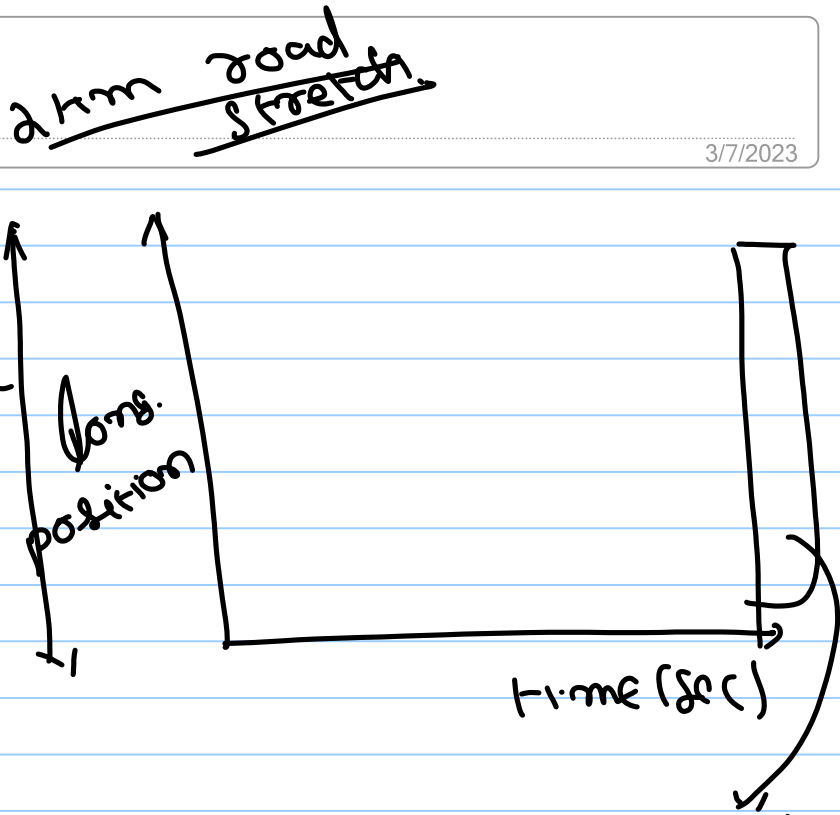
Note Title 3/7/2023

lane

t → 1 → driving lane

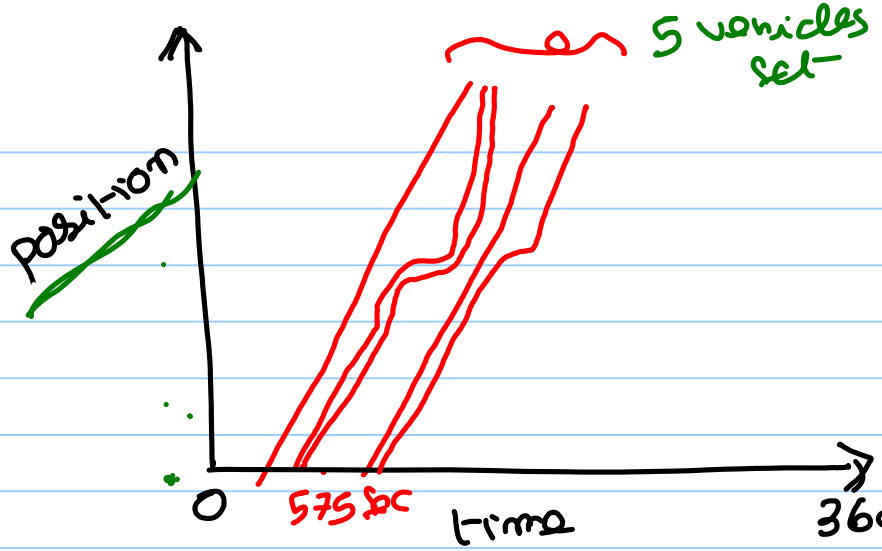
t+Δt → 2 → passing lane

change the lane →



Speed graph.

5 hours data



5 sets of data

each set consist 5 vehicles

1) 575 sec → 5 vehicl

2) 1025 sec → 5 vehicls

3) 1800 sec → 5 vehicls

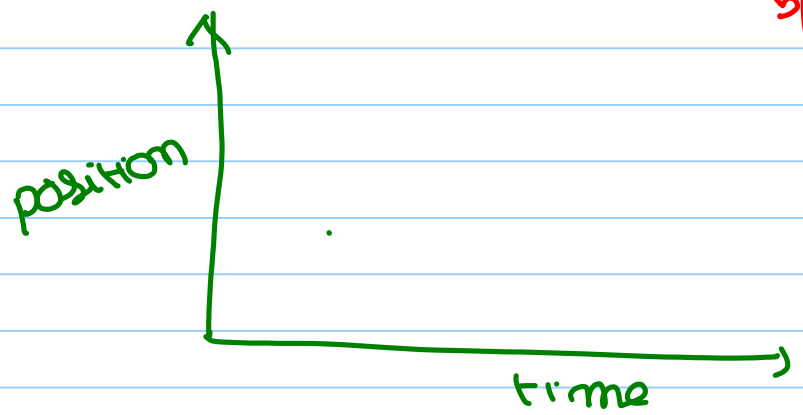
4) 2480 sec → 5 vehicles

5) 3500 sec → 5 vehicles

1) (long, lat) →

local coordinate

5 (set of data)

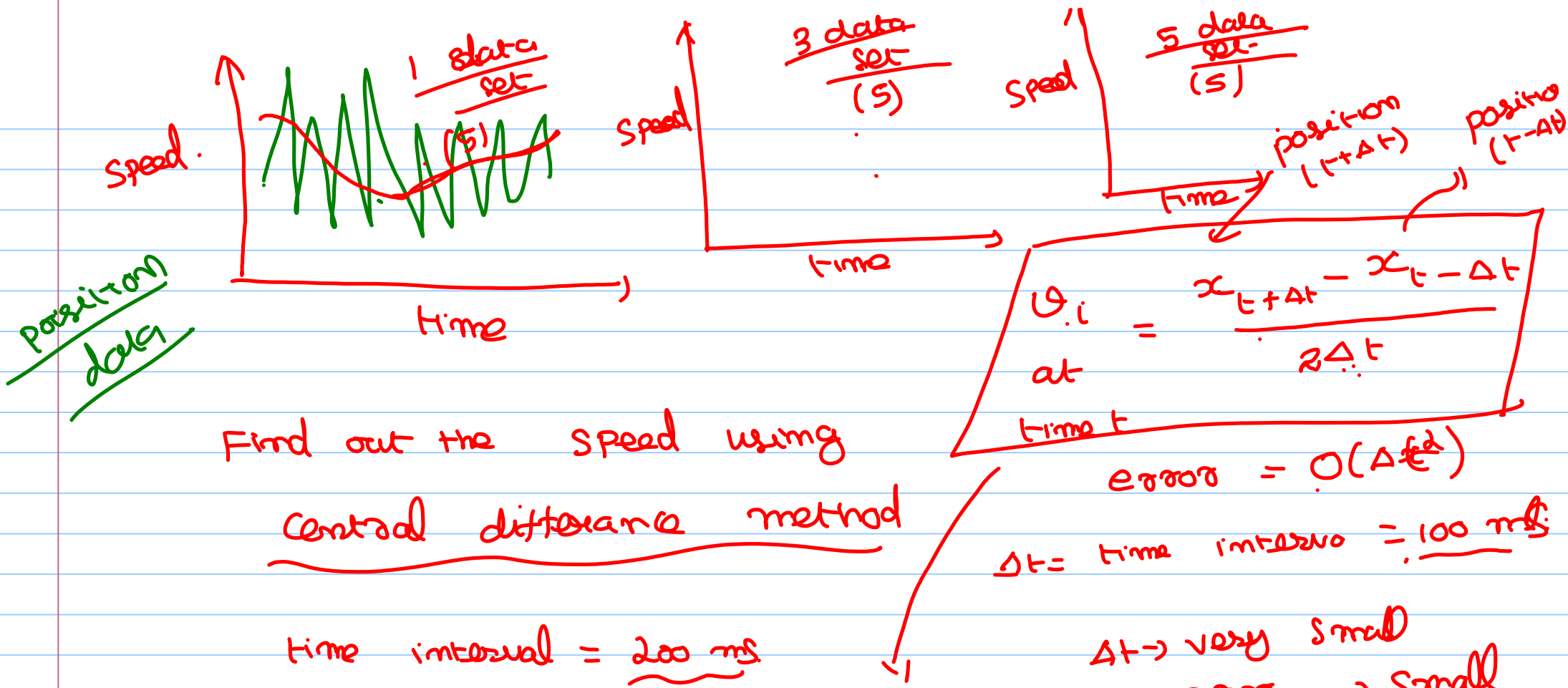


=

(or)

vehicle distance from the mile post

(5 set of data)


Speed
1 data set
(s)
Time
Position data
Speed
3 data set
(s)
Time
Speed
5 data set
(s)
Time
position (t+Δt)
position (t-Δt)
$v_i = \frac{x_{t+\Delta t} - x_{t-\Delta t}}{2\Delta t}$
at time t
error = $O(\Delta t^2)$
Δt = time interval = 100 ms
Δt → very small
error → small
Find out the speed using central difference method
time interval = 200 ms

