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18/Eng06/015
Mechanical Engineering

1) The particle travels along a straight track such that it's position is described by the s-t graph. Construct the v-t graph for the given time interval

From S-t curve,

$S = 0.8t^3$ ---- $0 \leq t \leq 6$

$S = 108m$ ---- $6 \leq t \leq 10$

∴ for time interval, $0 \leq t \leq 6$,

$V = ds/dt = d/dt (0.8t^3)$

$V = 0.8 \times 3t^2$ $\quad [\because d/dt (t^n) = nt^{n-1}]$

$V = 1.8t^2$ ---- $0 \leq t \leq 6$

at $t = 0$, $V = 0$

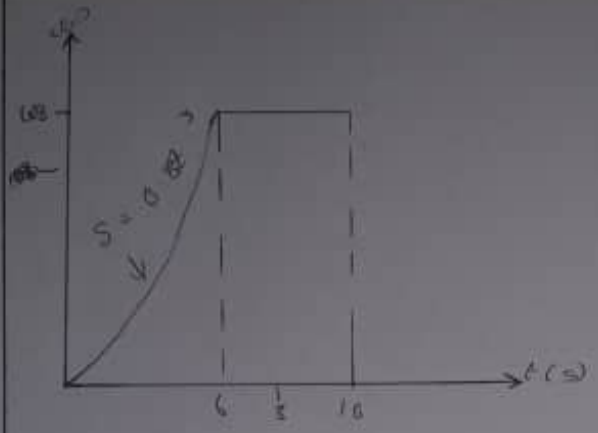
at $t = 6sec$, $V = 1.8 \times 6^2 = 54 m/s$

during the time interval,

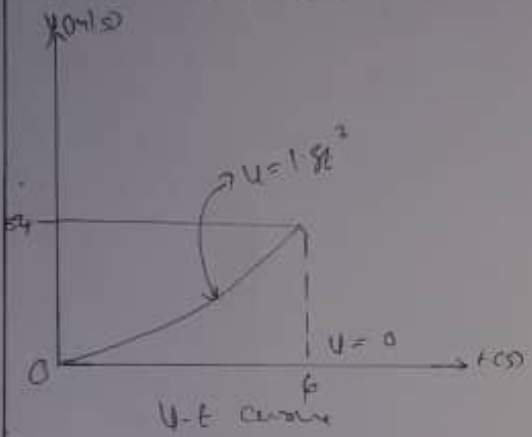
$6 \leq t \leq 10$

displacement, $S = 108$ i.e $S =$ constant

∴ $V = ds/dt = 0$ ---- $6 \leq t \leq 10$



S-t curve



V-t curve

2. A van travels along a straight road with a velocity described by the graph. Construct the S-t and a-t graphs during the same period. Takes 0 when t = 0.

Given $V = -4t + 80$

$ds/dt = -4t + 80$

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

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

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

also $S = 0$ for $t = 0$

$S = -2t^2 + 80t$

① $S = 0$, at $t = 0$

② $S = 0 \Rightarrow 2t^2 = 80t$

$t = 40s$

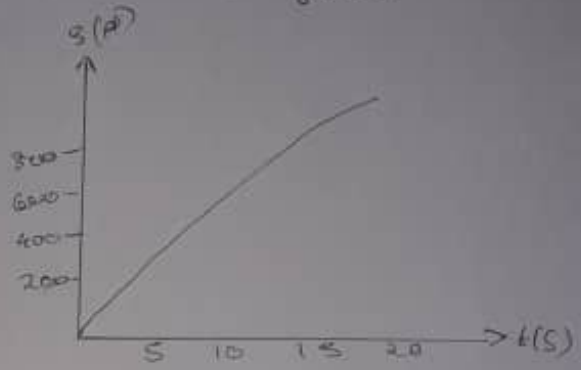
③ $ds/dt = 0 \Rightarrow -4t = -80$

$t = 20s$

$S|_{t=20} = -2 \times (20)^2 + 80 \times 20$

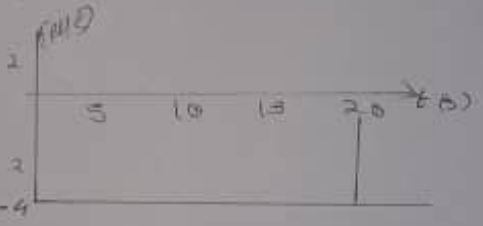
$= -800 + 1600$

$= 800m$



S-t graph

$dv/dt = a = -4$



3. A bicycle travels along a straight road where it's velocity is described by the v-s graph. Construct the a-s graph for the same time interval.

