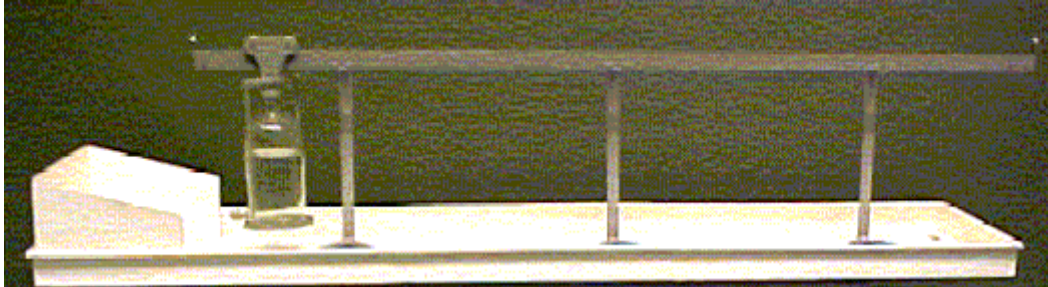


Bottle rocket

- Aim:**
- To show the effect of a (horizontal) impulse.
 - To give an example of Newton's third law.

- Subjects:**
- 1H10 (Action and Reaction)
 - 1N10 (Impulse and Thrust)
 - 1N22 (Rockets)

Diagram:



- Equipment:**
- Rail ($l=2.50$ m).
 - Cart with wheels, hanging on rail.
 - Decantation bottle with cork in bottom opening (opening ϕ 25mm).
 - Tray as long as rail to catch the water.
 - Shield at the beginning of the tray.

- Safety:**
- It is inevitably that in this demonstration water will spoil on the ground. In our lecture-hall this makes the ground very slippery!

Bottle rocket

Presentation: The bottle is filled with water and is at rest. Then the cork is pulled out of the bottom opening. The cart with bottle starts moving and accelerates along the rail.

Explanation: The cart with bottle accelerates so a horizontal force acts on this cart. This force (F) arises due to the impulse of the water streaming out of the bottle $F = -v \frac{\Delta m}{\Delta t}$, in which v is the velocity of the water relative to the bottle and $-\Delta m$ the change in the mass of the bottle with water.

The mechanism of movement can also be explained by Newton's third law. The cart with water pushes a part of itself (water) away. Force is needed for that. Then the water exerts a reaction force on the cart.

Remarks:

- The velocity (v) of the water flowing out of the bottle can be reduced by placing a narrow tube in the cork. The reduced velocity of the cart can be observed.
- This demonstration can be made an experiment by using commercial water-rockets. Then the effects of the exhaust velocity and the mass ejected can be demonstrated by:
 - pumping the rocket at various air pressures;
 - first using only air and then using a mixture of air and water.

Sources:

- [Roest, R., Inleiding Mechanica](#), pag. 96.
- [Borghouts, A.N., Inleiding in de Mechanica](#), pag. 93.
- [Friedrich, Artur, Handbuch der experimentellen Schulphysik, part 2, Mechanik der festen Körper](#), pag. 170.
- [Ehrlich, Robert, Turning the World Inside Out and 174 Other Simple Physics Demonstrations](#), pag. 33.