Let's consider what we call the window washer problem.

What we have is suspended from some ceiling.

We have a pulley.

And the pulley is suspended by a rope, which we're going to call this string 3.

And we have a rope that is wrapping around this pulley.

And then it wraps around another pulley.

So this rope is going around another pulley.

And it's fixed to the ceiling.

And this is what we're going to call string 1.

And then this string, there's another string that comes down to a platform.

And this one we're going to call string 2.

And sitting on the platform is a person.

So we have a person sitting on the platform.

And that person is pulling the rope down.

Now this is a very complicated problem.

And it's a classic example of how do we choose systems so that we can apply Newton's second law.

Now, one of the important things we're going to do is learn to see when we choose a system what forces are internal and external.

And that will enable us to pick a very nice system, which will make the analysis easy.

The way we'll do this is will approach it in stages.

We'll first focus on the person, the platform, and this pulley.

By the way, this is pulley A. And this one is pulley B.

And let's use a symbol P for the platform.

And we'll call this a washer person.

And we're going to use the symbol W for the person.

So what makes this problem complicated is all these different elements.

Now the first stage is that what we're going to do is we're going to separately look at the person, the platform, and then combine them into a system of person and platform.

But notice, the rope is connected to the platform.

So the next stages will also consider a system consisting of pulley A, person, and the platform, and the washer.

Now let's draw the free body diagram.

Let's begin by drawing the free body diagram on the washer.

So what do we have on the washer?

The first thing to think about is the string.

The washer is pulling the string down.

So the string is pulling the washer up.

So that's a force of string 1 on the washer.

Now, there's also the gravitational force m washer g.

And what we also have to consider the fact is that the person is sitting on the platform.

So the platform is pushing the person up.

And we'll call that a normal force on the washer due to the platform.

And those are the free body diagram for the body diagram on the washer.

Now let's focus on the platform.

So here, we'll draw the platform.

And now let's look at the forces on the platform.

Let's begin by looking for the internal forces, the Newton's third law pairs.

The platform is pushing the person up.

The person is pushing the platform down.

So we'll write that force as N on the platform due to the washer.

And immediately, let's just circle this third law pair.

Now, string 2 is pulling the platform up.

So let's draw that force.

We'll call that a tension force in the string.

It's on the platform due to string 2.

And finally, we have the gravitational force on the platform.

And that's our free body diagram on the platform.

Now, you may have said, well, why should I separate these out?

Why didn't I just use the person and the platform?

So let's draw that picture.

So now imagine underneath this is a system consisting of the person and the platform.

And I'll just draw that system like that.

So what we're doing is we're taking these two separate free body diagrams and we're going to combine them here.

And by Newton's third law, all internal forces should cancel in pairs.

So now let's separately think about the forces and see that that's the case.

Well, we have the gravitational force on the system, which is the mass of the platform plus the mass of the washer times g.

We still have the string pulling the person up because the person is pulling the string down.

So we still have the force F1 on the washer.

That's string 1 on the washer.

And we still have the pulley, the tension in string 2, pulling it up.

So we still have the force T2 on the platform.

Now, when you look at this, what we're doing is we're adding these two free body diagrams together.

The internal forces now are the normal force.

They're equal in magnitude, opposite in direction.

So when you add them together, they cancel.

And we're just left with that, with that, with that, and with that.

And so this is now the combined system.

Now you might ask, why did we not include the pulley?

Well, let's take a look at that.

So I'm going to draw the free body diagram just on pulley A. So let's draw pulley A.

Now what we have here is the string on both sides is pulling pulley A up.

And that's the tension in string 1.

So what we have is-- I'm going to call that tension in string 1, tension in string 1.

And just to alert you that keep in mind that this force here is the force of the string on the person and this too is also tension in the string, because this is our assumption of a massless string.

So notice that everywhere in the string, the tension is uniform.

So I'm just going to simplify that by calling it T1.

What are the other forces on the pulley?

Well, we're assuming that these pulleys are massless.

And so there's no gravitational force on the pulley.

And the only thing we have is the string pulling-- is the tension in the string.

So now this is a little bit different.

This is a force on the pulley too.

So at the moment, let's do something a little bit different.

Let's consider our system to be the string.

So it's pulley A. We call that string 2.

That's our system.

So I modified that a little bit.

I just didn't consider the pulley separately.

I considered the pulley and the string as the system.

Then here the string is pulling the platform up.

The platform therefore is pulling the string down.

And once again, we have a third law pair.

And so if I added these two together, then what I now have-- and this is why this problem is kind of complex-- we have pulley A, string 2, platform P and washer person.

And if we now add these two systems together, we have this complicated system.

But what are the forces in this system?

Well, the rope is pulling it up.

The person was-- remember we had this force, W1, was the force of string 1 on the washer.

That also was the tension everywhere in the string.

So we have another T1 up.

These two forces now cancel in pairs, the internal forces there.

And so down, we just have mass platform plus mass of a washer times g.

And so you see in this problem, if we tried to treat everything separate-- and I could have even had the string separate-- I have a lot of free body diagram.

But when I think about what's internal and what's external, I can take these two pieces, combine them here, internal forces cancel in pairs.

I can draw these two separate systems, again, combine them.

Internal forces cancel in pair.

And now I have this pulley A.

Now I can write down Newton's second law.

So what I'll do next is I'll introduce-- I still have to consider pulley B. I'll use this as my system.

And I'll write down Newton's second law.

And we'll be able to solve this problem.