

Ballistics

Launch from a height and angle with coasting ascent and descent (no drag, no thrust)

Space-time	Time-space
Initial space angle = θ	Initial time angle = φ
Initial height distance = y_0	Initial height distime = b_0
Elapsed time interval = t	Elapsed stance interval = s
Distance downrange or horizontal location = x	Distime downrange or horizontal chronation = a
Altitude distance or vertical location = y	Altitude distime or vertical chronation = b
Gravitational acceleration = g	Levitational retardation = h
Initial velocity = v_0	Initial lenticity = w_0
Initial horizontal velocity = $v_{0x} = v_0 \cos \theta$	Initial horizontal lenticity = $w_{0a} = w_0 \cos \varphi$
Initial vertical velocity = $v_{0y} = v_0 \sin \theta$	Initial vertical lenticity = $w_{0b} = w_0 \sin \varphi$
Horizontal velocity = $v_x = v_{0x}$	Horizontal lenticity = $w_a = w_{0a}$
Vertical velocity = $v_y = v_{0y} - gt$	Vertical lenticity = $w_b = w_{0b} - hs$
Velocity at apex point: $v_y = 0$	Lenticity at apex instant: $w_b = 0$
Horizontal location $x = v_{0x} t$	Horizontal chronation $a = w_{0a} s$
Vertical location $y = v_{0y}t - \frac{1}{2} gt^2$	Vertical chronation $b = w_{0b}s - \frac{1}{2} hs^2$
Vertical location at impact point: $y = 0$	Vertical chronation at impact instant: $b = 0$
Time of flight to apex $t_{\text{apex}} = v_{0y}/g$	Stance of flight to apex $s_{\text{apex}} = w_{0b}/h$
Total time of flight $t_{\text{total}} = 2t_{\text{apex}} = 2v_{0y}/g$	Total stance of flight $s_{\text{total}} = 2s_{\text{apex}} = 2w_{0b}/h$
Distance range to apex $x_{\text{apex}} = v_{0x} v_{0y}/g$	Distime range to apex $a_{\text{apex}} = w_{0a} w_{0b}/h$
Total distance range $x_{\text{total}} = 2v_{0x} v_{0y}/g$	Total duration range $a_{\text{total}} = 2w_{0a} w_{0b}/h$
Max altitude distance $y_{\text{apex}} = \frac{1}{2} v_{0y}^2/g$	Max altitude duration $b_{\text{apex}} = \frac{1}{2} w_{0b}^2/h$
Trajectory formula: $y = y_0 + x \tan \theta - \frac{1}{2} gx^2/v_{0x}^2$	Trajectory formula: $b = b_0 + a \tan \varphi - \frac{1}{2} ha^2/w_{0a}^2$

Note trigonometry identity for range: $2 \sin \theta \cos \theta = \sin 2\theta$.