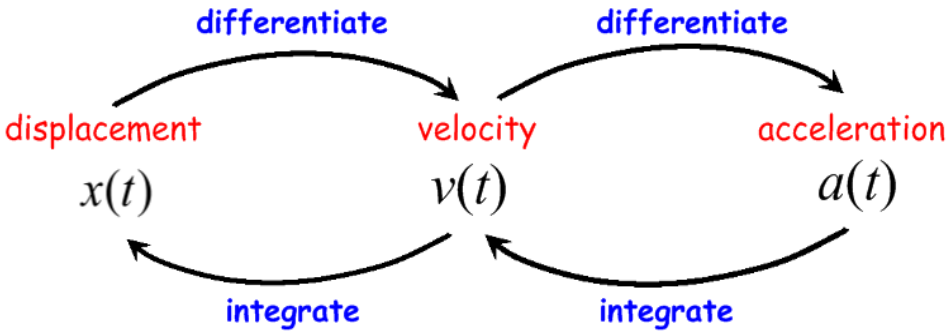
	Positive	Zero	Negative
Displacement	Forward of starting point	At starting point	Behind starting point
Velocity	Moving forwards	Not moving	Moving backwards
Acceleration	Speeding up	Constant speed	Slowing down

The following formulae are not given on the formula sheet in the exam and in unit assessments.

Formulae

- The **displacement** $x(t)$ is the x-coordinate of the particle at time t.
- The **velocity** $v(t)$ is the rate of change of displacement with respect to time, i.e. $v = \frac{dx}{dt}$.
- The **acceleration** $a(t)$ is the rate of change of velocity with respect to time, i.e. $a = \frac{dv}{dt} = \frac{d^2x}{dt^2}$.

Velocity may also be written as $\dot{x}(t)$ and acceleration as $\ddot{x}(t)$.



If displacement is measured in metres and time in seconds, then velocity is measured in metres per second, abbreviated m/sec or m/s or ms^{-1}, and acceleration is measured in metres per second per second, abbreviated m/s² or ms^{-2}. Velocity and time can also be shown on a graph – see page 99.

Example 1

A plane starts from rest. Its velocity in metres per second after t seconds is given by $v(t) = \frac{50t}{3t+10}$. Find the acceleration after 12 seconds.

Solution

We differentiate velocity to obtain a formula for acceleration. For this we need to use the quotient rule with $u = 50t$ and $v = 3t + 10$:

$$a(t) = \frac{v\frac{du}{dx} - u\frac{dv}{dx}}{v^2}$$

$$= \frac{(3t+10)(50) - (50t)(3)}{(3t+10)^2}$$

$$= \frac{150t + 500 - 150t}{(3t+10)^2}$$

$$= \frac{500}{(3t+10)^2}$$

We need to calculate $a(12)$:

