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18/ENG05/040

Mechatronics Engineering.

N/B : WORK IS PRESENTED IN ORDER.

OBI-OBUOHA ABIAMAMFLA

18/F/G05/040

MECHATRONICS ENGINEERING.

F 12-9

For $0 \leq t \leq 6$ seconds

$s = 0.5t^3$

Note: $\frac{ds}{dt} = v$

$\therefore v = \frac{d\,0.5t^3}{dt}$

$v = (3 \times 0.5)t^2$

$= 1.5t^2$

For $6 \leq t \leq 10$ seconds

$s = 108m$

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

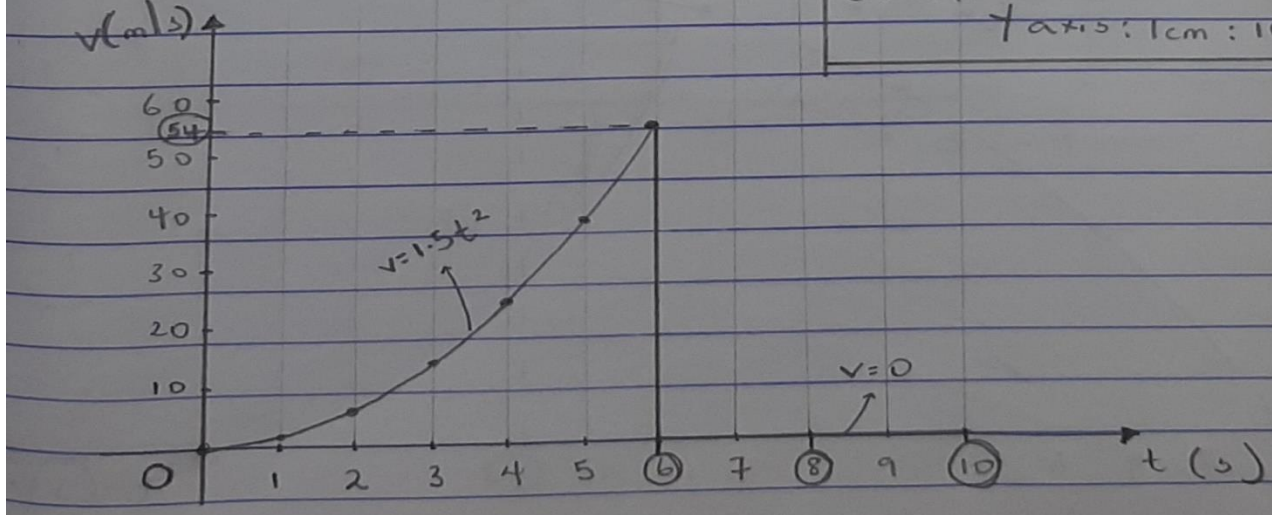
$\therefore v = \frac{d(108)}{dt}$

$v = 0$

$\therefore$ steady velocity.

at $t = 0$, $v = 0$, at $t = 1$, $v = 1.5 m/s$, at $t = 2$, $v = 6 m/s$, at $t = 3$, $v = 13.5 m/s$, at $t = 4$, $v = 24 m/s$ at $t = 5$, $v = 37.5$ at $t = 6$, $v = 54 m/s$

