Let's now extend our concept of momentum to a system of particles.

Again, we need to choose a reference frame.

So we'll have a ground frame.

And let's consider N particles.

Now when we have a lot of particles, we need some type of notation.

So let's use the symbol j.

And it will goes from 1 to N. And then our arbitrary j particle will be moving.

This particle will have mass mj.

And it will be moving with a velocity vj.

Now recall in our system, we have many other particles.

We can call that one 1.

This is one n.

We have lots of different particles in the system.

And this just represents an arbitrary particle in that system.

And the momentum of the jth particle is just the mass, mj, times the velocity, vj.

And again, we're assuming some fixed reference frame.

So the total momentum of this system, we now have to add up the momentum of all the particles, all the way up to the nth particle.

Now, when we make a sum like this, there is a standard mathematical summation notation, which we'll write like this.

We'll do the sum, this capital sigma sin of j goes from 1 to j goes to N of the momentum of the jth particle.

And that represents the sum j goes from 1 to n of mj vj.

And this is what we call the momentum of the system.

This is a vector sum.

And now let's see how Newton's second law applies to the momentum of the system.

Suppose that acting on our particles-- for instance, here's our jth particle-- we have a force Fj acting on the jth particle.

Then we know that from Newton's law that the force will be also the sum of the forces on all of the particles, F1, F2, plus dot, dot, dot, plus FN.

So once again, we can write this as a sum j goes from 1 to N of the force on the jth particle.

And that's the force on the summing over all the forces on all the particles in the system.

But now, we can apply Newton's second law.

So Newton's second law is the statement that the force on the jth particle causes the momentum of the jth particle to change.

And when we write that now, the total force on the system, j goes from 1 to N, is just the sum of the change in momentum.

Because every single term-- let's just look at that.

T1 plus dP2/dt plus dot, dot, dot, plus dPN/dt, that's what we mean by the sum.

We can rewrite this as d/dt of P1 plus P2 plus P3 plus dot, dot, dot, plus PN.

And what we see is that the total force is the derivative of the sum j goes from 1 to N of the momentum.

But recall, this sum we've defined as the momentum of the system.

So our conclusion is the total force causes the momentum of the system to change.

Now so far, all we've done is we've recast Newton's second law in this form.

Our next step is to analyze the forces on the individual particles we have and apply Newton's third law.

So we'll do that next.