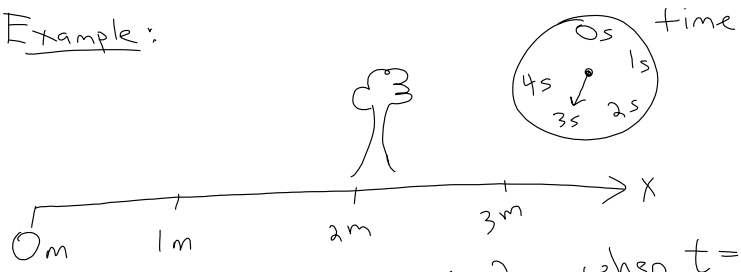
Chapter 2 – 1-D Motion (straight line motion)

Definitions –

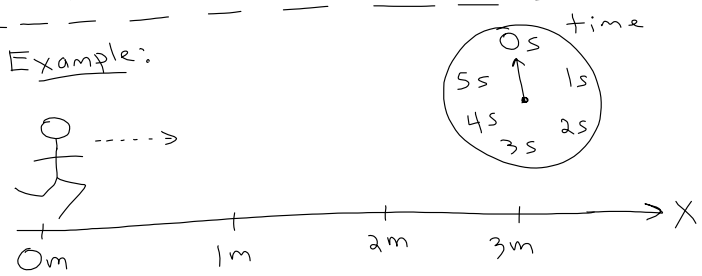
- An object's position (X) is its location on some chosen coordinate system.
- time is also measured w.r.t. some reference time t_0 (usually $t_0 = 0$).

Example:

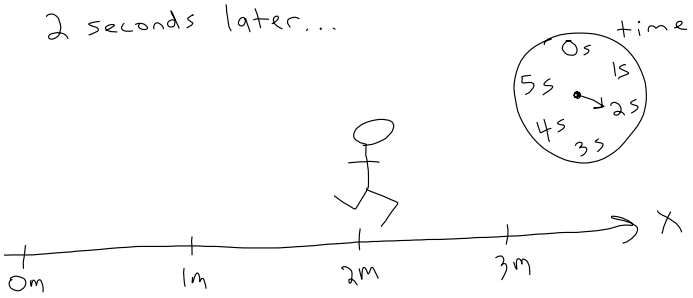


the tree's position is $X = 2m$ when $t = 3s$.

Example:



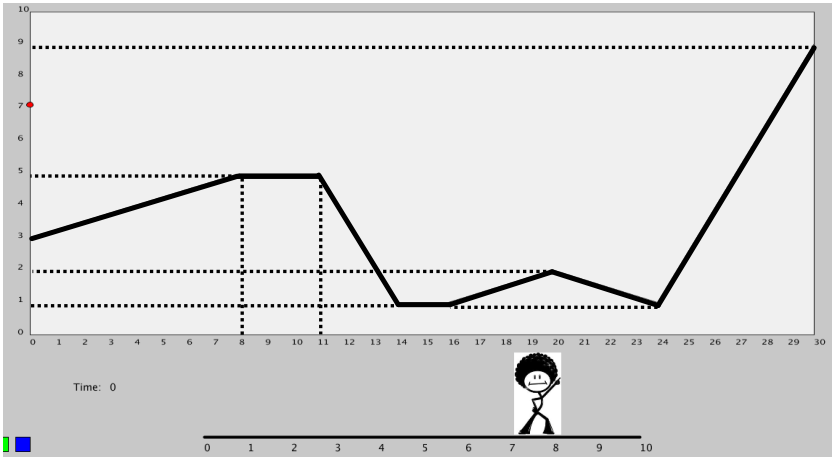
2 seconds later...



- Velocity tells you how much distance is covered in one unit of time (units: m/s)
  - average velocity: $V_{ave} = \frac{\Delta X}{\Delta t} = \frac{X_f - X_i}{t_f - t_i}$
  - instantaneous velocity: $V = \lim_{\Delta t \to 0} \frac{\Delta X}{\Delta t} = \frac{dX}{dt}$

in the above example –

$$V_{ave} = \frac{X_f - X_i}{t_f - t_i} = \frac{2m - 0m}{2s - 0s} = 1\ m/s$$



https://github.com/naharrison/motion-tracker/releases

calculate V_{ave} between:

