# Kinematics

Kinematics refers to motion of the particle w/ respect to time

Kinematics

| Scalar quantities | Vector Quantities |
| --- | --- |
| → distance | → displacement |
| → speed | → velocity |
| → time | → acceleration |

distance :-
distance refers to units travelled by a particle

displacement
is the shortest distance from the starting point.

speed
is the rate of change of distance. This is a scalar quantity and is always positive

Velocity

The rate of change of displacement. Once the particle turns, the sign of the velocity changes.

Acceleration

Acc is the rate of change of speed and/or velocity. When the particle is speeding up, acc is positive. When the particle is slowing down, acc is negative, which is also known as retardation or deceleration. When the particle is travelling w/ constant speed or velocity, acceleration is 0.

Time:

Time is the duration of the motion of the particle

| | | |
|---|---|---|
| Distance | km | m |
| Time | hrs | s |
| Speed | $kmh^{-1}$ | $ms^{-1}$ |
| acc | $kmh^{-2}$ | $ms^{-2}$ |

particles travelling at constant speed

particle travelling at varying speed.

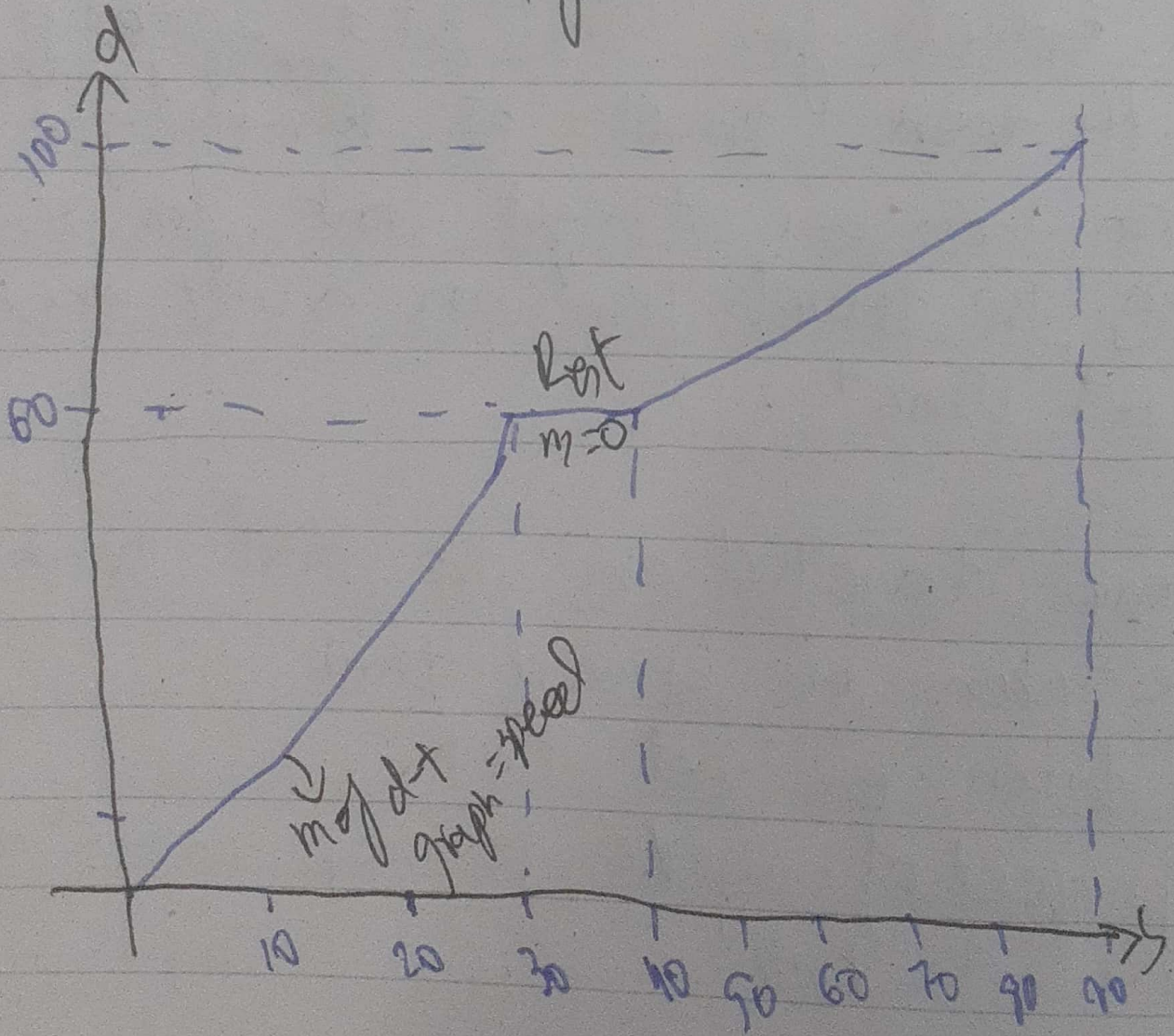
Avg Speed = $\frac{\text{total distance}}{\text{total time}}$