First point

$$v_0 = \frac{x_{t+\Delta t} - x_{t-\Delta t}}{\Delta t}$$

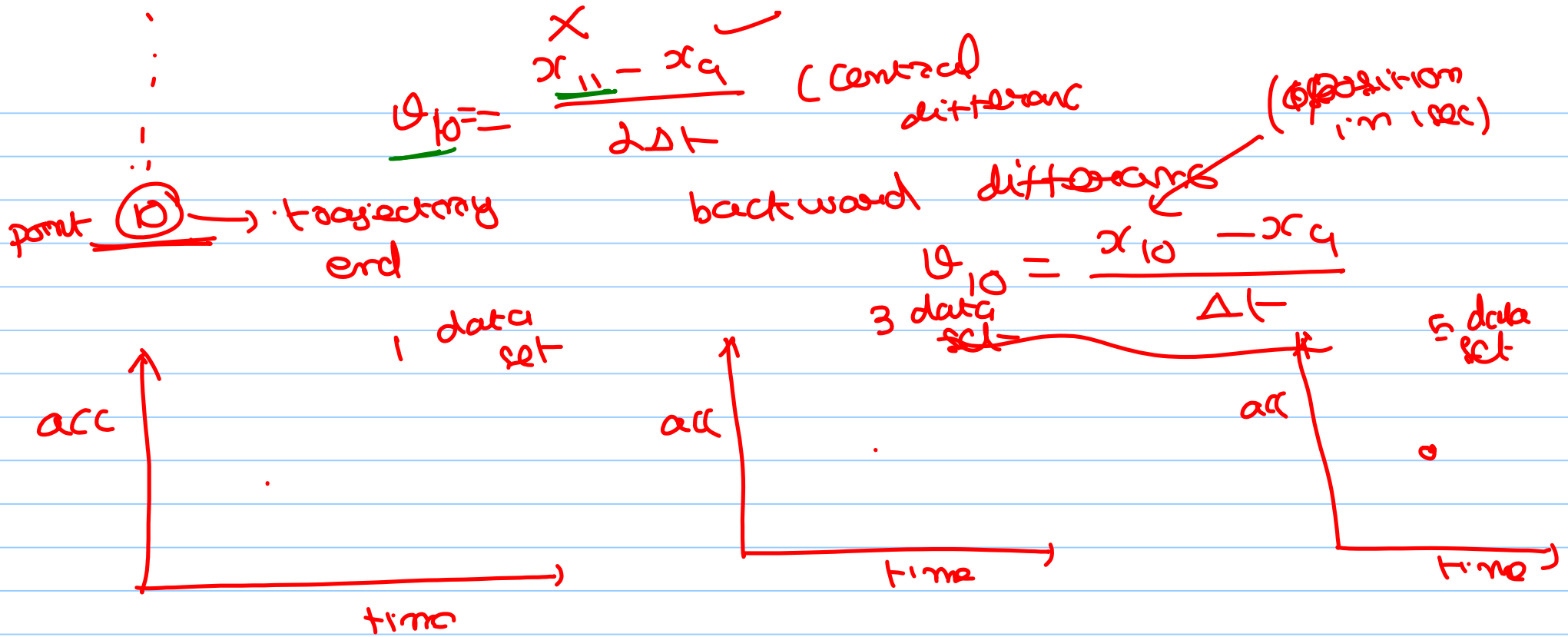
point 1

$$v_1 = \frac{x_{t+2} - x_0}{2\Delta t}$$

0.1sec (1) →
0.1sec (2)
0.1sec (3)
0.1sec (4)

$$\frac{dx}{dt} \approx \frac{x_{t+\Delta t} - x_t}{\Delta t}$$ First point forward difference method

$$v_1 = \frac{x_{t+2} - x_1}{\Delta t}$$


$v_{10} = \frac{x_{11} - x_9}{2\Delta t}$
(central difference
(backward difference
$v_{10} = \frac{x_{10} - x_9}{\Delta t}$
point 10
trajectory
end
1 data set
3 data set
5 data set
acc
time

Central difference method.

$$a_i \approx \frac{x_{i+\Delta t} - 2x_i + x_{i-\Delta t}}{(\Delta t)^2}$$

error $O(\Delta t^2)$

$\Delta t < 1$ sec

0.01 sec

$\Delta t = 1$

$x_{i+1} - x_{i-1} = 5$ m (assumed)

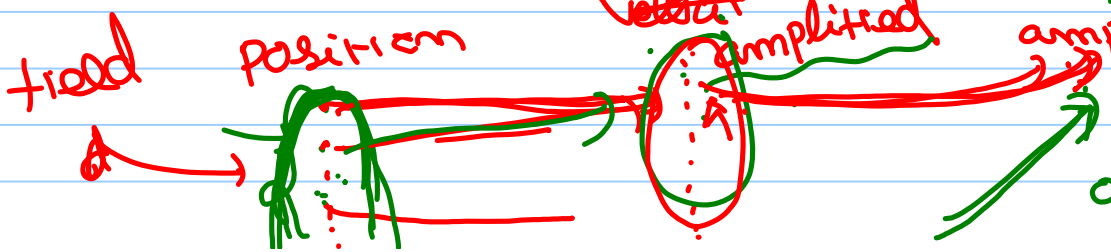
(0.01 sec)

measure = 7 m

$\Delta t = 0.01$ sec

$a = \frac{dv}{dt} = \frac{d^2x}{dt^2}$ → second derivative of position

acc



$v = \frac{dx}{dt} \approx \frac{x_{i+1} - x_{i-1}}{2\Delta t}$

$\approx \frac{5}{2 \times 0.01}$

$= 250$ m/sec

$\frac{1}{0.01}$ time

$\frac{1}{0.01}$ time

$\Delta t = 0.01$ sec

with noise

source noise

Smoothing techniques

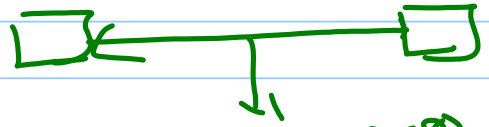
reduce

due to differentiation error

proces

$\frac{\text{error}}{(0.01)}$.

$\Delta t = 0.01$ sec < 1 sec



noise (or) error

$= 100$ times $= \frac{7}{2 \times 0.01}$

$= 350$ m/sec

$\text{error} \times \left(\frac{1}{0.01}\right)$

human error

instrument error

measurement error

0%

(1) point forward difference method

last point backward difference method

error $O(\Delta t^2)$ →

Δt very small

First point
→ Forward

last point
→ backward

other points
→ central difference method

data → consist of noise (position consist of noise)
→ figures