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 - 1/2gt^2	Vertical displacement
vx = u cos theta	Horizontal velocity (constant)
vy = u sin theta - gt	Vertical velocity at time t
R = u^2 sin(2theta) / g	Range on level ground
t_flight = 2u sin theta / g	Total time of flight
H = u^2 sin^2theta / (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 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 = 1/2(9.8)t^2 -> t = 3.03 s
2. x = 20 x 3.03 = 60.6 m
3. t = 2(30)sin60deg / 9.8 = 5.30 s
4. H = (30^2 x sin^260deg)/(2x9.8) = 34.4 m
5. R = (30^2 x sin120deg)/9.8 = 79.5 m
6. R = (25^2 x sin80deg)/9.8 = 62.8 m
7. t = 30/15 = 2 s; h = 1/2(9.8)(4) = 19.6 m
8. sin(2theta) = (35)(9.8)/400 = 0.8575 -> 2theta ? 59.0deg -> theta ? 29.5deg
9. vy = 40 sin30deg - 9.8(2) = 20 - 19.6 = 0.4 m/s
10. By symmetry, lands at 50 m/s (energy conserved)