$v\,dv = a\,ds$

$v = 0.25s$

$dv/ds = 0.25$

$dv = 0.25\,ds$

$a\,ds = v\,dv$

$a\,ds = (0.25s)(0.25\,ds)$

$a = 0.25s \times 0.25$

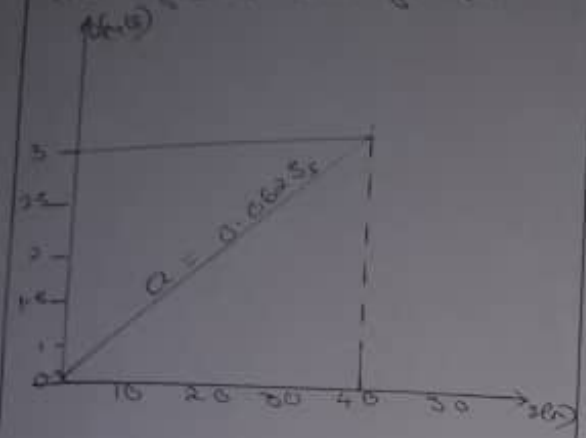
$a = 0.0625s$

at $s = 40$

$a = 0.0625(40)$

$a = 2.5 m/s$

the given v-s graph



4) The stock car towards along a straight road such that it's position is described by the graph. Construct the v-t and a-t graphs for the time interval $0 \leq t \leq 10s$

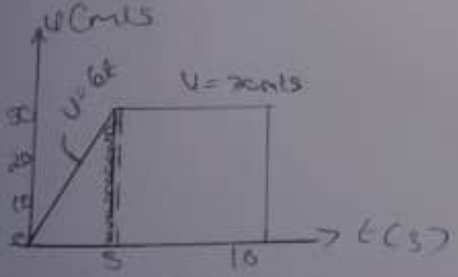
Solution

$0 \leq t \leq 5s, \quad s = 3t^2$

$v = ds/dt = 6t \ m/s$

$5 \leq t \leq 10, \quad s = 30t - 75$

$v = ds/dt = 30 m/s$



v-t graph

$v = \frac{\Delta s}{\Delta t}$

$= \frac{225 - 25}{10 - 5} = 40 m/s$

a-t graph

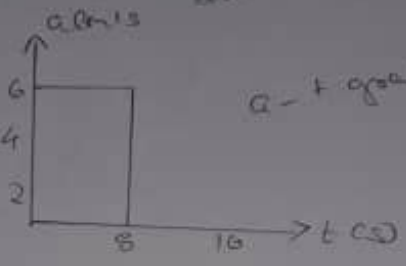
$0 \leq t < 5s, \quad v = 6t \ (m/s)$

$a = dv/dt$

$= 6 m/s^2$

$5 < t \leq 10s, \quad v = 30 m/s$

$a = \frac{dv}{dt} = 0$



5) The dragster starts from rest and has an acceleration described by the graph. Construct the v-t graph for the time interval $0 \leq t \leq t'$. where t' is the time the car has come to rest

