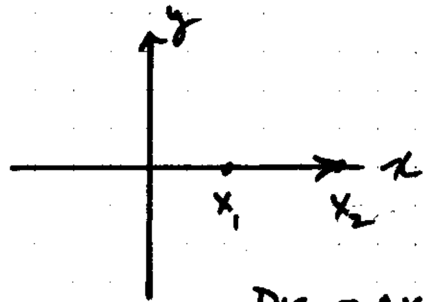
POSITION - DISPLACEMENT - VELOCITY - ACCELERATION



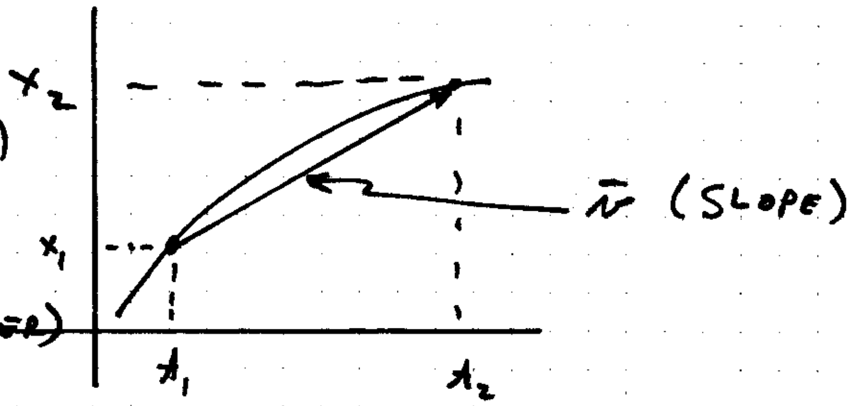
$DISP = \Delta X = X_2 - X_1$ (VECTOR)

AVG. VELOCITY

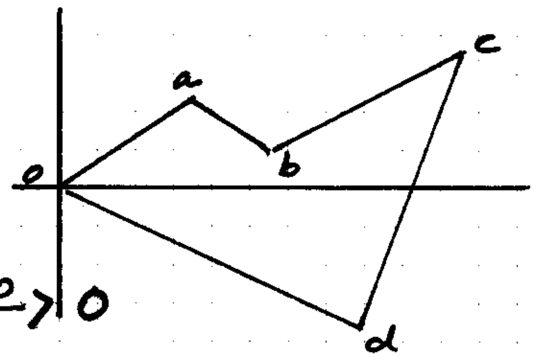
$\bar{v} = \dfrac{\Delta X}{\Delta t} = \dfrac{X_2 - X_1}{t_2 - t_1}$ (VECTOR)

AVG SPEED

$\bar{S} = \dfrac{\text{TOTAL DISTANCE}}{\text{TOTAL TIME}}$ (SCALER)



$S_{oc} = \dfrac{oa + ab + bc}{t_{o \to c}}$

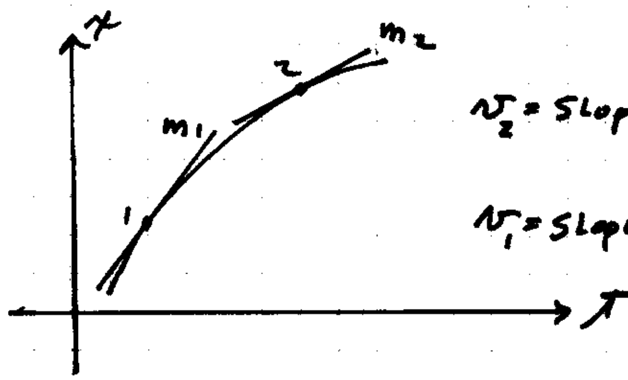


$\bar{S}_{oo} = \dfrac{oa + ab + bc + cd + do}{t_{o \to o}} > 0$

$\bar{v}_{oo} = 0$ (ZERO NET DISPLACEMENT)

