Let's try to find the center of mass of a uniform object like a uniform rod.

And let's assume this rod is length L, and we want to find the center of mass.

Now, before I begin this calculation, you can probably already guess that it's going to be exactly in the middle, and we'll verify that, but let's first define what we mean by our center of mass for discrete particles.

Recall that this was a sum over all the particles in the system.

So we'll take a label J goes from 1 to N, and it was the mass of that jth particle times the position vector that jth particle with respect to some origin, and we're dividing that by j equals from 1 to N of the total mass in the system.

Now, how do we translate this equation for a continuous system?

And let me just again show that we had chosen an origin.

Here was our jth particle of mass mj and rj.

So what we want to do is draw the analogy, and here's how it works-- that for each discrete particle, we're going to look at that as some mass element delta mj.

Our vector rj will go to a vector for this mass element.

I'll just write it delta m.

And our sum from j goes from 1 to N is actually going to go to an integral over the body.

So let's see how that looks.

So first, we'll do it with the total mass, m-- here we're summing over j-- from 1 to N of mj.

That goes to the integral over the body.

Now, the delta m, when we take limits, because that's when an integral goes, we'll write that as dm.

So that becomes a limit over the body.

And likewise, our sum j goes from 1 to N of mj rj goes to an integral over the body of dm vector r going to that element.

So we can say in the limit that this becomes r going to that element.

Now, that means that our continuous expression for the continuous object is an integral over the body of dm r to that element dm divided by an integral over the body of dm.