Scale: x axis: 1cm : 1unit
y axis: 1cm : 10units



V - t GRAPH

F 12-10

$v = -4t + 80$

Note $v = ds/dt$

$\therefore s = \int v\,dt$

$s = \int (-4t + 80)\,dt$

$s = \frac{-4t^2}{2} + 80t + c$

$s = -2t^2 + 80t + c$

Note when $t = 0$, $\therefore s = 0$

$\therefore 0 = -2(0)^2 + 80(0) + c$

$c = 0$

$\therefore s = -2t^2 + 80t$

For the s-t graph

$\therefore$ at $t = 20$

$s = -2(20)^2 + 80(20)$

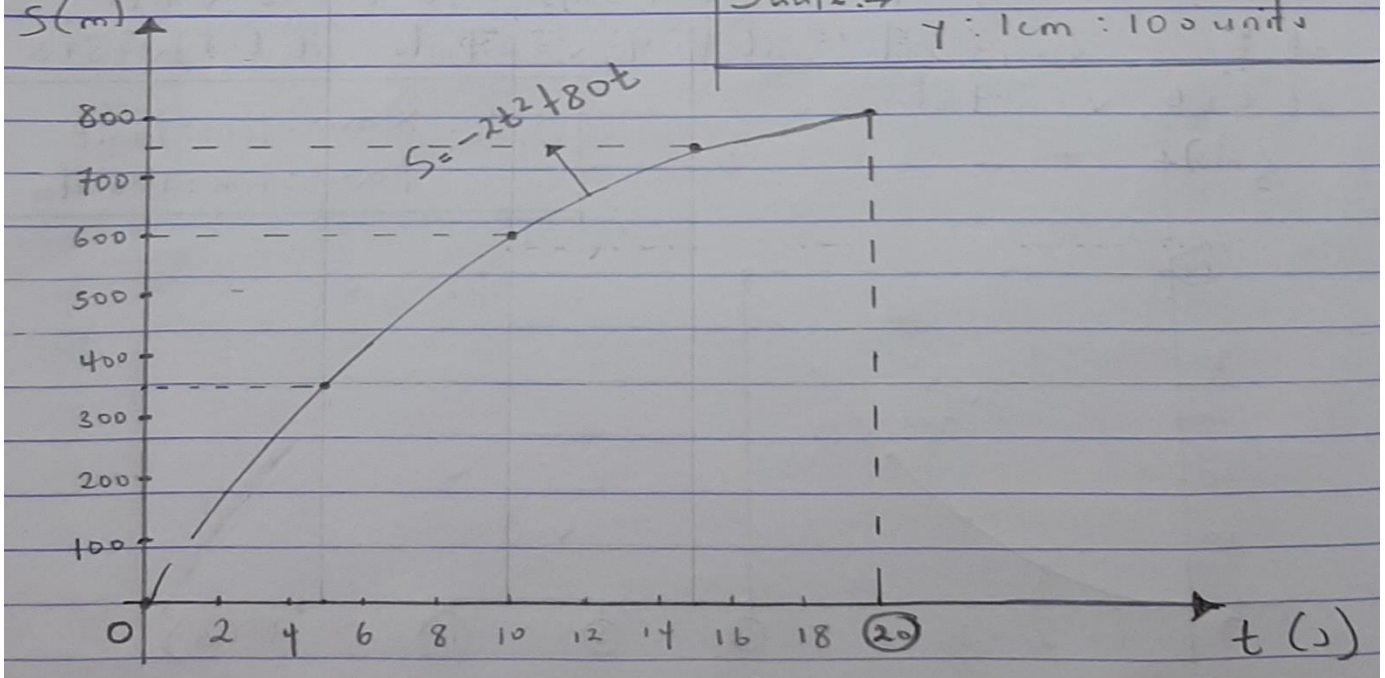
$s = -800 + 1600$

$s = 800\ m$

Coordinates: (0, 0), (5, 350), (10, 600), (15, 750), (20, 800)