INSTANTANEOUS VELOCITY

$\vec{v} = \lim\limits_{\Delta t \to 0} \dfrac{\Delta x}{\Delta t} = \dfrac{dx}{dt}$

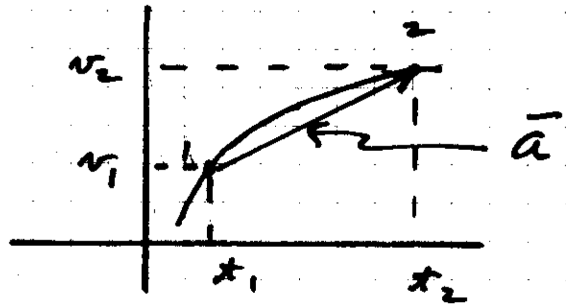


v_2 = SLOPE m_2 AT 2

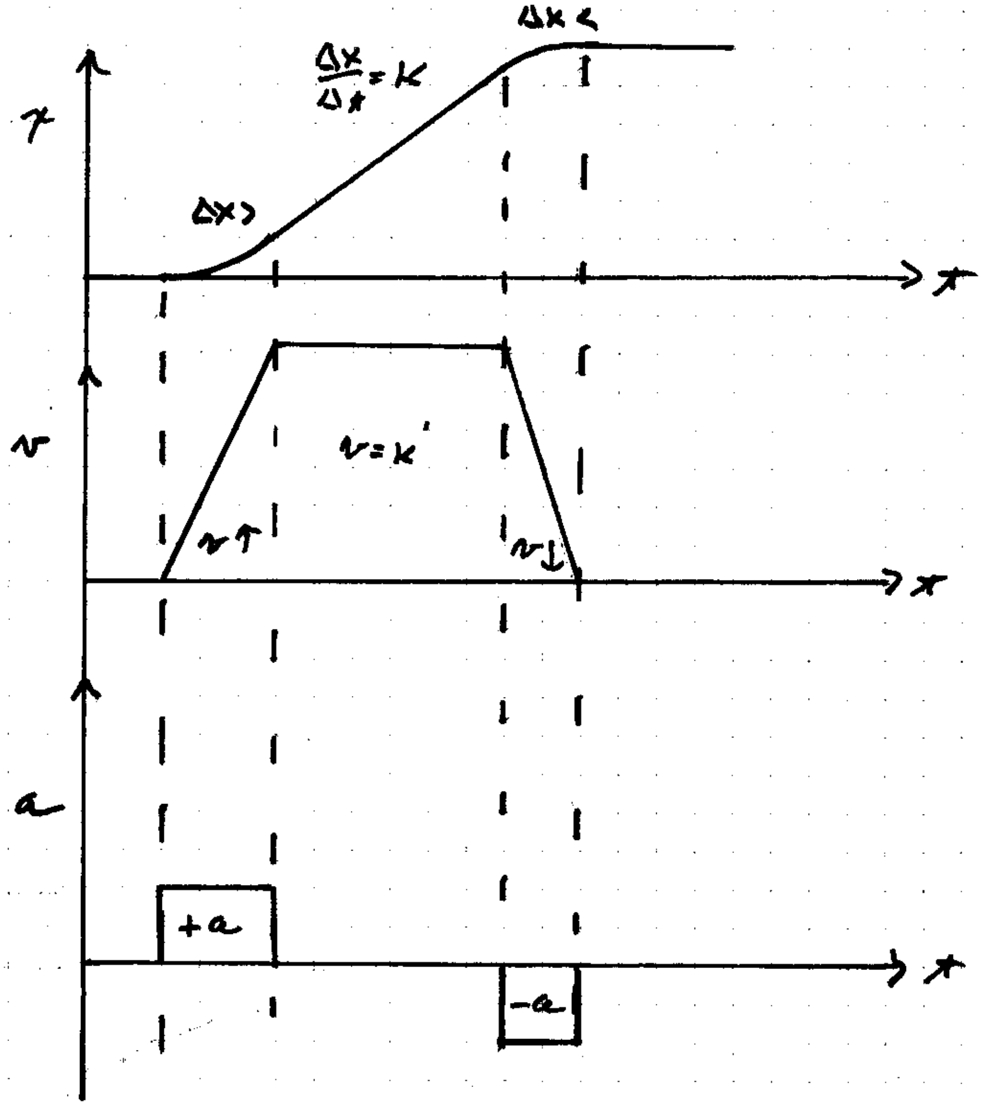
v_1 = SLOPE m_1 AT 1

$$\vec{a} = \frac{v_2 - v_1}{t_2 - t_1} = \frac{\Delta v}{\Delta t}$$

AVG ACCELERATION



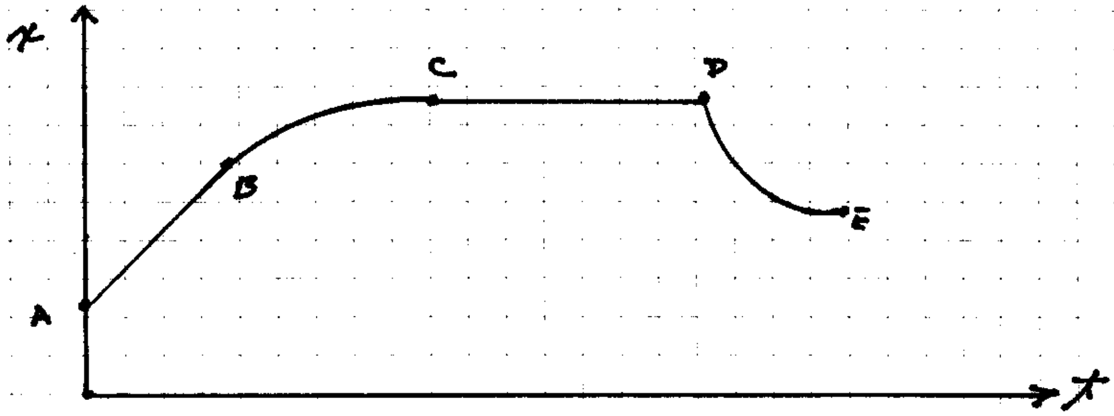
$$\vec{a} = \lim_{\Delta t \to 0} \frac{v_2 - v_1}{t_2 - t_2} = \frac{dv}{dt} = \frac{d^2 x}{dt^2}$$



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

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

EXAMPLE DETERMINE WHETHER $\vec{v}$ & $\vec{a}$ ARE POSITIVE, NEGATIVE OR ZERO IN THE REGIONS SHOWN



AB - STRAIGHT LINE $\quad v =$ CONSTANT (SLOPE = CONSTANT) $\quad a = 0$ SINCE $\frac{\Delta v}{\Delta t} = 0$

BC - DECREASING POSITIVE SLOPE $\quad v > 0$ & DECREASING TO ZERO AT POINT C $\quad \frac{\Delta v}{\Delta t} < 0 \quad a < 0$

$$\left(\frac{v_c - v_B}{t_c - t_B} < 0 \right)$$

CD - HORIZONTAL LINE $\quad \frac{\Delta v}{\Delta t} = 0 \quad v = 0 \rightarrow a = 0$

