W Aug 26

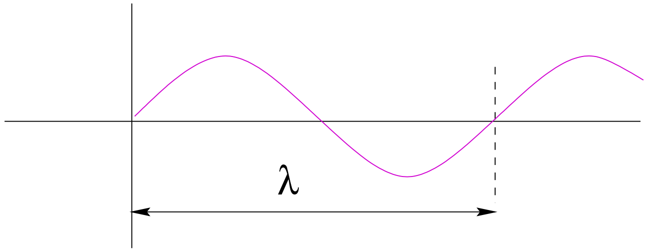
ANNOUNCEMENTS

1. Solutions/Exams on sale at TARGET COPY $6.25
2. Math review session W E2 (today) at 8:20 pm room NPB 1101
3. READING : Chapters 1-2
4. Ask questions!

1 MEASUREMENT

1.1 Definitions

- unit - measure of physical quantity: [meter,minute, gallon]
- Standard - way world scientific community has chosen to define particular unit.
  Example: meter, unit of length

period	standard
1792 - 1960	Pt-Ir bar kept in Paris 1,650,753.73 wavelengths of particular Kr spectral line 
1983 - present	length of path travelled by light in vacuum during 1/299,792,458 sec

Standards improve and are replaced as measurement techniques improve

- dimensions - physical properties associated with measurement

  Examples:

  1. [height of NPB]=L (length)
  2. [duration of Bill Clinton's speech]= T (time)
  3. [1 light-year]= L (length)
  4. [force of Mark McGuire's bat striking ball]= $M \cdot L/T^2$ $\left(\frac{\text{mass}-\text{length}}{\text{time}^2}\right)$

- base quantities - small collections of physical quantities needed to define all other physical quantities.

  Ex 1: L, M, T, Q (charge)

  Ex 2: W (weight) , V (speed) , T, Q

- systems of units - collections of units with standard base quantities L, M, T, Q

1. SI units ("MKS"): meter, kilogram, second
2. Gaussian units ("CGS"): centimeter, gram, second
3. English units : Foot, slug, second

1.2. Conversion of units

Be careful, write conversion factors explicitely:

$$1 = \left(\frac{60 \text{ sec}}{1 \text{ min}}\right)$$

Problem 1

a) You drive at 50 km/hr for 2 hrs, how far do you go?

$$x = vt = \left(50\,\frac{\text{km}}{\cancel{\text{hr}}}\right)\cdot(2\,\cancel{\text{hr}}) = 100\text{ km}$$

b) What is the distance travelled in furlongs? (1 furlong= 1/8 mile)

$$100\text{ km} = 100\,\cancel{\text{km}}\left(\frac{1\,\cancel{\text{mile}}}{1.6\,\cancel{\text{km}}}\right)\left(\frac{1\text{ furlong}}{1/8\,\cancel{\text{mile}}}\right) = 500\text{ furlongs}$$

c) What is speed in furlongs/fortnight?

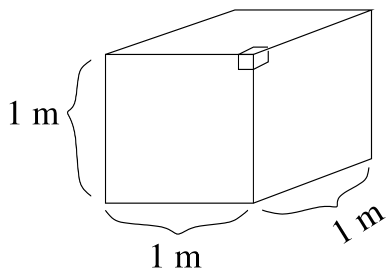
$$1\text{ fortnight} = 2\text{ wk} = 2\,\cancel{\text{wk}}\left(\frac{7\,\cancel{\text{day}}}{1\,\cancel{\text{wk}}}\right)\left(\frac{24\text{ hr}}{1\,\cancel{\text{day}}}\right) = 336\text{ hr}$$

$$\Longrightarrow\quad v = 50\,\frac{\cancel{\text{km}}}{\cancel{\text{hr}}}\left(\frac{500\text{ furlong}}{100\,\cancel{\text{km}}}\right)\left(\frac{336\,\cancel{\text{hr}}}{1\text{ fortnight}}\right)$$

$$= 8.4\times10^{4}\,\frac{\text{furlong}}{\text{fortnight}}$$

Problem 2

Give relationship between



(a) cubic meter and cubic centimeter ?

