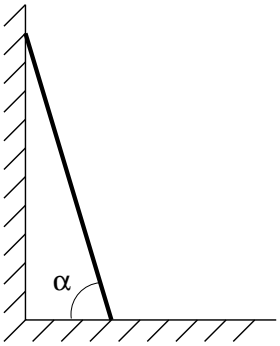
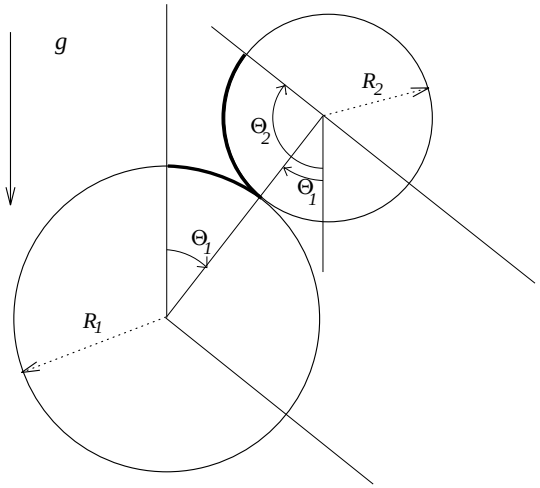
Caltech – Ph106a – Fall 2001

Problem Set 2 *due 10-24-2001*



1. (falling ladder) A ladder rests on a smooth wall and slides without friction on a smooth floor. Find the angle at which the ladder leaves the wall if it is released from rest at an initial angle α with respect to the floor. (It will be convenient to assume that the ladder has length $2l$, although the final answer will not depend on this.)



2. (rolling cylinders) A cylinder of radius R_2 rolls without slipping on a stationary cylinder of radius R_1. Assuming that the upper cylinder starts from rest at the top of lower cylinder, find the angle θ_1 at which the cylinders separate.

3. H&F 2-7 (Fermat's principle).

4. H&F 2-9 (brachistochrone).

5. (Goldschmidt discontinuous solution) In lecture we discussed the shape of a soap film suspended by two parallel hoops of radius R, held a distance ℓ apart. We

found three local extrema: (1) a slightly curved cylindrical surface, (2) a deeply curved cylindrical surface, and (3) two separate, disk-shaped films suspended from the separate hoops (the Goldschmidt discontinuous solution). I suggested that (2) was always disfavored as compared to (1), but I didn't claim to have proved this except for very large R/ℓ.

(a) Which solution—(1), (2), or (3)—is favored at which R/ℓ? (That is, for each R/ℓ, which one of these has the least area?)

(b) Suppose we start with solution (1) and very large R/ℓ. Now, holding R fixed, let us gradually increase ℓ. What happens, and at what R/ℓ does it happen?

6. **Optional challenge problem**
H&F 2-15 (rolling penny).

7. **Optional challenge problem**
H&F 2-16 (isoperimetric problem).