DE - NEGATIVE SLOPE (DECREASING) $\quad$ SLOPE IS GETTING LESS NEGATIVE & APPROACHES ZERO

$v < 0 \quad$ SO $v \rightarrow 0$

$$a = \frac{\cancelto{0}{v_f} - v_i}{t_f - t_i} = \frac{-(-v_i)}{\Delta t} > 0$$

1 D MOTION - CONSTANT ACCELERATION

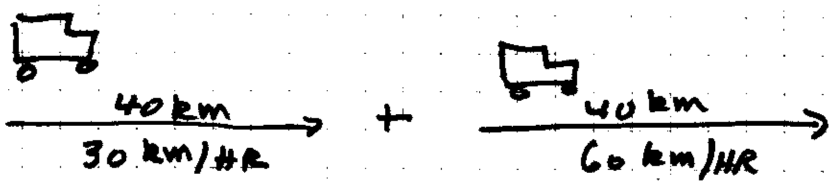
$$v = v_0 + at$$

$$x = x_0 + v_0 t + \frac{1}{2} a t^2$$

$$v^2 = v_0^2 + 2a(x - x_0)$$

$$\bar{v} = \frac{1}{2}(v + v_0)$$

EXAMPLE



a) WHAT IS THE AVG VEL OF THE CAR DURING THE TRIP

$$\bar{v} = \frac{\text{DISP}}{\text{TIME}}$$

$$40\text{ km} = 30\frac{\text{km}}{\text{HR}}\,t_1 \qquad 40\text{ km} = 60\frac{\text{km}}{\text{HR}}\,t_2$$

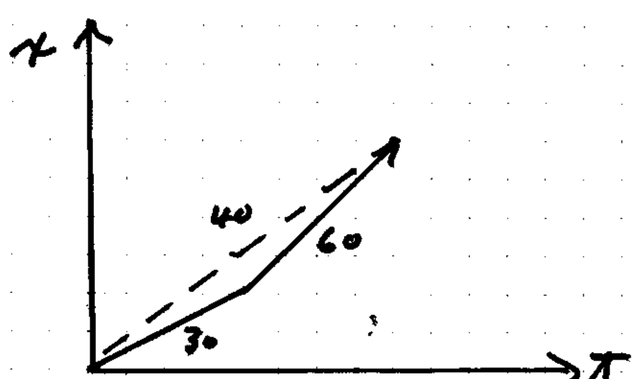
$$t_1 = \frac{40}{30} = 1.33\text{ HRS} \qquad t_2 = \frac{2}{3}\text{ HRS.}$$

$$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{40+40}{1\tfrac{1}{3}+\tfrac{2}{3}} = 40\text{ km/HR}$$

b) WHAT IS THE AVG. SPEED

$$\bar{S} = \frac{\text{TOTAL DIST}}{\text{TOTAL TIME}} = \frac{40+40}{2} = 40\text{ km/HR}$$