Scale: x : 1cm : 2units

y : 1cm : 100 units



S - t GRAPH

for the a-t graph

$v = -4t + 80$

$a = \frac{dv}{dt}$

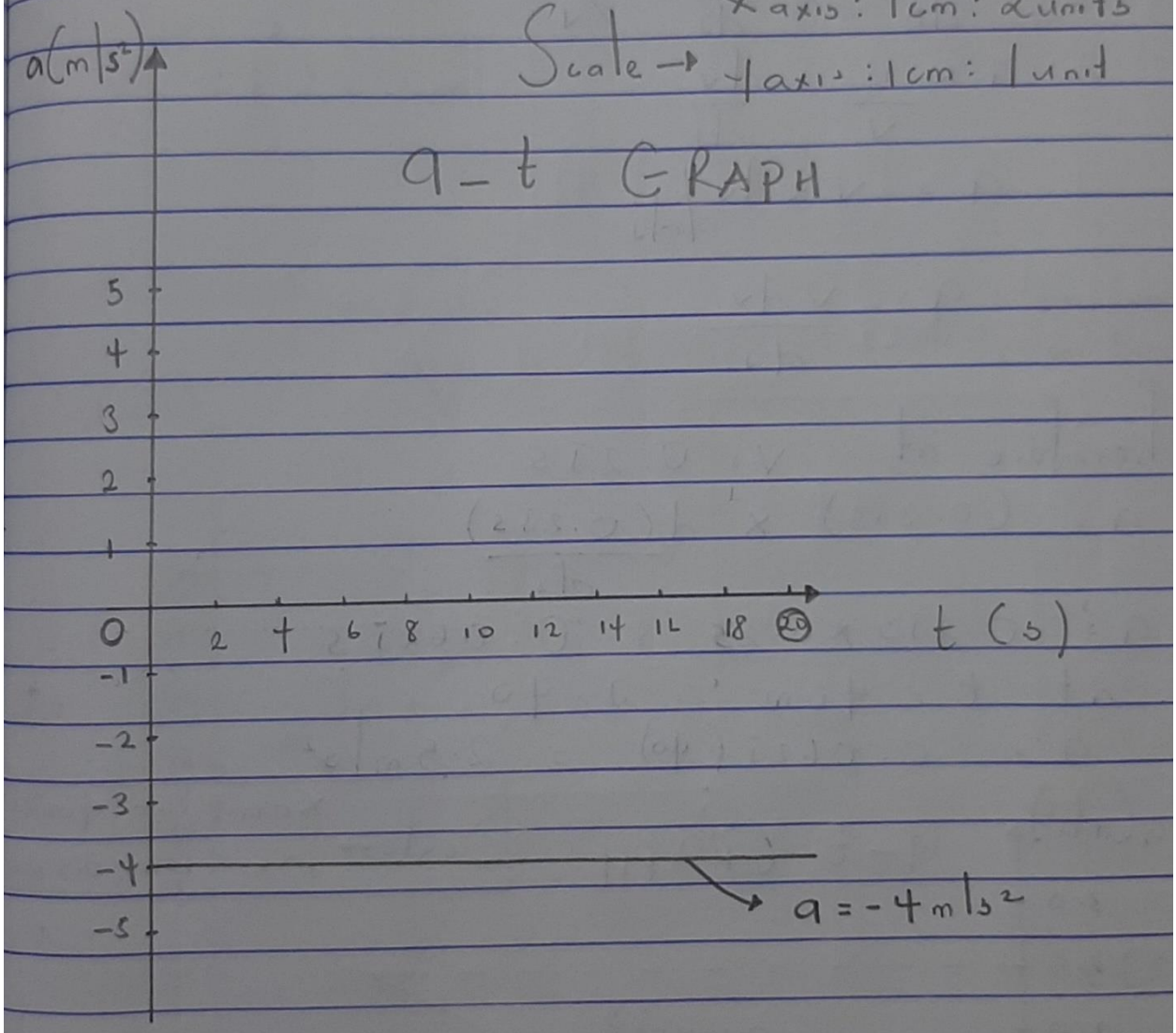
$\therefore a = \frac{d(-4t+80)}{dt}$

$\therefore a = -4 m/s^2$

Scale → x axis : 1cm : 2units

y axis : 1cm : 1unit

a-t GRAPH



F 12-11

from $\frac{dv}{dt} \times \frac{dt}{ds} = \frac{dv}{ds}$

where $\frac{dv}{dt} = a$

$\therefore a \times \frac{dt}{ds} = \frac{dv}{ds}$

also $v = \frac{ds}{dt}$ $\therefore \frac{dt}{ds} = 1/v$

