PROJECTILE MOTION PROBLEMS
Problems document

Brief answers to these problems are available in the Answers document.

Full solutions to the problems are available in the Solutions document, and in the YouTube videos.

You can find links to these resources at my website:
http://www.freelance-teacher.com/videos.html

Links to the documents are also in the video description boxes for the YouTube videos.

You can support these resources with a monthly pledge of $1 (or more) at my Patreon page: http://www.patreon.com/freelanceteacher

This video series is intended for students who find this material to be difficult, so in the videos I proceed slowly and repeat myself a lot. If you find the videos to move too slowly, you can simply try the problems in this Problems document, study the solutions in the Solutions document, and skip to any particular parts of the videos that cover aspects of the solutions that you find confusing.

Advice for those who find this material to be difficult:

You should complete the problems *in order*.

Take your time. As a beginner, your goal is to learn how to get the problems *right*—not, for the time being, how to get the problems right *fast*.

Don't "wing it". Try to use the same systematic process and notation in your solutions as I use in this Solutions document and in the video solutions. Model your scratchwork on the scratchwork illustrated in these Solutions and in the videos. Make your scratchwork as *neat* and *clean* as possible.

Don't work in pen. Use *a pencil with a good eraser*.

Always include a sketch in your solution. Make your sketch as neat as possible, and as *big* as space will allow. When possible, build the question and givens into your sketch. When possible, keep updating the sketch throughout your solution with new information that you figure out in the course of your solution.

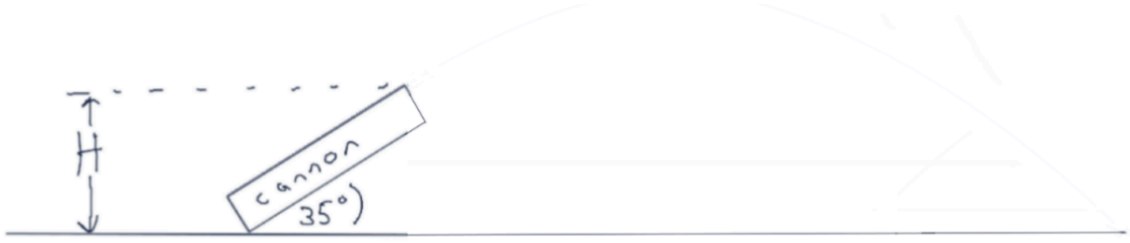
If you don't know how to solve a problem or get a problem wrong, then, after reviewing the solution, you should *retry* the problem, *before* moving on to the next problem in the series. Keep redoing each problem until you can get it right.

Try to avoid careless mistakes. *Double check* each line you write down in your solution *before* you write down the next line of your solution. Your goal is to learn how get *full credit* on each problem. Don't settle for partial credit—avoid careless mistakes!

Print out the Problems document. Read the problem carefully at least twice *before* beginning to work on the problem. *Reread* the problem periodically *while you are solving the problem* to check for details you may have missed or forgotten. Check the problem one more time *when writing your final answer* to be sure you answered the right question and answered all parts of the question.

Video (1)

A cannon shoots a ball with initial velocity 20.0 m/s at an angle of 35.0° upward from the horizontal. The ball lands at a horizontal distance of 41.0 m from the cannon. What is the height *H* of the top of the cannon barrel above the ground?



Video (2)

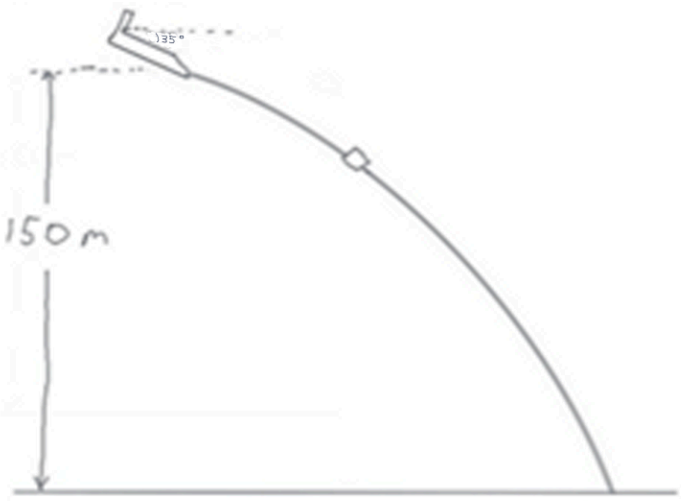
A volleyball player hits a ball from overhead and toward the floor. The ball is hit with an initial speed of v_0 = 17.0 m s^{-1} at a downward angle of θ = 15.0° below the horizontal. The ball strikes the ground at a horizontal distance of R = 5.80 m from the player.

