Kinematics Formulas

When dealing with objects moving at a **constant velocity**, we can determine

Displacement: $d = \bar{v}t$

Velocity: $\bar{v} = \frac{d}{t}$

Time: $t = \frac{d}{\bar{v}}$

Consider an object that starts out moving a certain velocity, then accelerates to go faster.

We need to differentiate 3 different velocity measures.

v_0 = initial, starting velocity

v_f = final velocity

v_{avg} = $\bar{v}$ is average velocity

When dealing with objects moving with a **constant acceleration,** we can use the following formulas.

$d = v_0 t + \frac{1}{2} a t^2$	$(v_f)^2 = (v_0)^2 + 2ad$
$v_f = v_0 + at$	$\bar{v} = \frac{v_f + v_0}{2}$

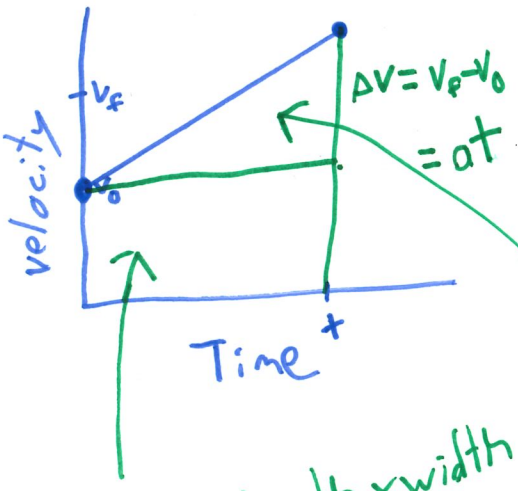
$v_f = v_0 + at$ derivation

$$a = \frac{\Delta v}{\Delta t} = \frac{v_f - v_0}{t} \rightarrow a = \frac{v_f - v_0}{t}$$

$$at = v_f - v_0$$

$$\boxed{v_0 + at = v_f}$$

$d = v_0 t + \frac{1}{2}at^2$ derivation



accelerates from v_0 to v_f in t

Area = length x width
$= t \times v_0$

Area = $\frac{\text{base} \times \text{height}}{2}$

$= \frac{t \times at}{2}$

$= \frac{1}{2}at^2$

Total area = $\boxed{v_0 t + \frac{1}{2}at^2}$

EXAMPLE:

1. A marble is accelerating down a ramp at a rate of $3.5\ m/s^2$. If it started with an initial velocity of $0.50\ m/s$. How far does it travel in 5.0 seconds?

$d = v_0 t + \frac{1}{2} a t^2$

$= \left(0.5 \frac{m}{s}\right)(5\ s) + \frac{1}{2}\left(3.5 \frac{m}{s^2}\right)(5\ s)^2$

$= 46.25\ m$

$= 46\ m$

$a = 3.5\ m/s^2$

$v_0 = 0.50\ m/s$

$t = 5.0\ sec$

$d = ?$

2. How long will it take a stone to fall from a 20.0 metre building to the ground if it accelerates at a constant rate of $9.8\ m/s^2$?