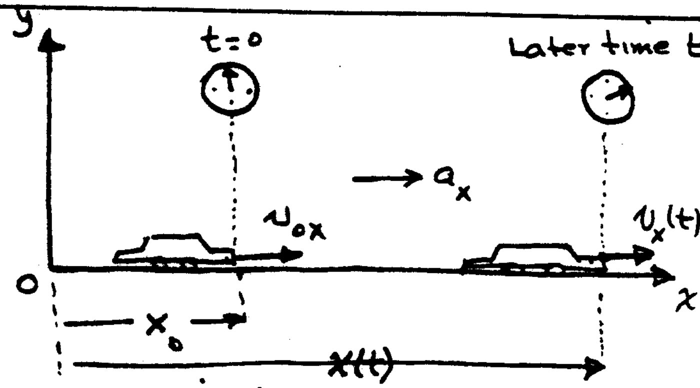
## (Eqs of motion along the x-axis with constant acc, $a_x$)

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




$x_0$ = initial displacement at t=0; At the origin, $x_0 = 0$

$v_{0x}$ = initial velocity at t=0. Starting from rest ⇒ $v_{0x} = 0$

$x(t)$ = displacement of the car at any later time

$a_x$ = acc of the car, uniform and constant. Example. 2 m/sec²

$v_x(t)$ = velocity of the car at any later time.

## Eqs of motion along the y-axis with Const acc, $g = \begin{cases} 9.8 \text{ m/sec}^2 \\ 980 \text{ cm/sec}^2 \\ 32 \text{ ft/sec}^2 \end{cases}$ FREE FALL

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

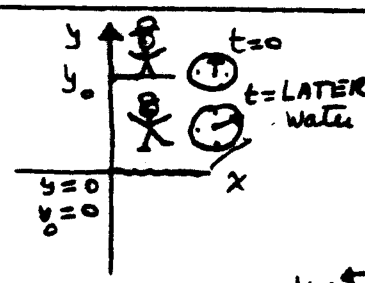



Fig A

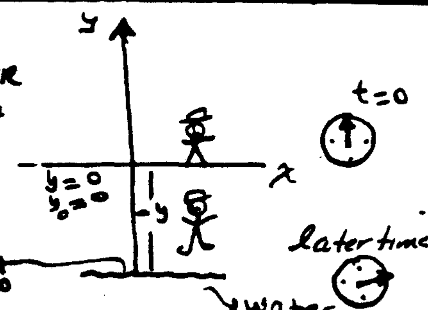



Fig B

$g$ = Acc due to gravity

$y_0$ = initial displacement at t=0; At the origin, $y_0 = 0$ (See Fig A)

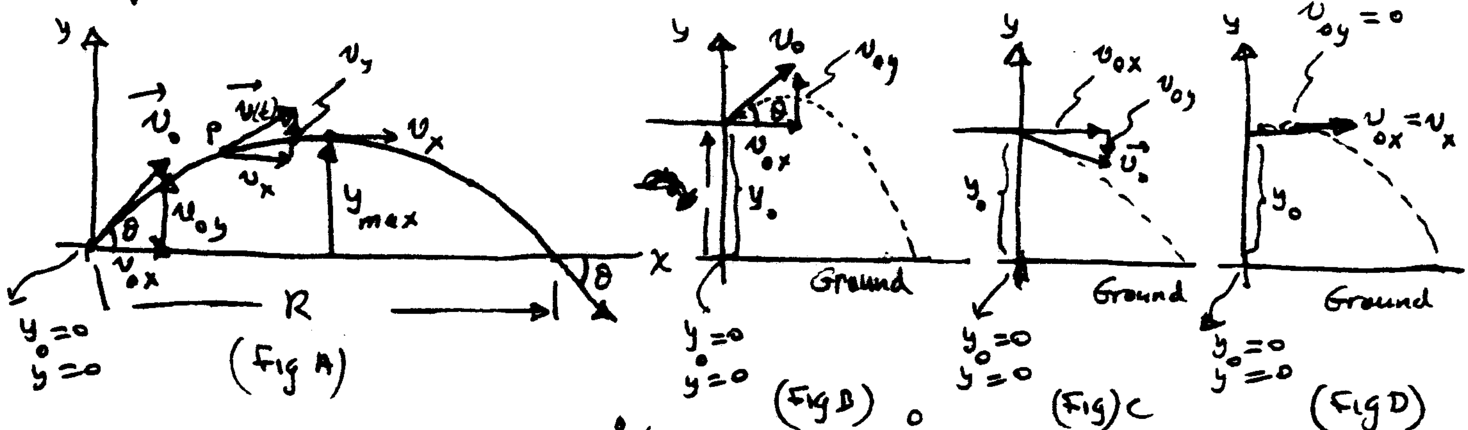
$y_0$ = initial displacement at t=0; At the origin, $y_0 = 0$ (see Fig B)

$y(t)$ = displacement at later time. When he hits water at later time t, $y(t) = 0$. (see Fig A)

$y(t)$ = displacement at later time. When he hits water at later time t, $y(t)$ is negative. (See Fig B)

$v_y(t)$ = vertical velocity at any later time.

Eqs of motion in two dim ; **projectile motion**. (Combination of $x$ and $y$ motions)




position at any later time $t$ $\left\{ \begin{array}{l} x(t) = \cancel{x_0} + v_{ox} t + \cancel{\frac{1}{2} a_x t^2} \\ y(t) = y_0 + v_{oy} t - \frac{1}{2} g t^2 \end{array} \right\}$ → $a_x = 0$ because projectile is only under the influence of acc of gravity

Comp of velocity at any later time $\left\{ \begin{array}{l} v_x = v_{ox} \\ v_y(t) = v_{oy} - g t \end{array} \right\}$

Speed $= |\vec{v}| = \sqrt{v_x^2 + v_y^2}$ at any time

initial speed at $t = 0$ $= |\vec{v}_0| = \sqrt{v_{ox}^2 - v_{oy}^2}$

height as a function of $x$ ] → $y(x) = \frac{v_{oy}}{v_{ox}} x - \frac{1}{2} \frac{g}{v_{ox}^2} x^2 + y_0$

time to reach max height ] → $t = v_{oy}/g$ (Fig A)

max height ] → $y_{max} = \frac{v_{oy}^2}{2g}$ (Fig A)

Range $= R = x = \frac{2 v_{ox} v_{oy}}{g}$

Important parameters in projectile motion

1. angle of projection. See (Fig A, B, C, d)
2. initial velocity or muzzel velocity $\vec{v}_0$

Utility Eqs

$$v_{ox} = v_0 \cos\theta$$
$$v_{oy} = v_0 \sin\theta$$