Let's apply the work energy theorem principle to the motion of a block sliding down an inclined plane.

And here is an inclined plane at an angle, theta.

And lets choose a coordinate system.

We'll choose x equals 0 up here, or i-hat here.

And here is our coordinate function.

And suppose that the object starts at xi, that it ends at x final.

If we want to calculate the work energy then what we're going to learn is that this theorem is two different sides.

Calculating the change in kinetic energy is simply a description.

This is 1/2 M v final squared minus 1/2 v initial squared.

That's a property, parameters of the system, at the initial state, the speed, or the velocity's speed, which is speed squared.

And the same property v final in the final state.

Now over here we have two types of forces acting on this object.

So here we need a free-body force diagram first.

And this side is where the physics [INAUDIBLE] lie.

And so we want to draw our force diagram.

So if we have our block, we have the friction force, we have the normal force, we have mg.

Recall, if the plane is inclined theta that's also the angle theta.

If we chose i-hat, j-hat unit vectors, I just want to repeat that on my free-body diagram.

Now we can think of this integral as just one-dimensional motion in the x direction.

And so we have two different forces that we have to calculate.

The friction force is in the minus x direction so we're integrating minus the friction force with respect to displacement from x initial to x final.

And what about the gravitational force?

Well the gravitational force has a component, mg sine theta in the x direction.

So when we integrate that x component we have now plus because it's in the same direction.

Remember, we're displacing a little bit dx down the inclined plane so we're going from x initial x final of mg sine theta, which is a constant, dx.

And so when you're applying the work energy theorem you need to integrate your forces and actually calculate the work.

Now again, if you looked in the j-hat direction, and we applied Newton's second law, n minus mg cosine theta 0, and our rule for friction is its mu k times n or mu k mg cosine theta, then what we have is in both instances we have a constant force.

So it's just force times displacement.

So we have minus mu k mg cosine theta times the displacement, which is x initial x final.

Over here we have mg sine theta times x final minus x initial.

And now we've calculated separately both sides of our work kinetic energy principle.

As in all our physical laws the equal sign means the work is equal to the change in kinetic energy.

I'll emphasize that by now placing the equal sign because of our physical law.

And so equaling 1/2 M v final squared minus v initial mean squared.

And now I have a relationship between the parameters of the initial state, which I'm calling x initial and v initial, and the parameters that describe the final state, x final, v final.

And depending on which set of these parameters are given I can conceivably solve for the other ones.

One thing I do want to point out when we do this example is we've described work as a dot product from A to B. Take the friction force.

Well in this instance, if we wrote this out explicitly it would be minus fk i-hat dot dx i-hat from the initial to the final.

i-had dot i-hat is 1.

And so you see, we recover from x initial to x final of fk dx.

And that was the first piece.

The second piece, the gravitational force, dotted into ds from x initial to x final.

Well, if you wrote down the gravitational force, mg, as a i-hat component and a negative mg cosine theta j-hat component, then when we take the dot product again where our ds-- here, we'll write ds as dx i-hat-- then when you dot product mg dot ds, mg dot ds, we have i-hat dot i-hat, which is one.

But j-hat dot i-hat, they're perpendicular so that's 0, so the only piece that survives in the scalar product mg dot ds is these two pieces.

And so we get the integral from x initial to x final of mg sine theta times dx.

And that's precisely our second piece here.

So here's the simple application of the work energy theorem.