(use 1 m = 100 cm)

A : 1 cu. m = $1\ m^3 = (1\ m)^3 = (100\ cm)^3$

$$1\ m^3 = (1\ m)^3 = (100\ cm)^3 = 100^3 (1\ cm)^3$$

$$= \underline{\underline{10^6 \times 1\ cm^3}}$$

(b) square inch and square centimeter ?

(use 1 in = 2.54 cm)

A: $1\ in = (2.54\ cm)^2 = \underline{\underline{(2.54)^2\ cm^2}}$

Problem 3

How many degrees of longitude are therein a time zone on average? How many kilometers?

(a) $1 \text{ time zone} = 1 \text{ hr} = 1 \text{ hr} \left(\dfrac{360^{\circ}}{24 \text{ hr}} \right)$

(earth rotates 360° in 2 hr !)

(b) $15^{\circ} \times \left(\dfrac{2\pi \times 6.37 \times 10^{3} \text{ km}}{360^{\circ}} \right)$

(looked up $r_R = 6.37 \times 10^{3}$ km in HRW !)

2. ONE DIMENSIONAL MOTION

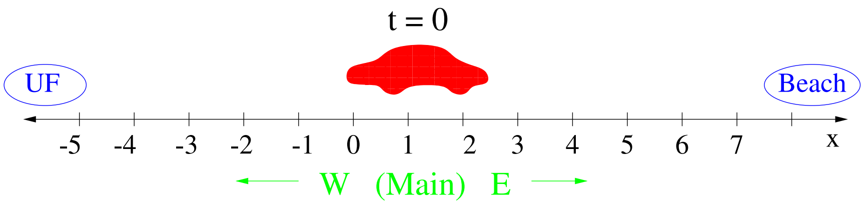
2.1 Average Velocity

Def: Kinematics: Study of motion of objects without reference to cause of motion.

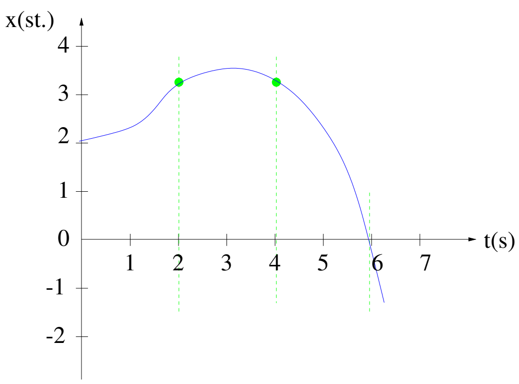
Most important concepts:

Position - where object is with respect to some coordinate system

e.g. Car on University Avenue.



car' position can be a function of time, e.g.



- displacement - change in position

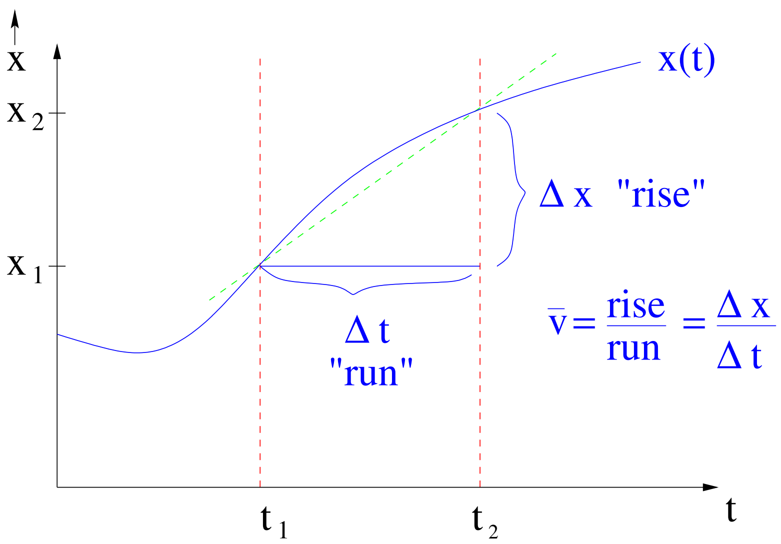
$$\Delta x = x(t_2) - x(t_1)$$

- average velocity between two points (t_1, x_1) and (t_2, x_2)

