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COURSE: ENGINEERING MECHANICS

DEPT: MECHATRONICS ENGINEERING

MATRIC: 18/ENG05/057

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Solution

(1) F12-9

$$s = 0.5t^3$$
$$\frac{ds}{dt} = v = 1.5t^2$$

at $t = 6$;

$$v = 1.5(6)^2$$
$$= 54 \text{ m/s}$$

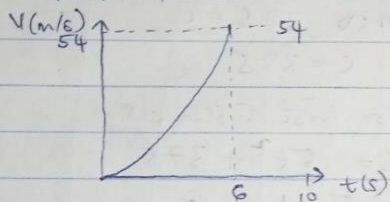
at $s = 108$

$$\frac{ds}{dt} = 0$$

\therefore at $t = 4\text{s}$;

$$v = 0 \text{ m/s}$$

v-t graph for F12-9



(2) F12-10

$$v = (-4t + 80)$$

$$\int v dt = s = -2t^2 + 80t + c$$

when $s = 0, t = 0, c = 0$;

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

a-t graph

$$v = -4t + 80$$

$$\frac{dv}{dt} = a = -4 \text{ m/s}^2$$

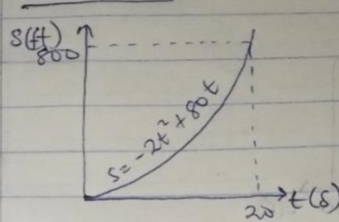
for s-t graph

when $t = 20$;

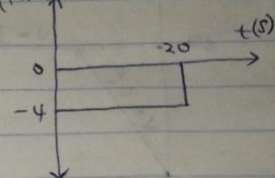
$$s = -2(20)^2 + 80(20)$$

$$= 800 \text{ ft}$$

s-t graph



a-t graph



(3) F12-11

$$v = 0.25s \quad \therefore \frac{dv}{ds} = 0.25$$

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

$$\frac{dv}{dt} = 0.25 \times v(t)$$

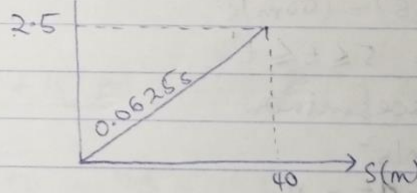
$$a = 0.25v$$

$$\text{since } v = 0.25s; \quad a = 0.25(0.25s)$$

$$a = 0.0625s$$

$$\text{when } s = 40; \quad a = 0.0625(40) = 2.5 \text{ m/s}^2$$

a(m/s²)



(4) F12-12, for (0-5) seconds

$$s = 3t^2$$

$$v = \frac{ds}{dt} = 6t; \quad a = \frac{dv}{dt} = 6 \text{ m/s}^2$$

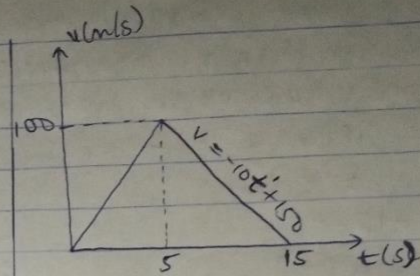
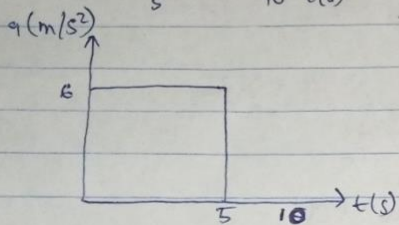
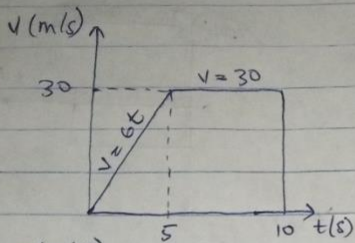
when $t = 5$ seconds

$$v = 6(5) = 30 \text{ m/s}; \quad a = 6 \text{ m/s}^2$$

for (5-10) seconds

$$s = 30t - 75$$

$$v = \frac{ds}{dt} = 30 \text{ m/s}; \quad a = \frac{dv}{dt} = 0 \text{ m/s}^2$$



(E) P12-14

for first 5 seconds;

$$v = 30t$$

$$\int v dt = s = 15t^2 + C$$

$$s = \text{speed} \times \text{time} = \frac{1}{2} \times b \times h$$

$$\Rightarrow \text{750} = \frac{1}{2} \times 5 \times 150$$

$$\therefore 375 = 15(5)^2 + C$$

$$750 - 375 = C$$

$$C = 375$$

\therefore for first 5 seconds;

$$s = 15t^2 + 375$$

for $5 \leq t \leq 15$;

$$v = -10t + 150$$

$$\int v dt = s = \frac{-10t^2}{2} + 150t + C$$

$$\text{Total distance travelled} = \frac{1}{2} b \times h$$

$$= \frac{1}{2} \times 15 \times 150 = 1,125 \text{ m}$$

(E) P12-13

at 5s, $a = 20 \text{ m/s}^2$

$$v = \int a dt = \int 20 dt$$

$$v = 20t$$

$$v = 20(5) = 100 \text{ m/s}$$

at $5 \leq t \leq t'$

at deceleration

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

$$\int_5^{t'} -10 dt = v$$

$$v = [-10t]_5^{t'}$$

$$v = -10t' + 50$$

$$\text{Initial } v = 100 \text{ m/s}$$

$$\therefore -10t' + 50 + 100$$

$$\therefore v = -10t' + 150$$

Since the car gets to rest, v becomes '0'

$$\therefore -150 = -10t'$$

$$t' = 15 \text{ s}$$

$$(c) a = 14$$

for first 5 seconds;

$$v = 30t$$

$$\int v dt = s = \frac{15t^2}{1} + C$$

$$\text{Distance } (s) = \frac{1}{2} \times 5 \times 150 = 375 \text{ m}$$

$$\therefore 375 = 15(s)^2 + C$$

$$C = 0$$

$$\therefore s = 15t^2$$

for $5 \leq t \leq 15$;

$$v = -15t + 225$$

$$\int v dt = s = \frac{-15t^2}{2} + 225t + C$$

$$\text{Total distance covered} = \frac{1}{2} \times b \times h$$

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

$$s = 1125 \text{ m}$$

$$1125 - 375 = 750$$

$$750 = \left(\frac{-15(15)^2}{2} + 225(15) + C \right) - \left(\frac{-15(5)^2}{2} + 225(5) + C \right)$$

$$750 = 750 + 2250 + C$$

$$C = 750$$

$$750 = \frac{-15(15)^2}{2} + 225(15) + \frac{15(5)^2}{2} - 225(5) + C$$

$$750 = 187.5 + C \quad 750 = 750 + C$$

$$C = 562.5 \quad C = 0$$

$$\therefore \text{for } 5 \leq t \leq 15;$$
$$s = -7.5t^2 + 225t$$

