8.1.1 Example: Deceleration of a car

MO2.4

A major objective of this subject is to introduce key concepts behind computational algorithms used to simulate phenomena that depend on time. Time rates of change, not surprisingly, play an important role in modeling time-dependent phenomena.

Consider the deceleration to rest of a car that is initially moving at 90 km/hr = 25 m/s. Figure 8.1 shows an example of how the car's position $x(t)$, velocity $V(t)$, and acceleration $a(t)$ might behave during the deceleration.

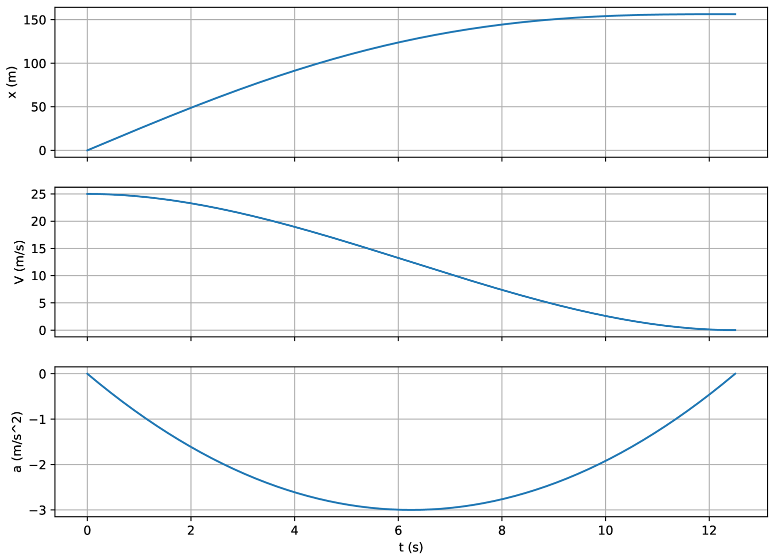

Figure 8.1: Position, velocity and acceleration of a vehicle braking from 25 m/s to rest.

The velocity $V(t)$ is defined as the time rate of change of the position $x(t)$,

$$V = \frac{\mathrm{d}x}{\mathrm{d}t} \tag{8.1}$$

Graphically, $V(t)$ is the slope at time t of the $x(t)$ plot. And similarly, the acceleration is defined as the time rate of change of the velocity,

$$a = \frac{\mathrm{d}V}{\mathrm{d}t} \tag{8.2}$$

The motion shown in the plot is one in which the acceleration is small initially, and then increases in magnitude during the middle of the deceleration, and again becomes small (in fact 0) at the end of the motion. As with the relationship of V to x, $a(t)$ is the slope at time t of the plot of $V(t)$.

Indeed, the notation $\frac{\mathrm{d}v}{\mathrm{d}t}$ for the derivative of v with respect to t is suggestive of a ratio of differences:

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