Phonebook friction

Aim: Showing that friction force can be very large

Subjects: 1K20 (Friction)

Diagram:

Equipment:

- Two (equal) phonebooks, 1000 pages each.
- Two strong students.

Presentation: The two phonebooks are interleaved page by page. Ask two volunteers to grab the spines of the books and to pull them apart. This will be impossible!

Explanation: First estimate the normal force between pages. The pages at the top are pressed together with almost zero force. The pages at the bottom are pressed together with a force equal to the weight of the portions of the pages from both books that overlap. If the pages are overlapped by half of their width, then the weight on the bottom pages is the weight of one book. So in that case the normal force varies from zero at the top to W_{book} at the bottom. The average normal force between pages then is $1/2W_{book}$. For two books of 1000 pages each there are 1999 page-surfaces in contact! Supposing that the static coefficient of friction between the pages is the same as that between a book and a table, than in this case the friction force between the books equals $1999\times\left(\mu_3 \tfrac{1}{2}W_{book}\right)$. In our situation: W_{book}=15N and υ=0.25, so

$F_{friction} \approx 3750\text{N}$!

Remarks: The books can also be held vertical. Due to the slanting pages, there is still enough normal force to prevent the lower book from falling. (Even a mass can be hung to it.)

Sources:

- Jewett Jr., John W., Physics Begins With Another M... : Mysteries, Magic, Myth, and Modern Physics, pag. 42
- Mansfield, M and O'Sullivan, C., Understanding physics, pag. 66-67