(a) What was H, the height from which the ball was struck?

(b) What is $\boldsymbol{v}$, the vector velocity of the ball when it hits the ground? Use the unit vectors $\boldsymbol{i}$ and $\boldsymbol{j}$ to express your answer.

Video (3)

An airplane releases a package while diving at a downward angle of 35.0° below the horizontal. The plane is travelling at a height of 150 m, with speed 90.0 m/s, when when the package is released. How far away horizontally from the release point will the package land on the ground?



Video (4)

A stunt motorcyclist leaves a takeoff ramp at a speed of 21.0 m/s. The ramp is inclined at 54.0° to the horizontal. The top of the ramp is 14.0 m higher than the ground.

(a) After jumping from the ramp, what horizontal distance does the motorcyclist travel before hitting the ground?

(b) What is the smallest value of the motorcyclist's speed as he flies through the air?

Video (5)

A football is kicked from ground level at a 20° angle from the horizontal, with initial speed 25 m/s.

(a) How long does it take the ball to reach its highest point?
(b) How far horizontally does the ball travel before it hits the ground?
(c) What is the speed of the ball right before it hits the ground?
(d) What is the smallest value of the ball's speed over its entire trajectory?

Video (6)

A golf ball is hit from the ground into the air. The ball reaches a maximum height of 25 m, and travels a horizontal distance of 215 m before it hits the ground.

(a) Calculate the initial speed and direction with which the ball was hit.
(b) How long was the ball in the air?
(c) What is the magnitude and direction of the ball's acceleration at the instant that it reaches its maximum height?

Video (7)

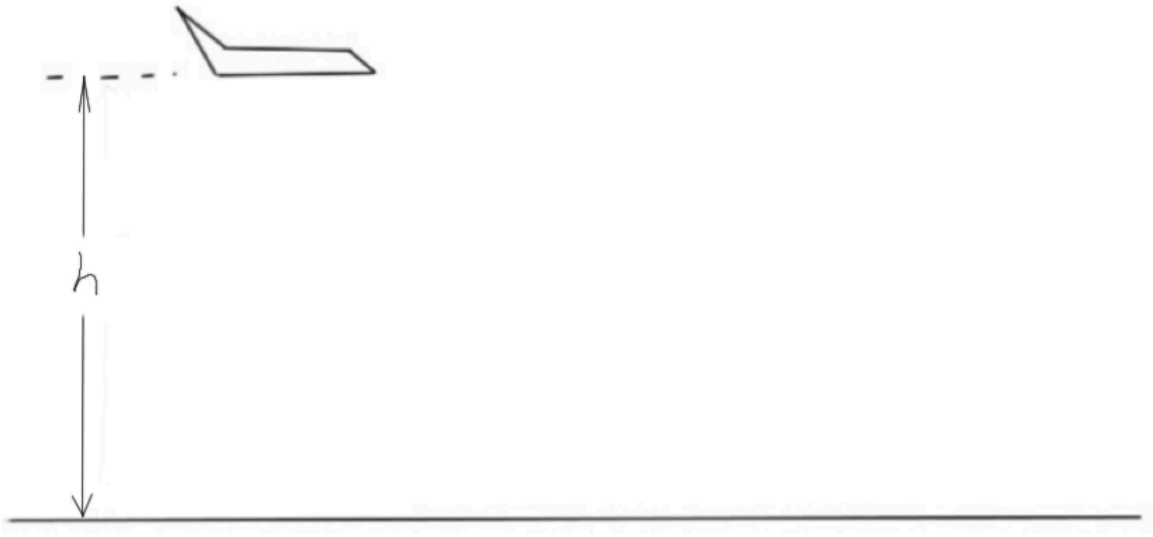
A stunt motorcyclist leaves a horizontal ramp at speed v_0. The ramp is at a height of h above the ground.

