Springs and Stomachs
or
Why Your Stomach Feels Like #*&%@?! When in Free Fall

Hold a slinky at least 5-6 ft off the floor (stand on a chair, stepstool, or table if necessary), with enough of the coils held in your hand so that there are about 2-3 ft of coils hanging freely downward from your hand. Then drop the entire slinky. Note that as the slinky falls it does not stay stretched -- the stretched coils come together. (Note: You can find outstanding slow-motion videos of a falling slinky on You Tube. The behavior is quite interesting and the physics explanations can get quite sophisticated, but for the purposes of the present demonstration the behavior that is of interest is that, as mentioned, the stretched spring comes together during free-fall.)

Figure 1 shows a wooden bar with a balloon attached to its underside, a mass suspended from it by rubber bands, and a sharp-pointed screw pointing upward from the top of the mass. Figure 2 shows a closer view of the assembly, without the balloon.

Drop the assembly (with the balloon in place) from a height of 4 or 5 ft. In free fall, the stretched rubber bands will contract just like the slinky did. When the balloon makes contact with the sharp point, it pops. Notice that this happens almost immediately. CAUTION: Dropping the assembly on a hard floor may damage it. Consider dropping it onto a pillow, jacket, or other soft object, to cushion its impact.

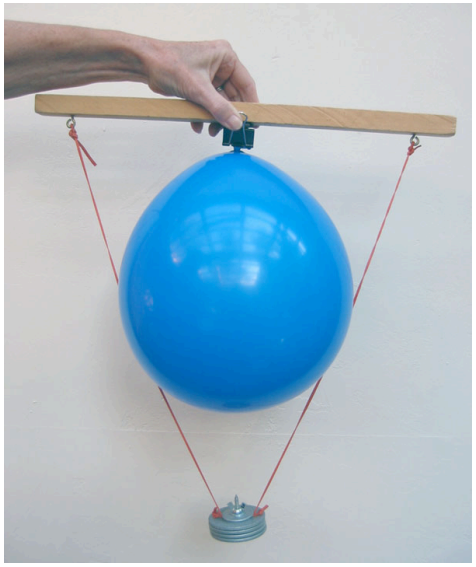

Figure 1

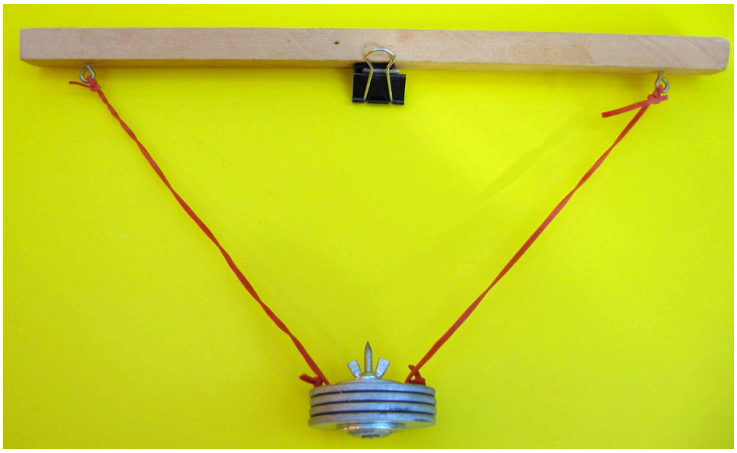

Figure 2

(continued)

Don Rathjen.....Exploratorium Teacher Institute.....San Francisco, CA.....drathjen@exploratorium.edu

NOTES FOR MATERIALS AND CONSTRUCTION DETAILS:

• mass used here is a collection of steel washers held together by a machine screw and wing nut -- most of the washers were hot-glued together to make them a more cohesive unit and keep them from sliding around
• the point on the machine screw was obtained by grinding with a bench grinder

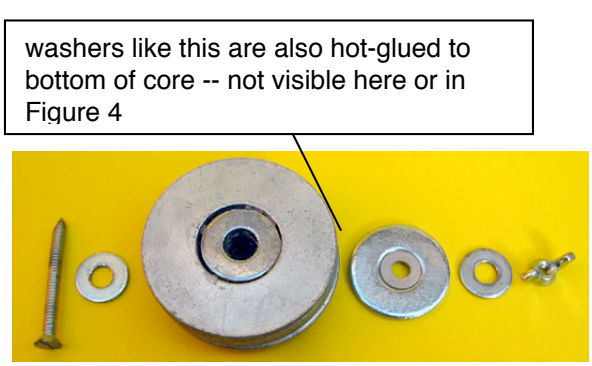

Figure 3

Figure 4

• you can substitute a reasonably large round lead fishing weight, and a push pin for the washer assembly and sharpened screw -- use two screw eyes screwed into the lead weight to provide places to tie the rubber bands -- drill a hole in the weight for the plastic head of the push pin, and fill with hot glue after the head is inserted
• whether you use the masses described here, or improvise your own, you will likely have to do some trial-and--error experimenting to get a combination of rubber band stretch and mass that works consistently
• the balloon is held by a binder clip that is in turn held to the wooden bar by adhesive-backed velcro pieces attached to it and to the bar
• this demonstration draws its inspiration from a NASA publication: see "Free Fall Demonstration" in the NASA publication "Microgravity," EG-103, 1995.

If the same demonstration is done using string instead of rubber bands, everything falls with the same acceleration right from the beginning, and the balloon will not pop until it hits the sharp point when everything reaches the floor. (Note: When the balloon travels all the way to the floor, air resistance tends to push it out of place on the way, killing the demonstration. You can get around this by just repeating things until the balloon finally stays in place and pops, or you can try using small pieces of tape to hold the balloon to the string.)

So what does all this have to do with your stomach? Well, let's compare your stomach to the mass. Normally the mass is held in place by the stretched rubber bands. Your stomach is normally held in place in your body cavity by stretched muscles. In the same way that the mass comes into contact with the balloon in free fall, your stomach in free fall finds itself in a position in your body cavity that it does not usually occupy. This abnormal situation is registered by the brain, triggering the physiological responses that make your stomach feel different in free fall. When you reflexively tense your abdominal muscles on rides, you are actually attempting to lessen this effect by holding the stomach in its normal place.

Don Rathjen.....Exploratorium Teacher Institute.....San Francisco, CA.....drathjen@exploratorium.edu