$\therefore a \times \frac{1}{v} = \frac{dv}{ds}$

$a = v \times dv/ds$

$\therefore a = \frac{v\,dv}{ds}$

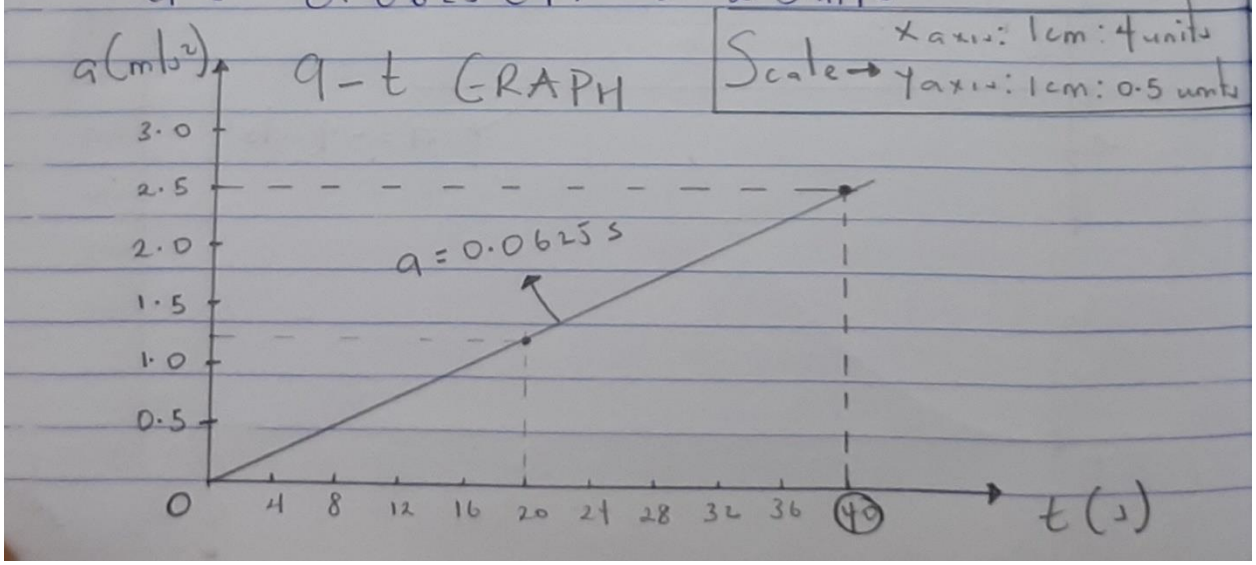
Therefore at $v = 0.2\bar{5}s$

$a = (0.2\bar{5}s) \times \frac{d(0.2\bar{5}s)}{ds}$

$a = 0.2\bar{5} \times 0.25 = 0.0625\bar{s}$

$\therefore$ at $t = 40m$ $\therefore s = 40$

$a = 0.0625(40) = 2.5\ m/s^2$



F-12-12

For part 1 $(0 \le t \le 5)$

$s = 3t^2$

Note $v = \frac{ds}{dt}$