a) 0 s – 8 s

b) 11 s – 14 s

c) 24 s – 30 s

d) 0 s – 30 s

a) $\frac{5-3\ m}{8-0\ s} = \frac{2\ m}{8\ s} = 0.25\ m/s$

b) $\frac{1-5m}{14-11s} = \frac{-4}{3}\frac{m}{s} = -1.33\ m/s$

c) $\frac{9-1\ m}{30-24\ s} = \frac{8\ m}{6\ s} = 1.33\ m/s$

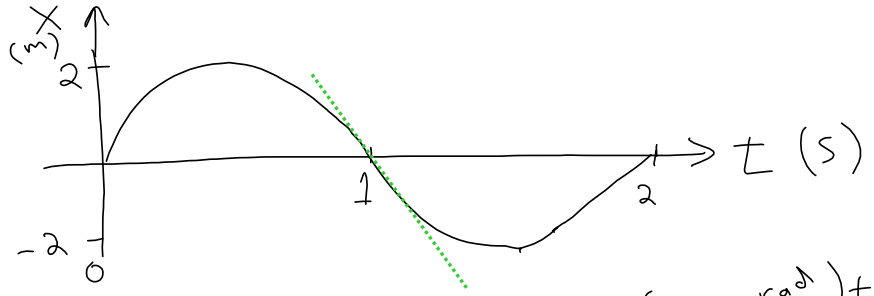
d) $\frac{9-3\ m}{30-0\ s} = \frac{6\ m}{30\ s} = 0.2\ m/s$

* observation – Velocity = slope of x vs. t fcn.

Another Example

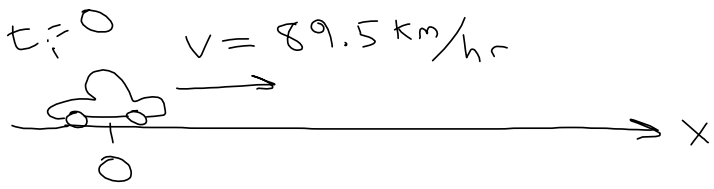
$$x(t) = (2\,m)\sin\left(\left(\pi\,\frac{rad}{s}\right)t\right)$$

what is v at t = 1s?



$$v = \frac{dx}{dt} = (2\,m)\left(\pi\,\frac{rad}{s}\right)\cos\left(\left(\pi\,\frac{rad}{s}\right)t\right)$$

$$v(t=1s) = (2\,m)\left(\frac{\pi}{s}\right)\cos\left(\pi\,rad\right) = \boxed{-6.28\,\frac{m}{s}}$$

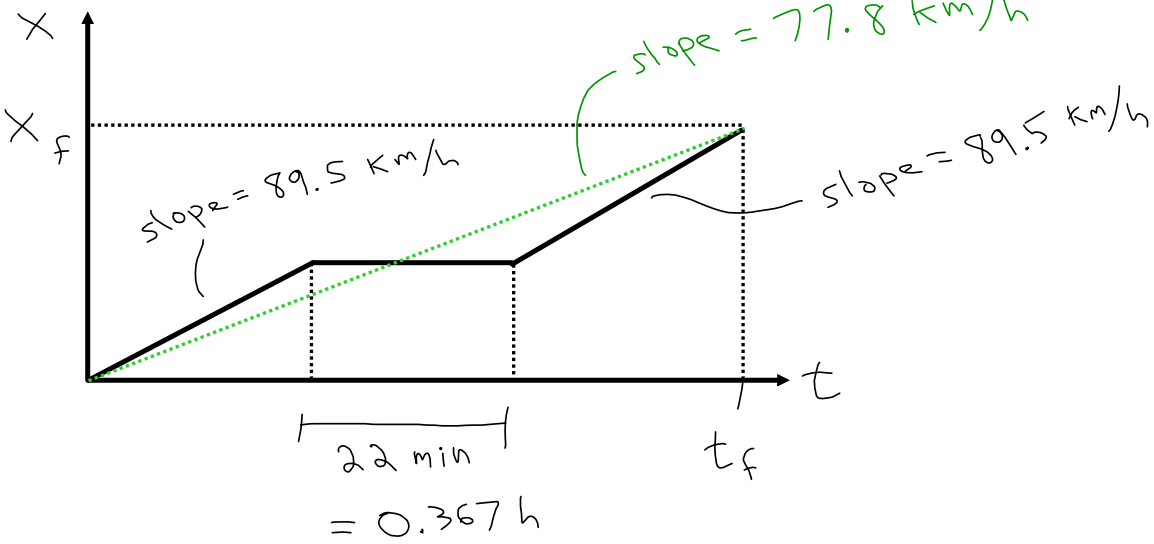


always traveling at 89.5 km/hr

except for a 22 minute rest stop ($v=0$) in the middle of the trip.

Given: $v_{ave} = 77.8$ km/hr

What are t_f and x_f?



$$\frac{x_f}{t_f} = 77.8 \qquad \frac{x_f}{t_f - 0.367} = 89.5$$

```
1  xf, tf = var("xf tf")
2  solve([xf/tf == 77.8, xf/(tf - 0.367) == 89.5], xf, tf)
```

$\Rightarrow$ $x_f = 218.4$ km , $t_f = 2.8$ h