Solution

at $= 0 \leq t \leq 5$

$dv = a\,dt$

$\int_0^v dv = \int_0^t 20\,dt$

$v = 20t$

at $t = 5s$

$v = 20(5) = 100 m/s$

at $5 \leq t \leq t'$

$a = -10$

$\int_{100}^v dv = \int_5^t -10\,dt$

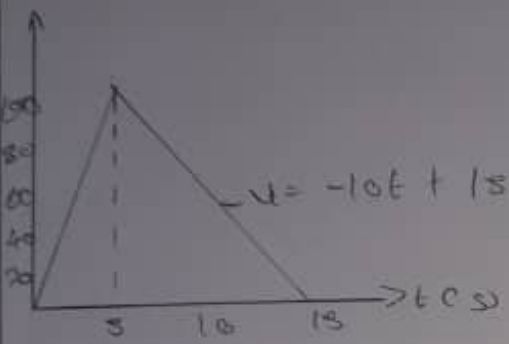
$v|_{100}^v = -10t|_5^t$

$V - 150 = -10t + 50$

$V = -10t + 150$

at $t = t^1$, $V = 0$

$t = \frac{0 - 150}{-10} = 15$



(b) The dragster starts from rest and has a velocity described by the equation. Construct the s-t equation during the time interval $0 \leq t \leq 15s$. Also, determine the total distance traveled during the time interval.

Solution

$V = 30t$ for $0 \leq t \leq 5s$

$V = -15t + 225$ for $5s < t \leq 15$

$\therefore V = ds/dt$

$ds = V dt$ — (1)

equation for the distance traveled between $0 \leq t < 5s$ is $V = 30t$

$ds = V dt$

$ds = 30t\, dt$

$\int_0^s ds = \int_0^t 30t\, dt$

$\int_0^s ds = \int_0^{5s} 30t\, dt$

$s - [30 \times t^2/2]_0^5$

$= 15 \times (5)^2$

$s = 375 m$

Equation for the distance traveled between $5s < t \leq 15s$

$\int_{375}^{s} ds = \int_5^t (-15t + 225)\, dt$

$[s]_{375}^{s} = \left[\frac{-15t^2}{2} + 225t\right]_5^t$

$[s - 375] = \left[\frac{-15t^2}{2} + 225t\right] - \left[\frac{-15 \times 5^2}{2} + 225 \times 5\right]$ — (2)

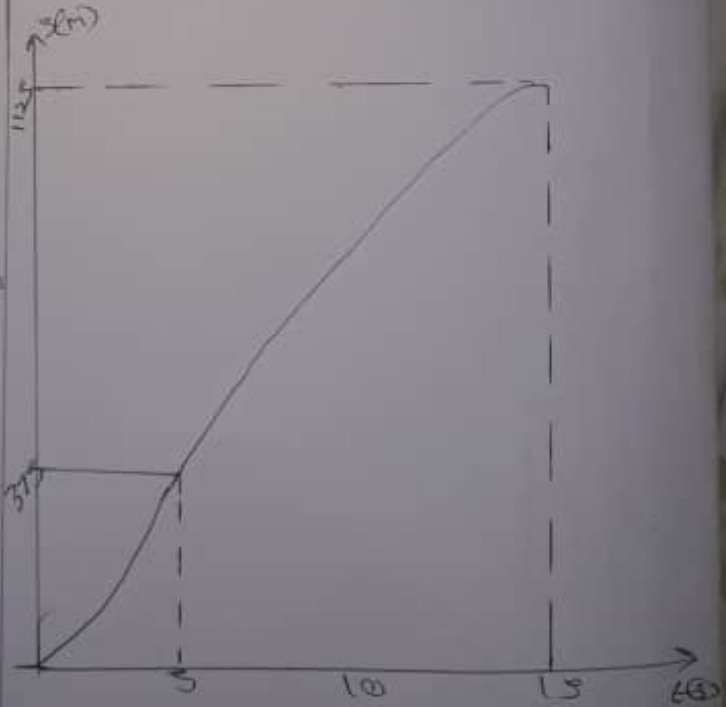
$s - 375 = (-7.5t^2 + 225t) - 937.5$

$s = [-7.5t^2 + 225t - 562.5] m$ — (3)

Sub $t = 15sec$ in eqn (3)

$s = (-7.5(15)^2 + 225 \times 15 - 562.5) m$

$s = 1125 m$



s-t graph