PROFESSOR: What now is the instantaneous acceleration a? The instantaneous acceleration a is defined as the time derivative of the velocity.

If I take a one-dimensional case, which I always like to do for us because then we can remove the vectors, because the signs then automatically take care of the directions. So always start with a one-dimensional case.

So we have now v, for instance, equals 3t squared minus 5. And so we will then have a equals 6t. And this number could be positive, could be 0, could be negative. In fact, if t equals 0, you will see that the acceleration is 0. If t is larger than 0 for positive numbers, the acceleration is positive. And for negative numbers of t, smaller then 0, the acceleration is negative. And so the signs here automatically take care of the direction. For values lower than 0 times lower than 0, the acceleration is in the minus x-direction. For values larger than 0, the acceleration is in the positive direction. Wonderful advantage of one-dimensional situations.

Now let's turn to a more complicated situation, the three-dimensional situation. 3-D.

Let the velocity vector be 3t x roof minus 2t squared y roof plus 4z. And distances are always in meters and time's always in seconds.

The components of the velocity in the x-direction and in the y-direction are time dependent. But this component in the z-direction is not time dependent. a, instantaneous value for a equals dv dt. And that now equals 3 x roof minus 4t y roof. So the acceleration has a component in the x-direction and has a component in the y-direction. It has no component in the z-direction.

If we take t equals plus 3, then we would have that the acceleration, which is a vector at t equals 3 is at a particular moment in time-- the instantaneous acceleration at t equal 3 would be plus 3 x roof minus 12 y roof. So a of x equals plus 3 meters per second squared. And a of y, the y-component of the acceleration would be minus 12 meters per second squared. a of z would be 0 and the magnitude of a at this moment in time t equal 3 would be the square root of 3 squared plus minus 12 squared meters per seconds squared.

When the acceleration is constant, when it is independent of the time, the time averaged acceleration between any moment in time is exactly the same as the instantaneous acceleration at any moment in time that you choose.

And I would like to revisit something that I did earlier, whereby we had v of x 33 plus 4. v of y equals minus 2t and v of z was plus 6.

We calculated the average acceleration between time t equals 1 and time t equals 4. And what did we find? We found 3 x roof minus 2 y roof. And we picked these two times randomly.

Now let's calculate the instantaneous acceleration a, which is dv dt. a of x equals plus 3, a of y equals minus 2, a of z equals 0. So what is the instantaneous acceleration at any moment in time that is plus 3 x roof minus 2 y roof?

And so you see that the instantaneous acceleration is independent of time, so the acceleration is constant. It doesn't change in time. And so it shouldn't surprise you that when you calculate the time averaged acceleration between any two points in time, any two that you can choose, that you find exactly the same results.

We will often encounter situations in Newtonian mechanics, whereby we have a constant acceleration. Whenever we deal with trajectories, we throw rockets, and we ignore air drag, we get a nice parabola. And if we call this the plus y-direction and this called the x-direction, which is quite common, we will have no acceleration in the x-direction unless there's air drag. And there will be an acceleration in the minus y-direction, which is 10 meters per second squared. So we will often deal in this course with situations whereby we do have a constant acceleration.