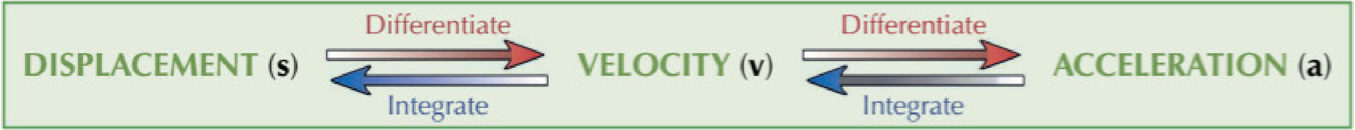
For **Non-Uniform** Acceleration, **Differentiate** or **Integrate** the **Vectors**

When you've got a particle moving in **two dimensions** you can still use the relationships between displacement, velocity and acceleration (see page 190):



This means that you'll have to differentiate and integrate **vectors** written in **i and j notation**. Luckily, doing this is as easy as squeezing lemons — just differentiate/integrate **each component** of the vector **separately**:

So, if $\mathbf{s} = x\mathbf{i} + y\mathbf{j}$ is a displacement vector, then:

Velocity, $\mathbf{v} = \frac{d\mathbf{s}}{dt} = \frac{dx}{dt}\mathbf{i} + \frac{dy}{dt}\mathbf{j}$

Acceleration, $\mathbf{a} = \frac{d\mathbf{v}}{dt} = \frac{d^2\mathbf{s}}{dt^2} = \frac{d^2x}{dt^2}\mathbf{i} + \frac{d^2y}{dt^2}\mathbf{j}$.

The shorthand for $\frac{d\mathbf{s}}{dt}$ is $\dot{\mathbf{s}}$ (the single dot means differentiate **s** once with respect to time)...

...and the shorthand for $\frac{d^2\mathbf{s}}{dt^2}$ is $\ddot{\mathbf{s}}$ (the double dots mean differentiate **s** twice with respect to time).

It's a similar thing for **integration**:

If $\mathbf{v} = w\mathbf{i} + z\mathbf{j}$ is a velocity vector, then displacement vector, $\mathbf{s} = \int \mathbf{v}\, dt = \int (w\mathbf{i} + z\mathbf{j})\, dt = \left[\int w\, dt\right]\mathbf{i} + \left[\int z\, dt\right]\mathbf{j}$