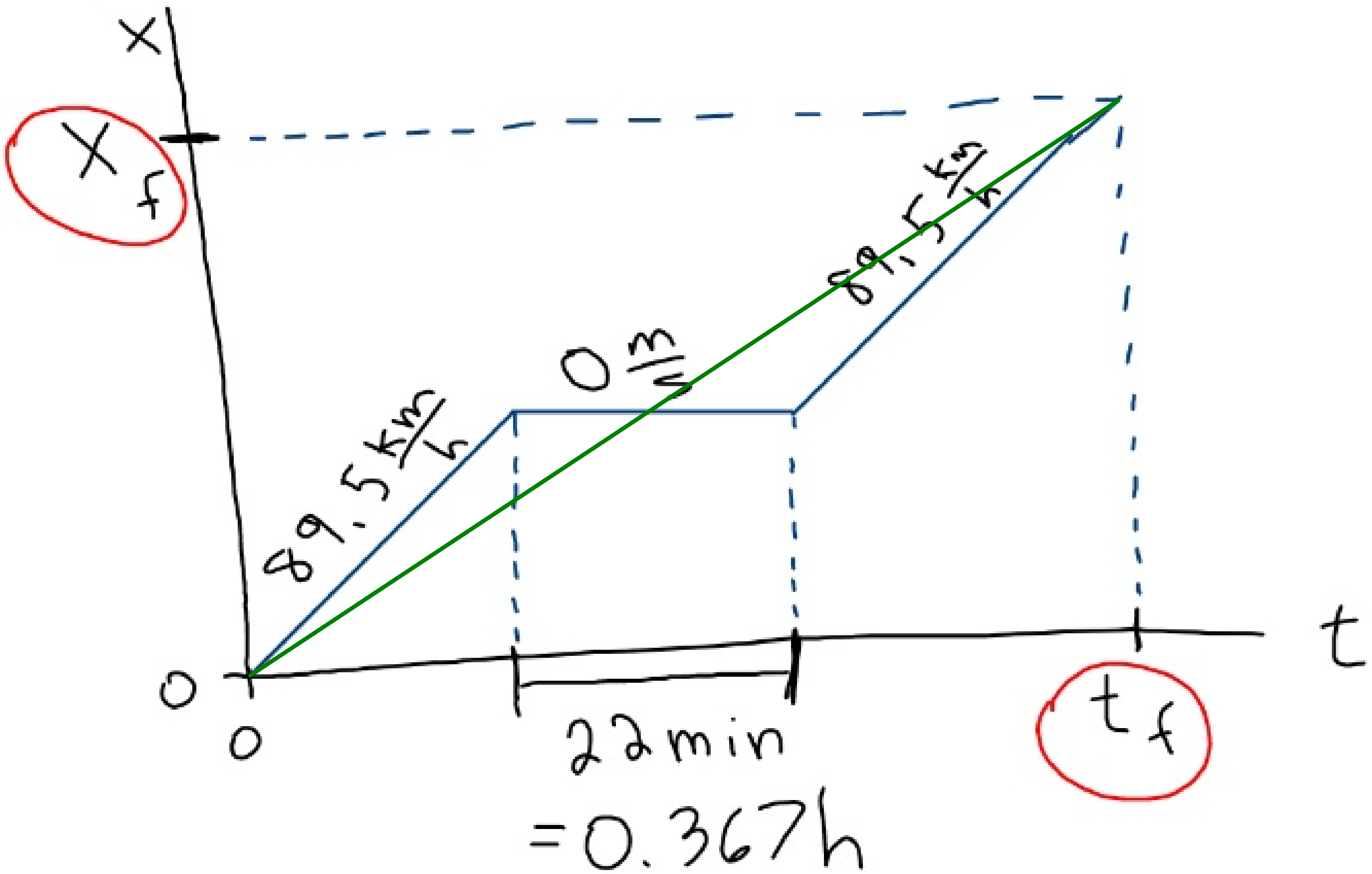
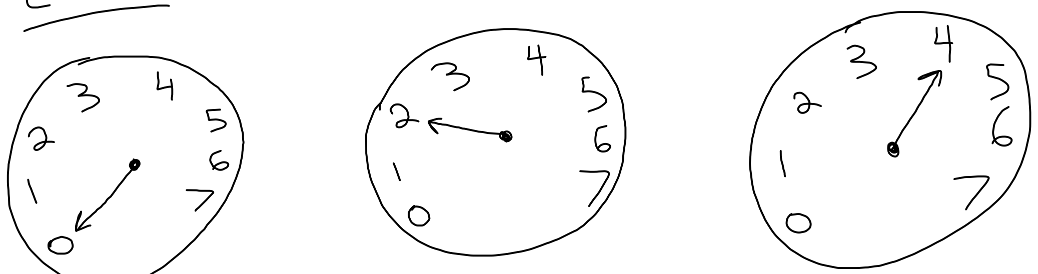


