So now we want to find the center of mass of a uniform rod.

And we have the result for a continuous body, which is that integral over the body of dmr to that mass element dm divided by an interval.

Now our goal is to figure out how to apply this result, specifically, to real physical objects.

And the key, as always, is choosing a coordinate system.

So now I'll draw the object, again.

And the first thing I'll do is choose an origin.

I can pick my origin anywhere I want.

I can pick it in the middle.

I can put it in the middle.

I could put it at this end.

I could put it that end.

I could put it down here, but I'll choose it over here.

Because the object is linear, this is a very Cartesian system.

I'm only doing a one dimensional object.

So I choose my coordinate system plus x.

That's step one.

Now my origin-- now here comes the crucial thing.

In this argument, dm is the infinitesimal mass element.

And I want to pick that at an arbitrary place in the object.

I don't want to pick it at the origin.

I don't want to pick it at the end.

Note down here this is x equals L.

So I'll arbitrarily pick an infinitesimal element.

I'll shade it in dm.

That represents-- this is what I'm going to make my summation over when I do my integral.

I'm going to add up all these dm's.

And the point is that the dm's are different distances from the origin.

So the vector-- and here's the next step-- is I draw a picture of my vector rdm.

So now I have these terms, at least, explained in my diagram.

The next step is to turn-- is to introduce an integration variable for both of these quantities.

So step one was the coordinate system.

Step two, was the identification of dm.

And step three and I think this is absolutely the crucial one is to introduce the integration variable.

Now you'll see that will come in two different cases.

So this is the quantity, the distance from dm to the origin that's changing.

You can see for each of these little elements, that changes.

So what I'll write [INAUDIBLE] as a vector is x prime, which will be my integration variable in the i hat direction.

So the integration variables x prime.

That's the first place that I introduced the integration variable.

And x prime, you can see, will vary.

And it varies from x prime equals 0 to x prime equals L.

And that will show up in terms of the limits of my integral.

Now the second place that the integration variable comes in is dm.

I want to express in terms of x prime, which is a measure of where this object is.

And that's how, if we choose this length here to be dx prime, notice in terms of the integration variable, then I have a relationship between and dm and dx prime.

dm is mass in this little element.

dx prime is the length of the element.

And if the whole object is a uniform rod with a mass capital M and a length L, then its just given by M over L dx prime.

And this quantity M over L is an example of a mass, linear mass density, which we have a scale challenge about.

So I have two places, where my integration variable has been introduced.

And now I can write up every piece in this interval.

So let's now indicate that we're integrating from x prime equals 0 to x prime equals L. dm is M over L dx prime, and our vector is x prime i hat.

And downstairs, it's just M over L dx prime from x prime equals 0 to x prime equals L.

And that's how I set up the integral for the center of mass.

Both of these integrals are now not difficult to do.

Notice, it's x prime dx prime.

So this integral is x squared over 2.

And I get 1/2 M over L, L squared.

And downstairs, dx prime from 0 to is just L.

So the downstairs integral is just M over L.

And when you have M over L's cancel, we just are left with a-- this is-- I'm sorry-- this is just M not M over L, dimension incorrect.

So we get for the position of the center of mass, the M's cancel.

One of the L's cancel.

And we have an i hat in this expression so our answer is r equals L over 2 I hat, which is exactly what we expected.

We expected the center of mass to be half way down the rod.