6. Kinematics: Rectilinear Motion

A **particle** is a body which can be modelled as a point mass in a given context. For example, for the motion of the planets about the Sun, then the Sun, Earth, etc., can be regarded as particles.

Kinematics is the study of the motions of particles and rigid bodies without any consideration of the forces required to produce these motions. Rectilinear motion is concerned with the motion of a single particle along a straight line.

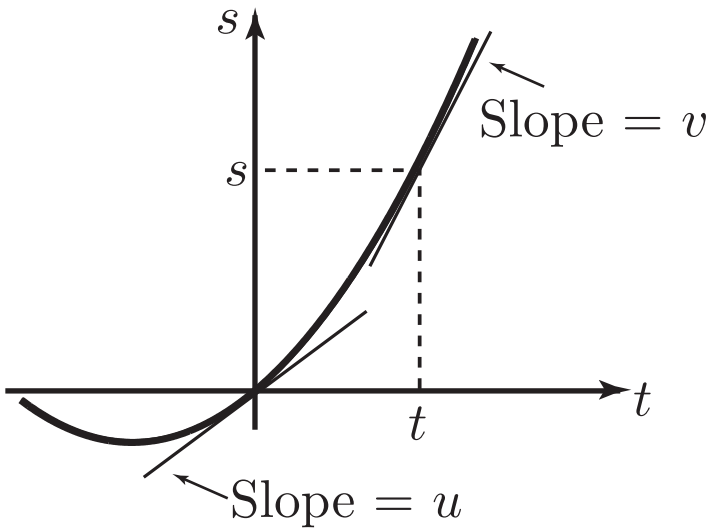
Constant acceleration:

The equations of motion are

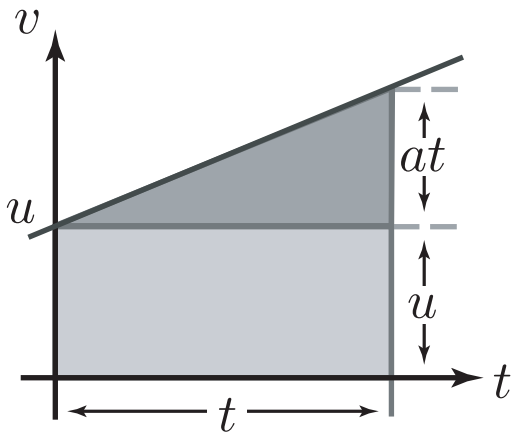
$$\begin{aligned} v &= u + at \\ s &= \frac{1}{2}(u+v)t \quad \text{or} \quad s = ut + \frac{1}{2}at^2 \\ v^2 &= u^2 + 2as \end{aligned}$$

where a is the (constant) acceleration, t represents time, v is the velocity at time t, u is the velocity at $t = 0$, s is the displacement at time t, and $s = 0$ at $t = 0$. These equations are obtained from $\dfrac{dv}{dt} = a$ and $\dfrac{ds}{dt} = v$.

The curve shown here is the **displacement-time graph** for motion with constant acceleration. The slope of the tangent at time t equals the velocity at time t.



The diagram here shows a **velocity-time graph** for rectilinear motion with constant acceleration. The area under a velocity-time graph equals the displacement. The gradient of the line represents the acceleration.



Non-constant acceleration:

Here the acceleration, a, is a function of time, t. As for constant acceleration, the equations of motion are found by integrating $\dfrac{dv}{dt} = a(t)$ and $\dfrac{ds}{dt} = v$.