MARKUS KLUTE: Welcome back to 8.20. In this short video, we want to discuss length contraction. We're going to actually derive length contraction. And we do this with an experiment.

The question is how long is Bob's spacecraft? The experiment is conducted by taking two pictures. So let's [? read ?] it here. The first picture is when Alice's and Bob's spacecrafts just start to meet. Bob's relative to Alice's, is moving with a velocity, v.

And we take the second picture when the back of Bob's spacecraft is meeting the front of Alice's, just like it's shown here. And the pictures-- take pictures of clocks. So in the first picture, we see Alice's clock showed a T A1 and Bob's T B1. And for the second equivalently we see T A2 and T B2.

So your task is now to express the length of Bob's spacecraft as Alice sees this from these pictures and as Bob now see it from his own pictures by comparing the time and the velocity. Now pause the video and try to work this out.

So I did this here for you. We calculate the length. We can do this with the velocity and simply the product of the velocity, and the time difference, and the pictures as shown [? of ?] those two clocks. We see this for Alice, and we see this for Bob.

And now we can start to compare. For Bob, Alice now is moving. So the time difference in Alice's clock will be smaller by 1 over gamma compared to what Bob sees on his own clocks. Bob says, "Your clock is slow."

So we can use this. We can then calculate the length of the spacecraft as Alice sees it equal to v times delta T A. And we'll just use the time dilation here. In this equation, we find that the lengths are actually not the same. The length as Alice sees this is 1 over gamma times the length as Bob sees this of the very same spacecraft. So the length of the spacecrafts are not the same as seen by Alice and seen by Bob.

Now here you have to see that, in this example, what I just did is I changed around who's moving and who's resting. So here the observation of Alice of Bob's spacecraft is that of a moving spacecraft. So Alice sees a moving spacecraft, which is shorter than the spacecraft itself at rest.

So how can we resolve this? Alice will argue that the two clocks Bob used are actually not synchronized. And if you paid a lot of attention, you'll see that I'm actually not looking at the same clock. I'm [? having ?] a look at the clock at the beginning of the spacecraft and at the end of the spacecraft. And while they're synchronized for Bob, they're not synchronized for Alice.

Who's right? Both are right. They're just observing events or sequences of events as two different [? reference ?] points.