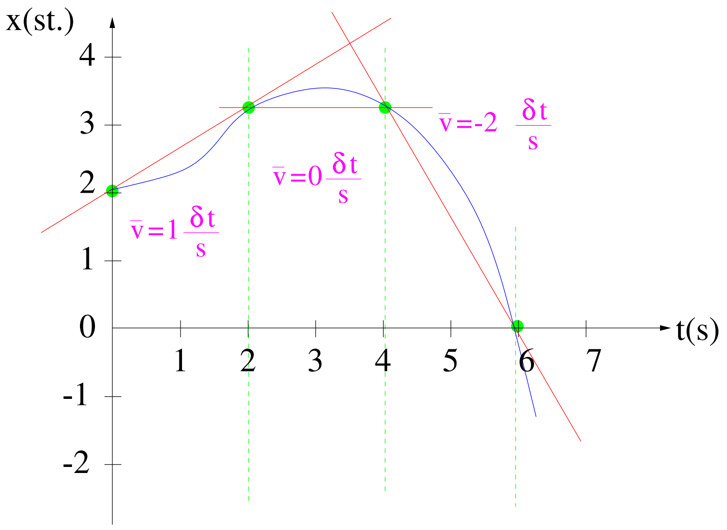
$$\bar{v} = \frac{\Delta v}{\Delta t} = \frac{x_2 - x_1}{t_2 - t_1}$$

where we mean $x_2 = x(t_2)$, etc

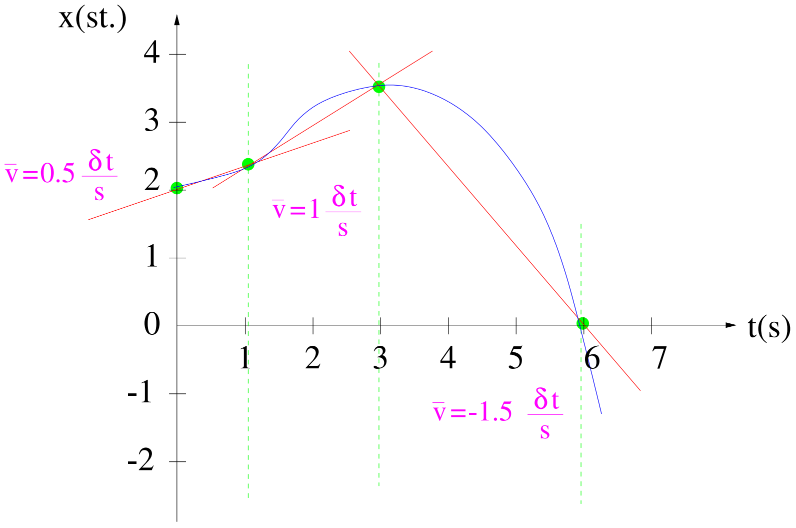
Note: $\bar{v}$ is slope of line connecting (t_1, x_1) and (t_2, x_2)



Average velocities for car example - Check!



Note: Average velocities depend in general on choice of t_1 and t_2.