$$\frac{x_f}{t_f} = 77.8\ \frac{km}{h}$$

$$\frac{x_f}{t_f - 0.367h} = 89.5\ \frac{km}{h}$$

Acceleration

$t=0$ $\qquad$ $t=1\,s$ $\qquad$ $t=2\,s$



speedometer (m/s) $\qquad$ (m/s) $\qquad$ (m/s)

acceleration = rate of change of velocity

$$= \frac{\Delta V}{\Delta t} = \frac{V_f - V_i}{t_f - t}$$

In the above example:

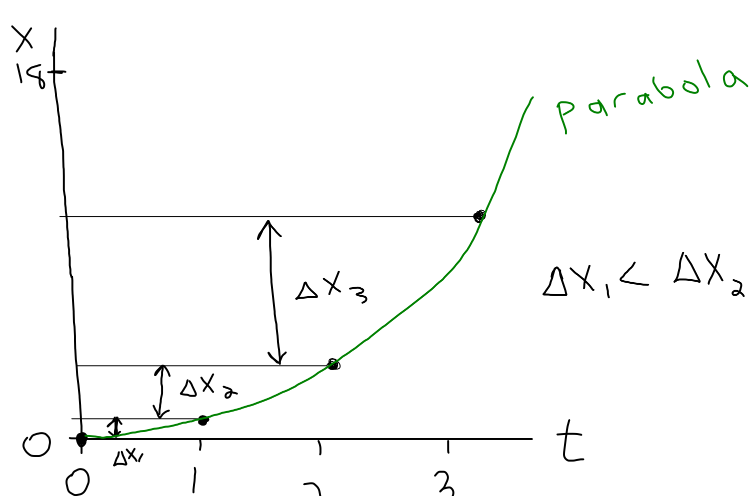
$$a = \frac{4\frac{m}{s} - 0\frac{m}{s}}{2s - 0s} = 2\,\frac{(m/s)}{s}$$

$$= 2\,\frac{m}{s^2}$$

- what's the velocity at $t=3s$?

$\Longrightarrow$ $6\,\frac{m}{s}$ (assuming constant acceleration)

- How much distance is traveled in 3 s?



$\Delta x_1 < \Delta x_2 < \Delta x_3$

Often, acceleration is constant

(doesn't change with time, ie. $a_i = a_f = a$).

In that case:

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

* if a is constant

* technically t should be Δt

- Answer to previous question:

$a = 2 \frac{m}{s^2}$, $V_i = 0$, $X_i = 0$, $t = 3s$

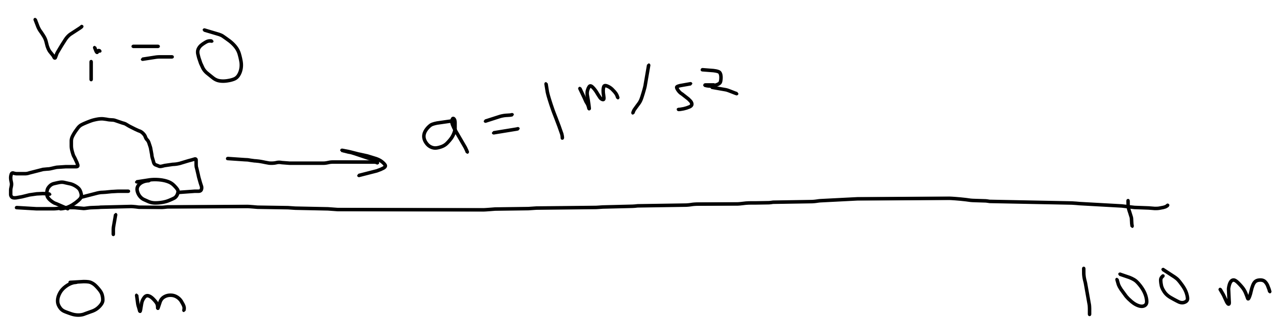
$X_f = ?$

$$\Rightarrow X_f = X_i + V_i t + \tfrac{1}{2} a t^2$$

$$= 0 + 0(3) + \tfrac{1}{2}(2)(3)^2$$

$$= \boxed{9\,m}$$

Example



(1) • what is V after 2 s?

