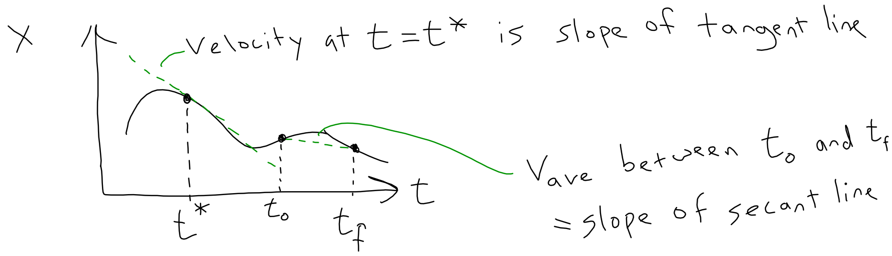
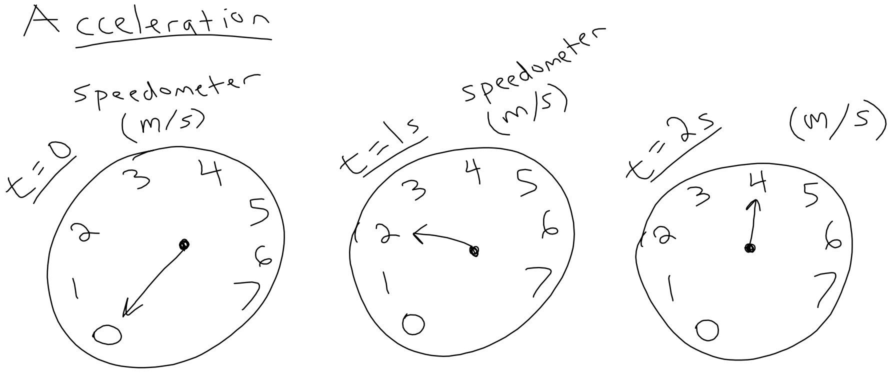
$$V_{ave} = \frac{x_f - x_i}{t_f - t_i} \qquad V = \frac{dx}{dt}$$



Acceleration



v = $0\frac{m}{s}$ $2\frac{m}{s}$ $4\frac{m}{s}$ $6\frac{m}{s}$

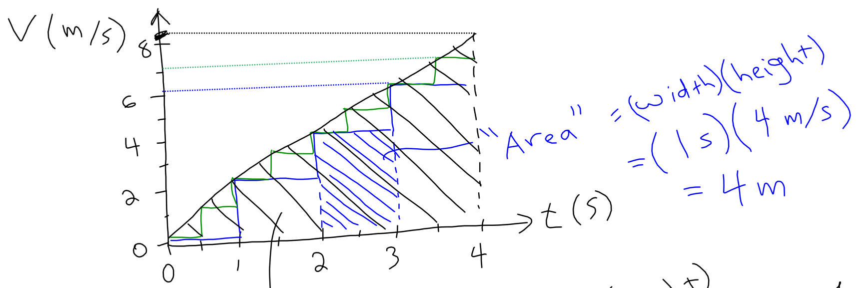
t (s): 0 1 2 3 4

x = 0 m 2 m 4 m 6 m → total x = 12 m

v = $0\frac{m}{s}$ $1\frac{m}{s}$ $2\frac{m}{s}$ $3\frac{m}{s}$ 4 5 6 7 → t (s)

t: 0 1 2 3 4

x = 0 m 0.5 1 1.5 2 2.5 3 3.5 → total x = 14 m



$$\text{Area} = \frac{1}{2}(\text{base})(\text{height})$$
$$\frac{1}{2}(4s)\left(8\frac{m}{s}\right) = \boxed{16\ m}$$

for constant acceleration:

$$x = \text{Area under } v \text{ vs. } t \text{ curve}$$
$$= \frac{1}{2}(t)(at) = \frac{1}{2}at^2$$

for <u>constant</u> acceleration

$$\boxed{\begin{aligned} V_f &= V_i + at \\ X_f &= X_i + V_i t + \tfrac{1}{2} a t^2 \\ X_f &= X_i + \tfrac{1}{2}(V_i + V_f)\, t \\ V_f^2 &= V_i^2 + 2a\,(X_f - X_i) \end{aligned}}$$

$(t \rightarrow \Delta t)$

*

Example

What is v when $t = 2$ s?

$$v_f = v_i + at$$
$$v_f = 0\tfrac{m}{s} + \left(1\tfrac{m}{s^2}\right)(2s)$$
$$= \boxed{2\ \tfrac{m}{s}}$$

What is v when $x = 100$ m?

Known: $a = 1\frac{m}{s^2}$, $v_i = 0$, $x_f = 100$m, $x_i = 0$m

unknown: v_f

don't care: t

$$v_f^2 = v_i^2 + 2a\Delta x$$
$$v_f = \sqrt{0^2 + 2(1)(100)}$$
$$\boxed{v_f = 14.14\ \tfrac{m}{s}}$$

What is t when $x = 100$ m?

Known: $a = 1\frac{m}{s^2}$, $v_i = 0$, $x_f = 100$m, $x_i = 0$m

unknown: t

don't care: v_f

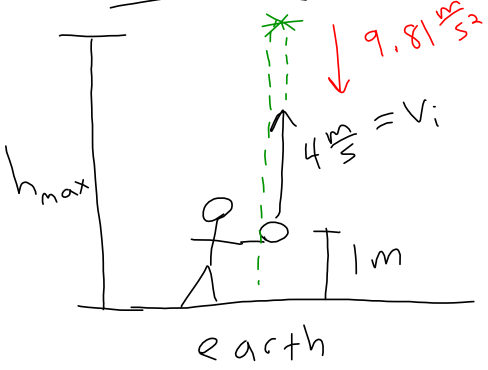
$$x_f = x_i + v_i t + \tfrac{1}{2}at^2$$
$$100 = 0 + 0t + \tfrac{1}{2}(1)t^2$$
$$\sqrt{200} = t$$
$$\boxed{t = 14.14\ s}$$

Free fall

Near the surface of the earth, objects in free fall accelerate downwards with constant acceleration $a_g = 9.81\ m/s^2$.

* tip: be careful w/ sign convention.

Example



known	unknown	don't care
$y_i = 1\ m$	y_f	t
$V_i = 4\ \frac{m}{s}$		
$a = -9.81\ \frac{m}{s^2}$		
$V_f = 0$		

$$V_f^2 = V_i^2 + 2a(y_f - y_i)$$

$$0^2 = 4^2 + 2(-9.81)(y_f - 1)$$

$$\boxed{y_f = 1.81\ m}$$