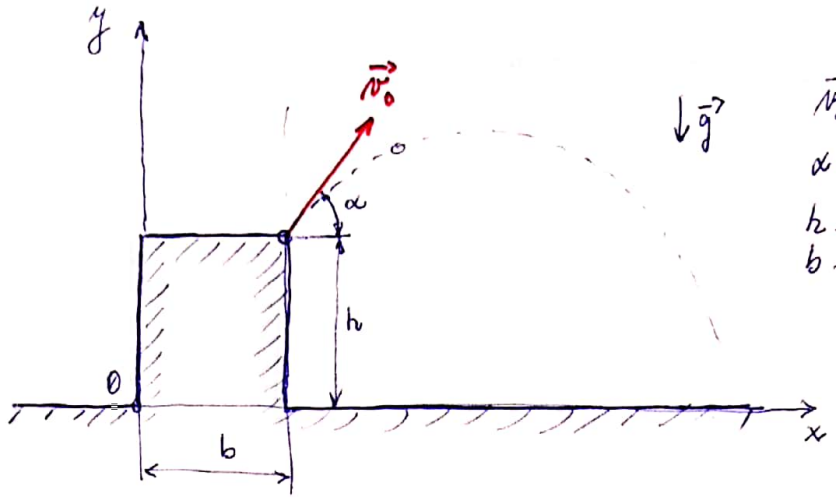
PROJECTILE MOTION



Free body diagram

Given: m... mass of part.
$\vec{v}_0$... initial velocity
α... angle of elevation
h... step's height
b... step's thickness

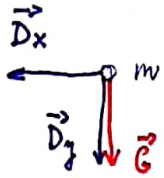
Task: acceleration, velocity and displacement of a particle in time

force specification

$\vec{D} = -m\vec{a}$

$\vec{D}(D_x, D_y)$; $D_x = ma_x$; $D_y = ma_y$

$G = mg$



Generally:

$$\sum_{(i)} \vec{F}_i + \vec{D} = \vec{\emptyset}$$

$$\vec{G} + \vec{D} = \vec{\emptyset}$$

Component equations:

(1) x: $D_x = \emptyset$

(2) y: $D_y + G = \emptyset$

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(1) $ma_x = \emptyset$

(2) $ma_y + mg = \emptyset$

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(1) $a_x = \emptyset$

(2) $a_y = -g$

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2) Velocity of particle

x-direction:

$$a_x = \frac{dv_x}{dt}$$

$$\frac{dv_x}{dt} = \emptyset \quad / \cdot dt$$

$$\int_{v_0 \cdot \cos\alpha}^{v_x(t)} dv_x = \emptyset \cdot \int_{\emptyset}^{t} dt$$

$$v_x(t) - v_0 \cdot \cos\alpha = \emptyset$$

$$v_x(t) = v_0 \cdot \cos\alpha = \text{const.}$$

y-direction:

$$a_y = \frac{dv_y}{dt}$$

$$\frac{dv_y}{dt} = -g \quad / dt$$

$$\int_{v_0 \cdot \sin\alpha}^{v_y(t)} dv_y = -g \int_0^t dt$$

$$v_y(t) = v_0 \cdot \sin\alpha - gt$$

3) Displacement in time

x - direction

$$v_x = \frac{dx}{dt}$$

$$\frac{dx}{dt} = v_0 \cos\alpha \quad / dt$$

$$\int_b^{x(t)} dx = v_0 \cos\alpha \int_0^t dt$$

$$x(t) - b = v_0 \cos\alpha \, dt$$

$$x(t) = b + v_0 \cos\alpha \cdot t \qquad (*)$$

y - direction

$$v_y = \frac{dy}{dt}$$

$$\frac{dy}{dt} = v_0 \sin\alpha - gt \quad / dt$$

$$\int_h^{y(t)} dy = \int_0^t (v_0 \sin\alpha - gt)\, dt$$

$$y(t) = h + v_0 \sin\alpha \cdot t - \frac{1}{2} g t^2 \qquad (**)$$

trajectory: $(*, **) \Rightarrow y(x)$