Tablecloth pull

Aim: To show an example of Newton's first law

Subjects: 1F20 (Inertia of Rest)

Diagram:

Equipment:

- Sheet of paper.
- Different objects placed on the sheet of paper.

Tablecloth pull

Presentation: Set the table as shown in Diagram (light a candle etc.). Our tablecloth is not really a tablecloth. We use a sheet of paper (see Diagram).
Take the protruding free end of the paper in both hands and give a sharp **downward** jerk. The sheet of paper comes out from under the glasses and they are hardly moved. (Even the water in the glasses is not disturbed!)

Explanation: This is one of the many possible demonstrations to show the validity of Newton's first law.
Also Newton's second law can be used to explain this demonstration:
The effect of a given force between the sheet of paper and the glasses depend on the impulse of that force ($F\Delta t$). The impulse is small when the sheet of paper moves away quickly (Δt is small). The resulting horizontal displacement will then be very small.
Analysis shows that the horizontal displacement d of a mass on the sheet equals:

$d = \frac{1}{2} k_1 g \Delta t^2 \left(1 + \frac{k_1}{k_2}\right)$, where k_1 is the coefficient of friction between sheet and glass and k_2 is the coefficient of friction between glass and table and Δt the time to pull the sheet from beneath the glasses. So d is very sensitive to Δt !

Remarks:

- After lecture students like to try the demonstration by themselves.
- This demonstration needs trying it before you show it!

Sources:

- Ehrlich, Robert, Turning the World Inside Out and 174 Other Simple Physics Demonstrations, pag. 21
- Sutton, Richard Manliffe, Demonstration experiments in Physics, pag. 46-49
- Jones, Evan, The Physics Teacher, Vol. 15, pag. 389
- Perez, Joseph, The Physics Teacher, Vol. 15, pag. 242