PROFESSOR: So now we're going to problem 1B5. 1B5 is a little tricky. It is a velocity time diagram. And I will first try to make the plot somewhat similar to what you have in your book. 1, 2, 3, 4 seconds. This is time and this is the velocity. And the velocity here is minus 1 meters per second plus 1, plus 2, and this is plus 3. This is a special point and this is a special point, and this is a special point, and this is a special point, and the curve v versus t runs as follows. Let me make sure that we agree on the 0. I call this time 0 and I call the velocity in this diagram here also 0. So we first see an increase in the velocity. Then an even sharper increase. Then the velocity remains constant. And then, I end up here, and then it stays constant again, and then it goes up in some fashion.

Let's first agree that the velocity here is 0 and that the velocity here is 0. At t equals 3.75 seconds, the object stands still. Notice that during the first second, during second number 1, the velocity is larger than 0. Positive values. It is increasingly linearly, so a must also be positive. And a, which is delta v divided by delta t, the mid value for a is the same as a itself equals 1 meter per second squared. As delta v changes by 1, delta t also changes by 1.

During the second second, I find that a equals plus 2 meters per second squared. It is this part, which you will be able to check quite readily. During the third second, the velocity is constant. You can see that here, it is 3 meters per second. And so the acceleration is 0. And during the fourth second, the velocity starts off to be larger than 0. It's plus 3. It becomes 0 and it ends up to be minus 1. So to velocity becomes 0 and then the velocity is even negative. And if now you calculate delta v divided by delta t, which is a constant, because this is a straight line, you'll find that this is minus 4 meters per second squared. So a is negative.

What does it mean that the velocity is positive, become 0, and becomes negative? Well, what it means is that the object goes in the x-direction, comes to a halt at this moment in time, and then the velocity becomes negative. So here the velocity was larger than 0, here the velocity equals 0, and here the velocity is less than 0. That's what it means. And that's what a negative acceleration can do for you. It can bring the object to a halt and it can reverse the direction in this case, and this moment here equals t equals 3.75 seconds. So the negative acceleration can turn a positive velocity into a negative one. A positive acceleration could turn a negative velocity into a positive one. You think about that one.

All right, let us now pursue this problem, and we are being asked now where this object is after 4 seconds, and I think after 3 and 1/2 seconds and 7 seconds. You do all that. I will do the 4 seconds.

So let us write down the famous equation that we just derived. We're going to need it and it's good to see it again. xt minus x0 equals v0t plus 1/2 a t squared.

This is the distance the elapsed between time t equals 0 and time t equals t. I'm now going to rewrite this a little bit, and I want to know the distance that elapsed between time t1 and between time t2. And so I'm going to write this equation slightly differently. xt2 minus xt1 now equals v0 at time t1 times the time that elapsed between t2 and t1 plus 1/2 a times the time that elapsed squared. Make sure that you appreciate that this equation is effectively identical to this one. You have to digest that completely. It's a must that you see that these are the same. I've just defined the times in a more general way. This is now my beginning time and this is now my end time.

If I now look at the first second, then t1 equals 0 and t2 equals 1. vt1 equals 0 and a equals plus 1. We just calculated that. And if you calculate now x1 minus x0, you can use this equation if you want to. Then you'll find plus 0.5 meters. If now you put a second second and you call now t1 equals 1-- so you start over after second number 2. You say this is now my starting time and my end time is now 2. The velocity at my starting time is now plus 1. You can see that from the graph. And my acceleration equals plus 2. You now calculate what x2 minus x1 is, and you find that it is plus 2 meters. In other words, in the first second it moves 1/2 a meter. In the second second it moves 2 meters. And so x2 minus x0, which is how far it moves in the first and the second second, that is, of course, 1/2 plus 2. So that would be 2 and 1/2 meters. And we will continue this process.

I now take the third second, t1 equals 2, t2 equals 3, vt1 equals plus 3, and a equals 0. And what do I find? x3 minus x2 equals plus 3 meters. And so x3 minus x0 then becomes plus 5.5 meters.

And now in the fourth second, I have t1 equals 3. So when I begin my fourth second I call that time t1. My t2 equals 4. My vt1-- that is the velocity when I start that first second equals plus 3. And my acceleration equals minus 4. That's now very important, this minus sign. And I now calculate what x4 minus x3 is. And I find that it's 3 minus 2 by using the equation that we had. And that is plus 1 meter. And so the net result is that in 4 seconds the object will find itself at the position plus 6.5 meters on the x-axis.

Now, I want you to realize that if I had calculated where that object is at 3.75 seconds after t0, then it would have been farther away from the origin than 6.5 meters. Because remember, the object comes to a halt and then comes back. And it comes to halt at 3.75 seconds. And so when it comes back, which is the four second point, it is less far away than at t equal 3.75 seconds. And I would like you to calculate how far it is away at 3.75 seconds.