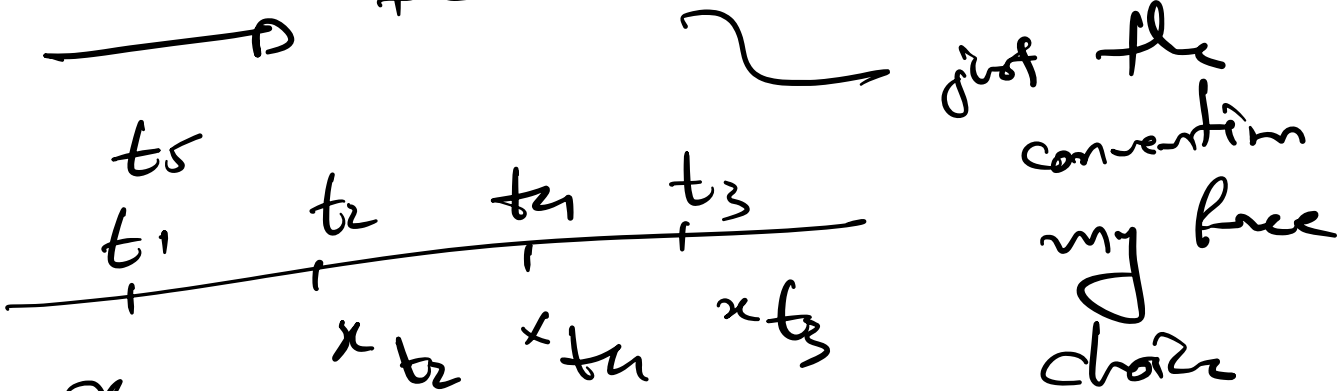
lecture 2

average speed = $\frac{\text{distance}}{\text{time}}$

the x



just the convention my free choice

average velocity

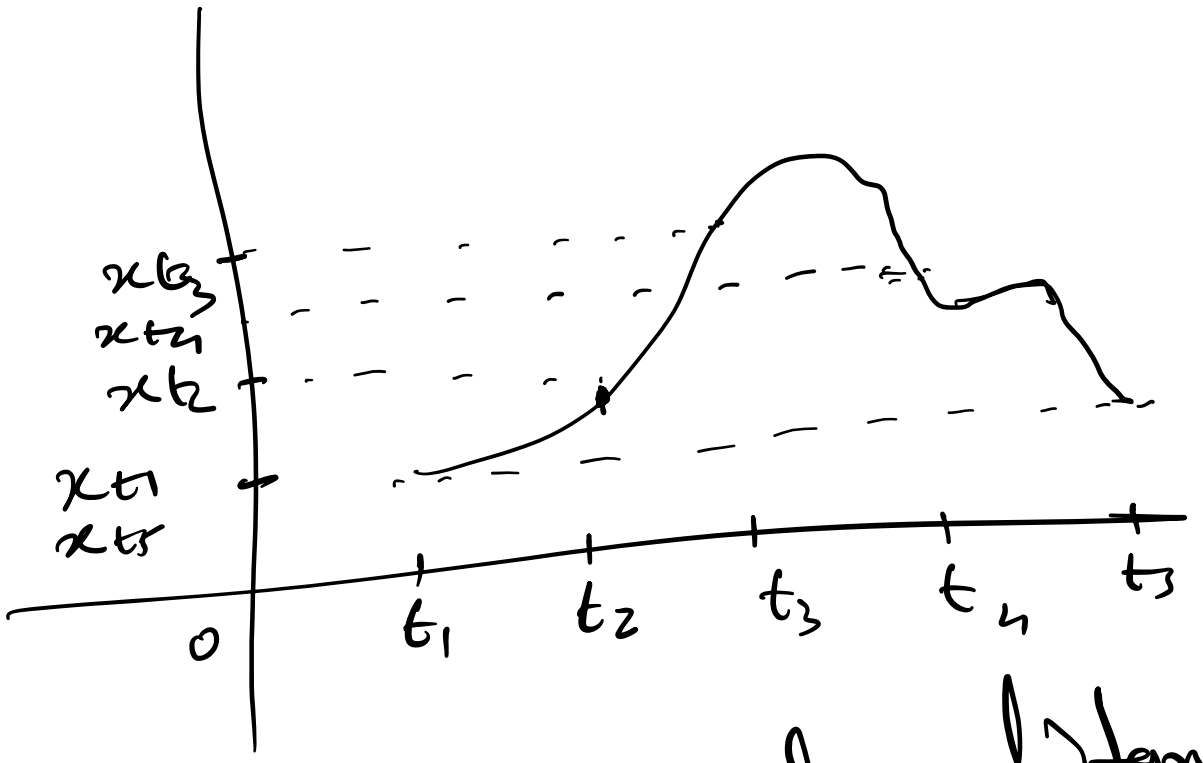
$$\bar{V}_{t_1 t_2} = \frac{x_{t_2} - x_{t_1}}{t_2 - t_1} > 0$$

