

Projectile Motion Equations Worksheet

Level: A-Level / AP Physics 1 / IB | Difficulty: Advanced | Topic: Mechanics

Practice projectile motion with 10 problems covering horizontal launches, angled trajectories, time of flight, maximum height, and range. Resolving into x and y components is the key skill.

Equations you will need

$x = (u \cos \theta) t$	Horizontal displacement
$y = (u \sin \theta) t - \frac{1}{2}gt^2$	Vertical displacement
$v_x = u \cos \theta$	Horizontal velocity (constant)
$v_y = u \sin \theta - gt$	Vertical velocity at time t
$R = \frac{u^2 \sin(2\theta)}{g}$	Range on level ground
$t_{\text{flight}} = \frac{2u \sin \theta}{g}$	Total time of flight
$H = \frac{u^2 \sin^2 \theta}{2g}$	Maximum height

Symbol key

Symbol	Quantity	Unit
u	launch speed	m/s
theta	launch angle	degrees
g	gravitational acceleration	9.8 m/s ²
R	horizontal range	m
H	maximum height	m
t	time	s

Practice problems

1. A ball is launched horizontally at 20 m/s from a 45 m high cliff. Find time to hit ground. ($g = 9.8 \text{ m/s}^2$)
2. Same ball: how far from the base does it land?
3. A projectile is launched at 30 m/s at 60deg above horizontal. Find the time of flight.
4. Same projectile: find the maximum height.
5. Same projectile: find the horizontal range.

6. A ball kicked at 25 m/s at 40deg above horizontal. Find horizontal range.
7. A stone thrown horizontally at 15 m/s lands 30 m away. Find the launch height.
8. A projectile launched at 20 m/s at angle theta has range 35 m. Find theta.
9. Find the vertical velocity of a ball 2 s after launch at 40 m/s at 30deg.
10. A projectile launched at 50 m/s at 45deg. Find the speed when it lands at the same height.

Answer key

Full worked solutions for each problem.

1. $45 = \frac{1}{2}(9.8)t^2 \rightarrow t = 3.03 \text{ s}$
2. $x = 20 \times 3.03 = 60.6 \text{ m}$
3. $t = 2(30)\sin 60^\circ / 9.8 = 5.30 \text{ s}$
4. $H = (30^2 \times \sin^2 60^\circ) / (2 \times 9.8) = 34.4 \text{ m}$
5. $R = (30^2 \times \sin 120^\circ) / 9.8 = 79.5 \text{ m}$
6. $R = (25^2 \times \sin 80^\circ) / 9.8 = 62.8 \text{ m}$
7. $t = 30/15 = 2 \text{ s}$; $h = \frac{1}{2}(9.8)(4) = 19.6 \text{ m}$
8. $\sin(2\theta) = (35)(9.8)/400 = 0.8575 \rightarrow 2\theta = 59.0^\circ \rightarrow \theta = 29.5^\circ$
9. $v_y = 40 \sin 30^\circ - 9.8(2) = 20 - 19.6 = 0.4 \text{ m/s}$
10. By symmetry, lands at 50 m/s (energy conserved)