How to calculate acceleration from velocity-displacement graph? It's from kinematics.

Acceleration is the rate at which the velocity of a body changes with time:

$$a = \frac{dv}{dt}$$

We can multiply it by $1 = \frac{dx}{dx}$:

$$a = \frac{dv}{dt}\frac{dx}{dx} = \frac{dv}{dx} * \frac{dx}{dt}$$

But by definition velocity equals:

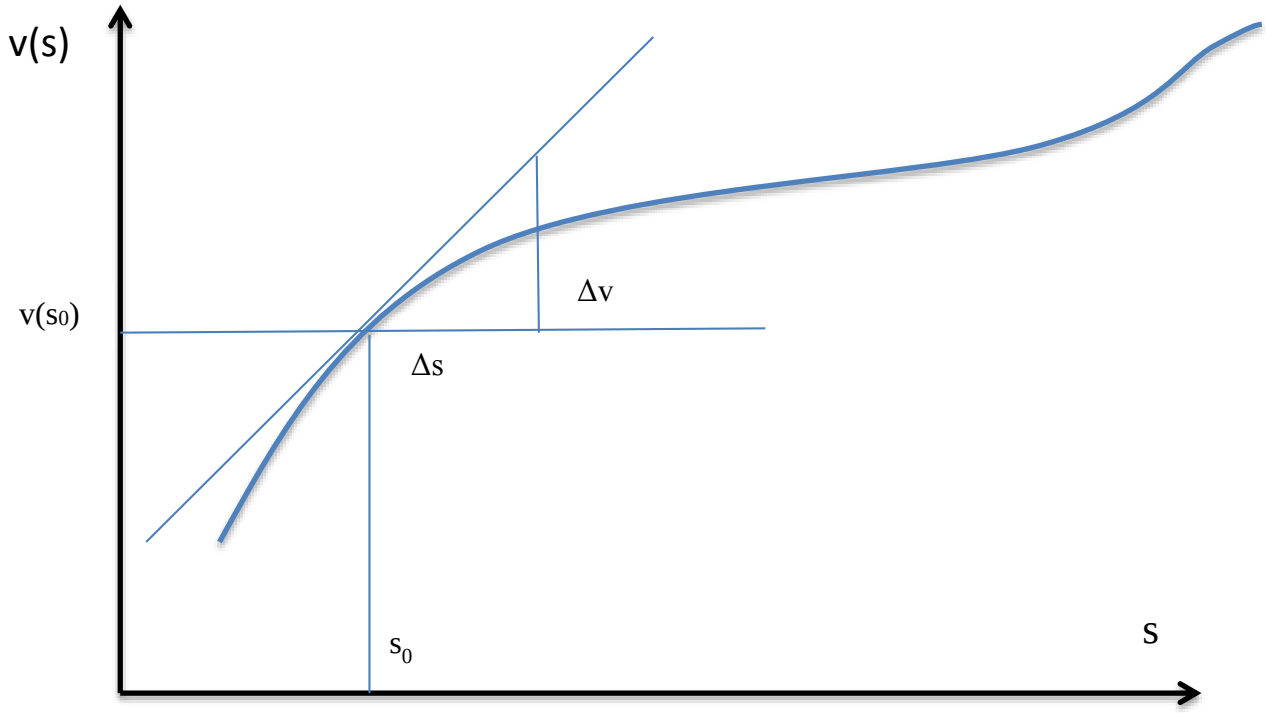
$$v = \frac{dx}{dt}$$

Therefore:

$$a = \frac{dv}{dx} * v$$

Therefore, acceleration equals slope on velocity-displacement graph multiplied by velocity.

For example, we have velocity-displacement graph and want to find acceleration in point $\big(s_0, v(s_0)\big)$:



Slope in this point equals

$$\frac{\Delta v}{\Delta s} = \frac{dv(s)}{ds}|_{s=s_0}$$

And velocity equals $v(s_0)$. Therefore, acceleration in this point:

$$a(s_0) = \frac{\Delta v}{\Delta s} v_0 = \frac{dv(s)}{ds}|_{s=s_0} v(s_0) = k * v(s_0)$$

where $k = \frac{dv(s)}{ds}|_{s=s_0}$ – slope in point $(s_0, v(s_0))$

Taking the slope of a v-t graph