We now would like to analyze the force law on an idealized spring, a force law called Hooke's law.

Let's begin by drawing a ideal spring connected to an object on a frictionless surface.

So we'll draw our object.

We'll draw our idealized spring.

This surface here is going to be frictionless.

And this is a wall, and we'll draw it like that.

And now what we'd like to do is to introduce the force law for a spring, a force law, which will be called Hooke's law.

So the way we'd like to analyze this is by drawing two pictures.

Our first picture will have the spring at an equilibrium picture.

So let's draw the wall again and let's draw the spring and our object.

And this is called the equilibrium picture, so I'll write equilibrium picture.

And now what we like to do is draw a picture, a dynamic picture at some arbitrary time t so here we have a dynamic picture at time t.

And I'll draw it in a second.

So we draw the same object, and now we're going to move our object to some arbitrary position.

In this case, the spring has been stretched, wall, frictionless surface.

And now, I'm in position to choose a coordinate system.

So what I'll do is I'll choose my origin at the edge right here, this is called x equal 0.

I'll show it in the dynamic picture.

And my coordinate function for the object here, I'm going to refer to that as x sub t.

Now, notice that this coordinate function is also an indication of how much the spring has been displaced.

As far as directions go, we'll have an axis.

And this is our plus x direction, so usually we indicate that with the unit vector i hat.

And now Hooke's law is the statement that the force on the spring, that the force on the object F is proportional to how much the object has displaced, which represents either the stretching or the compressing of the spring.

So it's equal to minus kx I hat.

Now, what does this minus sign mean?

Well, this is an example of what we call a restoring force.

And let's look at just a couple of examples.

When x is positive, that means that the object has been pulled out from the equilibrium position.

The spring is undergoing tension, it's being stretched apart.

The molecules in the spring that constitute the spring are being pulled apart, and there's a restoring force inside the spring.

This is an atomic force in nature that's pulling the spring backwards, hence exerting a restoring force on the object.

So this forces in the minus i hat direction.

It's restoring in that direction.

I'll draw the force like that.

Now, suppose we drew another picture where the object is pushed in, compressing the spring.

So let's draw once again a diagram.

And let's show the spring under compression from our equilibrium position.

Now here, we have, again, that x of t.

But in this case, x of t is negative.

So this is extension, so we'll call that case A.

And case B, when x is less than 0, it's under compression.

And then we see that with x negative and the additional minus sign, the force is in the positive direction.

And so in both instances, the force is a restoring force back to equilibrium.

So the restoring force, whether you're under extension or compression, is pointing, let's just call it, is the direction of the force is towards the equilibrium position.

And this example of a restoring force is also only proportional to x.

And so in that case, we can add the word linear, because it's just to the single power x.

And this is an example of a linear restoring force.

And this is a model for an ideal spring.

Now, this constant k is called the spring constant.

And the units of the spring constant, if you divide the units of force by the units of distance-- so we have SI units are Newton over meters, and that's the measure of the spring constant.

Now, what we'll show next is an experiment in which we can figure out how to actually measure that spring constant k.