$\therefore v = \frac{d(3t^2)}{dt}$

$v = 6t$

at time 5

$v = 6(5) = 30 \text{ m/s}$

For part 2 $(5 \le t \le 10)$

$s = 30t - 75$

Note $v = ds/dt$

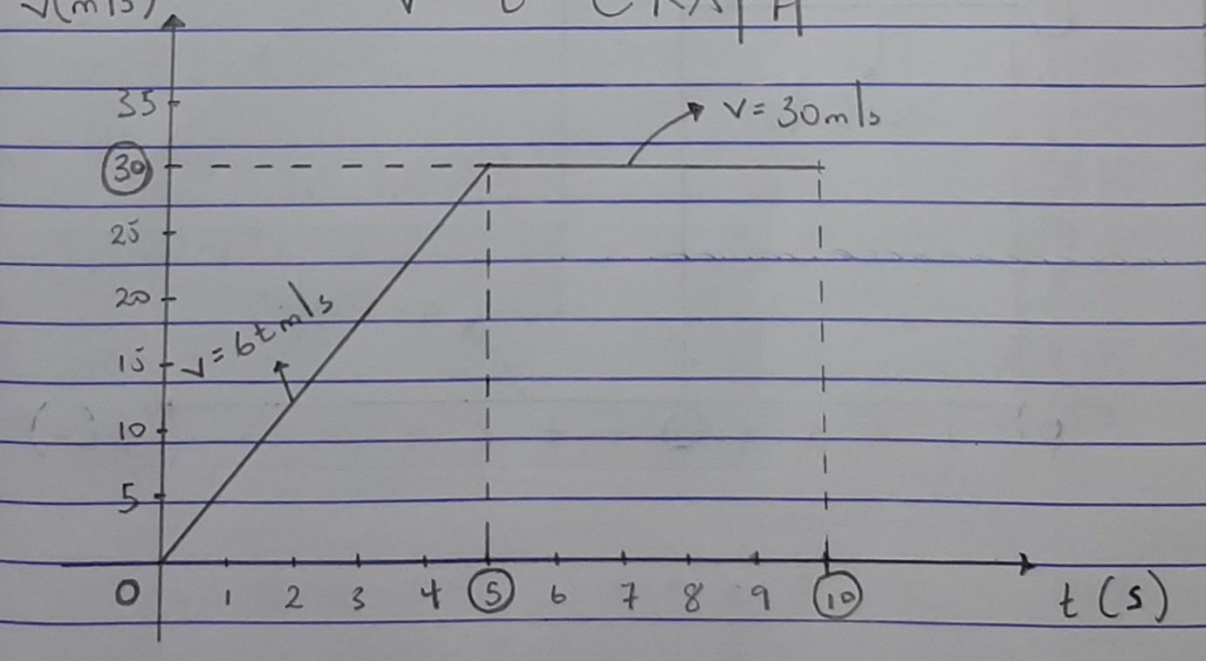
$v = \frac{d(30t - 75)}{dt}$

$v = 30$

$\therefore v = 30$ (constant).

Scale → x: 1cm : 1unit
y: 1cm : 5units

V-t GRAPH



for the a-t graph

first part $(0 \leq t \leq 5)$

$v = 6t$

$\therefore a = \frac{dv}{dt}$

$\therefore a = \frac{d(6t)}{dt}$

$a = 6\ m/s^2$ (constant)