F Aug 28

Announcements:

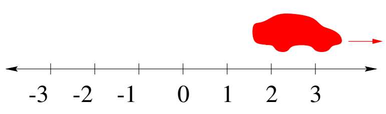
- Review sessions meet M-R next week.
  E1 - see WWW, syllabus.
  Math review: Tanner/Hirshfeld T, W E2
  Rm 1101

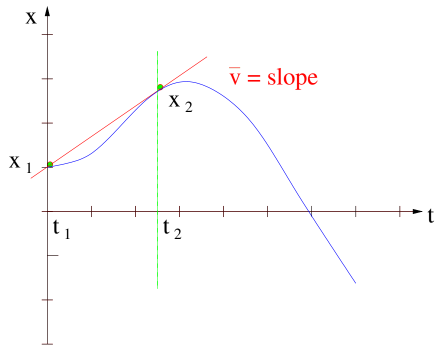
- Web page http//:www.phys.ufl.edu , click on "courses"

Last time

Ch. 1 units, standards, dimensions, systems of units, converting

Ch. 2





average velocity $$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{x_2 - x_1}{t_2 - t_1}$$

2.3 Acceleration = change of velocity with time

Defs:

- average acceleration

$$\bar{a} = \frac{v_2 - v_1}{t_2 - t_1} = \frac{\Delta v}{\Delta t}$$

- instantaneous acceleration

$$a = \frac{dv}{dt} = \frac{d^2x}{dt^2}$$

Notes:

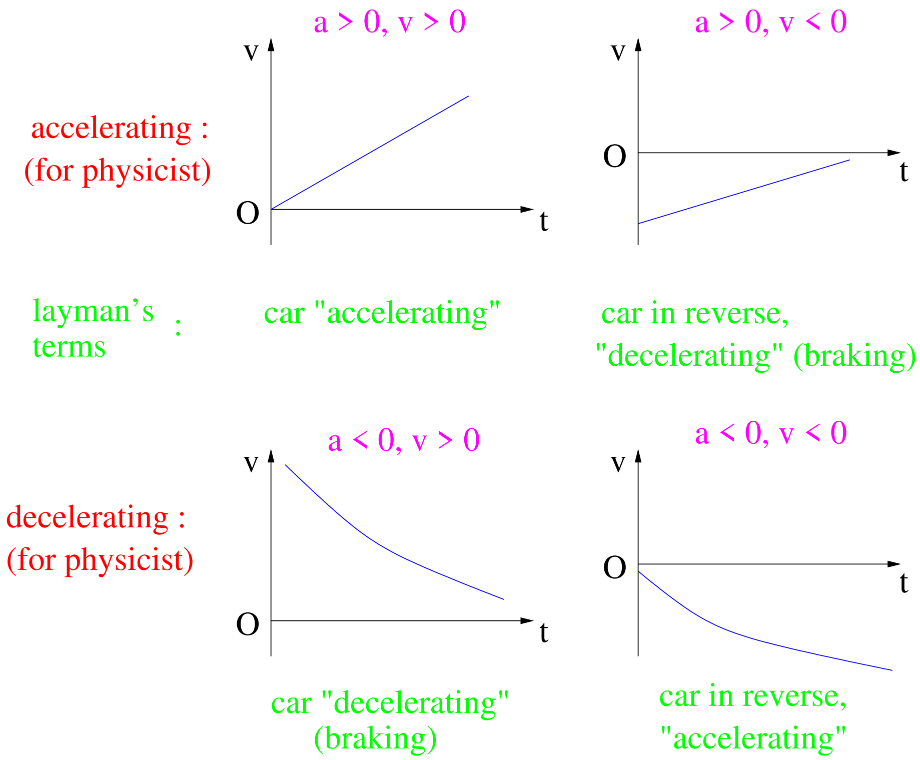
- acceleration is a also a vector; it can be + or -
- dimensions/units:

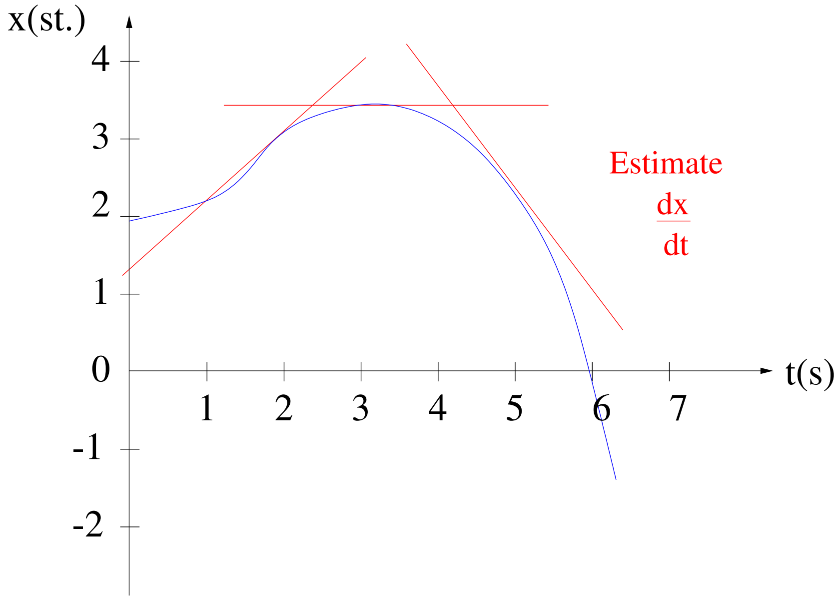
$$[\mathrm{x}] = \mathrm{L}; \qquad [\mathrm{v}] = \frac{\mathrm{L}}{\mathrm{T}}; \qquad [\mathrm{a}] = \frac{\mathrm{L}}{\mathrm{T}^2}$$

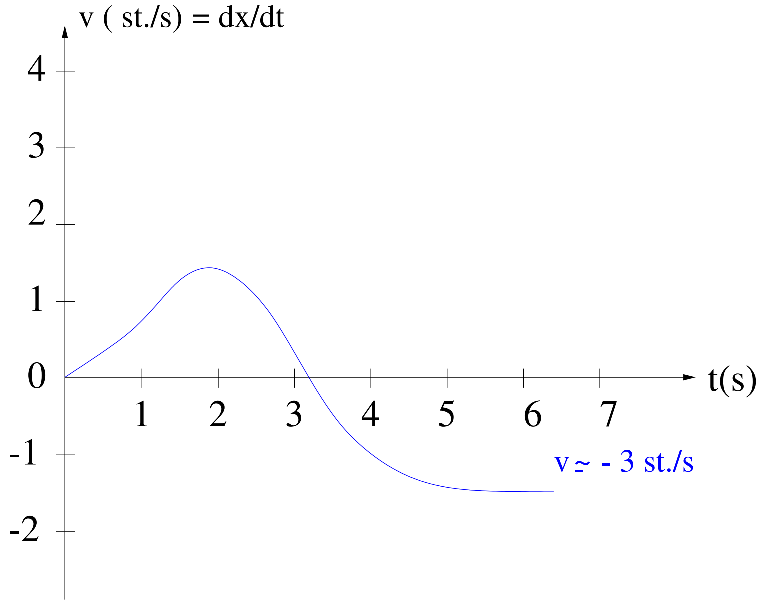
  SI units [m/s^2]

- Careful with terms accelerating $(a > 0)$
  decelerating $(a < 0)$

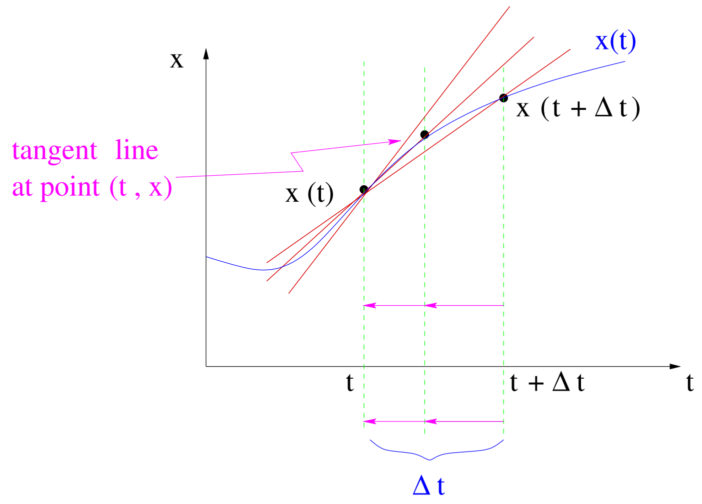
Examples:


