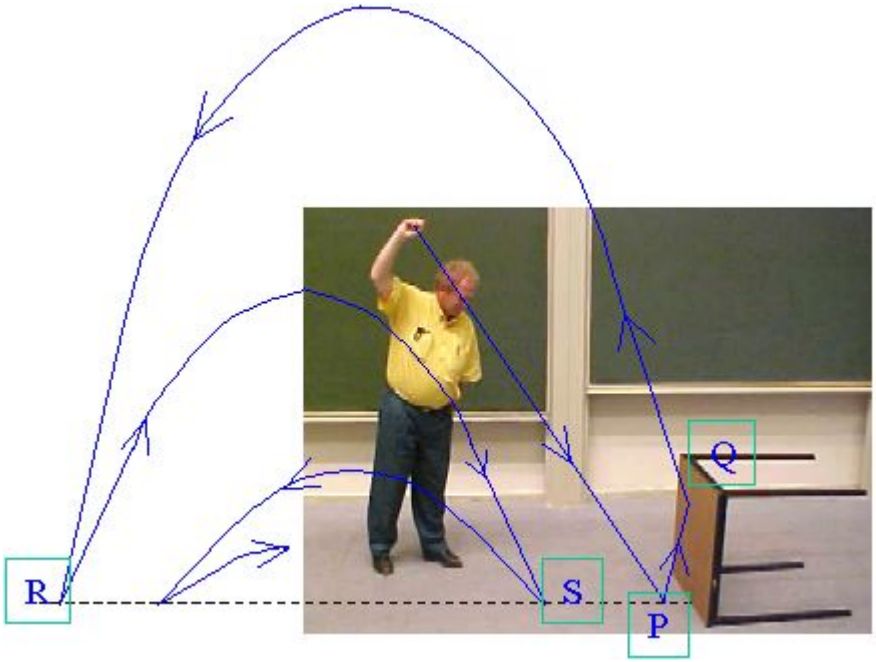
Boomerang ball (2)

Aim: The concept of impulse explains this very peculiar behavior of a bouncing ball.

Subjects: 1K10 (Dynamic Torque)
1N10 (Impulse and Thrust)

Diagram:



Equipment:

- Superball.
- Table.

Safety:

- A superball can jump into many unexpected directions, so mind vulnerable objects in the neighborhood.

Boomerang ball (2)

Presentation: The table is positioned as shown in Diagram. The ball is thrown as shown. The ball bounces to a fro.

Explanation: As a basis to explanation see the demonstration "Boomerang ball (1)" in this database.
Using a large basketball thrown against the floor and then bouncing against a vertical wall, shows that after hitting the vertical wall the basketball still rotates clockwise. Figure 1A shows this.

