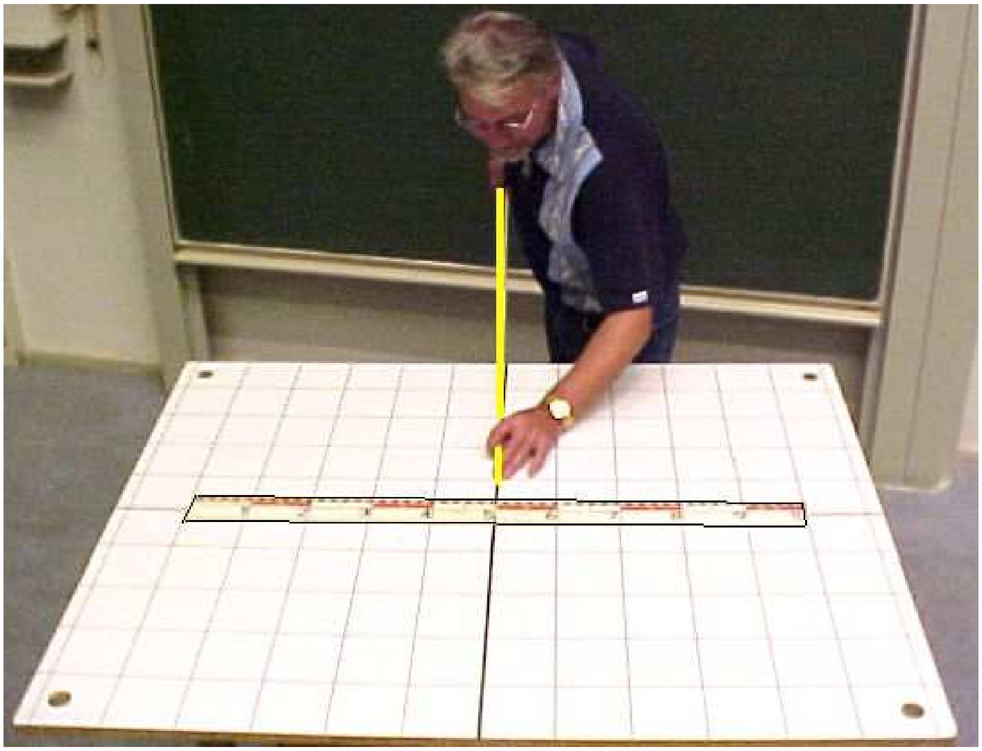
Percussionpoint (1)

Aim: To show the behavior of a stick to a short impulse.

Subjects: 1Q60 (Rotational Stability)

Diagram:



Equipment:

- Platform with grid, used as reference.
- Ruler, 1m.
- Stick.

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Presentation:

1. Place the ruler with its centerline on the thick centerline of the grid (see Diagram). With the stick you give a short blow to the center of the stick (a movement like you are playing pool-billiards). There will result a translation of the stick.
2. Again place the ruler with its centerline on the grid. With the stick you give a short blow to the ruler e.g. at 60cm. There will result a translation and rotation of the stick.
3. With the stick you give a short blow to the ruler at 100cm. There will result a translation and rotation of the stick. Special is that it rotates around the point of 33cm on the ruler.
4. With the stick you give a short blow to the ruler at 67cm. There will result a translation and rotation of the stick. Special is that it rotates around the beginning of the stick.

The point, around whioch the stick rotates is called "percussionpoint". In Presentation3 and -4, this point is on the stick; in Presentation2 it is outside the stick.

Explanation: Due to the short blow, the ruler performs a movement that can be considered as consisting of two movements: a translation and rotation around its center of mass CM (see Figure1).

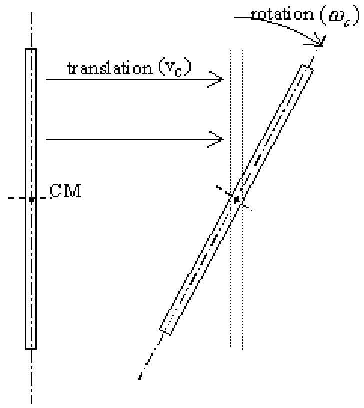

Figure 1

During the short blow force acts on the ruler. The total momentum of this force is $\int F dt = p$. The ruler gets a speed v_c, so the momentum of the ruler is mv_c. This makes $v_c=p/m$.

Relative to CM the ruler has also an angular momentum $I_c\omega_c=bp$ (see Figure2). So $\omega_c=bp/I_c$. On one side of CM, v_c and ω_c have the same direction; on the other side v_c and ω_c are

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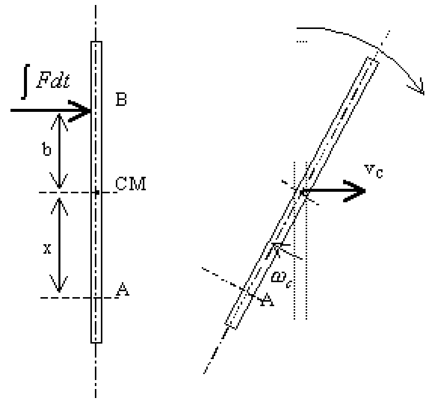

Figure 2

opposite to each other. Looking at point A: $v_A = v_c - \omega_c x$. When point A remains at rest after the blow (A is then the socalled percussion point) then $0 = v_c - \omega_c x$. This happens at $x = \frac{v_c}{\omega_c} = \frac{p/m}{bp/I_c} = \frac{I_c}{mb}$. For this ruler: $I_c = 1/12 ml^2$, making $x = \frac{1}{12}\frac{l^2}{b}$.

Applying this to the different situations of the Presentation shows the observed percussion points: in Presentation1 (b=0), -3 (b=.5m) and -4 (b=.17m). In Presentation2 (b=.1m), the percussion point is outside the ruler (x=.83m).

Remarks:

- Playing billiards with a stick instead with a ball needs practice!

Sources:

- Borghouts, A.N., Inleiding in de Mechanica, pag. 182-183
- Roest, R., Inleiding Mechanica, pag. 172-173 and 176-177