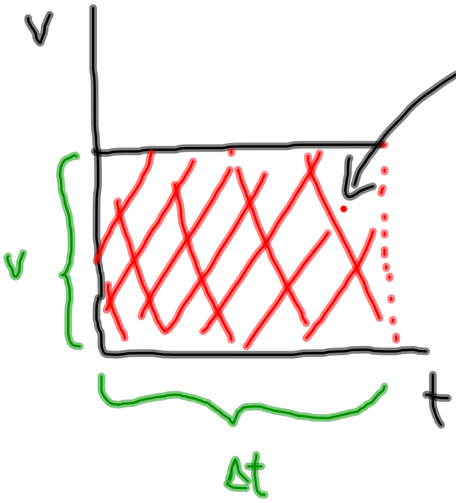
Acceleration + Displacement

Consider an object with constant velocity:



area of rectangle = b × h

area = $v\Delta t$

area = Δd

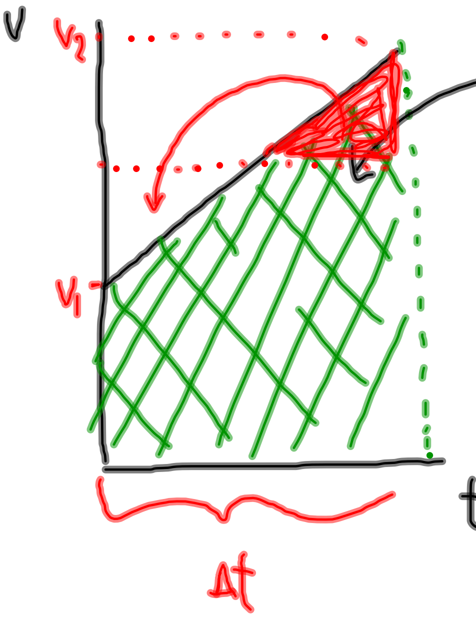
RECALL:

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

$\Delta d = v\Delta t$

The area under a v-t graph gives us the displacement.

Consider an object with constant acceleration:



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

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

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

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

RECALL: $\Delta d = v\,\Delta t$ — essentially the same.

If there is acceleration, there are 5 kinematics variables ⇒ $v_1, v_2, \Delta t, \Delta d, a$

If know any 3 of these, you can find the other two!

All you need is two BASIC EQUATIONS

$$v_{ave} = \frac{\Delta d}{\Delta t} \quad \text{and} \quad a = \frac{\Delta v}{\Delta t}$$

$$\left(v_{ave} = \frac{v_1 + v_2}{2}\right) \qquad (\Delta v = v_2 - v_1)$$

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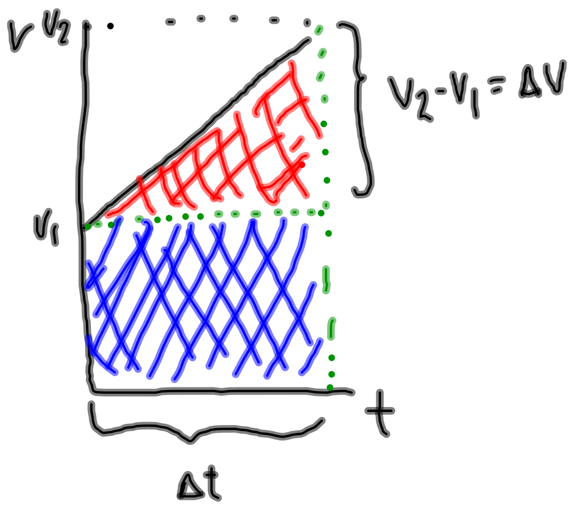
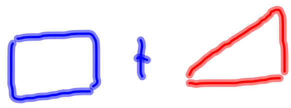


Area of trapezoid = 

$= b \times h + \frac{1}{2} b \times h$

$= v_1 \Delta t + \frac{1}{2}(\Delta v)(\Delta t)$

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

Recall:
$a = \frac{\Delta v}{\Delta t}$
$\Delta v = a \Delta t$

"maybe" useful equations.

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

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

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

RECAP

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

Constant Acceleration: $v_{ave} = \frac{\Delta d}{\Delta t}$ and $a = \frac{\Delta v}{\Delta t}$

$\left(v_{ave} = \frac{v_1 + v_2}{2}\right)$ $\left(\Delta v = v_2 - v_1\right)$

maybe useful

$$\Delta d = v_1 t + \frac{1}{2}at^2$$

$$\Delta d = v_2 t - \frac{1}{2}at^2$$

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

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MP|84

$\vec{v}_1 = 8.3 m/s$ [down] (−)

$\Delta t = 6.9 s$

$\Delta \vec{d} = ??$

$\vec{a} = 9.81 m/s^2$ [down] (−)

(implied) acceleration due to gravity

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

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

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

$\Delta d \doteq -290.80 m$

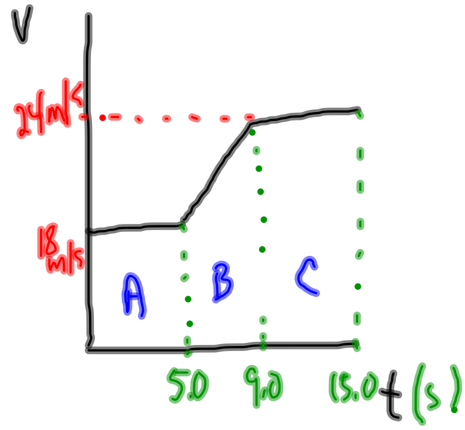
$\Delta d \doteq -2.9 \times 10^2 m$

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

The height of the cliff is $2.9 \times 10^2 m$ (the magnitude of the displacement)

Oct 12-10:49 AM

MP185



Section A - constant velocity

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

$\Delta d = v \Delta t$

$\Delta d = (18\ m/s)(5.0\ s)$

$\Delta d = 90\ m$

Section B - Constant Acceleration

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

$\Delta d = v_{ave} \Delta t$

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

$\Delta d = \left(\frac{18\ m/s + 24\ m/s}{2}\right)(4.0\ s)$

$\Delta d = (21\ m/s)(4.0\ s)$

$\Delta d = 84\ m$

Section C - Constant velocity

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

$\Delta d = v \Delta t$

$\Delta d = (24\ m/s)(6.0\ s)$

$\Delta d = 144\ m$

TOTAL DISPLACEMENT:

$90\ m + 84\ m + 144\ m = 318\ m$

$\vec{\Delta d} = 3.2 \times 10^2\ m\ [E]$