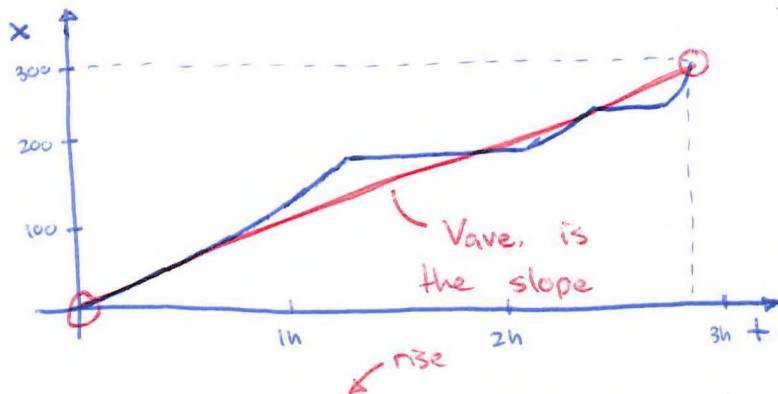


Kinematics

Study of motion without reference to the forces!!

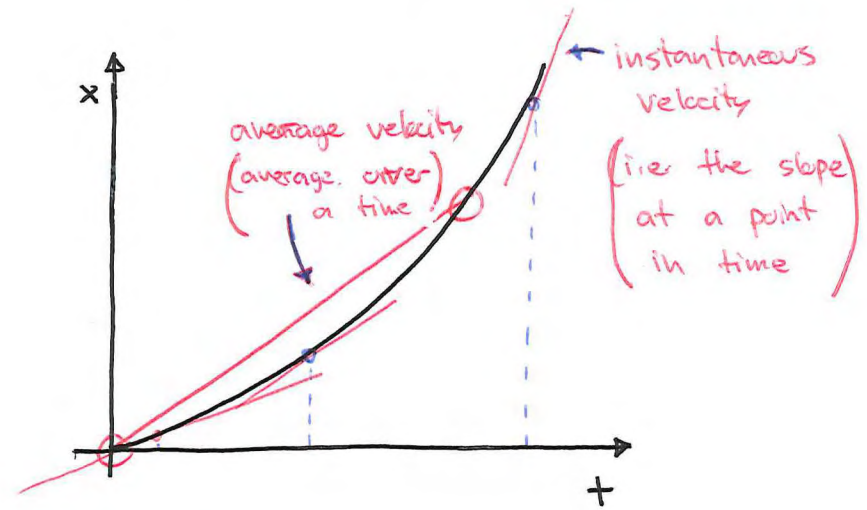
Example:

Toronto is 300 km from Kingston and you can drive there in 2 hours and 45 mins. How fast did you drive? was that your speed the whole way?



$$V_{ave} = \frac{300 \text{ km}}{165 \text{ min}} \left(\frac{1000 \text{ m}}{1 \text{ km}} \right) \left(\frac{1 \text{ min}}{60 \text{ sec}} \right)$$