$kmh^{-1} \xrightarrow{\times \frac{1000}{3600}} ms^{-1}$

$ms^{-1} \xrightarrow{\frac{\times 3600}{1000}} kmh^{-1}$

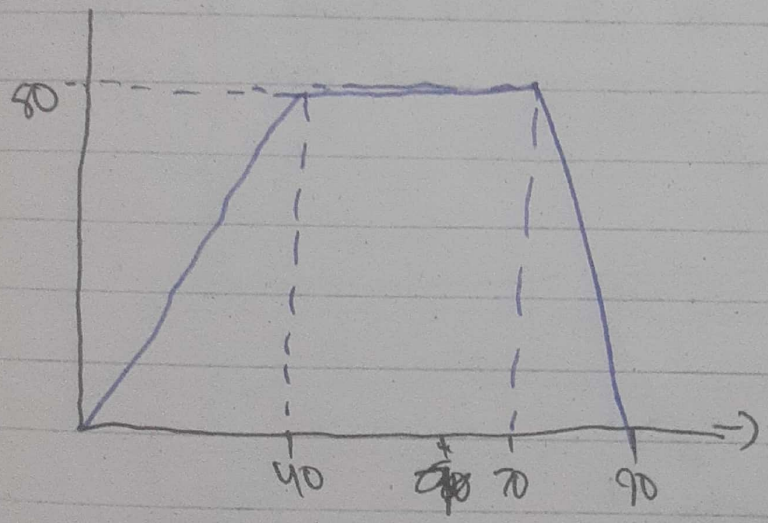
# Distance Time Graph

A particle started its journey from rest and travelled for 60m in 30s. It then rested for 10s and travelled a further 40m in the next 50s. Draw a dist/time graph to illustrate this info.



# Speed/Time Graph.

From rest particle travelled for 40s until it reached a speed of 80ms$^{-1}$. It then continued to travel at this speed for the next 30s. After which the partide applied brakes until it came to rest in the next 20s. Draw speed time graph. ~~Find~~ Find in the next 20s.




Find:-

i) acc between first 40s
ii) deceleration during last 20s
iii) total distance
iv) avg speed distance

i) $\frac{80}{40} = 2ms^{-2}$

ii) $\frac{80}{20} = 4ms^{-2}$

iii) $\frac{1}{2}(90+50) \times 80$

$\frac{1}{2} \times (120) \times 40 = 4800m$

iv) $\frac{4800}{90} = 53.3ms^{-1}$

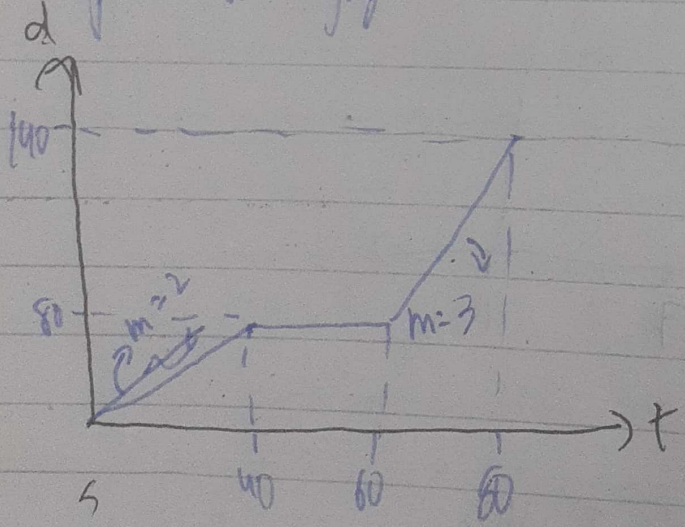
1) $m = \frac{0-v}{200-140} = \frac{-v}{60} = -0.2$

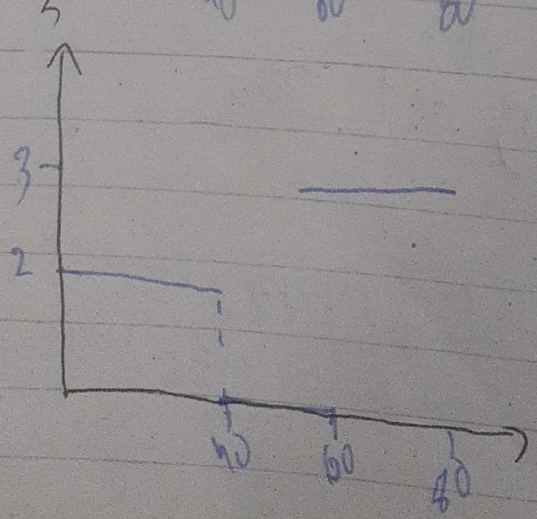
$= -v = -12$

$v = 12$

How to derive s/t graph from d/t graph

In order to do so, we will calculate the speed of each part of the journey and plot it on the speed time graph.

