Suppose I stand on a table. This is the table and I stand here. And I have here, carrying in my hand, a bottle of water. Let's say it's 1 gallon of water. Well, this bottle of water has a mass, m bottle. So the gravitational force down is mb g. since this bottle is not being accelerated vertically, I'm just standing still. I'm holding it in my hand. Then it must be a normal force from my hand onto the bottle, which I call N of b, which is the same as mb g. There's equilibrium. There's no acceleration in this direction.

Let's look at the situation here. My mass is m Walter Lewin. So it has a gravitational force, m Walter Lewin g. But of course, I also push down on the table with the gravitational force of this bottle. So there is an additional force, which is m bottle times g. And these two are exactly counter-balanced by a normal force. And this normal force, the magnitude of the normal force is m Walter Lewin. plus m bottle times g.

If I put a bathroom scale under here between my hands and the bottle, the bathroom scale would read this value and that's the weight of the bottle.

If I put a bathroom scale under my feet, the bathroom scale would read this value for m, which is the weight of Walter Lewin plus the bottle.

But now imagine that Walter Lewin and the bottle jump off. Then clearly, the bottle is going down with gravitational acceleration g. I go down with gravitational acceleration g. In other words, these values will become 0, and this value will become 0. Otherwise, we could never fall down with acceleration g. And therefore, if this becomes 0 and this becomes 0, the bottle has no weight and I have no weight. So as we jump, as we are in free fall, the bottle, as well as Walter Lewin are completely weightless.

You see, the muscles in my hand who are supplying this force up, this value N of b, is effectively taking the place of the bathroom scale. I feel in my hand clearly, this pushing down of the bottle of water on my hand, and I have to overcome that. So my hand is effectively playing the role of the bathroom scale and I really feel that I have to push up. The moment however that I jump, this value goes to 0 and I feel nothing. I feel absolutely no push from the bottle of water on my hand. And so when I jump off the table, I could lower my hands just below the bottle, it would make no difference because there is no contact force from my hands on the bottle anyhow. I could lower my hands just a little bit and we would all fall in free fall, and there would be no contact between the bottle and me. That's the idea of weightlessness.

So as we jump, the reading of this bathroom scale will instantaneously go down from the original value, which was the weight of the bottle to 0. And if I attach this bathroom scale under my feet, if I attach it to my feet, so I jump with the bathroom scale off the table, it's value will also instantaneously go down from the value that we measured before, which was the weight of Walter Lewin plus the weight of the bottle of water. It'll instantaneously go to 0.

Well, I suggest we're going to do this experiment. I hope I survive it, but I'm going to give it a try. I am wired up with a wire here, so we'll have to do something. But we'll be back on the air in about 30 seconds, and I'm going to jump off a table with this bottle of water to see whether I can convince you that the bottle becomes weightless when I jump.

OK, all right. Here's the bottle and here is a table. So let me go on the table. And here is the bottle. Maybe you can give me a little bit of a close-up. I'm going to jump off the table and as I do that, there's very little time. By the way, you should be able to calculate since this table is about a meter high, how long it takes me before I hit the ground. But I leave that up to you.

So as I jump, I want you to notice that during this short amount of time, I can take my hands of the bottle. I no longer have to carry it; the bottle has no weight. Are you ready? 3, 2, 1, 0. I will do it once more. And notice that the fact that I move my hands, I lower my hands, has no effect on my motion and no effect on the motion of the bottle. We both, being accelerated with the gravitational acceleration g, and if I pushed on the bottle upwards, it wouldn't even go down with acceleration g. There's no contact between us necessary. We are weightless. 3, 2, 1, 0.

I think you've seen it now. That's the ideal weightlessness, which is not always so very easy. It's not an easy concept.