THE SPILLNOT™

SPNT01

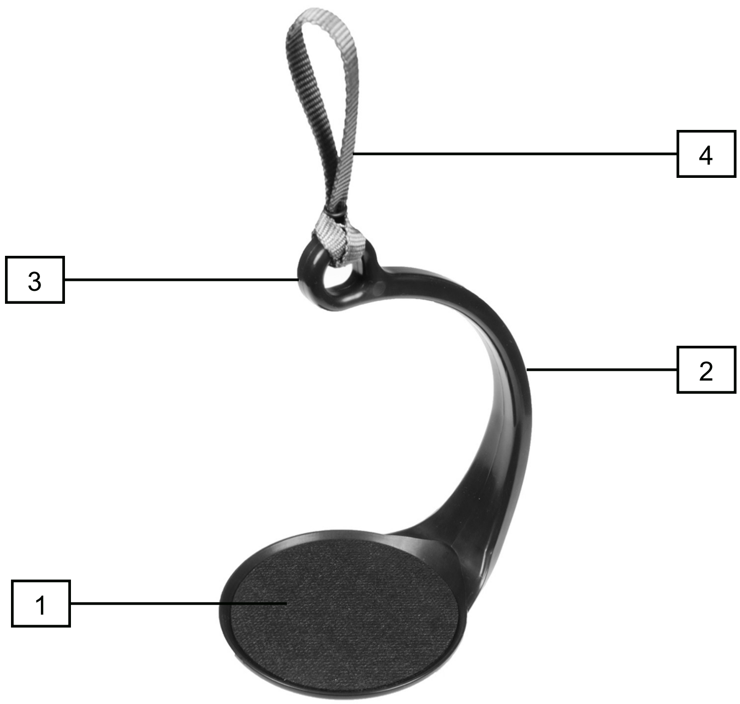

Figure 1

DESCRIPTION

The SpillNot™ is a simple but effective device for transporting an open container of liquid without spilling. It also presents an opportunity for examining some surprising aspects of the physics of accelerations in liquids.

The SpillNot™ consists of a molded tray with a coaster (1, *Figure 1*) attached to a rigid support (2) that curves around the outside of the tray to an eye (3) directly above the center of the tray. A flexible webbing handle (4) is looped through the eye.

The SpillNot™ is 19.5 cm high, excluding the 8 cm long handle, and the diameter of the tray is 11.2 cm. The height clearance for the liquid container is 14 cm (full tray width.) The empty weight is 138g.

A container (usually a beaker or a glass) full of liquid is placed centrally on the coaster, and the SpillNot™ is carried by the flexible handle. The shape of the SpillNot™ and the flexibility of the handle combine to sharply reduce the sudden accelerating forces applied to the liquid, and this prevents spillage in most situations.

INSTRUCTION MANUAL

To Spill or to SpillNot? That is the question…

THE MOLECULES of a liquid are held together by forces of cohesion, so a mass of liquid has a definite volume. But the molecules are free to move around each other, so the liquid does not have a definite shape.
If a force is applied to the liquid (always gravity, and sometimes other forces too) the liquid molecules will move until stopped by a solid—such as the wall of a glass. So the liquid at rest will take on the shape of its container. If the liquid doesn't fill the container completely, the top surface of the liquid will be exactly horizontal.

What happens if a container of liquid is pushed sideways by a force F—for instance, by a hand?

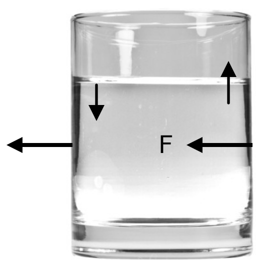

Figure 2a

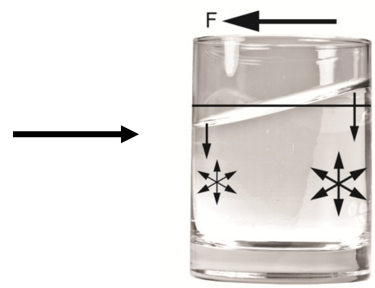

Figure 2b

Figure 2a shows a glass of water at rest suddenly pushed by a force F. The glass is a rigid solid, so the front and back of the glass both begin to move in the direction of F at the same rate. The liquid layers next to the glass walls begin to move with the walls, but are resisted by the layers next to them. They conform to the shape of the glass, but the only direction they can adjust is up or down, so the front layers move down to prevent a gap forming as the wall moves away. At the back, the wall is moving towards the liquid, so the first liquid layer is forced up. As the force is transmitted from layer to layer in the liquid, this creates the tilted surface shown in *Figure 2b*.

How does this up-and-down movement translate into a sideways movement of the liquid? At each level in the liquid, the pressure is proportional to the depth of liquid, and acts equally in all directions (Pascal's Law). For the back layers of liquid, the depth has become greater, increasing the pressure at every level. At the front, the depth has become less, reducing the pressure at every level. So now there is a pressure gradient in the liquid from back to front, and every part of the liquid experiences a force towards the front, causing it to accelerate along with the glass.

It is clear that the larger the force F, the larger the force on the liquid must be to produce the same acceleration as the glass. This means that a steeper tilt of the surface is needed for equilibrium. At some point, the tilt is steep enough for the top layer of liquid to rise over the edge of the back of the glass and spill out.

Also, if a smoothly moving glass of liquid is stopped by a backward force, the same situation is encountered in reverse, with the liquid spilling over the front of the glass if the stopping force is large enough.