2nd part $(5 \leq t \leq 10)$

$v = 30$

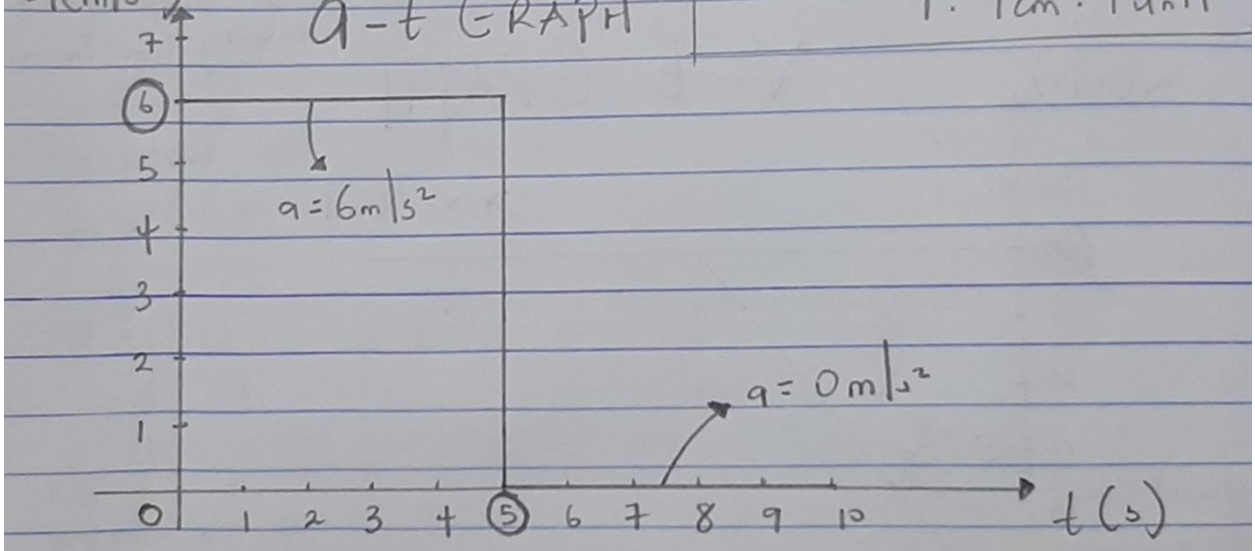
$a = \frac{dv}{dt}$

$\therefore a = \frac{d(30)}{dt}$

$a = 0\ m/s^2$ (constant)