c) GRAPH x VS t & INDICATE HOW THE $\bar{v}$ IS FOUND



EXAMPLE

$v = 18\,m/s \rightarrow$ & in 2.4 sec $\leftarrow v = 30\,m/s$

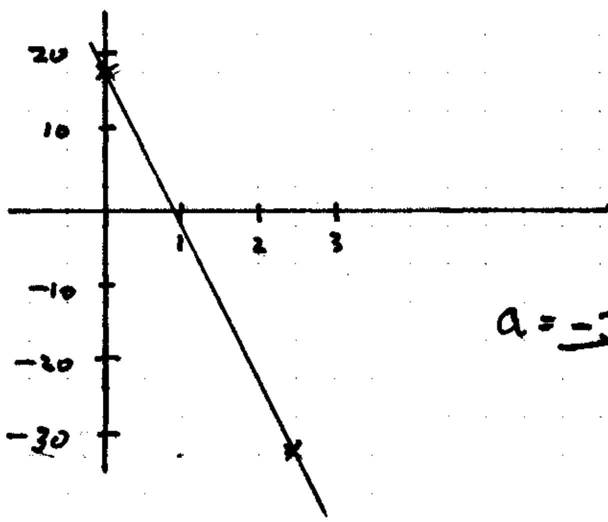
a) find the accel

$\overset{+}{\rightarrow}$

$v = v_0 + at$

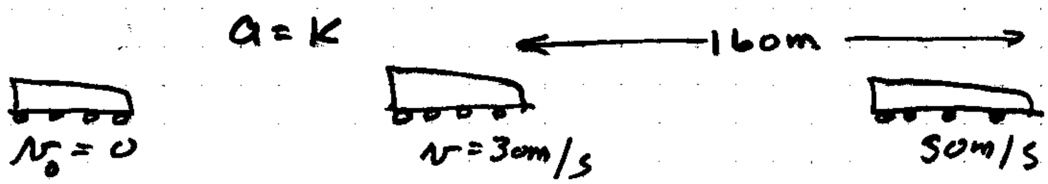
$-30 = 18 + 2.4a \qquad \dfrac{-48}{2.4} = a = -20\,m/s^2$

b) Graph v vs t & indicate how to find the avg accel



$a = \dfrac{-30 - (+18)}{2.4}$ = Slope of the curve

EXAMPLE



a) find the accel

$v_f^2 = v_0^2 + 2a\,\Delta x$

$50^2 = 30^2 + 2a(160)$

$2500 = 900 + 320a$

$a = 5\,m/s^2$

b) find the time to travel the 160 meters

$v = v_0 + at \qquad 50 = 30 + 5t \qquad t = \frac{20}{5} = 4$ Sec

c) find the time REQ'D to attain the initial 30 m/s

$$v = v_0 + at$$

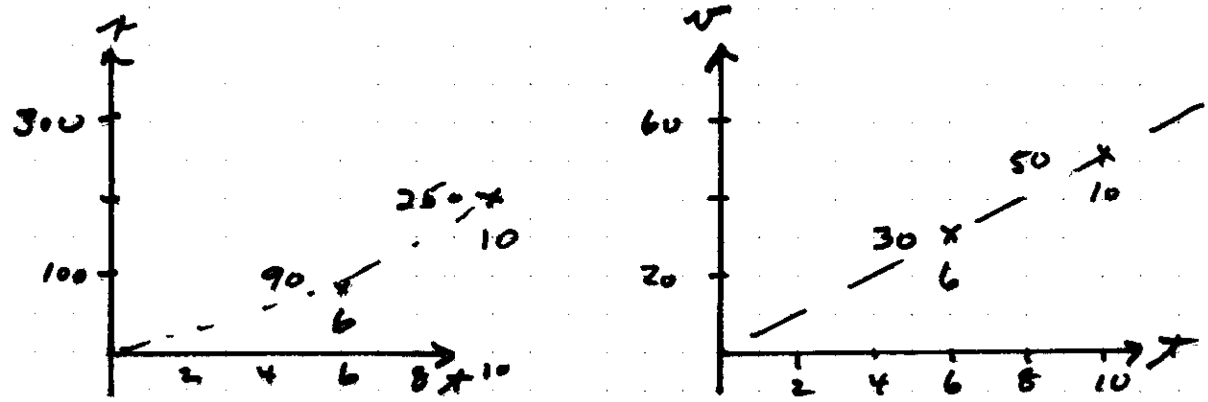
$$30 = 0 + 5t \qquad t = \frac{30}{5} = 6 \text{ sec}$$

d) The distance traveled in attaining the 30 m/s

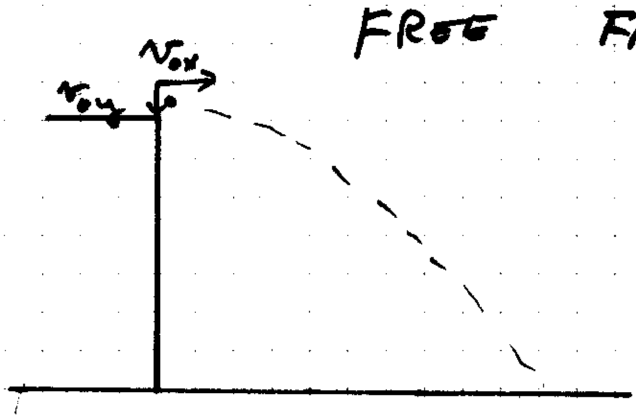
$$x = \cancelto{0}{v_0 t} + \cancelto{0}{x_0} + \frac{1}{2}at^2$$

