## Deriving the Kinematic Equations



The slope is *defined* to be velocity.

$$\frac{∆x}{∆t}=\overbar{v}$$

Equation of the line





The slope is *defined* to be acceleration.

$\frac{∆v}{∆t}=\overbar{a}$

EQUATION 1

Equation of the line

EQUATION 2





Area of region **A**:

1/2 *height x base* area of a triangle





substitute in equation 1: $∆v=a∆t$

 =

Area of region **B**

*length x width* area of a rectangle

The velocity at the horizontal axis is zero;

= 

The total displacement is equal to A + B.



Rearranging:





EQUATION 3

Combining equations 2 and 3 produces a time-independent kinematics expression.

Rearrange equation 3:





Substitute equation 2 into equation 3:



Multiply both sides by 



Multiply out the terms on the right.



Simplify the right side of equation



Rearrange:

EQUATION 4



Summary of mathematical models:

  Eq. 1 definition of average acceleration

 Eq. 2 linear equation for a **v**-t graph

 Eq. 3 parabolic equation for an **x**-t graph

  Eq. 4 algebraic combination of equations 2 and 3