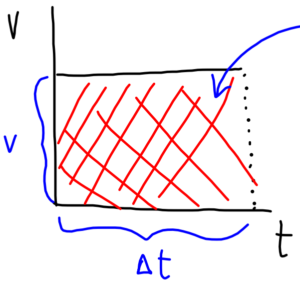
Acceleration + Displacement

Consider an object moving with a constant velocity:



area of the rectangle $= l \times w$

area $= v\Delta t$

$\therefore$ area = Δd v-t graph

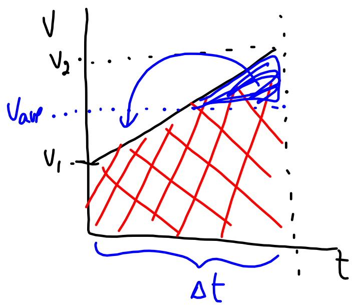
Think:

$v = \frac{\Delta d}{\Delta t}$

$\Delta d = v\Delta t$

The area under a v-t graph represents the displacement of the object during a given time interval

Now consider an object with constant acceleration:



area of trapezoid $= \frac{1}{2}(h_1 + h_2)\, b$

$$\Delta d = \frac{1}{2}(v_1 + v_2)\,\Delta t$$

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

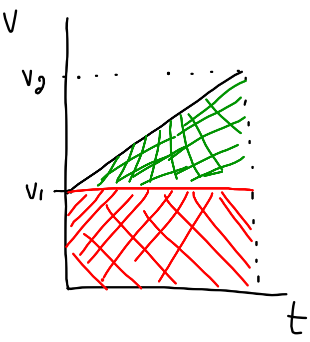
$$\Delta d = V_{ave}\,\Delta t$$

Think

$V_{ave} = \frac{\Delta d}{\Delta t}$

$\Delta d = V_{ave}\,\Delta t$

Another way to think of the trapezoid is as a rectangle and a triangle.



$$\Delta d = v_1\Delta t + \frac{1}{2}a(\Delta t)^2$$

$$\Delta d = v_2\Delta t - \frac{1}{2}a(\Delta t)^2$$

$$v_2^2 = v_1^2 + 2a\Delta d$$

Kinematics Equations

Constant Velocity → $v = \frac{\Delta d}{\Delta t}$

Constant Acceleration → $a = \frac{\Delta v}{\Delta t}$ where $\Delta v = v_2 - v_1$

$v_{ave} = \frac{\Delta d}{\Delta t}$ where $v_{ave} = \frac{v_1 + v_2}{2}$

Maybe useful:

1. $\Delta d = v_1 \Delta t + \frac{1}{2} a (\Delta t)^2$
2. $\Delta d = v_2 \Delta t - \frac{1}{2} a (\Delta t)^2$
3. $v_2^2 = v_1^2 + 2a\Delta d$

With any acceleration problem, there are 5 kinematic variables: v_1, v_2, a, Δt, Δd

If you know any 3 of these, you can find the other 2.

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$\vec{v}_1 = 8.3\,m/s$ [down] ⊖

$\Delta t = 6.9\,s$

$\Delta\vec{d} = ?$

$\vec{a} = 9.81\,m/s^2$ [down] ⊖

(acceleration of gravity)

$\Delta d = v_1 \Delta t + \frac{1}{2} a (\Delta t)^2$

$\Delta d = (-8.3\,m/s)(6.9\,s) + \frac{1}{2}\left(-9.81\,m/s^2\right)(6.9\,s)^2$

$\Delta d = -57.27\,m - 233.53\,m$

$\Delta d = -290.80\,m$

$\Delta\vec{d} = 2.9 \times 10^2\,m$ [down]

Therefore the height of the cliff is $2.9 \times 10^2\,m$.