

Independent horizontal and vertical motion of projectiles

Physics grades 11-12 (A Level · IB · Class 11-12) · Worksheet

Name: _____ Date: _____ Class: _____

These problems train you to split a projectile's motion into independent horizontal and vertical parts, find the time of flight, and combine the results into range, height and impact velocity. Qualitative questions ask you to explain the effect of air resistance. They are written for A Level, IB Physics and CBSE Class 11-12 students. Work from level 1 to level 3, write the x and y columns separately and use $g = 9.81 \text{ m/s}^2$.

Level: Physics grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** A Level 3.4

Problem 1 True or false (easy)

Decide whether each statement about a projectile is true or false, ignoring air resistance.

1. The horizontal acceleration is zero.
2. The vertical velocity is zero at the top of the path.
3. The acceleration is zero at the top of the path.
4. A heavier ball of the same size lands sooner.

Problem 2 Launch components (easy)

A golfer in Texas hits a ball at 35 m/s at 25° above the horizontal.

1. Calculate the horizontal component of the initial velocity.
2. Calculate the vertical component of the initial velocity.

Problem 3 Stone from a bridge (easy)

Mei in Singapore drops a stone from a bridge 20 m high. Ignore air resistance.

1. Calculate the time of fall.
2. She now throws a second stone horizontally at 8.0 m/s from the same height. State its time of fall and explain.

Problem 4 Garden hose (easy)

Wanjiru in Nairobi holds a hose so that water leaves horizontally at 4.0 m/s from a height of 0.80 m.

1. Calculate the time for the water to reach the ground.
2. Calculate how far from the hose the water lands.

Problem 5 Strobe picture (easy)

The strobe picture shows a dropped ball and a ball projected horizontally at the same moment.



Strobe flashes at equal time intervals.

1. State what the picture shows about the vertical motion of the two balls.
2. State what it shows about the horizontal motion of the projected ball.

Problem 6 Vertical component and flight time (easy)

A cricket ball is thrown with an initial vertical velocity component of 14.7 m/s and lands at the same height.

1. Calculate the time of flight.
2. Calculate the maximum height above the release point.

Problem 7 A six in cricket (medium)

Chiamaka in Lagos hits a cricket ball at 28 m/s at 35° above the horizontal from ground level. The boundary rope is 70 m away.

1. Calculate the horizontal and vertical components of the initial velocity.
2. Calculate the time of flight.
3. Calculate the range and decide whether the ball clears the rope on the full.

Problem 8 Sprinkler jet (medium)

Aarav in Pune uses a sprinkler that sends water horizontally at 6.0 m/s from a height of 1.8 m .

1. Calculate the time of fall.
2. Calculate the horizontal range.
3. Calculate the speed and angle below the horizontal when the water reaches the ground.

Problem 9 Kick from a wall (medium)

Diego kicks a ball horizontally from the top of a 2.0 m high wall. It lands 6.0 m from the base of the wall.

1. Calculate the time of fall.
2. Calculate the speed with which the ball left his foot.

Problem 10 Complementary angles (medium)

Bilal in Lahore throws a ball at 25 m/s at 30° above the horizontal on level ground.

1. Calculate the range.
2. State another launch angle at the same speed that gives the same range.
3. Compare the times of flight for the two angles qualitatively.

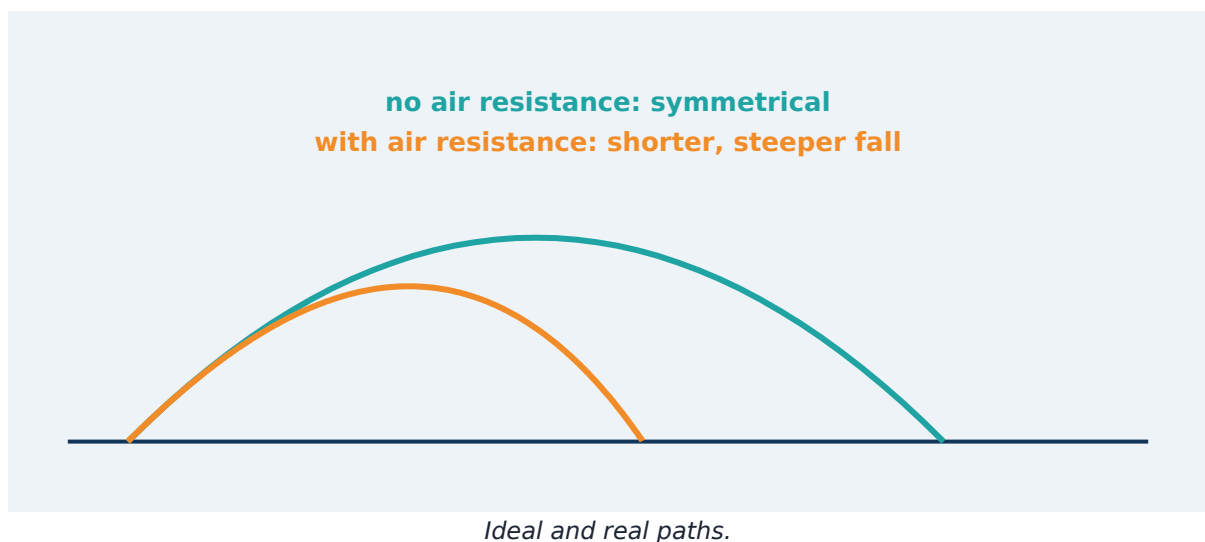
Problem 11 Maximum range (medium)

A golfer drives the ball at 38 m/s. Ignore air resistance.