(a) What horizontal distance D from the ramp does the motorcycle travel before it hits the ground?

(b) What is the speed v_f of the motorcycle when it hits the ground?

Video (8)

A plane flies horizontally with constant speed *v*. The plane releases a package which covers a horizontal distance of *D* before hitting the ground. What is the height *h* above the ground at which the plane was flying when the package was released?



Video (9)

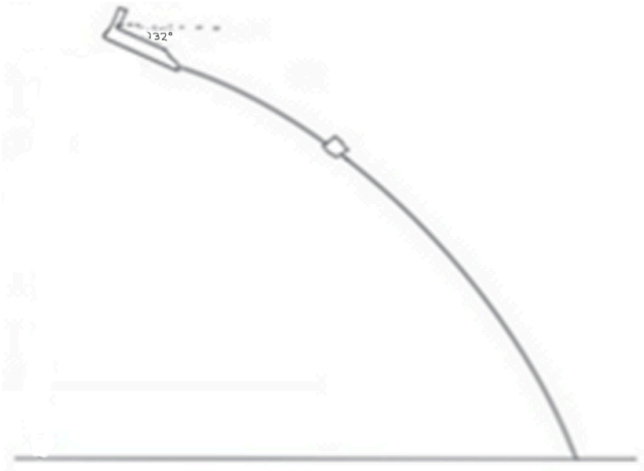
A golf ball is hit into the air. When it reaches a height of 34.0 m above the ground, the ball is moving at a speed of 23 m/s at an angle of 17° above the horizontal.

(a) How fast was the ball initially hit, and at what angle above the horizontal?
(b) After being hit, how much time does it take the ball to reach a height of 34.0 m above the ground?
(c) At that point, what is the horizontal distance of the ball from the point at which it was hit?

Video (10)

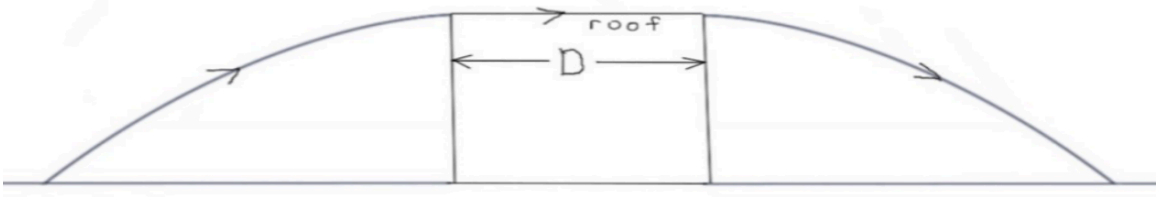
An airplane is diving at a constant speed at an angle of 32° below the horizontal when it releases a package. The height of the plane above the ground when it releases the package is 670 m. The package is in the air for 4.5 s before it hits the ground.

(a) Determine the speed of the plane.
(b) What horizontal distance does the package travel while it is falling?
(c) Determine the horizontal and vertical components of the package's velocity just before it hits the ground.



Video (11)

A rock is thrown, with initial speed v_0 and angle α, up onto a horizontal, ice-covered, frictionless roof of width D, so that it just reaches to the top of the roof. It then slides across the roof with constant speed, and falls off on the other side. How much time passes between the moment when the rock is thrown, and the moment when it lands on the opposite side?



Video (12)

A rock is thrown, at an angle θ, up onto a horizontal, ice-covered, frictionless roof of width 10 m and height 4 m, so that that the rock lands on the roof at the highest point of its trajectory. The rock takes 2.0 s to slide across the roof with constant speed, and then falls off on the other side.

(a) Find the initial speed and direction with which the rock was thrown.

(b) Find *D*, the total horizontal distance traveled by the rock.