$\boxed{2\ m/s}$

$$V_f = \underset{0}{V_i} + \underset{1}{a}\,\underset{2}{t} = 2\,\frac{m}{s}$$

(1b) How much dist. after 2 s?

$x_f = \ldots + \frac{1}{2}at^2 = \boxed{2m}$

(2) • How much time to reach 100 m?

$$x_f = x_i + V_i t + \frac{1}{2}at^2$$

$$100\,m = 0\,m + \left(0\,\frac{m}{s}\right)t + \frac{1}{2}\left(1\,\frac{m}{s^2}\right)t^2$$

$$100\,\cancel{m} = \frac{1}{2}\,\frac{\cancel{m}}{s^2}\,t^2$$

$$\sqrt{200\,s^2} = \sqrt{t^2}$$

$$\boxed{t = 14.14\,s}$$

Free fall

Near the surface of the earth, freely falling objects accelerate towards the center of the earth with constant acceleration (due to gravity).

$$\boxed{a_g = 9.8 \frac{m}{s^2}} \; *$$

* Tip: be careful with sign conventions

Example: find max height.

earth

$y_i = 0$

$y_f = ?$

$v_i = 4 \frac{m}{s}$

$a = -9.8 \frac{m}{s^2}$

$v_f = 0$

$$v_f^2 = v_i^2 + 2a(y_f - y_i)$$

$$0 = \left(4 \frac{m}{s}\right)^2 + 2\left(-9.8 \frac{m}{s^2}\right) y_f$$

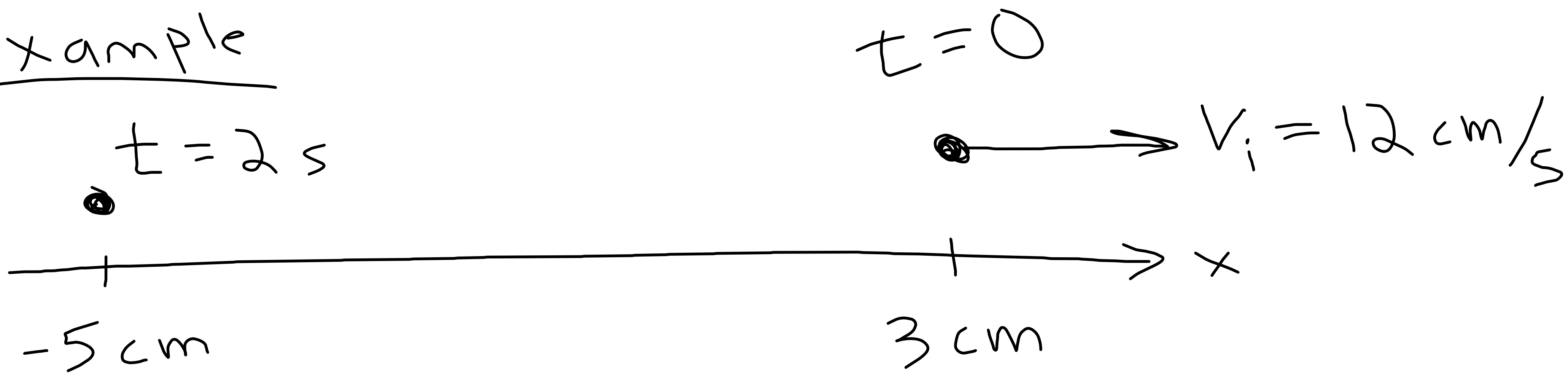
$$0 = 16 \frac{m^2}{s^2} - \left(19.6 \frac{m}{s^2}\right) y_f$$

$$\left(19.6 \frac{\cancel{m}}{\cancel{s^2}}\right) y_f = 16 \frac{m^{\cancel{2}}}{\cancel{s^2}}$$

$$19.6\, y_f = 16\, m$$

$$y_f = \frac{16\, m}{19.6} = \boxed{0.816\ m}$$

Example



find the acceleration, and V_f.

$x_i = 3\,cm$

$x_f = -5\,cm$

$t = 2\,s$

$V_i = 12\,cm/s$

accel.

$$x_f = x_i + V_i t + \frac{1}{2} a t^2$$

$$-5\,cm = 3\,cm + \left(12\,\frac{cm}{s}\right)(2\,s) + \frac{1}{2} a (2\,s)^2$$

$$-32\,cm = (2\,s^2)\,a$$

$$\boxed{a = -16\,\frac{cm}{s^2}}$$

final vel.

$$V_f = V_i + at = 12 + (-16)(2) = \boxed{-20\,\frac{cm}{s}}$$