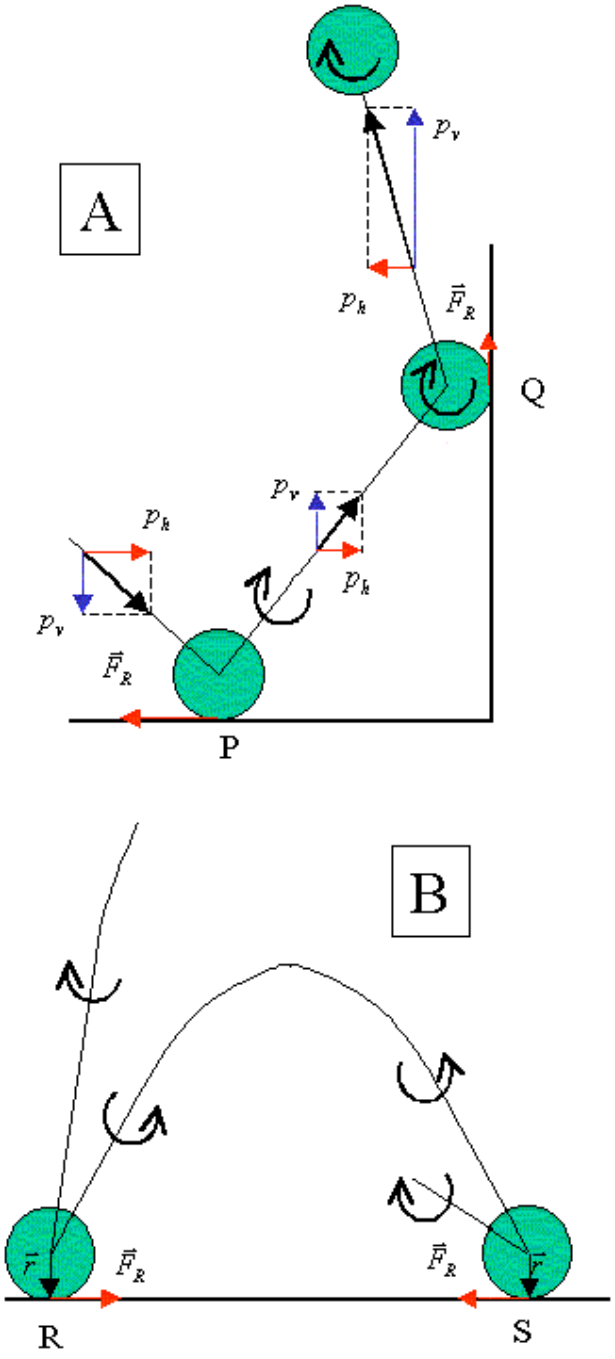


Figure 1

Boomerang ball (2)

(The effect of the friction force F_R in Q is not that large as that of F_R in P, since the ball approaches the vertical wall with $\vec{p}_h$ and this momentum is smaller than $\vec{p}_v$ in P.)

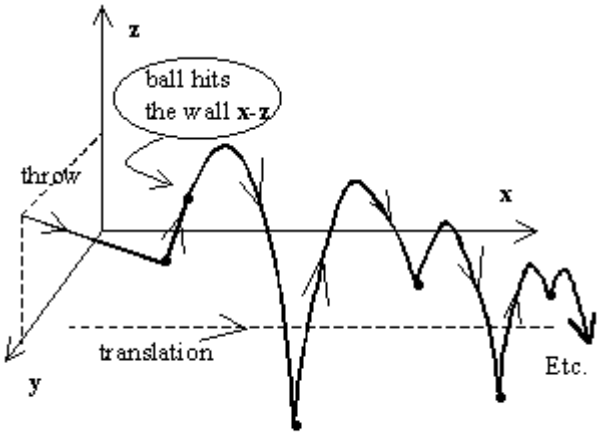
Having hit the vertical wall the ball climbs steep (see Figure 1A). A parabola-trajectory follows. On hitting the floor in R, the friction force is directed to the right (Figure 1B). The impulse $\int F_r dt$ is large enough to make the component $\vec{p}_h$ change direction and $\vec{M} = \vec{r} \times \vec{F}_R$ is inducing a counter clockwise rotation.

It bounces towards S and again F_R is directed to the inner side of the parabola, making the component $\vec{p}_h$ reverse direction and $\vec{M} = \vec{r} \times \vec{F}_R$ inducing clockwise rotation.

And so on.

Remarks:

- Practicing this demonstration against a real wall will learn that this part of the demonstration can also be appreciated on its own. Having the right speed and right angle, a very high climbing ball will be the result of your practicing. Figure 1A shows the explanation of this phenomenon: After bouncing at Q, $\vec{p}_v$ has a very high value.
- A nice variation to this demonstration is the "drunken student" (sorry, "drunken sailor"). To throw a ball that follows such a staggering trajectory, see Figure 2.



Throwing a "drunken student"

Figure 2

Sources:

- Walker, J., Roundabout, the Physics of Rotation in the Everyday World, pag. 8-12.
- American Journal of Physics, pag. 875-883 (Vol. 72-7; 2004).