accelerating :
(for physicist)
a > 0, v > 0
v
O
t
a > 0, v < 0
v
O
t
layman's terms :
car "accelerating"
car in reverse,
"decelerating" (braking)
decelerating :
(for physicist)
a < 0, v > 0
v
O
t
a < 0, v < 0
v
O
t
car "decelerating"
(braking)
car in reverse,
"accelerating"


x(st.)
4
3
2
1
0
-1
-2
1
2
3
4
5
6
7
t(s)
Estimate
dx
dt


v (st./s) = dx/dt
4
3
2
1
0
-1
-2
1
2
3
4
5
6
7
t(s)
v ≃ - 3 st./s

2.2 Instantaneous velocity - shrink Δt



$$v(t) = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$$

Note

- position, velocity are vectors even in 1D

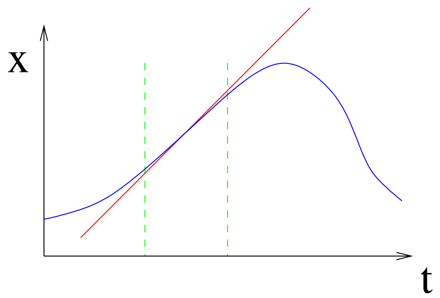
  x, v can be positive or negative !

- magnitude of velocity $|v| > 0$

  (speed)

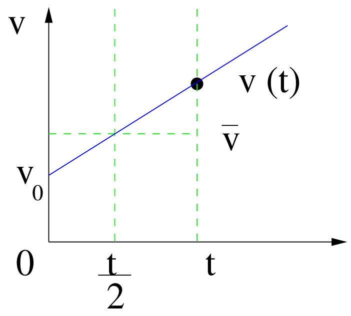
- IF v doesn't change

  $v = \bar{v}$



2.4 SPECIAL CASE - constant acceleration

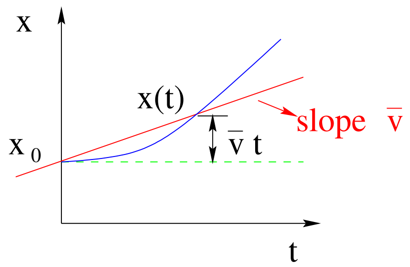
$$a = \text{const} = \bar{a} = \frac{v(t) - v_0}{t - 0}$$



$$v(0) = v \implies v(t) = a\,t + v_0$$

$$x(t) = x_0 + \bar{v}\,t$$

but $\bar{v} = \frac{1}{2}(v_0 + v(t))$



$$x = x_0 + \frac{1}{2}(v_0 + v)\,t$$

$$= x_0 + \frac{1}{2}(v_0 t + [a\,t + v_0]\,t)$$

$$= x_0 + v_0 t + \frac{1}{2} a\,t^2$$

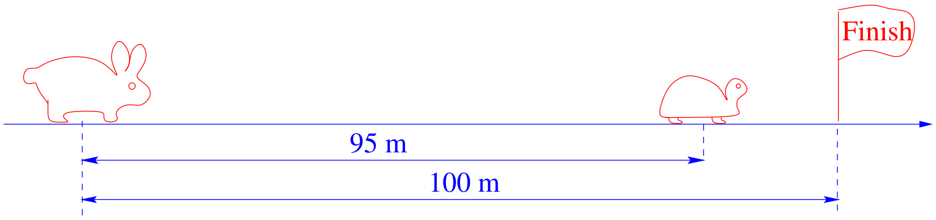
check by differentiation

$$\boxed{\begin{aligned} x &= x_0 + v_0 t + \frac{1}{2} a\,t^2 \\ v &= v_0 + a\,t \\ a &= a \end{aligned}}$$

