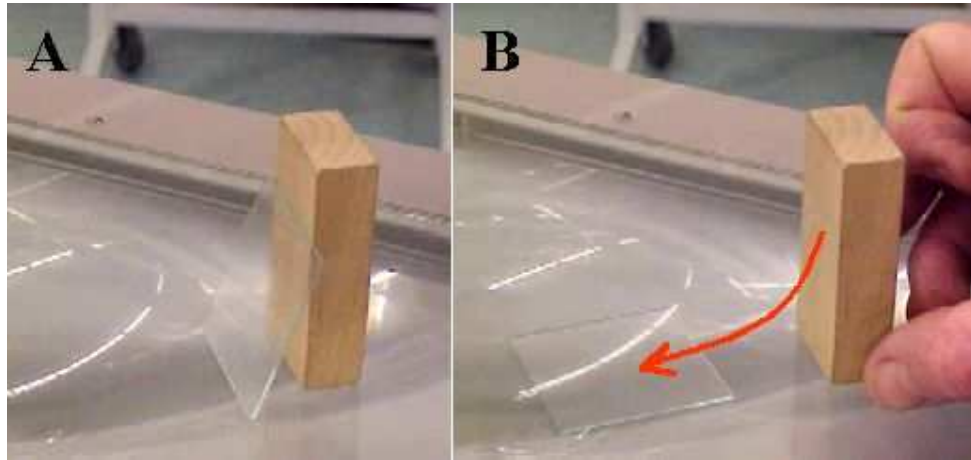# Sliding ladder

Aim: To show an example where the concept 'impulse' explains the phenomenon.

Subjects: 1N10 (Impulse and Thrust)

Diagram:

Equipment:
- Cover glass (we use 50×50×1 mm).
- Wooden block (we use 7×3.5×2 cm).
- Overhead projector.

Sliding ladder

Presentation: <u>Preparation.</u>
The glass of the overhead projector and the coverglass are cleaned and polished.
<u>Prersentation.</u>
The coverglass rests against the wooden block (see Diagram A). By hand, the inclination of the coverglass is decreased by pulling the wooden block very slowly to the right (see Diagram B). At a certain moment the coverglass starts sliding: It moves downwards and away from the wooden block. Pose the question to the students: "What makes the coverglass move away from the wooden block?"

Explanation: During the sliding movement, five forces are acting: The weight G, the normal forces N_A and N_B and the friction forces in A and B (see Figure1; the friction forces are neglected).
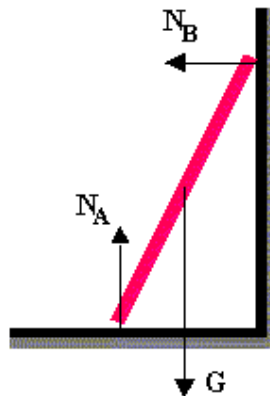

Figure 1

At a certain moment in the movement, B leaves the wooden block. This is only possible if the coverglass has a component in its velocity that is directed to the left and correspondingly a momentum to the left. The only force directed to the left is N_B. N_B itself is not moving to the left, but gives the coverglass an impulse to the left equal to

$\int_{t_1}^{t_2} N_B dt$, t_2-t_1 being the time that B slides the vertical wall. (Will the coverglass leave the vertical wall before point B hits the ground?)
After some time the movement to the left stops due to friction forces between the horizontally sliding coverglass and the glass of the overhead projector.

Remarks:
- Notice that the force N_B does no work!
- This demonstration can be easily performed in a simulation program. The advantage then is that the friction on the ground can be made zero and the ladder (coverglass) will continue moving over the ground. Such a simulation is a usefull follow-up of the demonstration in our real world.
Also the question raised in the Explanation about the sliding point B can be answered by observing the movement of point B in that simulation.

Sources:
- Borghouts, A.N., Inleiding in de Mechanica, pag. 92
- Mansfield, M and O'Sullivan, C., Understanding physics, pag. 123
- Young, H.D. and Freeman, R.A., University Physics, pag. 228-229