Scale → x: 1cm : 1unit
y: 1cm : 1unit

a-t GRAPH



F 12-13

From rest $\therefore v_0 = 0$

for interval $0 \le t \le 5$

$a = 20 \text{ m/s}^2$

$a = \frac{dv}{dt}$

$\therefore v = \int a$

$v = \int 20\, dt$

$v = 20t + c$

at time $= 0$, $v = 0$

$\therefore 0 = 20(0) + c$

$\therefore c = 0$

$\therefore v = (20t) \text{ m/s}$

at $t = 5$, $v = 20(5)$

$= 100 \text{ m/s}$

for time interval $5 \le t \le t'$

$a = -10 \text{ m/s}^2$

$a = dv/dt$

$\therefore v = \int a\, dt$

$\therefore v = \int -10\, dt$

$v = -10t + c$

starting from $t = 5$

$v_0 = 100 \text{ m/s}$

$\therefore v = (-10t + 100) \text{ m/s}$

To find t' = time car come to rest

$\therefore v = 0$

$\therefore -10t + 100 = 0$

$-10t = -100$

$t = -100/-10$

$t = 10 \text{ s}$

$\therefore$ Total time $= 5 + 10$

$= 15 \text{ s}$

$\therefore t' = 15$ seconds

$\therefore v = 20t \quad (0 \le t \le 5)$

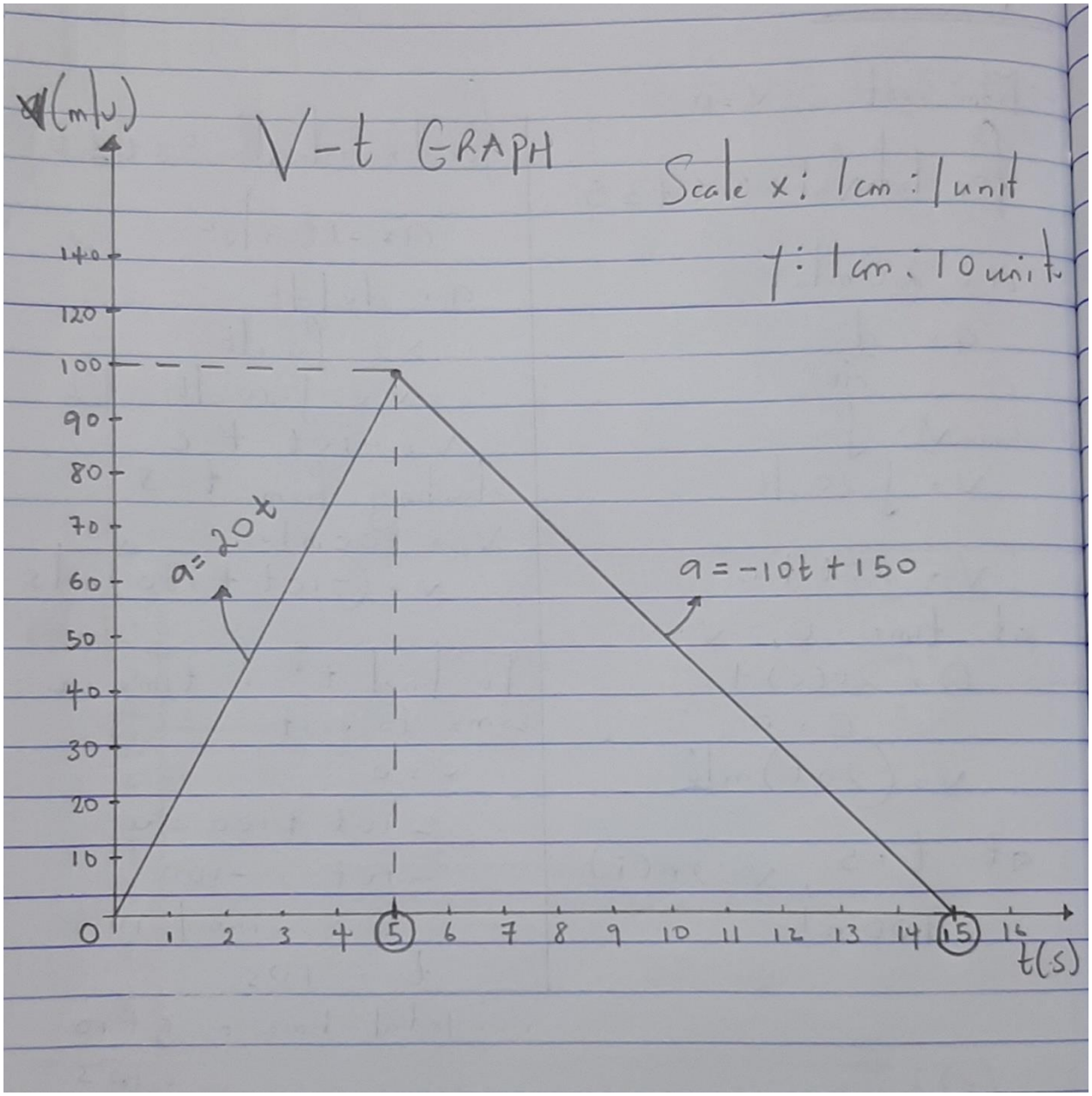
$v = -10t + 100 \quad (5 \le t \le 15)$

$\Downarrow$

adding constant for previous 5 seconds

$10 \times 5 = 50$

$\therefore v = -10t + 150$


V-t GRAPH
Scale x: 1cm : 1unit
y: 1cm : 10 units
v(m/s)
140
120
100
90
80
70
60
50
40
30
20
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
t(s)
a = 20t
a = -10t + 150

Q 12-14

from rest $\therefore v = 0$ at $t = 0$

$a = 0$ at $t = 0$

Total distance travelled for a v-t graph

= TOTAL AREA UNDER THE GRAPH.

= Area of triangle $= \frac{1}{2} \times b \times h$

$= \frac{1}{2} \times 15 \times 150$

$= 1125\,m$

for $0 \le t \le 5$

$v = 30t$

$v = ds/dt$

$\therefore s = \int v\,dt$

$s = \int 30t\,dt$

$s = \frac{30t^2}{2} + c$

$s = 15t^2 + c$

from rest $\therefore$ at $t = 0$, $s = 0$

$\therefore s = 15t^2$

Note $\left[15t^2\right]_0^5$

$= 375 - 0 = 375\,m$

(Distance covered in first portion)

