STATE OF THE ARC

Guided tutorial companion

Arc smarter, not harder.

Horizontal release / student edition

Follow the 24-step guided prelab from the first instrument reading to a worked example, your own prediction, recorded evidence and the link to battle. No physics experience is assumed.

NAME _____ CLASS _____

DATE _____ INSTRUCTOR _____

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Open the matching lesson

Enter Academy, then select Start or resume the guided prelab. Use Back and Continue at your own pace. The paper link in each step opens its matching page.

Predict, then observe

Work left to right through the five G.U.E.S.S. boxes. Your first Solve answer is your prediction. Keep it visible when correcting; there is no extra prediction line above the table.

Print Letter paper in portrait at actual size. Worksheets have two questions per page. Save & skip preserves progress without creating completion. In Options, export your record; your written reasoning stays on this paper. Review companion for the current pilot; the broader Academy and battle manuals remain available.

STEPS 1-7 / READ THE SCENE

Read the scene before calculating

Academy example: payload release at (0,100) m; landing plane y = 0 m. Positive x points right; positive y points up. The calculation begins at the marked centre of the payload, not the edge of its artwork.

Quantity / screen color	Read it as	Example at release
Position / yellow	Where it is, measured in metres	$x_0 = 0$ m; $y_0 = 100$ m
Velocity / cyan	Change of position per second	$v_x = +16$ m/s; $v_{y0} = 0$ m/s
Acceleration / red	Change of velocity per second	$a_x = 0$; $a_y = -2.0$ m/s^2
Shared time / purple	Seconds since release	$t = 0$ s
Displacement / green	Final position minus initial position	$\Delta x = x - x_0$; $\Delta y = y - y_0$

Find a number, then name it

Use Show me where to highlight the relevant diagram, readout or equation. At step 4, choose the horizontal velocity readout. The symbol v_x and unit m/s matter as well as the color.

g is a strength; a_y has a direction

Academy gravity is $g = 2.0$ m/s^2. With up positive, $a_y = -g = -2.0$ m/s^2. Every second, vertical velocity becomes 2 m/s more negative. Zero starting vertical velocity does not remove gravity.

One flight, one clock

Horizontal and vertical motion happen together. A 3-second fall includes 3 seconds of horizontal travel. The carrier approach happens before this flight clock starts. No air resistance means v_x stays constant.

Step 7 / worked displacement snapshot

At t = 2 s, the illustrated payload is at (32,96) m. Its y coordinate is positive even though its vertical displacement is negative:

$\Delta x = 32 - 0 = +32$ m

$\Delta y = 96 - 100 = -4$ m

The subscript 0 means at the start; Δ means change in. This is an explicitly labeled illustration, not a flight you have already run. The Scene, Graphs and Data table tabs show different views of the same quantities.

STEPS 8-13 / FOLLOW THE EXAMPLE

Build the worked prediction

Collect signed givens. Find time from vertical motion first, then use that same time horizontally. These filled work boxes mirror the guided example; the example flight has not run yet.

1 / Find the flight time to the landing plane.

Givens	**U**nknowns	**E**quation	**S**ubstitute	**S**olve
$y_0 = 100$ m $y = 0$ m $\Delta y = -100$ m $v_{y0} = 0$ m/s $a_y = -2$ m/s^2	t in seconds	$\Delta y = v_{y0}t + \frac{1}{2}a_y t^2$	-100 m = (0 m/s)t + ½(-2 m/s^2)t^2 t^2 = 100 s^2	t = 10 s Use the positive root: after release.

The two negative signs cancel. In $\frac{1}{2}a_y t^2$, (m/s^2) × s^2 gives metres, so the units match Δy.

2 / Use the shared time to find horizontal displacement.

Givens	**U**nknowns	**E**quation	**S**ubstitute	**S**olve
$v_x = 16$ m/s $a_x = 0$ t = 10 s $x_0 = 0$ m	Δx in metres	$\Delta x = v_x t$ $x = x_0 + \Delta x$	Δx = (16 m/s)(10 s) x = 0 m + 160 m	Δx = 160 m x = 160 m They match because $x_0 = 0$.

From the boxes to the flight

The worked prediction is 10 s and 160 m. At step 14, choose Release payload. The example is already worked through, so it does not ask you to type those answers. The second drop will require your own entries.

Givens: what is known. Unknowns: what to find. Equation: the relationship before numbers. Substitute: signed values with units. Solve: answer, units and a reasonableness check.

STEPS 14-16 / TWO QUESTIONS

Observe and inspect the evidence

Release the worked example. Use Pause flight or +1 s to advance deliberately. After landing, use the recording slider, Previous/Next second, Data table or Play replay. Menus and interruptions pause the motion; choose Resume yourself.

