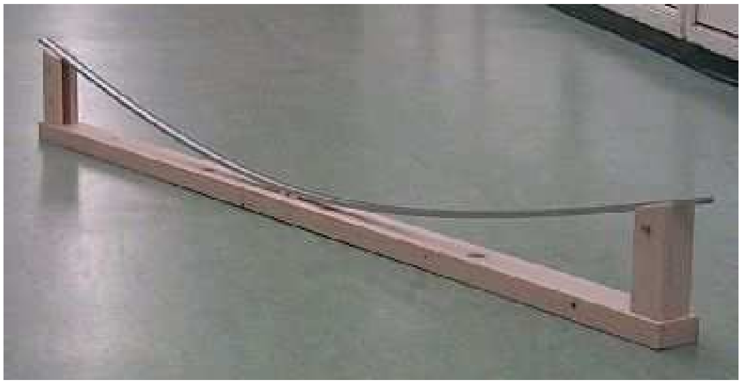
Rolling up-and-down, again and again

Aim: Determining the coefficient of rolling friction and to give an impression how low the coefficient of rolling friction is.

Subjects: 1K20 (Friction)

Diagram:



Equipment:
- U-shaped railtrack
- Metal ball

Rolling up-and-down, again and again

Presentation: Release the ball and it will roll down the track, climb the other track, and so on. But gradually the distance it rolls reduces (due to rolling friction).
After n runs the coefficient of rolling friction can be determined by measuring the distance the ball travels upward in the n-th run.

Explanation: The potential energy of the ball equals (see Figure 1 and 2)

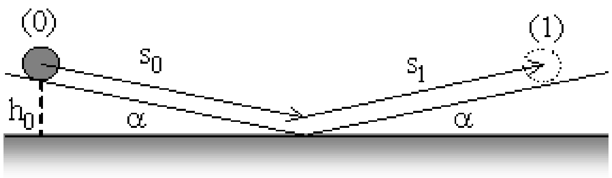


Figure 1

$$U_p(0) = mgs_0 \sin(\alpha) = Fs_0$$

Reacting the other side (1): $U_p(0) - U_p(1) = F_f(s_0 + s_1)$

So: $F(s_0 - s_1) = F_f(s_0 + s_1)$

$$s_1 = s_0\left[\frac{F - F_f}{F + F_f}\right] = s_0\left[\frac{1 - \frac{F_f}{F}}{1 + \frac{F_f}{F}}\right] = s_0 b$$

Rolling back (s_1) and up (s_2) again:
$s_2 = s_1.b = s_0.b^2$
The coefficient of friction (μ) is by definition F_f/F_N.

In this case (see Figure 2): $\mu = \frac{F_f}{F}\tan\alpha$.

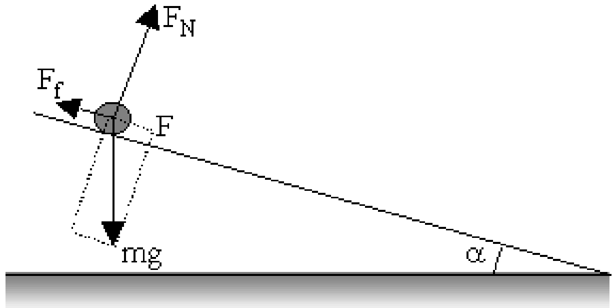


Figure 2

So the coefficient of friction can be determined by measuring s_0, s_2 and α and using the formulas above.

Sources:
- Jordens, H.

TU Delft