in our case

$\bar{V}_{t_1 t_5} = 0$ → same same position

$\bar{V}_{t_3 t_4} < 0$

So velocity has sign
+ve or -ve



average speed = $\frac{\text{distance}}{\text{time}}$

$$V_t = \lim_{\Delta t \to 0} \frac{x_{t+\Delta t} - x_t}{\Delta t}$$

$$= \frac{dx}{dt}$$ — first derivative of position w.r.t. time

$$v = \frac{dx}{dt}$$

> 0 tangent
$= 0$ of the curve
< 0 at time t

instantaneous speed is non signed value of average velocity

How would we measure speed of bullet?

lets say its less than sound < 300 m/s.

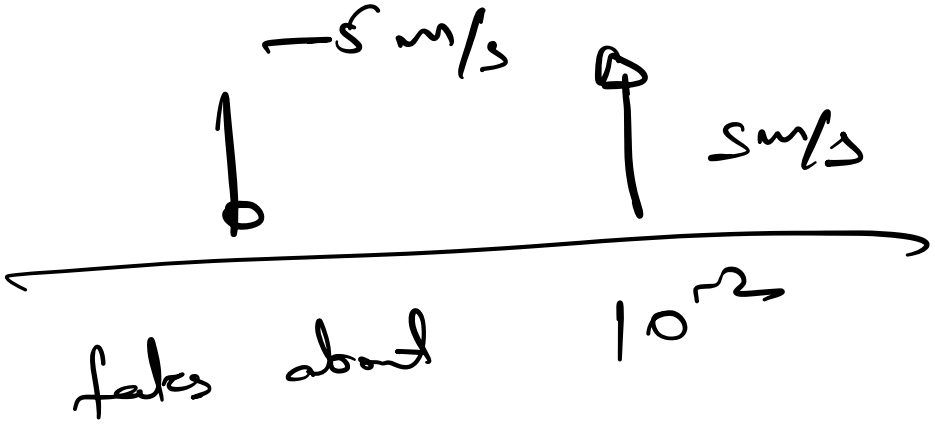
Now the setup has distance of 148.5 ± 0.5 mm

So this distance forces us to have timer which can measure atleast $1/10^{th}$ of milli seconds.

average acceleration

$$\bar{a} = \frac{\Delta v}{\Delta t} \qquad \boxed{a = \frac{dv}{dt}} = \frac{d^2x}{dt^2}$$

Example of bouncing tennis ball



takes about 10^{-2}

So

$$\bar{a} = \frac{5 - (-5)}{10^{-2}} = 10^3 \text{ m/s}^2$$

High acceleration can break things

$$a_t = \lim_{\Delta t \to 0} \frac{v_{t+\Delta t} - v_t}{\Delta t}$$

Example

$$x = 8 - 6t + t^2$$

$$v = -6 + 2t$$

$$a = 2$$

This would be one of the segment.

in motion planning.

