Impulse and Momentum

Put a line of blocks on a sheet of A3 paper. *Whip the paper out as fast as you can.* The blocks move a few mm, but they almost stay where they were. That few mm of movement is the clue to understanding this demonstration. Friction forces between the blocks and the moving paper act for a fraction of a second. That small impulse adds a little momentum (*mv*) to each block. After the paper has gone they quickly slide to rest on the table. Inertia is important but the demonstration is about *impulse* and *momentum.*

Now suppose we scale up the demo. Get a motorbike and a table as long as a bus. There is a video on the web that you must watch. https://www.youtube.com/watch?v=KcSwxT_z6io

The cloth has gone and everything is still in place (exactly in place). If you understood what you read above, you will know that the physics is wrong. Suppose the coefficient of friction is 0.1 and it takes one second to remove the cloth. The impulse applied to each object is $\mu mg.\Delta t$. The velocity of the things on the near end of the table as the cloth leaves will be something like 1.0 m/s …. more than enough to drop them on the floor.

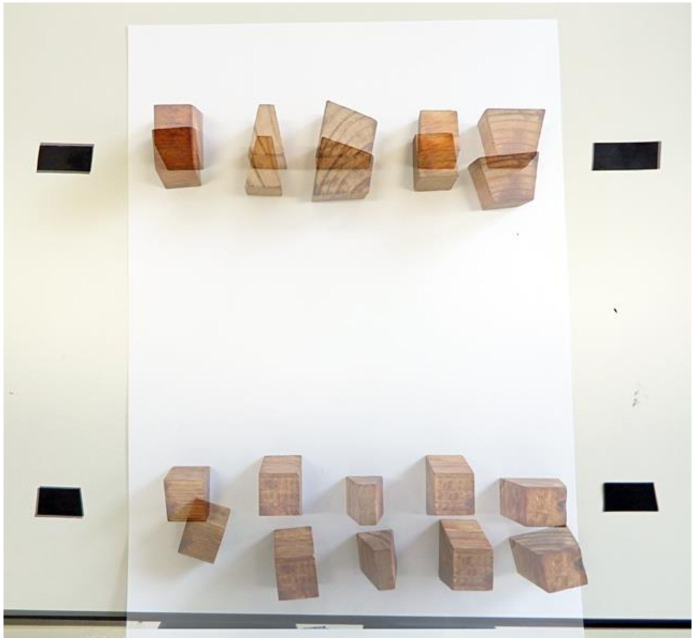
We could try it ourselves … we have a motorbike, lots of stuff and a long table, but it's been done for us. Please watch https://www.youtube.com/watch?v=lK1ci50DUgc

That's what would really happen. The first video was faked.

A more complete demonstration

To demonstrate that impulse is the important principle here, two lines of blocks, each of different shape and mass, are lined up on A3 paper as shown.

The paper is suddenly pulled by hand. The blocks come to rest in two lines. The lower line, closer to the leading edge of the paper, is displaced more than the upper line because the time in contact with the moving paper was longer (in this case about 4 times longer).



Questions

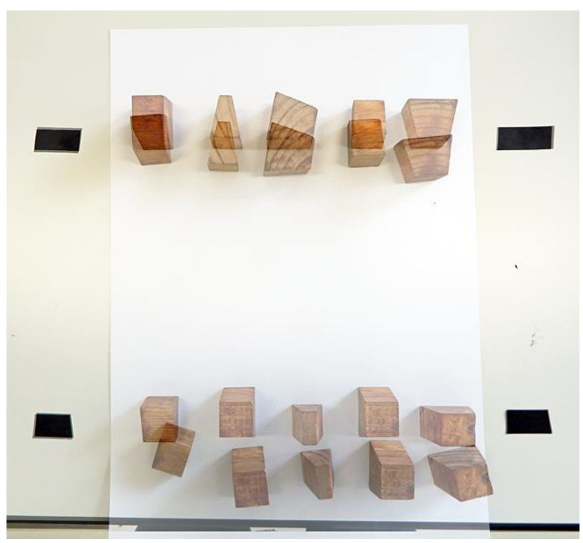
1 Blocks are placed on a sheet of paper which is then suddenly removed.

a Show that the velocity of a block w.r.t the table as it leaves the paper is independent of its mass and the area in contact with the paper.

b Show that blocks that leave the paper with the same velocity will slide the same distance on the table.

c If the paper is removed in a time Δt, much shorter than the slide time on the table, estimate the ratio of speeds of the upper and lower lines as they leave the paper by taking measurements on the paper.

d* *Has the condition on Δt in* **c** *been met in the example photographed below?.*



2* When an experienced teacher did the demonstration, a single upper line of blocks stayed where they had been initially, and they did not side on the table after the paper was removed. He claimed (wrongly) that he had demonstrated the principle of inertia.

*How did he do that***?**