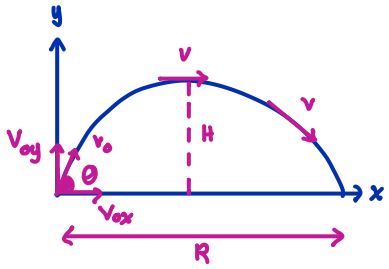
fundamental equations

$S = \bar{v}t$

$V = V_0 - gt$

$V^2 = V_0 - 2gs$

$S = V_0 t - \frac{1}{2}gt^2$



θ = Angle of departure
H = Maximum height
R = Horizontal range
V_0 = initial velocity
V_{ox} = initial velocity (x component)
V_{oy} = initial velocity (y component)

① Horizontal distance,

$S = \bar{v}t$

$S_x = V_{ox}t$

$S_x = V_0 \cos\theta \cdot t$ @ $S_x = V_{ox}t$

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② Horizontal velocity,

$V = V_0 - gt$

$V_x = V_{ox} - \cancel{gt}$ * gravity doesn't influence horizontal motion

$V_x = V_0 \cos\theta$ @ $V_x = V_{ox}$

∴ final velocity (x component) = initial velocity (x component),
Hence, velocity (x component) is constant

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③ vertical distance,

$S = V_0 t - \frac{1}{2}gt^2$

$S_y = V_{oy}t - \frac{1}{2}gt^2$

$S_y = V_0 \sin\theta\, t - \frac{1}{2}gt^2$ @ $S_y = V_{oy}t - \frac{1}{2}gt^2$

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④ vertical velocity

$V = V_0 - gt$

$V_y = V_{oy} - gt$

$V_y = V_0 \sin\theta - gt$ @ $V_y = V_{oy} - gt$

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⑤ time of flight,

$V = V_0 - gt$

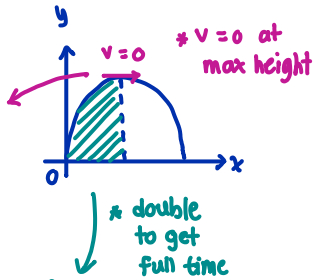
$V_y = V_{oy} - gt$

$0 = V_{oy} - gt$

$gt = V_{oy}$

$t = \frac{V_{oy}}{g}$

$t = \frac{V_0 \sin\theta}{g} \times 2$



$t = \frac{2V_0 \sin\theta}{g}$ @ $t = \frac{2V_{oy}}{g}$

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⑥ maximum height,

$V^2 = V_0^2 - 2gs$

$V_y^2 = V_{oy}^2 - 2gs$

$0 = V_{oy}^2 - 2gH$

$2gH = V_{oy}^2$

$H = \frac{V_{oy}^2}{2g}$

$H = \frac{V_0^2 \sin^2\theta}{2g}$ @ $H = \frac{V_{oy}^2}{2g}$

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⑦ Horizontal Range,

$S = \bar{v}t$

$S_x = V_{ox} \cdot t$

$R = V_{ox} \cdot \frac{2V_{oy}}{g}$ from ⑤

$R = V_0 \cos\theta \cdot \frac{2V_0 \sin\theta}{g}$

$R = \frac{V_0^2 \sin 2\theta}{g}$

$2\sin\theta \cdot \cos\theta = \sin 2\theta$