All right, so if you're ready, I'm ready, and we start with problem 4.B.3. Potential energy of a spring.

I have here a spring, think of it as a spring being on a frictionless horizontal surface. It has a relaxed length l0. That means not stretched, it's not pushed. I call this x equal 0. And I, Walter Lewin, take it in my hands and I'm going to extend it all the way to distance x0. If I'm somewhere here at a distance x from its relaxed position, then there is a spring force, which is trying to drive it back to equilibrium. Let's call it Fs equals minus kx. I'll give it a vector. This is actually, also a vector because this is a one-dimensional problem x is one-dimensional, so the minus indicates that when x is positive the force is in the opposite direction as the positive x.

The force that I have to apply to pull it, that is the force of Walter Lewin, would then be plus kx exactly opposing the spring force. But of course, equal in magnitude.

I do work when I stretch this spring. And when I stretch it from x plus dx, so I go from x to x plus dx. So this little separation is dx. Then the work I do, the work done by Walter Lewin equals the dot product of force my force dot dx. I assume that over the small distance, my force is not changing. That's why I'm not writing it here yet as an integral over the x. I just assume it's constant. And this is a vector in the plus x direction. The angle between the force and the displacement is 0, so the cosine theta is 1. So I can forget the dot. And so this equals kx dx.

Now I'm going to calculate all the work I have to do to bring it to x0. That is the total work to bring it from x equals 0 to x0. And that is the integral from x equals 0 to x0 of kx dx. And that equals 1/2 k x0 squared. It's the work that I have to do between here and here. And that is, per definition, the potential energy between here and here. And for a spring it is only sensible to call the potential energy 0 at its unstretched state, in the relaxed state. And so, we will then simply say that the potential energy at this point x0 is 1/2 k x0 squared.

You could retrieve this energy if you wanted to. You could release it. And if there is no friction, then it will convert this potential energy back into kinetic energy. And when it go through this equilibrium, then it will have reached-- it will have converted all the potential energy back into kinetic energy. And then it will convert it back to potential energy, kinetic energy, and so on.