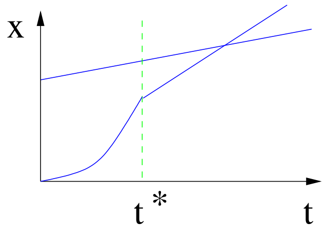
" Equations of motion for constant acceleration"

Problem

Hare starts accelerating from rest with $a = 40\ \mathrm{m/s^2}$, at t=0, until it reaches top speed of $16\ \mathrm{m/s}$, then runs at constant speed. Tortoise has constant speed of $0.5\ \mathrm{m/s}$ at t=0 and maintains it. If initial positions are as shown, who wins?

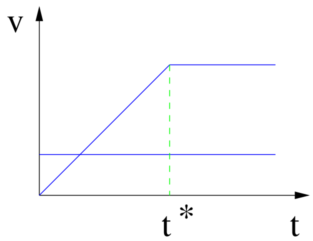


$$x_H(t) = \begin{cases} 0 + 0 \cdot t + \frac{1}{2} a_H t^2 & t < t^* \\ x^* + v^* \underbrace{(t - t^*)}_{\text{elapsed time after "gearshift"}} & t > t^* \end{cases}$$



$$v_H(t) = \begin{cases} 0 + a_H t & t < t^* \\ v^* + 0 & t > t^* \end{cases}$$

$$a_H(t) = \begin{cases} a_H & t < t^* \\ 0 & t > t^* \end{cases}$$



$$x_T(t) = x_{0T} + v_{0T} + 0$$

$$v_T(t) = v_T$$

$$a_{\text{T}} = 0$$

$$t^* = \text{Time Hare stops acelerating}$$

$$x^* = \text{position at } t^*$$

$$v^* = \text{velocity at } t^*$$

Q.1: What is t^*? It is the time when $v = v^* = 16$ m/s.

$$a_{\text{H}} t^* = v^* \quad \Rightarrow \quad t^* = \frac{v^*}{a_{\text{H}}} = \frac{16 \text{ m/s}}{4 \text{ m/s}} = 4 \text{ s}$$

$$x^* = \frac{1}{2} a_{\text{H}} t^{*2} = \frac{1}{2}(4 \ \frac{\text{m}}{\text{s}^2})(4 \text{ s})^2 = 32 \text{ m}$$

Q.2: What does the problem ask ? "who wins ?"
= what is time t_{H} when hare is at 100 m mark, t_{T} when Tortoise gets there? $t_{\text{H}} > t_{\text{T}}$ or $t_{\text{H}} < t_{\text{T}}$

$$
\begin{aligned}
x_{\text{Finish}} &= 100 \text{ m} \\
x_{\text{Finish}} &= \underbrace{x^* + v^*(t_{\text{H}} - t^*)}_{\text{Hare}} = \underbrace{x_{0\text{T}} + v_{0\text{T}} t_{\text{T}}}_{\text{Tortoise}} \\
t_{\text{H}} - t^* &= \frac{x_{\text{Finish}} - x^*}{v^*} = \frac{100 \text{ m} - 32 \text{ m}}{16 \text{ m/s}} = 4.25 \text{ s} \\
t_{\text{H}} &= 8.25 \text{ s} \\
t_{\text{T}} &= \frac{x_{\text{Finish}} - x_{0\text{T}}}{v_{0\text{T}}} = \frac{100 \text{ m} - 95 \text{ m}}{0.5 \text{ m/s}} = 10 \text{ s} \\
t_{\text{T}} &= 10 \text{ s}
\end{aligned}
$$

Hare wins