3 / At t = 3 s, calculate x, y and v_y for the example. Then inspect that instant.

Givens	**U**nknowns	**E**quation	**S**ubstitute	**S**olve

Observed at 3 s: x _____ m y _____ m v_y _____ m/s

4 / Find signed areas under both velocity-time graphs from 0 to 10 s. What does each area mean?

Givens	**U**nknowns	**E**quation	**S**ubstitute	**S**olve

Use the horizontal rectangle at +16 m/s and the vertical triangle from 0 to -20 m/s. Observed landing: time _____ s; horizontal displacement _____ m.

Explain why horizontal velocity stays constant while vertical velocity changes:

STEPS 17-20 / TWO QUESTIONS

Your turn: a different release

New givens: x_0 = 40 m, y_0 = 64 m; landing y = 0 m. Use v_x = +16 m/s, v_{y0} = 0 m/s and a_y = -2.0 m/s^2. At step 18, check the sign of Δy before calculating.

Keep the full calculator value until your final answer. The distance field asks for displacement Δx, not the final coordinate x.

5 / Find the flight time from this release to the landing plane.

Givens	**U**nknowns	**E**quation	**S**ubstitute	**S**olve

6 / Use that time to find horizontal displacement. Show final x separately in Solve.

Givens	**U**nknowns	**E**quation	**S**ubstitute	**S**olve

Record before releasing

At step 19, enter your two Solve values into Predicted flight time and Predicted horizontal displacement. Select Record prediction. At step 20, select Release payload. Predictions do not steer the motion.

Touch entry: tap a box, use the game number pad, then Use. Cancel leaves the old value. Options can switch to a physical/native keyboard. Three hints are available; record any hint used next to your work. Do not erase your first Solve answer.

STEPS 21-22 / TWO QUESTIONS

Compare, correct and explain

Read the First prediction, Latest prediction and Observed landing table. If they differ, check height, sign, shared time, and displacement versus coordinate. Try another prediction keeps the first answer. This practice is evidence of learning, not a grade.

Observed trial: t _____ s Δx _____ m final x _____ m

7 / Find your first prediction minus the observation for time and Δx. Use observed Δx to check final x = 40 m + Δx.

Givens	**U**nknowns	**E**quation	**S**ubstitute	**S**olve

8 / Explain what happens to horizontal velocity during the fall. Use a_x and the velocity-time graph as evidence.

Givens	**U**nknowns	**E**quation	**S**ubstitute	**S**olve

In these boxes, Equation may be a physical relationship and Solve may be a sentence. A zero error does not replace an explanation. A negative vertical graph area describes downward displacement, not a negative distance traveled.

My correction or evidence-based explanation:

STEPS 23-24 / FIELD REFERENCE

Bring the method into battle

Read the new givens

Training values are not universal. In a match the carrier payload release height is 130 m, carrier v_x is +16 m/s to the right or -16 m/s to the left, and terrain may be cratered. Read the actual release/target geometry and permitted release window.

World	Moon	Academy	Mars	Earth
g (m/s^2)	1.6	2.0	3.7	9.8

For an ideal horizontal release to a flat target plane:

$$\Delta y = \text{target } y - \text{release } y = \tfrac{1}{2} a_y t^2$$

$$\text{release } x = \text{target } x - v_x t$$

Find positive future flight time with the signed vertical displacement. Then use signed v_x to locate the release coordinate. That coordinate is the command; the predicted time and displacement are evidence supporting it. Check the allowed window before entering the command.

For a cannon, begin at its muzzle

Use the firing cannon’s displayed launch coordinates, speed limit and angle convention. An angled shot begins with two velocity components. The next Academy lessons explain $v_x = v \cos \theta$ and $v_{y0} = v \sin \theta$ before predicting its landing.

Choose the next drill

Open battle school for private volleys, cannon movement, crater recovery, blocked shots, counterattacks and carrier operations. Any number of cannons can choose Move instead of Fire; winching happens automatically when needed. Re-read launch coordinates after movement or terrain changes.

Carrier schedule

Rounds 1/4/7 deploy; 2/5/8 release ordnance; 3/6/9 return to the home pad for service. At the cannon cap, a reinforcement is held and the schedule continues. Deployment bounce and powered braking after contact are separate from this ideal-flight lesson.

Finish and keep your record

At step 24, Finish & save practice records completion. Export learning record keeps a JSON copy of the first answer, later attempts and observations. Save & skip remains available without creating completion. Browser records and written reasoning are separate.

Continue with the existing Academy Field Manual and Battle School Companion from the Academy menu. This companion follows the currently implemented horizontal-release pilot. Later guided chapters and their matching pages will be added as the course expands.