$$= 30 \text{ m/s} \quad (109 \text{ km/h})$$



$$\vec{V}_{ave} = \frac{\Delta \vec{x}}{\Delta t}$$

displacement

time difference

where as

$$\vec{V} = \lim_{\Delta t \rightarrow 0} \frac{\Delta \vec{x}}{\Delta t}$$

$$\vec{a}_{ave} = \frac{\Delta \vec{V}}{\Delta t}$$

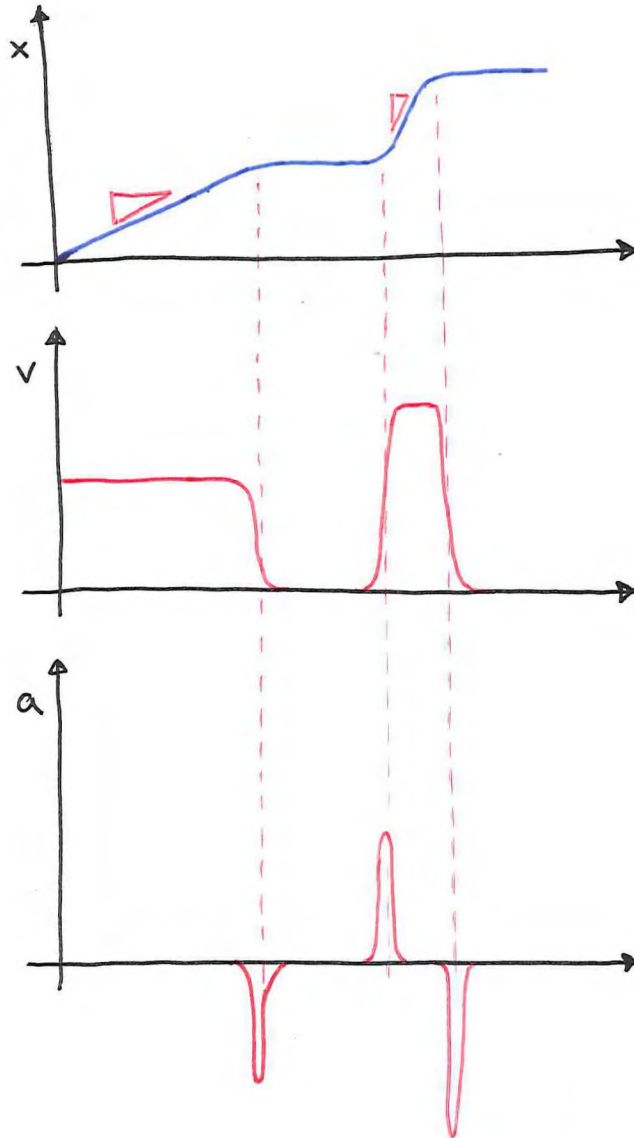
where as

$$\vec{a} = \lim_{\Delta t \rightarrow 0} \frac{\Delta \vec{V}}{\Delta t}$$

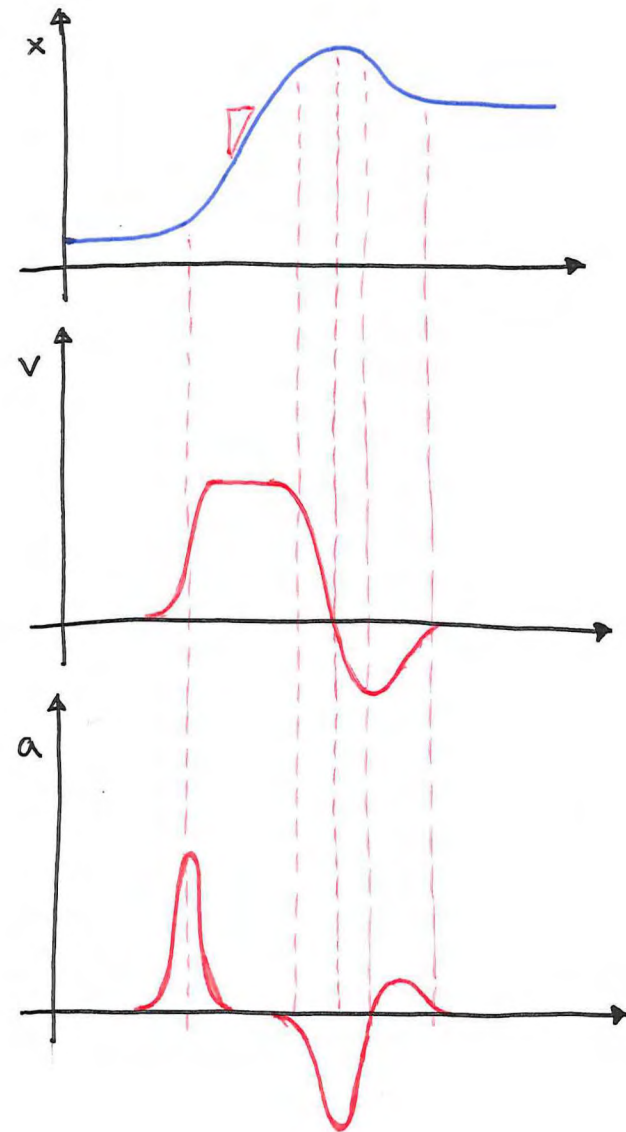
Kinematics

Example: draw the velocity-time & acceleration-time graphs given a displacement-time graph.