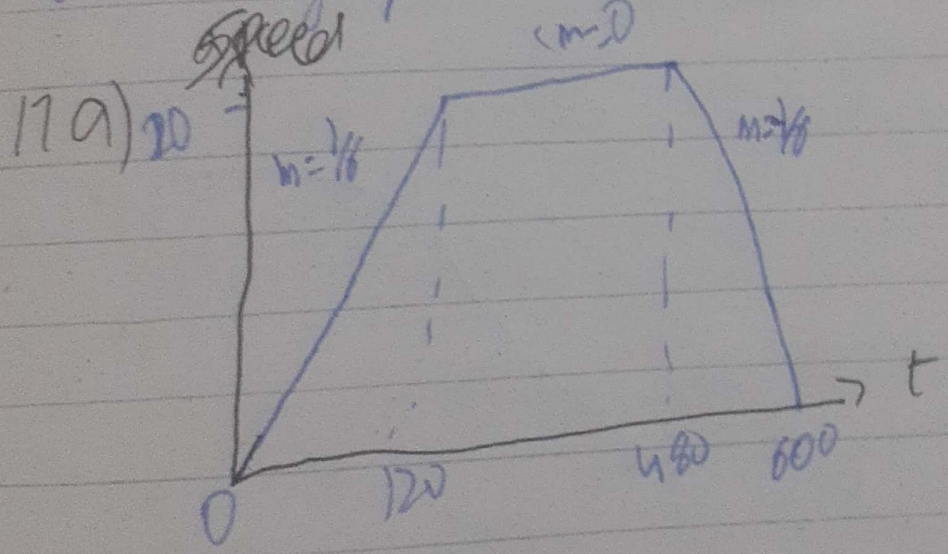


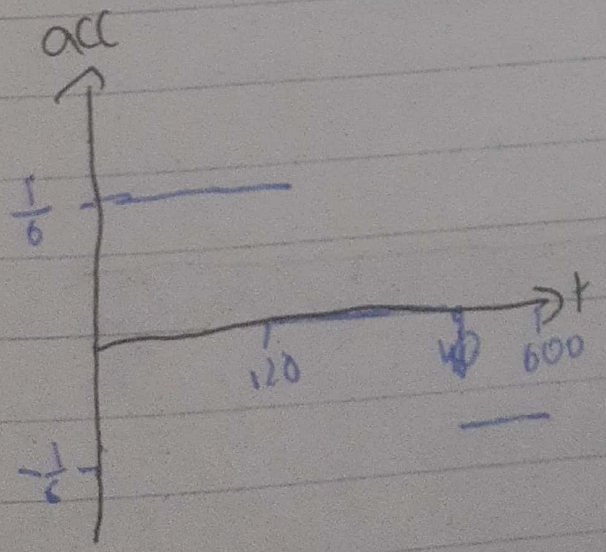



# How to derive acc/t graph from s/t graph

The method of deriving acc/time graph from s/t graph is exactly the same as deriving s/t from d/t i.e. we will calculate the acc of each part of the journey and plot it on the graph.

17a)

