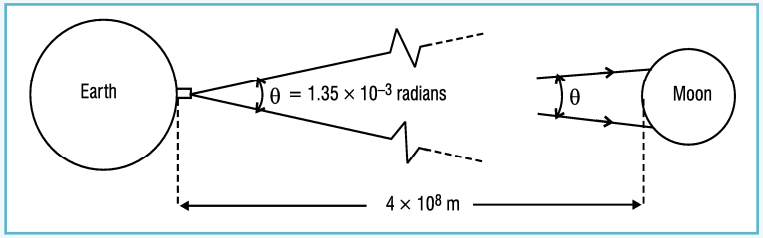
Math for Laser and Optics Technicians

Trigonometry

Pythagorean Theorem

Photonics Technicians need to be able to recognize when the Pythagorean formula needs to be used to solve a particular problem.



EXAMPLE

US astronauts placed a retroreflector panel of dimensions one meter by one meter on the surface of the moon. On the earth, a team of scientists pointed an Nd:YAG laser of beam divergence θ=1.35 milliradians at the panel. Take the distance from the laser on the earth to the panel on the moon to be roughly 4×10^8 meters.

Question

1. What is the diameter of the circular spot of the Nd:YAG laser beam that strikes the panel on the moon?

Key Concepts

A **right triangle** is a triangle that contains a right angle.

Right angle (90 degrees)

The side opposite the right angle is the **hypotenuse.**

The **legs** of the triangle form the right angle.

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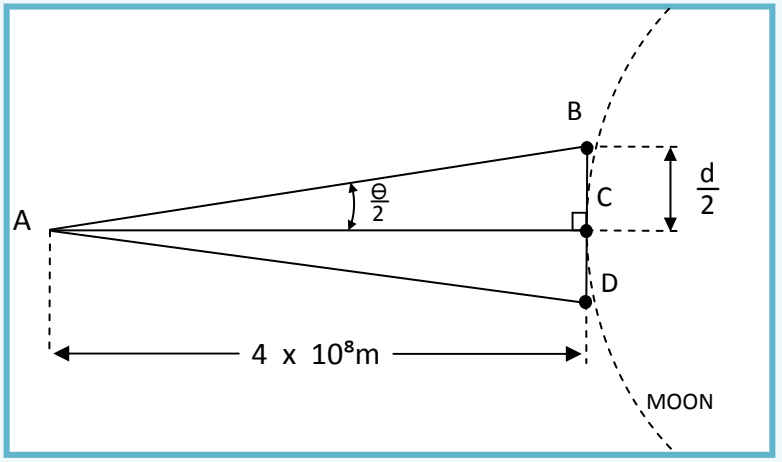
Solution to Trigonometry Question

Point **A** is the origin of the laser on the earth.

Segment **BD** is the diameter (d) of the laser spot when it strikes the moon.



From the right triangle ACB,

$$\tan\frac{\Theta}{2} = \frac{BC}{AC}$$

$$\tan\frac{\Theta}{2} = \frac{\frac{d}{2}}{4 \times 10^8 \text{ m}}$$

$$\therefore \quad \frac{d}{2} = (4 \times 10^8 \text{ m})\left(\tan\frac{1.35 \times 10^{-3} \text{ rad}}{2}\right)$$

(With the calculator set to radians, use the tan key to evaluate.)

$$\frac{d}{2} = (4 \times 10^8 \text{ m})(6.75 \times 10^{-4} \text{ rad})$$

$$\frac{d}{2} = 2.7 \times 10^5 \text{ m}$$

d = 5.4 x 10^5 m = 540 km (MUCH larger than the 1-m^2 retroreflector)