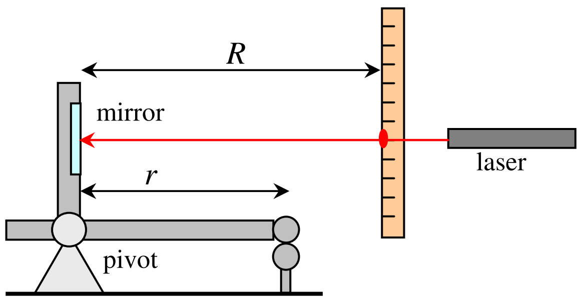
Analytical Physics II Laboratory
Dr. Pogo

Due May 4, 2026

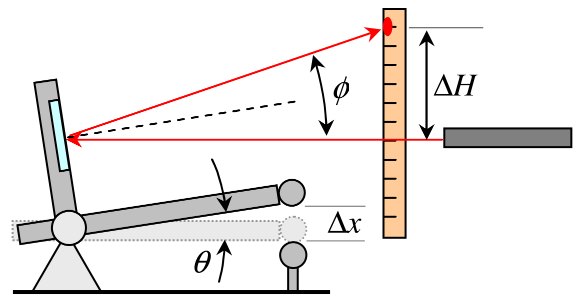
Quiz #13

Name:______________________________

In the first picture, two (gray) cylinders (running into the page) touch each other. In the second image, the arms are rotated by some small angle θ, and we want to know the separation Δx between the two gray cylinders. It's too difficult with a ruler because all the parts are small and wobbly. At first, the laser shines on the mirror so that its reflected beam strikes the ruler near the laser. But after the arms rotate, the reflected beam is at a new point ΔH.



Starting Position



Final Position

1. Through what angle did the *mirror* rotate (circle one)? [θ] [ϕ]
2. Consider the (dashed) imaginary line which is *always perpendicular to the mirror*. Through what angle did this imaginary line rotate? [θ] [ϕ]
3. Reflected light/Snell's law: find the angle ϕ in terms of θ. ϕ = ________
4. Final position: use the triangle $r/\Delta x/\theta$ to determine Δx in terms of r and θ: Δx = ____________
5. Final position: use the triangle $R/\Delta H/\phi$ to determine ΔH in terms of R and ϕ. ΔH = __________
6. For any small angle α, $\tan\alpha \approx \sin\alpha \approx \alpha$. Use this fact to simplify your answer for (4):

   simplified Δx = ____________

7. Use this fact again, this time to simplify your answer for (5):

   simplified ΔH = ____________

8. Combine your answers to parts (3), (6) and (7) to find an equation for Δx in terms of r, R, and ΔH.

   Δx = ______________

9. Suppose also each gray cylinder has a known diameter D. Combine this with your answer (8) to determine the center-to-center separation a of the two gray cylinders.

   a = ______________

10. If r = 16 cm, R = 96 cm, ΔH = 3 cm, and D = 4 mm, what is a?

    a = ______________ mm