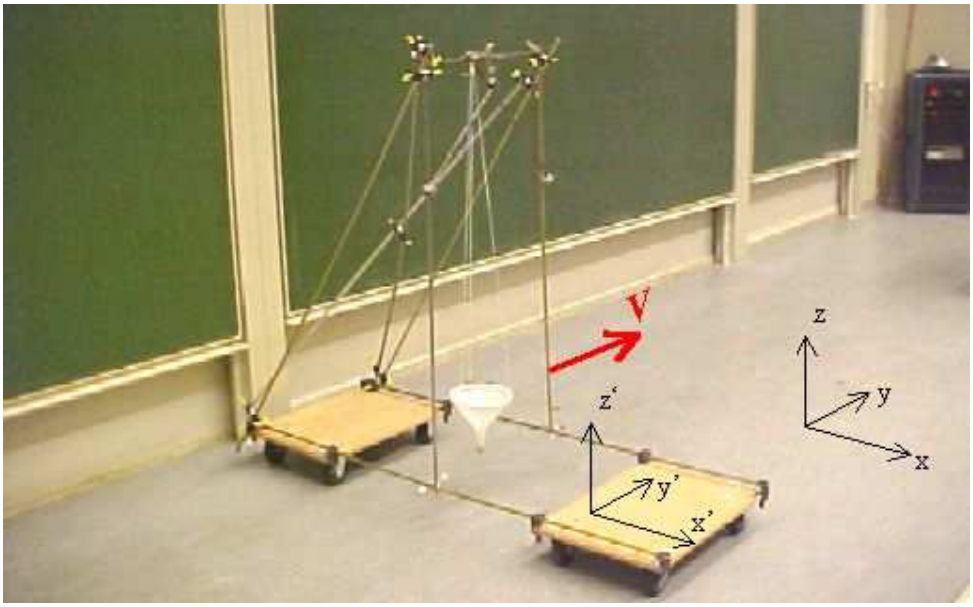
Galilean cart

Aim: To show and discuss an example of Galilean transformations

Subjects: 1E10 (Moving Reference Frames)

Diagram:



Equipment:

- Two carts, easy rolling and able to carry a human being; construction as shown in Diagram.
- Large funnel (outlet reduced to 4mm), suspended by three cords.
- Clamping material to support the funnel-pendulum.
- 1kg of salt.
- Broom.

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Presentation:

- One person sits on the cart and fills the funnel with salt, keeping the outlet closed with a finger and gives the funnel-pendulum a deflection into the x'-direction. The demonstrator moves the cart with constant speed along the front of the lecture hall (y-direction). As soon as the speed is constant, the person on the cart makes the pendulum go. A salt-track is written on the floor of the lecturehall (see Figure2). This track shows the recording of the movement of the swinging funnel in the x-y plane.

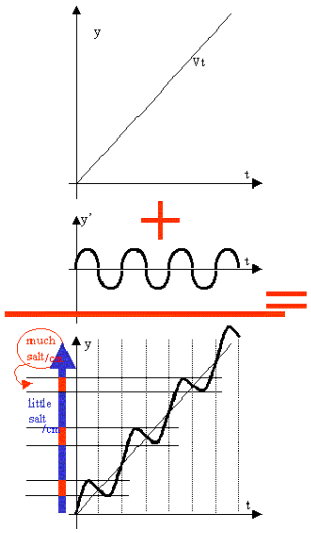

Figure 1

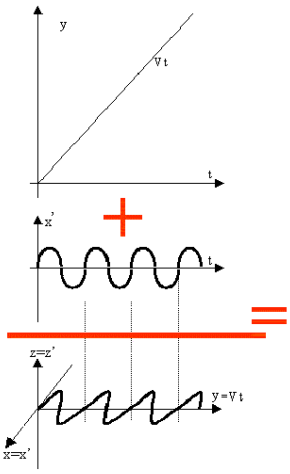

Figure 2

- The same demonstration is performed but now with the funnel-pendulum swinging into the y'-direction. A second salt-track appears on the floor (see Figure1).

Again the salttrack shows the recording of the movement of the swinging funnel in the x-y plane.
The results are discussed.

Explanation:

- The pendulum moves in the x'-y'-z'-frame according to: $x' = A\sin(\omega t + \varphi)$; *y'=0; z'=0*. The writing on the ground in salt is in the x-y-z-frame. The x'-y'-z'-frame moves with a speed V into the y-direction., so a point measured in the x'-y'-z'-frame will have an y-coordinate: $y = Vt$. (see Figure2).
- When the pendulum swings into the y'-direction, the movements in the x-y-z-frame will be: $y = Vt + A\sin(\omega t + \varphi)$; *x=0* and *z=0* (see Figure1).

Remarks:

- As Figure1 makes clear, the difference between much - and little salt is more pronounced when *y=Vt* is steeper; that is at higher speeds of the cart.

Sources:

- Mansfield, M and O'Sullivan, C., Understanding physics, pag. 173-174
- McComb,W.D., Dynamics and Relativity, pag. 24-25

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