1D Constant acceleration

$$x = c_1 + c_2 t + c_3 t^2$$

c_1: zero

$$v = c_2 + 2c_3 t$$

c_2: v0

$$\boxed{a = 2c_3}$$

Constant.

actual acceleration value

$$c_3 = \frac{1}{2} a$$

Drop vertically up or down

$a = g = 9.8\ m/s^2$

↳ independent of mass shape

Can it be proved?

Not through first principle

$t = 0 \quad x_0 = 0 \quad v_0 = 0$

$x = x_0 + v_0 t + \frac{1}{2} g t^2$

$v = v_0 + gt$

$a = g$

$x = 3$ meters measured

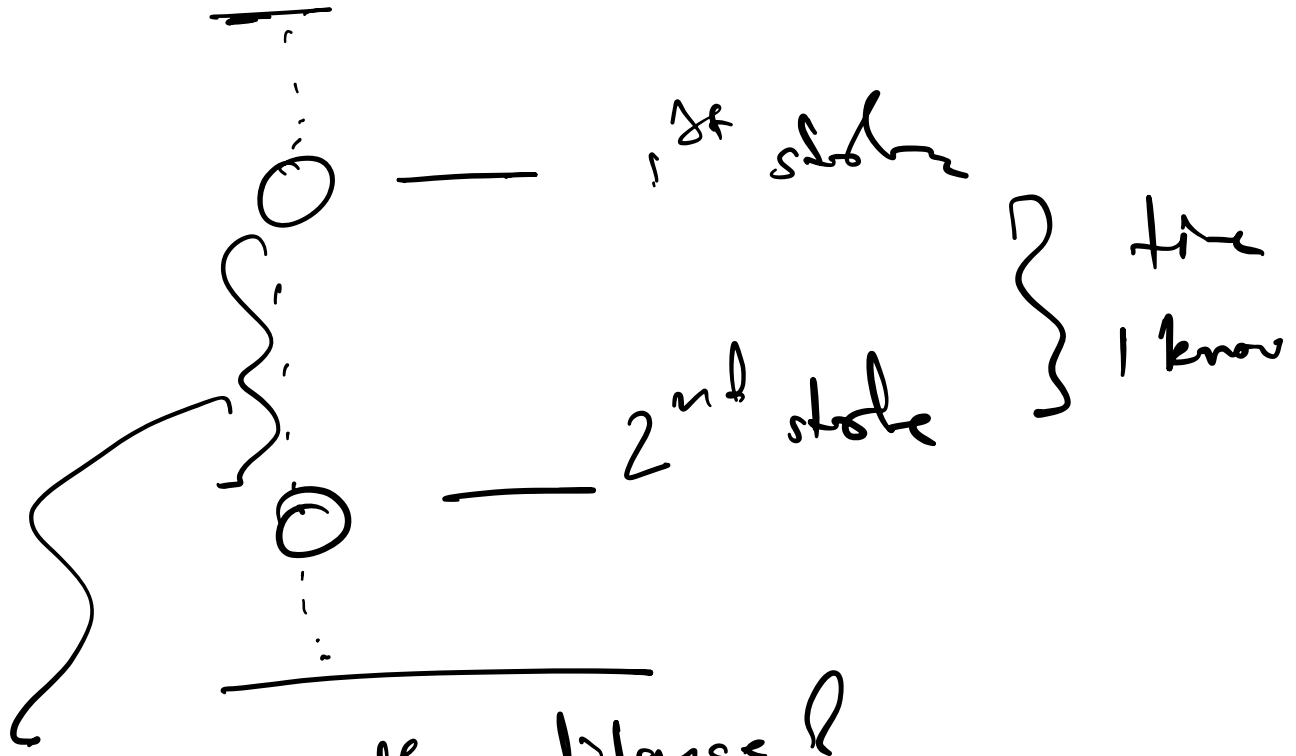
& get the value of g with uncertainity.

$t = c\sqrt{\frac{h}{g}}$ $\quad \boxed{c = \sqrt{2}}$

$h = 3$ time ~ 0.8 sec

stroke 2 Hz ~ 2 hits per second

This becomes like a vision problem.



measure the distance?

can using g g and the t get the depth.

probably could