The BIG Five

possible vectors

The 5 Variables/Equations of Accelerated Motion

v_i / v_1 – the initial/1st speed/velocity (before the acceleration) – m/s

v_f / v_2 – the final/2nd speed/velocity (after the acceleration) – m/s

a – acceleration – the rate at which the object's speed/velocity changes – m/s^2

Δd – the object's displacement during the period of acceleration – m

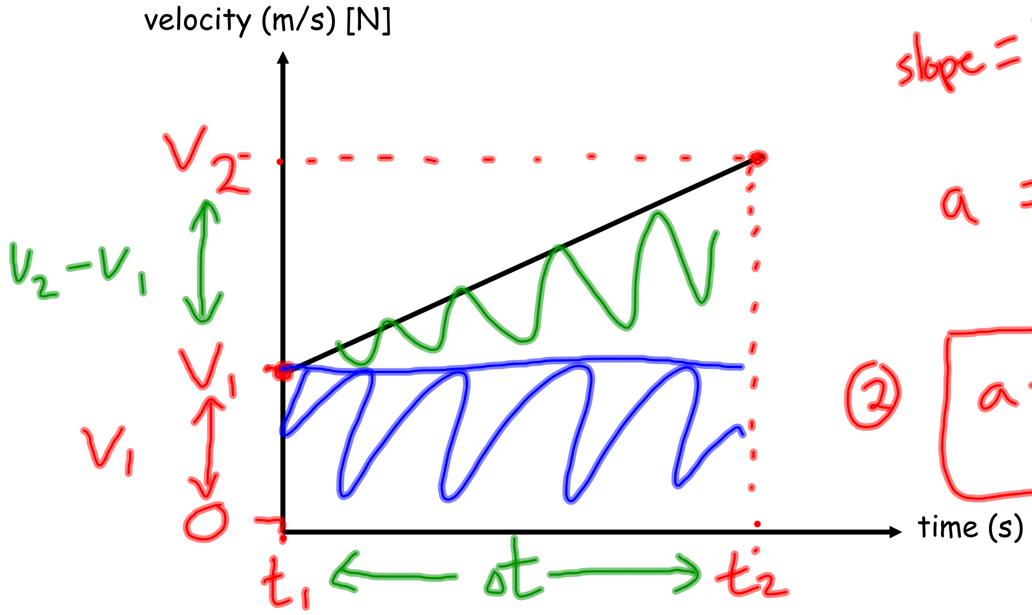
Δt – the amount of time during the period of acceleration – s

NOTES: The vector notation has been dropped here, but all variables except for time can be either vectors or scalars.

In order to use any equation we need 4 out of 5 variables.

Equation	Variables				
	v_i	v_f	a	Δd	Δt
1. $\Delta d = \left(\frac{v_i + v_f}{2}\right) \cdot \Delta t$			X		
2. $a = \frac{v_f - v_i}{\Delta t}$				X	
3. $\Delta d = v_i \cdot \Delta t + \frac{1}{2} a \cdot \Delta t^2$		X			
4. $\Delta d = v_f \cdot \Delta t - \frac{1}{2} a \cdot \Delta t^2$	X				
5. $v_f^2 = v_i^2 + 2a \cdot \Delta d$					X

Let's take a look at where some of these equations come from. Using our graphical analysis skills we can show where equations 1 and 2 come from. Consider the velocity-time graph below.



$$\text{slope} = \frac{\text{rise}}{\text{run}}$$

$$a = \frac{V_2 - V_1}{t_2 - t_1}, \quad t_2 - t_1 = \Delta t$$

② $$a = \frac{V_2 - V_1}{\Delta t}$$

① $$\Delta d = \text{Area}$$

$$\Delta d = \square + \triangle$$

$$\Delta d = V_1 \Delta t + \frac{1}{2}\Delta t (V_2 - V_1)$$

$$\Delta d = V_1 \Delta t + \frac{1}{2} V_2 \Delta t - \frac{1}{2} V_1 \Delta t$$

$$\Delta d = \frac{1}{2} V_1 \Delta t + \frac{1}{2} V_2 \Delta t$$

$$\Delta d = \left(\frac{1}{2} V_1 + \frac{1}{2} V_2\right) \Delta t$$

$$\Delta d = \left(\frac{V_1 + V_2}{2}\right) \Delta t$$

THE PERFECT SOLUTION:

1. Pick a positive direction
2. Write out all variables with signs and units
3. Covert units to m, s or kg
4. Pick the appropriate equation – box it
5. Rearrange for the variable you need N/A
6. Sub in numbers in brackets
7. Type into calculator in one step
8. Answer with units and direction – circle it

Sample Problem:

A child is running away from his mother at a constant speed of 3 m/s [R] when his elastic leash "kicks in" and brings him to a stop in 4.5 s.

a) At what rate does the leash accelerate the boy?

[R] = +

$v_1 = +3.0\ \frac{m}{s}$

$v_2 = 0$

$a = ?$

~~$\Delta d =$~~

$\Delta t = 4.5\ s$

$$a = \frac{v_2 - v_1}{\Delta t}$$

$$a = \frac{(0) - (+3)}{4.5}$$

$$= -0.67\ \frac{m}{s^2}$$

$\therefore \vec{a} = 0.67\ \frac{m}{s^2}$ [L]

b) What is the boy's displacement during this acceleration?

avoid using rounded #s if possible

$(a = -0.67\ \frac{m}{s^2})$

$\Delta d = ?$

$$\Delta d = \left(\frac{v_1 + v_2}{2}\right)\Delta t$$

$$= \left(\frac{(+3) + (0)}{2}\right)(4.5)$$

$$= +6.75\ m$$

$\therefore \vec{\Delta d} = 6.75\ m$ [R]

c) How long will it take before the boy is moving at a velocity of 2 m/s [L]?

[R] = +

$v_1 = +3.0\ m/s$

$v_2 = -2.0\ m/s$

$a = -0.67\ m/s^2$

~~$\Delta d =$~~

$\Delta t = ?$

$a = \frac{v_2 - v_1}{\Delta t}$

$\Delta t = \frac{v_2 - v_1}{a}$

$= \frac{(-2)-(+3)}{-0.67}$

$= +7.5\ s$

$\therefore \Delta t = 7.5\ s$

d) How far away is the boy from his starting position at the moment outlined in question c)?

$\Delta d = ?$

$\Delta d = \left(\frac{v_1 + v_2}{2}\right)\Delta t$

$\Delta d = \left(\frac{(+3)+(-2)}{2}\right)\cdot(7.5)$

$= +3.75\ m$

$\therefore \Delta \vec{d} = 3.75\ m\ [R]$