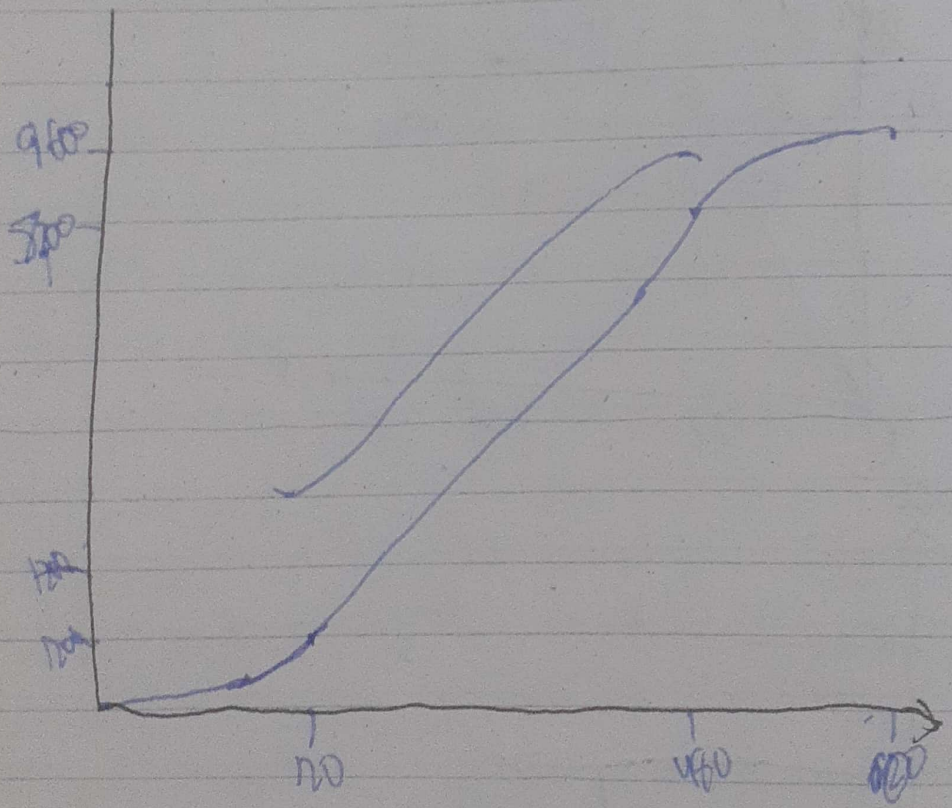


# How to derive d/t graph from s/t graph.

In order to do so, we will ~~draw~~ calc distance of each part of the journey and add all the distance on the distance time graph.

(same graph on b4)



till 120 = $\frac{1}{2} \times 120 \times 20 = 1200$m

till 120-480 = $\frac{1}{2}(360) \times 20 = 7200$m

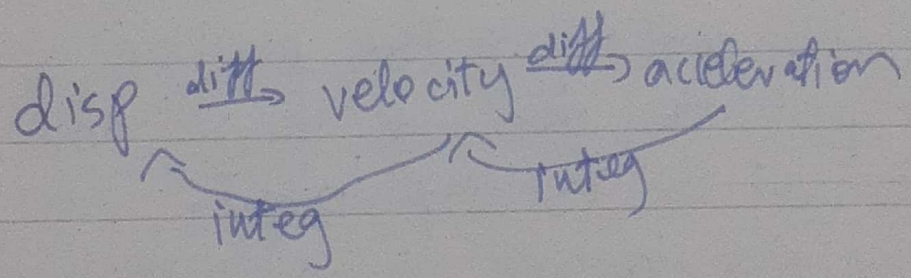
480 - 600 = $\frac{1}{2} \times 120 \times 20 = 1200$m

increasing speed ⟋ (smiley)

decreasing speed ⟍ (sad)

const —

when acc varies w.r.t time, we need to apply calculus and then we apply the following rules




disp: $2t^4 - 27t$

Find velocity and acc of particle. Also find s, v and a when $t=2$.

$v = 8t^3 - 27$

$a = 24t^2$

$t=2$

$v = 8(8) - 27$

$= 64 - 27$

$= 37 \text{ ms}^{-1}$

$a = 24(4)$

$= 92 \text{ ms}^{-2}$

(1) At initial point, $t=0$.
(2) At maximum velocity, $a=0$.
(3) At maximum displacement, $v=0$.
(4) When the particle turns, $v=0$ at that instant
(5) When the particle is instantaneously at rest, $v=0$
(6) Thus, it can be concluded that when the particle turns, if it is at instantaneous rest, its velocity is 0, its displacement is at a maximum
(6) If the motion of the particle is such that the particle does not turn, then its distance is equal to its displacement.
(7) Once the particle turns, the sign of its velocity changes.
(8) When the particle is speeding up, its acceleration is positive
(9) When the particle is slowing down, its acc. is negative
(10) When the particle is travelling at a constant speed, its acc is 0.
(11) To check whether the direction of the particle has changed, we check the sign of the velocity.

(12) Displacement is the shortest distance from starting point.

(13) If the requirement of the qs is to find distance from O, or the distance from the starting point, it is an indication that we need to calculate displacement.

(14) When we substitute the time in the eqs of displacement, we achieve displacement, not distance, only when the particle has not turned, distance will be equal to displacement.

(15) If we need to calculate the total distance travelled by the particle, then, we will apply the following steps:-

(1) Calculate the time at which the particle has turned by substituting velocity as 0.

(2) Substitute the time at which the particle has turned in the eqs of displacement. (we will refer to this as A).

(3) Substitute the time given in the qs at which the distance is required (we will refer to this as B)

(4) If B is +ve, total distance will be 2A-B. If B=0, total distance will be 2A. If B is neg, total dist will be 2A+B

A-B=C  A-B+A

→ When B is positive, it is an indication that the particle has not reached the starting point after turning.

→ When B is 0, it is an indication that the particle is at the starting after turning.

→ When B is negative, it is an indication that the particle has gone beyond the starting point after turning.