of inclination and the concept of trig ratios to find missing lengths.

Extension Activities

1. Find the heights of other objects. Have students find others in the school or assign them to find the height of something at home.
2. Introduce the idea of clinometers to find angle of elevation. If it did not come up in follow up question 3, foreshadow the idea of trig ratios to solve right triangles