We now would like to explore the concept of potential energy difference for a conservative force.

Let's consider the following case.

Suppose you have an object of mass m and it's located at a certain height y i initial.

And so this is our initial state.

And we would like to move this object upwards.

So it goes up to a height y final.

This is our final state.

And in our initial state, we might have some initial velocity.

And then the final state might have some final speed.

And what we'd like to do now is-- we know that if there is a gravitational force, mg, acting downwards, that this gravitational force is a conservative force.

And now what I'd like to do is-- because the force is conservative, it doesn't depend on the path that our object goes to the final state.

It just depends on the parameters that describe the initial and the final states.

In fact, we'll see it only depends on the initial height and the final height.

So what I'd like to do is define a potential energy difference in the following way.

So as a definition, the potential energy difference between these two points is given by the negative of the work done by the gravitational force in going from the initial state to the final state.

Notice this negative sign.

Because the gravitational force here, Fg is minus mg j hat-- where we're taking j hat up-- we've seen that this is an example of a conservative force.

And it doesn't matter how we went from the initial to the final states.

So we can generalize this idea for potential energy.

But first, let's just remind ourselves of the calculation.

When we did this calculation before, we had u final minus u final initial equals a negative sign in the definition.

And when we calculated the work done by the conservative force, we had negative mg y final minus y initial.

Notice the two minus signs.

So we get mg y final minus y initial.

Now, many times people talk about changes in potential energy.

So when I write delta u, I mean precisely the potential energy at the final state minus potential energy of the initial state-- the change in potential energy.

And that's equal to mg times the change in the displacement.

And so we see here for this example, that if delta y is positive, that implies that the potential energy is increasing.

Now let's connect that to our definition.

Why is the potential energy increasing when we raise something?

Well, the gravitational force points downwards.

The displacement is upwards.

So the work done is negative.

And another minus sign means the change in potential energy is positive.

If the object is moving with no change in height, that tells us that the potential energy is change is zero.

And finally, if delta y is less than zero, that implies that the change in potential energy is negative.

Now again let's examine this case.

If we were actually lowering an object, dropping it down.

The object moved downward from the initial state to a final state, the gravitational force is downward, the displacement is downward, the integral is positive, the extra minus sign corresponds to the change of potential energy being negative.