1. Calculate the maximum possible range.
2. Calculate the range when she hits the ball at 30° instead.
3. Calculate the percentage reduction.

Problem 12 Effect of drag (medium)

A football is kicked on a windless day. Compare its real path with the ideal parabola.



1. State two ways in which the real path differs from the ideal one.
2. Explain why the descent is steeper than the climb.

Problem 13 Archery (medium)

Kofi in Accra fires an arrow horizontally at 60 m/s at a target 30 m away at the same height as the arrow.

1. Calculate the time for the arrow to reach the target.
2. Calculate how far the arrow drops.
3. State how he should adjust the aim.

Problem 14 Velocity after one second (medium)

A footballer kicks a ball at 22 m/s at 50° above the horizontal.

1. Calculate the horizontal and vertical velocity components after 1.0 s.
2. Calculate the speed after 1.0 s.
3. Calculate the direction of motion above the horizontal after 1.0 s.

Problem 15 Over the crossbar (medium)

Emma in Leeds kicks a ball at 18 m/s at 40° above the ground from a point 20 m from the goal line. The crossbar is 2.44 m high.

1. Calculate the time for the ball to reach the goal line.
2. Calculate the height of the ball at that moment.
3. State whether it passes over the crossbar.

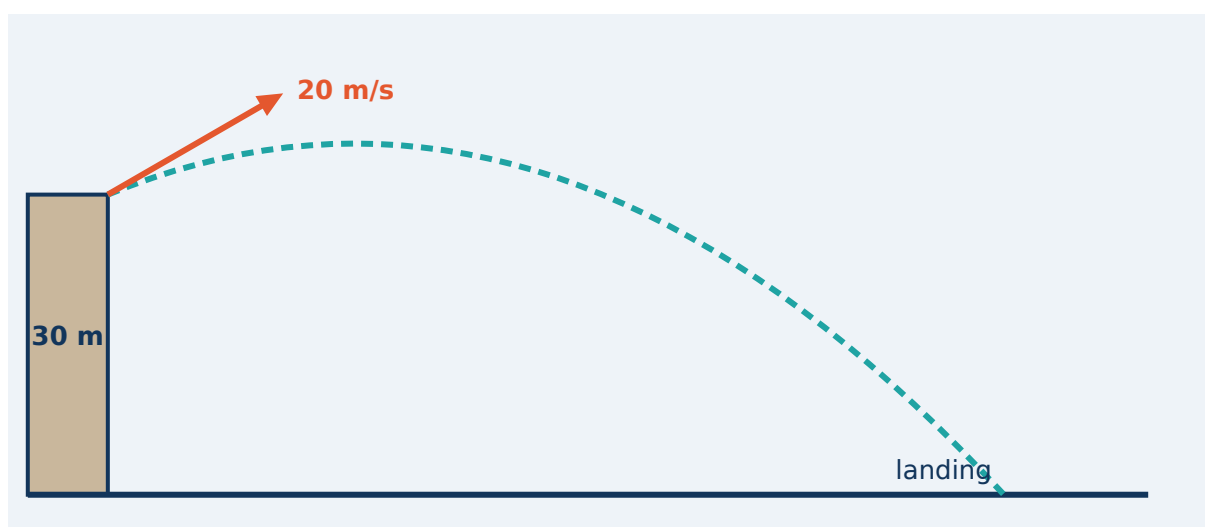
Problem 16 Ball against a wall (hard)

Aarav throws a ball from ground level at 15 m/s at 60° above the horizontal towards a wall 8.0 m away.

1. Calculate the time for the ball to reach the wall.
2. Calculate the height at which it hits the wall.
3. Decide whether the ball is rising or falling when it hits the wall.

Problem 17 Ball from a cliff (hard)

A ball is thrown from the top of a 30 m cliff at 20 m/s at 30° above the horizontal.



Launch from the top of the cliff.

1. Calculate the time to reach the ground.
2. Calculate the horizontal distance from the base of the cliff.
3. Calculate the speed at impact.
4. Calculate the angle of the velocity below the horizontal at impact.

Problem 18 Finding the launch angle (hard)

A ball thrown at 20 m/s lands 30 m away on level ground.

1. Calculate the possible launch angles.
2. Calculate the time of flight for each angle.

Problem 19 Motorbike jump (hard)

A stunt rider takes off from a ramp at 25° above the horizontal at 22 m/s. The landing ramp is at the same height as the take-off ramp, with a gap of 35 m.

1. Calculate the range of the jump.
2. State whether the rider clears the gap.
3. Calculate the minimum take-off speed at 25° to clear the gap.

Problem 20 Launch from height and range (hard)

A ball on level ground has a range $R = 48$ m and a maximum height $H = 18$ m.

1. Show that $\tan \theta = 4H \div R$.
2. Calculate the launch angle.
3. Calculate the launch speed.