for $5 \le t \le 15$

$v = -15t + 225$

$\therefore v = ds/dt$

$s = \int v\,dt$

$s = \int_5^t (-15t + 225)\,dt$

$s = \frac{-15t^2}{2} + 225t + A$

Initial $= \left[\frac{-15t^2}{2} + 225t\right]_5^t$

$= \left(\frac{-15t^2}{2} + 225t\right) - 937.5$

$\therefore$ Add initial distance

$= \frac{-15t^2}{2} + 225t - 937.5 + 375$

$s = \frac{-15t^2}{2} + 225t - 562.5$

Also

Total distance

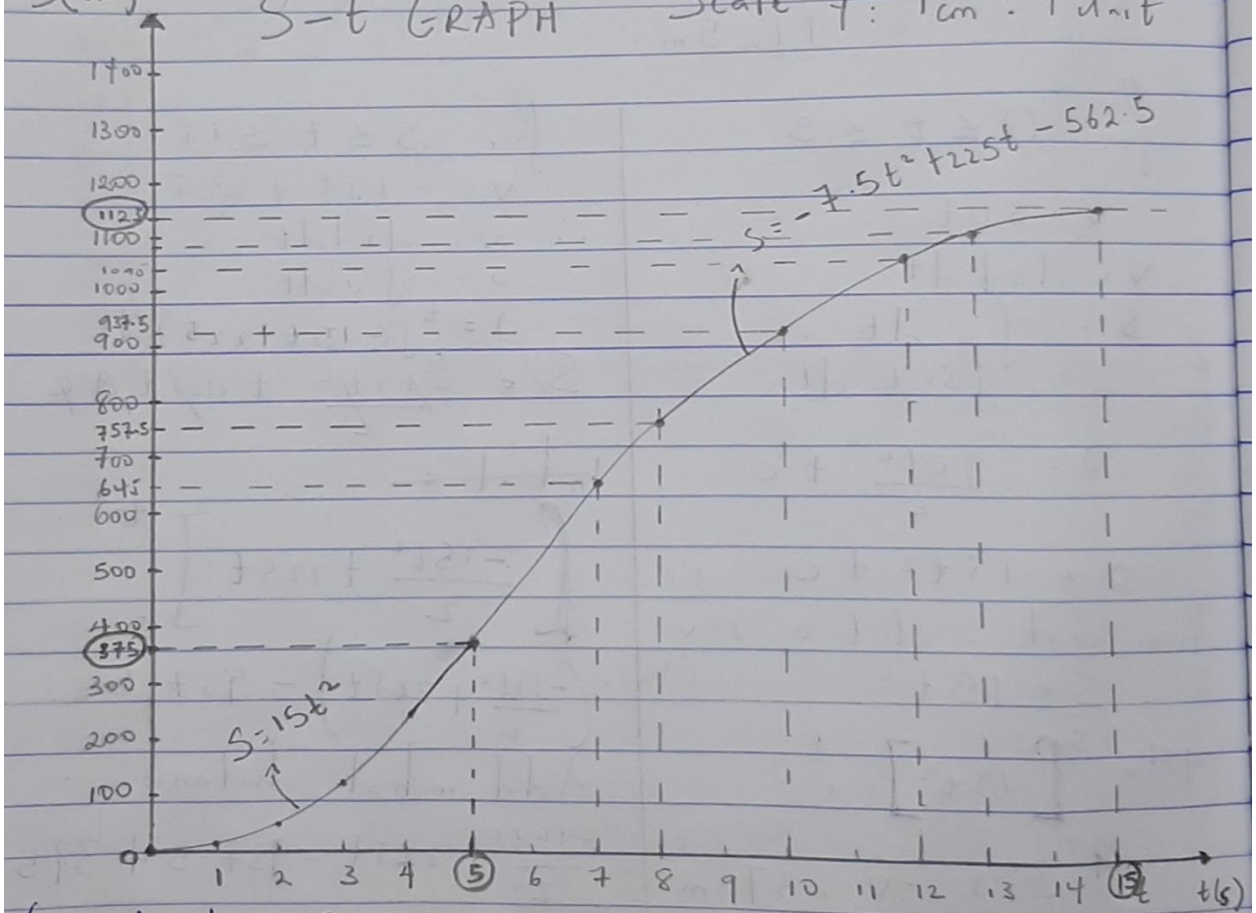
$S = -7.5t^2 + 225t - 562.5$

at $t = 15$

$S = -7.5(15)^2 + 225(15) - 562.5$

$\Rightarrow$ 1125 m

S(m) S-t GRAPH Scale x: 1cm : 100 unit. y: 1cm : 1 unit



Coordinates (1, 15), (2, 60), (3, 135), (4, 240), (5, 375), ~~(6, 540), (7, 735), (8, 960), (9, 1215), (10, 1500)~~ (10, 937.5)