$$= \frac{1}{2}(5)(6)^2 = 90 \text{ meters}$$

e) Graph $x(t)$ & $v(t)$ for the train starting from rest



FREE FALL



$$x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$$

$$y = y_0 + v_{0y}t - \frac{1}{2}g t^2$$

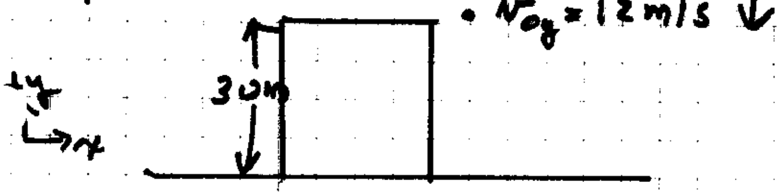
$$v_x = v_{0x} + a_x t$$

$$v_y = v_{0y} - gt$$

$$v_y^2 = v_{0y}^2 - 2g(y - y_0)$$

$$v_x^2 = v_{0x}^2 + 2a\,\cancelto{0}{(x - x_0)}$$

EXAMPLE



a) HOW LONG BEFORE THE STONE REACHES THE GROUND

$$y = y_0 + v_{oy} t - \frac{1}{2} g t^2$$

a) AT ROOF TOP $\quad y_0 = 0 \quad$ & $\quad y_{final} = -30$

OR

b) AT GROUND LEVEL $\quad y_0 = 30 \quad y_{final} = 0 \quad$ ← USE THIS CONDITION

$$y = y_0 + v_{oy} t - \frac{1}{2} g t^2$$

$$0 = 30 - 12t - \frac{1}{2}(9.8)t^2$$

$$t^2 + 2.45t - 6.12 = 0$$

$$t = \frac{-2.45 \pm \sqrt{2.45^2 - 4(1)(-6.12)}}{2}$$

$$t = \frac{-2.45 + 5.52}{2} = 1.54 \text{ Sec}$$

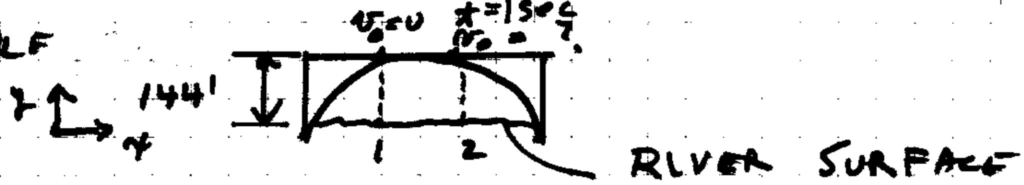
b) find the impact Velocity

$$v_{y_{impact}} = v_{oy} - gt$$

$$= 12 - 9.8(1.54)$$

$$= -3.09 \text{ Sec}$$

EXAMPLE



BOTH STONES REACH THE WATER AT THE SAME TIME

FOR STONE #1

$$y = y_o + \cancel{v_{oy}}\,t - \frac{1}{2} g t_1^2$$

$$0 = 144 - \frac{1}{2}(32) t_1^2$$

$$t_1 = \sqrt{\frac{144(2)}{32}} = 3 \text{ SEC}$$

FOR STONE #2

$$y = y_o + v_{oy2}\, t_2 - \frac{g t_2^2}{2} \qquad t_2 = t_1 - 1 = 3 - 1 = 2$$

$$0 = 144 + v_{oy2}(2) - \frac{32(2)^2}{2}$$

$$0 = 144 + 2v_{oy2} - 64$$

$$v_{oy2} = \frac{-144 + 64}{2} = -40 \text{ FT/S} \quad \downarrow$$