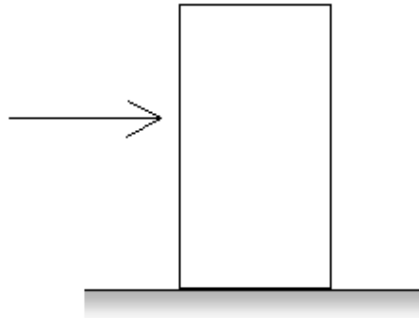


No tipping allowed

Aim: To show that a cylinder that slides to a stop tips only if its diameter-to-height ratio is less than the reciprocal of the coefficient of kinetic friction.

Subjects: 1K20 (Friction)

Diagram:



- Equipment:
- 5 pvc cylinders, ϕ 80 mm
 - $l_1=285$ mm
 - $l_2=320$ mm
 - $l_3=335$ mm
 - $l_4=350$ mm
 - $l_5=385$ mm
 - Horizontal surface (smooth table)

No tipping allowed

Presentation: The lateral standing cylinder is given a push by hand. (Push the cylinder on the bottom half, a number of times from left to right and vice versa).

Cylinder l_1 never tips, l_5 always tips, l_2, l_3 and l_4 tip sometimes/often ($l_3, 50\%$).

Explanation: On the verge of tipping, the upward normal force acts at the leading edge of the base (Figure 1, point A).

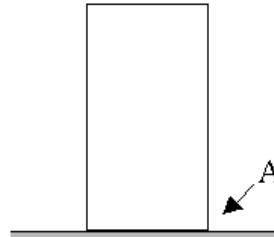


Figure 1

In the decelerating reference frame ma acts on the center of mass, along with the vertical gravitational force mg . (See Figure 2).

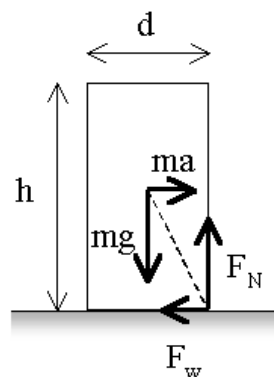


Figure 2

When the resultant of ma and mg is directed to point A, the cylinder is on the verge of tipping. Figure 2 shows that in that case $\mu_k = d/h$.

Remarks: When constructing the demonstration, you need to know the value of μ_k before you can cut the cylinder to the proper heights. μ_k can easily be determined by placing a short cylinder on an inclined board and finding the angle of incline for which the cylinder slides at constant speed after being given an initial push. $\mu_k = \tan(\alpha)$ (α = angle of incline).

Sources:

- [Ehrlich, Robert, Turning the World Inside Out and 174 Other Simple Physics Demonstrations](#), pag. 43
- [Friedrich, Artur, Handbuch der experimentellen Schulphysik, part 2, Mechanik der festen Körper](#), pag. 128