

Newton's Second Law

Computer Graphics

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

$s = \int v dt$

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

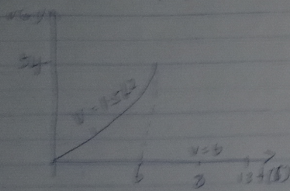
$v = \int a dt$

Initial Speed

Initial Position

$v = \int a dt + v_0$

The v-t graph



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

$\int ds = \int v dt$

$0.4 + 6.70 \quad v = -6t + 18.6$

$s = \int (-6t + 18.6) dt$

$s = \left[ -\frac{6t^2}{2} + 18.6t \right]$

$s = -2t^2 + 30t$

at  $t=20$

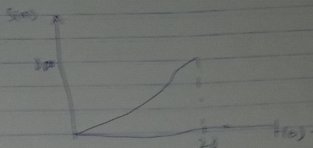
$s = -2(20)^2 + 30(20) = -800 + 600$

$s = -200$

at  $t=0$

$s = -2(0)^2 + 30(0) = 0$

See s-t graph



To get it at a-t graph

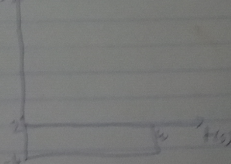
$a = \frac{dv}{dt} \quad v = -6t + 18.6$

$a = -6 \text{ (m/s}^2\text{)}$

$a = -4 \text{ (m/s}^2\text{)}$

$a = -4 \text{ m/s}^2$  is the value of deceleration

a (m/s<sup>2</sup>)



3)  $a = 0.25$   $0 \leq t \leq 40$   $v = 0.25t$

$a = dv/dt$

$a = 0.25 \text{ d/ds } (0.25t)$

$u = 0.25 \times 0.25$

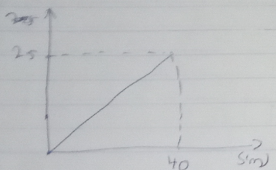
$a = 0.0625 \text{ m/s}^2$

$s = 40 \text{ m}$

$a = 0.0625 \times 40$

$u = 2.5 \text{ m/s}^2$

$\Delta t = 0$   $a = 0 \text{ m/s}^2$



The  $a$ - $s$ - $s$  graph

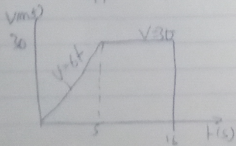
4)  $v = ds/dt$   $0 \leq t < 5$   $s = 3t^2$   
 $v = ds/dt = d/dt (3t^2)$

$v = 6t$

$\Delta t = 5$

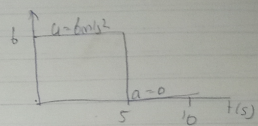
$u = 6(5) = 30 \text{ m/s}$

For  $v = ds/dt = 2/dt (30t - 7s) v = 30 \text{ m/s}$



for  $0 \leq t < 5$   $v = t$   $a = dv/dt = d/dt (t) = a = 1 \text{ m/s}^2$   
 for  $5 \leq t < 10$   $v = 5$   
 $a = dv/dt = d/dt (5) = 0$

The  $a$ - $t$  graph



$\Rightarrow a = dv/dt$   $d = at^2$

$\int_0^t dr = \int_0^t a dt$

for  $0 \leq t < 5$   $a = 20$

$dv = a dt$   
 $\int_0^t dv = \int_0^t a dt$

$v = \int_0^t 20 dt$

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

$\Delta t = 5$

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

$5 \leq t < 10$   $a = -10 \text{ m/s}^2$

$a = dv/dt$

$v = \int_0^t dv = \int_0^t a dt$

$v = 100 = \int_5^t -10 dt$

$v = [-10t \text{ m/s}]_5^t + 10$

$v = -10t + 150 \text{ m/s}$



when  $t = t'$   $v = 6$

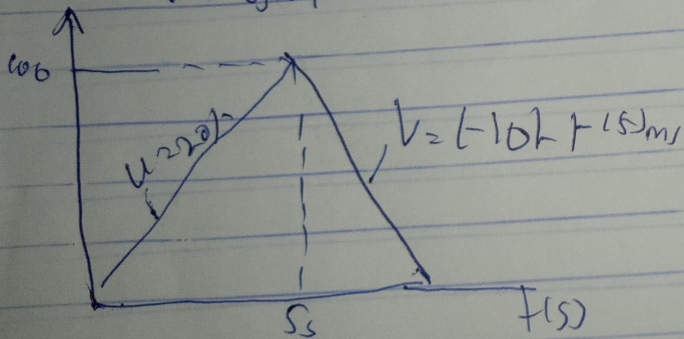
$$0 = 10t' + 15$$

$$10t' = 15$$

$$t' = 1.5s$$

$$v = (-10t + 15) \text{ m/s}$$

$v-t$  graph



$v-t$  graph

$$(30) = 0$$

$$a = 6 \text{ m/s}^2$$

$$a = 0$$

5

0

$$6) \quad 0 \leq t \leq 5s \quad v = 30t$$

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

$$s = 15t^2$$

$$\text{when } t = 5$$

$$s = 15(5)^2 = 375 \text{ m}$$

$$5s \leq t \leq 15s$$

$$v = -15t + 225 \text{ m/s}$$

$$\int_{375}^s ds = \int_{5s}^t (-15t + 225) dt$$

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

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

$$\text{When } t = 15$$

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

$$1125 \text{ m}$$

