



One-Ball Bounce

Why if you drop a ball from say 2 meters does it bounce higher than a ball dropped from 1 meter?

What is Needed

- A rubber ball

What to Do

Drop the ball from 1 meter. Note how high it bounces. Next, drop the ball from 2 meters. Again, note how high it bounces. Why does the ball bounce to different heights?

What is Happening?

If you follow the motion of either ball, you'll realize that there's a moment halfway through its bounce when the ball is perfectly motionless in contact with the floor. At that instant, how does the ball "know" how high it should bounce? Something about its situation then must determine its rebound, but what?

The answer lies in how far the ball has dented inward due to its collision with the floor. As it falls, the ball converts energy stored in the force of gravity—gravitational potential energy—into energy of motion—kinetic energy. By the time it reaches the floor, the ball is traveling quickly and it hits the floor hard. It pushes downward on the floor and the floor pushes upward on it. Because of those forces, both the ball and the floor deform inward. This denting extracts energy from the ball's motion and stores much of it in the elastic surfaces of the floor and ball. Because the ball is softer than the floor, it does most of the denting and stores most of the energy. By the time the ball comes briefly to a stop, most of its missing energy has been stored in its dented surface.

The ball then rebounds; it undents and tosses itself up into the air to a good fraction of its original height. That height fraction is equal to the fraction of energy that the ball successfully stored and returned during its bounce. Thus a typical ball bounces to 60% of

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its original height because it stores and returns 60% of the energy it had before the bounce. Conveniently enough, this fraction of returned energy is nearly independent of how much energy the ball had to begin with. It depends only on the elasticity of the ball itself—a super ball returns a large fraction while a beanbag a tiny fraction.

When you drop a ball from a greater height, it has more kinetic energy just before it hits the floor and stores more energy during the bounce—it dents farther as it comes to a stop. When the ball rebounds, its stored energy reappears and it leaps higher into the air than it would have had you dropped it a shorter distance.