1)



2)



Kinematics

If we "assume" that $\vec{a} = \text{constant}$ then:

$$V = V_0 + at$$

$$x = x_0 + V_0 t + \frac{1}{2} at^2$$

$$V^2 = V_0^2 + 2a\Delta x$$

The kinematics equations

We also assume that on the earth's surface the acceleration due to gravity is constant at:

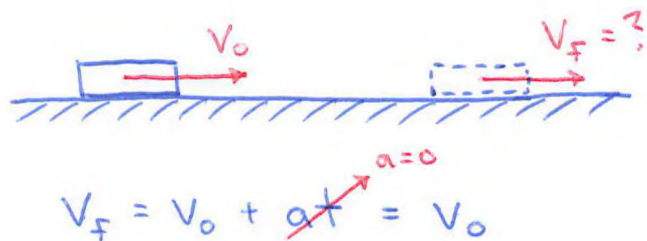
$$g = 9.81 \text{ m/s}^2 \text{ towards the earth's centre}$$

We use kinematics when we don't deal with forces. They are mostly used when dealing with projectile motion and other gravity bound problems only if the acceleration due to gravity is constant.

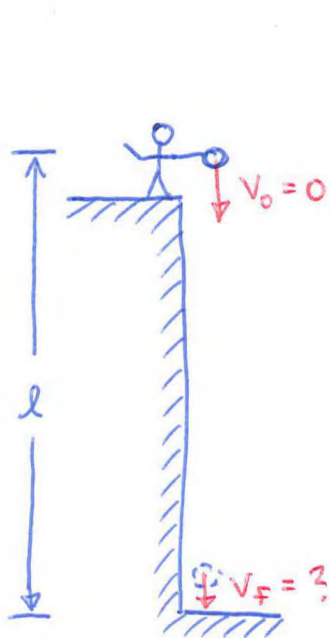
These are the only equations needed for kinematics. Note: they are solved in a single dimension and only combined after for the result, just like with vectors.

Kinematics

Example: Slide a puck across the ice



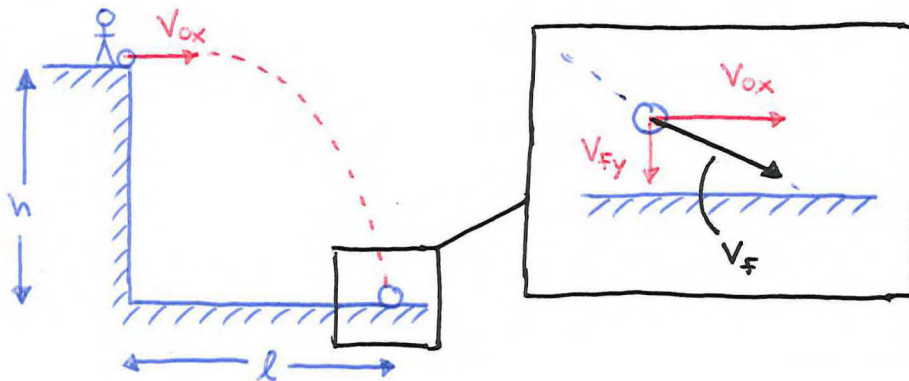
Example: Drop a ball from a cliff.



$$V_F^2 = \cancel{V_0^2} + 2ad \quad V_0 = 0$$

$$V_F = \sqrt{(2)(-9.81)(-l)}$$

Example: Kick a ball from a cliff.



$$y_F = y_i + \cancel{V_{oy}t} + \frac{1}{2}at^2 \quad V_{oy} = 0 \quad (y\text{-dir.})$$

$$t = \sqrt{\frac{2(y_F - y_i)}{-g}} \quad (1)$$

$$x = \cancel{x_0} + V_{ox}t \quad x_0 = 0 \quad (x\text{-dir.}) \quad (2)$$

sub (1) into (2)

$$x = l = V_{ox} \left(\sqrt{\frac{2h}{g}} \right)$$

$$l = V_{ox} \sqrt{\frac{2h}{g}}$$