QUESTION: Describe four workable ways to determine the height of a tall building using a laser—without turning on the laser.

That’s the problem we posed to OPN’s readers in our May Puzzler, Do You Know Your Optical Allusions?, and you rose to the challenge! We received many responses that showcased your originality, humor and ingenuity. While some of you played fast and loose with the laws of physics, others remained firmly grounded in reality; one respondent felt hindered by our failure to quantify the term “tall” or define “workable.” Still others chose to take approaches that were, um, less scientific. These included cutting all kinds of deals with building superintendents and architects—bribery was more popular than threats by a two-to-one margin—and making use of additional resources such as Google, eBay, magic genies, dynamite and an avocado sandwich (don’t ask).

Compiled by Christina Folz

1. Drop the laser from the top of the building and time its fall. Use the formula $s=0.5gt^2$, where $g=9.8 \text{ m/s}^2$, $s=$height in meters and $t=$time of the fall. True to your roots, 18 of you took this classical physics approach. Stop watches were usually involved to ensure accuracy, and one reader suggested disassembling the laser to obtain a statistical average. (And, yes, it’s safe to assume the building is immersed in a known gravitational field.) Another respondent was thoughtful enough to recommend placing a foam mat on the ground to protect the laser.

2. Measure the height of the laser and the length of its shadow. Then determine the length of the building’s shadow. Determine the height of the building using ratios. Ten of you offered variations on this solution, with some assuming that they had access to a measuring stick, and others incorporating their own height to obtain an estimate. Several of you specified that—in the absence of another measuring device—the answer would have to be given in terms of laser lengths. (Conversion to standard units not recommended.)

3. Use the laser as a yardstick. Nine of you suggested this. Some scaled the building; some used the stairs; and some delegated the tedious details to undergraduates or research assistants. Taking a liberal interpretation of “workable solution,” one person turned the building on its side for more convenient assessment.

4. Bribery. This was the problem-solving method of choice for nine readers. Variations included betting and bartering, and you offered the laser to superintendents, surveyors, architects, building managers … and even other OPN readers who would solve the problem for you.

5. Attach a rope to the laser. Most of those who suggested this solution proposed lowering the laser until it just clears the ground, swinging the rope, and determining height by measuring the period of the resulting pendulum. A few others recommended lowering the rope until the laser touches the ground, marking the position of the string when it is taut, and then measuring its length to get a height determination.

6. Threats. Four of you proposed brandishing the laser and threatening to blind, hit or “shoot” architects and building staff with it. As one reader pointed out, this may require plugging the laser into the wall for added authenticity.

7. Use triangulation. A few of you suggested positioning the laser so that the angle it subtends to the eye is the same as that of the building. Measure the distance to the laser, $x_1$, and to the building, $x_2$, and the laser length $l$. Building height is $h=l(x_1/x_2)$.

8. Weigh the laser on the ground floor and compare with weight at the top. If you know the gravitational gradient, the difference in weights could be used to determine building height. You’d need a really sensitive balance.
A number of readers pointed out that they have heard this question before. However, there was no consensus on its age or origin. One respondent said that the challenge was originally posed to Niels Bohr, but that it had involved a barometer rather than a laser.

Others believed that the problem can trace its roots to a physics professor who asked his students on an exam how to measure the height of the building using a barometer; one clever student eschewed the expected answer—measuring the change in air pressure with altitude—and came up with others that are applicable to the case of the laser.

Still other respondents told us that the question is an urban legend or an old joke. You can add your own punchlines about which answers should be attributed to optical physicists, physical chemists, engineers, mathematicians and, of course, lawyers.

In any case, we clearly didn’t ask an original question. But we are confident that we received many new and unusual answers. Here are some of our favorites …

**Mount unpowered laser on a tripod, and aim it at building. Wait for stray light to enter the emitter and build up sufficient charge to cause it to spontaneously discharge a beam. Building should vaporize. Voila! Height of building = 0.”**

— David Karp

**“Most lasers have sufficient levels, optics and angle manipulation parts to assemble a sextant. Find the angle for the top of the building with the sextant and pace off the distance for the base. Then it’s a right triangle problem. (The fate of masochist engineers.)”**

— Jason Byars

**“If the laser has free space optics that can be manipulated by hand, take them out to create some sort of imaging device with magnification < 1. Use the laser case to calibrate, then image the building and multiply by the magnification to get the actual height.”**

— Anonymous

**“Polish the laser until an architect appears in a puff of smoke. He is obliged to grant you the answers to three questions about the building. Use the first to determine the height. You can use the other two to find out other useful details, such as where the bathrooms and coffee are.”**

— David Theil

**“Become mayor of the city. Declare war on a neighboring town, forming an army of local police and citizen militias. After a series of attacks and counterattacks, call a meeting with top staff. Argue that a good defense is needed from aerial attack, and pull the laser out from under the table. Pause for effect. Then declare that, for this weapon to work properly, it must be mounted on the building in question, which, at a quarter-mile high, is the tallest in the city. When your chief of staff exclaims, ’But sir! That building is only …’, take note of the number.”**

— Timothy Miller

**Design a metrology system around the laser and put the system in a box that is isolated from the rest of the universe. Throw an identical laser that is turned on into the same box, quantum mechanically entangling the two lasers. There is now a finite probability that the measurement will occur. Open the box and check for a reading. If it hasn’t occurred, reisolate the box and try again (and again and again).”**

— David Theil

**“Take the case off the laser. Cut the case so that you are left with just one corner with three attached sides. Glue three mirrors onto the sides inside the corner. Mount it on the top of the building as a retroreflector. Get a laser rangefinder and, from the ground, measure the distance to the retroreflector and, thus, the height of the building.”**

— Robert Tyson

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